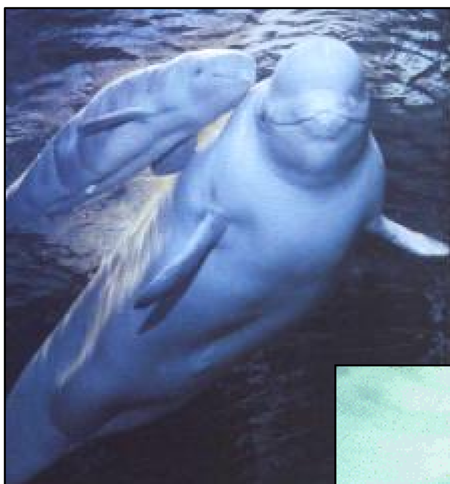
Effects of Oil and Gas Activities in the Arctic Ocean

Final Environmental Impact Statement

Volume 2: Chapters 4-8


October 2016

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Office of Protected Resources

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Prepared by:
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4.0 ENVIRONMENTAL CONSEQUENCES

This chapter provides the scientific and analytic basis for evaluation of the potential effects or impacts of each of the alternatives described in Chapter 2 on the physical, biological, and social environments. To complete the analysis of effects entails two steps. The first step is to examine the direct and indirect effects to a particular resource resulting from the implementation of a particular alternative. The second step focuses on cumulative effects, considering the contribution of the proposed alternatives to the effects of the past, present, and reasonably foreseeable future actions (RFFAs). These steps are described in more detail below.

This chapter also includes a separate discussion and analysis of potential environmental impacts resulting from an oil spill within the EIS project area. Oil spills are accidental or unlawful events that are evaluated according to three different size categories: small; large; and very large. A small oil spill is defined as less than 1,000 barrels (bbl). Small fuel spills could occur during G&G or exploration drilling activities. Additional information regarding small fuel spills from G&G or exploration drilling activities is discussed in Section 4.2.7 of the EIS. A large or very large oil spill (VLOS) is not considered part of the proposed action for any alternative because the occurrence of such a spill applies to all action alternatives and is a statistically low probability event. Regardless of probability, a very large oil spill could have major regional adverse impacts on a variety of physical, biological, and social resources and activities, depending on the effectiveness of spill response, containment, and clean-up activities. Potential environmental consequences of a VLOS are discussed for all resources in Section 4.10. However, if a large or very large spill were to occur, it could result in adverse impacts on the resources discussed below. For this reason, the potential impacts of a very large oil spill are discussed and analyzed separately in Section 4.10 of this EIS.

4.1 Analysis Methods and Impact Criteria

The following terms are used throughout this document to discuss effects:

Direct Effects – caused by the action and occur at the same time and place (40 CFR § 1508.8). "Place" in this sense refers to the spatial dimension of impacts and generally, would be analyzed on the basis of the project area. The spatial dimension of direct impacts may not be the same for all resources, and will be defined on a resource by resource basis;

Indirect Effects – defined as effects which are "*caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems*" (40 CFR 1508.8). Indirect effects are caused by the project, but do not occur at the same time or place as the direct effects;

Cumulative Impacts – additive or interactive effects that would result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7). Interactive impacts may be either countervailing – where the net cumulative impact is less than the sum of the individual impacts; or synergistic – where the net cumulative impact is greater than the sum of the individual impacts. Focusing this EIS on reasonably foreseeable cumulative impact issues, rather than on speculative impact relationships, is critical to the success of the analysis. Direct impacts are limited to the proposed action and alternatives only, while cumulative impacts pertain to the additive or interactive effects that would result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions. Sections 4.11.1 and 4.11.2 describe the steps involved in the cumulative impact assessment; and

Reasonably Foreseeable Future Actions – this term is used in concert with the CEQ definitions of indirect and cumulative impacts, but the term itself is not further defined. Most regulations that refer to "reasonably foreseeable" do not define the meaning of the words but do provide guidance on the term. For this analysis, RFFAs are those that are likely (or reasonably certain) to occur, and although they may be uncertain, they are not purely speculative. Typically, they are based on documents such as existing plans and permit applications.

Effects can include ecological, aesthetical, historical, cultural, economic, social, or health, whether indirect, direct, or cumulative. The terms "effects" and "impacts" are often used interchangeably in preparing these analyses. The CEQ regulations for implementing the procedural provisions of NEPA also state: "Effects and impacts as used in these regulations are synonymous" (40 CFR 1508.8).

4.1.1 EIS Project Area and Scope for Analysis

The overall spatial scope of the analysis is illustrated in Figure 1.1. It includes state and OCS waters adjacent to the North Slope of Alaska and transit areas of the Chukchi Sea north of the Bering Straits. The oceanographic area extends from Kotzebue on the west to the U.S.-Canada border on the east. The offshore boundary is the BOEM Beaufort Sea and Chukchi Sea Planning Areas, approximately 322 km (200 mi) offshore. Onshore locations include the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue, as well as the Prudhoe Bay area. When the overall spatial scope is not applicable to a given resource, a relevant geographic sub-area within this overall project area is defined in the analysis.

Evaluation of cumulative effects requires an analysis of the potential direct and indirect effects of the proposed alternatives, in combination with other past, present and RFFAs. Potential sources of past, present, and RFFAs may occur outside of the EIS project area, such as oil and gas activities in Canadian and Russian OCS waters. For each resource, the time frame for past/present effects is defined under the corresponding cumulative effects section. RFFAs considered in the cumulative effects analysis consist of projects, actions, or developments that can be projected, with a reasonable degree of confidence, to occur over the next five to ten years and are likely to affect the resources described.

4.1.2 Incomplete and Unavailable Information

The CEQ guidelines require that (40 CFR 1502.22):

When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking.

(a) If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.

(b) If the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known, the agency shall include within the environmental impact statement:

1) *A statement that such information is incomplete or unavailable;*
2) *A statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;*
3) *A summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment, and*
4) *The agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community. For the purposes of*

> *this section, "reasonably foreseeable" includes impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.*

NMFS and BOEM have relied upon the best available science to inform our consideration of the environmental impacts surrounding oil and gas exploration activities in the Beaufort Sea OCS, Chukchi Sea OCS, and in State of Alaska waters of the Beaufort Sea. However, the nature, abundance, and quality of the data often varies depending upon the action, the geographic region in which it occurs, and the environmental resources that may be affected, and all of these variables influence our understanding of how certain oil and gas exploration activities may affect environmental features. When confronted with missing information, this EIS complies with 40 CFR 1502.22 by employing the methodology outlined in Figure 4.1.

4.1.3 Methods for Determining Level of Impact

4.1.3.1 Direct and Indirect Effects

Direct effects would be caused by the alternative action and would occur at the same time and place as the alternative action. Indirect effects would also be associated with the alternative but would occur later in time or at a more distant location from the action. Direct and indirect effects could be associated with seismic activities or exploratory drilling activities identified in the alternatives.

NEPA requires federal agencies to prepare an EIS for any major federal action that significantly affects the quality of the human environment. The CEQ regulations implementing NEPA state that an EIS should discuss the significance, or level of impact, of the direct and indirect impacts of the proposed alternatives (40 CFR 1502.16). Significance is determined by considering the context in which the action will occur and the intensity of the action (40 CFR 1508.27). Actions may have both adverse and beneficial effects on a particular resource. The direct and indirect effects for each resource or resource use are based on the intensity (magnitude), duration, extent, and context of the impact. General definitions are provided below.

4.1.3.1.1 Intensity (Magnitude)

Low:	A change in a resource condition is perceptible, but it does not noticeably alter the resource's function in the ecosystem or cultural context.
Medium:	A change in a resource condition is measurable or observable, and an alteration to the resource's function in the ecosystem or cultural context is detectable.
High:	A change in a resource condition is measurable or observable, and an alteration to the resource's function in the ecosystem or cultural context is clearly and consistently observable.

4.1.3.1.2 Duration

Temporary:	Impacts would be intermittent, infrequent, and typically last less than a month.
Interim:	Impacts would be frequent or extend for longer time periods (an entire project season).
Long-term:	Impacts would cause a permanent change in the resource that would perpetuate even if the actions that caused the impacts were to cease.

4.1.3.1.3 Extent

Local: Impacts would be limited geographically; impacts would not extend to a broad region or a broad sector of the population.

Regional: Impacts would extend beyond a local area, potentially affecting resources or populations throughout the EIS project area.

State-wide: Impacts would potentially affect resources or populations beyond the region or EIS project area.

4.1.3.1.4 Context

Common: The affected resource is considered usual or ordinary in the locality or region; it is not depleted in the locality and is not protected by legislation. The portion of the resource affected does not fill a distinctive ecosystem role within the locality or the region.

Important: The affected resource is protected by legislation (other than the ESA). The portion of the resource affected fills a distinctive ecosystem role (such as an important subsistence resource) within the locality or the region.

Unique: The affected resource is listed as threatened or endangered (or proposed for listing) under the ESA or is depleted either within the locality or the region. The portion of the resource affected fills a distinctive ecosystem role within the locality or the region.

Resource-specific impact criteria tables were developed for certain resource categories. Within some of these tables, duration and context of impacts are defined differently to more precisely characterize the effects. For example, the impact criteria for Marine Mammals and Biological Resources define the impact levels differently based on the type of effects.

4.1.3.2 Impact Criteria and Summary Impact Levels

The impact criteria tables located at the start of each resource section provide a guideline for the analysts to place the effects of the alternatives in an appropriate context and to draw conclusions about the level of impact. The criteria used to assess the effects of the alternatives vary for the different types of resources analyzed, but each resource establishes criteria to determine the level of impact based on magnitude, duration, extent, and context of occurrence. The impact criteria tables use terms and thresholds that are quantified for some components and qualitative for other components. The terms used in the qualitative thresholds are relative, necessarily requiring the analyst to make a judgment about where a particular effect falls in the continuum from “negligible” to “major”. A determination of “no effect” is also possible. The following descriptions are intended to help the reader understand the distinctions made in the analyses.

Negligible[1]: Impacts are generally extremely low in intensity (often they cannot be measured or observed), are temporary, localized, and do not affect unique resources.

Minor: Impacts tend to be low in intensity, of short duration, and limited extent, although common resources may experience more intense, longer-term impacts.

[1] The term negligible in this EIS does not have the same meaning as in the MMPA. The term has different meanings under the two statutes and is being used in two different contexts.

Moderate: Impacts can be of any intensity or duration, although common resources may be affected by higher intensity, longer-term, or broader extent impacts while important and/or unique resources may be affected by medium or low intensity, shorter-duration, local or regional impacts.

Major: Impacts are generally medium or high intensity, long-term in duration, a regional or state-wide extent, and affect important or unique resources.

4.1.4 Resources Not Carried Forward for Analysis

Resources that were chosen for analysis in this EIS may be impacted by offshore oil and gas seismic exploration activities or the authorized take of marine mammals that could occur from seismic or drilling exploration activities. While the affected environment for geology is relevant to the proposed action, geological processes would not be altered by the project alternatives; this resource is not carried forward for analysis in Chapter 4.

4.2 Assumptions for Analysis

A programmatic EIS utilizes assumptions and development scenarios to analyze potential consequences of similar activities that can be expected to occur on a regular basis within a specific geographic area. By analyzing the potential environmental consequences using scenarios and assumptions that capture a reasonably foreseeable range of offshore oil and gas development activities, NEPA compliance for future specific activities can be tiered from this analysis of environmental consequences as needed. The following discussion provides potential assumptions and scenarios about how geophysical survey methods and exploratory drilling programs could be prepared in order to provide a more complete context for the analysis of effects in this EIS. These assumptions are based on recent federal and state lease planning and recent industry plans for both seismic surveys and exploratory drilling programs in the Beaufort and Chukchi seas. The purpose of developing these assumptions is to ensure a common basis for the analysis of potential environmental effects associated with these future activities.

An overriding assumption for this EIS is that activities associated with lease operations (exploratory drilling and site clearance high resolution seismic surveys) would only occur on or adjacent to active leases, along potential pipeline corridors, and on leases acquired in future lease sales (both federal and state). Exploratory drilling operations in the OCS will only occur on active lease(s) that have an EP approved by BOEM and approved APDs from BSEE. In addition, there were five pre-2003 leases in the Northstar and Liberty units which could be subject to additional seismic exploration. Seismic surveys not specifically associated with a lease (e.g., 2D and 3D surveys) would potentially occur over large areas within the EIS project area and could occur either on- or off-lease.

For federal leases, it is reasonable to analyze exploratory operations on active leases in both the Beaufort and Chukchi seas. As of June 30, 2016, active federal leases in the Beaufort Sea include 42 leases (199,255 acres); and one lease (5,693 acres) from the Sale 193 in the Chukchi Sea (Figures 1.2 and 1.3).

Active State of Alaska leases only occur in the Beaufort Sea from the coastline out to three nautical miles (Figures 1-2 and 1-3) except in the areas of Harrison Bay and Smith Bay, which are considered historical bays thus extending the area beyond three nautical miles from the coastline. Most of the State's active leases are concentrated between Harrison Bay and Bullen Point. There are currently no State of Alaska leases in the Chukchi Sea. As of February 2016, the State has 681,661 acres (62,163 onshore acreage and 619, 498 offshore acreage) on 255 leases in the Beaufort Sea (ADNR 2016). Exploratory activities (drilling and seismic surveys) could occur in any of these active state leases within the life of this EIS. The State of Alaska has plans to conduct area-wide lease sales in the Beaufort Sea annually through 2019 (ADNR 2015a), potentially adding new areas where exploratory activities could occur. Such sales could occur on state-owned tide and submerged lands located along the Beaufort Sea coast between the U.S./Canada border and Point Barrow. Industry activities on State of Alaska Beaufort Sea leases in the recent past have largely been concentrated offshore between Harrison Bay and Bullen Point. For this EIS, it is assumed that future activities would likely be concentrated here but could eventually expand beyond this area.

As mentioned in Chapter 2, in a given G&G permit application or exploration plan (EP), a company may describe a “program” that utilizes multiple seismic vessels or drilling units simultaneously within a given operating season. However, for the sake of analysis in this EIS (which necessitates a good sense of the spatial and temporal extent of the projected activities), one “program” indicates the use of only one source vessel (or two if the vessels are working in tandem such as with ocean-bottom cable or nodal seismic surveys) or one drilling unit (e.g., drillship, jackup rig, SDC) at a time. The definition of “program” employed in this EIS is used only to simplify the analysis of impacts; it does not change the way the BOEM issues G&G permits for seismic surveys or BSEE’s approval of applications for permits to drill for exploratory drilling, and it does not limit the number of drilling rigs a single company may employ at one time per sea under an approved EP.

Different combinations of seismic activity types could potentially occur under the different action alternatives within the overall limits for the three levels of activity outlined in Chapter 2. For the purposes of analysis only in this EIS, the different types and maximum numbers of seismic and exploration drilling activity that could occur under the action alternatives is analyzed as identified in Tables 4.2-1, 4.2-2, and 4.2-3 below. A conceptual example of temporal and spatial distributions that could occur for exploration activities is depicted for Alternative 2 (Figures 4.7 through 4.9), Alternative 3 (4.10 through 4.12), and Alternative 4 (4.15 through 4.17). These are only examples that are depicted in order to provide a conceptualization of the differences in levels of activity that could potentially occur under the different alternatives.

Table 4.2-1 Alternative 2, Activity Level 1

Beaufort Sea	Chukchi Sea
Two 2D/3D deep penetration towed-streamer seismic surveys	**Two** 2D/3D deep penetration towed-streamer seismic surveys
One in-ice towed-streamer 2D survey (using icebreaker)	**One** in-ice towed-streamer 2D survey (using icebreaker)
One ocean-bottom cable or node survey	**Three** site clearance and high resolution shallow hazards survey programs
Three site clearance and high resolution shallow hazards survey programs	**One** exploratory drilling program
One on-ice vibroseis seismic survey	
One exploratory drilling program	

Table 4.2-2 Alternative 3, Activity Level 2

Beaufort Sea	Chukchi Sea
Three 2D/3D deep penetration towed-streamer seismic surveys	**Four** 2D/3D deep penetration towed-streamer seismic surveys
One in-ice towed-streamer 2D survey (using icebreaker)	**One** in-ice towed-streamer 2D survey (using icebreaker)
Two ocean-bottom cable or node surveys	**Five** site clearance and high resolution shallow hazards survey programs
Five site clearance and high resolution shallow hazards survey programs	**Two** exploratory drilling programs
One on-ice vibroseis seismic survey	
Two exploratory drilling programs (**one** in federal waters, **one** in state waters)	

Table 4.2-3 Alternatives 4, 5, and 6, Activity Level 3

Beaufort Sea	Chukchi Sea
Three 2D/3D deep penetration towed-streamer seismic surveys	**Four** 2D/3D deep penetration towed-streamer seismic surveys
One in-ice towed-streamer 2D survey (using icebreaker)	**One** in-ice towed-streamer 2D survey (using icebreaker)
Two ocean-bottom cable or node surveys	**Five** site clearance and high resolution shallow hazards survey programs
Five site clearance and high resolution shallow hazards survey programs	**Four** exploratory drilling programs
One on-ice vibroseis seismic survey	
Four exploratory drilling programs (there is the potential for a combination up to 4 total in federal and state waters)	

4.2.1 2D and 3D Seismic Surveys

Marine 2D and 3D seismic surveys towing long streamers in OCS waters require essentially ice-free conditions to effectively maneuver the source arrays and receiver streamers, which usually begin in July or August and end in October or November depending on the onset and presence of winter ice. Marine in-ice 2D seismic surveys towing a single, long streamer and a source array can operate in up to ten tenths ice coverage by using special deployment gear to protect the equipment and following an ice breaker. In-ice surveys can be conducted in late-September into December. Marine seismic surveys could cover hundreds to a few thousand square miles depending on the survey objectives. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for 2D and 3D marine seismic surveys, including in-ice surveys, are as follows:

- One "survey" program would be the 2D or 3D exploration conducted by a single company (or multiple companies working together) in a specific year (July to November if a traditional open water survey or late-September to December if an in-ice survey with an icebreaker for support) in either the Beaufort or Chukchi Sea.
- It is assumed that there could be one 2D/3D seismic survey in state waters of the Beaufort Sea each season. There would be no 2D/3D seismic surveys occurring in state waters of the Chukchi Sea.
- One seismic survey vessel would be deployed, supported by up to two chase/monitoring vessels or an icebreaker for surveys occurring in-ice.
- Chase/monitoring vessels would provide crew change, resupply, and acoustic and marine mammal monitoring support, and assist in ice management operations if required. These vessels would not be introducing sounds into the water beyond those associated with standard vessel operations.
- The survey source vessel, chase/monitoring vessels, and icebreaker would be self-contained, with the crew living aboard the vessels. Crew changes and resupply for open-water activities would occur at least once during each survey, involving transit to onshore support areas.
- Surveys would operate 24 hours per day and data acquisition would occur over 90 days per survey, not including downtime, such as weather delays or shutdowns for mitigation.
- For surveys in the Beaufort Sea, support operations (including crew changes and resupply) would occur out of West Dock or Oliktok Dock near Prudhoe Bay or Barrow. Air support would occur out of Prudhoe Bay or Barrow.
- For surveys in the Chukchi Sea, support operations (including crew changes and air support) would occur primarily out of Nome or Wainwright, with the possibility that these activities could be conducted out of Barrow or Wainwright as well.
- Helicopters stationed at Barrow (for operations in either the Beaufort or Chukchi Sea) or Deadhorse (for operations in the Beaufort Sea) would provide emergency or search-and-rescue (SAR) support, as needed.
- On-ice vibroseis surveys and OBC or OBN surveys are also used to acquire 2D and 3D data. Vibroseis surveys occur in near shore areas (primarily on state leases) and federal acreage in shallow water on thickened sea ice capable of supporting the equipment during the winter months. OBC/OBN surveys are conducted during open water in near shore shallow water zones. This type of seismic survey is used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. For this EIS, these two survey methods are only analyzed for use in the Beaufort Sea.

4.2.2 Site Clearance and High Resolution Shallow Hazards Surveys

These surveys in OCS waters are conducted on active leases to evaluate for potential hazards at specific drilling locations prior to drilling or along potential pipeline routes. For analysis in this EIS, a site clearance and high resolution shallow hazards survey program may consist of several surveys conducted by a single company (or multiple companies working together) in a specific year (open water season of July to November) in either the Beaufort or Chukchi Sea. Such surveys would use the variety of methods and devices discussed in Section 2.3.2. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for site clearance and high resolution shallow hazards surveys are as follows:

- Mobilization of a survey program would occur by mid-July and end by November 30.
- Surveys would operate 24 hours per day, and total time for data acquisition for a single program could last 30-60 days, not including downtime.
- Survey vessels are self-contained with the crew living aboard the vessel. Refueling, resupply, and crew changes would occur one time during the season.
- For surveys in the Beaufort Sea, support operations would occur out of West Dock or Oliktok Dock near Prudhoe Bay or Barrow.
- For surveys in the Chukchi Sea, support operations would occur out of Wainwright, Nome, or Barrow.
- Helicopters stationed at Barrow (for operations in either the Beaufort or Chukchi Sea) or Deadhorse (for operations in the Beaufort Sea) would provide emergency or SAR support, as needed.
- Site clearance and shallow hazards survey programs in the OCS typically also include ice gouge and strudel scour surveys. The ice gouge and strudel scour surveys do not involve the use of airguns but do involve the use of smaller, higher-frequency sound sources, such as multi-beam echosounders, and sub-bottom profilers, and side scan sonar.

4.2.3 Exploratory Drilling in the Beaufort Sea

Exploratory drilling located in offshore portions of the Beaufort Sea (as compared to directional drilling from onshore or existing offshore facilities) could occur on any active lease with appropriate exploration approvals from BOEM and BSEE. There is also the potential for one or two exploratory drilling programs on state leases in the Beaufort Sea. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for exploratory drilling in the Beaufort Sea OCS are as follows:

- For each exploratory drilling program, a drillship, steel drilling caisson (SDC), or other Mobile Offshore Drilling Unit (MODU) with a fleet of support vessels (typically about 8-12 vessels) would be deployed that would be used for ice management (likely an icebreaker), anchor handling, oil spill response, capping and spill containment, refueling, resupply, and servicing the drilling operations.
- At the start of the program, the drillship, SDC, or other MODU and support vessels would transit the Bering Strait into the Chukchi Sea, and then transit further on to the Beaufort Sea drill site(s). Vessels could transit from maritime ports anywhere in the world.
- Timing of operations would commence in approximately early July and end by approximately early November. (In the future, with changing ice conditions, there is the potential that seasons could begin slightly earlier and end slightly later.)
- Drilling could occur on multiple drill sites per drilling program per year, allowing for up to four wells to be drilled per season per program depending upon weather and ice conditions. For purposes of analysis, assume up to three wells could be drilled in the season. If two programs were conducted simultaneously in the Beaufort Sea, this could result in up to six to eight wells drilled per season (with some on federal leases and others on State of Alaska leases). If up to four

programs were to occur simultaneously in one season, up to 12-16 wells could be drilled in Beaufort Sea State and federal waters per year.

- Resupply vessels would operate from both Dutch Harbor and West Dock at Prudhoe Bay. Ten resupply trips per drilling program are estimated.
- Helicopters would provide support for crew change, provision resupply, and SAR operations for each drilling program. Helicopters (assume two flights per day or 12 flights per week) used for crew change and resupply would be based in Deadhorse or Barrow and transit to/from the drill sites. Fixed winged aircraft operating daily out of Deadhorse or Barrow would support marine mammal monitoring and scientific investigations. SAR helicopters would operate as needed from Barrow.
- At the end of the drilling season, the drilling unit and associated support vessels would typically exit the area by traveling west into and through the Chukchi Sea and Bering Strait. As an alternative, the SDC, if used, could be towed to the Canadian Beaufort for the winter.

Assumptions for analysis within this EIS for exploratory drilling in state waters of the Beaufort Sea are as follows:

- Exploratory drilling would occur within State of Alaska waters which are within three miles of the coastline and barrier islands in the Beaufort Sea between Point Barrow and the Canadian border; most of the state leases are concentrated between Harrison Bay and Bullen Point.
- The use of artificial ice islands requires that drilling occur during the winter months (December to April).
- Resupply and crew change support would occur through the construction of ice roads to the artificial ice island, originating from the road system at or near the Prudhoe Bay oilfield. Helicopters could also be used that would operate out of the Deadhorse airport.

4.2.4 Exploratory Drilling in the Chukchi Sea

Exploratory drilling located in offshore portions of the Chukchi Sea could occur on any active lease, with the appropriate exploration approvals from BOEM and BSEE. As part of the assumptions for analysis in this EIS (similar to the Beaufort Sea), it is assumed that exploratory drilling in the Chukchi Sea would occur on federal leases for which exploration plans have recently been submitted or are intended to be submitted during the time frame of this EIS and where there have been recent requests to approve ancillary activities. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for exploratory drilling in the OCS portion of the Chukchi Sea are as follows:

- For each exploratory drilling program, a drillship or jackup rig (i.e., drilling unit) with approximately six to eight support vessels would be deployed. Support vessels would be used for ice management (likely an icebreaker), anchor handling, oil spill response, refueling, resupply, and servicing the drilling operations. Oil spill response vessels would be staged near the drillship or jackup rig. The icebreaker and anchor handler would be staged away from the drill site when not in use but would move closer to perform duties when needed.
- The drilling unit and support vessels would be deployed on or about July 1, traveling from the south through the Bering Sea, or from the east through the Beaufort Sea, arriving on location in the Chukchi Sea in early July.
- Timing of drilling operations would commence soon after arriving at the drill site in early July and ending by approximately mid-November. (In the future, with changing ice conditions, there is the potential that seasons could begin slightly earlier and end slightly later.)

- Drilling could occur on multiple drill sites per drilling program per year, depending upon weather and ice conditions, allowing for up to four wells to be drilled per season. For purposes of analysis, assume up to four wells could be drilled in the season. If two programs were conducted simultaneously in the Chukchi Sea, this could result in up to six to eight wells drilled per season. If up to four programs were to occur simultaneously in one season, up to 12-16 wells could be drilled in the Chukchi Sea per year.
- Marine resupply vessels would operate between the drill sites and Dutch Harbor or Wainwright. Ten resupply trips per drilling program are estimated.
- Aircraft operations, up to 12 flights per week, would transit from Wainwright or Barrow to each of the drilling sites. For emergencies, Search and Rescue (SAR) helicopters would operate out of Barrow.
- At the end of the drilling season, the drillship or jackup rig, and associated support vessels would transit south out of the Chukchi Sea through the Bering Strait.
- There are currently no leases available in state waters in the Chukchi Sea. Exploratory drilling in state waters of the Chukchi Sea is not analyzed in this EIS.

4.2.5 Conceptual Examples

Three conceptual examples have been provided to help illustrate potential temporal and spatial arrangements of exploration activities under the action alternatives and to assist with the analysis of potential environmental consequences. The three conceptual examples are within the levels of activity contemplated for Alternatives 2, 3, and 4, i.e., they do not exceed the level of each type of activity described in the scenarios presented in Tables 4.2-1, 4.2-2, 4.2-3 above, but they also do not represent the maximum level of activity allowed, but rather something slightly lower than the maximum level.

For Alternative 2, Figures 4.7 and 4.8 depict conceptual examples of the spatial distribution of different activity types in the Beaufort and Chukchi seas, respectively. In order to help reviewers better visualize the impacts that could potentially result from these activities, these maps include examples of: the distances from certain sources at which sounds attenuate to below NMFS MMPA harassment threshold levels, tracklines of seismic vessels, the locations of associated support vessels for drilling platforms, and areas of particular importance for marine mammals. To avoid making the maps hard to read, subsistence areas were not included, but reviewers may cross reference to Figures 3.3-8 through 3.3-17. An associated bar graph (Figure 4.9) was included to depict an example of the temporal distribution of the activities in Alternative 2 illustrated in Figures 4.7 and 4.8, which provides an example of the number and types of activities that might be occurring concurrently, and for how long.

For Alternative 3, the same conceptual examples described above for Alternative 2 were also included in Figures 4.10, 4.11, and 4.12. These figures illustrate how for Alternative 3 (as compared to Alternative 2), which adds both seismic surveys and drilling operations, the total area over which potential impacts from the activities may occur is larger, and the amount of time that multiple activities are co-occurring (and the number of activities that are co-occurring) either within or across the Beaufort and Chukchi seas is greater. For these reasons, these figures support the general suggestion that conducting the level of activity proposed for Alternative 3 would result in impacts to individuals within a marine mammal population, as well as impacts of a likely more intense nature (from the combined exposure to more activities in time and space), than conducting the level of activity proposed for Alternative 2.

For Alternative 4, the same conceptual examples described above for Alternatives 2 and 3 were also included in Figures 4.15, 4.16, and 4.17. These figures illustrate how for Alternative 4 (as compared to Alternatives 2 and 3), which includes additional drilling operations but the same number of seismic surveys as Alternative 3, the total area over which potential impacts from the activities may occur is likely somewhat larger, and the amount of time that multiple activities are co-occurring (and the number of activities that are co-occurring) either within or across the Beaufort and Chukchi seas is somewhat greater. For these reasons, these figures support the general suggestion that conducting the level of activity proposed for Alternative 4 could result in both impacts to more individual marine mammals, as well as impacts of a likely more intense nature (from the combined exposure to more activities in time and space), than conducting the level of activity proposed for Alternatives 2 and 3. However, the difference in the level of direct impacts between Alternative 4 and Alternative 3 is not expected to be as large as the difference between Alternative 3 and Alternative 2.

4.2.6 Estimating Take of Marine Mammals

4.2.6.1 Background

The MMPA prohibits the taking of marine mammals with certain exceptions, one of which is MMPA incidental take authorizations. Incidental take authorizations (ITA) allow for the take of small numbers of marine mammals if NMFS finds that the activity will have a negligible impact[2] on the affected marine mammal species and will not have an unmitigable adverse impact[3] on subsistence uses, and provided mitigation and monitoring requirements are set forth. Applicants for these authorizations are required by the MMPA implementing regulations to estimate (in advance) the number of individuals of each species that may be taken by their proposed activity [50 CFR 216.104 (a)(6)]. Take estimates are also necessary to inform the analyses that NMFS must conduct.

In order to help applicants with noise-producing activities understand when their activity might be expected to take a marine mammal (i.e., when an ITA would be needed) and to assist in the necessary quantification of likely takes, NMFS has established acoustic thresholds (discussed below). Acoustic thresholds identify received sound levels above which marine mammals would be expected to be taken (either by behavioral harassment or auditory injury), if exposed. In short, animals predicted to be exposed to levels at or above the acoustic threshold are predicted to be taken in the specified manner (i.e., by behavioral harassment or auditory injury).

The estimated number of animals that will be exposed at or above acoustic thresholds (and, therefore, predicted to be taken) is a valuable piece of both the “negligible impact” and “unmitigable adverse impact” analyses and directly informs whether the take numbers are “small,” however, it is only one piece of an effects analysis under the MMPA. The expected occurrence of a take or a particular *number* of estimated takes does not necessarily relate directly to the biological significance of the impacts, i.e., whether the takes will result in adverse impacts on the fitness or health of the individuals taken. The potential and likelihood of impacts on the health and fitness of individuals taken must be determined in consideration of the manner, context, duration, and intensity of those incidental takes.

For example, some takes (such as injuries or those with substantial negative energetic impacts) may have the potential to negatively affect reproductive success or survivorship, depending on the circumstances, while other takes may have no impact on the health or fitness of the affected individual. Typically, while many other factors come into consideration, exposures to higher levels of sound are generally expected to

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[2] Under the MMPA implementing regulations, a negligible impact is defined as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR § 216.103).

[3] An unmitigable adverse impact is defined as an impact resulting from the specified activity that is: 1) likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: causing marine mammals to abandon or avoid hunting areas; directly displacing subsistence users; or, placing physical barriers between the marine mammals and the subsistence users; AND 2) cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

result in more severe effects – and it is worth noting that, in the quantification of takes, due to the geometry of how sound spreads through water and NMFS historical "step" thresholds (where every exposure above a single level is estimated to be a take), the majority of the predicted number of takes would be expected to be on the lower end of levels associated with the effect the threshold illustrates, just above the threshold (i.e., less likely to be significant). If the analysis predicts that the activity is likely to adversely affect the reproductive success or survivorship of any individual marine mammals, then additional analysis must consider how the anticipated fitness effects to those individuals would likely affect the population (e.g., rates of recruitment and survival), in consideration of the species status. Additionally, the negligible impact analysis considers impacts on marine mammal habitat, such as impacts on prey species or the more difficult-to-quantify acoustic habitat impacts that can translate into chronic effects from longer-term exposure to increased sound levels.

Finally, the need to ensure "no unmitigable adverse impacts" to the availability of marine mammals for subsistence uses requires consideration of far more than just take numbers, both because activities can interfere with a hunt without ever affecting a marine mammal (e.g., by blocking access of hunters to marine mammals), and because it is possible for noise to affect marine mammals in a way that would make them more difficult to hunt without always rising to the level of a take (e.g., as traditional knowledge suggests, making them "skittish.")

4.2.6.2 Current Acoustic Thresholds

When assessing impacts to marine mammals from sound sources, NMFS has historically used the following acoustic thresholds for the types of sound sources analyzed in this EIS (meaning that take is predicted to occur, or assumed to have occurred, if animals are exposed at or above these levels). These thresholds have been applied to all marine mammal species under NMFS' jurisdiction.

- **Level A Harassment (potential injury) from all sound sources[4]: 180 and 190 dB re 1 µPa (rms) received level for cetaceans and pinnipeds, respectively**. These received levels represent the levels above which, in the view of a panel of bioacoustics specialists before TTS measurements for marine mammals became available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals (NMFS 1995, 2000).
- **Level B Harassment (behavioral harassment) from impulse sources (e.g., seismic airguns): 160 dB re 1 µPa (rms) received level for all species.** This sub-injurious threshold was based on measured avoidance responses observed in whales in the wild. Specifically, the 160 dB rms re: 1µPa threshold was derived from data for mother-calf pairs of migrating gray whales (Malme et al. 1983, 1984) and bowhead whales (Richardson et al. 1985; Richardson et al. 1986) responding when exposed to seismic airguns.
- **Level B Harassment (behavioral harassment) from continuous sources (e.g., drilling): 120 dB re 1 µPa (rms) received level for all species.** This threshold originates from research on baleen whales, specifically migrating gray whales (Malme et al.1984; predicted 50% probability of avoidance) and bowhead whales reacting when exposed to industrial (e.g., drilling and dredging) activities (non-impulsive sound source) (Richardson et al. 1990).

[4] Different Level A Harassment thresholds have been used by NMFS for other types of sound sources not analyzed in this EIS (e.g., explosives). Those thresholds are not listed here, as they are not relevant to the activity types analyzed in this document.

4.2.6.3 Revision of Acoustic Thresholds

Concurrently with the development of this EIS, NMFS undertook a rigorous process of revising and updating the thresholds for estimating onset of auditory injury (which NMFS considers the onset of Level A Harassment in the context of the MMPA) to incorporate newer science and utilize improved methods. In addition to ensuring that NMFS is using the appropriate acoustic thresholds in its decision-making processes, the development of these revised acoustic thresholds includes the creation of a single document/ reference that clearly articulates the thresholds, how they were scientifically derived, and how NMFS plans to apply them pursuant to the multiple NOAA authorities that address noise impacts (e.g., MMPA, ESA).

In the SDEIS, NMFS referenced and discussed the revision of these acoustic thresholds and how they could potentially affect our analyses, as well as our intent to include further discussion in the FEIS. At the time of publication of the SDEIS, NMFS believed that revisions to both auditory injury thresholds, as well as thresholds for acoustic behavioral harassment, would be complete by the time this EIS was finalized. However, because of the complexity involved in appropriately considering context, as well as multiple other technical and policy-related factors, NMFS does not anticipate the revisions to the acoustic thresholds for behavioral harassment will be completed for multiple years. Therefore, the analysis of behavioral effects in this FEIS maintains the current behavioral harassment thresholds (i.e., 160 dB for impulse sources like seismic and 120 dB for continuous sources like drilling), which NMFS determined represent the best available science and are used in combination with other qualitative factors that allow for robust assessment of the full effects of the analyzed actions. However, the revision of the auditory injury thresholds is final, and we consider those revised thresholds in this analysis.

The process for revising the auditory injury thresholds was separate from this NEPA process for Arctic Oil and Gas Exploration. The acoustic threshold revision process includes extensive internal (NOAA) review, multiple external peer reviews, and multiple public review periods. NMFS is aware of the time (sometimes multiple years) and resources that go into the preparation of environmental compliance documentation, and we acknowledge that there will be a transition period during which the new acoustic injury thresholds will be final and available, but many applicants will have already conducted extensive analyses using the historic thresholds. During this time, in some cases it will likely be necessary for NMFS to analyze the effects of activities for which we have take estimates based on historic thresholds, with an inclusion of qualitative consideration of the revised thresholds.

Government agencies must make decisions every day based on the best available science. NEPA requires agencies to conduct environmental impact analyses, some of which (as here) span multiple years during which science and policy related to the actions being considered are constantly evolving. As noted above, the process for revising the auditory injury thresholds included multiple peer reviews and public reviews. The last and final review of the revised auditory injury thresholds was a brief review by both the public and the peer reviewers focusing on a few specific technical changes in early 2016. The auditory injury thresholds considered in this EIS analysis are the new, revised final thresholds that were released by NOAA in July 2016 (see Appendix B). These guidelines include all of the input from the multiple peer-review and public input received throughout the process.

Below, we include a description of the final revised acoustic thresholds for auditory injury, along with a summary of the ways in which changes of the nature discussed might be expected to shape the analysis of effects contained elsewhere in the document (and informed by the current acoustic thresholds). Additionally, we include a brief discussion of NMFS' future plans to revise the behavioral harassment thresholds. As discussed in more detail above and below, acoustic thresholds are only one part of the analysis of marine mammal and subsistence impacts, and the analysis contained elsewhere in this document (informed by both the previous and revised final acoustic thresholds) creates a solid analytical foundation upon which considerations of acoustic threshold revisions can be layered for a fuller understanding of how the anticipated changes may inform future decision-making.

4.2.6.4 Auditory Injury Thresholds

As noted above, NMFS has finalized the process of revising its acoustic threshold levels for auditory injury (permanent threshold shift) via its 2016 Technical Guidance (NOAA 2016). Southall et al. (2007) identified dual criteria (using peak pressure sound pressure level [PK] and cumulative sound exposure level [SEL_{cum}]) for assessing PTS from multiple pulse sounds. Building upon those proposed levels, NMFS modified them using more recent data, which suggest: 1) that phocids should be separated from otariids when estimating TTS or PTS (because of their inner ear anatomy) and likely incur hearing impairment at lower received levels based on the data currently available (Kastak and Schusterman 1998; Hemilä et al. 2006; Mulsow et al. 2011), and; 2) that marine mammals are more likely to incur TTS and subsequent PTS within the frequency ranges of their best hearing sensitivity (Finneran and Schlundt 2010; Finneran and Jenkins 2012, Finneran 2015). An overview of the final revised auditory injury thresholds and weighting functions is included below. Tables including the final revised thresholds and figures depicting the associated marine mammal auditory weighting functions are included below and in Volume 3 of this FEIS. NMFS (2016), which was released to the public on March 16, 2016 for a last public comment and concurrent follow-up peer review, and describes the derivation of the revised thresholds in detail, is included here as Appendix B.

Table 4.2-4 Final revised auditory injury acoustic threshold levels

	PTS Onset Threshold Levels* (Received Level)	
Hearing Group	**Impulsive**	**Non-impulsive**
Low-Frequency (LF) Cetaceans	*Cell 1* $L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	*Cell 2* $L_{E,LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	*Cell 3* $L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	*Cell 4* $L_{E,MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	*Cell 5* $L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	*Cell 6* $L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7* $L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	*Cell 8* $L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	*Cell 9* $L_{pk,flat}$: 232 dB $L_{E,OW,24h}$: 203 dB	*Cell 10* $L_{E,OW,24h}$: 219 dB

* Dual metric acoustic threshold levels for impulsive sounds: Use whichever results in the largest effect distance (isopleth). If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa^{2}s. In this table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Guidance. Hence, the subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the functional hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in multitude of ways (i.e., varying exposure levels and durations, duty cycle). It is valuable for action proponents, if possible, to indicate under what conditions these acoustic threshold levels will be exceeded.

Source: NMFS 2016

When considering how the final revised acoustic thresholds for auditory injury outlined above might compare to the current 180/190-dB rms thresholds, it is important to note three important differences in what the two sets of thresholds (former and revised) represent. First, dual criteria are utilized, meaning that whichever is exceeded first is the one that should be used for assessing injury for impulsive sources (in almost all cases, the SEL_{cum} metric will be exceeded first). Second, the thresholds outlined above use the SEL_{cum} metric (which allows for the consideration of how the sound accumulates over time), not the SPL rms metric of the current thresholds (which does not directly take into account the duration of exposure). (Note that the revised PK metric also does not account for accumulation.) This means, for example, that one 100-ms pulse with a received SPL rms level of 161 dB would only have an SEL of 151 dB. However, multiple pulses must be taken into consideration, and, if a receiver were in a position to receive 10 of those same pulses within that same distance, the SEL_{cum} would accumulate up to 161 dB (e.g., SEL_{cum} equals SPL rms levels when the total duration of exposure to the same level is 1 second). Last, the SEL_{cum} thresholds outlined above take into account the frequency range of highest sensitivity for each functional hearing group and are intended to be used in conjunction with frequency weighting functions that are depicted above and outlined in more detail by NMFS (2016; see Appendix B). In short, applying frequency weighting functions considers sound produced by the source in conjunction with the functional hearing group-specific and frequency-specific filter and for any part of the signal that is not in the area of highest sensitivity for that functional hearing group, i.e., more energy is needed to reach the threshold (e.g., range to isopleth decreases).

Because our understanding of marine mammal hearing has advanced greatly, these final revised auditory injury thresholds are notably more complex to apply (primarily in how they consider taxa-specific auditory weighting functions and exposure duration) and have the potential to be challenging for applicants without the benefit of more sophisticated modeling capabilities. Therefore, NMFS has provided simplified methods (i.e., less sophisticated models) to incorporate weighting functions and exposure duration that ***may*** be used if applicants do not have access to models that cannot account for these factors. This simple method generates a “safe distance” (the distance from the source beyond which a threshold for that metric is not exceeded) and accounts for several factors, including source level, interpulse interval or duty cycle, and velocity of the source, and is independent of exposure duration. Appendix B describes this simplified method in more detail and outlines the simplifying assumptions. This method is considered conservative because of some of the inherent assumptions and is expected to result in a higher take estimate than if more sophisticated modeling (which can be carefully refined to the specific parameters of a given survey/environment) is used.

Appendix G of the FEIS depicts representative 120, 160, 180, and 190-dB isopleths (the latter two representing the distances within which cetaceans and pinnipeds, respectively, could potentially incur auditory injury in the form of PTS based on historic thresholds) from past seismic surveys. As noted previously, in the past, NMFS did not typically authorize Level A take because we assumed marine mammal avoidance of loud sounds and effective mitigation would likely result in avoidance of auditory injury. Using the final revised acoustic thresholds and the simple method referenced above, NMFS calculated the “safe distances” for seismic surveys and a simplified 24-hr accumulation for drilling, which (when the simple method is used) would likely be used in lieu of the historic 180 and 190-dB isopleths to calculate take. By comparing these simple method calculations with the historic 180 and 190-dB isopleths, we can get a sense of the differences between predicted injury using the historic auditory injury thresholds versus using the final revised acoustic thresholds.

Using the simple method (with final revised thresholds and weighting functions) and some basic generalizations (based on data) about larger array seismic surveys (source level of 235 dB RMS SPL, source velocity of 2.315 m/s, 0.01 duty cycle), we calculated the following safe distances for the SEL metric: 2,119 m for low frequency cetaceans, 2 m for mid-frequency cetaceans, 240 m for high frequency cetaceans, 350 m for phocids, and 7 m for otariids. The new acoustic guidance provide dual metrics (SEL and SPL peak) and instruct users to use the more conservative of the two (i.e., the one that would result in the larger isopleth or greater take estimates). In this example, using the SEL metric produces the larger isopleths for all but mid-frequency cetaceans, for which the SPL peak isopleth would be about 6 m, assuming that the SPL peak source level is about 10 dB above the SPL rms level and assuming a spreading coeeficient of 20logR. These safe distances are very much within the realm of the 180 and 190-dB isopleths that have been modeled or measured in past surveys (in fact, they are substantively smaller for mid and high frequency cetaceans and otariids), suggesting that the revisions in the auditory injury thresholds do not change our analysis of impacts notably, and further suggesting that traditionally applied 180 and 190-dB mitigation zones likely provide a similar degree of protection as previously assumed.

Using the simple method (with final revised thresholds and weighting functions) and some basic generalizations (based on data) about drilling activities (source level of 187 dB RMS SPL, activity duration of 24 hours, and transmission loss of 15 logR) the following safe distances were calculated: 309 m for low frequency cetaceans, 17 m for mid-frequency cetaceans, 271 m for high frequency cetaceans, 166 m for phocids, and 12 m for otariids. Measured 180 and 190-dB RMS SPL isopleths for drilling are typically much smaller (on the order of 10 m or less) and injury has not typically been anticipated or authorized. Prior assessments of the unlikelihood of injury would likely not change given the small area encompassed by the safe distance (and resulting small take estimates, if projected) and the expectation that many marine mammals will avoid sounds at these levels. The safe distances above assume that animals remain closer than that to the noise source for a full 24 hours to exceed the exposure threshold, which is quite unlikely. However, the potential for injury should not be entirely ruled out, especially in situations where there is reason to believe that marine mammals need to be in the immediate area for extended periods of time, and some small number may occasionally be authorized.

4.2.6.5 Behavioral Harassment Thresholds

As noted above, NMFS is planning to revise the acoustic thresholds for behavioral harassment for all activities. When the DEIS and SDEIS were published, we believed that this process would be complete in time to inform the FEIS, however, we have since realized that that the revision of the behavioral harassment thresholds will take at least an additional couple of years to complete, given some of the known technical and policy challenges associated with such a revision. Given this delay, and in consideration of both the evolving science and the upcoming process, which will include extensive expert and public input and could result in recommended methods that are currently unforeseen, the analysis contained in this FEIS utilizes NMFS' current behavioral harassment thresholds for estimating take. Nonetheless, we outline below some of the limitations of the current thresholds and highlight opportunities to qualitatively consider the most up-to-date information.

The current acoustic threshold for behavioral harassment from impulsive sounds, a 160-dB rms step function, predicts that all animals exposed to levels above 160 dB would be taken, and that no animals exposed to levels below 160 dB would be taken. Both data and logic suggest that this method may oversimplify the relationship between sound exposure and behavioral harassment, and there are other methods available that could better characterize this relationship, given the available data, while also incorporating consideration of variability in individual responses to sound. Dose-response-type curves, or risk functions, when supported by data and with an appropriate cut-off, can be used to more fully describe how exposures to different received levels can result in different outcomes (e.g., number of animals responding in a certain way, probability of individual responses). For example, given a specifically defined response, a risk function could describe how a higher percentage of animals exposed to higher received levels might demonstrate that response, while a lower percentage of animals exposed to lower received levels might demonstrate that response (see example used for Navy mid-frequency sources below). NMFS' preliminarily plans include exploring the use of dose-response or risk function-like curves to characterize the relationship between received sound level and behavioral responses. Further, while other metrics have been explored, based on the available data NMFS' believes that dB rms (the metrics used in the current acoustic thresholds) is still the most appropriate metric to characterize the relationship between received level and behavioral response.

Additionally, as has become increasingly evident and more highlighted in publications (Ellison et al., 2011), the context of an exposure of marine mammals to sound (e.g., the behavioral state of the animal, whether a sound source is approaching and how fast) can affect both how an animal initially responds to a sound and the ultimate impacts of the sound exposure on that individual. NMFS is also exploring additional methods of augmenting the use of a dose-response-like curve to address contextual factors beyond received level (such as distance from the sound or behavioral state of the animal), as well as the more chronic effects of sound sources operated over longer periods of time.

In the future, based on the limited data available, NMFS is considering exploring having different basic acoustic thresholds for mysticetes, odontocetes, and pinnipeds, with the recognition that sometimes there may be sufficient data to suggest that a species within one of those groups is "sensitive" and should have different (lower) acoustic threshold. Because data indicate that not all mysticetes exposed to received levels of 160 dB or above would be expected to be taken (Miller 2005, Malme et al. 1983, 1984, 1985), a dose-response approach for mysticetes, if explored, would likely result in estimates that show fewer takes resulting from exposures to received levels above 160 dB (than when the current step function is used). Alternately, there are also data showing that some portion of mysticetes (including, and perhaps especially, bowheads) exposed to seismic signals at received levels below 160 dB, and potentially down to around 120 dB, may sometimes respond in a manner that NMFS would categorize as a Level B behavioral take, especially in certain contexts, such as within a migratory corridor or if the activity were expected to be continuous over multiple days (Di Iorio and Clark 2009, Richardson et al. 1985/1986, Richardson et al. 1999). A dose-response-like approach incorporating these data, if explored, would likely result in some number of animals exposed at levels below 160 dB being predicted to be taken. However, while considering these approaches through the appropriate process, we believe that the 160-dB is still the best generalized method for predicting when level B harassment occurs.

Fewer data exist showing how odontocetes and pinnipeds (as compared to mysticietes) behaviorally respond to seismic airguns and similar sources. However, what data are available suggest that some percentage of odonotcetes exposed to received levels above 160dB would not be taken and that some percentage exposed to levels below 160 dB may respond in a manner that NMFS would consider Level B harassment (Miller et al. 2005). Alternately, data suggest that not all pinnipeds will be taken at received levels of 160 dB (or higher), and there are no data (with measured received levels) indicating how they would respond to levels below 160 or 165 dB.

In consideration of the acoustic threshold revisions, NMFS qualitatively considers how changes of the nature described above could potentially shape our further analyses of the alternatives in this FEIS. As described above, much of the impact analysis occurs subsequent and in addition to the initial estimate of the number of exposures that are predicted to result in a take. This additional analysis determines whether the anticipated exposures with the potential to injure or disturb marine mammals (counted as takes) would be likely to affect the health or fitness of any individuals (in a manner that would affect survivorship or reproductive success), whether altered health or fitness of the expected number of individuals would adversely affect rates of recruitment or survival, and whether any of the expected effects on individuals would have an unmitigable adverse impact on subsistence uses.

As discussed above, the quantification of anticipated takes is only part of the larger marine mammal impact analysis and is separate from the analysis of the severity of any single one of those takes, which must consider the biological and operational context in which those takes occur. Additionally, the analysis of the potential health and fitness impacts of the expected take, or the population level impacts, includes consideration of the life history of the affected species, their behavioral patterns and distribution within the action area, the duration, season, geographic scope, and operational parameters of the expected activities, along with the potential implementation of multiple mitigation measures intended to minimize the intensity of the effects – and these analyses are not expected to change notably based solely on any anticipated future modification of the behavioral harassment threshold.

Separately, any revisions to the acoustic thresholds also result in changes to the distances from sound sources within which we quantify impacts. NMFS has previously qualitatively acknowledged our concerns regarding the more chronic, longer-term effects of increasing noise levels (at levels below 160 dB) in potentially interfering with marine mammal's ability to detect and interpret important environmental cues (especially for low frequency specialists and low frequency sounds). For example, we outlined the 120-dB isopleths around seismic airgun operations in the original DEIS (even though the current acoustic threshold for behavioral harassment is 160 dB) to give a sense of the geographic scope of these chronic noise concerns. In response to public comments requesting NMFS better address the effects of more chronic and aggregate noise exposure, NMFS has conducted a novel first-order chronic and cumulative analysis, the preliminary results of which have been reported in Section 4.5.2.4.9 and considered in the FEIS analysis.

4.2.6.6 Overview of Take Estimates

Tables 4.2-5, 4.2-6, and 4.2-7 contain a representative summary of takes that were predicted to occur in the Beaufort and Chukchi seas based on previously issued IHAs for the different types of activities analyzed in this EIS.

In 2015, NMFS modified the way we calculate take in certain situations and some activities to better account for the duration of the activities, which resulted in take numbers that were sometimes several times higher than those calculated in previous years. While these estimates better account for duration, it is also important to note that the numbers generated with this newer method represent the number of *instances* of take, not the number of *individuals* taken. The higher take estimates generated using the newer methods are expected to be overestimates of the number of individuals taken to differing degrees because of the fact that depending on several factors (activity type, behavior, life history, etc.) individuals are likely taken more than one time on multiple days across the duration of the action. Further, because the takes from each activity type indicated below are simply added together, the totals generated for each alternative do not take into consideration the fact that an animal may be taken by two or more different activities (i.e., just adding activity takes may further overestimate the number of individuals). For example to illustrate both of these points, a bowhead may remain in an area for a couple days feeding and therefore be taken by a stationary drilling activity a couple of times (reflected as two takes in activity estimate), and then move away continuing on its migration and swim through the ensonified zone of a couple of seismic surveys and be taken two more times. In such a scenario, four of the takes represented in the take estimate for a total alternative would actually represent only one individual. Alternately, animals that remain in the general area of these activities all year round or for a season may be taken many more times each. Therefore, although newer methods may increase the estimated take numbers in applications by several times over those reflected in the tables below, because of the reasons above, we determined that the alternative totals below still generally represent the *numbers of individuals* that may be taken by the combined activities. However, in acknowledgement of the generalized nature of these take estimates and the new methods mentioned above, we will consider the possibility that the number of individuals could be twice as high as those reflected in the tables below when we address magnitude or intensity in the impact criteria for behavioral disturbance.

Using the methods described in the previous paragraph, Table 4.2-5 indicates that between 3,460 and 6,920 bowheads might be behaviorally harassed as they travel through the Beaufort Sea under Alternative 2. Fleishman et al. (2016) modeled 80% of the bowhead population (11,566) moving through the Beaufort Sea in a 47-day period and their sound exposure given the modeled sound field of two production islands, one offshore and one nearshore vessel towing a barge, and two offshore and three nearshore seismic survey operations. In the modeled scenario, given a 0.6 probability of modeled aversion to seismic at 160 dB SPL (which seems reasonable), about 22% of the modeled population (2,544 individuals) was exposed to levels of 160 dB or above at some time during their trip through the Beaufort, though only about 1% of the population was exposed to levels above 170 dB. If this number is proportionally corrected for the current minimum population estimate (16,091) passing through the same fields, the exposures above 160 dB SPL would be 3,540. Alternative 2 assumes four 2D/3D seismic surveys, three site clearance, one on-ice survey, and one exploratory drilling program in the Beaufort Sea. Given the general similarity between the levels of activity contemplated in Alternative 2 and the levels of activity contemplated in Ellison et al. (2016; acknowledging that Alternative 2 levels are somewhat higher), and the fact that cumulative exposure to multiple sources is not strictly additive, the exposures modeled in Ellison et al. (2016) generally do not seem to be out of line with the exposures above 160 dB estimated here for Alternative 2.

Separately, note that the estimates presented below all represent Level B behavioral harassment takes and assume no injury (or mortality) based on previous analyses using historical Level A harassment thresholds and assumptions about avoidance and mitigation. As described above, future analyses and calculations utilizing the revised auditory impact thresholds will likely not result in much of a change to predicted numbers, but it is probably not appropriate to rule out the chance of PTS completely, so there may be cases in the future in which, based on the project-specific analysis conducted, NMFS authorizes a small number of Level A harassment takes. However, if so, it would not change the numbers in the table below, as those Level A harassment takes would come from the pool of takes that would otherwise have been estimated as Level B harassment. We also emphasize here that not all takes are biologically significant. Additional contextual analysis is needed and typically only some portion (depending on the circumstances and context of the exposures) of any estimated takes have the potential or likelihood of affecting animal fitness.

Table 4.2-5 Examples of estimated take for different types of oil and gas exploration activities in the Beaufort Sea using the current behavioral acoustic thresholds, followed by estimated takes if those examples are used to total maximum activity levels for each alternative.

BEAUFORT	Bowhead Whale	Beluga Whale	Gray Whale	Minke Whale	Humpback Whale	Harbor Porpoise	Ringed Seal	Bearded Seal	Spotted Seal	Ribbon Seal
OBC or OBN Seismic Survey using an 880 in^3 array	20	15	0	0	0	0	225	30	15	0
3D Seismic Survey using a 3147 in^3 array	400	210	250	0	0	0	7300	375	20	0
Site Clearance and High Resolution Shallow Hazards Survey using a 40 in^3 airgun	300	10	5	0	0	0	140	10	5	0
On-ice Seismic Survey	0	0	0	0	0	0	500	5	0	0
In-ice 2D Seismic Survey	240	4900	20	18	18	18	39,200	70	17	17
Exploratory Drilling Program with a drillship	1500	20	10	0	0	15	440	22	5	2
ALTERNATIVE 2 Total - Maximum levels of all Beaufort activities combined	**3460**	**5385**	**545**	**18**	**18**	**33**	**55385**	**907**	**92**	**19**
ALTERNATIVE 3 Total - Maximum levels of all Beaufort activities combined	**5980**	**5650**	**815**	**18**	**18**	**48**	**63630**	**1354**	**142**	**21**
ALTERNATIVE 4 Total - Maximum levels of all Beaufort activities combined	**8980**	**5690**	**835**	**18**	**18**	**78**	**64510**	**1398**	**152**	**25**

Table 4.2-6 Examples of estimated take for different types of oil and gas exploration activities in the Chukchi Sea using the current behavioral acoustic thresholds, followed by estimated takes if those examples are used to total maximum activity levels for each alternative.

CHUKCHI	Bowhead Whale	Beluga Whale	Gray Whale	Minke Whale	Humpback Whale	Fin Whale	Killer Whale	Harbor Porpoise	Ringed Seal	Bearded Seal	Spotted Seal	Ribbon Seal
3D Seismic Survey using a 3000 in^3 array	150	190	145	5	5	5	5	20	6,500	215	130	10
Site Clearance and High Resolution Shallow Hazards Survey using a 40 in^3 array	5	10	20	2	2	2	5	7	700	30	7	2
In-ice 2D Seismic Survey	40	50	5	5	5	0	0	5	21,300	20	5	5
Exploratory Drilling Program with a drillship	80	15	50	15	15	15	15	15	815	35	20	15
Exploratory Drilling Program with a jack-up rig	70	10	35	5	5	5	20	10	340	160	160	15
ALTERNATIVE 2 Total - Maximum levels of all Chukchi activities combined	**435**	**475**	**405**	**36**	**36**	**31**	**40**	**81**	**37215**	**575**	**306**	**46**
ALTERNATIVE 3 Total - Maximum levels of all Chukchi activities combined	**825**	**890**	**785**	**65**	**65**	**60**	**75**	**150**	**52430**	**1100**	**600**	**85**
ALTERNATIVE 4 Total - Maximum levels of all Chukchi activities combined	**985**	**920**	**885**	**95**	**95**	**90**	**105**	**180**	**54060**	**1170**	**640**	**115**

Table 4.2-7 Using the examples provided above, estimated takes for total maximum activity levels in both the Beaufort and Chukchi seas combined for each alternative*.

BEAUFORT/CHUKCHI COMBINED	Bowhead Whale	Beluga Whale	Gray Whale	Minke Whale	Humpback Whale	Fin Whale	Killer Whale	Harbor Porpoise	Ringed Seal	Bearded Seal	Spotted Seal	Ribbon Seal
ALTERNATIVE 2 Total - Maximum levels of all activities combined	3895	5860	950	54	54	31	40	81	92,600	1,482	398	65
ALTERNATIVE 3 Total - Maximum levels of all activities combined	6805	6540	1600	83	83	60	75	150	116,060	2,454	742	106
ALTERNATIVE 4 Total - Maximum levels of all activities combined	9965	6610	1720	113	113	90	105	180	118,570	2,568	792	140

* Note, for the reasons described above in Section 4.2.6.6, for the purposes of evaluating the magnitude or intensity for the behavioral disturbance impact criteria, NMFS is considering values of twice those indicated in this table.

4.2.7 Exploration Spills

A hydrocarbon spill or release is an event of concern because it has the potential to result in environmental impacts. A hydrocarbon spill can affect environmental, social, and economic resources. For these reasons, it is important to understand the frequency of occurrence and fate for impact assessment purposes. To this end, the frequency of varying sizes of hydrocarbon spills have been estimated using historical data from the U.S. OCS and other offshore oil and gas development regions, and the trajectories of large and very large spill scenarios have been modeled (MMS 2003, 2007, 2008, BOEM 2010a, b; BOEM 2011a, c; BOEM 2012; BOEM 2015b).

For the purposes of the environmental assessment in this FEIS, two types of spills during exploration operations are considered – small spills and very large spills. Small spills are likely to occur over the life of exploration activities and are generally 50 bbl or less. Approximately 99% of OCS spills are less than 50 bbl (BOEM 2012). Very large spills greater than or equal to 150,000 bbl have a very low probability of occurring during exploration activities. Although very large spills are not estimated to occur during exploration activities, Section 4.10 addresses very large spills to inform the decision maker of the impacts of a very unlikely but not impossible VLOS.

Small fuel spills associated with the vessels used for G&G activities could occur, especially during fuel transfer. However, there are no reported historical fuel spills from geological or geophysical operations on the Beaufort and Chukchi OCS. Small spills could also occur during exploration drilling operations. A ≤50 bbl spill was estimated to occur during exploration drilling operations from refueling (MMS 2009a, b; BOEM 2011a, c; BOEM 2012; BOEM 2015b). Historical Beaufort Sea and Chukchi Sea OCS exploration spill data suggest that a small spill is likely to occur. Thirty five exploration wells were drilled in the Arctic OCS from 1981-2003. During that time period 35 small spills have occurred spilling a total of 26.7 bbl (of which 24 bbl was recovered). The largest Arctic OCS exploration spill was less than 20 bbl. The most likely cause of a small oil spill during exploration is operational, such as a hose rupture. Estimated ranges for small fuel spill volumes with respect to G&G activities and exploration activities are discussed below and summarized in Table 4.2-8.

Table 4.2-8 Number of respective activities for each activity level and the estimated small spill volume range used for purposes of analysis.

Alternative	Activity	Activity Number Beaufort	Activity Number Chukchi	Small Spill Volume Range (bbl)
2	Seismic surveys	4	3	0–<7*
	Exploratory Drilling	1	1	0–100*
3	Seismic surveys	6	5	0–<11*
	Exploratory Drilling	2	2	0–200*
4	Seismic surveys	6	5	0–<11*
	Exploratory Drilling	4	4	0–400*

*A single small exploratory drilling spill would be ≤50 bbl, and a single seismic survey spill would be <1 bbl.

G&G Small Fuel Spill. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1-13 bb (BOEM 2010a, b). The <1 bbl minimum volume represents a spill where dry quick disconnect and positive pressure hoses function properly. The 13 bbl maximum spill volume represents a spill where spill prevention measures fail or fuel lines rupture. For purposes of analysis the lesser volume is used to estimate cumulative spill volumes. Using the maximum volume would overestimate the likely volume spilled at the upper end of the range. Should one fuel hose rupture occur the fate and effects would be similar to the upper range volume.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum anticipated annual levels of geophysical or geological activities for Alternative 2 could range from zero bbl if no fuel spills occur to <7 bbl if every operation refuels, every refueling operation has a fuel spill, and spill prevention equipment functions properly. For Alternatives 3, 4, 5 and 6, small spills could range from zero if no fuel spills occur to <11 bbl if every operation refuels, every refueling operation has a fuel spill, and spill prevention equipment functions properly. Refueling operations for Beaufort Sea operations likely would occur at Prudhoe Bay's West Dock facility, in Tuktoyuktok, Canada, or at sea with the use of fuel supply vessels. Refueling operations in the Chukchi Sea likely would occur at sea with the use of fuel supply vessels.

Exploration Small Fuel Spill. For purposes of analysis, a ≤50 bbl spill was estimated to occur during exploration drilling operations from refueling (MMS 2009a, b; BOEM 2012, 2015b). For Alternative 2 the estimated fuel spills that could occur during exploratory drilling could range from zero if no fuel spills occur to 100 bbl if both exploratory drilling operations have a spill. For alternatives 3, 5 and 6 estimated fuel spills could range from zero to 200 bbl and for Alternative 4 could range from zero to 400 bbl.

Summary. Previous NEPA analyses, such as those for Shell's 2010 and 2012 Exploration Plans (MMS 2009a, b; BOEM 2012; 2015b), concluded any effects from a 48 bbl spill would be local and temporary (persisting up to 3 days). At the high end of the range, exploration spills would not overlap temporally or spatially, such that any single spill would likely be ≤50 bbl. Likewise the effects of seven spills <1 bbl (each) or 11 spills <1 bbl (each) cannot reasonably be expected to exceed those of a 48 bbl spill as was analyzed in Shell's 2010 and 2012 Exploration Plan (MMS 2009a, b; BOEM, 2011a, c; 2012; 2015b). Therefore the effects of seven spills <1 bbl (each) or 11 spills <1 bbl (each) would most likely be local, persisting less than three days.

Given that small spills are low in intensity, temporary in duration, and local in extent, and that small spills would not overlap in time or space, they are analyzed only once for each resource under Alternative 2. Subsequent alternatives 3, 4, 5 and 6 reflect the same level of effect for small spills.

4.3 Mitigation Measures

Mitigation measures associated with this EIS (Appendix E) are placed into two categories for analysis:

Standard Mitigation Measures – These measures, which are required in all five of the action alternatives, are those that NMFS deemed appropriate to *require* in MMPA authorizations. These measures (e.g., shutdown zones, time/area closures to protect known subsistence uses) have been used consistently in past permits and authorizations.

Additional Mitigation Measures – These measures, which are evaluated *but not required* in all five action alternatives, may or may not be implemented in current and future activities depending on the outcome of the MMPA authorization processes (or other environmental compliance processes) associated with current and future actions. These measures are intended to include other reasonable potential mitigation measures, such as those that have been required or considered in the past or recommended by the public, which may or may not have been required or considered in the past.

The suite of standard and additional mitigation measures that are analyzed in this EIS are designed specifically to reduce adverse impacts to marine mammals and to subsistence uses of marine mammals for species managed by NMFS. Therefore, the discussion and full analysis of the standard and additional mitigation measures, the degree to which the measures are expected to lessen impacts to the resource, their likely effectiveness, and their practicability for implementation are contained in the marine mammal and subsistence sections of Alternative 2 (Sections 4.5.2.4.16, 4.5.2.4.17, 4.5.3.2.3, 4.5.3.2.5). As each measure is analyzed independently in this EIS, the additive evaluation and implementation of measures will occur at the MMPA authorization stage. Even though the measures are specifically designed to mitigate impacts to marine mammals and to ensure the availability of marine mammals for subsistence uses, there is the potential for some measures to mitigate impacts to other resources described in this EIS. Sections 4.5.1.7, 4.5.2.6, and 4.5.3.10 contain brief summaries regarding the mitigation measures for the Physical, Biological, and Social Environments.

As discussed in Chapter 2 (Section 2.4.2), NMFS' evaluation of the standard and additional mitigation measures is needed in order to better assess the programmatic appropriateness of each measure (i.e., based on the generalized expectations for a given year of projected activities) and to inform decisions of whether the measure should:

a) be considered a Standard Mitigation Measure (i.e., required in every ITA for a given activity type);

b) be included in the Additional Mitigation Measure category, which means that the measure will be considered for inclusion as a requirement through future regulatory or authorization processes during which more specific information is known; or

c) never be required.

All Additional Mitigation Measures identified in this FEIS for a particular activity type will be further evaluated for potential required inclusion for any specific proposed activity through the MMPA process (and potentially other environmental compliance processes) using the additional detail available once applicants determine the specific activities they propose to conduct in a given year and submit their applications. These measures will be further evaluated using this more specific information to determine the degree to which the measure is likely to reduce impacts to marine mammals or subsistence uses of marine mammals based on the proposed specified activity, the likely effectiveness of the measure, and the practicability of the measure. This implementation and evaluation process is outlined in more detail in Chapter 5, but the following are some of the types of more specific information that will be used to make the decision of whether to require a given measure in a given MMPA ITA:

- The timeframe, duration, and location of the proposed activity and the spatiotemporal overlap with marine mammal distribution and subsistence hunts of marine mammals;
- The specific characteristics of the sound sources used in the proposed activity;
- The availability and cost of the resources needed to carry out the measure;
- The timeframe, duration, and locations of other activities expected in the same season; and
- New information related to the likely success of the measure (from reports from previous years).

4.4 Direct and Indirect Effects for Alternative 1 – No Action

Under Alternative 1, NMFS would not issue any ITAs under the MMPA for seismic surveys or exploratory drilling in the Beaufort and Chukchi seas, and BOEM would not issue G&G permits or concur on ancillary activities in the federal waters of the Beaufort and Chukchi seas. Consequently, no seismic surveys, ancillary activities, or exploratory drilling would be expected to occur in federal waters of the Beaufort and Chukchi seas under this Alternative. While not specifically anticipated, in theory, the State of Alaska could authorize seismic surveys or exploratory drilling in State waters in a situation where a company did not request or receive an ITA for these types of activities.

If no seismic surveys, ancillary activities, or exploratory drilling were conducted, there would be no direct or indirect effects to resources as a result of Alternative 1, other than to socioeconomics and land and water use, management, and ownership. Therefore, only these two resources are discussed under Alternative 1. However, if some amount of seismic surveys, ancillary activities, or exploratory drilling operations were permitted by the State but without an associated MMPA ITA from NMFS, some impacts to marine mammals, subsistence uses, and other biological resources could occur. These impacts to biological resources would be expected to be of the exact nature and quality analyzed in Alternatives 2, 3, and 4 but of significantly lower quantity and limited spatial extent (i.e, only Beaufort Sea state waters) because activities in State waters are already only a subset of the total activity levels analyzed in the alternatives. Therefore, this situation would be a further subset of the levels already considered in the other alternatives in the small likelihood that a company elected to conduct operations resulting in marine mammal take without pursuing an MMPA ITA. Separately, because of the importance to the effects analysis of the marine mammal subsistence coordination prescribed through ITAs, this resource is addressed briefly in Section 4.4.1.2.1 in the context of potential activites in State waters conducted without an associated MMPA ITA.

Over the past several years, there has been a certain level of oil and gas exploration activity permitted by BOEM in the Beaufort and Chukchi seas, with associated MMPA ITAs issued by NMFS. This level of activity is greater than what is associated with Alternative 1 (no activity permitted) but less than what is associated with Alternative 2. The impacts analyzed for Alternative 1 would be less than the status quo for oil and gas exploration activities in the Beaufort and Chukchi seas.

4.4.1 Social Environment

4.4.1.1 Socioeconomics

Offshore seismic activity and exploration drilling is conducted to locate potential commercially recoverable sources of oil and gas. Offshore exploratory drilling is a precursor to oil and gas development and production if potentially commercial quantities of oil are found in a prospect. Alaska OCS development is anticipated to be a driver in “the next generation of economic activity by extending the duration of the petroleum industry in the state” (NEI and ISER 2009). Northern Economics, Inc. (NEI) and the Institute of Social and Economic Research (ISER) at the University of Alaska, Anchorage conducted a study for Shell Exploration and Production to estimate the economic impacts of exploration, development, and production in three Alaska OCS areas (Beaufort Sea, Chukchi Sea, and North Aleutian Basin). Based on certain assumptions and production scenarios, ISER concluded that OCS development could offset the decline of petroleum production on state lands on the North Slope.

A number of issues associated with economic development and potential socioeconomic effects were raised during the scoping process. Because of the potential importance of offshore oil and gas development to Alaska’s economy, there was interest in the potential for this EIS to result in greater predictability in the issuance of MMPA ITAs. New natural gas production from the Alaska OCS was also perceived to enhance the economic viability of the proposed natural gas pipeline from Alaska to the Lower 48. In addition, a concern was voiced during scoping that the personal incomes of whaling crews could be negatively impacted because greater deflection of marine mammals could make subsistence activities more expensive.

The following discussion of direct and indirect effects of the Alternatives (which were presented in Chapter 2) describes the nature of the socioeconomic contribution of offshore (including on-ice) seismic and exploratory drilling activities in the Beaufort and Chukchi seas. Based on the nature of these activities, this section describes effects on public revenues and expenditures, employment and personal income, demographic characteristics, and demand on social organizations and institutions. Section 3.3.1.2 provided the best available detailed information regarding current employment and personal income in the NSB and NAB.

The level of impacts are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.4-1.

Table 4.4-1 Impact Criteria for Effects on Socioeconomics

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: <5% increase or decrease in social indicators	**Medium**: 5% to 10% increase or decrease in social indicators	**High**: >10% increase or decrease in social indicators (such as employment, population, or tourism levels)
Duration	**Temporary**: Changes in social indicators last less than one year	**Interim**: Changes in social indicators extend up to several years	**Long-term**: Changes in social indicators persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects a sector of a single community; may alter but does not impair functions of that sector	**Regional**: Affects two or more communities in the region or multiple sectors of a single community	**State-wide**: Affects multiple sectors of multiple communities in the region and/or a single sector of a community outside the region
Context	**Common**: Affects communities that are not minority or low-income	**Important**: Not Applicable	**Unique**: Affects minority or low-income communities

4.4.1.1.1 Direct and Indirect Effects

Public Revenue and Expenditures

Under Alternative 1, there would be no new (or there would be delayed) public revenue sources associated with offshore exploration activities and any subsequent production. There would be no change of expenditures to the public sector from federal, state, or local governments. If Alternative 1 results in no issuance of authorizations or permits by NMFS and BOEM, respectively, then exploratory drilling and new leasing could be delayed or may not occur. Furthermore, if there is no prelease seismic surveying or issuance of MMPA ITAs, potential lessees might not participate in the OCS lease sales as scheduled under the 2012-2017 Program or proposed under the 2017-2022 Program; as a result, revenue from bids and rentals might not be generated from federal and state oil and gas leases.

There is potential corresponding loss in state revenue from foregone taxes, and to the NSB from foregone facility improvements to handle produced petroleum. If MMPA ITAs are not issued, there is potential lost revenue associated with future sale of Beaufort Sea Area wide state leases. The State of Alaska received approximately $88,413 from the 2014 Beaufort Sea Area wide Lease sale (ADNR 2015b). Because NMFS and BOEM have assumed that no staging activities would occur out of Kivalina or Kotzebue, as such activities have not occurred from those communities in the past, there would be no change to municipal tax revenue for the NAB. Potential production foregone associated with Alternative 1 could result in a decline in domestic production and an increase in the import of fossil fuels from other countries, which would not have the same revenue benefits as production from federal and state waters in the Beaufort and Chukchi seas. Further, potential offshore production would not occur or would be delayed.

Although the likelihood of exploration resulting in production cannot be predicted, and the magnitude is unknown, any production from a successful oil discovery would likely be transported through the Trans-Alaska Pipeline System (TAPS). Current TAPS throughput has fallen to one-third its peak flow, and any OCS contribution would extend its commercial life. This would continue state and local royalty oil revenue that otherwise would end immediately upon closure of TAPS. If the inability of NMFS and BOEM to issue authorizations and permits delays offshore leasing and exploration, OCS production could occur too late to contribute to TAPS throughput.

Employment and Personal Income

Alternative 1 would result in unrealized opportunities for employment and personal income in areas providing support activities in the NSB, NAB, Nome, and Dutch Harbor. There could also be unrealized employment and personal income to oil and gas professionals in Anchorage, other parts of the state and nation as a result of Alternative 1, particularly when considering the potential multiplier effect of 4.8 new indirect jobs for every oil and gas job created from future OCS development (NEI and ISER 2009). An example of the number of direct unrealized jobs in the regional economy is shown in Tables 4.5-22 and 4.5-23.

Demographic Characteristics

Under Alternative 1employment to NSB and NAB residents as PSOs, subsistence advisors, Com Center staff, and spill response personnel. There could also be unrealized employment and personal income to oil and gas professionals in Anchorage, other parts of the state, and nation as a result of Alternative 1, particularly when considering the potential multiplier effect of 4.8 new indirect jobs for every oil and gas job created from future OCS development (NEI and ISER 2009). An example of the number of direct unrealized jobs in the regional economy can be found in Tables 4.5-22 and 4.5-23.

The potential for new local jobs associated with exploration activities would be unrealized. However, the small number of foregone local hire positions and short term nature of the work is not enough to cause outmigration. Therefore, no change would occur to coastal communities' populations in the Beaufort and Chukchi seas.

Social Organizations and Institutions

Under Alternative 1, there would be no impact to social organizations and institutions because there would be no new revenue to municipalities, native villages, or native corporations. There would also be no additional demand for non-governmental organization (NGO) response.

4.4.1.1.2 Conclusion

The general direction of the socioeconomic direct and indirect impacts under Alternative 1 would be negative, due to unrealized local employment and tax revenue to local, state, and federal governments and the strong probability that at a minimum the federal government would return several billion dollars to the current leaseholders. In terms of local employment and sales tax, the potential impact would be low in magnitude because total personal income and local employment rates would not be increased by more than five percent. The duration of the local socioeconomic impacts would be interim because it would not be year-round, but the multi-year exploration activity regime associated with each lease sale could be halted. With regard to potential unrealized revenue for state and federal governments, the likelihood of exploration resulting in production cannot be predicted, and the magnitude is unknown but is likely to be medium to high as only a large discovery would be developed. These potential negative economic impacts of the activity would be local, statewide and even nationwide. The context of the socioeconomic impacts, the people that would experience the flow of workers and research vessels, are considered unique Iñupiat (minority population) communities. Therefore, the summary impact level for socioeconomics is moderate.

4.4.1.2 Land and Water Ownership, Use, and Management

Section 4.1.3 describes the basic significance criteria used to assess direct and indirect impacts throughout this document. For land and water ownership, use and management, impact levels would be derived primarily from the response needed by owners or managers, and whether or not the impacts were perceived as positive or negative. A major adverse impact would be one associated with a forced change in ownership or management that is inconsistent with existing plans and management regulations. It is assumed for all action alternatives that existing land use and management is in compliance with current federal regulations, state regulations, and existing management plans, and is consistent with other land uses. Currently, the BOEM manages oil and gas activities in federal waters, and these activities comply with federal management guidelines. Similarly, ADNR manages oil and gas activities in state waters, and permitted exploration activities comply with state management guidelines. Offshore activities are subject to voluntary compliance with the NSB and the NAB management guidelines. For this section, the basic significance criteria are further refined as described in Table 4.4-2.

Table 4.4-2 Impact Criteria for Land and Water Ownership, Use, and Management

Impact Category	Intensity Type	Definition
Intensity (Magnitude)	Low	Land/water ownership/use or development rights do not change and/or owner need not respond to action in any substantive way; action is substantially consistent with existing land use and management plans.
	Medium	Changes in land/water ownership/use or development rights are minor and/or owner must respond to the action, but response is minor or routine. Action is neither wholly consistent nor wholly inconsistent with existing uses and management plans.
	High	Changes in land/water ownership/use are major and/or owner must respond in substantial ways to the action—change in ownership (condemnation) or substantial change in management– major inconsistency with land management plan that forces amendment of plan.
Duration	Temporary	Land/water use, ownership or management changes do not occur, are expected to be infrequent, or last less than a month.
	Interim	Land/water use, ownership, or management changes may reasonably be expected to convert (or revert) to another use frequently, or extend for longer time periods.
	Long-term	Land/water use, ownership, or management changes are expected to have a permanent change that would last beyond the life of the plan even if the actions that caused the change were to cease.
Extent	Local	Impacts would be limited geographically; impacts would not extend to a broad region or a broad sector of the population.
	Regional	Impacts would extend beyond a local area, potentially affecting resources or populations throughout the EIS project area.
	State-wide	Impacts would potentially affect resources or populations beyond the region or EIS project area.
Context	Common	The supply of land or water for an affected use or management category is extensively available, serves no specialized function and is not identified as having special, rare, protected or unique characteristics in an adopted management plan.
	Important	The supply of land or water for an affected use or management category is moderately available, serves a specialized function but is not identified as having special, rare, protected, or unique characteristics in an adopted management plan.
	Unique	The supply of land or water for an affected use or management category is constrained and is identified as having special, rare, protected, or unique characteristics in an adopted management plan.

Under Alternative 1, NMFS would not issue ITAs under the MMPA for seismic surveys or exploratory drilling in the Beaufort and Chukchi seas. BOEM would not issue G&G permits or authorize ancillary activities in the federal waters of the Beaufort and Chukchi seas. The State of Alaska could authorize seismic surveys or exploratory drilling in state waters, but ITAs would not be issued for these activities. From a land ownership and use perspective, this is characterized as the inability to issue permits and authorizations, as compared to the denial of a permit/authorization based on regulatory review. Alternative 1 would result in leaseholders not being able to drill, and would affect the leaseholders' ability to pursue exploration and discovery of hydrocarbons. This would run contrary to current federal and state management of OCS waters and nearshore waters. It would cause some change in activity levels or procedures and affect management plans for land and water in the EIS project area. The potential effects on land and water ownership, use, and management are analyzed below separately.

4.4.1.2.1 Direct and Indirect Effects

Land and Water Ownership

Federal Ownership

Because BOEM has awarded leases in the Beaufort and Chukchi seas for the purposes of exploring for and developing petroleum resources in the federal OCS, the non-issuance of G&G permits and authorizing ancillary activity by BOEM would prevent leaseholders from pursuing exploration activities in compliance with federal regulations. This would indirectly affect the BOEM mandate to manage development of offshore energy and balance economic development, energy independence, and environmental protection by constraining activities on leases awarded and represents a high intensity, interim adverse effect of regional extent. There would be no indirect effect to federal ownership by constraining activities on leases. The federal ownership would be maintained.

State Ownership

The ADNR has awarded leases in the Beaufort Sea for the purpose of exploring and developing petroleum resources. ADNR could continue to permit activities on awarded leases, but the inability to obtain ITAs from NMFS would prevent leaseholders from pursuing exploration activities if there would be potential for take of marine mammals. Non-compliance with federal regulations could limit the ability to utilize leases, and would indirectly affect state ownership by constraining activities on awarded leases. It would be a high intensity, interim adverse effect of regional extent. There would be no indirect effect to state ownership from limits to leases, and the state ownership would be maintained.

Private Ownership

The award of oil and gas leases to a private entity is a right to use property and is characterized as a form of private ownership for the purposes of this EIS. The U.S. Supreme Court has recognized that "[u]nder OCSLA's plain language, the purchase of a lease entails no right to proceed with full exploration, development, or production…; the lessee acquires only a priority in submitting plans to conduct these activities" (Secretary of the Interior v. California, 464 U.S. 312, 339 [1984]). The inability of BOEM and NMFS to issue permits and authorizations, as compared to the denial of a permit/authorization based on regulatory review, would prevent leaseholders from pursuing exploration activities on awarded federal and state offshore oil and gas leases in compliance with federal regulations and would constrain their ability to utilize their leases. This represents a high intensity, interim adverse effect of regional extent to leases awarded to private parties and exploration rights.

There would be no direct or indirect effects on Alaska Native land ownership, including corporation lands, corporation land selections, and Native allotments, from the inability of BOEM and NMFS to issue permits and authorizations.

Borough and Other Municipal Lands

There would be no direct or indirect effects on borough and other municipal land ownership from the inability of BOEM and NMFS to issue permits and authorizations.

Land and Water Use

Recreation

There would be no direct or indirect effects on recreation use from the inability of BOEM and NMFS to issue permits and authorizations.

Subsistence

If BOEM and NMFS do not issue permits and authorizations for activities in the Arctic OCS, this could reduce or eliminate potential conflicts between oil and gas exploration activities and subsistence uses. These conflicts can be mitigated to some degree through plans of cooperation and other measures. However, no such plans would be required if MMPA ITAs are not issued. For more detail, see Section 4.7.3.2, Subsistence.

If activities occur in State waters of the Beaufort Sea without MMPA ITA coverage, there is the potential for impacts on marine mammal subsistence hunting in the region. Operators would not be required to produce a Plan of Cooperation, which is meant to include measures to reduce impacts to Alaska Native subsistence hunters. Under Alternative 1, the mitigation measures described in Section 4.5.3.2.3 of this FEIS would not be included as standard mitigation measures in ITAs, and additional mitigation measures described in Section 4.5.3.2.5 of this FEIS would not be considered for inclusion during the MMPA ITA process. Under Alternative 1, operators conducting oil and gas exploration activities in State waters and without an ITA would not be required to ensure availability of marine mammals for subsistence uses and would not be required to implement mitigation measures to that effect.

Industrial

The inability of BOEM and NMFS to issue permits and authorizations could reduce or eliminate oil and gas exploration activities on existing leases in federal and state waters. This would lead to an overall reduction in ship traffic and the potential for a decrease or elimination of support activities, including crew change and survey preparations, in areas such as Prudhoe Bay, Barrow, Wainwright, Nome, and Dutch Harbor. These activities require facilities and structures (e.g., warehouses, repair and maintenance shops) in areas generally zoned for industrial use. A reduction in support activities could create decreased demand for industrial facilities resulting in higher vacancy rates and building underutilization as compared to current levels.

Residential

There would be no direct or indirect effects on residential use from the inability of BOEM and NMFS to issue permits and authorizations.

Mining

There would be no direct or indirect effects on mining from the inability of BOEM and NMFS to issue permits and authorizations.

Protected Natural Areas

There would be no direct or indirect effects on lands used as protected natural areas from the inability of BOEM and NMFS to issue permits and authorizations.

Transportation

The inability of BOEM and NMFS to issue permits and authorizations could reduce or eliminate transportation activities supporting oil and gas exploration activities on existing leases in federal and state waters. This would be reflected in lower numbers of ships, aircraft, and surface vehicles and a reduction in use of affiliated docks, airstrips, and roads. Initially, lower usage would place fewer maintenance demands on these facilities. However, chronically low usage can have a long-term detrimental effect on maintenance and funding priorities resulting in accelerated infrastructure deterioration. Deteriorating infrastructure then impacts the viability of surrounding land uses that rely on it. Transportation uses most likely to be affected would occur primarily in Prudhoe Bay, Barrow, Wainwright, Nome, and Dutch Harbor.

Commercial

The inability of BOEM and NMFS to issue permits and authorizations could reduce or eliminate commercial uses supporting oil and gas exploration activities on existing leases in federal and state waters. This could indirectly affect commercial land use if demand is reduced for the sale of goods and services to support exploration activities. This would reduce the amount of crew and resupply activity in port communities and could impact retail stores, maintenance equipment suppliers, restaurants, taxi services, and similar commercial businesses. A reduction in demand would be reflected in reduced sales and could result in struggling businesses, business closures, and the rezoning of land to other uses. Commercial uses most likely to be affected would occur primarily in Prudhoe Bay, Barrow, Wainwright, Nome, and Dutch Harbor.

Land and Water Management

Federal Land and Water Management

BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS, and the inability to issue ITAs and G&G permits and authorizing ancillary activities would prevent leaseholders from pursuing exploration activities in compliance with federal regulations and constrain the ability to utilize leases. This would indirectly affect federal management by constraining activities on leases and conflicting with the BOEM mandate to manage development of offshore energy and balance economic development, energy independence, and environmental protection. This represents a high intensity, interim adverse effect. Effects would reach beyond the project area, and therefore would be state-wide in extent. However, leases may be considered a national resource.

State Land and Water Management

The ADNR has awarded leases in the Beaufort Sea for the purpose of exploring for and developing petroleum resources. The ADNR could continue to permit activities on leases awarded, but the inability to obtain ITAs from NMFS would prevent leaseholders from pursuing exploration activities in compliance with federal regulations and constrain their ability to utilize their leases. This would indirectly affect state management of waters by constraining activities on leases awarded and conflicting with the management objective of allowing oil and gas exploration and development of state waters. Preventing oil and gas exploration and development of the federal OCS would eliminate any oil production that could extend the commercial life of TAPS. This represents a high intensity, interim adverse effect of state-wide extent.

Borough and Municipal Land and Water Management

The inability of BOEM and NMFS to issue permits and authorizations for offshore oil and gas exploration activities would reduce or eliminate potential conflicts of exploration activities with NSB and NAB comprehensive plans and Land Management Regulations coastal management policies. However, compliance with NSB and NAB Land Management Regulations is undertaken on a voluntary basis for activities occurring on state and federal waters. As indicated in Section 3.3.5.3, State Waters Management, the Alaska Coastal Management Program was not reauthorized by the state legislature and has not been in effect since 2011.

Private Land Management

The inability of BOEM and NMFS to issue permits and authorizations for offshore oil and gas exploration activities could have an adverse effect on management of Alaska Native corporation lands that would provide support for offshore oil and gas activities. This would apply to lands intended to provide support activities primarily in Wainwright, where there has been discussion of developing marine support facilities, and potentially in Barrow.

4.4.1.2.2 Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water ownership under Alternative 1 are described as follows. The magnitude of ownership impacts on federal and state waters may be high because major changes in the ability to conduct activities on leases on federal and state waters would result from this action. The duration of impact would be interim because leaseholders would not be able to utilize leases for exploration of oil and gas resources. The extent of impacts would be regional, covering federal and state leases in the Beaufort and Chukchi seas. The context of impact would be important because the affected federal and state waters are currently available for leasing, and no additional waters would be available for exploration under the characteristics of this alternative. In total, the direct and indirect impacts on land ownership are considered to be major; they would be high intensity, interim duration, regional in extent, and result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations.

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water use under Alternative 1 are described as follows. The magnitude of use impacts on federal and state waters would be high because major changes in the ability to conduct activities on leases in federal and state waters may result from this action, also affecting industrial, transportation, and commercial uses that support these activities. The duration of impact would be interim because leaseholders would not be able to utilize leases for exploration of oil and gas resources. The extent of impacts would generally be regional, covering federal and state leases in the Beaufort and Chukchi seas. However, supporting transportation and commercial uses would be affected out of region in areas that provide support services, such as Nome and Dutch Harbor. The context of impact would be important because the affected federal and state waters are currently available for leasing, and no existing or additional waters would be available for exploration under the characteristics of this alternative. In total, the direct and indirect impacts on land use are considered to be major; they would be high intensity, interim, regional, and result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations. This would be offset to some degree by the potential reduction/elimination in conflicts with subsistence uses in the EIS proposed project area.

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water management under Alternative 1 are described as follows. The magnitude of management impacts on federal and state waters would be high because major changes in the ability to conduct activities on leases on federal and state waters could result from this action and conflict with management objectives. The duration of impact would be interim because leaseholders would not be able to utilize leases for exploration of oil and gas resources. The extent of impacts would generally be regional, covering federal and state leases in the Beaufort and Chukchi seas, although some changes in federal land and water management could occur state-wide. The context of impact would be important because the affected federal and state waters are currently available for leasing, and no additional waters would be available for exploration under the characteristics of this alternative. In total, the direct and indirect impacts on land and water management are considered to be major; they would be high intensity, interim, state-wide, and result in changes of federal and state land and water management by effectively preventing exploration for oil and gas resources.

4.4.2 Mitigation Measures Under Alternative 1

No standard or additional mitigation measures associated with socioeconomics would be implemented or utilized under Alternative 1 because no permits or authorizations would be issued by BOEM or NMFS related to oil and gas activities.

4.5 Direct and Indirect Effects for Alternative 2 – Authorization for Level 1 Exploration Activity

4.5.1 Physical Environment

4.5.1.1 Physical Oceanography

Physical characteristics of the ocean in the EIS project area are discussed in Section 3.1.1 of this EIS. The discussion in Section 3.1.1 is divided into several sections, with each section focusing on particular physical characteristics of the ocean:

- Water Depth and General Circulation;
- Currents, Upwellings, and Eddies;
- Tides and Water Levels;
- Stream and River Discharge; and
- Sea Ice.

The analysis below discusses the effects of the proposed activities on the physical characteristics of the ocean and potential hazards that may be caused by physical characteristics of the ocean on the proposed activities (i.e., risks to human safety). The analysis of alternatives is structured in a fashion parallel to the discussion of physical oceanography in Section 3.1.1. The level of impacts on physical oceanography would be based on criteria of intensity, duration, geographic extent, and context, as shown in Table 4.5-1.

Table 4.5-1 Impact Criteria for Effects on Physical Oceanography

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Changes in physical characteristics of the ocean may not be measurable or noticeable	**Medium**: Noticeable changes in physical characteristics of the ocean	**High**: Acute or obvious changes in the physical characteristics of the ocean including waves, currents, tides, sea ice
Duration	**Temporary:** Impacts would be intermittent, infrequent, and typically last less than a month.	**Interim:** Impacts would be frequent or extend for longer time periods (an entire project season).	**Long-term:**: Impacts would cause a permanent change in the resource that would perpetuate even if the actions that caused the impacts were to cease.
Geographic Extent	**Local**: Impacts limited geographically; <10% of EIS project area affected	**Regional**: Affects physical characteristics of the ocean beyond a local area, potentially throughout the EIS project area	**State-wide**: Affects physical characteristics of the ocean beyond the region or EIS project area
Context	**Common**: Affects usual or ordinary physical characteristics of the ocean	**Important**: Affects semi-unique physical characteristics of the ocean	**Unique**: Affects unique physical characteristics of the ocean

4.5.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

Effects on water depth and general circulation resulting from the activities described under Alternative 2 would be restricted to changes in bathymetry that would result from deposition of material discharged to the seafloor during exploratory drilling programs. Certain permitted materials, including drill cuttings and drilling fluids, would be discharged to the water in the vicinity of the drilling activity (see Section 2.3.3 - Exploratory Drilling Activity Discharges and Emissions). The discharged cuttings and drilling fluids would be composed of a slurry of particles with wide ranges of grain sizes and densities, ranging from liquids and neutrally-buoyant colloids to gravel (Neff 2005). Most cuttings solids would have densities between 2.30 to 2.65 g cm^{-3}, whereas barite (a common component of drilling muds) has a density of 4.3 g cm^{-3} (Neff 2005). As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo rapid fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90 percent of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10 percent of the mass of the mud solids consisting of fine-grained particles would drift with prevailing currents away from the drilling site (NRC 1983, Neff 2005). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor, whereas coarser and denser particles would be deposited on the seafloor within several hundred meters of the point of discharge, forming a mud/cuttings pile that would affect water depths near the drilling site (Figure 4.13) (Neff 2005, NRC 1983).

A working definition of a cuttings pile is taken to be “a discrete accumulation of material clearly identifiable as resulting from material discharged from drilling activities, and forming a topographic feature distinct from the surrounding seabed” (adapted from Gerrard et al. 1999).

The distance traveled by discharged particles, and thus, the spatial extent and depth of the cuttings pile would depend not only upon the attributes of the discharged material but also upon the rate and duration of the discharge, the distance between the discharge point and the seafloor, lateral transport of discharged material in the water, turbulence, and local current speeds (MMS 2002, Neff 2005). Modeled distribution and loading of material on the seafloor following discharges of drill cuttings to OCS waters suggests that maximum loading of the seafloor from drilling waste solids would be 64 kg m^{-2}, equating to a depth of about 4 cm (1.6 inches), in an area adjacent to a platform (Smith et al. 2004, Neff 2005). However, cuttings pile heights measured in the North Sea under conditions different from those used in the model are 15 to 19 m (49 to 62ft) for cuttings piles with volumes of 40,000 to 45,000 m^3 (251,592 to 283,041 bbl) (Gerrard et al. 1999; Koh and Teh 2011). Exploratory wells are estimated to discharge about 1,000 m^3 (6290 bbl) of dry solids over the life of the well (NRC 1983). In 2012, the EPA released information regarding the deposition of open water drilling fluid solids in the Beaufort and Chukchi Seas in relation to Shell’s exploration drilling programs on leases in both OCS regions (EPA 2012c, d). In the Beaufort Sea, the maximum deposition for a slower current speed of 0.1 m/s (0.32 ft./sec) occurs from 100 to 500 m (328 to 1,640 ft.) from the discharge point while the maximum deposition occurs 800 to 1,400 m (2,624 to 4,600 ft.) from the discharge point for a higher current speed of 0.3 m/s (1 ft./sec) (EPA 2012c, d). Current speeds in the Beaufort and Chukchi seas can exceed 0.3 m/s. Additional information can be found in the EPA’s evaluations (EPA 2012c, d). Changes in water depth from discharged material would have only minor effects on the physical resource character of the EIS project area. Those effects would be low-intensity, long-term, and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS.

Currents, Upwellings, and Eddies

Seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys would have only negligible effects on currents, upwellings, and eddies within the proposed action area.

Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of one island per year under Alternative 2, would result in medium-intensity, long-term, local effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial islands are constructed to support exploratory drilling activities. Use of drillships or jackup rigs in deeper state and federal waters would be temporary in nature and have only a seasonal presence of extremely limited size and geographic distribution, and would have negligible effect on currents, upwellings, and eddies within the proposed action area.

Tides and Water Levels

The activities described under Alternative 2 would be temporary in nature and would have only a seasonal presence of extremely limited size and geographic distribution, and would not affect tides or water levels within the proposed action area.

However, wind, waves and storm surge would potentially impact seismic and exploratory drilling activities, and could influence human safety as a result of the activities described under Alternative 2.

Stream and River Discharge

The activities described under Alternative 2 would occur in marine waters and would generally not affect stream and river discharge within the proposed action area. Exploratory drilling in state waters on grounded ice could occur from manmade reinforced ice "islands," but would have negligible effects on stream and river discharge within the nearshore portion of the proposed action area.

Sea Ice

Seismic surveys and site clearance and shallow hazards surveys conducted during the open water period would not affect sea ice in the proposed action area.

Icebreaking activities and thermal inputs associated with in-ice seismic surveys and exploratory drilling activities in the Beaufort and Chukchi seas would result in noticeable changes in the character of the sea ice in the vicinity of the icebreaking activity. However, when ambient temperatures are far below zero °C (32 °F), as is often the case in Arctic regions when sea ice is present, the effects of icebreaking activities would be temporary as seawater exposed to the air as a result of icebreaking activities would freeze within hours of the activity, effectively replacing the broken ice. Repeated icebreaking within a given channel leads to formation of brash ice and an overall thickening of ice within the channel (Ettema and Huang 1990, Thomas and Dieckmann 2010). Icebreaking activity would have medium-intensity, temporary, and local effects on sea ice. These effects would be minor and would affect a common resource.

On-ice seismic surveys involving truck-mounted vibrators would have minor effects on sea ice within the proposed action area. On-ice vibroseis operations would require stable sea ice at least 1.2 m (3.9 ft.) thick. Such surveys would generally occur only between January and May over landfast ice or stable pack ice near the shore. Noticeable changes to the character of the ice would result from marking the ice in order to designate source receiver locations and from construction of snow ramps to smooth rough ice within the survey area. The effects of these activities on sea ice would be medium-intensity, local, temporary, and would affect a resource that is common in the proposed action area.

Construction of ice islands, which could occur in nearshore state waters of the Beaufort Sea under Alternative 2, would result in medium intensity, temporary, local effects on sea ice in state waters of the Beaufort Sea. These effects would be minor, and would occur only if artificial islands are constructed to support exploratory drilling activities.

The presence of sea ice in lease and non-lease areas targeted for open water seismic exploration and exploratory drilling could result in changes to the schedule, location and duration of exploratory activities. The presence of ice also represents a potential hazard to vessels and exploratory drilling platforms. Industry operators in offshore areas have developed procedures for managing sea ice, including changes to schedule, vessels dedicated to ice management, and procedures for taking drilling platforms off location until potential hazards subside.

In-ice and on-ice seismic exploration activities could experience similar and additional hazards from sea ice, including the potential for ice override events. On-ice exploration activities have established protocols for response to potential ice hazards. Moving ice is not expected to impact drilling on artificial ice islands, but storm surge and ice override events could have potential effects. Within the Beaufort Sea, where drilling on artificial ice islands could occur in state waters, much of the area is protected from ice override by barrier islands. Individual drilling operations would need to assess the potential for ice related hazards and develop appropriate design and operation protocols. In-ice exploration activities would use an ice breaker for the purpose of ice management and have established protocols for response to potential ice hazards.

4.5.1.1.2 Conclusion

The overall effects of Alternative 2 on physical ocean resources would be of medium intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall direct and indirect effects of the proposed level of activity described in Alternative 2 on physical ocean resources in the EIS project area would be minor.

4.5.1.2 Climate

The IPCC (2014) reports the Alaskan Arctic has reacted to changes in climate over the past century. Alaska has warmed twice as fast as the rest of the nation, bringing widespread impacts. Sea ice is rapidly receding and glaciers are shrinking (Chapin *et al.* 2014). Emissions of GHGs around the world are believed to be one of several factors driving the changes, which are attributed to atmospheric warming of the Earth's climate. As a result, the CEQ released revised draft guidance that describes how federal agencies should consider the effects of greenhouse gas emissions and climate change in their NEPA reviews (CEQ 2014)

Following this guidance, NMFS finds the proposed action and alternatives have the potential to emit GHGs into the atmosphere in quantities that may be meaningful to an evaluation of climate change. Consequently, GHG emissions due to the proposed action and alternatives are quantified and disclosed as a factor that could potentially contribute to changes in the global climate. GHG emissions are also discussed relative to the relationship to (or effect on) the proposed action and alternatives.

The GHGs that EPA regulates under the Clean Air Act are, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases as defined in 40 CFR 98.6. The combustion of fossil fuels, such as diesel and gasoline, is responsible for the majority of GHGs. For example, when burned, a gallon of regular diesel fuel produces 22.4 pounds of CO_2, and burning a gallon of regular gasoline (with 10 percent ethanol) produces 17.7 pounds of CO_2 (BP 2005; EIA 2012). Because carbon dioxide (CO_2) is the reference gas for climate change, measures of non-CO2 GHGs are converted into CO_2 equivalent (CO_2e) based on their potential to absorb heat in the atmosphere (known as global warming potential [GWP]) (40 CFR 98.6).

Refer to Section 3.1.2.4 (Climate Change in the Arctic) for a thorough discussion of climate systems.

4.5.1.2.1 Direct and Indirect Effects

Direct effects contributing to climate change would occur as a result of CO_2e emissions caused by the drilling and seismic vessels proposed to be used under this alternative. Indirect effects occur due to the operation of vessels and aircraft in support of the proposed activities but are separated from the original project in either time or space. In addition, the sources identified as causing indirect effects are those that remain under practical control and responsibility of the operator, assuming the effects can be quantified.

Direct Effects

Direct effects contributing to climate change under this alternative would occur from CO_2e emissions occurring during operation of engines used to power the drillships, drilling units, seismic vessels, and all other onboard engines and generators necessary to operate the vessels and equipment. The engines are powered by diesel oil, a fuel produced from a fossil source of carbon that when burned adds CO_2e emissions to the biosphere contributing to climate change.

Indirect Effects

Indirect effects to resources under this alternative that have the potential to contribute to climate change are emissions of CO_2e from the operation of crew boats, supply vessels, icebreaker vessels, aircraft, and other support vessels needed to complete and protect the activities and programs proposed under this alternative. The owner or operator would have an oversight role in these activities and would have the authority to limit or otherwise control operations of the vessels and hence the emissions. The activities proposed under this alternative, which include EPs and seismic surveys, do not include removal or extraction of any product of drilling. Therefore, potential emissions from the transport of raw materials, refining the oil and gas product, usage of oil and related products, or the manufacturing of plastic products and asphalt from crude oil is not considered under this or any other alternative in this EIS.

Regulatory Reporting and Permitting

The EPA established the portion of the GHG Reporting Rule that applies to petroleum and natural gas systems in 2010 (75 FR 74458, November 30, 2010). Established at 40 CFR Part 98, Subpart W, the EPA requires the owner or operator of certain stationary facilities to report potential emissions of CO_2e that is expected to equal or exceed 25,000 metric tons per year (tpy). The EPA finalized the last step to the phase-in approach to permitting emissions of CO_2e under the Clean Air Act effective on August 13, 2012 (77 FR 41051, Jul. 12, 2012). Under the last step, certain new and existing stationary industrial facilities identified by the EPA with CO_2e emissions that equal or exceed 100,000 metric tpy must obtain an operating permit under Title V of the Clean Air Act.

The data are used by EPA to implement the Clean Air Act Section 103(g) regarding improvements in strategies and technologies for preventing or reducing air pollutants, and to inform policy-makers on possible regulatory actions to address and reduce CO_2e emissions. The rule, as it applies to the oil and gas industry, pertains only to the extraction of crude petroleum and natural gas, the transportation by pipeline of natural gas, and natural gas distribution facilities. Consequently, the activities and programs proposed under this alternative are not subject to the EPA GHG Reporting Rule and a permit is not required. However, reporting the total potential emissions of CO_2e should be disclosed in any environmental review under the NEPA.

CO_2e Projected Emissions Inventory

Under this alternative several programs and activities are proposed including exploration plans, multiple seismic surveys (some including an icebreaker vessel), shallow hazards surveys, and on-ice seismic surveys plans within the U.S. Beaufort and Chukchi seas. The specific description and number of each of these programs and activities proposed for the U.S. Beaufort and Chukchi seas, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*). The estimated potential annual emissions of CO_2e for each type of activity and program proposed under this alternative are provided in Table 4.5-2. The data in this table assume no controls to reduce emissions.

Effects of this Alternative on Climate Change

Existing climate models are not refined enough to accurately predict changes in the climate within the timeframe considered under this EIS. This is because climate change resulting from CO_2e emissions occurs many years, often decades, after the emissions are generated and in locations far from the point of emission. Given the uncertainty of existing climate change models, it is not feasible to determine the effect of this alternative to such a degree that measurable consequences can be defined over a relatively short period of time (120-day drilling season or 76-day survey). Nonetheless, the potential impact of contributions to the CO_2e emission budget, particularly in the Arctic, is recognized as a concern by the

EPA. Therefore, total annual CO_2e emissions would be reported for activities and programs once specific project details are proposed and available under this alternative.

Table 4.5-2 Projected CO_2e Emissions by Activity and Program Type for the Arctic OCS

Activity/Program Types	**Chukchi Sea OCS Annual CO_2e Emissions (metric tons per year)**
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	44,761
Site Clearance and High Resolution Shallow Hazards Survey Program	7,435
Exploration Plan	93,007
Total	**145,203**
Activity/Program Types	**Beaufort Sea OCS Annual CO_2e Emissions (metric tons per year)**
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	58,405
Site Clearance and High Resolution Shallow Hazards Survey Program	7,435
On-Ice Seismic Survey	25
Exploration Plan	93,007
Total	**158,872**

Sources: EPA. October 1996. Compilation of Air Pollutant Emission Factors (AP-42) 5th ed., Volume I, Chapter 3, Table 3.3-1 and Table 3.4-1.
EPA. July 2010. Median Life, Annual Activity and Load Factor Values for Nonroad Engine Emissions Modeling (EPa-420-R-10-016, NR-005d).
BOEM 2012b. ION Seismic Survey.
EPA 2012. EPA and NHTSA Set Standards to Reduce GHG and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks. Table 1. http://www.epa.gov/oms/climate/documents/420f12051.pdf

Effects of Climate Change on Resources under this Alternative

Decreases in sea ice thickness and extent associated with climate change could affect timing and location of in-ice seismic and on-ice vibroseis surveys, as well as extend the season for drilling activities requiring ice-free conditions. The types of conditions that could affect activities under this alternative may require unique planning and engineering but are not expected to adversely affect the implementation of this alternative.

4.5.1.2.2 Conclusion

An analysis was performed to quantify emissions of greenhouse gases associated with Alternative 2. Under this alternative, the estimated annual emissions of CO_2e would be 145,203 metric tons in the Chukchi Sea OCS area, and 158,872 metric tons in the Beaufort Sea OCS area. Emissions of CO_2 and other greenhouse gasses under Alternative 2 could potentially contribute to changes in global climate. However, the amount to which changes in global climate are attributable to any single anthropogenic source is very small, and it is not currently useful to attempt to link specific climate impacts to the particular activities proposed under Alternative 2, as such direct linkage is difficult to isolate and to understand. In this case it is appropriate to evaluate and disclose estimated CO_2e emissions by activity and program type for the Arctic OCS under Alternative 2. These data are provided in Table 4.5-2.

The sources identified above would also produce GHG emissions that would contribute to climate change. This level of emissions would be negligible relative to existing GHG emissions at the regional, State, national, and global levels and would represent a negligible level of effect. It is also acknowledged that some portion of the oil and gas produced from Arctic OCS leases would be consumed as fuel, which would produce GHG emissions that would contribute to climate change. However, because end use consumption is not part of the Proposed Action and because any attempt to quantify a marginal increase in national oil and gas consumption (much less resulting GHG emissions or ensuing environmental effects) attributable to Arctic OCS oil and gas would be unduly speculative, this EIS does not attempt to quantitatively analyze or model environmental effects from the end use consumption of produced oil and gas.

4.5.1.3 Air Quality

Activities associated with oil and gas exploration work that have the potential to affect air quality include: seismic surveys, site clearance and shallow hazards surveys, other various surveys (e.g., on-ice vibroseis and electromagnetic surveys), and exploratory drilling. A list of typical equipment used for these activities is provided in Table 2.2 *Summary of Typical Support Operations for Exploration Activities*, and includes survey vessels, diesel-fired power generating equipment needed for drilling and miscellaneous support activities, and various other vessels used in support of these survey and drilling activities (e.g., tugboats, supply boats, icebreakers, crew boats, oil spill response vessels, and aircraft). The majority of air emissions from these activities are due to fuel combustion used to power vessel propulsion and power generation. The federal and state regulated air pollutants that are associated with this alternative are summarized in Table 3.1-4 *Federal and State Ambient Air Quality Standards*, which is based on the National Ambient Air Quality Standards (NAAQS). The criteria pollutants mainly associated with combustion of diesel fuel include:

- CO – carbon monoxide,
- PM_{10} – coarse particulate matter,
- $PM_{2.5}$ – fine particulate matter,
- SO_2 – sulfur dioxide, and
- NO_2 – nitrogen dioxide.

Also under consideration are emissions of volatile organic compounds (VOCs), not a criteria pollutant, but a precursor to the formation of O_3; therefore, VOC is a regulated pollutant under national emission standards for hazardous air pollutants (40 CFR 61 and 40 CFR 63.40) Fuel combustion releases lead (Pb), ammonia (NH_3) and reduced sulfur compounds (RSC) depending on fuel characteristics and applied control technologies, if any are used. While not specifically evaluated, the activities proposed under this alternative may release a limited amount of fugitive emissions from storage tanks (i.e., VOCs) and potential associated onshore activities (i.e., emissions of fugitive dust from roads and disturbed lands).

4.5.1.3.1 Direct and Indirect Effects

The assessment of direct and indirect air quality effects that may potentially occur as a result of implementation of an OCS EP or to conduct seismic surveys requires consideration of provisions under NEPA, the Clean Air Act, and the OCSLA. Under NEPA, a projected inventory is created to disclose total emissions likely to occur as a result of the proposed alternative. The total projected emissions inventory would include an accounting of emissions from all reasonably foreseeable sources, including mobile and stationary, land, sea, and air, and temporary and permanent emissions—all emissions that would occur only through the implementation of the proposed alternative. Based on the annual projected emission rate (expressed in tons per year), the inventory may be translated into pollutant concentrations (expressed as micrograms per cubic meter, $\mu g/m^3$) using an EPA-approved computer dispersion model to assess the onshore effect of the proposed alternative. The results of the computer dispersion modeling would be compared to the NAAQS, together with the background concentrations, as required under the Clean Air Act.

Emission Inventory

Projected emission inventories measure the total rate of direct and indirect emissions from a proposed action and are the first step in identifying potential air quality effects of a proposed alternative. The projected emission inventory is also the basis for dispersion analysis, when needed, that measures the actual air quality effect on the nearest onshore areas, including potentially affected communities on the North Slope. Regulated pollutants that are considered in the projected emission inventory include:

- CO;
- PM_{10};
- $PM_{2.5}$;
- SOx – sulfur oxides that include emissions of SO_2;
- NO_x – nitrogen oxides that include emissions of NO_2;
- VOC; and
- CO_2e – carbon dioxide equivalent emissions.

Preparing an inclusive projected emission inventory for each proposed alternative requires operational information for all the marine engines and equipment sources of the pollutants listed above. As no specific project or plan is proposed under the alternatives of this EIS, the inventories provided in this section reflect emissions from sources likely to be engaged in an EP or seismic survey plan. Likely sources include the drilling unit for the EP (i.e. drillship), survey vessels, and support vessels for monitoring, crew change, ice-management, oil-spill-response equipment, fuel barges, and aircraft (helicopter and fixed-wing). The varied use of these sources would be specific to actual operations proposed for an action, and the operational specifics would modify the projected emission inventory presented in an EIS or environmental assessment (EA). Operational specifics include vessel transit speeds, which are highly variable, and range from 8 knots to 20 knots depending on the operational need, vessel's design, the sea state, ice conditions, local meteorology, length of the operation, and choice and design of drilling units and survey vessels.

Exploration Plan Projected Emission Inventory. An inventory of projected emissions likely to occur from the implementation of the EP under the proposed alternative was prepared using information available from recent EPs submitted to BOEM AOCSR (Shell Chukchi Sea & Beaufort Sea EP 2012). A summer drilling season on the Arctic OCS for an EP was assumed to be 120 days throughout the ice-free period from July through the end of October. The inventory methodology conservatively assumes operation of the drilling unit for 24 hours each day for the entire 120 days.

The projected emission rates likely to occur as a result of implementation of one EP, where one EP is proposed for the Chukchi Sea OCS and one EP for the Beaufort Sea OCS, are presented in Table 4.5-3.

Aircraft emissions includes both helicopter and fixed-wing aircraft. Emissions from aircraft were estimated using the Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT, Version 2B; released May 29, 2015), a software system designed to dynamically model aircraft performance in space and time to compute emissions. (FAA 2015).

Table 4.5-3 Projected Annual Emission Inventory of an Exploration Plan

Pollutant Sources	One (1) Exploratory Drilling Program and Annual Emissions for One Drilling Season (tons per year)					
	PM	NO_X	SO_2	CO	VOC	CO_2e*
Drillship	2.53	20.90	0.22	6.47	3.16	12,805
Ice Breakers (2 vessels each EP)	6.35	37.20	0.27	29.15	6.83	16,676
Anchor Handler	6.47	37.80	0.27	29.52	6.92	16,620
Oil Spill Response Vessels	0.90	98.10	0.27	27.61	9.74	5,561
Oil spill Response Work Boats	1.00	14.40	0.01	3.10	1.10	
Auxiliary Marine Vessels	11.00	158.00	0.00	28.00	5.00	6,598
Aircraft	NA	0.17	0.08	3.48	1.47	204
Total	**28.25**	**366.57**	**1.12**	**127.33**	**34.22**	**58,464**

Note: CO2e is the carbon dioxide equivalent, and represents greenhouse gas (GHG) emissions.
Annual refers to one total drilling season, approximately 120 days.
NA is not available.
Values of 0.00 are not zero, rather the values are less than 0.005 tons/year.
Source: BOEM, 2012 Shell Revised Chukchi Sea EP EA, Table 27

Survey Projected Emission Inventory. An inventory of emissions likely to occur from operations throughout seismic, on-ice, and shallow hazards surveys was prepared using information developed for the 2012 ION Seismic Survey EA (BOEM 2012b) (more recent projected emission estimates were released in a 2014 study supported by BOEM [Fields Simms et al 2014]), which for each survey assumed a research survey vessel with gross tonnage of approximately 3,500 tons. The survey was conservatively assumed to occur over a period of 76 days, operating 24 hours each day. The annual emission rates likely to reflect the multiple surveys proposed under this alternative for the Arctic OCS are presented in Table 4.5-4.

Greenhouse Gases and Hazardous Air Pollutants

In addition to the pollutants regulated under the BOEM AQRP, emissions of GHGs and hazardous air pollutants (HAPs) occur as a result of the operation of diesel-powered vessels supporting oil and gas activities on the OCS. Because of the change in jurisdiction under Pub. L. 112-74, GHG and hazardous air pollutant (HAP) emissions are no longer reported to the EPA through the Clean Air Act Title V or Prevention of Significant Deterioration (PSD) permitting processes. The BOEM does not require reporting these emissions as a condition of EP approval. It is, therefore, the independent responsibility of the lessee to coordinate with the appropriate EPA office to arrange and comply with mandatory reporting of GHG and HAP emissions, including any permits for GHG emissions that exceed 100,000 tons per year under the PSD Tailoring Rule (77 FR 41051, Jul. 12, 2012) or for HAPs under Section 112 of the Clean Air Act. Should a State of Alaska air permit be required, which would only occur if a lessee proposed a drilling location within the three-mile State boundary, an accounting of ammonia (NH_3) emissions and RSC may be required. The BOEM does not regulate emissions of NH_3 or RSC. Therefore, the lessees would be expected to coordinate independently with the ADEC to arrange and comply with mandatory reporting of NH_3 and RSC emissions.

Applications for State air quality permits, if required, are not included as part of this EIS. State air quality permits on the Arctic OCS are only required when a lessee proposes a drilling location within three miles of shore, which are considered State jurisdictional waters. Details regarding air permit actions (type and schedule), along with specific source/equipment applicability, will be determined once a project alternative has been selected and specific project details are known.

Fugitive Emissions and Oil Spills

Potential fugitive emissions from fuel storage tanks on vessels are not included in this EIS assessment and would be expected to have a minor impact at the facility and an even lower impact onshore. However, fugitive emissions may need to be inventoried in connection with a State of Alaska air permit, if one is required.

There are no regular activities associated with the proposed alternative that would generate fugitive dust, as most activities would occur over open water. In the event of temporary onshore activities that may generate fugitive dust, measures would be taken to reduce fugitive dust. Neither of these localized or onshore occurrences is expected to vary with the proposed alternatives; therefore, no evaluation of these pollutant sources is provided in this analysis.

There is the potential for oil spills from drilling failure or equipment leaks under the proposed alternative. Although these emissions are unplanned, oil spills have the potential to impact air quality due to the hydrocarbon volatilization, in-situ burning of spilled fuel, and the operation of additional vessels and equipment for cleanup and restoration. The use of oil spill response vessels as a precaution is included in the emissions estimates for the proposed alternative. Fugitive emissions from oil spills are addressed in Section 4.10, and are not used as a criterion for comparing effects on air quality between alternatives.

Table 4.5-4 Estimated Annual Emission Inventory of Multiple Surveys on the Arctic OCS

Vessels	Arctic OCS Total Project Emissions- Potential to Emit (tons per season)					
	PM	NO_X	SO_2	CO	VOC	CO_2e*
Geo Arctic	5.72	159.02	23.51	35.59	6.03	7,374
Polar Prince	2.81	96.28	16.22	22.07	2.87	4654
Total	**8.53**	**255.30**	**39.73**	**57.66**	**8.90**	**12,028**

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
Sources: BOEM 2012c ION Seismic Survey EA (Table 6)

4.5.1.3.2 Air Quality Impact Analysis

To date, much of the emissions and meteorological data developed for the Arctic region are project specific. BOEM is currently undertaking an Arctic Air Quality Modeling Study aimed at providing a comprehensive baseline air quality analysis with a comprehensive emissions inventory, consistent meteorological dataset, and air dispersion analysis to support environmental impact assessments under NEPA. The Arctic Air Quality Modeling Study will also assess current methods for estimating thresholds used to assess the potential adverse effects that planned offshore oil and gas activities might have on onshore air quality, as required by the BOEM AQRP, and recommend improvements, if necessary. . The Arctic Air Quality Modeling Study will also provide improved and consolidated information about the emission sources in the study area, disseminate that information to the public, and inform several environmental justice initiatives.

Due the ongoing nature of the aforementioned Arctic Air Quality Modeling Study, adequate *de minimis* and screening thresholds based on total emissions did not exist at the time this particular programmatic NEPA study was prepared. Therefore, air dispersion modeling would be required to understand the impacts to air quality from the sources. Such modeling is anticipated to be performed as part of the project-specific permitting efforts to be reviewed by BOEM.

When an air quality impact analysis is required, the lessee would use a computer dispersion model approved by the EPA to predict concentration of pollutants and report potential air quality impacts. The analysis would be conducted using the methods, and a preferred model, recommended in the EPA *Guideline on Air Quality Models* (40 CFR Part 51 Appendix W). A meteorological data set of sufficient length would be used to ensure that worst-case meteorological conditions are adequately represented in the model results. For NEPA purposes only, and in lieu of dispersion modeling of total emissions, with approval from the reviewing authority, the air quality effect may be satisfied by a lessee who provides documentation of a previous oil and gas air quality impact analysis conducted for a project of similar size and scope. The similar project would not be farther from shore than the proposed plan and the similar project would also be located on the Arctic OCS.

Results of the dispersion analysis of total emissions would be used to determine the project's air quality level of effect on the State of Alaska. The dispersion analysis, if required, would provide at a minimum, predicted pollutant concentrations on the State of Alaska and in the nearest community (under NEPA) for all the primary and secondary standards (except ozone) regulated by the Clean Air Act (i.e., the NAAQS). Predicted cumulative concentrations in excess of the NAAQS would be considered substantial and likely require mitigation through emission controls and reduction strategies.

Air Quality Related Values (AQRV) Analysis

Air quality related values (AQRVs) are resources sensitive to air quality and include a wide array of resources including but not limited to vegetation, soils, water, fish and wildlife, and visibility. Visibility is a particular concern for a project proposed near an EPA Class I wilderness area and national parks. Alaska has four Class I areas. The nearest Class I area to the proposed action is the Denali National Park, located approximately 650 kilometers (400 statute miles) distance from the project area. There would be no impact to Denali National Park from the activities proposed under this alternative and an AQRV analysis is not required.

Emission Controls and Reduction Strategies

There would be no emission controls or pollution reduction strategies required for a stationary facility unless there is a potential for substantial air quality impacts onshore. Emissions from stationary sources can include operator adherance to manufacturer's recommendations; for instance, operating diesel engines at 80% power to avoid wearing out the engine prematurely. Such strategies are typically accounted for in the air quality analysis. Other potential strategies include after-market mechanical scrubbers and control devices, such as a Selective Catalytic Reduction (SCR) device. Such strategies were not included in this analysis of emissions from stationary sources or mobile sources but may in fact be utilized to further reduce emissions to comply with applicable regulatory requirements. (BOEM 2015)

4.5.1.3.3 Level of Effect

Establishing thresholds and *de minimis* levels for the study area is a current on-going task of BOEM. It is a complicated process based on distance to shore and magnitude of emissions. As previously stated, these thresholds do not exist and air dispersion modeling is really the best way to understand if a particular activity will comply with the NAAQS. The BOEM Arctic Air Quality Study is currently under way with the objective of establishing *de minimis* emissions thresholds.

The calculations for dispersion emission indicate the greater the rate of emissions offshore, the greater the impact onshore; however, many factors combine to affect the transport of air pollutants, including meteorological conditions, the temporary nature of the activities, the location on the OCS of any stationary sources of emissions, and whether the entire proposal includes only mobile sources and. no stationary sources.

As detailed in a 2015 EIS for the Chukchi Sea, BOEM stated: “Dispersion analysis is necessary when impacts from the Scenario cannot be discerned solely from the projected emissions. As previously described, prior to December 2011, the EPA had jurisdiction to control air emission sources on the Chukchi Sea OCS Planning Area, and lessees submitted a permit application to EPA that included results obtained through computer simulation modeling. The modeling included the use of a Gaussian steady-state computer model. Similar modeling would be conducted by lessees to satisfy requirements of BOEM’s AQRP in the event that projected potential annual emissions exceeded an applicable AQRP exemption threshold….” (BOEM 2015)

Preliminary screening model results discussed in comments from BOEM suggest that available data indicate that the NO_x emissions stated in Table 4.5-3 would exceed the 1-hr 188 µg/m^3 NAAQS by 18 µg/m3 (the solution was 206 µg/m^3) at a distance of 5 miles from shore, which could occur in the Beaufort Sea OCS leases. While drillship activity associated with Alternative 2 are generally centered greater than 10 miles beyond the federal/state maritime boundary located three miles offshore, a number of 3D ocean-bottom cable seismic survey vessel activity would be centered just beyond the federal/state maritime boundary (see Figures 4.7 and 4.8, Conceptual Example for Alternative 2 [Level 1 Exploration Activity for U.S. Beaufort and Chukchi seas, respectively]). As noted by BOEM commentors, the seismic ships would likely traverse back and forth through a grid that keeps the ship close to shore line and within the same general area, creating a scenario similar to a stationary source. For this reason, the magnitude of air quality impacts associated with the proposed project is medium to high.

Further discussion of the applicability of single line source analyses is provided by BOEM in the previously referenced 2015 EIS for the Chukchi Sea (BOEM 2015). The 2015 analysis is available at:

> http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/2015_0127_LS193_Final_2nd_SEIS_Vol1.pdf

Due to the variability of exploration activities, potential effects of emissions from an EP at unique or sensitive locations are expected to be only a temporary occurrence. Therefore, the context of air quality effects is expected to be the same for any of the alternatives. Table 4.5-5 presents the impact criteria used to evaluate effects on air quality.

Table 4.5-5 Impact Criteria for Effects on Air Quality

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Effects are below air quality regulatory limits.	**Medium**: Effects are equal to air quality regulatory limits.	**High**: Effects are sufficient to exceed air quality regulatory limits.
Duration	**Temporary**: Air quality would be reduced infrequently but not longer than the span of the project season and would be expected to return to pre-activity levels at the completion of the activity.	**Long-term**: Air quality would be reduced throughout the life of the project and would return to pre-activity levels at some time after completion of the project.	**Permanent**: Air quality would be reduced and would not be anticipated to return to previous level.
Geographic Extent	**Local**: Affects air quality only locally.	**Regional**: Affects air quality on a regional scale.	**State-wide**: Affects air quality beyond a regional scale.
Context	**Common**: Affects areas of common air quality or unclassified airsheds.	**Important**: Affects unclassified airsheds with local air quality standards.	**Unique**: Affects areas of very high or very low quality air: Class I airshed or EPA non-attainment area.

4.5.1.3.4 Conclusion

Absent *de minimis* thresholds or screening tools currently being developed by BOEM, a project-specific dispersion analysis would be conducted to assess the effect of the subject emission sources for comparison with the NAAQS. However, considering project emissions, and distance to shore in the context of model-predicted impacts provided by a BOEM commentor, there may be a moderate air quality effect on the State of Alaska due to the drillship alone.

While emissions from the survey vessels are much lower compared to an EP, the survey activities involve back-and-forth travel in a relatively tight grid at distances closer to the shoreline (within both the 3-mile federal/state maritime boundary and the 5-mile distance suggested by a BOEM commentor). Taken together, the smaller emissions could result is disproportionately higher impacts when compared to those from an EP located further offshore. For these reasons, both the EP and survey activities have the potential to exceed the NAAQS.

Cumulatively, the total estimated emissions for the Arctic OCS planning area, when considering all plans and activities described under this alternative, are summarized in Table 4.5-6. The effects of Alternative 2 on air quality range from medium (if emission reduction strategies are used to reduce onshore effects) to high (if reduction strategies are not used).

Table 4.5-6 Projected Annual Emission Inventory for Arctic OCS – Level 1 Activity

Plan/Activity	Arctic OCS Annual Emissions (tons per year)					
	PM	NO_X	SO_2	CO	VOC	CO_2e*
Multiple Surveys	8.53	255.30	39.73	57.66	8.90	12,028
Exploration Plans - One (1)	28.25	366.57	1.12	127.33	34.22	58,464
Total	**36.78**	**621.87**	**40.85**	**184.99**	**43.12**	**70,492**

4.5.1.4 Acoustics

The term acoustics for purposes of this EIS refers to the state of ensonification of the environments of the EIS project area by anthropogenic noise resulting from activities of the alternatives. The acoustic environment is an important habitat component for multiple species. For example, sound is critical to marine mammals for communication, prey and predator detection, and for detecting and interpreting other important environmental clues (e.g., navigation). The presence of increased sound levels from anthropogenic activity and consequent exposures of marine wildlife to these conditions could potentially cause effects. In addition, the acoustic environment influences the success of subsistence uses through disturbance and behavior modification of marine mammals and other subsistence resources, and potentially impeding subsistence harvest activities and use of the environment. This section considers levels of ensonification (intensity), duration and spatial extent of anthropogenic noise produced by Alternative 2 to inform the wildlife and subsistence effects assessments elsewhere in this EIS. Alternative 2 is the first alternative that introduces anthropogenic noise sources associated with oil and gas exploration. The acoustic characteristics of these sources are compiled and discussed in this section specifically for Alternative 2 but the same sources are used in other alternatives and the information presented here is also relevant for those.

The evaluations of acoustics effects in this section consider three criteria: intensity, duration, and extent, as defined in Table 4.5-8 below. The criteria are based on sound levels that have been associated with possible disturbance of marine mammals, although specific impacts are not considered here (see section 4.2.6). Intensity considers the magnitude of the broadband acoustic source levels associated with the activity. Duration considers the time period over which sound sources operate. Extent considers the spatial area over which sound levels exceed the lowest marine mammal disturbance level relative to the Beaufort and Chukchi seas; the impact category of context is not applicable to acoustics, as it is not a resource that can be classified as common, important, or unique (although context in a more general sense is critical to an assessment of acoustic impacts and is therefore discussed in relation to its importance to certain biological resources in those individual sections).

Table 4.5-8 Impact Criteria for Acoustics

Impact Category	Intensity Type	Definition
Intensity (Magnitude)	Low	Broadband acoustic source levels from anthropogenic sources are below 160 dB re 1 uPa @ 1 m (either continuous SPL or 90% rms SPL for impulsive sources).
	Medium	Broadband acoustic source levels from anthropogenic sources reach or exceed 160 and are below 200 dB re 1 µPa @ 1 m.
	High	Broadband acoustic source levels from anthropogenic sources reach or exceed 200 dB re 1 uPa @ 1 m.
Duration	Temporary	Acoustic levels are modified for days to one month.
	Interim	Acoustic levels are modified for 1 to 6 months (an entire project season).
	Long-term	Acoustic levels are increased for more than 6 months in a given year or for multiple months that recur over multiple successive years.
Geographic Extent	Local	Anthropogenic noise levels are increased above 120 dB re 1 uPa over less than 10% of the EIS project areas.
	Regional	Anthropogenic noise levels exceed 120 dB re 1 uPa over at least 10% and less than 50% of the EIS project areas.
	State-wide	Anthropogenic noise levels exceed 120 dB re 1 uPa over 50% or more of the EIS project area.

Alternative 2 includes exploration activities that would likely require an ITA for possible harassment of marine mammals from noise produced by seismic survey sources, drill rigs and vessels. Other than the No Action Alternative, Alternative 2 contemplates the lowest level of activity.

Noise sources included in Alternative 2 include deep-penetration seismic airgun arrays, seismic survey vessels, including in-ice seismic vessels for winter programs, small airgun arrays for site clearance and high resolution shallow hazards surveys or for use during VSP surveys in conjunction with exploration drilling activities, vibroseis systems for on-ice surveys, and drilling rigs. With the exception of exploratory drilling rigs, all of the source types have operated in the EIS project area environments for commercial oil and gas exploration projects between 2006 and 2010. Most of these projects operated under IHAs that required acoustic measurements of underwater noise sources, and the results are cataloged in a series of monitoring reports submitted to NMFS (see references in Table 4.5-8). The reports dating back to 2006 are publicly available on NMFS' ITA website: http://www.nmfs.noaa.gov/pr/permits/incidental.htm.

Table 4.5-9 lists the specific programs conducted in the EIS project area and the sources included in the reported acoustic measurements that are relevant to understanding sound levels produced by airgun arrays and vessels as included in activities under the alternatives.

Table 4.5-9 O&G Exploration Projects in the EIS Project Area, 2006- 2015, that have reported measurements of sound levels produced by their activities

Project Operator and Year	Primary Survey Type	Location	Water Depths (m)	Airgun Array	Survey Vessel	Support Vessel	Sidescan/Multibeam	Sub-bottom Profiler	Spark/Boom/Pulse	Drilling	Reference
Shell Offshore Inc. 2006	3D 3D, SH	Chukchi, Beaufort	40 40-50	X X	X X	X X			 X		Blackwell 2007
GX Technology 2006	2D	Chukchi	30-3,800	X							Austin & Laurinolli 2007
ConocoPhillips Alaska 2006	3D	Chukchi	<50	X	X						MacGillivray & Hannay 2008
Shell Offshore Inc. 2007	3D, SH	Chukchi, Beaufort	40+	X	X	X		X	X		Hannay et al. 2008
Eni and PGS 2008	OBC	Beaufort	2-14	X	X	X					Warner et al. 2008
BP Alaska 2008	OBC	Beaufort	0.3-9.1	X	X	X					Aerts et al. 2008
ConocoPhillips Alaska 2008	SH	Chukchi	32		X				X		Turner and Trivers 2008
Shell Offshore Inc. 2008	3D, SH	Chukchi, Beaufort	19-44	X	X	X		X	X		Hannay et al. 2009
Shell Offshore Inc. 2009	SH	Chukchi	48, 41	X	X			X			Warner et al. 2010
Statoil 2010	3D	Chukchi	38-43	X							O'Neill et al. 2010
Shell Offshore Inc. 2010	SH,GT	Chukchi, Beaufort	46-51 15-38	 X	X X		X X	X X			Chorney et al. 2011

Project Operator and Year	Primary Survey Type	Location	Water Depths (m)	Airgun Array	Survey Vessel	Support Vessel	Sidescan/Multibeam	Sub-bottom Profiler	Spark/Boom/Pulse	Drilling	Reference
Statoil 2011	SH,GT, GC	Chukchi	37	X	X	X	X	X			Warner and McCrodan, 2012
BP 2012	OBC	Beaufort	1.8-18	X	X						McPherson and Warner, 2012
ION 2012	2D	Beaufort	50-1016	X	X						Wladichuk et al. 2013
Shell 2012	DR	Beaufort				X				X	Austin et al. 2013
Shell 2012	DR	Chukchi				X				X	Austin et al. 2013
Shell 2013	SH, GT	Chukchi	42-48	X	X	X	X	X			Reider et al. 2013
TGS 2013	2D	Chukchi	41-48	X	X	X					Austin and Baily 2013
SAE 2014	OBC	Beaufort	4.0-7.9	X							Heath et al. 2014
Shell 2015	Drilling	Chukchi	46							X	Austin and Li 2016

Notes:

2D = 2-Dimensional seismic survey using airgun array sources

3D = 3-Dimensional seismic survey using airgun array sources

OBC = Ocean Bottom Cable or Ocean Bottom Sensor survey using airgun array sources

SH = Site Clearance and high resolution shallow hazards surveys using small airgun arrays, sparkers or boomers or bubble pulsers.

GT = Geotechnical survey using sidescan, multibeam, single beam sonars

GC = Geotechnical Coring

DR = Drilling using drillship or drill rig

4.5.1.4.1 Acoustic Propagation Environments

The Alternative 2 noise sources generate acoustic footprints that depend on the source type and location of operation. For this discussion, the overall EIS project area is divided into three primary acoustic environments introduced in Section 3.1.4.1. These environments are the Chukchi shelf, the Beaufort shelf, and Beaufort coastal area. Though the sediment type and water column features may vary across these environments, the primary distinguishing factor for influencing sound propagation in each environment is water depth. The EIS project area on the Chukchi Shelf is comprised of spatially-uniform water depths between approximately 25 m (82 ft.) and 50 m (164 ft.) in the areas of oil and gas activities. Bottom relief over the extent of individual seismic or site clearance survey areas is generally small, typically within 10 percent of the nominal location depth, but spatially-extended 2D surveys can cover larger depth intervals. The Beaufort shelf areas have a larger depth range, from approximately 15 m (50 ft.) to a few hundred meters near the shelf edge; however, most recent exploration activity has occurred in less than 35 m (115 ft.) water depth. The lower depth range limit of 15 m (50 ft.) is due mainly to difficulties towing seismic streamers in shallower water. Surveys in shallower water are performed using OBC/OBN systems with hydrophones deployed on the seabed. OBC surveys were performed by Eni/PGS and BP in 2008 inside the barrier islands of the Beaufort Sea, in water depths less than 5 m (16 ft.), to a few kilometers outside the islands in water depths to approximately 15 m (50 ft.).

4.5.1.4.2 Relevant Acoustic Thresholds

Acoustic footprints will be considered in terms of areal extents and source-receiver distances to specific noise thresholds that are pertinent for assessing marine mammal acoustic impacts. NMFS historically considered thresholds of 190 and 180 dB re 1 µPa (rms) to be representative of the levels below which we can be confident that PTS (or auditory injury) will not occur, based on TTS data in pinnipeds and cetaceans respectively. Thresholds for marine mammal disturbance are 120 dB and 160 dB re 1 µPa for continuous and pulsed noises, respectively. However, as discussed in Section 4.2.6.4 of this EIS, NMFS has revised its acoustic thresholds for auditory injury. NMFS notes that marine mammals may respond to pulsed noise at levels below 160 dB re 1 µPa (potentially down to 120 dB) in a manner with the potential to impact subsistence uses of those animals, and, therefore, distances to the 120 dB re 1 µPa isopleths are typically identified for both continuous and pulsed sources. Richardson (1995) noted bowhead deflections at 35 km (21 mi) distance from a seismic survey airgun array source in the Alaskan Beaufort Sea, and estimated the corresponding exposure SPL between 125 and 133 dB re 1 µPa. Additionally, as noted earlier (Section 4.2.6), other studies also suggest that some portion of mysticetes may respond to seismic sources at received levels lower than 160 dB (potentially down to 120 dB) in a manner that NMFS would consider harassment, and therefore, we are currently considering revisions to the acoustic thresholds for behavioral harassment. Therefore, acoustic information will be presented pertaining to the occurrence of sound levels at threshold values of 190 dB, 180 dB, 160 dB and 120 dB re 1 µPa.

4.5.1.4.3 Acoustic Footprints of Airgun Sources

Airgun array sources generate impulsive sound with source levels typically exceeding 200 dB re 1 µPa @ 1m. The SSV measurements for the oil and gas programs listed in Table 4.5-8 have determined the distances at which certain sound level isopleths from airgun sources are reached. The common approach to determine threshold distances has been to fit smooth curves through broadband rms SPL measurements and then to select the distances at which the curves cross the thresholds (Warner et al. 2008). Conservative estimates of the distances are obtained by shifting the best-fit curves upward in level so they exceed 90 percent of the measurement data values. The distances determined from the shifted curves are referred to as 90^{th} percentile distances. Most of the measurements of airgun array sources have sampled sound levels in both the endfire direction (parallel to airgun array tow direction) and broadside direction (perpendicular to tow direction) to quantify direction-dependent sound emissions. Appendix G provides a summary of the airgun array measurements that have been performed for the programs listed in Table 4.5-9. Measured distances for sound, including seismic survey sound, change depending upon ambient conditions (e.g., wind, waves, salinity, temperature). Therefore, Appendix G provides a snapshot of one set of measurements taken at these sites rather than a static threshold.

The results in Appendix G exhibit variability of the measured levels, even when considering similar sources in the same primary acoustic environment. This can arise due to differences in the source geometry such as the layout of airguns in an array and the tow depth. The results are also dependent on the seafloor sediment types and the structure of the ocean sound speed profile, both factors that influence sound propagation. At present, there is not sufficient geoacoustic information available to quantify these differences and allow the primary acoustic environments to be further subdivided. Instead the measurements have been averaged to provide representative propagation ranges for each environment by size of source.

Representative distances to sound level thresholds of 190, 180, 160 and 120 dB re 1 µPa (rms) for airgun sources were obtained by averaging Appendix G results for offshore and coastal surveys, and are presented in Table 4.5-11. The averages are based on the 90^{th} percentile measured distances and the maxima of broadside and endfire measurements where both directions are sampled. These distances were used to assess the direct and indirect acoustic effects zones from airgun sources for each action alternative.

Table 4.5-11 Average distances to sound level thresholds from measurements listed in Appendix G for several airgun survey systems.

The averages are based on 90th percentile distances, where available, and the maxima of broadside and endfire measurements are used where both directions were sampled.

Array Volume (in^3)	Average distance (m) and standard deviation to sound levels (dB re 1 µPa; 90% rms SPL) based on 90th percentile fit			
	190	**180**	**160**	**120**
Chukchi Sea Shelf, 25 to 50 m depth				
10	13 (6)	44 (10)	506 (191)	18380 (6801)
20	26 (8)	76 (10)	710 (177)	20333 (4643)
40	<10 (-)	76 (-)	1360 (-)	41100 (-)
60	37 (10)	127 (26)	1320 (397)	27200 (3544)
105	10 (3)	56 (13)	1550 (50)	43000 (17000)
1049	62 (-)	179 (-)	1449 (-)	30988 (-)
~3200	420 (-)	1350 (-)	3240 (-)	61400 (-)
Beaufort Sea Shelf, ≥15 m depth				
10	21 (23)	53 (48)	401 (135)	12710 (3340)
20	17 (17)	54 (41)	729 (199)	17475 (5197)
30	8 (5)	30 (22)	1180 (188)	24600 (490)
40	24 (-)	158 (-)	1602 (-)	9221 (-)
70	24 (1)	84 (10)	1051 (310)	27670 (24330)
280	89 (-)	250 (-)	1750 (-)	22220 (-)
320	360 (-)	1134 (-)	4265 (-)	13313 (-)
640	516 (-)	1386 (-)	4616 (-)	14163 (-)
3147	889 (32)	2573 (328)	11453 (1953)	74813 (-)
4380	341 (54)	1770 (520)	12480 (6220)	96450 (34550)
Beaufort Coastal, <15 m depth				
10	54 (-)	188 (-)	1049 (-)	n/a
20	52 (31)	139 (53)	833 (175)	6525 (4275)
40	147 (9)	263 (30)	1016 (83)	3242 (-)
320	260 (-)	472 (-)	1545 (-)	16598 (-)
320	195 (-)	635 (-)	1818 (-)	n/a
880	225 (45)	485 (90)	2225 (1021)	14500 (7015)

A dash (-) signifies that only one data point was available and standard deviation could not be calculated.

4.5.1.4.4 Acoustic Footprints of Non-Airgun Sources

The non-airgun sources of Alternative 2 include seismic vessels, support vessels, drill rigs (drillships and jack-up rigs) and on-ice surveys using vibroseis. Site clearance surveys also employ high-resolution acoustic sources including multibeam and sidescan sonars, echosounders and sub-bottom profilers. The majority of these sources do not ensonify areas where sound levels exceed NMFS' injury thresholds. However, they may produce sound levels that exceed NMFS' continuous and/or pulsed noise thresholds for marine mammal disturbance (i.e., Level B harassment). Sound source noise emissions are discussed here, and representative distances to the 120 dB re 1 µPa threshold are summarized in Table 4.5-12. This table only presents a representative sample, and other vessels will likely have different sound propagation characteristics.

Support vessel operations in the Beaufort and Chukchi Shelf environments may, depending on the type of vessels employed, individually generate 120 dB re 1 µPa zones extending approximately 1 km to 5.4 km (0.6 to 4 mi) (Chorney et al. 2010). For reference, open water ambient noise levels in the Chukchi Sea in the 10 Hz to 24 kHz frequency band can fall below 100 dB re 1 µPa (Fig 3.19 in O'Neill et al. 2010). Noise generated by research vessel *Mt. Mitchell*, transiting at 10 knots over the Burger prospect during Shell's 2010 Geotechnical Survey, reached 120 dB re 1 µPa at 1.6 km distance. Its sound emission levels increased when operating in dynamic positioning (DP) mode, and the estimated distance to 120 dB re 1 µPa increased to 5.6 km (Chorney et al. 2010).Vessel operations in the shallower coastal areas of the Beaufort Sea produce smaller noise footprints due to reduced low frequency sound propagation in shallower water. Acoustic measurements of nine vessels, including two source vessels, three cable lay vessels, and two crew-change/support vessels were made in 9 m water depth during the Eni/PGS 2008 OBC project (Warner et al. 2008). Their 120 dB re 1 µPa threshold distances ranged from 280 m, for a cable lay vessel to 1,300 m (0.8 mi) for a crew change vessel. The average distance was 718 m (0.43 mi), and that value is considered as representative for support vessels in coastal operations.

Drillship sound levels are discussed in Section 2.3.3. An initial estimate of the 120 dB re 1 µPa threshold distance for drilling from a drillship was based on the source level measurements of the drillship *Noble Discoverer* made in 2009 in the South China Sea (Austin and Warner 2010). Those measurements indicated drilling source levels from 178.5 to 185.4 dB re 1 µPa@1m (10 Hz to 24 kHz). Based on that information, acoustic modeling using Marine Operations Noise Model (MONM, JASCO Applied Sciences) estimated the 120 dB re 1 µPa threshold distance at between 1.5 and 2 km (0.9 and 1.2 mi). Subsequently, Shell's 2012 drilling program SSC measurements were reported in their 2012 90-day report (Austin et al., 2012). Drilling of a 26" diameter hole at Shell's Burger-A site in the Chukchi Sea with no other vessels nearby produced a source level of 181 dB re 1µPa@1m and resulted in a 120 dB re 1 µPa distance of 1.5 km. Drilling with a support vessel alongside increased the distance to 2.7 km. The measurements also included short-term auxiliary activities, including excavation of mudline cellar using an auger style drill system, ice management with an icebreaker, and anchor connections involving use of a tug (*Tor Viking*) to attach cables from the drillship to anchors set on the seafloor to hold the *Noble Discoverer* in place. A summary of measurements for these activities is provided in Table 4.5-12.

Shell's drilling project in the Chukchi Sea in 2015 involved two drill ships and more than ten support vessels. A summary of measurement results from drilling at their Burger J prospect using the semi-submersible drillship *Polar Pioneer*, is given in Table 4.5-13.

Table 4.5-12 Sound level threshold distances for drilling by *Noble Discoverer* and related ancillary activities in the Chukchi Sea during Shell's 2012 drill program. Reproduced from Shell's 2013 program Comprehensive Report.

Drill Site Activity	rms SPL Threshold Radii (m)			
	190 dB re 1 µPa	180 dB re 1 µPa	160 dB re 1 µPa	120 dB re 1 µPa
Drilling 26" hole with *MSV Fennica* on DP alongside*	<10	<10	11	2687
Drilling 26" hole (no ancillary vessels)	< 10	< 10	< 10	1500
Drilling of mudline cellar**	< 10	<10	71	8159
Ice management	< 10	< 10	60	9600**
Anchor connection	<10	20	178	14,069**

* *MSV Fennica* is a 116 m (381-foot) multipurpose icebreaker and supply vessel.
** Extrapolated from maximum measurement range of 8200 m.

Table 4.5-13 Sound level threshold distances for drilling by *Polar Pioneer* and related ancillary activities in the Chukchi Sea during Shell's 2015 drill program. Reproduced from Shell's 2015 program 90-Day Report.

Activity	rms SPL threshold distances (m)							
	190 dB re 1 µPa		180 dB re 1 µPa		160 dB re 1 µPa		120 dB re 1 µPa	
	Best fit	90% fit	Best fit	90% fit	Best fit	90% fit	Best fit	90% fit
Circulating1	0*	0*	0*	0*	0*	0*	870	1,150
Running casing1	0*	0*	<10*	<10*	<10*	<10*	1,330	1,750
Drilling1	0*	0*	0*	0*	0*	0*	2,950	6,150
MLC construction1	<10*	<10*	<10*	<10*	40*	40*	19,050*	20,880*
Anchor handling2	<10**	<10**	<10**	<10**	40**	60**	9,730**	11,140**

*Extrapolated inside of or beyond measurement range from 0.5 km to 16 km.
** Extrapolated inside of or beyond measurement range from 0.1 km to 2.1 km.
1 Measured at Burger J site
2 Measured at Burger V site

Shell's 2015 acoustic analysis also considered the aggregate area ensonified above 120 dB re 1 uPa on a continuous basis due to noise from drilling and all of their support vessels was on average 1264 km^2. This area corresponds to a circle of radius 20.1 km, although the actual shape of the area depends on support vessel location distribution.

Jack-up drill rigs produce lower level of sounds than vessels as the support legs do not effectively transmit vibrations from on-rig equipment into the water. For the purpose of this evaluation, the 120 dB re 1 µPa threshold distance is based on modeled noise levels predicted by a noise model prediction made for a 2014 exploration drilling program contemplated by ConocoPhillips (O'Neill et al. 2012). This modeling assumed a broadband source level of 167 dB re 1 µPa@1m and estimated the 120 dB re 1 µPa threshold distance at 210 m (689 ft.).

Sounds from on-ice vibroseis systems are discussed in Section 2.3.2. Vibroseis source pressure waveforms are typically frequency sweeps below 100 Hz, though strong harmonics may exist to 1.5 kHz, and with signal durations of 5 to 20 seconds. They are presently categorized as continuous-type sounds (Richardson et al. 1995). The measurement of on-ice vibroseis source levels in shallow water is complicated by interference from bottom and surface reflections, and as a consequence there is considerable variability in the published source levels. Holliday measured an on-ice vibroseis source level of 187 dB re 1 µPa@1m, with bandwidth 10 to 70 Hz (Holliday et al. 1984 as discussed in Richardson et al. 1995). While this source level is several decibels higher than those of vessels, its low operating frequency will lead to shorter horizontal propagation distances. It is expected the maximum levels will be similar to or less than those from the larger vessels. The largest 120 dB re 1 µPa threshold distance for vessels in the Eni/PGS 2008 OBC study was 1,300 m (0.8 mi). That distance is assumed for the vibroseis in this analysis.

The measurements referenced in the preceding discussion are summarized in Table 4.5-14a, providing the expected distances to the 120 dB disturbance threshold for each non-airgun source. These values are used in the impact assessments that follow for each alternative.

Table 4.5-14a Examples of measured distances to 120 dB re 1 µPa for non-airgun sources, from discussion above

Source Type	Distance to 120 dB re 1 µPa
Drillship alone	2-6 km (1.2-3.6 mi)
Jack-up rig alone	210 m (689 ft.)
Support Vessel in Offshore Operation	1.6 km (1 mi)
Drillship with support vessel fleet	20.1 km (12.5 mi)
Support Vessel in Coastal Operation	0.72 km (0.43 mi)
On-ice vibroseis	1.3 km (0.78 mi)

4.5.1.4.5 Direct and Indirect Effects

Under Alternative 2, underwater noise levels will increase in the vicinity of seismic survey and support vessels, drill rigs, and airgun sources. The effects considered here are based on the current NMFS rms sound level thresholds for PTS (auditory injury) and disturbance that were discussed above.

Estimates of Total Surface Areas of Ensonification at Threshold Levels

Table 4.5-14a contains estimates of surface areas ensonified above given threshold levels under Alternative 2 based on the ranges provided in Appendix G. For the purpose of computing these notional areas, the seismic survey activities listed in Table 4.2-1 for Activity Level 1 are distributed among the three environments considered in this EIS. The three 2D/3D surveys and three site clearance or high resolution shallow hazards surveys in the Chukchi Sea are all assumed to be in the mid-depth shelf region; the four exploration surveys and three site clearance or high resolution shallow hazards surveys in the Beaufort Sea are divided between the mid-depth shelf and the shallow-depth coastal regions in the proportions of 3:1 and 2:1 respectively (giving greater representation to the shelf region makes the estimates more precautionary). The source array sizes in the three zones reflect the prevailing configurations for seismic surveys conducted in each region. The percentages are based on nominal surface areas of 263,500 km^2 for the Chukchi Sea portion of the EIS project area and 255,350 km^2 for the Beaufort portion. Of note, the total surface areas do not subtract out either overlap with other isopleths of concurrent source operation or land area where activities are closer to shore. For that reason, the area ensonified over 120 dB re 1 µPa is likely an overestimate (see Figures 4.7 through 4.12 illustrating conceptual examples). Also of note is that Tables 4.5-14 a-c provide percentages of EIS areas ensonified above 120 dB re 1 µPa for all sources (seismic and drilling/support vessel) and separately for just drilling/support vessels. The latter value is used for assessing Alternatives in terms of magnitude of effect for behavioral disturbance because NMFS applies the 120 dB re 1 µPa threshold only to continuous-type noise sources; impulsive sounds from seismic surveys are evaluated with the 160 dB re 1 µPa threshold. The former (area above 120dB for all sources including seismic) is included to be generally illustrative and to inform the magnitude of effects on the acoustic environment and acoustic habitat (i.e., animals will hear seismic at these levels and the potential to mask acoustic cues exists).

Table 4.5-14b Total Surface Areas (km²) Ensonified Above Sound Level Thresholds Under Alternative 2, From Average Distances Listed in Table 4.5-11 and 4.5-14a

		Total Surface Area (km²) to sound level (dB re 1 µPa; 90% rms SPL)			
		190	**180**	**160**	**120**
Chukchi Sea Shelf, 25 to 50 m depth					
	3 x ~3200 in³	2.64	26.6	1010	81398
	3 x 40 in³	0.01	0.15	16.4	6973
	1 x drill/support*				1264
	% Chukchi (all sources)	**0.00%**	**0.01%**	**0.39%**	34.02%
	% Chukchi (drill/support* only)				**0.48%**
Beaufort Sea Shelf, ≥15 m depth					
	3 x ~3200 in³	7.44	62.4	1236	52750
	2 x 20 in³	0.00	0.02	3.34	1919
	1 x drill/support*				1264
Beaufort Coastal, <15 m depth					
	1 x 880 in³	0.16	0.74	15.6	661
	1 x 20 in³	0.01	0.06	2.18	134
	% Beaufort (all sources)	**0.00%**	**0.02%**	**0.49%**	22.22%
	% Beaufort (drill/support* only)				**0.50%**
Entire Region					
	all sources	10.26	89.9	2283	146362
	% EIS area (all sources)	**0.00%**	**0.02%**	**0.44%**	28.21%
	% EIS area (drill/support* only)				**0.49%**

*drill/support indicates the combined area ensonified by a drillship and all support vessels.

Table 4.5-14c Total Surface Areas (km^2) Ensonified Above Sound Level Thresholds Under Alternative 3, From Average Distances Listed in Table 4.5-11 and 4.5-14a

		Total Surface Area (km²) to sound level (dB re 1 μPa; 90% rms SPL)			
		190	**180**	**160**	**120**
Chukchi Sea Shelf, 25 to 50 m depth					
	5 x ~3200 in³	4.39	44.33	1682.60	135663.59
	5 x 40 in³	0.02	0.25	27.37	11621.38
	2 x drill/support*				2528
	% Chukchi (all sources)	**0.00%**	**0.02%**	**0.65%**	56.86%
	% Chukchi (drill/support* only)				**0.96%**
Beaufort Sea Shelf, ≥15 m depth					
	4 x ~3200 in³	9.92	83.16	1648.20	70333.79
	3 x 20 in³	0.00	0.03	5.01	2878.10
	2 x drill/support*				2528
Beaufort Coastal, <15 m depth					
	2 x 880 in³	0.32	1.48	31.11	1321.04
	2 x 20 in³	0.02	0.12	4.35	267.51
	% Beaufort (all sources)	**0.00%**	**0.03%**	**0.66%**	30.28%
	% Beaufort (drill/support* only)				**0.99%**
Entire Region					
	all sources	14.67	129.4	3399	227141
	% EIS area (all sources)	**0.00%**	**0.02%**	**0.66%**	43.78%
	% EIS area (drill/support* only)				**0.97%**

*drill/support indicates the combined area ensonified by a drillship and all support vessels.

Table 4.5-14d Total Surface Areas (km^2) Ensonified Above Sound Level Thresholds Under Alternative 4, 5, and 6, From Average Distances Listed in Table 4.5-11 and 4.5-14a

		Total Surface Area (km^2) to sound level (dB re 1 μPa; 90% rms SPL)			
		190	**180**	**160**	**120**
Chukchi Sea Shelf, 25 to 50 m depth					
	5 x ~3200 in^3	4.39	44.33	1682.60	135663.59
	5 x 40 in^3	0.02	0.25	27.37	11621.38
	4 x drill/support*				5056
	% Chukchi (all sources)	**0.00%**	**0.02%**	**0.65%**	57.81%
	% Chukchi (drill/support* only)				**1.92%**
Beaufort Sea Shelf, ≥15 m depth					
	4 x ~3200 in^3	9.92	83.16	1648.20	70333.79
	3 x 20 in^3	0.00	0.03	5.01	2878.10
	4 x drill/support*				5056
Beaufort Coastal, <15 m depth					
	2 x 880 in^3	0.32	1.48	31.11	1321.04
	2 x 20 in^3	0.02	0.12	4.35	267.51
	% Beaufort (all sources)	**0.00%**	**0.03%**	**0.66%**	31.27%
	% Beaufort (drill/support* only)				**1.98%**
Entire Region					
	all sources	14.67	129.4	3399	232197
	% EIS area (all sources)	**0.00%**	**0.02%**	**0.66%**	44.75%
	% EIS area (drill/support* only)				**1.95%**

*drill/support indicates the combined area ensonified by a drillship and all support vessels.

4.5.1.4.6 Conclusion

Alternative 2 presents the lowest activity level analyzed of the alternatives, but it represents an increase in activity above current levels of activity in the EIS project area. The distances to PTS thresholds are given in Appendix G (summarized in Table 4.5-11) for deep penetration airgun array sources and shallow hazards sources. The 180 dB re 1 μPa distance for deep penetration seismic sources extends out to 2,570 m for 2D and 3D surveys on the Beaufort Shelf based on measurements of 3147 in^3 arrays. All of the sound sources associated with Alternative 2 will ensonify nearby areas above the current marine mammal disturbance threshold of 120 dB re 1 μPa for continuous noise and 160 dB re 1 μPa (90 percent rms) for impulsive noise. Estimated distances to these thresholds for seismic airgun sources are given in Table 4.5-11 and for all other sources in Table 4.5-13a, b, c,. The largest expected distance to the 160 dB re 1 μPa disturbance threshold for airgun sources is 11.4 km (6.8 mi), and to the 120 dB re 1 μPa continuous SPL for non-airgun sources it is the drillship at 10 km (6 mi). The maximum measured 120 dB re 1 μPa radius from airgun sources is 167 km (104 mi) (Austin and Laurinolli, 2007), but the average distance for recent 3-D surveys in the Beaufort and Chukchi Sea is 95 km (59 mi) (Table 4.5-11). The relevance of these disturbance zones to specific marine mammal species is discussed in Sections 4.5.2.4.

Separately, modeled chronic and aggregate effects on acoustic habitat from July through mid-October were substantial at several modeled sites in the Beaufort Sea, with losses of up to 98% of the broadband listening area for mid- and low frequency species and up to 20% of bowhead whale communication space (see Section 4.5.2.4.9 for full explanation of the acoustic habitat analysis). The relevance of these modeled results to specific marine mammal species and their acoustic habitat is discussed in Section 4.5.2.4.

The intensity rating of this alternative is high, as additional exploration activities will introduce sound sources with levels that exceed 200 dB re 1 µPa. Because the exploration activities could continue for several months over successive years, the duration is considered long-term. The spatial extent of these activities is regional, since the distribution of exploration activities over the EIS project area will lead to 25 percent of the EIS project area being exposed to sound levels in excess of 120 dB re 1 µPa. Therefore, the overall impact rating for direct and indirect effects to the acoustic environment under Alternative 2 would be moderate.

4.5.1.5 Water Quality

The EPA has the authority to regulate discharges of pollutants to federal waters of the Beaufort and Chukchi seas under the NPDES program. ADEC has the authority to regulate discharges of pollutants to state waters of the Beaufort and Chukchi seas under the APDES program. Wastewater generated from activities within the EIS project area would be discharged in accordance with the conditions of the applicable NPDES and/or APDES permits, as described in Section 3.1.5.1.

The water quality parameters most likely to be affected by the activities described in the alternatives fall into four categories: temperature and salinity; turbidity and total suspended solids; dissolved metals; and hydrocarbons and other organic contaminants. There are many additional metrics for water quality that could be applied to the EIS project area (e.g., pH, fecal coliform counts, residual chlorine concentrations), but considering the nature of the activities described in the alternatives, these four categories encompass the water quality parameters most likely to reflect the potential effects of the alternatives on long-term productivity and sustainability of valued ecosystem components.

The actions proposed in Alternatives 2, 3, 4, and 5 are defined by four action components and various combinations of mitigation measures. The action components are: seismic surveys, site clearance and shallow hazards surveys, on-ice seismic surveys, and exploratory drilling programs, which are described in detail in Chapter 2 of this EIS. The water quality effects of each action component are analyzed separately for each alternative. Overall, seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys are expected to have negligible impacts on water quality. Effects of exploratory drilling on water quality would depend upon the specific techniques used for exploratory drilling, the location of the activity, and mitigation measures implemented, such as reduced discharge and seasonal prohibitions. For example, construction of gravel artificial islands in nearshore waters would result in different impacts to water quality than would drilling from a floating vessel or a jackup rig in OCS waters (see Section 2.3.3).

In any case, exploratory drilling programs would involve discharges to the marine environment that could result in adverse impacts to water quality. The transport, dispersion, and persistence of materials discharged into the marine environment from exploratory drilling operations have been previously evaluated for several areas of the Alaska Arctic OCS. The general conclusions reached in these studies regarding the transport, dispersion, and persistence of drilling discharges are discussed below (from EPA 2006b):

> *The drilling mud discharge separates into an upper and lower plume. Physical descriptions of effluent dynamics and particle transport differ substantially for the two plumes. Drill cuttings (parent material from the drill hole) are generally coarse materials that are deposited rapidly following discharge and settle within the 100-m radius mixing zone. Discharged drilling*

> *materials typically settle in the immediate vicinity of the discharge area. However, deposition patterns are extremely variable and are strongly influenced by several factors, including the type and quantity of mud discharged, hydrographic conditions at the time of discharge, and height above the seafloor at which discharges are made.*
>
> *Although metals were enriched in the sediment, enrichment factors were generally low to moderate, seldom exceeding a factor of 10. The spatial extent of this enrichment also was limited. These considerations suggest that exploratory activities will not result in environmentally significant levels of trace metal contamination. However, other factors, such as the intensity of exploratory activities, normal sediment loading, and proximity either to commercial shell fisheries or to subsistence populations, could alter this conclusion. Analyses of sediment barium and trace metal concentrations have been used to examine nearfield fate of drilling fluids on the seafloor (e.g. the rate of dispersion of sedimented material). If high concentrations of barium are persistently found near a well site, this finding suggests it is in a lower energy area, which favors deposition. If elevated levels cannot be found, even soon after drilling, then this finding suggests a higher energy environment, where resuspension and sediment transport were promoted.*
>
> *Data from exploratory drilling operations have been used to examine deposition of metals resulting from drilling operations. These indicate that several metals are deposited, in a distance-dependent manner, around platforms, including cadmium, chromium, lead, mercury, nickel, vanadium, and zinc. At present, the area-wide large-scale distribution of drilling discharges is difficult to predict. However, it can be surmised that drilling discharges associated with short-term exploration operations will have little effect on the environment due to deposition of drilling-related materials on the seafloor.*

In October 2012, the EPA released updated analyses in conjunction with the new NPDES permits for the Beaufort and Chukchi seas (EPA 2012c, d). At that time, the EPA also released a technical memorandum on the "Results from Chukchi/Beaufort Seas Permit Dilution Modeling Scenarios" (EPA 2012h). This memorandum documents the simulation of mixing and dispersion of pollutant discharges authorized by the Beaufort and Chukchi general permits. The primary discharge type of interest is drilling fluid (mud) with dispersal in the water column and deposits on the sea bed producing smothering impacts and potentially exposing water column and benthic organisms to contaminants in the drilling fluid. The evaluation considered a range of expected discharge rates and physical configurations for the range of ambient environmental conditions including water depth, stratification, and tidal and non-tidal currents characterizing the areas. Mixing, dispersion, and deposition are simulated using version 2.5 of the Offshore Operators Committee Mud and Produced Water Discharge Model (OOC Model). Additional information can be found in the memorandum issued by the EPA and is incorporated herein by reference.

The level of impacts to water quality are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-15a.

Table 4.5-15a Impact Criteria for Effects on Water Quality

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Effects are below water quality regulatory limits	**Medium**: Effects are equal to water quality regulatory limits	**High**: Effects are sufficient to exceed water quality regulatory limits
Duration	**Temporary:** Impacts would be intermittent, infrequent, and typically last less than a month.	**Interim:** Impacts would be frequent or extend for longer time periods (an entire project season).	**Long-term:** Impacts would cause a permanent change in the resource that would perpetuate even if the actions that caused the impacts were to cease.
Geographic Extent	**Local**: Affects water quality only locally	**Regional**: Affects water quality on a regional scale	**State-wide**: Affects water quality beyond a regional scale
Context	**Common**: Affects areas of common water quality or where there is an abundance of water sources	**Important**: Affects areas with high water quality or water sources that are considered important in the region	**Unique**: Affects areas of high water quality that are protected by legislation

<u>4.5.1.5.1 Direct and Indirect Effects</u>

Water Temperature and Salinity

Seismic Surveys

Seismic surveys conducted from ships are not expected to have any measureable impact on water temperature or salinity in the proposed action area. Thermal inputs to the water from seismic survey activities would be extremely local in nature, and any effects on water quality resulting from such inputs are expected to be negligible. If there is coolant water withdrawn or water for desalination withdrawn, there would be negligible temperature and salinity effects in surface waters, as permitted and regulated under current NPDES general permits in federal waters or APDES general permits in state waters.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys are not expected to have any measureable impact on water temperature or salinity in the proposed action area. Thermal inputs to the water from site clearance and shallow hazards survey vessels would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible. If there is coolant water withdrawn or water for desalination withdrawn, there would be negligible temperature and salinity effects in surface waters, as permitted and regulated under current NPDES general permits in federal waters or APDES general permits in state waters.

On-ice Seismic Surveys

On-ice seismic surveys are not expected to have any measureable impact on water temperature or salinity in the proposed action area. Thermal inputs to the water from on-ice seismic surveys vehicles would cause some ice melt but would be extremely local in nature, and any effects on water quality resulting from such inputs are expected to be negligible. Likewise, on-ice seismic surveys are not expected to affect the salinity of waters within the proposed action area.

Exploratory Drilling Programs

Exploratory drilling programs can be conducted from a variety of different platforms (see Chapter 2). The choice of platform affects the type and magnitude of impacts on water temperature and salinity. Certain discharges from oil and gas exploratory drilling programs in the Beaufort and Chukchi seas would be considered by the EPA under the CWA Section 402, NPDES permitting authority. Prior to issuance of NPDES discharge permits for these actions, EPA is required to comply with the Ocean Discharge Criteria (40 CFR 125 Subpart M) for preventing unreasonable degradation of ocean waters.

In addition to muds and cuttings, NPDES-permitted discharge streams may include deck drainage, sanitary wastes, domestic wastes, desalination unit wastes, blowout preventer fluid, boiler blowdown, fire control system test water, non-contact cooling water, uncontaminated ballast water, bilge water, excess cement slurry, and test fluids (EPA 2012a; EPA 2012b).

Non-contact cooling water is comprised of seawater that would be pumped continuously to provide cooling for certain pieces of machinery associated with exploratory drilling activities. Heat transferred from the machinery to the water is expected to raise the temperature of the seawater in the system by about 1.5 degree Celsius (EPA 2012h). Chlorine, as calcium hypochlorite, or a similar biocide, would be added to the non-contact cooling water to reduce biofouling and would contribute to the overall salinity of the waste stream. Before discharge, water from the cooling system would generally be mixed with other discharges. After mixing, sodium metabisulfate may be added to the effluent to reduce total residual chlorine concentration to comply with regulatory limits (MMS 2002, EPA 2006b). Discharged waters would be slightly warmer and would contain higher concentrations of dissolved salts relative to the ambient waters of the Beaufort and Chukchi seas. Therefore, discharged waters would increase the temperature and salinity of the seawater in the immediate vicinity of the discharge. Effects on water quality resulting from increased temperature and salinity from exploratory drilling activities under Alternative 2 are expected to be low-intensity, temporary, local, and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS.

Turbidity and Total Suspended Solids

Seismic Surveys

Seismic surveys conducted using shipboard acoustic instruments generally do not involve chemical inputs, discharges to the marine environment, or contact with the seafloor. Therefore, in most instances, seismic survey activities would not be expected to affect turbidity or concentrations of total suspended solids within the proposed action area. If any of the vessels involved in seismic survey activities were to set an anchor within the action area, then suspension of seafloor sediments could result in localized increases in turbidity around the area where the anchor is set and retrieved. Ocean-bottom cable/node seismic surveys would result in localized, temporary increases in turbidity in the immediate vicinity of the survey area as the lines are laid on and retrieved from the seafloor. There is also the potential for the lines to affect turbidity if the lines move while on the seafloor. Effects on water quality resulting from increases in turbidity and/or total suspended solids as a result of conducting seismic surveys, if any, would be low-intensity, temporary, local, and would affect a common resource.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys are conducted using echosounders and various subbottom profiling instruments, as well as other acoustic sources, which would not affect turbidity or concentrations of total suspended solids in the proposed action area. If any of the vessels involved in site clearance or shallow hazard survey activity were to set an anchor within the action area, then suspension of seafloor sediments could result in localized increases in turbidity around the area where the anchor is set and retrieved. Effects on water quality resulting from potential increases in turbidity and/or total suspended solids as a result of conducting site clearance and shallow hazard surveys, if any, are expected to be low-intensity, temporary, local, and would affect a common resource.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of total suspended solids in the proposed action area, as they occur on the ice and not in the open-water environment. No contact is made with the seafloor during these types of surveys.

Exploratory Drilling Programs

Construction and maintenance of gravel islands for exploratory drilling would result in additional turbidity caused by increases in suspended particles and sediments in the water column. The release of sediments and drilling muds associated with exploratory drilling activity would also result in increased turbidity and concentrations of suspended solids in the water column. Increased turbidity and suspended solids resulting from artificial island construction or exploratory drilling discharges could have adverse impacts on water quality if increases persisted for extended periods of time. Direct toxicity from suspended sediments is not considered to be a regulatory issue, and neither state nor federal water quality standards have been established with regard to toxicity of suspended sediments in the marine environment. Expected toxicity for suspended sediments resulting from discharges of drill cuttings and water based drilling fluids is expected to be somewhere between that of a clay such as bentonite, and that of calcium carbonate (NRC 1983, MMS 2002). The LC_{50} (i.e., the concentration that is lethal to half of the organisms in a test population after a 96-hour exposure period) for bentonite is 7,500 parts per million (ppm) (test organism, eastern oyster [Daugherty 1951]), and because surface seawater is saturated with calcium carbonate (Chester 2003), it can be considered nontoxic.

For this analysis, 7,500 ppm suspended solids is used as an unofficial acute toxicity criterion for water quality. This value is the lowest (most toxic) LC_{50} for a clay or calcium carbonate reported in the National Research Council (1983) assessment of drilling fluids in the marine environment, and adoption of this unofficial criterion is consistent with previous analyses of the environmental effects of oil and gas activities in the proposed action area (MMS 2001, MMS 2002).

Increases in suspended solids resulting from construction of artificial islands are generally expected to be less than the 7,500 ppm suspended solids used in this analysis as an unofficial criterion for water quality (MMS 2002). The intensity, duration, and extent of the effects on water quality resulting from increased suspended sediment concentrations and turbidity levels depend on the grain-size distribution of the material being introduced to the water, the rate and duration of the activity, lateral transport and turbulence in the water column, local current speeds, and where applicable, the ice regime in the potentially affected area (MMS 2002). Data from site-specific studies in the Beaufort Sea indicate that concentrations of suspended sediments introduced as a result of construction activities decrease to well below the threshold values within 30 m (98 ft.) of the activity (MMS 2002).

The release of drill cuttings and drilling muds associated with exploratory drilling activity would also result in increased turbidity and concentrations of total suspended solids in the water column. Drill cuttings and water-based drilling fluids are comprised of a slurry of particles with a wide range of grain sizes and densities, and various fluid additives may be water soluble, colloidal, or particulate in nature (Neff 1981, Neff 2005). Drill cuttings are particles of sediment and rock extracted from the bore hole as the drill bit penetrates the earth. Water-based drilling fluids consist of water mixed with a weighting agent (usually barium sulfate [$BaSO_4$]) and various additives to modify the properties of the mud (Neff 2005).

As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90 percent of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10 percent of the mass of the mud solids consists of fine-grained particles that would drift with prevailing currents away from the drilling site (NRC 1983, Neff 2005). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor. Models, lab-scale simulations, and field studies suggest that discharged drilling muds and cuttings would be rapidly diluted to very low concentrations, and that suspended particulate matter concentrations would drop below effluent limitation guidelines within several meters of the discharge (Nedwed et al. 2004, Smith et al. 2004, Neff 2005). In well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft.) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft.) from the platform (Neff 2005). Therefore, effects on water quality resulting from turbidity from discharged drill cuttings and drilling fluids are expected to be temporary, local to the vicinity of the discharge, and would be low-intensity with regard to the overall water quality in the proposed action area.

Turbidity above ambient levels caused by increases in suspended particles in the water column would affect water quality in the proposed action area. Turbidity levels are generally expected to remain considerably below 7,500 ppm suspended solids, which is used as an acute toxicity criterion for water quality in this analysis (NRC 1983, MMS 2002). In the immediate vicinity of exploratory drilling and anchor handling activities, turbidity may locally exceed the 7,500 ppm threshold. Local effects on water quality may be high-intensity but would dissipate quickly with distance from the activity. Effects resulting from increased turbidity would be temporary and expected to end within a few days after drilling or anchor handling activity stops. Effects on water quality resulting from increased turbidity would be local and would generally be restricted to the areas within 100 m (328 ft.) of the drilling or anchor handling activity (NRC 1983, Neff 2005).

Material discharged at the seafloor would be similar in composition to naturally-occurring seafloor sediments, and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor surface before drilling activities (MMS 2002).

If floating vessels or jackup rigs were used for exploratory drilling, overall effects on water quality from normal operations would be low-intensity, temporary, local, and would affect a common resource. Construction of gravel artificial islands to support exploratory drilling activities could result in effects on water quality that are medium-intensity, long-term, local and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS. If oil and gas industry operators comply with EPA CWA requirements, then elevations in turbidity and concentrations of total suspended solids resulting from exploratory drilling activity would not result in unreasonable degradation of the marine environment.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals (see Section 2.4.7) have the potential to further reduce adverse impacts to water quality by reducing discharge of drill cuttings and drilling muds.

Metals

Seismic Surveys

Seismic surveys conducted from ships would not be expected to have any measureable impact on total or dissolved metal concentrations in the EIS project area. Inputs to the water from ship-based seismic survey activities would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys conducted from ships would not be expected to have any measureable impact on total or dissolved metal concentrations in the EIS project area. Inputs to the water from ship-based site clearance and shallow hazards surveys would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible.

On-ice Seismic Surveys

On-ice seismic surveys would not be expected to have any measurable impact on total or dissolved metal concentrations in the EIS project area. Inputs to the water from on-ice seismic survey activities would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible.

Exploratory Drilling Programs

Discharge of drill cuttings and drilling fluids from exploratory drilling programs could result in elevated levels of metals in the water (Neff 1981, NRC 1983). Chromium, copper, mercury, lead, and zinc are the metals of greatest concern resulting from the discharge of drill cuttings and drilling fluids (Neff 1981). The EPA marine water quality criteria concentrations for these metals are given in Table 3.1-6 (EPA 2009b). Arsenic, nickel, vanadium, and manganese may also be present at elevated concentrations in some drill cuttings and drilling fluids. Barium, as $BaSO_4$, is usually present at high concentrations in drilling fluids, but due to its low solubility in seawater and low reactivity, barium sulfate would settle to the seafloor as it is discharged, and would not be expected to have any effects on water quality (DHHS 2007). Some metals are present in additives that may be mixed with the drilling mud to improve the physical and chemical properties of the mud, while other metals may be contaminants of major mud ingredients or may be present in drill cuttings (Neff 1981). Additives such as drill pipe dope, which contains 15 percent copper and seven percent lead, and drill collar dope, which can contain 35 percent zinc, 20 percent lead, and seven percent copper, may also contribute trace metals to discharges of drill cuttings and drilling fluids (EPA 2006b). Lignosulfonate compounds that are commonly added to drilling fluids as deflocculants and thinners are another source of metals in discharges from exploratory drilling programs. The concentrations of some metals commonly found in drill cuttings are given in Table 3.1-8.

A detailed discussion related to the environmental distribution of trace metals from exploratory drilling activities is available in the *Ocean Discharge Criteria Evaluation for Oil and Gas Exploration Facilities on the Outer Continental Shelf and Contiguous State Waters in the Beaufort Sea, Alaska (NPDES Permit No.: AKG-28-2100)* (EPA 2012c) and *Ocean Discharge Criteria Evaluation for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea, Alaska (NPDES Permit No.: AKG-28-8100)* (EPA 2012d) and is incorporated here by reference. EPA's exploration GPs include an environmental monitoring program that is designed to evaluate environmental distribution of trace metals from exploratory drilling activities.

As discussed in the section about turbidity and suspended solids, the discharge plume would undergo rapid fractionation as it is discharged to the ocean. Most of the discharged drill cuttings and drilling fluids would rapidly sink to the bottom near the discharge location (Neff 2005). The actual distance traveled by the discharge would depend on the water depth, lateral transport, particle size and the density of the discharged material (NRC 2003). A smaller fraction of the discharge plume, consisting of soluble components and fine-grained particles, is likely to remain in the water column longer, and may be transported considerable distances from the discharge site. Depending on the composition of the discharged drill cuttings and drilling fluids, as well as the rate of discharge, lateral transport, and dilution rates, concentrations of soluble metals may exceed EPA marine water quality criteria for dissolved metals within a small area around the site of discharge. Effects on water quality would be local and would generally be restricted to the areas within 100 m (328 ft.) of the activity (NRC 1983, Neff 2005). Direct effects on water quality resulting from increased dissolved metal concentrations from exploratory drilling activities under Alternative 2 are expected to be low-intensity, temporary, local, and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS.

Indirect effects could result from resuspension of deposited sediments with elevated concentrations of trace metals. Metals from resuspended sediments could contribute to elevated concentrations of metals dissolved in the water. The magnitude of effects on water quality resulting from elevation of metal concentrations would depend on the composition of the sediments, concentrations of certain metal ions in the water column, and the uses of the affected water. As discussed in the previous paragraphs, concentrations of certain dissolved metals above the established threshold values would result in adverse effects on water quality within the proposed action area (Table 3.1-6, EPA 2009b). These effects could occur indirectly (i.e., at a later time than the proposed action) if deposited sediments with elevated concentrations of soluble metals were resuspended by tides, waves, or other natural or unnatural events. The magnitude of such indirect effects on water quality would depend on the composition of the deposited sediments, as well as other factors. Based on analysis of sediments discharged from oil and gas operations (NRC 1983) and chemical assessment of sediments in the Sivulliq Prospect around Hammerhead drill site (Trefry and Trocine 2009), concentrations of metals dissolved from resuspended sediments are unlikely to exceed the EPA Water Quality Criteria (EPA 2009b). Recent investigation on the deposition of metals produced by exploratory drilling programs in the early history of exploratory activities found sediments essentially unaffected with respect to trace metals of anthropogenic origin with the exception of two small areas nearby two drilling sites (Fox et al. 2014; Trefry et al. 2014). If such indirect effects were to occur, the effects on water quality in the proposed action area under Alternative 2 are expected to be low-intensity, temporary, local, and would affect a common resource.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Seismic surveys conducted from ships, as described in Section 2.3.2 of this EIS, would have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Inputs to the water from seismic survey activities would be extremely local in nature, and effects on water quality resulting from such inputs, if any, are expected to be negligible.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys would have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Inputs to the water from site clearance and shallow hazards survey activities would be extremely local in nature, and effects on water quality resulting from such inputs, if any, are expected to be negligible.

On-ice Seismic Surveys

On-ice seismic surveys would have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Contaminants from fluids entrained in the ice roads would be discharged every spring during breakup. Entrained hydrocarbons and other organic contaminants from vehicle exhaust, oil, grease, and other vehicle-related fluids would pass into the Beaufort Sea system at each breakup as a result of on-ice seismic surveys. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys are expected to be minor as defined in the impact criteria in Section 4.1 of this EIS.

Exploratory Drilling Programs

Inputs of hydrocarbons and other organic contaminants resulting from construction activities related to exploratory drilling programs are expected to be negligible. Other activities associated with exploratory drilling activities are addressed below.

Discharge of drill cuttings and drilling fluids from exploratory drilling programs would result in increased concentrations of hydrocarbons and other organic contaminants in the water (Neff 1981, NRC 1983, EPA 2012d). Organic additives are often used to modify the properties of the water based fluid (Neff 2005). These additives serve a variety of purposes. Petroleum products may be added to drilling fluid as lubricants and fluid loss agents, and blends of organic compounds, synthetic polymers, and salts may be added to the fluid as heat-stable dispersants and thinning agents (Neff 1981). In most cases, discharges of spent drilling fluids and cuttings coated by those fluids contain considerable amounts of relatively stable and potentially toxic hydrocarbon compounds (Patin 1999). Example concentrations of several organic compounds in drill cuttings are provided in Table 3.1-8 (Chapter 3).

Like metals and suspended sediments discharged as components of drilling fluid mixtures, the dispersion, distribution, and fate of discharged hydrocarbons and other organic contaminants would depend upon the chemical attributes of the compounds being discharged, as well as the rate of discharge, lateral transport, and dilution rates of the discharge plume in the environment. Also, because of the lack of applicable water quality criteria for some of the organic compounds present in drilling fluids, determination of potential exceedances resulting from drilling fluid organics in marine water is problematic.

Impacts to water quality resulting from hydrocarbons and other organic contaminants would be temporary and would dissipate soon after the discharge is stopped. Such impacts would be local in nature due to rapid dilution of discharged compounds into the ocean. It seems probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 2 would have minor to moderate effects on water quality outside of the discharge plume area.

There is the potential that a small fuel spill of less than 50 bbl could occur (see Section 4.2.7). A fuel spill would introduce hydrocarbons and temporary toxicity to the surface water. The effects of a fuel spill would be limited by required deployment of booming equipment during fuel transfers and automatic shutdown of fuel lines triggered by decreased pressure. The effects are anticipated to be local and short-term. The potential effects of a VLOS are discussed in Sections 4.10.6.6 and 4.10.7.6.

4.5.1.5.2 Conclusion

The effects of Alternative 2 on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 2 on water quality in the EIS project area would be minor.

4.5.1.6 Environmental Contaminants and Ecosystem Functions

"Ecosystem functions" refer to the capacity of natural components and processes to provide goods and services that satisfy human needs, directly or indirectly (De Groot et al. 2002). Ecosystem goods (such as subsistence foods) and services (such as waste assimilation) represent the benefits that human populations derive, directly or indirectly, from ecosystem functions (Costanza et al. 1997). A large number of Alaska Arctic Region OCS ecosystem functions can be identified, and many of the goods and services that depend on those functions are discussed in the other resource-specific sections of this document (e.g., subsistence, recreation, cultural resources). Some examples of relevant ecosystem goods and services from the Alaska Arctic region OCS and the functions from which they are derived are summarized in Section 3.1.6.1 of this EIS.

The values of ecosystem goods and services in the Alaska Arctic Region OCS are usually derived from interplay among various ecosystem components — the physical environment, chemical environment, and biological communities (Costanza et. al 2014). Ecosystem goods and services are only rarely the product of a single species or component. Therefore, the interactions of various ecosystem components are essential to the provision of ecosystem goods and services, and must be considered as important aspects of the affected environment. Incorporating ecosystem services considerations into decision-making processes supports functional, resilient ecosystems (Schaefer et al. 2015). The practical application of ecosystem services principles in policymaking and commercial activities makes tradeoffs in decision making more transparent, informs efficient use of resources, enhances resilience and sustainability, and potentially avoids unintended negative consequences of policy actions (Schaefer et al. 2015).

Environmental contaminants resulting from activities described in the alternatives have the potential to impact ecosystem goods and services by upsetting the synergies that exist between different components of the ecosystem and disrupting the ecosystem functions from which humans derive value. These contaminants of concern would be introduced to the environment through various pathways associated with the alternatives, as well as from sources outside of the action area via transport and deposition processes (Woodgate and Aagaard 2005). Many environmental contaminants are discussed in the resource specific sections of this document (e.g., water quality, air quality), and this section does not aim to repeat those discussions. Rather, in response to comments received during the scoping process, this analysis takes an integrated approach by assessing the effects of contaminants on ecosystem functions, which are derived from connectivity and interplay between ecosystem components. Comments from Scoping Report (Appendix C):

COR 11 *"The EIS should follow an ecosystem approach in its evaluation of impacts to biological resources and their habitats…"*

RME 1 *"The EIS needs to consider that the Arctic contains some of the world's last remaining intact marine ecosystems and impacts to this baseline from climate change, ocean acidification, and increasing industrial activities."*

Traditional Knowledge also suggests that an ecosystem approach is needed for assessment of effects of oil and gas activities in the Arctic. On March 11, 2010 at the Nuiqsut Scoping Meeting for this EIS, Rosemary Ahtuangaruak of the Iñupiat Community of the Arctic Slope stated:

> *"The process with the issues related to the water quality, you know, I don't know how the process is still presented to us in the plan, dumping the muds into the water. I mean, where is the level of understanding of the importance of the biological diversity of the area, the increased risk factors we have because of our continued living in this area and the increased concentration in these animals because of the decades of lives that they live and the reactions that occur to us."*

Taking an ecosystem approach, this section presents qualitative analyses of potential impacts under each alternative related to the influence of environmental contaminants on ecosystem functions. These analyses identify potential environmental contaminants, explore potential exposure pathways for habitat and biological resources, and assess the effects of contaminants on selected ecosystem functions.

Although a wide range of ecosystem functions have been described, they can generally be grouped into four basic categories based on definitions provided by DeGroot et al. (2002). **Regulation functions** relate to the capacity of natural systems to maintain essential ecological processes (such as nutrient cycles) and life support systems (such as provision of clean water). **Habitat functions** relate to provision of refuge and reproduction habitats and therefore contribute to the (*in situ*) conservation of biological diversity and evolutionary processes. **Production functions** relate to conversion of energy and nutrients into biomass by primary producers, as well as subsequent trophic transfers and biogeochemical processes, which create a diversity of living biomass, as well as non-living resources, from which a wide range of ecosystem goods and services are provided. **Information functions** contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002).

The level of impacts from environmental contaminants are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-15b.

Table 4.5-15b Impact Criteria for Effects of Environmental Contaminants

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Changes in ecosystem functions may not be measurable or noticeable	**Medium**: Noticeable changes in ecosystem functions	**High**: Acute or obvious changes in ecosystem functions
Duration	**Temporary**: Impacts would be intermittent, infrequent, and typically last less than a month	**Interim:** Impacts would be frequent or extend for longer time periods (an entire project season**)**	**Long-term:** Impacts would cause a permanent change in the resource that would perpetuate even if the actions that caused the impacts were to cease
Geographic Extent	**Local**: Impacts limited geographically; <10% of EIS project area affected	**Regional**: Affects ecosystem functions beyond a local area, potentially throughout the EIS project area	**State-wide**: Affects ecosystem functions beyond the region or EIS project area
Context	**Common**: Affects usual or ordinary ecosystem functions; not impacted	**Important**: Affects ecosystem functions within the locality or region	**Unique**: Affects unique ecosystem functions

4.5.1.6.1 Direct and Indirect Effects

Potential Environmental Contaminants

Organochlorines

Organochlorine contaminants, such as dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyl compounds (PCBs), chlorinated benzene isomers (ClBz), and hexachlorocyclohexane isomers (HCHs), would not be introduced into the EIS project area in substantial quantities as a result of the activities proposed under Alternative 2. As noted previously, organochlorines have been detected in marine mammal tissues in the Arctic. These contaminants are aerially transported from far-field sources and are not generated by oil and gas activities. Therefore, the impacts of Alternative 2 on organochlorine contaminants in the EIS project area are expected to be negligible.

Petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs)

Petroleum hydrocarbons and PAHs would be introduced into the EIS project area in measureable quantities as a result of the actions proposed under Alternative 2. Petroleum hydrocarbons and PAHs would be discharged as a result of activities associated with exploration drilling, and would also be present in fuel and exhausts from vehicles and machinery associated with all components of Alternative 2. The toxicity of PAHs is highly variable and is driven by the number of ring structures and molecular weight (Eisler 1987). Low molecular weight (LMW) PAHs consist of fewer than four fused benzene rings and have molecular weights less than 200. LMW PAHs are more soluble and bioavailable in aqueous solution than high molecular weight (HMW). PAHs and are associated with acute toxicological effects on biota. Unsubstituted lower molecular weight PAH compounds, containing 2 or 3 rings, exhibit significant acute toxicity and other adverse effects to some organisms, but are non-carcinogenic; the higher molecular weight PAHs, containing 4 to 7 rings, are significantly less toxic, but many of the 4- to 7-ring compounds are demonstrably carcinogenic, mutagenic, or teratogenic to a wide variety of organisms, including fish and other aquatic life, amphibians, birds, and mammals (Eisler 1987). LMW PAHs are much less persistent in the environment, are not considered bioaccumulative, and are readily metabolized by birds and mammals. HWM PAHs consist of four or more fused benzene rings and have a molecular weight greater than 200. HMW PAHs exhibit greater environmental persistence than LMW PAHs, which is attributed to their higher hydrophobicity. Due to their size, HMW PAHs are relatively immobile and exhibit extremely low volatility and solubility (Eisler 1987). Bioconcentration of PAHs from water into aquatic tissues tends to increase with the increasing molecular weight of PAHs. LMW PAHs are rapidly accumulated in algae, mollusks and other invertebrates which do not readily metabolize PAHs (Eisler 1987). Most hydrophobic HMW PAHs have a high affinity for dissolved humic materials and have rapid biotransformation rates, which tend to lessen or negate bioaccumulation and food chain transfer of HMW PAHs.

As described in section 4.5.1.5.1, discharge of drill cuttings and drilling fluids from exploratory drilling programs would result in increased concentrations of hydrocarbons and other organic contaminants in the water (Neff 1981, NRC 1983, EPA 2012d). In addition, PAHs and petroleum hydrocarbons resulting from past oil and gas exploration activities have been measured in sediments in the vicinity of Prudhoe Bay (Neff 2010). Because discharge of drill cuttings and drilling fluids from exploratory drilling programs would result in increased concentrations of hydrocarbons and other organic contaminants in the water and sediments, it is probable that the activities proposed in Alternative 2 would lead to increases in concentrations of PAHs and total petroleum hydrocarbons in organisms and habitat matrices in the EIS project area. However, the cANIMIDA study found that PAH profiles in tissues of fish and invertebrates in the Beaufort Sea were consistent with a petrogenic and pyrogenic sources, and that PAHs in biological tissues of Beaufort Sea organisms originate from a combination of atmospheric deposition, industrial activity, erosion, and runoff from land (Neff 2010). A study specifically intended to determine concentrations of PAHs in bowhead whales harvested around Barrow found that no PAH compounds, nor PAH parent compounds or homologs, were present in detectable amounts in samples collected from different fractions of bowhead whales (Wetzel et al. 2008). Similarly, analyses to assess PAHs in stored samples of whale muscle and blubber produced no detectable levels of PAH compounds (Wetzel et al. 2008). The activities proposed under Alternative 2 would lead to measureable changes in PAH concentrations in some environmental matrices. Effects resulting from point-source discharges would be medium-intensity and local, and effects from atmospheric deposition would be low-intensity and widespread (i.e., state-wide as defined under the impact criteria). Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern (see Additional Mitigation Measures C2 and C3) because these measures would limit discharges and drilling muds that enter the marine environment.

Metals

Metals would be introduced into the EIS project area in measureable quantities as a result of the actions proposed under Alternative 2. Metals are also discussed under Section 4.5.1.5 (Water Quality); this discussion is based on the premise that not all metals of concern are water soluble, and as a result, water quality criteria do not necessarily account for all of the impacts associated with the introduction of metals to the EIS project area. While state and federal regulations establish criteria for concentrations of potentially toxic metals in water, these criteria do not account for concentrations of metals in other environmental matrices including sediments, which could lead to adverse effects in benthic organisms as well as effects on higher trophic levels. Drilling muds and cuttings discharged on the seafloor may impact benthic organisms through the toxic actions of some of the drilling mud components; chromium, copper, mercury, lead, and zinc would be the metals of greatest concern in sediments (Neff 1981). The major concerns associated with metals in the marine environment are that they could cause deleterious sublethal effects in sensitive organisms; and could accumulate to dangerous levels in higher trophic level organisms as a result of bioconcentration processes. Elevated concentrations of chromium, lead and zinc would occur in sediments in close proximity to discharges, however, concentrations of these metals in the sediments would likely decrease to background levels within several hundred meters of the discharge (Neff 1981).

The effects of chromium overexposure on marine organisms depend largely on the oxidation state of the chromium. The mechanism of toxicity differs for hexavalent versus trivalent chromium. Hexavalent chromium causes cellular damage via its role as a strong oxidizing agent, whereas trivalent chromium can inhibit various enzyme systems (Irwin et al. 1997). Elevated levels of copper could interfere with the functioning of certain enzymes involved in respiration, and could cause delayed development of larval organisms (Flemming and Trevors 1989; Bianchini et al. 2004). Elevated concentrations of mercury, lead, and zinc could result in adverse effects to marine organisms (Bryan 1971; Boening 2000). The activities proposed under Alternative 2 would lead to measureable changes in concentrations of metals in some environmental matrices. Impacts resulting from point-source discharges would be medium-intensity and local, but the intensity of the impacts would decrease rapidly with distance from the point of discharge. Overall, effects of introduced metals resulting from the activities proposed in Alternative 2 would be minor.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

In order for exposure of habitats and biological resources to occur, stressors (in this case contaminants of concern), and receptors (habitats and biological resources), would need to be present at the same time and at the same place (i.e., co-occurrence). Therefore, in order to assess the exposure of habitat and biological resources to contaminants of concern resulting from the actions proposed under Alternative 2, the behavior and partitioning of the contaminants in the environment should be considered. As described in Section 3.1.6.2, many of the contaminants of concern associated with the proposed action have low solubility in water as a result of their non-polar molecular structures. As a result of low aqueous solubility, these compounds would tend to associate with organic material or solid-phase particles (such as sediments) in the environment (Trefry et al. 2004, MMS 2004-031).

In general, because contaminants of concern partition into the organic and particulate phases, the concentrations of these contaminants in water would be low. Depending on their molecular structures and properties, organic contaminants originating from seismic and exploratory drilling activities would partition into sediments, which would settle out on to the seafloor. Therefore, in order for substantial exposure to occur, receptors would have to come into contact with sediments containing substantial levels of the contaminant of concern. We can conclude that the direct impact to pelagic organisms from contaminants of concern introduced to the EIS project area as a result of the activities proposed under Alternative 2 would be minor, with the exception of those organisms located directly in the plume of materials discharged from exploratory drilling operations and those that feed on benthic species. However, pelagic species with large foraging ranges are less likely to be impacted by bioaccumulative chemicals.

Many of the contaminants of concern, including organic contaminants such as HMW PAHs, as well as selected metals such as mercury, have the potential to accumulate in higher trophic level organisms. With regard to such higher trophic level organisms, there is potential for indirect effects to result from exposure to contaminants of concern through the food web, when the relevant pathway of exposure would involve trophic transfers of contaminants rather than direct exposure. However, monitoring conducted as part of the ANIMIDA and cANIMIDA projects has shown that oil and gas developments in the Alaskan Beaufort Sea "are not contributing ecologically important amounts of petroleum hydrocarbons and metals to the near-shore marine food web of the area" (Neff 2010).

Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 2 on the four categories of ecosystem functions are assessed below.

Regulation Functions

The actions proposed under Alternative 2 would affect regulation functions such as nutrient cycling and waste assimilation in the EIS project area. These ecosystem functions depend on biota and physical processes to facilitate storage and recycling of nutrients, and breakdown or assimilation of contaminants. The magnitude and extent of effects of Alternative 2 on regulation functions would depend upon interrelationships between impacts to biological and physical resources, which are addressed by resource in sections 4.5.1 and 4.5.2 of this EIS.

Habitat Functions

Effects of Alternative 2 on habitat functions would include impacts to refugium functions and nursery functions (provision of suitable reproduction habitat) associated with benthic habitats resulting from discharges from exploratory drilling. Contaminants of concern, including hydrocarbons and metals, would affect benthic habitats in the vicinity of the discharges. Due to the relatively high octanol water partitioning ratios for most contaminants of concern, the contaminants of greatest concern would preferentially partition into sediments and the greatest impacts would be on functions associated with benthic habitats. Overall effects to benthic habitat functions would be interim, local, and low-intensity. Effects would also occur to functions associated with pelagic and epontic habitats. Functions associated with terrestrial habitats would be affected to a lesser degree. Overall, effects of Alternative 2 on habitat functions would be medium-intensity, interim, and local. The functions affected could be common, important, or unique depending on the spatial location of the impact. On the spectrum from negligible to major, described in Section 4.1.3, the effects of Alternative 2 on habitat functions would be considered minor due to the limited spatial extent of the impacts.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts to habitat functions and are described in greater detail below.

Production Functions

Effects of Alternative 2 on production functions would include not only impacts on primary productivity (discussed in the lower trophic levels section) but also impacts to higher-level trophic transfers, leading to indirect effects on a wide range of ecosystem goods and services. Impacts to production functions related to provision of raw materials and food (i.e., subsistence) could be affected by the activities proposed under Alternative 2. These impacts are described in the subsistence section of this EIS. In addition to introducing contaminants to secondary and tertiary consumers via trophic transfer processes, contaminants of concern could interrupt trophic transfer processes resulting in shorter food chains (less complex food webs) and reduced throughput of energy and nutrients at higher trophic levels.

Information Functions

Information functions contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002). The effects of Alternative 2 on information functions in the EIS project area would depend upon interrelationships between impacts to cultural resources, social resources and aesthetic resources, which are addressed in other sections of this EIS.

4.5.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 2 would be medium-intensity, interim, local, and common in context. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e., resistant to stressors) than are species composition and other structural properties. Overall effects of Alternative 2 on ecosystem functions would be minor.

4.5.1.7 Mitigation Measures for the Physical Environment

Standard Mitigation Measures are outlined in Section 2.4.10 and Additional Mitigation Measures are outlined in Section 2.4.11, and both are described in detail in Appendix E. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. A combination of mitigation measures could be required for any one ITA. Of note, there are a large number of mitigation measures that are intended to reduce impacts to the acoustic environment with the ultimate goal of reducing impacts to a particular resource, such as marine mammals or subsistence hunts. These measures are evaluated within the context of those more targeted resources and are not repeated here.

4.5.2 Biological Environment

Table 4.5-16 indicates the mechanisms by which effects of oil and gas exploration activities identified in the alternatives on biological resources can be measured. This table summarizes the criteria for determining the level of impact to biological resources based on the magnitude, duration, extent, and context of occurrence. Note that impacts to marine mammals are analyzed using different impact criteria described in Table 4.5-18.

Table 4.5-16 Impact Criteria for Effects on Biological Resources

Type of Effect	Impact Component	Effects Summary		
Behavioral Disturbance	Magnitude or Intensity	**High**: Acute or obvious/abrupt change in behavior due to exploration activity; animals depart from the EIS project area	**Medium**: Noticeable change in behavior due to exploration activity; animals move away from the specific activity area but remain in the EIS project area	**Low**: Changes in behavior due to exploration activity may not be noticeable; animals remain in the vicinity
	Duration	**Long-term**: Change in behavior patterns even if actions that caused the impacts were to cease; behavior not expected to return to previous patterns	**Interim**: Behavior patterns altered for several years and would return to pre-activity patterns at some time after actions causing impacts were to cease	**Temporary**: Behavior patterns altered infrequently but not longer than the span of one year and would be expected to return to pre-activity patterns after actions causing impacts were to cease
	Geographic Extent	**State-wide**: Affects resources beyond the region or EIS project area	**Regional**: Affects resources beyond a local area, potentially throughout the EIS project area	**Local**: Impacts limited geographically; <10% of Beaufort or Chukchi seas affected
	Context	**Unique**: Resources listed as threatened or endangered (or proposed for listing) under the ESA and/or depleted under the MMPA and the portion of the resource affected fills a unique ecosystem role	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary resources in the EIS project area; resource is not depleted in the locality or protected by legislation

Type of Effect	Impact Component	Effects Summary		
		within the locality or region		
Injury and Mortality	Magnitude or Intensity	**High**: Incident of mortality or multiple incidences of injury	**Medium**: Incident of injury	**Low**: No noticeable incidents of injury or mortality
	Duration	**Long-term**: Incidences of mortality or injury would continue to occur longer than five years or persist after actions that caused the disturbance ceased	**Interim**: Incidence of injury would continue for greater than one year to less than five years	**Temporary**: Interactions would occur for a brief, discrete period lasting less than one year
	Geographic Extent	**State-wide**: Impacts would occur beyond the EIS project area	**Regional**: Impacts would occur within the Beaufort or Chukchi seas	**Local**: Impacts would not extend to a broad region
	Context	**Unique**: Resources listed as threatened or endangered (or proposed for listing) under the ESA and/or depleted under the MMPA and the portion of the resource affected fills a unique ecosystem role within the locality or region	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary resources in the EIS project area; resource is not depleted in the locality or protected by legislation
Habitat Alterations	Magnitude or Intensity	**High**: Acute or obvious changes in resource character	**Medium**: Noticeable changes in resource character	**Low**: Changes in resource character may not be measurable or noticeable
	Duration	**Long-term**: Chronic effects; resource would not be anticipated to return to previous levels	**Interim**: Resource would be reduced for five to seven years and would return to pre-activity levels at some time after that point	**Temporary**: Resource would be reduced infrequently but not longer than the span of one year and would be expected to return to pre-activity levels
	Geographic Extent	**State-wide**: Affects resources beyond the region or EIS project area	**Regional**: Affects resources beyond a local area, potentially throughout the EIS project area	**Local**: Impacts limited geographically; <10% of Beaufort or Chukchi Sea affected
	Context	**Unique**: Resources listed as threatened or endangered (or proposed for listing) under the ESA and/or depleted under the MMPA and the portion of the resource affected fills a unique ecosystem role within the locality or region	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary resources in the EIS project area; resource is not depleted in the locality or protected by legislation

4.5.2.1 Lower Trophic Levels

The oil and gas exploration activities proposed in Alternative 2 can impact the lower trophic levels in a number of different manners. The direct and indirect effects may be caused by specific oil and gas exploration activities or a combination thereof. The categories of proposed exploration are: high resolution shallow hazard and site clearing surveys; 2D/3D deep penetration seismic surveys; and exploratory drilling (see Section 2.3 for a complete description of exploration activities). The effects most likely to be encountered during these activities are: disturbance of benthic habitat and displacement of organisms from drilling, sediment sampling, ship anchoring, or platform installation; toxicity due to discharge; increased productivity due to ice breaking; and introduction of invasive species, due to ship traffic. A brief summary of each is provided below. On-ice seismic surveys are not expected to have any effects on lower trophic levels since the activity occurs on top of the ice and not in the water column.

4.5.2.1.1 Direct and Indirect Effects

Oil and gas exploration activities under Alternative 2 include the use of a variety of small and large support vessels and icebreakers. Seismic airgun arrays, and associated gear such as sensor arrays in streamers, on cables, and nodes are deployed in the water column and on the ocean bottom. Drilling rigs are also associated with exploration activities. All of these can directly and indirectly cause behavioral disturbance, injury/mortality of lower trophic level organisms, and/or habitat loss/alteration in the EIS project area.

Behavioral Disturbance

There is not much direct evidence regarding how oil and gas exploration activities affect or disturb behavior in lower trophic level organisms. However, it can be assumed any activities that might directly impact the seabed could also disturb benthic infaunal and macrofaunal populations. These activities could include ice breaking efforts that could disturb ice-associated organisms. However, ice typically returns to fill the wake as the ship passes (NMFS 2010c). Benthic organisms could be displaced from locations where drilling, sediment sampling, or ship anchoring would occur. Because these populations are typically impacted by seasonal displacement due to natural ice scour and because the areas impacted would be very limited in relation to the overall available benthic habitat, the anticipated effect of disturbance would be local in geographic extent, low in intensity and , and temporary in duration.

Injury and Mortality

The effects of seismic energy on invertebrate populations is increasingly debated in light of case studies in European waters of the Atlantic Ocean involving populations of cephalopods. Numerous laboratory studies have attempted to illustrate the potential effects on invertebrate populations, both larval and adult, by seismic energy. In a laboratory study of four species of squid, André et al. (2011) demonstrated that exposure to low-frequency sounds resulted in damage to the statocysts, the structures responsible for the animals’ sense of balance and position.

Any exploration activities that directly impact the seafloor, such as anchoring of drill ships and support vessels could cause direct injury and mortality to lower trophic level organisms. It is not clear if ice scouring, a naturally occurring event, would be affected by the use of icebreaking vessels during oil and gas exploration because these ships are not used in shallow waters, although ice floes that could extend to the ocean floor could be set in motion by ice breakers. Ice scouring can also directly cause injuries and mortalities to the benthos as ice is dragged across the seafloor. In addition, organisms can be buried and smothered as the ice moves through the substrate. Activities that disturb the bottom habitat in areas such as Hanna Shoal, the shelf break of the central Beaufort Sea, and the Western Beaufort Sea can be particularly damaging since these areas support biologically unique communities, as well as provide important feeding and resting grounds for demersal species and macrofauna.

Recent studies show that metals associated with water-based drilling fluids are not readily absorbed by living organisms, but they do carry organic additives that can result in oxygen depletion, which could adversely affect benthic organisms in the immediate area of discharge. Likewise, increased sedimentation by the discharges of drilling fluids and cuttings could adversely affect benthic organisms via physical smothering in the area of discharge. Modeling indicates that under most scenarios, the majority of the drill cuttings would settle within 100 m (328 ft.) and the solids associated with the drilling fluids are deposited within 1,000 m (3,280 ft.) of the discharge. Overall, the drilling fluid and cuttings deposition are predicted to deposit on the seafloor in substantially different patterns due to the difference in solids characteristics and current speed. The drilling fluids are predicted to deposit in a thinner layer, and over a larger area, than the cuttings deposits. Effects of deposition are considered low in intensity and local in extent.

There is the potential for lower trophic levels to be exposed to small fuel spills of less than 50 bbl (see Section 4.2.7). The effects of a small fuel spill would be dependent upon sea conditions at the time of the spill. With high wind conditions and rough seas, the diesel would be rapidly diluted and dispersed, and effects of the spill would be negligible. In calmer waters, evaporation of the diesel would be rapid, and the area covered by dispersion of the remaining hydrocarbons would be dependent upon wind speed, wind direction, and water temperature. Loss of benthic organisms due to hydrocarbon poisoning would probably not occur due to dispersion of hydrocarbons before reaching benthic surface. Effects on common pelagic organisms would be local in geographic extent, and low in intensity.

Habitat Loss/Alteration

The primary cause of habitat loss and alteration would be due to exploratory drilling activities, which can cause disturbance to the benthic habitat; the effect would be very local in extent and disparate and therefore difficult to quantify. Some species are quick to repopulate the disturbed area, but it can take a decade for the habitat to fully recover from disturbance. Some species, such as the large clams that walruses feed on, have been shown to take nine years to recolonize a disturbed area, and even then, they did not recover completely (Conlan and Kvitek 2005, BOEM 2010a).

The other potential cause of habitat loss/alteration is invasive species. As vessel traffic increases, the potential for non-native species to be introduced and alter the habitat increases. Temperate species have the potential to become established in Arctic waters (Sirenko and Gagaev 2007), as described in Section 3.2.1.1. The effects of invasive species on benthic habitat would be speculative without knowing something about potential species, but could result in some noticeable change in the resource character of the benthic community, therefore, effects are considered of medium intensity. Once invasive species are established, the duration of effects would be long-term.

4.5.2.1.2 Conclusion

Using the criteria identified in Table 4.5-16, the direct and indirect effects discussed above would likely be low in intensity, temporary to long-term in duration, of local extent and would affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.5.2.2 Fish and Essential Fish Habitat

The oil and gas exploration activities covered in Alternative 2 can impact fish resources in a number of different ways. Some effects are specific to a certain activity, while others are common to multiple activities. For the purposes of this analysis, the mechanisms for each effect are first explained, and then the effects from each of the four main categories of activity are described. The four categories of activity are: 2D/3D Seismic Surveys including an In-Ice Survey, Site Clearance and High Resolution Shallow Hazard Surveys, On-ice Seismic Surveys, and Exploratory Drilling (see Section 2.3 for a complete description of the activities). The effects most likely to be encountered during these activities are: exposure of fish to noise caused by seismic surveys, exploratory drilling, and vessel traffic; and temporary or long-term fish habitat loss and/or alteration from icebreaking and exploratory drilling activities. Effects to fish from site clearance and high resolution shallow hazard surveys that use airguns would be expected to be similar to the effects from 2D/3D seismic surveys, but to a lesser extent due to the much smaller volume of the airgun(s). Fish may also be exposed to small contaminant discharges from vessels, but the effect would be temporary and limited to the immediate vicinity. On-ice seismic surveys could affect under-ice-shelter for various fish life stages, including Arctic cod eggs and developing larvae. The effects on fish resources resulting from a potential very large oil spill in the Beaufort and Chukchi seas are analyzed in Section 4.10.6.9 and 4.10.7.9.

During the scoping process, a number of stakeholders identified concerns related to fish resources within the EIS project area. The major issue identified was the impact of noise from oil and gas activities on marine species. In regards to fish, the concerns specifically centered on the potential for hearing loss, behavioral disruptions, and mortality of fish eggs and larvae, in addition to the impacts from acute and chronic stress and reductions in availability of fish as prey for marine mammals. Subsistence concerns addressed the potential effects of oil and gas activities on the availability of saffron cod and salmon. Saffron cod (known as tomcod in Native communities along the Arctic coast), and salmon (particularly pink and chum) are important to Alaska Native residents both directly as subsistence species and indirectly as prey for marine mammal subsistence species such as beluga whales, ice seals, and walruses. A final concern was the overall scarcity of scientific data regarding biological resources in the EIS project area, yet a desire for quantifiable impacts was expressed. The concerns identified in the scoping process have been addressed in the analysis below.

Exposure to Sound

The range of potential effects to fish from intense sound sources, such as seismic airguns, varies widely, but is primarily influenced by the level of sound exposure. Higher sound levels are more damaging, as shown in Table 4.5-17. Data in this table are based on information from reports of responses of fish to seismic airgun pulses. The reports consider non-Arctic taxa as well as taxa found within the EIS project area. . Although direct physiological effects such as hearing damage or loss, tissue damage, or death can occur, indirect effects that modify fish behavior are much more common and likely. These behavioral modifications are highly variable and are dependent on a range of factors, including species, life history stage, time of day, whether the fish have fed, and how sound propagates in a particular setting (CNLOPB 2007).

Table 4.5-17 Physical and Behavioral Effects of Seismic Airguns on Fish, Eggs, and Larvae

Effect	Sound Level (dB re 1 μPa)
Avoidance Behavior	160
Hearing Damage	180
Temporary Stunning	192
Egg/Larval Damage	210
Egg/Larval Mortality	220
Internal Injuries (swimbladder rupture, hemorrhaging, eye damage)	220
Fish Mortality	230-240

Source: Modified from Turnpenny and Nedwell 1994; Davis et al. 1998

While a number of studies have been undertaken, the number of species and species groups of fish is vast, and results obtained in studies on one species may not directly apply to other species. Likewise, the response to different types of stimuli can vary greatly, even when applied to the same species. For example, seismic signals have been shown to have a more pronounced effect on larger fish than on smaller fish of the same species (CNLOPB 2007).

Research on acoustic impacts to fish has been limited to relatively few species, and specific data regarding the effects of noise on taxa of fish found within the EIS project area are sparse. Despite the recognized need for further study on the effects of oil and gas activities on specific Arctic fish, sufficient information is available to support rational scientific judgments and reasoned managerial decisions regarding potential impacts of anthropogenic sound on fish. Given the nature of the proposed action, no substantial effects are expected to occur to these resources under any alternative. Moreover, the missing information pertains to impacts that would be common to all action alternatives and would not aid the decision maker between those alternatives. More information of this type is not essential for a reasoned choice among alternatives.

Fish rely heavily on sensory perceptions of sound and pressure for many activities vital for survival, such as feeding, navigation, spatial orientation, predator avoidance, and even communication. They possess hearing organs roughly comparable to other vertebrates with which they hear sounds and also utilize a lateral line system which detects pressure waves near the fish. Combined, these two sensory systems provide fish with the ability to survive in their complicated underwater environment.

For a fish to detect a sound, two conditions must be met. The fish has to have the ability to hear the sound in the first place (frequency), and the sound needs to be loud enough for the fish to register (intensity). Most fish can detect sounds ranging in frequency from 50 Hz to 1,500 Hz, with some able to detect sounds up to 3 kHz (Popper and Hastings 2009).

The lateral line system is common to all fish and detects pressure waves in the water near the fish. It senses pressure differences along a line running down the length of the fish and enables the fish to detect movement nearby. It allows fish to detect currents and is vital for schooling fish, enabling them to sense and adjust their proximity and velocity within the body of their school (Stocker 2002). This system also enables fish to detect sound waves at very low frequencies of 100 Hz or less.

Direct harm to fish through physiological damage or death is very seldom documented, usually only in relation to repeated, extremely loud activities such as pile driving (Popper and Hastings 2009). Laboratory studies have been able to cause measurable physiological harm to captive fish exposed at close range to acoustic sources, such as permanent hearing loss or swim bladder damage, typically with sound sources measured at or above 180 dB re 1 µPa (McCauley et al. 2003; Stocker 2002; Turnpenny and Nedwell 1994) and resulted in abnormalities in larval scallops after exposure to low frequency noise in tanks (de Soto et al. 2013). However, these observations have been under controlled experimental conditions that do not represent wild behavior of fish, and exposure to seismic sound is considered unlikely to result in direct fish or invertebrate mortality (DFO 2004). This is because fish are unlikely to remain in an area where intense sounds sources are present (Fewtrell and McCauley 2012) long enough to be injured or killed, though this is difficult to demonstrate in field conditions. Death can eventually result from a reduction in fitness due to hearing loss or tissue damage, but direct harm is generally limited to within 5 m (16 ft) of the sound source, at levels in excess of 230 dB (Turnpenny and Nedwell 1994). Finally, other studies provide examples of no fish mortality upon exposure to seismic sources (e.g., Popper et al. 2005; Boeger et al. 2006).

Eggs and larvae are more vulnerable to effects from sound than juvenile and adult fish as they are much less mobile, instead typically relying on currents for locomotion. In some instances, eggs are fixed to the substrate and therefore completely stationary. Sound levels in the vicinity of 220 dB have been shown to be lethal to fish eggs and larvae (Davis et al. 1998) (see Table 4.5-17). These sound levels correspond to a distance of 0.6 to 3 m (2 to 10 ft) from an airgun. Visible damage to larvae can occur at 210 dB, which corresponds to a distance of approximately 5 m (16 ft) from an airgun (Turnpenny and Nedwell 1994; Davis et al. 1998).

A more relevant concern is the indirect effect of noise on fish behavior. Typical effects from introduced noise include displacement, avoidance, startle responses, and stress (Turnpenny and Nedwell 1994). Scientific evidence suggests that some species of fish may be displaced from or choose not to enter areas of intense underwater noise, while short exposures to seismic sound may drive some demersal species to the seabed (Turnpenny and Nedwell 1994). Furthermore, numerous studies have shown catch rates to decline substantially immediately following the use of airguns for seismic surveys, with a period of up to five days required for catch rates to return to normal (Hassel et al. 2004, Popper and Hastings 2009). Engås et al. (1996) found that abundance and catch rates for haddock and Atlantic cod did not return to pre-shooting levels during the five-day period after seismic shooting and observed reductions in catch rates up to 18 nm from the seismic shooting area. They also found a more pronounced reduction in abundance and catch rates for larger fish. Researchers noted avoidance behavior in squid at levels between 156 and 174 dB re 1 µPa, and the peak source levels of airgun impulses are typically between 250 to 255 dB re 1 µPa (Stocker 2002).

The effects of avoidance and displacement can be numerous. By forcing fish away from their preferred habitats, risk of predation increases, and potential impacts from less desirable feeding and spawning habitat are also possible. There is also potential for disruption of reproductive behavior and the alteration of migration routes. More persistent sound intrusions have the potential for greater impacts, as they can displace fish for longer periods of time. Stress can result in increased mortality as well. Studies suggest that if exposure to sound results in highly-stressed fish, they may be more susceptible to predation or other environmental effects than non-stressed fish (Popper and Hastings 2009).

There are numerous sources of noise generated from oil and gas exploration activities that can affect fish resources. These sources are detailed below, along with their impacts on fish resources. The primary concern is noise generated from seismic surveys and exploratory drilling, while secondary concerns consider a noise generated from regular vessel operations and icebreaking activities.

Seismic Surveys

Acoustic energy pulses emitted by airguns are the principal impacting agents attributable to seismic surveys. The surveys are typically transient, passing through the survey area in a grid pattern. The energy emitted by a typical airgun shot is anticipated to range in frequency from 10 Hz to 120 Hz. This falls within the hearing range of most fish; however the sound level of airgun arrays can be as high as 255 dB, which is well above the level that has been shown to impact fish (see Table 4.5-17). Ramp-up procedures are likely to mitigate many impacts from exposure to these high sound levels as the gradual introduction of sound allows fish to move away from the source before exposure to detrimental sound levels occur.

Fish eggs and larvae would be unable to escape exposure to airgun noise associated with seismic surveys. However the potential for impact is very low given that the airguns would need to pass within meters of the eggs or larvae to have any detrimental effect (see Table 4.5-17). Although it is likely that some eggs and larvae will be exposed to detrimental sound levels, the small fraction of sea area covered by seismic surveys and the widespread nature of the resource make a population level impact unlikely.

Exploratory Drilling

The noises generated from exploratory drilling differ from seismic surveys in two key ways: they are less intense but are more stationary and persistent. A drilling operation has a single source of sound emanating from a fixed location for up to 90 days at a time. The sound produced by the drilling operation consists of loud mechanical noises emitted over a range of frequencies and intensities (see Section 2.3.3 for details). While the intensity of the sound is less than airgun arrays, a potential stationary zone of displacement will be created around the well site. If this zone of displacement is located in important spawning, fish-rearing, or feeding habitat, fish could be negatively impacted over time. However, this impact could be naturally mitigated by habituation of fish to the noise produced by the drilling activity. Since the noise would be somewhat regular in type and source, it is possible that some fish species may become habituated to them and the zone of displacement may be reduced over time.

Vessel Noise

Vessels produce baseline levels of noise when under power. Engines, generators, propellers, and pumps produce sound, much of which is transferred directly to the marine environment. Some of this noise falls within the range of fish sensory perception, and fish have been shown to exhibit avoidance behaviors when confronted with noisy vessels (Mitson and Knudson 2003). However, vessel noise constitutes a relatively small component of the overall soundscape, especially when compared to the amount of noise introduced by seismic survey sources.

Icebreaking

The noise levels resulting from icebreaking operations vary depending on ice thickness, ice condition, vessel used, and vessel speed. Despite the variations due to these factors, operations can reach peak levels of 190 dB, and are typically continuous in nature (Roth and Schmidt 2010). This sound level is above the threshold to initiate avoidance behavior in fish (see Table 4.5-17), although the transient nature of the operation is not likely to result in long-term displacement.

Habitat Loss/Alteration

Habitat loss and alteration can result from several activities involved in oil and gas exploration. Most activities will result in very few habitat impacts, mostly of a temporary nature, although any structures created during exploratory drilling would be considered long-term from a fish resource standpoint. Temporary habitat loss could result from displacement associated with introduced noise or from direct alteration of the seafloor. Long-term habitat loss would be associated with the removal or addition of substrate to the seafloor.

The specific activities likely to result in habitat loss or alteration are icebreaking during fall or winter seismic surveys, anchoring of seismic or support vessels, mud cellar construction, and exploratory drilling.

Icebreaking

Icebreaking from support vessels during fall and early winter for seismic in-ice surveys would result in the direct loss of habitat for the cryopelagic fish assemblage, particularly Arctic cod. Sea ice forms the centerpiece for the entire cryopelagic community, and any alteration to the sea ice has the potential to impact this community. As an icebreaking vessel passes through sea ice, the ship causes the ice to part and travel alongside the hull. This ice typically returns to fill the wake as the ship passes. The effects are temporary and transitory, hours at most, and constrained to a narrow swath of approximately 10 m (30 ft) to each side of the vessel (NMFS 2010c).

Icebreakers could cause rapid pack ice movement at a time of year when the ice may not normally be breaking and moving in some locations; these ice movements could affect ice-associated fish species, particularly Arctic cod eggs and larvae. These effects would be local in geographic extent and low in intensity.

Anchoring

Vessel anchoring, which may be necessary at times during the course of exploration activities, can cause fish habitat loss or alteration through direct seafloor contact. Demersal fish, larvae, or eggs can be impacted directly if the anchor or chain contacts them, causing injury or even mortality. They may also be directly impacted due to sediment displacement, suspension, and deposition downstream, and by the scars caused by deployment, setting, and retrieval of the anchors and chains. A more likely effect will result indirectly through destruction or alteration of habitat. Anchors and chains are capable of destroying or damaging fish habitat by crushing and dragging along the sea floor during deployment, movement, and retrieval. Anchoring in fragile areas valuable as fish habitat such as kelp beds and coral will result in more damage than anchoring in sand or mud. The few known kelp beds in the EIS project area are located in nearshore areas or coastal lagoons, unlikely sites for a vessel to anchor unless necessary for safety (BOEM 2015b). Likewise, there is a known boulder patch in Steffanson Sound that provides relief from predators in the form of a hiding area or refuge from predators. The magnitude of any damage to the seafloor will depend chiefly on the type of substrate the anchor is deployed in and whether any dragging occurs, but would be local in extent and low in intensity.

Exploratory Drilling

Exploratory drilling operations may involve the discharge of drilling fluids and cuttings directly into the ocean at the drill site. Discharges can be detected over a much broader area than the effects of those discharges; while the zone of detection for drilling discharges can be up to 8 km (5 mi) from the drill site, the impacts to benthic communities is typically not detected further than 1 km (0.6 mi) out (Hurley and Ellis 2004).

Most of the major ingredients of drilling fluids have a low toxicity to marine organisms (Luyeye 2005), and, although observed impacts of drilling wastes have generally been attributed to chemical toxicity or organic enrichment, there is increasing evidence to indicate that fine particles in drilling wastes, such as bentonite and barite, can have detrimental effects to filter feeders (Hurley and Ellis 2004).

Heavy particles tend to settle within a few meters of the discharge site and can form a pile on the seafloor. There is potential that the cutting piles resulting from the heavy particles can smother benthic communities and result in artificial reef effects where the piles attract marine organisms and epifaunal animals such as crabs to colonize (BOEM 2007). These measurable effects on benthic communities have the potential to affect fish resources, particularly benthic feeders. Any effects would be local in geographic extent and low in intensity. However, scientific evidence suggests that drilling discharges and cuttings have minor effects on fish health (Hurley and Ellis 2004). The mobility of fish species and the relevant scale of environmental change appear to be the primary reasons for a lack of documented effects in the fish species studied.

Gravel Island Construction

Gravel island construction involves the addition of gravel to the seafloor to create an artificial island to be used as a drilling platform. Gravel islands are typically constructed in shallow areas, and any construction would result in the long-term loss of any spawning, rearing, or feeding habitat located within the impacted area. These effects would be local in geographic extent.

4.5.2.2.1 Direct and Indirect Effects

Marine Fish (Cryopelagic, Nearshore Demersal, Nearshore Pelagic, Offshore Demersal, Offshore Pelagic)

Of the noise sources introduced by Alternative 2, most have been shown to have no long-term impact on fish or fish resources. Because marine fish are widely dispersed and are largely unrestricted in their movements, noises associated with these activities are not expected to have a measurable effect on marine fish populations. All fish assemblages could potentially be exposed to noise, although pelagic and cryopelagic species are more likely to be affected, mainly through behavioral disturbance. However, the transient nature of the noise sources associated with seismic surveys, vessel traffic, and icebreaking minimize the exposure to fish and fish resources, with standard ramp-up procedures allowing further opportunity for mobile fish to escape the area of impact before any detrimental effects are felt. For more stationary noises associated with exploratory drilling, habituation provides a mechanism for fish to reduce effects from displacement. Based on the small footprint of the seismic surveys relative to the amount of habitat over the entire EIS project area, the effect on juvenile and adult fish would be temporary and low in intensity.

General population trends and life histories are sufficiently understood to support sound scientific judgments. While further study would provide a more complete understanding of the fish resources within the EIS project area, existing information on the distribution of eggs and larvae throughout the EIS project area is sufficient to make an informed choice among the alternatives. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would not aid the decision between those alternatives. More information of this type is not essential for a reasoned choice among alternatives.

The opportunity for habitat loss or alteration resulting from Alternative 2 is small. Direct effects to nearshore and offshore demersal fish and fish habitats from exploratory drilling, gravel island construction, icebreaking, and anchoring would be local in geographic extent, particularly when compared to the total area of benthic habitat available. Therefore, the impacts are considered low in magnitude or intensity.

Migratory Fish (Anadromous, Amphidromous)

The effects on migratory fish resulting from Alternative 2 would be similar to those described for marine fish, although on a lesser scale. As migratory fish spend substantial parts of their life cycles away from the marine environment, and therefore away from any potential effects, the risk of exposure is reduced.

Within the broad classification of migratory fish, anadromous species (e.g., salmon) are more likely to be impacted than are amphidromous fish due to the increased time they spend in the ocean. As discussed in Section 3.2.2.3, amphidromous fish typically spend most of their lives in fresh or brackish waters, rarely venturing out to sea. Anadromous fish, however, spend the majority of their adult lives at sea, and are therefore more susceptible to impacts from oil and gas exploration activities. They would therefore be susceptible to effects from noise and loss of habitat, particularly if any important feeding areas were impacted.

As described in Section 3.2.2.3, salmon numbers decrease north of the Bering Strait, and they are relatively uncommon in the Beaufort Sea (Craig and Halderson 1986). Chum is the only salmon species regarded as natal to the Mackenzie River watershed, although both pink and chum salmon appear to be natal to Alaska’s North Slope rivers (Irvine et al. 2009). However, spawning runs in Arctic streams are minor compared to those of commercially important populations farther south (Craig and Halderson 1986). Chum salmon are known to migrate as juveniles to the Bering Sea to mature, and pink salmon have been infrequently encountered in marine Arctic surveys (see Section 3.2.2.3).

Therefore, as with marine fish, the potential for impacts to migratory fish are very low when compared to the overall size of the habitat area and population that the effects are considered to be low in magnitude.

Essential Fish Habitat

As discussed in Section 3.2.2.5, EFH has been identified for all five species of Pacific salmon in addition to Arctic cod, saffron cod, and snow crab. Large portions of the EIS project area fall within the boundaries of the described EFH for these species. However, the amount of habitat actually essential to the survival of these fish that falls within the boundaries of the described EFH may be smaller than what is described.

Of the activities described in Alternative 2, only those resulting in potential habitat loss or alteration are relevant to EFH. Effects to fish habitat from exploratory drilling, gravel island construction, and anchoring would be restricted to very limited areas, particularly when compared to the total area of benthic habitat available. Icebreaking would impact a small percentage of ice, which is essential for Arctic cod. Salmon species spend much of their adult life at sea and therefore require feeding habitat. Saffron cod spend their entire lives in the marine environment and require spawning, rearing, or feeding habitat. However, as with the analysis for marine fish, the opportunity for habitat loss or alteration resulting from Alternative 2 is small. Most impacts would be of low intensity and of small geographic extent.

There is the potential for fish and EFH to be exposed to small fuel spills of less than 50 bbl (see Section 4.2.7). A fuel spill of this size and type would introduce hydrocarbons and effects with respect to toxicity to the surface water. Pelagic fish adults, juveniles, eggs, and larvae would be exposed, and there could be acute effects on these various life stages for the fish species in the area. However, at these concentrations, the spill effects would be short-term and spatially limited.

4.5.2.2.2 Conclusion

Given the potential implementation of standard mitigation measures considered by NMFS in this EIS, the effects on marine and migratory fish and EFH would likely be low in magnitude, temporary to interim in duration, of local extent, and would affect common resources. The direct and indirect effects resulting from Alternative 2 would therefore be considered minor for fish and fish resources.

4.5.2.3 Marine and Coastal Birds

This section describes the potential effects of oil and gas exploration activities on marine and coastal birds of the Beaufort and Chukchi seas. Two of these species are listed under the ESA: spectacled eider (threatened) and Steller’s eider (threatened). As a result of ESA Section 7 consultations with the USFWS, BOEM has required lessees and permittees to implement specific mitigation measures to protect listed eiders when conducting permitted activities. In recent years, NMFS has required the oil and gas industry to implement a number of mitigation measures to reduce potentially adverse impacts on marine mammals and subsistence users and is considering additional mitigation measures in this EIS. These measures are intended to protect marine mammals and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses, but these measures may also have direct and indirect effects on marine and coastal birds, including listed eiders.

The potential effects of oil and gas exploration activities of Alternative 2 on marine and coastal birds include:

- Disturbance from exploration vessels, seismic activities, and aircraft (fixed-wing and helicopter);
- Injury/mortality from collisions with vessels/structures and oil spills; and
- Habitat alteration, loss, orcontamination.

4.5.2.3.1 Direct and Indirect Effects

Exploration activities under Alternative 2 include the use of a variety of large and small vessels, icebreakers, seismic airgun arrays, associated gear such as hydrophones and sensor arrays on cables or nodes that are deployed in marine waters and on the ocean bottom, drilling rigs, helicopters and fixed-wing aircraft, and on-shore support facilities. These facilities and activities could have effects on marine and coastal birds through various mechanisms as discussed below.

This EIS includes a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals and the availability of marine mammals for subsistence uses but these mitigation measures may also help to reduce adverse effects on marine and coastal birds, which are under the jurisdiction of the USFWS. In addition to the mitigation measures imposed by NMFS, the oil and gas industry operates under regulations and permits from BOEM that authorize oil and gas exploration activities. Because these authorizations are federal actions subject to Section 7 consultation requirements of the ESA, BOEM has consulted with the USFWS on the effects of the authorized exploration activities on the ESA-listed spectacled and Steller’s eiders. The USFWS issued a programmatic Biological Opinion (BiOp) for exploration activities in the Beaufort and Chukchi seas (USFWS 2012) that includes an Incidental Take Statement and required Reasonable and Prudent Measures to minimize incidental take of the two listed eider species. The implementing Terms and Conditions would also effectively reduce adverse effects on other marine and coastal bird species, especially those using the Ledyard Bay Critical Habitat Unit (LBCHU) after July 1. The Reasonable and Prudent Measures and Terms and Conditions contained in the BiOp are designed to avoid and minimize bird collisions and to avoid and minimize impacts of disturbance from aircraft, vessels, and drilling operations on listed eiders (USFWS 2012). NMFS does not include stipulations to explicitly protect birds in the ITAs they issue for exploration activities because the agency does not have the authority to do so within an MMPA authorization. However, BOEM and BSEE include measures in permits for oil and gas exploration activities on the Beaufort and Chukchi seas to minimize incidental take of listed eiders. Those measures are outlined in Appendix E of this EIS and are thus incorporated into the analysis of potential effects under Alternative 2. NMFS would work with MMPA applicants to ensure that MMPA authorizations do not conflict with any required USFWS measures to protect ESA-listed birds. Measures implemented to minimize take of listed eiders also protect other migratory birds as required by the MBTA.

Disturbance

Birds’ responses to disturbance vary according to the species, physiological and reproductive status of the individual, distance from the disturbance, and the type/intensity/duration of the disturbance. Reactions of birds to vessels associated with exploration activity would be expected to be the same as reactions noted for other vessels used in Arctic waters, although birds normally move away from slow-moving vessels engaged in exploratory activities (i.e., survey vessels and drill rigs). Vessel traffic may cause local, temporary displacement and disruption of feeding or resting for some species. However, other species such as gulls and fulmars often follow vessels to forage on small fish and invertebrates brought to the surface in their wakes.

The presence of seismic survey ships would likely increase disturbance from vessel traffic, but changes would be incremental since a variety of ships regularly transit the Beaufort and Chukchi seas to supply goods and services to the communities or for military, search-and-rescue, or scientific purposes.

Seismic surveys with airgun arrays result in both horizontal and vertical sound propagation in the water column. There has been some directed research on the potential effects of these sounds on birds. Stemp (1985) observed birds in the proximity of seismic surveys and did not see noticeable disturbance of birds during airgun deployment. Stemp (1985) concluded that negative effects from seismic operations were not likely, as long as the activities were conducted away from the colonies of birds and their feeding concentrations.

Lacroix et al. (2003) examined the potential effects of seismic surveys on a particularly sensitive group of birds, molting long-tailed ducks, along barrier islands near Prudhoe Bay. Aerial surveys were conducted before, during, and after the seismic activity, which lasted 21 days, and the abundance of birds around islands near the seismic activities were compared to those around islands that were far from the seismic work. The number of birds recorded declined substantially between the pre-seismic survey (July 24) and during-seismic survey (August 6) at all locations, but the decline was greater at the near islands (89 percent) than at the far islands (42 percent). There was a further decline in numbers after the post-seismic survey (September 7), but the magnitude of decline was similar among all areas. Lacroix et al. (2003) also used radio-tagged ducks and a series of automated receiver stations to investigate movement patterns in relation to the seismic work and found essentially no difference between ducks around the near-seismic islands and those around the distant islands. These results indicated that even though ducks were moving away from the islands during the study period as they completed their molts, ducks did not move away from seismic areas any faster than they did from distant areas. The telemetry data also included information on diving rates (indicating feeding behavior), and there was no difference in the diving patterns between near-seismic birds and those far away. Lacroix et al. (2003) concluded that the similarity of data from near-seismic birds and distant birds meant that other factors determined the abundance and movement patterns of long-tailed ducks other than their proximity to the seismic survey. However, they cautioned that their study methods did not account for short-term or localized disturbance, such as those that occur from passing vessels and recommended additional behavioral studies to examine these potential effects.

There is a limited spatial/temporal overlap of eiders with seismic surveys in the Beaufort and Chukchi seas (USFWS 2009c). King eiders begin migrating through the spring lead system from the Chukchi Sea to the Beaufort Sea in April-May (males) and May-June (females) (Phillips 2005, Suydam et al. 2000, Quakenbush et al. 2009) and fly inland to nesting areas soon afterward. A similar pattern occurs for many other marine species, which move to terrestrial breeding grounds in early summer. The great majority of birds are therefore not present in OCS waters when the ice recedes enough to allow seismic survey vessels to operate. The number of eiders and other marine and coastal birds that would likely be exposed to seismic survey vessel activity in OCS waters of the Beaufort and Chukchi seas in the early open-water season would be relatively small, but more birds would be expected to occur in the Chukchi Sea than the Beaufort Sea. Designated vessel travel routes for support vessels supporting stationary drilling structures could allow for habituation by some bird species (Schwemmer et al. 2011).

The number of birds in the Chukchi Sea increases later in the open-water season, after the breeding season as adults and hatch-year birds move west out of the Beaufort Sea towards molting and wintering areas. After breeding, tens of thousands of eiders move to nearshore marine areas to molt, with large concentrations using the LBCHU, which would not receive any OCS oil and gas industry traffic after July 1 of each year.

The potential effects on birds through disturbance and other mechanisms could be magnified if exploration activities occurred adjacent to nesting colonies, which occur on many barrier islands. However, because most nesting occurs in June and early July and most open-water activities in the Beaufort Sea occur later in the season, there may be little potential for overlap and disturbance of nesting birds on barrier islands. Similarly, the nesting season occurs after the conclusion of on-ice seismic activities, which usually end by May because of concerns over ice thickness.

Another situation where effects on birds could be magnified is if exploration activities occurred in areas and times used by high concentrations of birds or when they are especially vulnerable to disturbance. This would be the case if exploration activities occurred in coastal waters and lagoons used by molting waterfowl and seabirds. Many nearshore areas along the Beaufort Sea are used by birds staging during migration in the spring and fall, but, since vibroseis surveys would be completed before open leads developed in the spring and other exploration activities generally take place further offshore in late summer-fall during open-water season, disturbance of birds in fall staging areas would be limited.

In the Chukchi Sea, LBCHU was designated as a critical habitat for ESA-listed spectacled eiders in 2001 due to its importance for the persistence and recovery of spectacled eiders. Ledyard Bay is also important habitat for many other species of waterfowl and seabirds, including ESA-listed Steller’s eider and yellow-billed loon. Because of the importance of this area to spectacled eiders, stipulation 7 of the Chukchi Lease Sale 193 Second Supplemental Environmental Impact Statement (SEIS) places timing and elevation restrictions on vessels and aircraft that directly support oil and gas exploration and delineation drilling (see Appendix E).

Frequent low-level traffic can result in chronic stress responses that could harm birds, especially during sensitive life stages like molting. Low-flying aircraft used to support oil and gas exploration activities can cause temporary disturbance of nearby birds, but minimum flight altitudes (above 1,500 ft) over the LBCHU by all OCS lessees/permittees (or their agents) considered as standard mitigation measure B1 should minimize potential disturbance. Helicopters may disturb nearby birds more than fixed-wing aircraft, at least at take-off and landing, because they hover in one place for some minutes, but birds are likely to recover soon after the source of disturbance has left.

Injury/Mortality

Seismic surveys with airgun arrays result in both horizontal and vertical sound propagation in the water column. As with other animals, there is some potential for a bird to be injured by a seismic airgun pulse if the bird was in very close proximity (<2 m [<6.6 ft]) to an operating airgun. This situation is anticipated to be rare because birds tend to avoid operating vessels and the airborne sound associated with an active airgun. During a start-up, birds on the water close to the seismic vessel would be alerted to the initiation of the airgun by the required ramping up procedure.

Many waterfowl and seabird species fly at low altitudes over water (Johnson and Richardson 1982), so the potential exists for these birds to collide with offshore structures and ships, especially under conditions of poor visibility such as fog, precipitation, and darkness. Some birds are also attracted to lights from the vessels, which can increase the risk of collisions and result in injury or death (Marquenie 2007).

As a result of Section 7 consultation with the USFWS, BOEM requires OCS lessees to explore and implement a suite of methods to reduce the amount of light directed outward and upward from exploration drilling structures to reduce the risk of bird collisions. These could include shading and/or light fixture placement, different types of lights, adjustment of the number and intensity of lights as needed during specific activities, dark paint colors for selected surfaces, low-reflecting finishes or coverings for selected surfaces, and refined facility or equipment configuration.

Studies in the North Sea indicated that different colored lights caused different responses. White lights caused attraction, red caused disorientation, and green and blue caused a weak response (Marquenie 2007). White lights were replaced with lights that appeared green, and this resulted in 2 to 10 times fewer birds circling the offshore platforms (Marquenie 2007).

A study on the effects of anti-collision lighting systems on Northstar Island for eiders and other birds found in the Beaufort Sea showed that there was a substantial slowing of flight speeds at night and movement away from the island when strobe lights (40 flashes per minute) were used. The lights did not cause other bird species to avoid the island but may have caused a weak attraction. Therefore, the effectiveness was not clear and was inconsistent (Day et al. 2003, Day et al. 2005).

The risk of birds colliding with vessels would increase incrementally. A full complement of vessels for a full season as considered under this alternative may result in a greater number of strikes than occurred during the 2012 drilling season. Based on the existing preliminary bird strike reports from 2012, two simultaneous future drilling operations could result in an estimated 178 bird strikes per open-water season—this could include an estimated 98 passerines, 22 shearwaters/storm petrels/auklets, 9 shorebirds, and 48 seaducks. Of the seaducks, 24 could be king eiders, 16 could be long-tailed ducks, and 8 could be common eiders. This potential mortality for each species is small by comparison with the post-breeding population; thus, no species would experience a population-level effect. Listed eiders would be a subset of the total number of seaducks killed by a strike.

There is the potential for marine and coastal birds to be exposed to small fuel spills of less than 50 bbl (see Section 4.2.7). As explained in greater detail in the Lease Sale 193 EIS (MMS, 2007a) and the Lease Sale 193 Secondary Final SEIS (BOEM 2015b), spilled hydrocarbons can adversely affect marine and coastal birds because these species spend so much time on the water surface and are highly susceptible to mortality if contacted. It is assumed that any bird contacted by hydrocarbons would die. However, the most likely outcome is a spill that is immediately contained and would have a negligible effect on marine and coastal birds. Moreover, if a small spill of less than 50 bbl were to escape containment or response measures offshore, it would not persist very long, resulting in few opportunities to contact many marine and coastal birds. The potential effects of a VLOS are described in Sections 4.10.6.10 and 4.10.7.10.

Habitat Changes/Contamination

Seismic airguns may affect invertebrates and fish (prey species used by birds). However there are very few effects on invertebrates and fish from the airgun noise unless they are within a few feet of the sound source (McCauly 1994). These disturbance effects are highly local and transient and not likely to decrease the availability of prey to any bird species. See Section 4.5.2.2 for effects on fish and Section 4.5.2.1 for effects on lower trophic level species.

Exploratory drilling could directly affect a very small area of benthic habitat with increased turbidity and discharge of drilling cuttings. Given the very small number of sites involved in exploratory drilling under Alternative 2 and the temporary nature of the habitat disturbance, the potential for effects on any bird species is considered negligible.

4.5.2.3.2 Mitigation Measures

Standard mitigation measures could reduce adverse impacts to marine and coastal birds (see Sections 2.4.10 or 4.5.2.4.16 or Appendix E for detail). This includes aircraft flight paths and altitude restrictions to reduce the chance of disturbing marine and coastal birds. Additionally, in order to help avoid causing bird collisions with seismic survey and support vessels, BOEM may require that those vessels minimize the use of high-intensity work lights, especially within the 20-m-bathymetric contour.

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on birds except for Additional Mitigation Measures C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the reduction in adverse effects relative to the standard mitigation measures would be limited to small numbers of birds and small areas of benthic habitat. Additional mitigation measures are not required under any of the alternatives and do not affect the summary conclusion below.

4.5.2.3.3 Conclusion

Marine and coastal birds are legally protected under the MBTA and two are protected under the ESA. Birds fulfill important ecological roles in the Arctic and are considered to be important or unique resources in a NEPA perspective. In the absence of a large oil spill, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary, local, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 2 on marine and coastal birds would be considered minor according to the impact criteria in Table 4.5-16. Conclusions about impacts to birds in the event of a large oil spill are described in Sections 4.10.6.10 and 4.10.7.10. Impacts are anticipated to be reduced based on the mitigation measures required by BOEM in G&G permits (see Appendix E).

4.5.2.4 Marine Mammals

Noise exposure, habitat degradation, and vessel activity (potentially causing displacement from preferred habitats or, though very unlikely, ship strikes) are the primary mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi Seas could directly or indirectly affect marine mammals. The impacts of anthropogenic noise on marine mammals has been summarized in numerous articles and reports including Richardson et al. (1995), Cato et al. (2004), NRC (2003, 2005), Southall et al. (2007), Nowacek et al. (2007), and Weilgart (2007). The following introduction to general effects of noise from oil and gas exploration activities on marine mammals is drawn largely from these and other available literature. Impacts specific to the marine mammal species of interest in the EIS project area are discussed and evaluated separately. Because the occurrence of a large oil spill is a highly unlikely event, it is not part of the proposed action for any alternative. However, in the highly unlikely event a large spill were to occur, it could result in adverse impacts on marine mammals discussed in this section. The oil spill analysis is not contained in the sections that analyze direct and indirect effects of the alternatives on marine mammals; rather, it is discussed and analyzed separately in Section 4.10 of this EIS.

In this section of the EIS, a general discussion of the potential effects of the various activities on marine mammals is presented first. Following this general discussion, more specific examples and information are presented for the different species or marine mammal groups, where available. Finally, an analysis of the standard and additional mitigation measures is presented for each species or group of marine mammals, as well as analysis for mitigation measures dismissed from further implementation consideration. The impact criteria for marine mammals are outlined for magnitude or intensity, duration, extent, and context in Table 4.5-18.

Table 4.5-18 Impact Criteria for Marine Mammals

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	**Low**	Changes in behavior due to exploration activity may not be noticeable; animals remain in the vicinity; Level B take of marine mammals is not anticipated
		Medium	Noticeable change in behavior due to exploration activity; animals move away from activity area; Level B take of marine mammals expected, number of individuals taken is less than 30% of population
		High	Level B take of more than 30% of the individuals in the population expected
	Duration	**Temporary**	Temporary effect that lasts days to 1 month
		Interim	Temporary effect that lasts 1 to 6 months. Impacts would be frequent or extend for longer time periods (an entire project season).
		Long-term	Effects that last more than 6 months (i.e., one season) in a given year or multi-month effects that recur over multiple successive years.
	Geographic Extent	**Local**	Impacts limited geographically; <10% of EIS project area affected
		Regional	Affects resources beyond a local area, potentially throughout the EIS project area
		State-wide	Affects resources beyond the EIS project area
	Context	**Common**	Affects usual or ordinary resources in the EIS project area; species are not listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA; impacts *will not* occur in times or areas of specific importance for affected species (e.g., feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population
		Important	1) Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA but do not also have impacts to important areas, OR 2) Species are *not* listed in this manner, but species abundance trend is declining or, impacts *will* occur in times or areas of specific importance for affected species (e.g., feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population.
		Unique	1) Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA and; impacts *will* occur in times or areas of specific importance for affected species (e.g., feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population OR 2) Species is not listed, but species is declining and impacts will occur in areas of specific importance.
Injury and mortality	Magnitude or Intensity	**Low**	No noticeable incidents of injury or mortality
		Medium	Few injuries may occur
		High	Incident of mortality or multiple incidences of injury
	Duration	**Temporary**	Injury to affected animal(s) lasts days to 1 month; animal reverts back to pre-activity condition once healed from injury
		Interim	Incidences of injury of affected animal(s) lasts 1 to 6 months; animal reverts back to pre-activity condition once healed from injury
		Long-term	Mortality of animal(s) or incidences of injury persist for more than 6 months; Injury is permanent in some cases
	Geographic Extent	**Local**	Impacts local; would not extend to a broad region or sector of the population
		Regional	Impacts would occur beyond a local area
		State-wide	Affects resources beyond the region or EIS project area

Type of effect	Impact Component	Effects Summary	
	Context	**Common**	Affects usual or ordinary resources in the EIS project area; species are not listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA
		Important	Species is listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA but the population is stable or increasing
		Unique	Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA and the population is decreasing
Habitat alterations	**Magnitude or Intensity**	**Low**	Changes in resource character may not be measurable or noticeable
		Medium	Noticeable changes in resource character
		High	Acute or obvious changes in resource character
	Duration	**Temporary**	Habitat would be impacted for days to 1 month; no permanent changes to habitat
		Interim	Habitat would be impacted from 1 to 6 months; minimal, temporary alterations to marine mammal habitat
		Long-term	Habitat would be impacted for more than 6 months (i.e., one season); potential for permanent changes to marine mammal habitat
	Geographic Extent	**Local**	Impacts limited geographically; <10% of EIS project area affected
		Regional	Affects resources beyond a local area, potentially throughout the EIS project area
		State-wide	Affects resources beyond the region or EIS project area
	Context	**Common**	Affects usual or ordinary resources in the EIS project area; species are not listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA
		Important	1) Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA but do not also have impacts to important areas, OR 2) Species are *not* listed in this manner, but species abundance trend is declining or, impacts *will* occur in times or areas of specific importance for affected species (e.g., feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population.
		Unique	1) Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA and; impacts *will* occur in times or areas of specific importance for affected species (e.g., feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population OR 2) Species is not listed, but species is declining and impacts will occur in areas of specific importance.

4.5.2.4.1 General Effects of Noise on Marine Mammals

Marine mammals use hearing and sound transmission to perform vital life functions. Sound (hearing and vocalization/echolocation) serves four primary functions for marine mammals, including: (1) providing information about their environment; (2) communication; (3) prey detection; and (4) predator detection. Introducing sound into the ocean environment could disrupt those functions. The distance from oil and gas exploration activities at which noises are audible depends upon source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and sensitivity of the receptor (Richardson et al. 1995, Nowacek et al. 2007).

In assessing potential effects of noise, Richardson et al. (1995) suggested four criteria for defining zones of influence:

Zone of audibility – the area within which the marine mammal might hear the noise. Marine mammals as a group have functional hearing ranges of 10 Hz to 180 kHz, with best thresholds near 40 dB (Ketten 1998, Kastak et al. 2005, Southall et al. 2007). These data show reasonably consistent patterns of hearing sensitivity within each of four groups: small odontocetes (such as the harbor porpoise), medium-sized odontocetes (such as the beluga and killer whales), large cetaceans (such as bowhead whales), and pinnipeds.

Zone of responsiveness – the area within which the animal reacts behaviorally or physiologically. The behavioral responses of marine mammals to sound depend on: 1) the acoustic characteristics of the noise source; 2) the physical and behavioral state of animals at time of exposure; 3) the ambient acoustic and ecological characteristics of the environment; and 4) the context of the sound (e.g., whether it sounds similar to a predator) (Richardson et al. 1995, Southall et al. 2007). Temporary behavioral effects, however, often merely show that an animal heard a sound and may not indicate lasting consequences for exposed individuals (Southall et al. 2007). Additionally, in the context of the MMPA, not all responses will rise to the level of a "take;" however, NMFS recognizes some responses in certain situations can rise to this level (Southall et al. 2013).

Zone of masking – the area within which the noise may interfere with detection of other sounds, including communication calls, prey sounds, or other environmental sounds.

Zone of hearing loss, discomfort, or injury – the area within which the received sound level is potentially high enough to cause discomfort or tissue damage to auditory or other systems. This includes temporary threshold shifts (TTS, temporary loss in hearing) or permanent threshold shifts (PTS, permanent loss in hearing at specific frequencies or deafness). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage.

4.5.2.4.2 Potential Effects of Noise from Airguns

The effects of airgun noise on marine mammals could include one or more of the following: tolerance; masking of natural sounds; behavioral disturbance; temporary or permanent hearing impairment; or non-auditory physical or physiological effects (Richardson et al. 1995, Gordon et al. 2004, Nowacek et al. 2007, Southall et al. 2007). The effects of noise on marine mammals are highly variable, often depending on species and contextual factors (Ellison et al. 2012, Richardson et al. 1995).

Tolerance

Richardson et al. (1995) defined tolerance as the occurrence of marine mammals in areas where they are exposed to human activities or manmade noise. In many cases, tolerance develops by the animal habituating to the stimulus (i.e., the gradual waning of responses to a repeated or ongoing stimulus), but because of ecological or physiological requirements, many marine animals may need to remain in areas where they are exposed to chronic stimuli (Richardson et al. 1995). Pulsed sounds from airguns are often detectable in the water at distances of tens of kilometers, without necessarily eliciting behavioral responses. Numerous studies have shown that marine mammals at distances over a few kilometers from operating seismic vessels may show no apparent response (Richardson et al. 1995). That is often true even when pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to temporarily react behaviorally to airgun pulses under some conditions, at other times, marine mammals of all three types have shown no overt reactions (Richardson et al. 1995, Stone 2003, Stone and Tasker 2006, Moulton et al. 2005, MacLean and Koski 2005).

Masking

Masking occurs when biologically meaningful sounds (e.g., communication, predator or prey detection, navigation, other environmental cues) are obscured by ambient or anthropogenic noise (Richardson et al. 1995, Clark et al. 2009). Introduced underwater sound will, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used by the marine mammal and if the anthropogenic sound is present for a substantial period of time (Richardson et al. 1995).

Marine mammals are highly dependent on sound, and their ability to recognize sound signals amid other noise is important in communication, predator and prey detection, navigation and sensing other important environmental cues, and, in the case of toothed whales, echolocation. Even in the absence of manmade sounds, the sea is usually noisy. Background ambient noise often interferes with or masks the ability of an animal to detect a sound signal even when that signal is above its absolute hearing threshold. Natural ambient noise includes contributions from wind, waves, precipitation, other animals, and (at frequencies above 30 kHz) thermal noise resulting from molecular agitation (Richardson et al. 1995). Based on autonomous acoustic recordings from September 2006 to June 2009 north of Barrow, Alaska, on the continental slope between the Beaufort and Chukchi Seas, mean monthly spectrum levels (selected to exclude impulsive events) show that months with open-water had the highest noise levels (80-83 dB re: 1 μPa^2/Hz at 20-50 Hz), months with ice coverage had lower spectral levels (70 dB at 50 Hz), and months with both ice cover and low wind speeds had the lowest noise levels (65 dB at 50 Hz). Background noise also can include sounds from human activities. Masking of natural sounds can result when human activities produce high levels of noise. Conversely, if the background level of underwater noise is high (e.g., on a day with strong wind and high waves), an anthropogenic noise source will not be detectable as far away as would be possible under quieter conditions and will itself be masked.

Although some degree of masking is inevitable when high levels of manmade broadband sounds are introduced into the sea, marine mammals have evolved systems and behavior that function to reduce the impacts of masking. Structured signals, such as the echolocation click sequences of small toothed whales, may be readily detected even in the presence of strong background noise because their frequency content and temporal features usually differ strongly from those of the background noise (Au and Moore 1988, 1990). The components of background noise that are similar in frequency to the sound signal in question primarily determine the degree of masking of that signal.

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The sound localization abilities of marine mammals suggest that, if signal and noise come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Richardson et al. 1995). The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may substantially reduce the masking effects of these noises by improving the effective signal-to-noise ratio. In the cases of high-frequency hearing by the beluga whale and killer whale, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking noise (Penner et al. 1986, Dubrovskiy 1990, Bain et al. 1993, Bain and Dahlheim 1994). Toothed whales and probably other marine mammals as well, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background noise. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient noise toward frequencies with less noise (Au et al. 1974, 1985; Moore and Pawloski 1990; Thomas and Turl 1990; Romanenko and Kitain 1992; Lesage et al. 1999). A few marine mammal species are known to increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Dahlheim 1987; Au 1993; Lesage et al. 1993, 1999; Terhune 1999; Foote et al. 2004; Parks et al. 2007, 2009; Di Iorio and Clark 2009; Holt et al. 2009).

These data demonstrating adaptations for reduced masking pertain mainly to the very high frequency echolocation signals of toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies or in other types of marine mammals. For example, Zaitseva et al. (1980) found that, for the bottlenose dolphin, the angular separation between a sound source and a masking noise source had little effect on the degree of masking when the sound frequency was 18 kHz, in contrast to the pronounced effect at higher frequencies. Directional hearing has been demonstrated at frequencies as low as 0.5 to 2 kHz in several marine mammals, including killer whales (Richardson et al. 1995). This ability may be useful in reducing masking at these frequencies. In summary, high levels of noise generated by anthropogenic activities may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking may be more prominent for lower frequencies.

For higher frequencies, such as that used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such masking.

Although there is little data describing the ultimate effects of masking on animals, there can be a measurable loss of communication space that would likely be of more concern for low-frequency species (mysticetes) from lower frequency sources, both because of the communication strategies used by mysticetes (they can communicate over 100s of kilometers for days) and the physical propagation properties of lower frequency sounds (less absorption). Analysis of distant (450 to 2800 km) seismic survey sounds and Antarctic blue and fin whale songs suggest that increased background noise levels decrease potential communication distances by 29 to 40 percent (Gedamke 2011). Vessel noise in a heavily trafficked region off New England may have diminished right whale communication space by an estimated 63 to 67 percent (Hatch et al. 2012). Some whales are known to continue calling in the presence of seismic pulses; however, observers typically note some proximity around the source within which the calls decrease in number or become less frequent (Richardson et al. 1986, McDonald et al. 1995, Greene et al. 1999, Nieukirk et al. 2004, Di Iorio and Clark 2009). Additionally, as described above, some marine mammals, such as the small toothed whales communicate within frequency bands that are quite different from the frequencies of background sounds. Marine mammals that are able to use directional hearing may also be less impacted by masking effects. The greatest limiting factor in estimating impacts of masking is a lack of understanding of the spatial and temporal scales over which marine mammals actually communicate, although some estimates of distance are possible using signal and receiver characteristics. Estimates of communication masking, however, depend on assumptions for which data are currently inadequate (Clark et al. 2009).

The *Cumulative Effects of Anthropogenic Underwater Sound on Marine Mammals* is a University of California project sponsored by British Petroleum (BP) for which an expert committee was convened and tasked with developing a model for systematically evaluating the potential effects of multiple sound sources. Although additional work is needed, the model provides a first step to better understanding the cumulative impacts of the sound sources associated with oil and gas exploration (Streever et al. 2012). After outlining a quantitative method, the committee conducted a trial to assess impacts to bowheads based broadly on operational conditions in the Alaskan Beaufort in September and October of 2008. The model results highlighted some of the limitations of the model, which primarily arose from the simplifying assumptions necessary due to the lack of empirical data. However, the model also illustrated how these types of tools can be used for improved, scenario-driven, evaluations of multiple-source sounds (e.g., to compare sound exposure or extra distance traveled off migration path given different individual sound avoidance strategies). Further, the committee recognized the complexities and resource cost of developing and implementing a quantitative model-based framework, and how they may constrain the regular use of such models. However, the committee continues to work on a more qualitative method for more routine use and also to further flesh out the quantitative method.

Through the process of developing this FEIS, commenters recommended that NMFS include a mechanism for better assessing the chronic and aggregate effects of the Alternatives explored in this EIS. NMFS designed and conducted such an analysis and Section 4.5.2.4.9 includes a description of the results and limitations of this first-order assessment. Results predict losses in broadband listening area and bowhead communication space at 10 specific receiver sites when averaged over July through mid-October.

Disturbance Reactions

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, environmental conditions, and many other factors (Richardson et al. 1995, Stone and Tasker 2006). Responses also depend on whether an animal is less likely (habituated) or more likely (sensitized) to respond to sound exposure (Southall et al. 2007). Responses to anthropogenic sounds are highly variable. Meaningful interpretation of behavioral responses should not only consider the relative magnitude and severity of reactions but also the relevant acoustic, contextual variables (e.g., proximity, subject experience and motivation, duration, or recurrence of exposure), and ecological variables (Southall et al. 2007).

If a marine mammal reacts briefly to an underwater sound by minimally changing its behavior or moving a short distance, the impacts of the change are unlikely to be substantial to the individual and will not impact the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be noteworthy. Data on short-term reactions (or lack of reactions) do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect marine mammal reproductive rates or distribution and habitat use in subsequent days or years. However, the Western Arctic stock of bowhead whales has been increasing at approximately 3.7 percent per year (Givens et al. 2013), during a period of exposure to exploration activities in the Beaufort and Chukchi seas since the late 1960s. Additionally, enough information is available to make a reasoned choice among alternatives. Further, impacts to other arctic marine mammal species' reproductive rates or stock sizes have not been documented.

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Observable reactions of marine mammals to sound include attraction to the sound source, increased alertness, modification to their own sounds, cessation of feeding or interacting, alteration in swimming or diving behavior (change direction or speed), short or long-term habitat abandonment (deflection, short or long-term avoidance), and, possibly, panic reactions, such as stampeding or stranding (Nowacek et al. 2007, Richardson et al. 1995, Southall et al. 2007).

Because the physiological and behavioral responses of the majority of the marine mammals exposed to anthropogenic sound cannot be detected or measured (not all responses visible external to animal, portion of exposed animals underwater [i.e., not visible], many animals located many miles from observers and covering very large area, etc.) and because NMFS must authorize take prior to the impacts to marine mammals, a method is needed to estimate the number of individuals that will be taken, pursuant to the MMPA, based on the proposed action. To this end, NMFS developed acoustic thresholds that estimate at what received sound levels the Level B Harassment, Level A Harassment, and mortality of marine mammals would occur from different types of sounds. The current NMFS acoustic threshold for Level B behavioral harassment is 160 dB re 1 μPa rms received level for impulse noises (such as airgun pulses) and 120 dB re 1 μPa rms for continuous sounds (such as drill ships and icebreaking).

Noise Induced Threshold Shift

Animals exposed to intense sound may experience reduced hearing sensitivity for some period of time following exposure. This increased hearing threshold is known as noise induced threshold shift (TS). The amount of TS incurred is influenced by amplitude, duration, frequency content, temporal pattern, and energy distribution of the noise (Kryter 1985, Richardson et al. 1995, Southall et al. 2007). It is also influenced by characteristics of the animal, such as behavior, age, history of noise exposure, and health. The magnitude of TS generally decreases over time after noise exposure, and, if it eventually returns to zero, it is known as temporary threshold shift (TTS). If TS does not return to zero after some time, it is known as permanent threshold shift (PTS). Sound levels associated with TTS onset are generally considered to be below the levels that will cause PTS, which is considered to be auditory injury.

NMFS has established acoustic thresholds that identify the received sound levels above which permanent hearing impairment or other injury could potentially occur (Level A take). Historically, NMFS identified 180 and 190 dB re 1 μPa (rms) for cetaceans and pinnipeds, respectively as the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements (which inform PTS predictions) for marine mammals became available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. As discussed in Section 4.2.6, NMFS recently finalized revisions to these acoustic thresholds (NOAA 2016). The new auditory injury thresholds utilize dual metrics, one for peak pressure sound pressure level (PK), and one for cumulative SEL (SEL_{cum}) that takes into consideration the duration of the exposure within a day. Calculating exposures with the metric that incorporates duration is slightly more complicated, but it is still likely that most marine mammals avoid ships and/or seismic operations at distances that likely avoid PTS, or evern TTS, onset. In addition, monitoring and mitigation measures often implemented during seismic surveys are designed to detect marine mammals near the airgun array to avoid exposure to sound pulses of a level or duration that may cause hearing impairment. If animals do incur TTS, it is a temporary and reversible phenomenon unless exposure exceeds the TTS-onset threshold by an amount sufficient to cause PTS which, while unlikely, is still possible.

In a study on monkeys, Lonsbury-Martin et al. (1987) found that the long-lasting nature of changes in neural responsiveness suggests that each TTS episode may produce an increment of damage to the ear and eventually contribute to measurable PTS. This was tested by exposing monkeys to short-lasting TTS sound repeatedly for many months and then comparing their cochlear ducts for hearing loss damages. Hamernik et al. (2002) compared the inferior colliculus in chinchillas that were exposed to three different thresholds of noise exposure and found there was a consistent relationship between PTS and TTS. The following subsections summarize the available data on noise-induced hearing impairment in marine mammals.

Temporary Threshold Shift

TTS is the mildest form of hearing impairment that can occur during exposure to sound (Kryter 1985). It is not considered to represent physical injury, as hearing sensitivity fully recovers after the sound ends. TTS is defined as a temporary, reversible increase in the threshold of audibility at a specified frequency or portion of an individual’s hearing range above a previously established reference level. Sounds must be temporarily louder for an animal to hear them. The amount of TTS is customarily expressed in decibels (ANSI 1995; Yost 2007). Based on data from cetacean TTS measurements (see Finneran 2015 for a review), a TTS of 6 dB is considered the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a subject’s normal hearing ability (Schlundt et al. 2000; Finneran et al. 2000; Finneran et al. 2002). Several physiological mechanisms are thought to be involved with inducing TTS. These include reduced sensitivity of sensory hair cells in the inner ear, changes in the chemical environment in the sensory cells, residual middle-ear muscular activity, displacement of inner ear membranes, increased blood flow, and post-stimulatory reduction in efferent and sensory neural output (Kryter 1994, Ward 1997, Southall et al. 2007).

The magnitude of TTS depends on the level, duration, and frequency (kHz) associated with the noise exposure (Kryter 1985, Richardson et al. 1995, Southall et al. 2007). TTS has only been studied in captive odontocetes and pinnipeds (reviewed in Finneran 2015 and in Appendix B). No hearing or TTS data are available for mysticete species. Few data are available for marine mammals regarding exposure to multiple pulses of sound during seismic surveys (see Lucke et al. 2009 and Finneran et al. 2015). For species or groups of marine mammals for which studies have been conducted, those data or information are presented in the specific subsections below. It is difficult for researchers to present controlled exposures and conduct measurements in the wild, and it is not possible to conduct laboratory experiments on large baleen whales. Using extrapolated data from other species is considered an acceptable proxy for determining TTS in baleen whales or other groups where hearing data do not exist (Southall et al. 2007).

For toothed whales, experiments on a bottlenose dolphin (*Tursiops truncates*) and beluga whale showed that exposure to a single watergun impulse at a received level of 207 kPa (or 30 psi) peak-to-peak (p-p), which is equivalent to 228 dB re 1 mPa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran et al. 2002). No TTS was observed in the bottlenose dolphin. Finneran et al. (2005) further examined the effects of tone duration on TTS in bottlenose dolphins. Bottlenose dolphins were exposed to 3 kHz tones (non-impulsive) for periods of 1, 2, 4 or 8 seconds (s), with hearing tested at 4.5

kHz. For 1-s exposures, TTS occurred with SELs of 197 dB, and for exposures >1 s, SEL >195 dB resulted in TTS (SEL is equivalent to energy flux, in dB re 1 mPa2-s). At an SEL of 195 dB, the mean TTS (4 minutes (mins) after exposure) was 2.8 dB. Finneran et al. (2005) suggested that an SEL of 195 dB is the likely threshold for the onset of TTS in dolphins and belugas exposed to tones of durations 1–8 s (i.e., TTS onset occurs at a near constant SEL, independent of exposure duration). That implies that, at least for non-impulsive tones, a doubling of exposure time results in a 3 dB lower TTS threshold. However, the assumption that, in marine mammals, the occurrence and magnitude of TTS is a function of cumulative acoustic energy (SEL) is probably an oversimplification. Kastak et al. (2005) reported preliminary evidence from pinnipeds that, for prolonged non-impulse noise, higher SELs were required to elicit a given TTS if exposure duration was short than if it was longer, i.e., the results were not fully consistent with an equal-energy model to predict TTS onset. Mooney et al. (2009a) showed this in a bottlenose dolphin exposed to octave-band non-impulse noise ranging from 4 to 8 kHz at SPLs of 130 to 178 dB re 1 mPa for periods of 1.88 to 30 minutes (min). Higher SELs were required to induce a given TTS if exposure duration was short than if it was longer. Exposure of the aforementioned bottlenose dolphin to a sequence of brief sonar signals showed that, with those brief (but non-impulse) sounds, the received energy (SEL) necessary to elicit TTS was higher than was the case with exposure to the more prolonged octave-band noise (Mooney et al. 2009b). Those authors concluded that, when using (non-impulse) acoustic signals of duration ~0.5 s, SEL must be at least 210–214 dB re 1 mPa2-s to induce TTS in the bottlenose dolphin. The most recent studies conducted by Finneran et al. also support the notion that exposure duration has a more substantial influence compared to SPL as the duration increases, and that TTS growth data are better represented as functions of SPL and duration rather than SEL alone (Finneran et al. 2010a, 2010b). In addition, Finneran et al. (2010b) conclude that when animals are exposed to intermittent noises, there is recovery of hearing during the quiet intervals between exposures through the accumulation of TTS across multiple exposures. Such findings suggest that when exposed to multiple seismic pulses, partial hearing recovery also occurs during the seismic pulse intervals.

Permanent Threshold Shift

PTS is defined as “irreversible elevation of the hearing threshold at a specific frequency” (Yost 2000). It involves physical damage to the sound receptors in the ear and can result in either total or partial deafness or impaired ability to hear sounds in specific frequency ranges (Kryter 1985). Some causes of PTS are severe extensions of effects underlying TTS (e.g., irreparable damage to sensory hair cells). Others involve different mechanisms, for example, exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of inner ear fluids (Ward 1997, Yost 2000). The onset of PTS is determined by pulse duration, peak amplitude, rise time, number of pulses, inter-pulse interval, location, species and health of the receivers ear (Ketten 1994).

The relationships between TTS and PTS thresholds have not been studied in marine mammals, and there is currently no evidence that exposure to airgun pulses can cause PTS in any marine mammal, however there has been speculation about that possibility (Richardson et al. 1995, Gedamke et al. 2008).

Section 4.2.6.3 outlines NMFS final revisions to auditory injury thresholds. NMFS applied these thresholds to the types of sources analyzed in this EIS (seismic airguns and drilling sources of similar size) and found that the resulting distances at which injurious exposures could not be ruled out (i.e., those at which PTS might be incurred) were similar to those calculated using the 180 and 190-dB historical thresholds, meaning that the revisions to the auditory injury thresholds do not notably change any of the conclusions articulated in earlier versions of the EIS.

It is unlikely that a marine mammal would remain close enough to a large airgun array long enough to incur PTS. The levels of successive pulses received by a marine mammal will increase and then decrease gradually as the seismic vessel approaches, passes and moves away, with periodic decreases also caused when the animal goes to the surface to breath, reducing the probability of the animal being exposed to sound levels large enough to elicit PTS.

Non-Auditory Physiological Effects

Non-auditory physiological effects or injuries could include stress, neurological effects, bubble formation, and other types of organ or tissue damage. If any such effects do occur, they may be limited to unusual situations when animals might be exposed at close range for unusually long periods. Issues that may arise from adverse stress responses over a period of time include accelerated aging, sickness-like symptoms, suppression of the immune system, elevated stress hormones, and suppression of reproduction (physiologically and behaviorally) (Wright et al. 2008).

There are times during an animal's life when they have lower reserves and are more vulnerable to impacts from stressors. For example, if a mammal is stressed at the end of a feeding season just prior to a long distance migration, it may have sufficient energy reserves to cope with the stress. If stress occurs at the end of a long migration or fasting period, energy reserves may not be sufficient to adequately cope with the stress (Tyack 2008, McEwen and Wingfield 2003, and Romano et al. 2004).

Young animals (and fetuses) are sensitive to neurological consequences of the stress response and can suffer permanent neurological alterations. Deep diving marine mammals may also be more sensitive to neurological consequences of stress responses (Wright et al. 2008).

In an examination of beaked whales (which are not found in the Beaufort and Chukchi seas) that were stranded in association with military exercises involving sonar (psychological stressor), intracellular globules composed of acute phase proteins were found in cells in six out of eight livers examined, therefore, there is some indication that a stress response was partly involved (Wright et al. 2008). Hypoxia may also pose an issue for marine mammals being exposed to stressors at depth, due to increases in heart rate, which in turn causes an increase in oxygen consumption. This added oxygen demand could push the whales over the physiological edge. The combination of both the psychological stressor and the physiological stressor may have detrimental consequences (Wright et al. 2008). A study by Rolland et al. (2012) found a decrease in baseline concentrations of faecal adrenal glucocorticoids (fGCs) (a corticosteroid chemical compound produced as a physiological response to stress) in North Atlantic right whales associated with a 6 dB decrease in overall noise levels when ship traffic was reduced in the Bay of Fundy following the events of September 11, 2001. This reduced corticosteriod concentration suggests a reduced stress level in whales as a result of reduced noise exposure. However, it is difficult to definitively link chronic stress responses to long-term, detrimental health effects in large whales. Nonetheless, the study by Rolland et al. (2012) indicates that there is the potential for certain individuals to exhibit stress responses to anthropogenic sounds. Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg 2000, Sapolsky et al. 2005, Seyle 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: behavioral responses; autonomic nervous system responses; neuroendocrine responses; or immune responses.

In the case of many stressors, an animal's first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classical "fight or flight" response which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with "stress." The frequency of such short-term exposures and responses may have an important role on whether or not there would be a significant short- or long-term effect on an animal's welfare. Baker et al. (1983) described two avoidance techniques whales used in response to vessels: horizontal avoidance (faster swimming, and fewer long dives) and vertical avoidance (swimming more slowly but remaining submerged more frequently. Watkins et al. (1981) found that humpback and fin whales appeared startled and increased their swimming speed to move away from the approaching vessel. Johada et al. (2003) studied responses of fin whales in feeding areas when they were closely approached by inflatable vessels. The study concluded that close vessel approaches caused the fin whales to swim away from the approaching vessel and to stop feeding. These animals also had increases in blow rates and spent less time at the surface. This suggests increases in metabolic rates, which may indicate a stress response. All these responses can manifest as a stress response in which the mammal undergoes physiological changes with chronic exposure to stressors, it can interrupt essential behavioral and physiological events, alter time budget, or a combination of all these stressors (Frid and Dill 2002, Sapolsky 2000). All of these responses to stressors can cause an abandonment of an area, reduction in reproductive success, and even death (Mullner et al. 2004, and Daan et al. 1996).

An animal's third line of defense to stressors involves its neuroendocrine or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuro-endocrine functions that are affected by stress – including immune competence, reproduction, metabolism, and behavior – are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987, Rivier 1995), altered metabolism (Elasser et al. 2000), reduced immune competence (Blecha 2000), and behavioral disturbance. Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; see Romano et al. 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic functions, which impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called "distress" (sensu Seyle 1950) or "allostatic loading" (sensu McEwen and Wingfield 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiment; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton et al. 1996, Hood et al. 1998, Jessop et al. 2003, Krausman et al. 2004, Lankford et al. 2005, Reneerkens et al. 2002, Thompson and Hamer 2000). .

For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (e.g., elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper et al. (1998) reported on the physiological stress responses of osprey to low-level aircraft noise, while Krausman et al. (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith et al. (2004a, 2004b) identified noise-induced physiological transient stress responses in hearing-specialist fish (i.e., goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Hearing is one of the primary senses marine mammals use to gather information about their environment and communicate with conspecifics. Although empirical information on the relationship between sensory impairment (TTS, PTS, and acoustic masking) on marine mammals remains limited, it seems reasonable to assume that reducing an animal's ability to gather information about its environment and to communicate with other members of its species would be stressful for animals that use hearing as their primary sensory mechanism. Therefore, NMFS assumes that acoustic exposures sufficient to trigger onset PTS or TTS would be accompanied by physiological stress responses because terrestrial animals exhibit those responses under similar conditions (NRC 2003). More importantly, marine mammals might experience stress responses at received levels lower than those necessary to trigger onset TTS. Based on empirical studies of the time required to recover from stress responses (Moberg 2000), NMFS also assumes that stress responses could persist beyond the time interval required for animals to recover from TTS and might result in pathological and pre-pathological states that would be as significant as behavioral responses to TTS.

There is little information available on sound-induced stress in marine mammals or on its potential to affect the long-term health or reproductive success of marine mammals (Fair and Becker 2000, Hildebrand 2005, Wright et al. 2007a, 2007b). Potential long-term effects, if they occur, would be mainly associated with chronic noise exposure (Nieukirk et al. 2009). As noted above, exposure to low-frequency ship noise, particularly in heavy ship traffic areas, may be associated with chronic stress in whales - Rolland et al. (2012) suggest evidence of a reduction in stress hormone levels associated with reduced exposure of North Atlantic right whales to noise from large commercial vessels. Disruption in feeding, especially within small populations could have impacts on whales, their reproductive success and even the survival of the species (NRC 2005).

Available data on potential stress-related impacts of anthropogenic noise on marine mammals are extremely limited; research on the stress responses of marine mammals and the technologies for measuring hormonal, neuroendocrinological, cardiological, and biochemical indicators of stress in marine mammals are in the early stages of development (ONR 2009). Obtaining samples from free-ranging marine mammals is complicated by the brief periods of time most are visible while either hauled-out or at the surface to breath, by home ranges that may include expansive and inaccessible areas of ocean which limits the potential for continued or repeated monitoring, and many species cannot be easily captured or sampled using traditional methods (ONR 2009). Blood sampling is not currently possible for large, free-swimming whales. Conducting stress research on marine mammals, therefore, requires novel approaches to obtaining physiologic data and samples. Real time measurement of existing stress hormones and biomarkers are further limited by the invasive nature of many of the sampling methods (e.g., chase, restraint), which may, themselves, be stressors that could mask the physiological signal of interest (ONR 2009).

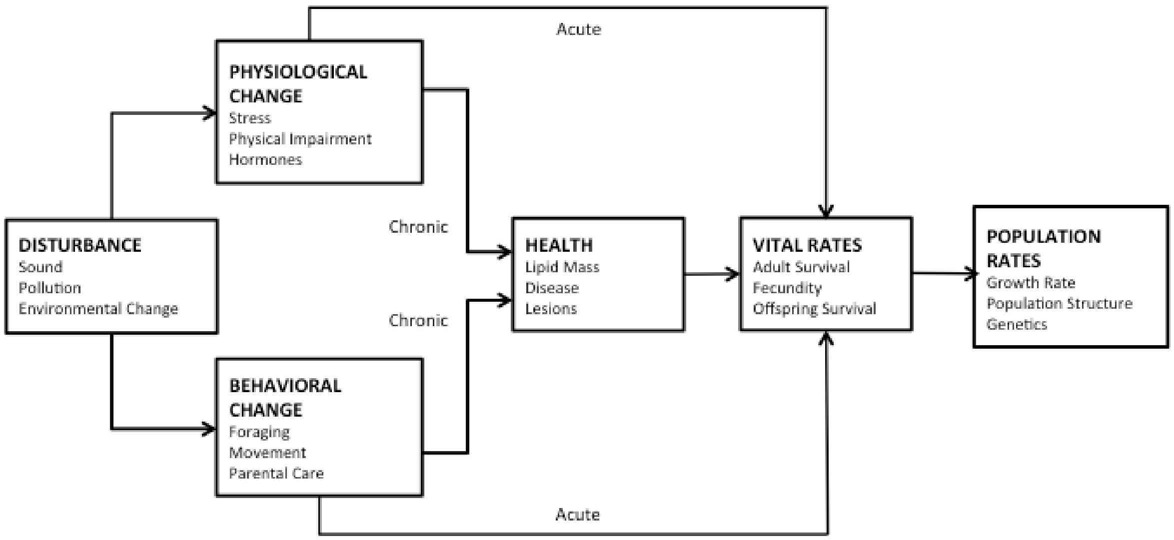
Although extensive terrestrial vertebrate datasets illustrate that the impacts of chronic stress effects can adversely impact individuals through immune suppression, inhibition of other hormonal systems, and the disruption of reproductive function, such studies within marine systems remain rare. Laboratory studies showing explicit stress responses to noise and field noise measurements have increased our ability to compare hormone levels with other potentially causative variables. However, there are no large cross-sectional datasets of stress markers in free-ranging marine populations, which means that we lack an understanding of natural variation within individuals based on sex, age, and reproductive status. Further, we do not fully understand the relationship among various hormones and the quantitative differences that may be expected among sample types (e.g., blood, blubber, feces) in free-ranging individuals. Therefore, there is a current inability to interpret context and the biological significance of variation in stress markers in individuals. Pursuant to NEPA, the full quantitative suite of this information is considered unavailable, however, the absence of this particular information does not inhibit our ability to evaluate the reasonably foreseeable significant adverse impacts on the human environment. The summary above of the available data related to stress effects, combined with the more complete data available regarding the more primary direct effects of behavioral disturbance from industry activities allow us to reasonably assess the effects of these activities on marine mammals.

Recent novel, non-invasive approaches developed for collecting corticosteroid and hormone samples from free-swimming large whales include fecal sampling (Hunt et al. 2006) and sampling whale blows (Hogg et al. 2009, NEA 2011). Both techniques have been used to collect samples from North Atlantic right whales (*Eubalaena glacialis*) and show promise. The former, however, is limited by the frequency with which feces are encountered. Methods for sampling whale blows, obtaining sufficiently large samples, and measuring stress hormones were being developed and tested by the New England Aquarium during 2011 (NEA 2011). These methods are still being developed and their practicability and viability have not been tested on Arctic species.

Linking Disturbance and Sub-lethal Effects to Population Level Effects

Because of the methodological challenges (including difficulty identifying all of the contributing variables), as well as the time and resource commitment necessary, few studies have quantified the ultimate impacts to marine mammal populations associated with disturbance from noise or other causes. Lusseau and Bejder (2007) present data from three long-term studies illustrating the connections between disturbance from whale-watching boats and population-level effects in cetaceans. Across these three multi-year studies, the effects of increased boat traffic from tourism ranged from a 15% decrease in abundance (Shark Bay Australia, bottlenose dolphins, Bejder et al., 2006), a transition from a short-term avoidance strategy to long-term displacement resulting in reduced reproductive success and increased stillbirths (Fiordland New Zealand, bottlenose dolphins, Lusseau 2004), to decreased foraging opportunities and increased traveling time that a simple bioenergetics model equated to decreased energy intake of 18% and increased energy output of 3-4% (Vancouver Island Canada, northern resident killer whale, Williams et al., 2006). These studies are presented because of the lack of similar studies for other activity types, not because of an enhanced concern for whale watching above other activity types. In fact, Weinrich and Corbell (2009) report that the reproductive success of female humpback whales was not affected by whale watching exposures in southern New England.

In order to understand how the effects of activities to individual marine animals may or may not impact stocks and populations, it is necessary to understand not only what the likely disturbances are going to be, but how those disturbances or other impacts may affect the reproductive success and survivorship of individuals, and then how those impacts to individuals translate to population changes. Following on the earlier work of a committee of the U.S. National Research Council (NRC 2005), New et al. (2014), in an effort termed the Potential Consequences of Disturbance (PCoD), outline an updated conceptual model of the relationships linking disturbance to changes in behavior and physiology, health, vital rates, and population dynamics, as depicted in the flow chart below. While this effort targets marine mammals, this conceptual model is broadly applicable in illustrating the potential pathways from individual disturbances to population-level impacts for other taxa.



Potential Consequences of Disturbance conceptual model of the relationships linking disturbance to changes in behavior and physiology, health, vital rates, and population dynamics (New et al., 2014).

As described in the PCoD model, adverse behavioral and physiological changes resulting from disturbance (stimulus or stressor) can either have acute or chronic pathways of affecting vital rates. For example, acute pathways can include changes in behavior or habitat use, or increased stress levels that directly raise the probability of mother-calf separation or predation. Chronic effects on vital rates occur when behavioral or physiological change has an indirect effect on a vital rate that is mediated through changes in health over a period of time, such as when adverse changes in time/energy budgets affects lipid mass, which then affects vital rates (New et al., 2014). New et al. (2014) outlined this general framework and compiled the relevant literature that supports it. Each box in the flow chart above contains added specific examples of types of behavioral, physiological and biological changes, health effects, vital rates and population rates for which there are data illustrating the connections between these stages of effects for certain species and situations. Further, these authors, and others involved in the PCoD effort, have developed state-space energetic models for four example species (southern elephant seal, North Atlantic right whale, beaked whale, and bottlenose dolphin), that illustrate how specific information about anticipated behavioral changes or reduced resource availability can be used to effectively forecast longer-term, population-level impacts (New et al., 2014; New et al., 2013a; Schick et al., 2013; New et al., 2013b).

Unfortunately, empirical data adequate to quantify the relationship between behavioral or physiological changes and fitness impacts does not exist for the majority of marine mammal species and the existing models are very species- and scenario-specific. However, some inferences regarding the relative importance of certain factors may be appropriate for different species in certain circumstances. Meanwhile, to fill this gap in adequate empirical data, an “interim” version of the PCoD framework has been developed that uses a formal expert elicitation process to estimate parameters (and associated uncertainty) that define how changes in behavior or physiology affect vital rates and incorporate them into a stochastic model. The framework can be used to predict the anthropogenic disturbances on animal populations. King et al. (2015) report on the outcome of the first interim PCoD effort to assess the effects of United Kingdom offshore wind farm construction on harbor porpoises. Similar efforts are currently underway to evaluate the effects of Navy activities on beaked whales and sperm whales in certain areas.

Stranding and Mortality

Causes of strandings and mortality related to sound could include: 1) swimming into shallow water to avoid sound; 2) a change in dive behavior; 3) a physiological change; and 4) tissue damage directly from sound exposure, such as through acoustically mediated bubble formation and growth or acoustic resonance of tissues. Some of these are unlikely to apply to airgun impulse sounds.

Seismic pulses and mid-frequency sonar signals are quite different, and some mechanisms by which sonar sounds have been hypothesized to affect beaked whales are unlikely to apply to airgun pulses. Sounds produced by airgun arrays are broadband impulses with most of the energy below 1 kHz. Typical military mid-frequency sonar emits non-impulse sounds at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time. A further difference between seismic surveys and naval exercises is that naval exercises can involve sound sources on more than one vessel. Thus, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar signals can, in special circumstances, lead (at least indirectly) to physical damage and mortality (Balcomb and Claridge 2001, NOAA and USN 2001, Jepson et al. 2003, Fernández et al. 2004, 2005, Hildebrand 2005, Cox et al. 2006) suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity "pulsed" sound.

There is no conclusive evidence of cetacean strandings or deaths at sea as a result of exposure to seismic surveys, but a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al. 2004) were not well founded (IAGC 2004, IWC 2007). In September 2002, there was a stranding of two Cuvier's beaked whales in the Gulf of California, Mexico, when the Lamont-Doherty Earth Observatory vessel *R/V Maurice Ewing* was operating a 20 airgun (8,490 in^3) array in the general area. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth 2002, Yoder 2002). A mapping survey using a high-power 12 kHz multi-beam echosounder (MBES) was considered a likely trigger for a highly unusual mass stranding of approximately 100 typically oceanic melon-headed whales (*Peponocephala electra*) in Madagascar in 2008 (Southall et al. 2013). Although the cause is equivocal and other environmental, social, or anthropogenic factors may have facilitated the strandings, the authors determined the MBES the most plausible and likely trigger initiating the stranding response (Southall et al. 2013). While seismic airguns have not been positively associated with strandings, and the sources themselves have different characteristics than those sources that have been found to contribute to the cause of known strandings, some of the hypotheses regarding why animals strand include behaviorally mediated responses in which animals have an adverse behavioral response (which seismic surveys are known to cause) and subsequent secondary behaviors (ascending too fast, swimming into areas that are too shallow, etc) that lead to stranding. However, the species present in the Arctic do not include those deep diving species that have been involved in previous strandings associated with loud manmade sound sources.

4.5.2.4.3 Potential Effects from Other Acoustic Sources Used during Surveys

In addition to a single airgun or airgun arrays, the industry typically uses additional acoustic devices during survey activities, such as single and multi-beam echosounders, sub-bottom profilers, and side scan sonars (many of which operate at frequencies outside of the ranges of best hearing for many baleen whales and some pinnipeds). The majority of these sources is smaller and emits sounds at higher frequencies than airguns. The source levels of these devices range from 180 dB re 1 µPa at 1 m to 250 dB re 1 µPa at 1 m and have frequency ranges from 0.2 kHz to 1,600 kHz. Section 2.3.2 of this EIS describes each of these sound sources, with source levels and frequency ranges, in more detail.

Given the directionality and small beam widths for these sources, marine mammal communications are not anticipated to be masked appreciably. Because of the small beam widths, marine mammals would not be in the direct sound field for more than one to two pulses. Additionally, many of these sources emit sounds at frequencies higher than that used by some marine mammals for hearing and/or vocalizing, especially baleen whales.

Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins et al. 1985) and increased vocalizations and no dispersal by pilot whales (Rendell and Gordon 1999). When a 38 kHz echosounder and a 150 kHz acoustic Doppler current profiler were transmitting during studies in the Eastern Tropical Pacific, baleen whales showed no substantial responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis 2005). Very few data are available on the reactions of pinnipeds to echosounder sounds at frequencies similar to those used during seismic operations. Hastie and Janik (2007) conducted a series of behavioral response tests on two captive gray seals to determine their reactions to underwater operation of a 375 kHz multibeam imaging echosounder that included significant signal components down to 6 kHz. Results indicated that the two seals reacted to the signal by significantly increasing their dive durations. It was determined that the frequencies produced by some sources such as sub-bottom profilers were too high to create TTS and/or PTS among pinnipeds or most cetaceans expected to occur in the area. However, based on some recent reports (Southall et al. 2013 regarding multi-beam echo sounders), NMFS recognizes that these types of sound sources can sometimes result in behavioral responses that rise to the level of take, although, in most cases the vast majority of the operation of these sources will occur while seismic airguns are also operating, which means that the animals in the vicinity of the airgun will already be projected to be taken. At any rate, NMFS will evaluate the potential effects of these source types when analyzing MMPA requests that include the use of such equipment.

4.5.2.4.4 Potential Effects of On-ice Seismic Surveys

Because these activities occur during the winter and early spring months over the ice, no impacts to cetaceans are anticipated, as cetaceans are typically not present in the Beaufort Sea during this time period. Impacts to pinnipeds could potentially occur when they are hauled out on the ice or inside subnivean lairs. Disturbance from noise produced by the seismic survey equipment is expected to include localized displacement from lairs by the seals in proximity (within 150 m [492 ft]) to seismic lines (Kelly et al. 1988). Impacts would only occur to pinnipeds in the Beaufort Sea, as no such surveys are expected to occur in the Chukchi Sea. See Sections 4.5.2.4.10 through 4.5.2.4.15 for details regarding potential effects on bowhead whales, beluga whales, other cetaceans, pinnipeds, walruses, and polar bears, respectively.

4.5.2.4.5 Potential Effects of Aircraft Activities

Potential effects to marine mammals from aircraft activity could involve both acoustic and non-acoustic effects. It is uncertain if the animals react to the sound of the aircraft or to its physical presence flying overhead. Minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including the Beaufort Sea (Richardson et al. 1985a, b, Patenaude et al. 2002). Reactions of hauled out pinnipeds to aircraft flying overhead have been noted, such as looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water (Born et al. 1999, Blackwell et al. 2004a). Reactions depend on several factors including the animal's behavioral state, activity, group size, habitat, and flight pattern (Richardson et al. 1995). Additionally, a study conducted by Born et al. (1999) found that wind chill was also a factor in level of response of ringed seals hauled out on ice, as well as time of day and relative wind direction. Marine mammal reactions to helicopter disturbance are difficult to predict and may range from no reaction to minor course changes or, occasionally, leaving the immediate area of the activity. Currently, NMFS' threshold for determining if an aircraft overflight may take a marine mammal or not is 1,000 ft. altitude (except for takeoffs, landings, and emergency situations).

4.5.2.4.6 Potential Effects of Icebreaking and Ice Management Activities

Icebreakers produce more noise while breaking ice than when transiting open waters primarily because of the sounds of propeller cavitation (Richardson et al. 1995). Icebreakers typically ram into heavy ice until losing momentum, then back off to build momentum before ramming again. The highest noise levels usually occur while backing full astern in preparation to ram forward through the ice. Overall, the noise generated by an icebreaker pushing ice is typically 10 to 15 dB greater than the noise produced by the ship underway in open water (Richardson et al. 1995). Roth and Schmidt (2010) noted a source level of 200 dB re 1 µPa at 1 m during backing and ramming of ice. Industry in-ice seismic surveys recently conducted in the U.S. Arctic did not employ the "backing and ramming" approach described above but rather required continuous forward progress at 3-4 knots in mostly newly forming juvenile first year ice or young first year ice less than 0.5 m (1.6 ft) thick instead of in thick, multi-year ice (ION 2012). Sounds generated by the icebreaker moving through relatively light ice conditions are expected to be far below the high sound levels often attributed to "backing and ramming" icebreaking in very heavy ice conditions, which are created by cavitation of the propellers as the vessel is slowed by the ice or reverses direction (Erbe and Farmer 1998, Roth and Schmidt 2010). Icebreaking is considered by NMFS to be a continuous sound. Haley et al. (2010a) estimated that as the icebreaker travels through the ice, a swath 3,500 m (2.17 mi) wide would be subject to sound levels ≥120 dB, based on the source level of 185 dB attenuating to 120 dB in about 1,750 m (1.09 mi).

Icebreaking activities may also have non-acoustic effects such as the potential for causing injury, ice entrapment of animals that follow the ship, and disruption of ice habitat (reviewed in Richardson et al. 1989:315). Ice management activities may also have similar effects when moving ice floes away from drill rigs. The species of marine mammals that may be present and the nature of icebreaker activities are strongly influenced by ice type. Some species are more common in loose ice near the margins of heavy pack ice while others appear to prefer heavy pack ice. Propeller cavitation noise of icebreaking ships in loose ice is likely similar to that in open water while noise is expected to be much greater in areas of heavier pack ice or thick landfast ice where ship speed will be reduced, power levels will be higher, and there will be greater propeller cavitation (Richardson et al. 1995).

There is little information available about the effect on marine mammals of the increased sound levels due to icebreaking, although beluga whales have been documented swimming rapidly away from ships and icebreakers in the Canadian high Arctic (Richardson et al. 1995). Little information is available regarding the effects of icebreaking ships on baleen whales, but a similar behavioral response would be expected as those mentioned above. Whales could be diverted or could rapidly swim away from the source. Please refer to Sections 4.5.2.4.10 through 4.5.2.4.15 for details regarding potential effects on bowhead whales, beluga whales, other cetaceans, pinnipeds, walruses, and polar bears, respectively.

4.5.2.4.7 Potential Effects of Vessel Activity

Reactions of marine mammals to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement. In heavily trafficked areas, vessel noise may induce stress and mask communication in whales (Hatch et al. 2012, Rolland et al. 2012). Past experiences of the animals with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow-moving vessels are less dramatic than their reactions to faster and/or erratic vessel movements. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Wartzok et al. 1989, Richardson et al. 1995, Heide-Jorgensen et al. 2003). Few authors have specifically described the responses of pinnipeds to boats, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. In places where boat traffic is heavy, there have been cases where seals have habituated to vessel disturbance (Bonner 1982, Jansen et al. 2006).

Collisions with seismic or support vessels are possible but highly unlikely. Ship strikes with marine mammals can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus 2001). Massive propeller wounds can be immediately fatal. If more superficial, whales may be able to survive the collisions (Silber et al. 2009). Vessel speed is a key factor in determining the frequency and severity of ship strikes, with the potential for collision increasing at ship speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007).

Incidence of injury caused by vessel collisions appears to be low in the Arctic. Less than 1 percent of bowhead whales have scars indicative of vessel collision. This could be due to either collisions resulting in death (and not accounted for) or a low incidence of co-occurrence of ships and bowhead whales (George et al. 1994).

4.5.2.4.8 Potential Effects of Exploratory Drilling

Exploratory drilling could affect marine mammals through noise, discharge of drilling waste, and accidental discharges such as oil spills. Sounds from exploratory drilling are different from airgun sounds. As described in Section 4.5.1.4 (Acoustics), most drilling sounds from vessels produce sounds at relatively low frequencies below 600 Hz with tones up to around 1,850 Hz (Greene 1987). The potential effects of noise from drilling operations are very similar to airguns, although at a lesser magnitude because source levels of drilling units are not as high as airgun arrays.

Exploratory drilling operations may involve the discharge of drill cuttings and drilling fluids directly into the ocean. As described in Section 4.5.1.5 (Water Quality) these discharges could result in elevated concentrations of metals such as chromium, copper, mercury, lead, and zinc, as well as increased concentrations of hydrocarbons and other organic compounds in the water. Some of the discharge streams that may be permitted for oil and gas activities in the proposed action area have been associated with impacts to marine resources, yet, despite a considerable amount of investment in research of exposures of marine mammals to organochlorines or other toxins, there have been no marine mammal deaths in the wild that can be conclusively linked to the direct exposure to such substances (O'Shea 1999). However, the impact of drill cuttings and drilling mud discharges would be local and temporary. Discharged drilling fluid should be well diluted within 100 m (330 ft) so that any impacts would be local and temporary, assuming that whales continue to swim through and past the discharge plume. If toxic contaminants are present in discharges, only a small area of potential habitat and prey base for marine mammals might be contaminated.

Many of the contaminants of concern, including organic contaminants such as organochlorine compounds and PAHs, as well as metals such as chromium and mercury, have the potential to accumulate in marine mammals. Indirect effects to marine mammals could result from exposure to contaminants of concern through the food web and the relevant pathway of exposure would involve trophic transfers of contaminants rather than direct exposure. Monitoring conducted as part of the ANIMIDA and cANIMIDA projects has shown that oil and gas developments in the Alaskan Beaufort Sea "are not contributing ecologically important amounts of petroleum hydrocarbons and metals to the near-shore marine food web of the area" (Neff 2010). Additional mitigation measures C3, C4, and C5 include requirements to ensure reduced discharge of the specific discharge streams identified with potential impacts to marine mammals or marine habitat. Those discharge streams include drill cuttings, drilling fluids, sanitary waste, domestic waste, ballast water, and bilge water. Elimination or reduction of those discharge streams is expected to reduce the potential for adverse impacts to marine mammals. Additional mitigation measures requiring operators to recycle drilling muds may also reduce the potential for adverse impacts to marine mammals and other organisms within the EIS project area.

Accidental discharges of oil or other contaminants could also occur during exploratory drilling and would likely adversely affect marine mammals. Standard mitigation measures requiring operators to have plans in place to minimize the likelihood of a spill would reduce the potential for adverse impacts from such discharges. The effects of a very large oil spill on marine mammals are analyzed in Sections 4.10.6.11 and 4.10.7.11.

4.5.2.4.9 Chronic and Aggregate Effects on Acoustic Habitat

In addition to predicting numbers of marine mammals taken by the individual sound sources proposed for use in each alternative (4.2.6), tables 4.5-14(a-c) specifically consider the total surface area ensonified above noise threshold levels corresponding with potential behavioral disturbance effects that could result in take. Other effects on marine mammals or other species, such as masking of conspecific or other important acoustic cues occurs when anthropogenic noise levels begin to exceed ambient noise levels – generally well below the levels corresponding with take. To get a very broad sense of how this might occur in this action, the total surface area ensonified above 120 was included above in Tables 4.5-14 (a-c). While low-level masking may not have an immediate impact, if it occurs for extended periods it has the potential to decrease the value of habitat and can lead to consequent chronic effects.

All of the sound present in a particular location and time, considered as a whole, comprises a “soundscape” (Pijanowski et al., 2011). When examined from the perspective of the animals experiencing it, a soundscape may also be referred to as “acoustic habitat” (Clark et al., 2009, Moore et al., 2012a, Merchant et al., 2015). Higher background noise levels, chronically sustained over time, limit the ability of marine species to detect and interpret important acoustic cues. Through the process of developing this FEIS, commenters recommended that NMFS include a mechanism for better assessing the chronic and aggregate effects of the Alternatives explored in this EIS. Below are the results of a first-order assessment to do so. The complete report is attached as Appendix F (Cumulative and Chronic Effects in the Arctic), and excerpts of the results are included below and are referenced elsewhere in the document, both in relation to changes in the acoustic environment and in potential impacts on marine mammal species. Additional public review (via the MMPA incidental take authorization process) and potentially peer review, of the methods, assumptions, and possible interpretations included in this approach will be solicited in order to ensure appropriate consideration and application of this analysis in a management context. Because this novel analytical exercise was conducted specifically for the purposes of this EIS and has not been published previously, it is presented here formatted similar to that of a journal article, including more detail than other EIS sections to ensure the reader is able to obtain the necessary information to fully understand this exercise without the need to consult appendices or other references.

Abstract

Effective detection of sounds is critical for aquatic animals, and methods are needed to assess and minimize the longer-term and aggregate effects of noise on marine species and their habitat, in addition to acute impacts at closer range. Here, we present the results of a first-order assessment of the chronic and cumulative effects of noise produced by oil and gas exploration activities in the Beaufort and Chukchi Seas. Modeling was conducted for a 3.5-month period (July through mid-October) for 10 locations (receiver sites) of biological importance and for six scenarios corresponding to alternatives in this EIS, including: all three levels of exploration activity (Alternatives 2, 3, and 4) and both with and without proposed time/area closures at each of these activity levels. “Lost listening area” was calculated among scenarios and relative to a baseline ambient noise estimate and considering the hearing sensitivity of low and mid-frequency cetaceans. “Lost communication space” was calculated among scenarios and relative to ambient estimates for a 1/3 octave band representing dominant frequencies of bowhead whale vocalizations. Results are reported as remaining listening area or communication space for a maximum of two depths (5 and 30 m) at each of the 10 locations.

Broadly, results for all three activity levels indicate substantial losses in listening area for both mid- and low frequency species at the three eastern-most sites, with near total loss at the Cross Island site (site 9, >95%), as well as the deeper Beaufort site (site 8, >95%), and significant losses at the Kaktovik site (site 10, >75%). Site 7 (Barrow Canyon) also sustained notable losses across all activity levels but only in

shallow depths (up to 70%). Site 3 incurred little listening area loss at the lowest level of activity, but loss at shallower depths increased notably with higher levels of activity (up to 72%). The remaining areas incurred virtually no lost listening area in any scenario. At the one receiver site located within a closure area that incurred listening area loss at any level (site 7 in Barrow Canyon), virtually no differences were noted in listening area when the closures were applied, which was likely heavily influenced by the method of removing the top 10% closest seismic shots, which is used to ensure that near-field seismic shots do not dominate the measured noise. Communication space did not notably decrease at any site except site 8 (bowhead migration route with cow-calf pairs) at the deeper depth, which suffered 24-28% loss.

There is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals; however, data are lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals. In contrast, with estimation of acoustic harassment, this analysis is not designed to evaluate the exposure of individual animals to seismic sources from one moment to the next. Rather, this analysis is intended to ensure consideration of the longer-term and wider-ranging noise effects from these sources and to augment the more traditional analysis of acute effects (injury and behavioral harassment). While these results are broadly informative (especially when considered as a whole across the U.S. Arctic), it is important to remain cognizant of the methods and simplifying assumptions when making location-specific interpretations and comparisons. For example, the distribution in space and time of seismic, drilling, and vessel activity will significantly influence the resulting cumulative noise exposure at a specific location. Here, projected levels were distributed based on informed conceptual examples, but actualized survey activity may result in higher concentrations in some areas and lower in others. The effect of concentrations of activity in high proximity to selected locations will continue to be offset by the methods applied here to remove the closest 10% of pulses in order to focus on long-term accumulation of energy at regional scales. However, this same method can result in an under-representation of the value of closure areas at maintaining listening and communication space. Similarly, the assumption made here that none of the activity that would have occurred in a closure area would be redistributed outside that area must be carefully considered when interpreting results (i.e., applying closures results in increased levels of activity in remaining area outside of closures). NMFS conducted this first-order chronic and cumulative assessment in response to recommendations made during the public comment period on the DEIS and SDEIS, and we are reporting our initial results as they relate to different scenarios addressed across EIS Alternatives.

Introduction

Human-produced underwater noise impacts aquatic animals and ecosystems in complex ways, including through acute, chronic, and cumulative effects. Sound is a fundamental component of the physical and biological habitats that many aquatic animals and ecosystems have evolved to rely on over millions of years. Increases in noise and changes in soundscapes (the sounds heard in a particular location, considered as a whole) can lead to reduced ability to detect and interpret environmental cues that animals use to select mates, find food, maintain group structure and relationships, avoid predators, navigate, and perform other critical life functions. Designing noise management techniques to conserve the quality of acoustic habitat in addition to minimizing more direct adverse physical and behavioral impacts necessitates new decision support tools.

Such tools include evaluation of noise influence over longer time and larger spatial scales appropriate to represent the ecological and human activity contexts in which animals are experiencing noise. Additionally, methods are needed to derive metrics associated with these noise field evaluations that can be used to estimate their biological consequences for animals. For example, "loss of communication space" estimates the area over which a specific animal signal, used to communicate with conspecifics in biologically-important contexts (e.g., foraging, mating) can be heard, in noisier relative to quieter conditions (Clark et al. 2009). "Lost listening area" similarly estimates the more generalized contraction of the range over which animals would be able to detect a variety of signals of biological importance, including eavesdropping on predators and prey (Barber et al. 2009). Such metrics do not, in and of themselves, document fitness consequences for the marine animals that live in chronically noisy environments. Fitness consequences, especially mediated through changes in the ultimate survival and reproductive success of whole populations of animals, rather than just individuals, are notoriously difficult to study, and particularly so underwater. However, it is increasingly well documented that aquatic species rely on qualities of natural "acoustic habitats", with researchers quantifying reduced detection of important ecological cues (reviewed in Francis & Barber 2013), as well as survivorship consequences in several species (Simpson et al. 2014; Nedelec et al. 2015). Application of this growing body of best available science to management decisions will therefore necessitate application of new approaches, as well as increasing investment and collaboration amongst scientists and managers to improve their efficacy and applicability to environmental protection.

Appendix F presents the results of a first-order cumulative and chronic effect assessment for noise produced by oil and gas exploration activities in the U.S. Arctic. Sources associated with these activities that were considered to contribute to cumulative, chronic noise levels in this region during the modeled time period included drillships and support vessels and four different types of airgun arrays. Vessel noise, mainly from propellers, is well documented to contribute to, and often dominate, background noise levels in regions where traffic is regular or during time periods where it is omnipresent (Urick 1983). Direct exposure to the intense pulses produced by airguns can result in acute impacts at close ranges. However, in addition, low-frequency dominant seismic airgun noise undergoes multiple reflections at the ocean bottom and surface and refraction through the water column sediment, causing prolonged decay time of the original acoustic signals (Urick 1984). Extended decay time can lead to high sound levels lasting from one impulse to the onset of the next, elevating ambient noise levels (Guan et al. 2015). In addition, low frequency energy from airgun surveys, with access to conducive propagation conditions (e.g., deeper waters), has been documented to travel long distances, contributing to background noise over very large areas. Seismic survey noise has been documented up to 3000 - 4000 km away as the loudest component of underwater ambient noise (Nieukirk et al. 2004, Nieukirk et al. 2012) and can raise background noise levels by 20 dB over 300,000 km^2 continuously for days (International Whaling Commission 2005). Baleen whales, including bowhead whales, produce calls that span a low frequency range that overlaps noise produced by airguns (Richardson et al. 1995), and presumably their best hearing abilities fall in this range as well (20 Hz-30 kHz) (reviewed in Ketten et al. 2013). Implications for acoustic masking and reduced communication space resulting from noise produced by airguns surveys and vessels are thus expected to be heightened for baleen whales.

Methods and Results

Appendix F presents details of the methodology applied in this study, including maps of key spatial attributes, and includes tables of all results. Key aspects of methods and results are summarized here, but for significant details and points of clarification, we refer the reader to the Appendix.

Acoustic modeling was conducted for 10 locations, (Table 4.5-19a), termed receiver sites, within the study area to examine cumulative noise produced by four exploration alternatives (Table 4.5-19b). The locations of the receiver sites are given in Table 4.5-19a and shown in the map of Figure 4.4. These sites were chosen to reflect areas of biological interest or diversity, such as important reproduction, feeding, and migrating areas, as well as subsistence hunting areas.

Table 4.5-19a. Modeled receiver site locations and water depths.

Site	Receiver Site	Latitude	Longitude	Water Depth (m)
1	West of Cape Lisburne	68.62	−167.91	51.16
2	Point Lay	69.82	−163.37	19.43
3	Chukchi leases	71.13	−162.43	44.26
4	Hanna Shoal	72.15	−163.33	32.02
5	Point Franklin	70.96	−159.62	54.54
6	Peard Bay	71.26	−157.30	54.60
7	East of Barrow	71.52	−154.85	31.23
8	Beaufort Sea shelf slope	71.54	−150.31	1853.82
9	Cross Island	70.56	−147.90	9.43
10	Kaktovik	70.28	−143.69	40.43

The activity level alternatives considered here are the same as those addressed in the remainder of this FEIS. These include a no-activity alternative (Alternative 1) and three activity levels (Alternatives 2-4) of increasing seismic and exploratory drilling activities. The number and type of activities in the Beaufort and Chukchi Seas for Alternatives 2-4 are presented in Table 4.5-19b. Two scenarios were considered for each Alternative. The first scenario assumed no closure areas/times. The second scenario excluded (but did not displace) activities or sections of surveys that would result in sound levels of ≥ 160 dB re 1 µPa (rms SPL) within the closure areas of Barrow Canyon, Hanna Shoal, Kasegaluk Lagoon, Ledyard Bay, Cross Island, and Kaktovik. For each Alternative, exemplar locations of activities were chosen. The location of the activities is shown for each Alternative and scenario in Figures 2-7 of Appendix F. Of important note, the number and distribution of activities modeled for each Alternative were based on the conceptual examples described in Section 4.2.5 of the EIS and illustrated in Figures 4.7 to 4.9 and 4.15 to 4.17, not on the maximum possible number of activities. The grey lines shown in these maps outside the closure areas indicate the extended zone required to keep root mean square (rms) seismic sound levels below 160 dB re 1 µPa at the closure area boundaries.

Table 4.5-19b. Number of modeled activities associated with each alternative in each sea.

Activity	Alternative 2		Alternative 3		Alternative 4	
	Beaufort	Chukchi	Beaufort	Chukchi	Beaufort	Chukchi
2D/3D seismic survey (4500/3200 in^3 airgun array)	1	1	2	2	4	4
3D ocean bottom cable/node survey (640 in^3 airgun array)	1	-	2	-	2	-
Shallow hazard survey (40 in^3 airgun array)	1	1	2	3	3	4
Exploration drilling (Mobile Offshore Drilling Unit with fleet of 8–12 support vessels)	1	1	2	2	4	4

Representative acoustic source types were specified for each activity type, with selected airgun array sizes used for seismic exploration representative of those used in the Arctic since 2006 (see Appendix F). The acoustic fields around the receiver sites were modeled at frequencies from 10 Hz to 5 kHz, up to a range of 500 km. Results are provided for two receiver depths: 5 and 30 m.

Cumulative SELs and time-averaged equivalent sound pressure levels (L_{eq}) at the selected receiver sites were calculated resulting from all shots from seismic surveys and exploratory drilling activities (which include support vessels), as specified for each Alternative. The accumulation period was three and a half months, from 15 July to 31 October, representing the duration of concentrated activity evaluated in the FEIS. A feature of underwater sound propagation is that nearby sources contribute substantially more SEL than more distant sources, since the exposure levels decay with the square of distance from the source. This causes cumulative SEL received from spatially distributed and moving sources to be dominated by the sources closest to a receiver. However, the duration of exposures from very close sources is typically quite short. While exposures from nearby sources are important for assessing acute effects, their inclusion in a chronic effects assessment can be misleading. To overcome this issue, this approach excluded the highest seismic shot exposures received during a fraction (10%) of the total study time period. No drilling noise was excluded, as it was assumed to remain constant for the full duration of the study period.

Marine mammal hearing frequency weighting filter coefficients were applied to the received levels, and results are presented both with and without weighting. Filters for Low-Frequency Cetacean (LFC) and Mid-Frequency Cetacean (MFC) were used, as defined by Southall et al. (2007). Results of cumulative SEL (Tables 4-6) and L_{eq} (Tables 7, 9 and 11) calculations are presented in Appendix F.

To prepare to estimate lost listening area and changes in communication space for various levels of seismic and exploratory drilling activities, a baseline ambient noise level was assumed. In this study, ambient noise levels were estimated using mean (50th percentile) ambient levels recorded in the Chukchi Sea over the 2014 open-water season. Ambient levels in the Beaufort Sea were also estimated based on those of the Chukchi Sea. Broadband ambient levels (10–5000 Hz) varied between 98.9 and 105.7 dB re 1 µPa, depending on the receiver location. Ambient levels for the 1/3 octave centered at 160Hz ranged between 86.2–91.9 dB re 1 µPa across sites. Mean ambient spectra were assigned to each receiver site based on proximity to the actual recorder sites where ambient noise was measured and on the similarity in water depth between the recorded and modeled receiver sites. Tables 8, 10 and 12 present modeled L_{eq} ***above ambient*** at each receiver site with M-weighting for low- (LFC) and mid-frequency cetaceans (MFC) and without weighting.

The lost listening area assessment method has been applied to in-air noise (Barber et al. 2009) and in National Park soundscape management contexts (NPS 2010). The term "listening area" refers to the region of ocean over which sources of sound can be detected by an animal at the center of the space. Sound sources considered by this method can be the same species (as discussed below for communication space), a different species (e.g., a predator or prey species), natural sounds (such as shifting ice), or anthropogenic sounds. The lost listening area method applied by Barber et al. (2009) calculates a fractional reduction in listening area due to the addition of anthropogenic noise to ambient noise. It does not provide absolute areas or volumes of space; however, a benefit of the lost listening area method is that it does not rely on source levels of the sounds of interest. Instead, the method depends on the rate of sound transmission loss. Such results can be considered with frequency weightings, which represent the hearing sensitivity variations of two marine mammal species groups and transmission loss variations with range, or more generally without weighting. Results are presented as ***a percentage of the original listening area remaining***, due to the increase in noise levels under each Alternative and scenario relative to no activity (ambient conditions), and between each Alternative and scenario (Appendix F, Tables 13 to 18).

The communication space assessment was performed using methods previously implemented for examining anthropogenic noise effects on blue, fin and right whales (Clark et al. 2009, Hatch et al. 2012). Communication space estimates the area within which bowhead whales can detect calls[5] from other bowhead whales. All calculations were performed in the single 1/3-octave frequency band centered at 160 Hz. This frequency band had the highest received sound levels for a large number of bowhead whale calls recorded during a multi-year acoustics survey in the northeastern Chukchi Sea. A 1/3-octave band sound level of 156 dB re 1 µPa at 1 m was specified. An estimate of ~15 dB signal processing gain (which accounts for the animal's ability to not only detect but recognize a signal from an animal of the same species) was applied. Noise L_{eq} across sites and Alternatives in the 1/3-octave band centered at 160Hz ranged from 86.2-92.0 dB re 1 µPa, a similar range to ambient. Noise levels at sites 3, 8, 9, and 10 were most often above ambient (depending on the alternative), but still fell within this min-max range. Tables 19-21 present the area (km^2) of communication space at each receiver for the modeled bowhead call under ambient conditions (titled "default") and under each Alternatives and scenario, ***representing lost communication space in both area and percentage***. Tables 22-24 assess relative loss of communication space between the Alternatives.

The results reflect the fact that the locations close to the coast in the Chukchi Sea were relatively distant from the placement of the modeled activities (see Figures 2 through 7 in Appendix F). Effects at these sites (receiver sites 1, 2, 5 and 6) showed little reduction in communication space and listening area, relative to ambient conditions, under any of the Alternatives.

One of the two sites further offshore in the Chukchi, site 4 (Hanna Shoal), showed a negligible (<0.5%) reduction in listening area and no reduction in communication space for any of the Alternatives. Although this site is of key biological interest for walrus and a closure was designed around it, the modeled seismic and drilling activity was some distance from this location.

The other offshore Chukchi site (Site 3) was closer to several of the modeled survey activities. The lowest levels of modeled activity (Alternative 2) did not result in significant lost listening area. However, higher levels of activity (Alternative 4) resulted in an up to 70% reduction of listening area, relative to the area available under ambient conditions. Losses were particularly high for the shallower modeling results (5 meters). Corresponding losses of communication space for bowhead whale calls at this location were less significant, with only 7% of communication space estimated lost under the highest activity levels. Communication space was estimated to be higher for the deeper modeling results at this site (30 meters).

Site 7, east of Barrow (important bowhead whale feeding site), showed more significant impacts from the modeled activities. This site showed decreases in listening area of up to 65% (leaving only 35% of the original area) under the lowest levels of modeled activity (Alternative 2) and up to 70% for Alternative 4. Interestingly, this site did not show corresponding reductions to communication space.

Site 8, which is located in deep water (1854 m) on the edge of the Beaufort Shelf, experienced very large decreases in listening areas due to anthropogenic sound related to exploration activities. Listening areas were reduced up to 98.1% under the lowest modeled activity levels (Alternative 2), leaving as little as 1.9% of the original listening area, due to additions of ~10dB of noise relative to ambient estimates. The corresponding reduction in the listening area for Alternatives 3 and 4 were up to 98.8%. The reductions in bowhead communication space were more significant than for other sites, though still more moderate than listening area losses. Communication space, relative to estimates of ambient, was reduced by up to 19.8% for Alternative 2, 24.2% for Alternative 3 and 26.2% for Alternative 4. The greater sensitivity of this site to exploration activities appears to be due to an upward refracting sound speed profile in the deep water

[5] The term "vocalization" is used here to refer to sounds produced by the vibration of tissues surrounding the blowhole of bowhead whales even though these are not produced by vocal chords.

environment that traps sound from more distant sources in the upper water column. As introduced above, airgun noise can propagate with relatively low transmission loss over large distances.

Site 9, offshore Cross Island, which is important for subsistence hunting of bowheads, also showed substantial reductions in listening areas. Listening area was reduced by up to 98.7% (leaving just 1.3% of the original listening area) for Alternative 2. The reduction was up to 98.8 for Alternatives 3 and 4. These substantial listening area losses were mainly due to the modeled presence of 12 drilling support vessels within 40 km of the receiver site. Resulting received vessel sounds exceeded ambient levels, which were estimated to be quite low in this very shallow area, by more than 10 dB. Reductions to communication space at this site were predicted to be much less than those for listening area; just 1% for all 3 Alternatives.

Site 10, in the Kaktovik whaling area, also showed substantial listening area reductions, but rather small bowhead communication space reductions. The lost listening area was up to 86% for Alternative 2 (leaving only 14% of the Alternative 1 space), up to 92% for Alternative 3, and up to 93% for Alternative 4. The communication space reductions were 0.3% for Alternative 2, 0.4% for Alternative 3, and 0.6% for Alternative 4.

Discussion

The goal of this analysis was to apply new analytical techniques to support assessment of the biological relevance of noise associated with the FEIS' Alternative levels of oil and gas exploration activity the Beaufort and Chukchi Seas. As stated above, this is considered a first-order analysis, and several simplifying assumptions were necessary. Changes in the distribution of survey and drilling activities would result in differences in the relative amount of noise accumulating at different receiver locations, and that variance was not examined here. Instead, we present results associated with an exemplar distribution of the activity levels examined in the FEIS Alternatives and modification of those distributions to avoid buffered closure areas. Similarly, the approach applied accounts for spatial variance due to factors affecting sound propagation (e.g., topography, bottom type) among the selected locations of documented biological importance to species of key management interest in the region but does not produce results for additional locations (e.g., a uniform map). That said, examination of the key drivers of the results suggest some ability for broader interpretation at other locations.

The metrics reported here (lost listening space and communication space) do not reflect variance in an individual animal's, including an individual bowhead whale's, experience of the noise produced by the modeled activities from one moment to the next. With both sources of noise and animals moving, the time-series of an individual's noise exposure will show considerable variation. The methods applied here are meant to average the conditions generated by introducing low frequency dominant noise sources over a several month period during which animals of key management interest rely on habitats in the study area. It should be noted that this examination is meant to be a companion to additional assessments of the acute effects of the same types of noise sources in the same region; approaches are designed to account for changes in exposure realized by individuals over time, mostly in relatively close proximity to noise sources. Considered as a complement to this, the assessment presented here estimates noise produced by the same sources over much larger spatial scales, and considers how the summation of noise from these sources relates to levels without activity (ambient). Approaches such as the communication space estimation presented here include approximation for the evolved ability of many acoustically active animals, such as bowhead whales, to hear the calls of conspecifics in the presence of some overlapping noise.

The role of ambient noise in setting baselines for evaluation of communication space and listening area loss under different activity levels is central to the interpretation and function of both metrics. Interpretively, both metrics seek to consider the acoustic conditions to which animals have evolved, specifically in places that sustain critical life functions (e.g., feeding, traveling with calves), and estimate degradation in those conditions under various chronically noise-producing scenarios. Ideally, therefore, selected baselines can approximate background noise conditions in key habitats with little to no intrusion of human-produced noise. It should be noted that such baselines will include sources of at times significant natural noise (e.g., wind and waves). For long-lived animals such as bowhead whales, contemporary noise measurements represent only, at most, a few generations of noise conditions experienced in the Arctic. However, relative to areas with higher levels of noise-producing human activity, contemporary measurements are a reasonable representation of more historical conditions, in the absence of such data. In this case, the mean (50^{th} percentile) level of broadband measurements made during the summer of 2014 in the Chukchi were used to establish baselines. In other regions, lower percentiles would be necessary to account for periodic human-produced noise within measurement data; however, it is believed that such noises were not present in these recordings.

The largest increases in noise levels resulted from transitioning from no activity (Alternative 1 in the FEIS) to any of the remaining Alternatives (2-4). At several locations, increases in cumulative noise levels associated with transitioning among activity levels (e.g., from Alternative 2 to Alternative 3, to Alternative 4) were lower than those associated with adding any level of activity to no activity. In deeper water, at site 8, transitioning from no activity to the lowest level Alternative for activity (2) resulted in an ~ 10 dB increase in noise levels at the site, while further transitioning to the highest level Alternative for activity (4) resulted in ~12 dB over ambient. Relatedly, the highest reductions in listening area and communication space at this and several other sites resulted from adding activity of any Alternative level to no activity. For example, losses of listening area at site 9 were almost complete under the lowest activity Alternative (2) and thus were relatively unchanged by the addition of significant proximate activity under Alternatives 3 and 4. Such findings for these Arctic locations, where ambient noise levels are, in general, lower than expected for areas with higher levels of noise producing activity, support the general assertion that the quietest marine and terrestrial environments are the most vulnerable to noise intrusions, with areas with lower ambient noise levels more easily elevated noise intrusion (Hatch & Fristrup 2009). Such assertions relate to observations that animals in quiet areas are more likely to perceive subtle noise alterations in their environments (Francis & Barber 2013).

That said, there were significant reductions in listening area at some locations resulting from transitioning between lower and higher activity levels (Alternative 2 vs. 4). Given the shallow depths at most of the receiver locations, losses in listening area and communication space resulting from transitioning between Alternatives were strongly influenced by how many of the additional modeled sources were in their proximity (see Appendix F, Figures 2 through 7). Site 10 experienced large reductions in listening area due to the addition of activity at the lowest levels (up to 83% lost) and significant additional loss was estimated in transitioning from Alternative 2 to Alternatives 3 and 4 (42-5%), due to the addition of 3D survey activity directly to the west of this site under Alternatives 3 and 4. Close-proximity vessel noise associated with exploratory drilling had the potential to strongly influence cumulative noise levels at receiver sites, as, in contrast to modeled noise from airgun shots, noise from vessels in very close proximity to receivers was not excluded from this analysis. This is reflected most strongly in the lost listening area calculations for sites 3 and 9, which were located close to concentrations of exploratory drilling support vessels under various Alternatives. At site 3, levels of modeled activity associated with Alternative 2 did not result in significant reductions in listening area relative to ambient and vessels were located at some distance. However, the addition of activity associated with Alternatives 3 and 4 included both the addition 3D airgun array surveys directly to the west and close proximity vessels, and reduced listening area at this site to only 32-33% what was available under Alternative 2. At site 9, close proximity exploratory drilling activity under all Alternatives drove significant listening area reductions estimated at this location.

The effects of closures (Scenario 2) at maintaining communication space or listening area in the presence of increasing activities levels under Alternatives 2 through 4 was relatively low, though notable in a few cases. Site 3, though not inside a closure area, was close to activities that were curtailed by closures surrounding site 4. Area closures resulted in only a 4.2% reduction in communication space (instead of

7% without area closures) at site 3 under Alternative 4. Lost listening area and communication space were consistently slightly less at site 7, which was inside a closure area, when the closure was in effect. The methods used in this assessment to remove 10% of shots from survey activity closest to the receiver locations are likely to have reduced the relative difference between accumulated energy resulting from closures (which further eliminated shots that would have taken place within the 160 dB buffered closure areas). This is especially relevant to interpretation of results at locations 7 and 10, which were nested in closure areas that, under non-closure scenario (1), would have been exposed to very proximate survey activity were it not for the removal of the top 10% of shots. This loss of resolution between closure and non-closure results does not adequately capture the reduction in acute noise exposure that would be experienced by animals within the closure if such mitigation is applied. However, again, the methods of this study focused instead on chronic, longer-term exposure associated with low frequency, well-propagating noise. It is well understood that the size of areas necessary to achieve significant reductions of low frequency chronic noise will vary significantly with local propagation conditions. This study does support the general premise that relatively small closures will be more relevant to reductions in regional-scale chronic noise reduction goals in areas with poorer propagation conditions (e.g., shallower) than in areas with well-propagating noise (e.g., deeper). Finally, this assessment did not evaluate the implications of displacing some or all of the activity that would have taken place within the closure to within the remaining area outside the closure. The FEIS does not estimate whether closures would result in lower activity levels and there was no basis for asserting what portion of activity would be redistributed. The implications of such redistribution on cumulative noise levels both within and outside closures would vary considerably. Some sites inside closures could experience reduced cumulative levels (depending on their size and propagation conditions as noted above) while some sites outside closures could experience higher noise levels due to survey levels displaced to their vicinity.

Comparison between the results between the two metrics applied here highlights important interpretive differences in evaluating the biological implications of higher background noise. The strength of the communication space approach is that it evaluates potential contractions in the transmission of a signal of documented importance to a population of animals of key management interest in the region. In this case, maximum losses of communication space for a calling bowhead whale (28%) were estimated to occur at the deepest water location, off the Beaufort Sea shelf slope (site 8), under the highest activity Alternative (4) with no closures in place (scenario 2). This site is within the Fall bowhead whale migration, when adult females are traveling west with calves and regular communication between them is likely important to maintain group cohesion. Losses were significantly higher at 30 meters depth than at 5 meters depth, reflected the fact that modeled noise within the 1/3 octave band centered at 160Hz were higher at 30 meters than at 5 meters.

Losses of broadband listening area, however, far exceeded losses of communication space evaluated at the same locations and under the same activity levels. This is appropriate to the interpretive role of the lost listening space calculation, which is to provide a more conservative estimate of the areas over which animals have access to a variety of acoustic cues of importance to their survival and reproductive success. It is not understood what all cues used by marine mammals are in the Beaufort and Chukchi, but it is well discussed that acoustics provide particularly important information in areas where other sensory cues are diminished (e.g., dark) and where navigation is challenging (e.g., complex coastlines, topography and ice). Documentation of such cues (reviewed in Barber et al. 2009, Slabbekoorn et al. 2010) indicate that they can be well outside of the frequencies that animals use to communicate with conspecifics, are often of lower source levels that conspecific calls and in many cases cannot benefit from evolved capacity to compensate for noise (e.g., gain applied to communication space calculations), due to the absence of mechanism for natural selection to act (e.g., most eavesdropping contexts). Broadband listening space losses in this study were near complete at sites 8 and 9 in the Beaufort, with maximum losses realized under the highest activity Alternative (4). Again, these areas are important for the Fall bowhead whale migration, with calves, and the shallower area at Site 9 (Cross Island) represents an important bowhead whale subsistence area]. Interestingly, listening area losses were higher at 5 meters depth than at 30 meters depth, reflecting the fact that modeled broadband noise levels were higher at 5 meters than at 30 meters.

Conclusion

This chronic and cumulative effects study is presented to assist the public and managers in further assessing the effects of noise associated with the Alternatives for oil and gas exploration off the coast of Alaska considered in the FEIS. It is meant to ensure treatment of longer-term and wider-range noise effects from sources such as airguns, used in seismic acquisition, to augment more traditional assessment of their acute effects (e.g., auditory injury and harassment). The metrics applied in this first-order study necessitate several simplifying assumptions and do not, in and of themselves, document the consequences of lost listening area or communication space for the survivorship or reproductive success of individual animals, including marine mammals in the Arctic. However, they do translate a growing body of scientific evidence for concern regarding the degradation of the quality of high value acoustic habitats into quantifiable attributes that can be compared among proposed activity levels and distributions and related to the baseline conditions to which animals have evolved.

4.5.2.4.10 Bowhead Whales

This section describes the potential effects of Alternative 2 to bowhead whales. This information is in addition to the information provided in Sections 4.5.2.4.1 through 4.5.2.4.9, which is applicable to marine mammals more generally. Here, we include information specific to bowhead whales.

4.5.2.4.10.1 Direct and Indirect Effects

The primary direct and indirect effects on bowhead whales from activities associated with oil and gas exploration in the Beaufort and Chukchi seas considered under Alternative 2 would result from noise exposure. Ship strikes and habitat degradation are also possible but low probability. Sources of noise include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs. Details of these activities and associated components can be found in Chapter 2.

Behavioral Disturbance

Anthropogenic noise from oil and gas exploration activities may elicit behavioral responses from bowhead whales. The suite of possible reactions is listed above; known reactions by bowhead whales are included here and described and assessed by region and activity.

Beaufort Sea Activities

2D/3D Seismic Surveys (July through November)

Airgun arrays are the most common source of seismic survey noise. Baleen whales generally avoid operating airguns, but avoidance distances vary by species, locations, behavioral activities, as well as environmental conditions that influence sound propagation (Richardson et al. 1995, Gordon et al. 2004).

Airgun sounds can propagate horizontally for many kilometers (Greene and Richardson 1988). In waters 25 to 50 m (82 to 164 ft) deep, airgun sound can be detected 50 to 75 km (31 to 46 mi) away; in deeper water, ranges can exceed 100 km (62 mi) (Richardson et al. 1995). Ranges from airgun arrays to SPL thresholds between 190 and 120 dB re 1 μPa rms were measured for most seismic surveys and site clearance programs performed with airgun sources in the Alaskan Beaufort and Chukchi Seas between 2006 and 2015 as a component of IHA requirements. A detailed listing of those results is provided in Appendix G and a summary of the average and standard deviations of the 190, 180 and 160 dB re 1 μPa rms distances by source type and environment is given in Table 4.5-11. For example, the average distances to these threshold levels for surveys on the Beaufort Sea Shelf in >15 m water depth using airgun arrays of 3147 in^3 total volume were: 889 m to 190 dB re 1 μPa, 2573 m to 180 dB re 1 μPa, 11452 m to 160 dB re 1 μPa, and 74813 m to 120 dB re 1 μPa rms.

(Refer to Appendix G for additional details on these measurements.)

Observed responses of bowhead whales to seismic noise vary and may depend on multiple contextual factors, such as whether the whales are feeding or migrating. Feeding bowheads tend to show less avoidance of sound sources than do migrating bowheads. Bowhead whales feeding in the Canadian Beaufort Sea in the 1980s showed no obvious behavioral changes in response to airgun pulses from seismic vessels 6 to 99 km (3.7 to 61.5 mi) away, with received sound levels of 107 to 158 dB rms (Richardson et al. 1986). They did, however, exhibit subtle changes in surfacing–respiration–dive cycles. Seismic vessels approaching within approximately 3 to 7 km (1.9 to 4.3 mi), with received levels of airgun sounds of 152 to 178 dB, usually did not elicit strong avoidance reactions (Richardson et al. 1986, 1995, Ljungblad et al. 1988). Richardson et al. (1986) observed feeding bowheads start to turn away from a 30-airgun array with a source level of 248 dB re 1 μPa at a distance of 7.5 km (4.7 mi) and swim away when the vessel was within about 2 km (1.2 mi); other whales in the area continued feeding until the seismic vessel was within 3 km (1.9 mi). More recent studies have similarly shown greater tolerance of feeding bowhead whales to higher sound levels than migrating whales (Miller et al. 2005, Harris et al. 2007, Koski et al. 2009, Christie et al. 2010). Koski et al. (2008, 2009) observed several groups of bowhead whales that continued feeding near seismic surveys in the central Beaufort Sea in 2007 and 2008 where received sound levels reached between 150 and 180 dB re 1 μPa. Data from an industry aerial monitoring program in the Alaskan Beaufort Sea during 2006 through 2008 and 2010 noted bowhead whale mean distance from the center of active seismic operations increased for traveling but not for feeding whales; however, ice conditions appear to be a factor as well (Funk et al. 2011). This apparent tolerance, however, should not be interpreted to mean that bowheads are unaffected by the noise. Feeding bowheads may be so highly motivated to stay in a productive feeding area that they remain in an area with noise levels that could, with long-term exposure, potentially cause some sort of phyisiological impairment. Koski et al. (2009) noted bowhead whales appear more tolerant of higher levels of seismic noise when there is reason to remain in an area, such as the presence of food. However, other factors likely influence distribution relative to seismic activity, including ice cover, water depth, distance from shore, age, size, breeding status, and other disturbances in the area.

Migrating bowhead whales respond behaviorally more strongly to seismic noise pulses than do feeding whales. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn showed avoidance out to 20 to 30 km (12.4 to 18.6 mi) from a medium-sized airgun source at received sound levels of around 120 to 130 dB re 1 μPa rms (Miller et al. 1999, Richardson et al. 1999). Avoidance of the area did not last more than 12 to 24 hours after seismic shooting stopped. Deflection might start as far as 35 km (21.7 mi) away and may persist 25 to 40 km (15.6 to 24.9 mi) to as much as 40 to 50 km (24.9 to 31.1 mi) after passing seismic-survey operations (Miller et al. 1999). Analyses of data on traveling bowheads in the Alaskan Beaufort Sea also showed a stronger tendency to avoid operating airguns than was evident for feeding bowheads (Christie et al. 2009, Koski et al. 2009). Richardson et al. (1999) suggests migrating bowheads start to show significant behavioral disturbance from multiple pulses at received levels around 120 dB re 1 μPa. Although travelling whales tend to divert around a sound source at lower sound levels than do feeding whales, some travelling whales appeared to tolerate sounds greater than 120 dB (Koski et al. 2009).

Surfacing, respiration, and diving behaviors of bowhead whales change when exposed to seismic activities (Robertson et al. 2013). Surfacing time decreased, particularly for traveling or socializing non-calf bowheads exposed to seismic sounds. Dive duration was also affected, but effects varied with season (more pronounced in autumn than in summer) and whale activity (e.g., traveling vs. feeding). Traveling whales exposed to seismic operations had the shortest surface times and fewest respirations per surfacing, while feeding whales appeared more tolerant (Robertson et al. 2013).

The effect of seismic airgun pulses on bowhead whale calling behavior has been extensively studied in the Alaskan Beaufort Sea. Recent analyses indicate that calling rates increase when airgun pulses are first detectable above background levels, then level off at nearly double the calling rate in the absence of seismic sounds. Calling rates decrease and the whales become virtually silent at higher received levels from airgun pulses (Blackwell et al. 2015). During the autumn season in 2007 and 2008, calling rates decreased substantially in the presence of airgun pulses (Blackwell et al. 2010a). During August to October 2007, call localization rates (CLRs) dropped substantially at the onset of airgun use at sites near to (median distance 41-45 km) airguns where median received levels from airgun pulses were 116–129 dB re 1 lPa (10–450 Hz). CLRs did not change at distant (median distance >104 km) sites where median received levels were 99–108 dB re 1 lPa (Blackwell et al. 2013). Reanalysis of data from 2007-2010 indicate that call detection rates dropped rapidly when cumulative sound exposure levels (CSELs) were greater than ~127 dB re 1 $\mu Pa^2 \cdot s$ over 10 minutes and whales are nearly silent at received CSELs close to 160 dB (Blackwell et al. 2015). The decrease could be caused by less or no calling by individual whales, deflection of whales around the seismic activity, or a combination of both. Calls resumed near the seismic operations area shortly after operations ended. Aerial surveys showed high sighting rates of feeding, rather than migrating, whales near seismic operations (Blackwell et al. 2010a). In contrast, reduced calling rates during a similar study in 1996 to 1998 were largely attributed to avoidance of the area by whales that were predominantly migrating, not feeding (Miller et al. 1999, Richardson et al. 1999).

The open water season (July through early November) during which proposed seismic activities would occur (for up to 90 days), overlaps with summer feeding and the late-summer/fall westward migration of bowhead whales across the Alaskan Beaufort Sea. Therefore, the potential for exposure and disturbance is high during this time period. Data available from the BWASP and ASAMM surveys and other surveys (Ashjian et al. 2010, Clarke et al. 2011a, 2011b, 2011c, 2012, 2013, Koski and Miller 2009, Moore et al. 2010, Okkonen et al. 2011) reveal areas where concentrations, including feeding aggregations and/or aggregations of females and calves, are more likely to occur in the Beaufort Sea. These areas include a bowhead whale feeding "hotspot" during late summer to fall from Point Barrow to Smith Bay and the Kaktovik area where whales are occasionally observed feeding as early as July, and often occur in higher concentrations beginning in late-August and September.

Seismic activity in the Beaufort Sea would likely impact bowhead whales, although the level of disturbance will depend on whether the whales are feeding or migrating, as well as other factors such as the age of the animal, whether or not it is habituated to the sound, etc. Responses can range from apparent tolerance to interrupted communication, minor displacement, or avoidance of an area. If multiple 2D/3D seismic surveys occurred in areas with concentrations of bowheads present, large numbers of bowheads could potentially be disturbed or potentially excluded by avoidance from feeding habitat for the duration of the survey period. Most observed disturbance reactions appear to be short-term (meaning the length of the exposure to seismic pulses or less time), and short-term reactions to airgun noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use over periods of days or years. The Western Arctic stock of bowhead whales has, however, been increasing at approximately 3.7 percent per year (Givens et al. 2013), during a period of exposure to exploration activities in the Beaufort and Chukchi seas since the late 1960s. In addition, the potential for increased stress, and the long-term effects of stress, are unknown, as research on stress effects in marine mammals is limited (see discussion above). The level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type.

In terms of the impact criteria of Table 4.5-18, the disturbance effects of exploratory activity under Alternative 2 would be considered of medium intensity. Additionally, contextually, these impacts take place within a known migratory corridor through which these endangered whales must travel with calves and some may be temporarily displaced from preferred feeding areas. The EIS project area encompasses a large portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not a likely option. The duration of exposures from these surveys, for this Alternative is considered interim because it is limited to the open water season, and any behavioral responses by bowhead whales to activities is expected to be temporary and contained primarily within the time-period that an individual is exposed to the sounds, and because while the impacts are expected to be repeated over multiple years, 3D seismic surveys do not necessarily occur in every year. The extent of the impact will depend on the number of seismic activities and associated support vessels in an area. For individual sound source vessels and likely disturbance effects, impacts are expected to be local. However, where acoustic habitat is concerned, and the potential to mask important acoustic cues, the effects are broader and may be more regional in nature. Bowhead whales are considered unique in context, given both their endangered species status and the important migratory areas in which the impacts occur.

In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

Disturbance effects from seismic activities are anticipated to be the same as described above. The difference with this activity is the additional sound input from icebreaking activities and the extended period of activity into late fall and early winter. The temporal component of this activity and the potential effects of icebreakers are addressed here.

Increased noise from icebreaking activities may present concerns for bowhead whales (NMFS 2010c). Estimated source levels for an icebreaker range from 177 to 191 dB re 1 μPa (Richardson et al. 1995). More recent measurements of the U.S. Coast Guard Cutter Healy found that the sound signature increased approximately 10 dB between 20 Hz and 2kHz when breaking ice (Roth et al. 2013). According to Roth et al. (2013), the highest noise levels resulted while the ship was engaged in backing-and-ramming maneuvers, owing to cavitation when operating the propellers astern or in opposing directions. They found that in frequency bands centered near 10, 50, and 100 Hz, source levels reached 190-200 dB re 1 μPa at 1 m (full octave band) during icebreaking operations. A study by Miles et al. (1987) used models to predict responses of bowhead whales to icebreaker noise and determined that response was likely at distances of 2 to 25 km (1.24 to 15.53 mi). Zones of responsiveness for intermittent sounds, such as an icebreaker pushing ice, were not studied. They further predicted that approximately half of the bowhead whales exhibited avoidance behavior to a traveling icebreaker in open water at 2 to 12 km (1.25 to 7.46 mi) when the sound-to-noise ratio is 30 dB and to an icebreaker pushing ice at a distance of 4.6 to 20 km (2.86 to 12.4 mi) when the sound-to-noise ratio is 30 dB. Migrating bowhead whales avoided an icebreaker-accompanied drillship (with nearly daily icebreaking) by >25 km (>15.5 mi) in 1992 (Brewer et al. 1993).

The additional sound from an icebreaker accompanying seismic activity could cause temporary avoidance of bowhead whales from areas where the vessels are operating and potentially cause temporary deflection of the migration corridor (NMFS 2010c). BWASP and ASAMM surveys flown in September and October of 2006 through 2012 of the Alaskan Beaufort Sea include sightings of bowhead whales through at least mid-October, with sightings occurring from the U.S./Canadian border to Point Barrow (Clarke et al. 2011b, 2011c, 2011d, 2012, 2013). It is during this time period that the likelihood of co-occurrence of bowhead whales and icebreaker-accompanied seismic activity is most probable. Avoidance by bowhead whales of important feeding areas and displacement during migration are possible. The likelihood of interaction diminishes by late October as most bowheads tend to have migrated out of the Beaufort Sea by this time; therefore, impacts to bowhead whales from this type of activity are only anticipated for a short period of time (likely the first few weeks of the survey).

Because in-ice seismic surveys are designed to begin in early to mid-October towards the end of the bowhead whale fall migration westward through the Beaufort Sea, anticipated impacts of in-ice activities would be anticipated to be somewhat lower than those described for 2D/3D seismic surveys above (see Table 4.5-18 for impact criteria definitions). Surveys utilizing icebreakers could, however, cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, but the period of time over which this activity would overlap with bowhead whales in the Beaufort Sea is much shorter. Based on these factors, anticipated impacts of in-ice activities are anticipated to be of medium intensity, interim duration, local in extent, and would affect a unique resource for any bowhead whales that may occur in vicinity at the beginning of in-ice operations. However, as operations continue, bowheads would no longer occur in the project area, as they overwinter south of the EIS project area.

Ocean-Bottom-Cable or Node Survey (July to October)

An OBC/OBN seismic survey typically covers a smaller area than the streamer surveys discussed above and may spend several days in an area. One such survey is anticipated in the Beaufort Sea under Alternative 2. OBC/OBN surveys may require the use of dual seismic source vessels working in tandem (see Chapter 2, Table 2.4). Noise and disturbance effects of support vessels are discussed separately below.

Reactions to sounds from OBC/OBN surveys are similar to those reported for 2D/3D streamer seismic surveys. A partially-controlled study of the effect of OBC seismic surveys on westward-migrating bowhead whales was conducted in late summer and fall in the Alaskan Beaufort Sea in 1996 to 1998. Whales avoided the sound source out to 20 to 30 km (12.4 to 18.6 mi) at received sound levels of around 120 to 130 dB re 1 μPa rms (Miller et al. 1999, Richardson et al. 1999). Miller et al. (1999) estimated the deflection may have begun about 35 km (22 mi) to the east. Several bowheads moved into the area close to the seismic vessel during periods when airguns were inactive. Avoidance of the area of seismic operations did not persist beyond 12 to 24 hours after seismic shooting stopped.

The open water season of July to October, during which OBC/OBN surveys are likely to occur, coincides with summer feeding and late-summer/fall migration periods for bowhead whales in the Beaufort Sea. Although most bowhead whales feed in the Canadian Beaufort and Amundson Gulf during the summer months, some may occur near Kaktovik as early as July (Koski and Miller 2009). From late-summer through October, bowhead whales commonly occur in nearshore, shallow waters. The median depths of bowhead sightings during 2006 to 2014 BWASP and ASAMM surveys ranged from 19 to 39 m (62 to 128 ft) (Clarke et al. 2015b). In addition, the distance from which migrating bowheads appear to deflect from OBC/OBN sound sources suggest possible disturbance to whales traveling or feeding farther offshore. Moreover, some OBC/OBN surveys occur inside the barrier islands, where bowhead whales are rarely sighted, thus reducing the potential for effects on the animals from these types of surveys.

Anticipated impacts of OBC/OBN surveys, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for 2D/3D seismic surveys above. See Table 4.5-18 for impact criteria definitions. Although disturbance effects may extend 20 to 30 km (12.4 to 18.6 mi) from the sound source, with one OBC/OBN survey anticipated in the Beaufort Sea, short-term effects should remain local.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

High-resolution shallow hazards surveys are of short duration, and the airguns are smaller, generating lower energy sounds and a smaller zone of influence than the larger airgun arrays used for 2D/3D seismic surveys (NMFS 2010b). The radii of ensonification at 120, 160, 180, and 190 dB re 1 μPa rms were calculated for sound sources proposed for use in 2010. Radii calculated for the 40 in^3 airgun were 14,000 m (45,932 ft), 1,220 m (4,003 ft), 125 m (410 ft), and 35 m (115 ft) for the respective sound source levels. Additional information on measured sound radii for such sound sources in the Beaufort and Chukchi seas between 2006 and 2010 is contained in Table 4.5-9. Ensonified zones were not calculated for side scan sonar, single-beam or multi-beam echosounders, or for the bathymetric sonar (NMFS 2010b), as many of these sources are outside the range of best hearing for mysticetes and possibly for other marine mammals. Additionally, as mentioned above, the beam widths of these sources are narrow, which would only expose marine mammals to the sounds for one or two pulses, at most, if the animal swims in the direct beam width of the source.

Bowheads appear to continue normal behavior when exposed to noise generated by high-resolution seismic surveys. Richardson et al. (1985) tested this by firing a single 40 in^3 airgun at a distance of 2 to 5 km (1.2 to 3.1 mi) from whales. Some bowheads continued feeding, surfacing, diving, or traveling when the airgun began firing 3 to 5 km (1.9 to 3.1 mi) away (received noise levels at least 118 to 133 dB re 1 μPa rms). In other tests, some whales oriented away at 2 to 4.5 km (1.2 to 2.8 mi) and at 0.2 to 1.2 km (0.12 to 0.75 mi) (received noise levels at least 124 to 131 and 124 to 134 dB, respectively). Turning, diving, surfacing, respiration and calling were similar with or without airguns (Richardson et al. 1985a, b).

Site clearance and high resolution shallow hazards surveys on active leases in the Beaufort Sea could overlap spatially and temporally with feeding bowhead whales in some years from Harrison Bay to Camden Bay, particularly during their fall migration from the eastern Beaufort Sea to the Chukchi Sea.

Based on the criteria defined in Table 4.5-18, anticipated impacts of these surveys, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for 2D/3D seismic surveys above.

On-ice Vibroseis Survey (January to May)

The presence of bowhead whales are not likely to overlap with an on-ice vibroseis survey due to their absence from the Beaufort Sea during the winter months. If, however, the activity continues into April and May, it could coincide with the spring migration through the nearshore lead system from the Chukchi Sea into the Beaufort Sea. The migratory pathway of bowheads is more narrowly defined during the spring migration largely due to constraints imposed by ice configurations and leads and fractures. The migration corridor through the Beaufort Sea extends farther offshore than that through the Chukchi Sea (Figure 3.2-6), so migrating whales may be sufficiently distant from noise produced from vibroseis to not be disturbed.

Bowhead whales are sensitive to sound, including on-ice sounds, during the spring migration, as noted by Iñupiat whalers:

> *The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, usually made from bearded sealskins. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales* (NMFS 2013).

Exploratory Drilling (July through October)

Exploratory drilling is anticipated to initially occur on active leases offshore of Camden Bay. In addition to a drillship or steel drilling caisson (SDC), there will be additional vessels for support and ice management (potentially as many as 8 to 12 for one drilling operation). Potential impacts from additional vessel traffic will be discussed separately from the effects of the drillship operations (see Associated Vessels and Aircraft below). Multiple sites could be drilled each season with up to three wells being a reasonable number for analysis purposes. This is based on the amount of time needed to drill each individual well and the available amount of time to conduct such operations during the ice free months. See Chapter 2 for details of this activity.

Reactions of bowhead whales to drillship operation noises varies. Whales exhibiting apparently normal behavior were observed several times within 10 to 20 km (6.2 to 12.4 mi) of drillships in the eastern Beaufort Sea, and whales have been sighted within 0.2 to 5 km (0.12 to 3 mi) of drillships (Richardson et al. 1985a, b, Richardson and Malme 1993). Bowheads may, however, avoid drillships and accompanying support vessels at 20 to 30 km (12.4 to 18.6 mi) (MMS 2003). The presence of actively operating icebreakers in support of drilling operations introduces additional sound into the marine environment and affects responses of whales. In 1992, Brewer et al. (1993) noted that migrating bowhead whales avoided an icebreaker-accompanied drillship by >25 km (>15.5 mi). Richardson et al. (1995) observed avoidance behavior in half of the bowhead whales exposed to 115 dB re 1 µPa rms broadband drillship noises. Reaction levels depended on whale activity, noise characteristics, and the physical situation, similar to that observed with seismic sounds. Richardson and Greene (1995) concluded that the observed playback effects of drilling noise were local and temporary and that effects on distribution, movements, and behavior were not biologically important. Continued long-term monitoring of effects may be needed to better address the issue of biological importance.

Continuous noise emitted from stationary sources, such as drillships, elicits less dramatic behavioral reactions (e.g., changes in swim speed, dive behavior) by bowhead whales than do moving sources, particularly ships (Richardson and Malme 1993). Most observations of bowheads apparently tolerating noise from stationary operations were opportunistic sightings of whales near oil-industry operations; whether more whales would have been present in the absence of those operations is not known. Richardson et al. (1990) performed 12 playback experiments in which bowhead whales in the Alaskan Arctic were exposed to drilling sounds. Whales generally did not respond to exposures in the 100 to 130 dB re 1 µPa rms range, although there was some indication of behavioral changes in several instances.

Some bowheads likely avoid closely approaching drillships by changing their migration speed and direction, making distances at which reactions to drillships occur difficult to determine. In a study by Koski and Johnson (1987), one whale appeared to alter course to stay 23 to 27 km (14.3 to 16.8 mi) from the center of the drilling operation. Migrating whales passed both north and south of the drillship, apparently avoiding the area within 10 km (6.2 mi) of the drillship. No bowheads were detected within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). They concluded westward migrating bowheads appeared to avoid the offshore drilling operation during the fall of 1986, and some may avoid noise from drillships at 20 km (12.4 mi) or more.

Monitoring of the Kuvlum drilling site north of Point Thompson occurred during the 1993 fall bowhead whale migration by Hall et al. (1994). These data were later reanalyzed by Davies (1997) and Schick and Urban (2000). Davies (1997) concurred with Hall et al. (1994) that the whales were not randomly distributed in the study area and that they avoided the area around the drill site at a distance of approximately 20 km (12.4 mi). Hall et al. (1994) noted that the distribution of whales observed in the Kuvlum drilling site is consistent with previous studies (Moore and Reeves 1993), where whales were observed farther offshore in this part of the Beaufort Sea than they were to the east of Barter Island and that it was difficult to separate the effect of the drilling operation from other independent variables, such as water depth. However, Davies (1997) noted whales were closer to shore and in shallower water. Results in Schick and Urban (2000) indicated whales within hearing range of the drillship (<50 km [<31.1 mi]) were distributed farther from the rig than they would be under a random scenario. They concluded the spatial distribution of whales was strongly influenced by the presence of the drillship but lacked data to assess noise levels. Other factors that could influence distribution relative to the drillship were support vessels and icebreakers operating in the vicinity, as well as ice thickness (Schick and Urban 2000). All of these studies noted some level of bowhead whale deflection from active drilling operations.

Bowhead whales, including mothers and calves, may occur in waters west of Kaktovik and near Camden Bay as early as July but more typically from late-August through September (Koski and Miller 2009). It appears to be part of the fall migration corridor. Consequently, there is a high likelihood drilling operations in September or October would coincide with bowhead whales migrating through the area, and would elicit reactions ranging from tolerance (mostly by feeding whales) to displacement and avoidance of the drilling noises.

Based on the impact criteria defined in Table 4.5-18, anticipated impacts of exploratory drilling activities in the Beaufort, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for seismic surveys. The zone of possible displacement around a drillship would also be influenced by accompanying support vessel and icebreaker activity and their respective working distances from the drillship or rig. Shell analyzed the composite noise footprint of its drillship and support vessels during its 2015 Chukchi Sea drill program. That analysis determined that the composite noise emissions exceeded 120 dB re 1 μPa over an average area of 1264 km^2 (488 mi^2) taken over the duration of its activities. This area represents approximately 0.5% of either the Beaufort or Chukchi EIS areas (Austin and Li 2016).

Associated Vessels and Aircraft

Bowhead whales react to approaching vessels at greater distances than they react to most other activities. Vessel sounds vary by vessel size and type, as well as vessel operating conditions. Vessel sounds measured in the Beaufort Sea since 2007 yielded threshold radii to 120 dB re 1 μPa between 120 m (390 ft) for smaller vessels and 13 km (8.1 mi) for large vessels, with a mean value of 2.3 km (1.4 mi) (LGL Alaska Research Associates, Inc. et al. 2013). Vessel-disturbance experiments in the Canadian Beaufort Sea by Richardson and Malme (1993) showed that most bowheads begin to swim rapidly away when fast moving vessels approach directly. Avoidance usually begins when a rapidly approaching vessel is 1 to 4 km (0.62 to 2.5 mi) away. Whales move away more quickly when approached closer than 2 km (1.2 mi) (Richardson and Malme 1993). A few whales reacted at distances of 5 to 7 km (3.1 to 4.3 mi), while others did not react until the vessel was <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 μPa, or 6 dB above ambient, elicited strong avoidance of an approaching vessel from 4 km (2.5 mi) away. During the experiments, vessel disturbance temporarily disrupted activities, and socializing whales moved apart from one another. Fleeing from a vessel usually stopped soon after the vessel passed, but scattering lasted for a longer time period. Some bowheads returned to their original locations after the vessel disturbance (Richardson and Malme 1993). Bowheads react less dramatically to and appear more tolerant of slow-moving vessels, especially if they do not approach directly. Acoustic monitoring in the vicinity of Northstar (an artificial oil production island in the Alaskan Beaufort Sea) indicated that when transient sounds, such as from boats, increased, bowhead whale calls were significantly shorter (Blackwell et al. 2007). Bowhead calling behavior may be affected by exposures to low levels of seismic survey noise from airguns. A study by Blackwell et al. (2013) found calling rates initially increased when they were exposed to low seismic sound levels, then decreased when the exposure levels continued to increase.

Data are not sufficient to determine demographic responses of bowhead whales to vessels. However, more information of this type is not essential for a reasoned choice among alternatives.

Iñupiat whalers expressed concern over vessel impacts on bowhead whales, noting observed displacement caused by barge activity:

> *Bowhead whales have a different view of how they interact with things. For instance, I want to say, again, I've met with you guys, and I explained when I was a whaling captain in '05 was my first year, I saw 100 -- over 100 whales diverted from one barge, and there was no other whales beyond that for the next 15 miles. So I've seen the activity and the diversion of bowhead whales from industry* (testimony provided by Thomas Napageak, Jr. at Nuiqsut Public Scoping Meeting for this EIS, March 11, 2010).

Data on reactions of bowheads to helicopters are limited. Most bowheads showed no obvious response to helicopter overflights at altitudes above 150 m (500 ft) (Richardson and Malme 1993). Patenaude et al. (2002) found that most reactions by bowhead whales to a Bell 212 helicopter occurred when the helicopter was at altitudes of ≤150 m (500 ft) and lateral distances of ≤250 m (820 ft). Reactions included abrupt dives, short surfacings, and breaching, and, most, if not all, reactions seemed brief. The majority of bowheads, however, showed no obvious reaction to single passes, even at those distances. Data were insufficient to analyze effects of repeated low-altitude passes (Patenaude et al. 2002).

Fixed-wing aircraft flying at low altitude often cause bowheads to dive rapidly. Reactions to circling aircraft may be conspicuous at altitudes <300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowheads sometimes elicited abrupt turns and quick dives (Richardson and Malme 1993). Aircraft on a direct course are audible only briefly, and whales are likely to resume their normal behavior within minutes after the plane passes (Richardson and Malme 1993). Only 2.2 percent of bowheads during the spring migration reacted to Twin Otter overflights at altitudes of 60 to 460 m (197 to 1,509 ft) (Patenaude et al. 2002). Reactions diminished with increasing lateral distance and altitude. Most observed reactions by bowheads occurred when the Twin Otter was at altitudes of ≤182 m (597 ft) and lateral distances of ≤250 m (820 ft). There was little, if any, reaction when the aircraft circled at an altitude of 460 m (1,509 ft) and a radius of 1 km (0.62 mi) (Patenaude et al. 2002). The effects from an encounter with aircraft are brief, and the whales generally resume their normal behavior within minutes.

During their study, Patenaude et al. (2002) observed one bowhead whale cow-calf pair during four passes totaling 2.8 hours of the helicopter and two pairs during Twin Otter overflights. All of the helicopter passes were at altitudes of 15 to 30 m (49 to 98 ft). The mother dove both times she was at the surface, and the calf dove once out of the four times it was at the surface. For the cow-calf pair sightings during the Twin Otter overflights, the authors did not note any behaviors specific to those pairs. Rather, the reactions of the cow-calf pairs were lumped with the reactions of other groups that did not consist of calves.

The likelihood of spatial and temporal overlap between support vessels and aircraft with bowhead whales in the Beaufort Sea is high. The degree of overlap and interaction depends on the spatial and temporal distribution of activities and whether they are broadly dispersed or clustered. The greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on bowhead whales is in areas where whales are aggregated, especially if aggregations contain large numbers of cow/calf pairs. Activities, such as exploratory drilling, will utilize multiple support vessels, as well as resupply trips and flights to the dock at Prudhoe Bay (see Chapter 2, Tables 2.2 and 2.4). The number of kilometers transited by seismic and various types of support vessels in the Beaufort Sea in 2006 to 2008 ranged from 9,580 km (5,953 mi) in 2006 to 67,627 km (42,021 mi) in 2008 (Funk et al. 2010). During operations, most source vessel speeds are relatively slow, in the range of 3 to 5 kn, although transit speeds are likely to be much higher. Source vessel transit speeds for 2D/3D seismic surveys are estimated at 8 to 20 kn (refer to Chapter 2 for details). If such activity coincides with aggregations of whales, then disruption is likely.

Most observed disturbance reactions to vessel and aircraft activity appear to be short-term. The longer term effects of repeated vessel interactions over a broad area or in a local area where there are concentrations of whales are unknown. Based on the impact criteria for marine mammals defined in Table 4.5-18, disturbance effects of vessel and aircraft activity would likely be considered of medium intensity since at least some whales would be displaced, but they are not likely to leave the EIS project area entirely. The duration of disturbance is expected to be interim; long-term effects are unknown. The extent of the impact would depend on the number of support vessels in an area, but, for individual activities, impacts are expected to be local. Multiple activities in one area or in several areas across the migratory corridor could result in a broader, regional impact. Bowhead whales are considered unique in context, given both their endangered species status and protection and importance to North Slope communities as a subsistence resource.

Chukchi Sea Activities

2D/3D Surveys (July through November)

Effects of 2D/3D seismic noise on bowhead whales in the Chukchi Sea would likely be similar to those described above for the Beaufort Sea. There may be regional differences in sound propagation and areas of ensonification due to bathymetric and water property differences between the two areas (see

Table 4.5-9, Section 4.5.1.4, Acoustics) that would affect distances at which noise impacts may occur. Differences also exist regionally within the Chukchi Sea OCS. For example, endfire sound level threshold distances for 180, 160, and 120 dB re 1 μPa rms were 1.27 km (0.79 mi), 6.69 km (4.16 mi), and 104.3 km (64.8 mi), respectively, at the Kakapo Prospect and 1.14 km (0.71 mi), 7.15 km (4.44 mi), and 58.4 km (36.3 mi), respectively, at the Burger Prospect (Martin et al. 2010). Additional examples of distances to threshold values for other source types and at other locations are provided in Table 4.5-11.

Most bowhead whales that encounter airgun sounds from seismic operations in the Chukchi Sea would be migrating. At the onset of seismic operations in July, few bowhead whales will likely be in the Chukchi Sea. Whales are occasionally seen feeding during summer in the northeast Chukchi Sea, although those observed in June and July 2009 were in the nearshore waters between Point Franklin and Barrow (Clarke et al. 2011a) with another observed feeding in early July 2012 near Icy Cape (Clarke et al. 2013), well inshore of the federal lease sale areas. In September and October, bowhead whales migrate west from the Beaufort Sea into the Chukchi Sea, and most traverse the lease sale area (Figure 3.2-11). It is during this time that disturbance is most probable. Satellite-tagged bowhead whales were most common in the Chukchi Sea Lease Sale 193 Area in September. In this month, the Lease Area contained 31 percent of the total probability of use for all bowhead whales and the areas with the greatest probability of use were in the northeastern part of the Lease Area. In October, the entrie Lease Area contained 7 percent of the total probability of use for all bowhead whales (Quakenbush et al. 2010a).

As detailed above, migrating bowhead whales in the Beaufort Sea respond to seismic noise pulses at lower received levels than do feeding whales, with avoidance out to 20 to 30 km (12.4 to 18.6 mi) from a medium-sized airgun source at received sound levels of around 120 to 130 dB re 1 μPa rms (Miller et al. 1999, Richardson et al. 1999). The estimated 120 dB re 1 μPa rms sound level threshold distances for seismic operations on the Kakapo and Burger Prospects in the Chukchi Sea were two to three times this distance (Martin et al. 2010). Haley et al. (2010b) found a lower percentage of cetacean sightings near source vessels in the Chukchi Sea, suggesting cetacean avoidance of underwater seismic sound. The small sample size of cetaceans exposed to received sound levels ≥160 dB rms was too small to make strong conclusions. The migration corridor in the Beaufort Sea is more concentrated in a relatively narrow band along the Alaskan coast, whereas the migration through the Chukchi Sea is less defined and spread out over a broader area, providing more area for the whales to migrate through on their way to the overwintering grounds (see Figures 3.2-6 and 3.2-11).

Avoidance at some distance from the sound sources is likely and depends on spatial and temporal overlap with migrating bowhead whales. Operations commencing in July may be complete before the peak of migration in September and October. Surveys starting later in the summer or fall, however, would likely ensonify some portion of the bowhead whale migratory corridor with sound levels known to elicit avoidance responses.

Based on the impact criteria defined in Table 4.5-18, anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea. However, impacts are anticipated on a smaller number of animals based on the fact that these activities and bowhead whale migration in the Chukchi Sea would co-occur for a shorter period of time than in the Beaufort Sea.

In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

Disturbance effects on bowhead whales that may occur in the vicinity of in-ice seismic surveys with icebreaker support in the Chukchi Sea would likely be similar to those described above for the Beaufort Sea. In-ice seismic surveys could occur both on- and off-lease.

The additional sound from icebreakers accompanying seismic activity could cause temporary avoidance of bowhead whales from areas where the vessels are operating and potentially cause temporary deflection of the migration corridor (NMFS 2010c). Bowhead whales are migrating into and through the Chukchi

Sea during September and October and typically traverse the Lease Sale 193 area at that time (Clarke et al. 2011a, 2013, Brueggeman et al. 2009, Brueggeman et al. 2010, Quakenbush et al. 2010b). Based on satellite-tag data, most bowheads are along the Chukotka coast by November and December (Quakenbush et al. 2010b), and no bowhead whales have been detected during limited COMIDA aerial surveys in November (Clarke et al. 2011a). Small numbers of bowhead whales have been acoustically detected in the Chukchi Sea until early January during low ice years (Delarue et al. 2009). Migrating bowhead whales and icebreaker-accompanied seismic activity are most likely to co-occur in October. Displacement during migration is possible, though the migratory corridor across the Chukchi Sea is broad and spans approximately 3 degrees of latitude (Quakenbush et al. 2010b).

Anticipated impacts of in-ice activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for the Beaufort Sea despite the less defined migratory corridor in the Chukchi Sea. However, impacts are anticipated on a smaller number of animals based on the fact that seismic operations and bowhead whale migration would only co-occur for a short period of time at the beginning of operations. If a similar survey were occurring concurrently in the Beaufort Sea, there is a potential for some later migrating bowhead whales to encounter survey activities in both seas. However, there would likely be considerable distance between the two operating programs.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

Disturbance effects on bowhead whales from site clearance and high resolution shallow hazards surveys in the Chukchi Sea would likely be similar to those described above for the Beaufort Sea.

Bowhead whales would most likely encounter these operations in the Chukchi Sea during fall migration. Few bowhead whales occur in the Chukchi Sea in July and August (Clarke et al. 2011a). In September and October, bowhead whales migrate west from the Beaufort Sea into and across the Chukchi Sea (Figure 3.2-11). Potential disturbance depends on spatial and temporal overlap with migrating bowhead whales. Operations commencing in July may be complete before the peak of migration in September and October. Surveys starting later in the summer or fall, however, would likely ensonify some portion of the bowhead whale migratory corridor, though the ensonified zones for these types of surveys are much smaller than those for the 2D/3D seismic surveys.

Based on the impact criteria defined in Table 4.5-18, anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for the Beaufort Sea. However, impacts are anticipated on a smaller number of animals based on the fact that these activities and bowhead whale migration in the Chukchi would only co-occur for a short period of time.

Exploratory Drilling (July through October)

Known effects of drilling operations on bowhead whales are as described above for the Beaufort Sea and would likely be similar for the Chukchi Sea. Drilling operations in the Chukchi Sea would likely initially occur in areas on federal leases for which exploration plans have recently been submitted or would be submitted during the time period of this EIS and where there have been recent requests for approval of ancillary activities. It is anticipated that either a drillship with eight to twelve support vessels or jackup rig with two to three support vessels would be used for exploratory drilling between early July and late October.

The drilling unit and support vessels typically do not enter the Chukchi Sea until after July 1 when most of the spring bowhead migration is complete. Few bowheads are expected to be encountered during the early season drilling operations, minimizing any effects at that time. Drilling operations occurring during September and October could potentially disturb and displace bowheads migrating through and across the Chukchi Sea.

Anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea. However, impacts are anticipated on a smaller number of animals based on the fact that these activities and bowhead whale migration in the Chukchi would only co-occur for a short period of time.

Associated Vessels and Aircraft

Known and potential effects of support vessel and aircraft on bowhead whales in the Chukchi Sea are as described above for the Beaufort Sea and would be expected to be similar for the Chukchi Sea.

Bowhead whales feeding and migrating in the Chukchi Sea could encounter numerous seismic vessels, support vessels, and associated aircraft. The number of kilometers transited by seismic and various types of support vessels in the Chukchi Sea in 2006 to 2008 ranged from 48,100 km (29,888 mi) (2007) to 106,838 km (66,386 mi) (2006) (Funk et al. 2010). Vessel sounds vary by vessel size and type, as well as vessel operating conditions. Vessel sounds measured the Chukchi Sea since 2007 yielded radii to 120 dB re 1 μPa between 360 m (1180 ft) for smaller vessels and 19 km (11.8 mi) for the largest vessels with powerful thrusters, with a mean value of 4.4 km (2.7 mi) (LGL Alaska Research Associates, Inc. et al. 2013). Offshore acoustic detections of bowhead whales during a period in mid-September 2012 coincided with the occurrence of numerous support vessels on standby to the southeast of the Burger drill site, suggesting that whales were not actively avoiding the area (LGL Alaska Research Associates, Inc. et al. 2013). The extent of disturbance depends on the areas in which vessels are transiting or operating, the number in a given area, and the time of operation. Bowheads feeding near shore in the northeast Chukchi Sea may be in the flight path for support flights and transits between Wainwright and Nome and possibly more susceptible to disturbance.

Based on the criteria defined in Table 4.5-18, anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea. However, impacts should affect a smaller number of animals based on the fact that these activities and bowhead whale migration in the Chukchi Sea would only co-occur for a short period of time.

Hearing Impairment, Injury, and Mortality

Although the likelihood of such impacts occurring is considered highly unlikely, the primary direct mechanisms of potential hearing impairment, injury, or mortality due to oil and gas exploration activities are hearing loss or damage (auditory injury) and collisions with vessels. The potential effects of a VLOS, which is considered improbable and for which incidental take would not be authorized by NMFS under any alternative, are discussed separately in Section 4.10.

Auditory Impairment (TTS and PTS)

Noise induced TS (including TTS and PTS) is described above. The potential for seismic airgun pulses to cause acoustic injury in marine mammals is not well understood (Gedamke et al. 2011), and data on levels or properties of sound that are required to induce TTS are lacking for baleen whales. Recent simulation models, using data extrapolated from TTS in toothed whales, suggest baleen whales 1 km (0.62 mi) or more from seismic surveys could potentially be susceptible to TTS (Gedamke et al. 2011). There is no information on TTS or PTS specifically for bowhead whales.

Because bowhead whales generally respond to loud noise by moving away, they are less likely to suffer hearing loss from increased noise. They are not likely to remain close enough to a large airgun array long enough to incur TTS, let alone PTS. The levels of successive pulses received by a marine mammal would increase and then decrease gradually as the seismic vessel approaches, passes and moves away, with periodic decreases also caused when the animal goes to the surface to breath, reducing the probability of the animal being exposed to sound levels large enough to elicit PTS. However, data suggest that exposures of longer duration and lower levels can lead to more TTS (i.e., onset at lower level and greater amount of TTS) compared to exposures of higher level and short duration with the same cumulative sound exposure level (Finneran et al. 2010, Kastak et al. 2005, 2007, Kastelein et al. 2012a, b, Mooney et al. 2009), and seismic airguns can ensonify larger areas to higher levels in which whales may remain in the proximity of for longer times. This, in combination with the fact that monitoring reports include occasional observations of bowheads within the 180-dB zone of seismic surveys suggests that TTS and PTS, though unlikely, cannot be entirely ruled out.

Since bowhead whales appear to be more tolerant of noise when feeding, work is needed to determine potential effects of repeated exposure to loud noise at distances tolerated in feeding areas. The potential for increased noise to cause physiological stress responses should also be considered, as it is not currently known (NMFS 2011a). Obtaining data on stress responses in large free-swimming whales would require potentially disruptive invasive techniques.

Section 4.2.6.3 outlines NMFS final revisions to auditory injury thresholds. NMFS applied these thresholds to the types of sources analyzed in this EIS (seismic airguns and drilling sources of similar size) and found that the resulting distances at which injurious exposures could not be ruled out (i.e., those at which PTS might be incurred) were similar to those calculated using the 180 and 190-dB historical thresholds (though actually notably smaller for mid-frequency cetaceans and otairids), meaning that the revisions to the auditory injury thresholds do not notably change any of the conclusions articulated in earlier versions of the EIS. As noted previously, most individual marine mammals are expected to avoid loud sounds at distances that would lead to PTS, and standard mitigation measures to shut down airguns if individuals approach within distances associated with injurious effects are expected to help minimize effects. That said, the potential for PTS cannot be ruled out for bowheads or other low-frequency cetaceans and phocids and is considered highly unlikely to occur for mid-frequency cetaceans and otariids.

Determining effects intensity is not possible, without instances of noise exposures severe enough to result in observed mortality where cause of death could be attributed to sound impulses. There are no known such incidences with bowhead whales. The duration of impact would be temporary for TTS but permanent if PTS were to occur. The extent of such impacts would be local and the context is important, since bowhead whales are listed as endangered (and the population is increasing).

Ship Strikes

Marine vessels could potentially strike bowhead whales, causing either injury or death. Incidence of ship strikes appears low, but could rise with increasing vessel traffic. Only three ship-strike injuries were documented in the 236 bowhead whales examined from the subsistence harvest from 1976 to 1992 (George et al. 1994). All of the injuries indicate the whales were struck by propellers of large (>30 m [>98.4 ft]) ships.

The low incidence of observed ship strikes, as of the early-1990s, was likely an artifact of the comparatively low rate of vessels passing through most of the bowhead's range or that many bowheads struck by ships do not survive (George et al. 1994). Ship strikes are a major cause of mortality and serious injury in North Atlantic right whales, accounting for 35 percent of deaths from 1970 to 1999 (Knowlton and Kraus 2001). Experimental playback studies revealed that right whales did not respond to sounds of approaching vessels or to actual vessels, suggesting habituation to engine sounds that are ubiquitous throughout most of their range (Nowacek et al. 2004). Most bowhead whales, in contrast, show strong avoidance reactions to approaching ships. Eskimo hunters report that bowheads are less sensitive to approaching boats when they are feeding (George et al. 1994), leaving them more vulnerable to vessel collisions.

The frequency and severity of ship strikes is influenced by vessel speed. The potential for collision increases at speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). For the activities considered under Alternative 2, speeds for most source vessels are relatively slow (approximately 3 to 5 kn) during oil and gas exploration activities. Transit speeds, however, are likely to be much higher. Seismic survey source vessel transit speeds are, for example, estimated at 8 to 12 kn (refer to Chapter 2, Alternatives for details), suggesting that, if collisions were to occur, they are more likely when vessels are in transit than when conducting active exploration operations. Vessels transiting to the Beaufort or Chukchi seas from Dutch Harbor at the start of the open water season, or returning across these areas to the Bering Strait at the end of the season, transiting between sites, or for resupply in and out of Nome or Wainwright in the Chukchi Sea or Prudhoe Bay in the Beaufort have the highest chance of encountering migrating bowheads or aggregations feeding in more coastal regions of the northeast Chukchi and between Point Barrow and Smith Bay in the Beaufort Sea.

The reported incidence of ship strikes is low, but, since collisions have occurred in the past, the intensity of the impact should be considered medium. The impact would be temporary, although the results (injury or mortality) would be permanent for the individual whale. The extent of impact would be local, given the infrequency of occurrence and the non-random distribution of both bowhead whales and exploration activity in the EIS project area. The context would be important, since bowhead whales are listed as endangered and the population is increasing Refer to Table 4.5-18 for marine mammal impact criteria definitions.

Small Fuel Spill

There is the potential for bowhead whales to be exposed to small fuel spills of less than 50 bbl (see Section 4.2.7). If a small spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact bowhead whales. Further, vessel activity associated with spill response would likely keep bowhead whales out of the spill area, and individual whales would likely avoid the spill by leaving the area during spill response activities. Oil generally poorly adheres to the skin of mysticete whales, and cetaceans are believed to have the ability to detect and avoid oil spills (Geraci, 1990; St. Aubin, 1990). Moreover, the weathering process should act to quickly break up or dissipate oil/fuel through the local environment to harmless residual levels that would eventually become undetectable. Therefore, small spills are anticipated to have no more than a negligible level of effect on bowhead whales.

Habitat Alterations

Alterations to marine mammal habitat could occur through physical changes, such as to the substrate or sea ice, pollution in the water column, alterations to prey species, or impacts on acoustic habitat relied upon by marine mammals for communication and other functions. This subsection describes the potential impacts of the various activity types on bowhead whale habitat (in the broader sense mentioned here).

Oil and gas exploration activities that may result in alteration of habitat include disturbance of sea ice from icebreaking, disturbance of benthic sediments during drilling, and contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities. Effects of icebreaking and exploratory drilling are discussed above in the introduction to effects on marine mammals (Section 4.5.2.4). Potential effects of a very large oil spill, including long-term displacement from areas impacted by oil, are discussed in Section 4.10. Additional details and impact assessments are provided here.

Potential impacts of drilling mud discharged into the marine environment are among concerns expressed by Iñupiat subsistence hunters:

> *I've experienced drilling mud on an iceberg north of Northstar at that time when Northstar was in a stage of being developed. So there were quite a few drilling muds being caught at -- on Northstar on a real calm, calm day. Not even one marine mammal was inside it. And you could hear that Northstar drill rig pounding away. Not one marine mammal, not even one waterfowl was sighted. And the only thing we encountered was an iceberg totally covered with drilling mud.*

> *It's not a natural mud.* (Testimony provided by Archie Ahkiviana at the Nuiqsut Public Scoping Meeting for this EIS, March 11, 2010).

Adverse effects of discharges on bowhead whales are directly related to whether or not any potentially harmful substances are released into the marine environment and whether they rapidly dilute or bioaccumulate through the food chain. Bowhead whales are long lived, and some individuals potentially could accumulate contaminants. Bowhead whales, however, feed on lower trophic level organisms (zooplankton) so are considered at lower risk of bioaccumulation of contaminants, such as persistent organic compounds, than higher level consumers. Levels of persistent organic compound concentrations in samples collected from bowhead whales in Alaska are low compared to other marine mammals (O'Hara and Becker 2003).

Drill cuttings and drilling mud discharges are regulated by either the EPA NPDES permits or the ADEC APDES permits as detailed in State waters in the Beaufort Sea.Section 4.5.1.5. The impact of drill cuttings and drilling mud discharges would be medium in intensity, local in extent,extent and temporary in duration. Drill cuttings and mud discharges could temporarily displace marine mammals a short distance from the drilling site. The EPA modeled a hypothetical 750 bbl/hr discharge of drilling fluids in 20 m (66 ft) of water in the Beaufort and Chukchi seas and predicted a minimum dilution of 1,326:1 at 100 m (330 ft) from the discharge point (Shell 2011a). Discharged drilling fluid should be well diluted within 100 m (330 ft) so that any impacts would be highly localized and temporary, assuming whales continue to swim through or past the discharge plume. If toxic contaminants are present in discharges, only a small area of potential habitat and prey base might be contaminated. Consequently, the resulting population-level effects would be negligible.

Bottom-founded drilling units or gravel islands could impact small areas of benthic habitat that support epibenthic prey aggregations that bowhead whales feed on, increasing turbidity or sediment suspension in the water column (Mocklin 2011). Exploration drilling on past and current leases would add incrementally to potential discharges into the Beaufort and Chukchi seas but would remain restricted to areas immediately surrounding exploration drilling activity.

Additionally, the acoustic habitat, within which whales use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the frequency bands of the signals of interest for the whales. Depending on the decibel level, frequency, and duration of these sounds, these acoustic habitat alterations may result in reduced ability to detect or interpret some important sounds.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order aggregate and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments on the DEIS and SEIS. Broadly, results suggest that even with the lower predicted activity levels in Alternative 2, substantial losses of listening area (up to 98%) and bowhead communication space (up to 20%), to a lesser degree, would occur in the Beaufort Sea area from July to mid-October (far less loss was noted in the Chukchi). As noted in section 4.5.2.4.9, there is evidence indicating significant reductions in listening area or communication space can negatively affect aquatic animals. Though data are lacking to document links to population consequences for long-lived and often wide-ranging species such as marine mammals, chronic noise effects that impair an animal's ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered, especially for bowhead whales, which migrate through with calves under conditions where communication is important to maintain group cohesion.

Effects on Zooplankton

In a review of available information on the effects of seismic sound on invertebrates, the Canadian Department of Fisheries and Oceans (DFO) reported lethal and/or sublethal effects have sometimes been observed in invertebrates (e.g., crustaceans, gastropods) exposed to airgun sounds at distances of <5 m

(<16.4 ft) under experimental conditions (DFO 2004). They considered exposure to seismic sound unlikely to result in direct invertebrate mortality, although invertebrates may exhibit short-term behavioral reactions to sound (DFO 2004). They found few studies on the effects of seismic noise on zooplankton. Zooplankton very close to the seismic source may react to the shock wave, but effects are expected to be local (LGL 2010). Potential non-seismic effects on zooplankton are noted above and in the respective sections on Lower Trophic Levels (see, for example, 4.5.2.1).

Potential impacts to bowhead whale habitat (including from discharge and to zooplankton and acoustic habitat) from oil and gas exploration activities permitted under Alternative 2 would, based on the criteria defined in Table 4.5-18, be of low to medium intensity. Most impacts would be local in the area immediately adjacent to the impacts (discharges, sediment disruption, or icebreaking), but disruptions to acoustic habitat could occur across a larger area. Most impacts would also be temporary, though longer-term and regional effects could occur to acoustic habitat and through the process of bioaccumulation through the food web..

4.5.2.4.10.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

Oil and gas exploration activities in the Beaufort and Chukchi seas, as analyzed under Alternative 2, would likely cause behavioral disturbance to bowhead whales, including varying degrees of disturbance to feeding, resting, or migrating bowhead whales depending on actual level of effort, type of activity, time of year, and whether activities run concurrent in the Beaufort and Chukchi seas. Disturbance could lead to displacement from and avoidance of areas of exploration activity. The EIS project area encompasses a portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not likely. The duration of disturbance (and acoustic habitat disturbance) from oil and gas activities is expected to be of long-term duration, lasting less than six months, but repeating over multiple years. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, but the period of time over which this activity would overlap with bowhead whale presence is much shorter. Although bowhead whales react to approaching vessels at greater distances than they react to most other activities, most observed disturbance reactions to vessels and aircraft appear to be brief. The extent of the impact will depend on the number of exploration activities and associated support vessels in an area, but, for individual sound sources, impacts are expected to be local. However, over the course of the season and considering the maximum level of activity potentially conducted under this activity, and considering areas that are potentially ensonified above 120 dB, the geographic scale could be considered regional.

Because whales respond behaviorally to loud noise, and because of the required standard mitigation measures, they are less likely to suffer auditory damage from increased noise due to oil and gas exploration activities. Additionally, based on the required standard mitigation measures, impacts from vessel strikes are considered unlikely.

The geographic area and extent of the population over which effects would be felt (especially considering the distances over which bowhead whales communicate and seismic sounds travel) would likely increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Potential long-term effects from repeated disturbance, displacement or habitat disruption on an extremely long-lived species such as the bowhead whale are unknown. The Western Arctic stock of bowhead whales has, however, continued to increase at an estimated 3.7 percent per year despite past and present exploration activities within their range (Givens et al. 2013). It is not currently possible to predict which behavioral responses to anthropogenic noise might result in population-level effects for marine mammals, such as bowheads, in the future (NRC 2005).

Bowhead whales are listed as endangered and impacts are expected to occur within an important migratory corridor where almost all mothers and calves will pass through within a year, which places them in the context of being a unique resource in the region. Potential impacts of the combined activities associated with oil and gas exploration considered under Alternative 2 on bowhead whales would likely be of medium to high intensity, interim to long-term duration, and on a local to regional geographic scale. Evaluated collectively, and with consideration given to reduced adverse impacts through the implementation of the standard mitigation measures, as appropriate, the overall impact to bowhead whales is likely to be moderate.

Table 4.5-20 Effects Summary for Bowhead Whales

Type of effect	Impact Component		Effects Summary
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Lower to moderate levels of activity within this Alternative (akin to recent years) would not result in disturbance of> 30% of population disturbed
		High	Impacts from max level activity expected to exceed take of 30% of population
	Duration	Temporary	At the lower levels of this Alternative, effects are closer to temporary - could be only couple smaller activities with short-term effects on individuals – and possible could be years with none
		Interim	In most Alternative configurations, all activity types last multiple months and some level of activities are recurring over multiple successive years. Effects to individuals could occur acros multiple months, though less likely for bowheads that migrate through.
		Long-term	
	Geographic Extent	Local	When the total area ensonified above the behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14b), the impacts are local.
		Regional	
		State-wide	
	Context	Common	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding and resting
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS to small number of individuals
		High	
	Duration	Temporary	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	
		Important	ESA-listed species, but population is increasing
		Unique	
Habitat alterations	Magnitude or Intensity	Low	Impacts to most habitat features are low in intensity
		Medium	Impacts to acoustic habitat are of medium intensity (~28% of EIS area ensonified over 120 dB, up to 98% lost listening area in some areas of Beaufort, and up to 20% lost bowhead communication space in some areas of Beaufort)
		High	
	Duration	Temporary	
		Interim	At the lower levels of this Alternative impacts are closer to interim, as could be only couple smaller activities – and possible could be years with none
		Long-term	In most Alternative configurations, all activity types last multiple months and some level of activities are recurring over multiple successive years.
	Geographic Extent	Local	It is possible that very low-level versions of this Alternative may result in only local effect.
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists), most scenarios will likely result in regional effects.
		State-wide	
	Context	Common	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding and resting

4.5.2.4.11 Beluga Whales

This section describes the potential effects of Alternative 2 to beluga whales. This information is in addition to the information provided in Sections 4.5.2.4.1 through 4.5.2.4.9, which is applicable to marine mammals more generally. Here, we include information specific to beluga whales.

4.5.2.4.11.1 Direct and Indirect Effects

The primary direct and indirect effects on beluga whales from activities associated with oil and gas exploration in the Beaufort and Chukchi seas considered under Alternative 2 would result from noise exposure. Ship strikes and habitat degradation are also possible. Sources of noise include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs. Details of these activities and associated components can be found in Chapter 2.

Behavioral Disturbance

2D/3D Seismic Surveys (July through November)

Anthropogenic noise from oil and gas exploration activities may elicit behavioral responses from beluga whales. The possible reactions by marine mammals are listed above; known reactions by beluga whales are included here and described and assessed by region and activity. Most of these mechanisms are common to both seas, and these potential effects are discussed together. Where activities or mechanisms are unique to one sea or the other, they are discussed separately. Beluga whales are observed in both seas. Vessels associated with the exploration activities identified in Chapter 2 introduce sound into the water and have a physical presence that could affect beluga whales. Although many of these vessels carried PSOs in the past, beluga whales are rarely seen from these vessels, particularly in the Chukchi Sea.

Miller et al. (2005) reported, based on observations collected during two years of seismic studies in the Beaufort Sea, that beluga whale sightings were unexpectedly high 20-30 km (12.4-18.6 mi) from the seismic vessel, and substantially lower 10-20 km (6.2-12.4 mi) from the vessel, indicating that whales may be avoiding operations by 10-20 km (6.2-12.4 mi). Studies of captive beluga whales have shown that they exhibit changes in behavior when exposed to strong, pulsed sounds similar in duration to those used in seismic surveys (Finneran et al. 2002a), but the received sound levels were relatively high before aversive behaviors were observed (peak to peak level >200 dB re 1 μPa). Behaviors such as vocalizing after the exposure and reluctance to station at the test site were observed (Finneran et al. 2002a). Similar behaviors were observed by a beluga whale exposed to a single underwater pulse similar to those produced by distant underwater explosions (Finneran et al. 2000). The applicability of these observations in trained, captive beluga whales exposed to a single transient sound to the natural environment of free-ranging animals exposed to multiple pulses over time, is unknown.

Most of the energy from airgun arrays is below 100 Hz, which is below the frequencies of calling and best hearing of beluga whales, however, behavioral observations indicate that they are not insensitive to sounds produced by these activities.

Anticipated impacts of 2D/3D surveys would be expected to be of medium magnitude (behavioral disturbance, but less than 30% of population affected), interim duration (between 1 and 6 months, and potentially not always occurring every year), local extent (not spanning more than 10% of the EIS area), and common to important context as, although beluga whales are not ESA-listed, industry activities will overlap with some areas of importance for belugas.

In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

While not many studies have been conducted to evaluate the potential interference of icebreaking noise with marine mammal vocalizations, a few studies have looked specifically at icebreaking noise and beluga whales. Erbe and Farmer (1998) reported that the Canadian Coast Guard ship, *Henry Larsen*, ramming ice in the Beaufort Sea, masked recordings of beluga vocalizations at a signal-to-noise ratio of 18 dB. At least six of 17 groups of beluga whales appeared to alter their migration path in response to underwater playbacks of icebreaker sound (Richardson et al., 1995). Received levels from the icebreaker playback were estimated at 78-84 dB in the 1/3-octave band centered at 5,000 Hz, or 8-14 dB above ambient. If beluga whales reacted to an actual icebreaker at received levels of 80 dB, reactions would be expected to occur at distances on the order of 6.2 mi (10 km). Finley et al. (1990) also reported beluga avoidance of icebreaker activities in the Canadian High Arctic at distances of 22-31 mi (35-50 km). In addition to avoidance, changes in dive behavior and pod integrity were also noted. However, an in-ice seismic survey cannot be conducted in ice thick enough to require ramming to break it up.

Erbe and Farmer (2000) modeled zones of impact for the bubbler system noise in addition to the propeller cavitation (ramming) noise. The propagation model predicted that icebreaker bubbler system noise could mask beluga whale communication out to 14 km (8.7 mi) from the vessel over the continental slope, as measured near the surface. The modeled zone of behavioral disturbance for the bubbler system noise extended to approximately 32 km (19.9 mi). Based on historical modeled estimates, in-ice surveys likely result in a larger number of harassed belugas than other activity types.

While Finley and Green (1993) observed belugas reacting to icebreaking from 50 km away, the same rule cannot be perfectly applied to ice management, which is the ice-related activity typically anticipated during the open water season. Unlike ice-breaking, which relies on an icebreaker ship smashing through areas of sea ice, ice management involves pushing or diverting ice away from operations at a relatively slow speed. Consequently ice management activities are expected to be much “quieter” than ice breaking activities, resulting in a much smaller area of effects on beluga whales. Though similar in that they both involve the use of ships with icebreaking capabilities, the two activities are very different, as are the disturbances created by these different activities.

Anticipated impacts of in-ice seismic surveys (2D/3D) with icebreaker support, in terms of magnitude (medium), duration (interim), extent (local), and context (important) would be generally similar to those described for 2D/3D seismic surveys above.

Ocean-Bottom-Cable or Node Survey (July to October)

An OBC/OBN seismic survey typically covers a smaller area than the streamer surveys discussed above and may spend several days in an area. One such survey is anticipated in the Beaufort Sea under Alternative 2. Beluga whales are present throughout the Beaufort Sea during this time period and may be concentrated in nearshore areas. Reactions to sounds from OBC/OBN surveys are similar to those reported for 2D/3D steamer seismic surveys. Anticipated impacts of OBC/OBN surveys, in terms of magnitude (medium), duration (interim), extent (local), and context (important) would be similar to those described for 2D/3D seismic surveys above. Although disturbance effects may extend 20 to 30 km (12.4 to 18.6 mi) from the sound source, with one OBC/OBN survey anticipated in the Beaufort Sea, short-term effects should remain local.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

High-resolution shallow hazards surveys are of short duration, and the airguns generate lower energy sounds and have a smaller zone of influence than the larger airgun arrays used for 2D/3D seismic surveys (NMFS 2010b). The radii of ensonification at 120, 160, 180, and 190 dB re 1 μPa rms were calculated for sound sources proposed for use in 2010. Radii calculated for the 40 in^3 airgun were 14,000 m (45,932 ft), 1,220 m (4,003 ft), 125 m (410 ft), and 35 m (115 ft) for the respective sound source levels. The beam widths of these sources are quite narrow, which would only expose marine mammals to the sounds for one or two pulses at most if the animal swims in the direct beam width of the source. Ensonified zones were not calculated for side scan sonar, single-beam or multi-beam echosounders, or for the bathymetric sonar (NMFS 2010b). The higher frequency sub-bottom profilers, side scan sonar, and echosounders often produce sounds at high enough energy to result in disturbance, to beluga whales. Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 s tonal signals at frequencies similar to those emitted by some of these higher frequency sound sources and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt et al. 2000, Finneran et al. 2002a, Finneran and Schlundt 2004). Based on some recent reports (Southall et al. 2013), NMFS recognizes that these types of sound sources can sometimes result in behavioral responses that rise to the level of take. NMFS will take this into consideration when analyzing MMPA requests that include the use of such equipment.

Based on results of noise studies on captive and wild populations of beluga whales, belugas would likely avoid the area directly around the shallow hazard operations using the higher frequency equipment, resulting in a temporary, local effect. If such types of shallow hazard operations were conducted in areas where belugas are feeding or nursing, continued operations may result in displacement from these important habitats. Anticipated impacts of these surveys are similar to those of 2D/3D surveys, but lower in magnitude and extent, and are generally characterized as: magnitude (low), duration (interim), extent (local), and context (common to important) would be similar to those described for 2D/3D seismic surveys above.

On-ice Vibroseis Survey (January to May)

Beluga whales are not likely to experience impacts resultant from an on-ice survey due to their absence from the Beaufort Sea during the winter months. If, however, the activity continues into April and May, it could coincide with the spring migration of the Beaufort Sea stock.

Exploratory Drilling (July through October)

Reactions of beluga whales to drillship operation sounds vary. As summarized in Richardson et al. (1995), belugas are often observed near drillsites within 100 to 150 m (328.1 to 492.1 ft) from artificial islands, which are production islands and are different than exploratory drilling platforms. However, belugas swimming in the spring leads change course when they came within 1 km (0.62 mi) of a drillship and exhibited aversive behavior when support vessels were operating near the drillship (Richardson et al. 1995). Reactions of belugas (captive and wild) to playbacks of the semisubmersible drillship *SEDCO 708* indicate that belugas exhibit slight avoidance reactions to drillship sounds (Richardson et al. 1995). Furthermore, belugas may not be able to detect the lower frequency sounds of drillships, which usually emit sounds below 1 kHz because they are below their best hearing sensitivity.

Exploration activities (including anchor handling and drilling) in the Beaufort Sea in 2012 occurred on the continental shelf. Belugas sighted from aerial surveys during these activities were off the shelf break, outside of the soundscape created for acoustic analysis (LGL Alaska Research Associates, Inc. et al. 2013). If calculated out to the location of the beluga sighting, the exposure level would have been between 100 and 103.7 median SPL [dB re 1 μPa (rms)], the same median SPL for beluga sightings in the absence of industrial activity in the area. Industrial sound levels to which beluga whales along the shelf break are exposed during drilling activity in the Beaufort Sea are, therefore, similar to typical ambient sound levels in the Beaufort Sea (LGL Alaska Research Associates, Inc. et al. 2013).

Anticipated impacts of exploration activities to beluga whales are likely to be medium in terms of magnitude, interim in duration, local in extent, and important in context.

Associated Vessels and Aircraft

Helicopter noise may be a source of disturbance to beluga whales, particularly during exploratory drilling crew transfers. During spring migration in the Beaufort Sea, beluga whales reacted to helicopter noise more frequently and at greater distances than did bowhead whales (Patenaude et al. 2002). Most reactions occurred when the helicopter passed within 250 m (820 ft) lateral distance at altitudes <150 m (492 ft). Neither species exhibited noticeable reactions to single passes at altitudes >150 m (492 ft). Belugas within 250 m (820 ft) of stationary helicopters on the ice with the engine running showed the most overt reactions. Whales were observed to make only minor changes in direction in response to sounds produced by helicopters, so all reactions to helicopters were considered brief and minor. Patenaude et al. (2002) noted that fewer belugas reacted to a Twin Otter than to a helicopter (3.2% instead of 38%).

Lesage et al. (1999) report that beluga whales changed their call type and call frequency when exposed to vessel noise. Beluga whales have been documented swimming rapidly away from ships and icebreakers in the Beaufort Sea when a ship approached to within 35 to 50 km (21.7 to 31.1 mi) and received levels ranged from 94 to 105 dB re 1 µPa in the 20 to 1,000 Hz band, and they may travel up to 80 km (49.7 mi) from the vessel's track (Finley et al. 1990). In addition to avoidance, changes in dive behavior and pod integrity were also noted.

Anticipated impacts of vessels and helicopters, are considered low in magnitude, interim in duration, and important in context. The extent of the impact would depend on the number of support vessels in an area, but, for individual activities, impacts are expected to be local. Multiple activities in one area or in several areas across the migratory corridor could result in a broader, regional impact.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential hearing impairment, injury, or mortality of beluga whales due to oil and gas exploration activities are hearing loss or damage (auditory injury) and collisions with vessels.

Auditory Impairment

Noise-induced threshold shift, including TTS and PTS, is described in Section 4.5.2.4.

NMFS currently considers the appropriate metric for TTS levels to be the rms received level, which is typically 10 to 15 dB higher than the SEL for the same pulse, therefore, a single airgun pulse would need to have a received level of ~196 to 201 dB to result in a brief, mild TTS in beluga whales. As also noted, NMFS is considering revisions to these injury thresholds, although even with the changes, the 180-dB rms mitigation zone is still expected to protect mid-frequency hearing specialists from potential injury.

As reported in the Section 4.5.1.4 (Acoustics), distances to the 180 dB rms received level from various sizes of airgun arrays are <2,570 m (8,432 ft). Therefore, TTS would be expected if beluga whales remained within this distance from the source vessel during airgun operations. However, beluga whales have been observed to avoid seismic vessels. Some beluga whales summering in the Eastern Beaufort Sea may have avoided the area around seismic program using 2 arrays with 24 airguns per array by 10 to 20 km (6.2 to 12.4 miles), although some occurred as close as 1,540 m (5,052 ft) to the operations (Miller et al. 2005). Based on these observed reactions, the likelihood of beluga whales being exposed to adverse sound levels is low. Recent seismic monitoring studies have confirmed that belugas remained further away from seismic operations than has been shown for other odontocetes (Harris et al. 2007).

Researchers have derived TTS information for odontocetes from studies on the bottlenose dolphin and beluga. For the harbor porpoise tested, the received level of airgun sound that elicited onset of TTS was lower (Lucke et al. 2009). If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (cf. Southall et al. 2007). Some cetaceans apparently can incur TTS at considerably lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin Utilizing the evoked-potential technique in captive animals, Popov et al. (2013) tested two belugas for temporary threshold shift (TTS) after exposure to loud noise.

This fatiguing noise had a 0.5 octave bandwidth, with center frequencies ranging from 11.2 to 90 kHz, a level of 165 dB re.1µPa and exposure durations from 1 to 30 min. The highest TTS with the longest recovery duration was produced by noises of lower frequencies (11.2 and 22.5 kHz) and appeared at a test frequency of +0.5 octave. At higher noise frequencies (45 and 90 kHz), the TTS decreased. The TTS effect gradually increased with prolonged exposures ranging from 1 to 30 min. These authors found considerable TTS differences between the two whales tested.

Section 4.2.6.3 outlines NMFS final revisions to auditory injury thresholds. NMFS applied these thresholds to the types of sources analyzed in this EIS (seismic airguns and drilling sources of similar size) and found that the resulting distances at which injurious exposures could not be ruled out (i.e., those at which PTS might be incurred) were similar to those calculated using the 180 and 190-dB historical thresholds for low-frequency specialists and phocids, but were actually notably smaller for mid-frequency cetaceans and otariids. As noted previously, most individual marine mammals are expected to avoid loud sounds at distances that would prevent PTS, and standard mitigation measures to shut down airguns if individuals approach within distances associated with injurious effects are expected to help minimize effects. That said, the potential for PTS cannot be ruled out but is considered *highly* unlikely to occur for mid-frequency cetaceans and otariids.

Exploratory drilling activities are not anticipated to induce TTS or PTS, as source levels for the drill ship and other equipment are typically between 175 and 185 dB re 1 µPa rms.

Ship Strikes

Marine vessels could potentially strike beluga whales, causing either injury or death. Incidence of ship strikes are currently low but could rise with increasing vessel traffic.

The frequency and severity of ship strikes is influenced by vessel speed. The potential for collision increases at speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). Most source vessel speeds are relatively slow (approximately 3 to 5 kn) during oil and gas exploration activities. Transit speeds, however, are likely to be much higher. Seismic survey source vessel transit speeds are, for example, estimated at 8 to 20 kn (refer to Chapter 2, Alternatives for details), suggesting that, if collisions were to occur, they are more likely when vessels are in transit. Vessels transiting to the Beaufort or Chukchi seas from Dutch Harbor at the start of the open water season, or returning across these areas to the Bering Strait at the end of the season, transiting between sites, or for resupply in and out of Nome or Wainwright in the Chukchi Sea or Prudhoe Bay in the Beaufort have the highest chance of encountering migrating and feeding beluga whales. Based on the required standard mitigation measures, impacts from vessel strikes are considered unlikely.

Small Fuel Spill

There is the potential for beluga whales to be exposed to small fuel spills of less than 50 bbl (see Section 4.2.7). However, few beluga whales are anticipated to occur in the vicinity of oil and gas activities and few would be exposed to a spill. Moreover, if a small spill were to escape containment or response measures, it would dissipate over a few days, resulting in few opportunities to contact beluga whales. Also, vessel activity associated with spill response would likely keep beluga whales out of the spill area, and individual whales would likely avoid the spill by leaving the area during spill response activities. Small spills are anticipated to have no more than a negligible level of effect on beluga whales.

Habitat Alteration

Alterations to marine mammal habitat could occur through physical changes, such as to the substrate or sea ice, pollution in the water column, alterations to prey species, or impacts on acoustic habitat relied upon by marine mammals for communication and other functions. This subsection describes the potential impacts of the various activity types on bowhead whale habitat (in the broader sense mentioned here).

Oil and gas exploration activities that may result in the alteration of beluga whale habitat include drill cuttings and drilling mud discharges from exploratory drilling. The impact of drill cuttings and drilling mud discharges would be local and temporary. Drill cuttings and mud discharges could temporarily displace marine mammals a short distance from the drilling location. Based on a hypothetical EPA model in the Beaufort and Chukchi seas, the potential source of an impact, the discharged drilling fluid is diluted to the extent that any impacts would be minimal and temporary, due to the whale's motility, assuming that the animal continues to swim through the discharge plume (Shell 2011a).

Discharges related to drilling would occur and, if released into the marine environment, effects would remain local in extent in relation to affecting whale habitat and prey populations. The effects of such discharges are anticipated to remain local as a result of rapid deposition and dilution and potential contamination (if toxic contaminants are present in discharges) of an extremely small proportion of the habitat or the prey base available to beluga whales; thus, population-level effects would be negligible, although interim in duration.

Additionally, the acoustic habitat, within which whales use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the frequency bands of the signals of interest for the whales. Depending on the level, frequency, and duration of these sounds, these acoustic habitat alterations can result in reduced ability to detect or interpret important sounds.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order aggregate and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments on the DEIS and SEIS. Broadly, results suggest that even with the lower predicted activity levels in Alternative 2, substantial losses of listening area (up to 98%) will occur in the Beaufort Sea area from July-mid-October. As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area can negatively affect aquatic animals. And, while data are lacking to document links to population consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animal's ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered.

Acoustic impacts to beluga whale habitat are determined to be medium in magnitude, interim in duration, local in extent, and important in context.

4.5.2.4.11.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

Oil and gas exploration activities in the Beaufort and Chukchi seas, as analyzed under Alternative 2, would likely cause behavioral disturbance to beluga whales, including varying degrees of disturbance to feeding, calving, or migrating whales depending on actual level and location of effort, type of activity, time of year, and whether activities run concurrent in the Beaufort and Chukchi seas. Disturbance could lead to displacement from and avoidance of areas of exploration activity. The EIS project area encompasses a large portion of beluga whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not likely. The duration of disturbance, and acoustic habitat disturbance, from oil and gas activities is expected to be of interim to long-term duration, lasting less than six months, but repeating over multiple successive years. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities. The extent of the impact will depend on the number of exploration activities and associated support vessels in an area, but all though impacts are expected to be local in the context of behavioral disturbance, they will likely be regional in the context of habitat alteration when acoustic habitat is considered.

Because whales respond behaviorally to loud noise, and because of the required standard mitigation measures, they are less likely to suffer auditory damage from increased noise due to oil and gas exploration activities. Of note also, although they still respond to these sources, the low frequency sounds from most exploration activities are outside of the range of highest hearing sensitivity for belugas and less likely to overlap with important interspecies communication. The magnitude of impacts is moderate. Additionally, based on the required standard mitigation measures, impacts from vessel strikes are considered unlikely.

Beluga whales in the Arctic are not listed under the ESA. They have feeding and calving areas that are important to the populations, making their context important for behavioral disturbance and habitat alterations.

The intensity and duration of the various effects and activities considered are mostly medium and interim. However, potential long-term effects from repeated disturbance are unknown. Currently, population trends for the Beaufort stock cannot be estimated and are not thought to be declining in the Chukchi stock. Although, individually, the various activities may elicit local effects on beluga whales, the area and extent of the population over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of the Arctic populations. The summary impact level of Alternative 2 on beluga whales would be considered moderate.

Table 4.5-21 Effects Summary for Beluga Whales

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed
		High	
	Duration	**Temporary**	At the lower levels of this Alternative effects are closer to temporary - could be only couple smaller activities with short-term effects on individuals – and possible could be years with none
		Interim	In most Alternative configurations, all activity types last multiple months and some level of activities are recurring over multiple successive years. Effects to individuals could occur across multiple months.
		Long-term	
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14b), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	Not ESA-listed. Population status not well known for Chukchi but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas, and wide migratory corridor likely not heavily impacted by activities.
		Important	Some activities may overlap known migratory corridor, and activities may occasionally impact important feeding areas.
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death highly unlikely
		Medium	Though highly unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Long-term	Though highly unlikely, PTS would be permanent if incurred.
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Not ESA-listed, populations not thought to be decreasing
		Important	
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	**Low**	Impacts to most habitat features are low in intensity
		Medium	When acoustic habitat impacts are considered, magnitude is medium (~28% of EIS area ensonified over 120 dB, up to 98% lost listening area in some areas of Beaufort).
		High	
	Duration	**Temporary**	
		Interim	At the lower levels of this Alternative impacts are clser to interim, as could be only cople smaller activities – and possible could be years with none
		Long-term	In most Alternative configurations, all activity types last multiple months and some level of activities are recurring over multiple successive years.
	Geographic Extent	**Local**	It is possible that very low-level versions of this Alternative may result in only local effects.
		Regional	When the total area ensonified above 120 dB by all sources is considered (used to indicate where animals will hear it and potential for masking exists), most scenarios will result in regional effects.
		State-wide	
	Context	**Common**	Not ESA-listed. Population status not well known for Chukchi but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas, and wide migratory corridor likely not heavily impacted by activities.
		Important	Some activities may overlap known migratory corridor, and activities may occasionally impact important feeding areas.
		Unique	

4.5.2.4.12 Other Cetaceans

This section discusses the potential direct and indirect effects of Alternative 2 on Other Cetaceans, excluding bowhead and beluga whales. Bowhead whales and beluga whales are addressed individually in Section 4.5.2.4.10 and Section 4.5.2.4.11, respectively, as they are both important subsistence species and common in the EIS project area. Other Cetaceans include all other cetaceans known to frequent the EIS project area and have been combined into two groups: baleen whales and toothed whales. The baleen whales include gray, humpback, fin, and minke whales, while the toothed whales include harbor porpoises, killer whales, and narwhals. Cetaceans are a diverse group with varied life histories and migratory patterns (see Chapter 3, Section 3.2.4.2 for more information). However, they share many important traits and exhibit similar physiological and behavioral responses. Each group is analyzed collectively where appropriate, as the individual species within each group share many similar characteristics which correlate with potential impacts from offshore oil and gas exploration activities. Where sufficient research exists for species-specific analysis, or unique effects or susceptibilities exist, individual species have been discussed separately. Greater emphasis in this section is on gray whales, as they are both common and numerous, particularly in the northeast Chukchi Sea portion of the project area. Most other species included here are infrequently observed.

4.5.2.4.12.1 Direct and Indirect Effects

In general, potential direct and indirect effects on Other Cetaceans resulting from exploration activities in the Beaufort and Chukchi seas authorized under Alternative 2 are similar to those discussed for bowhead whales (Section 4.5.2.4.10) and beluga whales (Section 4.5.2.4.11). The primary direct and indirect effects on other cetaceans would result from noise exposure. Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs. Details of these activities and associated components can be found in Chapter 2. For a general discussion of the types of effects of oil and gas exploration activities can have on marine mammals, see Section 4.5.2.4.

Behavioral Disturbance

Anthropogenic noise from oil and gas exploration activities has been shown to elicit behavioral responses from baleen and toothed whales. These responses include subtle changes in behavior, more conspicuous changes in activities, and displacement. Observable reactions of marine mammals to sound include attraction to the sound source, increased alertness, modification to their own sounds, cessation of feeding or interacting, alteration in swimming or diving behavior (change direction or speed), short or long-term habitat abandonment (deflection, short or long-term avoidance), and, possibly, panic reactions, such as stranding (Nowacek et al. 2007, Richardson et al. 1995, Southall et al. 2007, 2013). Most research on oil and gas exploratory activities have focused on the effects from seismic surveys. Although this research can also be applied to other activities covered in this EIS, the analyses of these other activities is therefore lacking in comparison.

2D/3D Seismic Surveys (July through November)

Baleen Whales (gray, humpback, fin, minke): Airgun arrays are the most common source of seismic-survey noise and would be employed for most exploratory activities. Baleen whales generally avoid operating airguns, but avoidance distances vary by species, locations, behavioral activities, as well as environmental conditions that influence sound propagation (Richardson et al. 1995, Gordon et al. 2004, Bain and Williams 2006). Some research has shown that airguns can interrupt feeding behavior in gray whales. Malme et al. (1986) studied the responses of feeding eastern gray whales to pulses from a single 100 in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50 percent of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 μPa, and that 10 percent of feeding whales interrupted feeding at received levels of 163 dB. However, findings in Russia and British Columbia have shown that gray whales have no apparent change in feeding patterns resulting from seismic surveys (Yazvenko et al. 2007, Bain and Williams 2006).

Studies examining the response of humpback whales to seismic surveys during migration and at summer feeding grounds have likewise observed very few effects. Limited avoidance is the primary reaction, with avoidance behavior first noted at distances of 4 to 8 km (2.5 mi to 5 mi) from the sound source, with stand-off ranges of 7 to 12 km (4.3 mi to 7.5 mi) noted for sensitive resting pods including cow-calf pairs (McCauley et al. 2000, Malme et al. 1986, Weir 2008). Typically, pods with females showed greater avoidance behavior than pods without. Malme et al. (1986) found that humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64 L (100 in^3) airgun and concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects.

Fin whales have also been shown to demonstrate very little behavioral change resulting from seismic surveys. Sightings by observers on seismic vessels during many large-source seismic surveys off the U.K. from 1997 to 2000 suggest that, during times of good visibility, sighting rates for fin and sei whales were similar when large arrays of airguns were shooting versus when they were silent (Stone 2003, Stone and Tasker 2006). However, the whales did exhibit localized avoidance, remaining farther from the airgun array during seismic operations compared with non-seismic periods and were more likely to swim away from the vessel than in any other direction while shooting (Stone and Tasker 2006). Baleen whales, as a group, were more often oriented away from the vessel while a large airgun array was shooting compared with periods of no shooting (Stone and Tasker 2006). In addition, fin and sei whales were less likely to remain submerged during periods of seismic shooting (Stone 2003). In contrast to the general trend of avoidance, minke whales have occasionally been observed to approach active airgun arrays where received sound levels were estimated to be near 170–180 dB re 1 μPa (MacLean and Haley 2004). This example highlights the variation in behavior between species and individuals within populations.

Behavioral effects on baleen whales from 2D/3D seismic surveys are therefore expected to result primarily in avoidance. Gray whales are the only baleen whale regularly observed within the EIS project area. Should any interactions occur, effects on gray whales would be of medium intensity, interim to long-term duration (because repeated over successive years) duration, local to regional in extent, and important in context. The summary impact level for gray whales would therefore be minor. For ESA-listed baleen whales (fin and humpback whales), should any interactions occur, effects would be of low to medium intensity, temporary to interim duration, local in extent and unique in context. Impact levels for minke whales would be similar except the context would be common.

Odontocetes (harbor porpoise, killer whales, narwhals): Toothed cetaceans typically display similar behavior to baleen whales in response to noise generated from seismic surveys. Various studies have shown that toothed whales head away or maintain a somewhat greater distance from the vessel, and stay farther away from seismic sources, during periods of airgun operation versus silent periods (Stone and Tasker 2006, Weir 2008).

Observers' records suggested that fewer cetaceans were feeding and fewer were interacting with the survey vessel (e.g., bow-riding) during periods with airguns operating, and small odontocetes tended to swim faster during periods of shooting (Stone and Tasker 2006). For most types of small odontocetes sighted by observers on seismic vessels, the median observed distance was ≥0.5 km (≥0.3 mi) larger during airgun operations than during silent periods (Stone and Tasker 2006). Killer whales appeared to be more tolerant of seismic shooting in deeper waters.

Porpoises show variable reactions to seismic operations, and reactions depend on species. Limited available data suggests that harbor porpoises show stronger avoidance of seismic operations than Dall's porpoises (Stone 2003, Bain and Williams 2006). In Washington State waters, the harbor porpoise—despite being considered a high-frequency specialist—appeared to be the species affected by the lowest received level of airgun sound (<145 dB re 1 µParms at a distance >70 km [43.5 mi]; Bain and Williams 2006). Similarly, during seismic surveys with large airgun arrays off the U.K. in 1997–2000, there were statistically significant differences in directions of travel by harbor porpoises during periods when the airguns were shooting vs. silent (Stone 2003, Stone and Tasker 2006). A captive harbor porpoise exposed to single sound pulses from a small airgun showed aversive behavior upon receipt of a pulse with received level above 174 dB re 1 µPapk-pk or SEL >145 dB re 1 µPa2 s (Lucke et al. 2009). Harbor porpoises in the North Sea reacted to 2D seismic survey noise from a 470 in^3 array (received peak-to-peak SPL of 165–172 dB re 1 µPa and SELs 145–151 dB re 1 $\mu Pa^2 s^{-1}$) over distances of 5-10 km. Porpoises were, however, detected again within a few hours and the response level decreased throughout the ten day survey period, suggesting that prolonged seismic survey noise of this type did not result in long-term displacement (Thompson et al. 2013). Thompson et al. (2013) further note that whether or not the porpoises detected after displacement were the same as those displaced is not known and that stronger responses may occur in areas that lack the long history of industrial activity and anthropogenic noise as in the North Sea. The extent to which displacement occurs could relate to habitat quality, with displacement less likely to be prolonged in high quality compared to lower quality habitats (Thompson et al. 2013). In contrast, Dall's porpoises seem relatively tolerant of airgun operations, although they too have been observed to avoid large arrays of operating airguns (Bain and Williams 2006). The apparent tendency for greater responsiveness in the harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson et al. 1995, Southall et al. 2007).

Behavioral effects on toothed whales from 2D/3D seismic surveys are therefore expected to result primarily in avoidance. Due to the limited distribution of toothed whales (except for belugas) within the EIS project area, there is a low likelihood of these encounters occurring. Should they occur, effects would be of low intensity, temporary to interim duration, local in extent, and common in context. The summary impact level would therefore be negligible to minor.

On-ice Vibroseis Survey (January to May) and In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

Winter exploratory activities, including on-ice vibroseis surveys, are not likely to overlap with baleen whale presence due to their southern migration for the winter months. Although toothed whales do not migrate as far as baleen whales, they are not typically associated with sea ice. Any activities occurring on or above sea ice would therefore be unlikely to impact either group. Should in-ice seismic surveys with icebreaker support overlap with whale or porpoise presence, effects would be similar to those described for summer seismic survey activities, described above.

Ocean-Bottom-Cable or Node Survey (July to October)

The areas within the EIS project area meeting these criteria are primarily the nearshore waters of the Beaufort Sea. Therefore, gray whales and harbor porpoise are the only species that might be exposed to any effects from these types of surveys, as all other species are so rarely observed in that region. Gray whales are more common along the northeast Chukchi Sea coast to Barrow Canyon, with only small numbers sighted east of Point Barrow in recent years. Past surveys of this type have typically not encountered any baleen whales (73 FR 40529, July 15, 2008; Lomac-MacNair et al. 2015).

Reactions to sounds from OBC/OBN surveys would be similar to those reported for 2D/3D steamer seismic surveys. Limited research has been conducted on the effects of OBC/OBN surveys on baleen whales, focusing exclusively on bowheads. Observed behavioral effects include deflection and avoidance (Miller et al. 1999, Richardson et al. 1999). The open water season of July to October, during which OBC/OBN surveys are likely to occur, coincides with summer feeding and late-summer/fall migration periods for gray whales in the Chukchi Sea and, to a lesser extent, Beaufort Sea. Anticipated impacts of OBC/OBN surveys, should any interactions occur, effects on gray whales would be of low intensity, interim duration, local in extent, and important in context. The summary impact level for gray whales would therefore be minor. For ESA-listed baleen whales (fin and humpback whales), should any interactions occur, effects would be of low intensity, interim duration, local in extent, and unique in context. Impact levels for minke whales would be similar except the context would be common. The summary impact level for all non-ESA-listed baleen whales would therefore be minor. Impacts would be similar to those described for 2D/3D seismic surveys above. Although disturbance effects may extend 20 to 30 km (12.4 to 18.6 mi) from the sound source, with only one OBC/OBN survey anticipated in the Beaufort Sea, short-term effects would remain local.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

High-resolution shallow hazards surveys are of short duration, and the airguns generate lower energy sounds and have a smaller zone of influence than the larger airgun arrays used for 2D/3D seismic surveys (NMFS 2010b). The radii of ensonification at 120, 160, 180, and 190 dB re 1 μPa rms were calculated for sound sources proposed for use in 2010. Radii calculated for the 40 in^3 airgun were 14,000 m (45,932 ft), 1,220 m (4,003 ft), 125 m (410 ft), and 35 m (115 ft) for the respective sound source levels. Ensonified zones were not calculated for side scan sonar, single-beam or multi-beam echosounders, or for the bathymetric sonar (NMFS 2010b), as many of these sources are outside the range of best hearing for mysticetes and possibly for other marine mammals. Additionally, as mentioned above, the beam widths of these sources are quite narrow, which would only expose marine mammals to the sounds for one or two pulses at most if the animal were to swim in the direct beam width of the source.

The limited sound levels combined with the low frequency of most cetaceans within the anticipated survey area result in a low likelihood of any adverse effects occurring. Any effects would be similar to those resulting from 2D/3D seismic surveys, but likely of a lower magnitude.

Exploratory Drilling (July through October) and Associated Vessels and Aircraft

Humpbacks whales respond behaviorally to anthropogenic noises, including vessels, aircraft, and active sonar (Richardson et al. 1995, Frankel and Clark 2000). Responses include alterations of swimming speed and decreased surface blow rates. Gray whales have also been shown to deflect from their course when exposed to industrial noise. Up to 50 percent of migrating gray whales deflected from their course when the received level of industrial noise reached 116-124 dB re 1 μPa, and disturbance of feeding activity may occur at sound levels as low as 110 dB re 1 μPa (Malme et al. 1986).

Most exploration activities in the Chukchi Sea occur offshore of the larger, coastal concentrations of gray whales. Acoustic measurements suggest that sounds from these activities reach background levels before reaching the areas of highest gray whale concentrations. In 2012, seven gray whales were sighted where sounds from industry vessels were ≤110 median SPL [dB re 1 μPa (rms)], two gray whales were sighted during active drilling in locations where industrial sounds were ≤105 median SPL [dB re 1 μPa (rms)], and two gray whale sightings occurred during ice management activities in locations where vessel sounds were <105 median SPL [dB re 1 μPa (rms)] (LGL Alaska Research Associates, Inc. et al. 2013). Although gray whales are less likely to be directly impacted by exploration activity sounds in Lease Sale 193, they could be impacted by increased vessel traffic transiting to and from the lease sale area and near the coast where they commonly feed during the open-water season (LGL Alaska Research Associates, Inc. et al. 2013).

Studies of behavioral reactions of whales to aircraft are limited, but indicate that whales react little, if at all, to fixed-wing aircraft operating at an altitude of 460 m (1,509 ft) and that most reactions to helicopters occur when the helicopter was at altitudes of ≤150 m (500 ft) (Patenaude et al. 2002, Richardson and Malme 1993, Richardson et al. 1991, Richardson et al. 1995).

Findings detailing the short-term responses of cetaceans to anthropogenic noises do not necessarily infer information about long-term effects. It is not known whether noises affect reproductive rates or distribution and habitat use in subsequent days or years. However, findings seem to suggest that long-term impacts when taken at a population level, are low in intensity and regional in extent. Despite decades of on-going seismic and vessel traffic in well-known cetacean habitats, gray whales have continued to migrate annually along the west coast of North America (Malme et al. 1986), and bowhead whales have continued to migrate in and out of the eastern Beaufort Sea each summer (Patterson et al. 2007). Furthermore, both populations have increased during this period (Allen and Angliss 2010). As the noise sources are located on moving ships, the brief exposures to sound pulses from the proposed airgun source are highly unlikely to result in prolonged effects. The history of coexistence between seismic surveys and baleen whales also suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects and are therefore considered minor.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential hearing impairment, injury, or mortality of cetaceans due to oil and gas exploration activities are hearing loss or damage (auditory injury) and collisions with vessels.

Auditory Impairment

The potential for seismic airgun pulses to cause acoustic injury in marine mammals, particularly noise induced threshold shift, is not well understood (Gedamke et al. 2011) and data on levels or properties of sound that are required to induce TTS are lacking for baleen whales. Recent simulation models, using data extrapolated from TTS in toothed whales, suggest the possibility that baleen whales 1 km (0.62 mi) or more from seismic surveys could be susceptible to TTS (Gedamke et al. 2011). Noise induced threshold shift, including TTS and PTS, is described in Section 4.5.2.4.

Because baleen whales generally respond to loud noise by moving away, they are less likely to suffer hearing loss from increased noise. They are not likely to remain close enough to a large airgun array long enough to incur PTS. The levels of successive pulses received by a marine mammal will increase and then decrease gradually as the seismic vessel approaches, passes and moves away, with periodic decreases also caused when the animal goes to the surface to breath, reducing the probability of the animal being exposed to sound levels large enough to elicit PTS. Since baleen whales appear to be more tolerant of noise when feeding, work is needed to determine potential effects of repeated exposure to loud noise at distances tolerated in feeding areas. The potential for increased noise to cause physiological stress responses should also be considered, as it is not currently known (NMFS 2011a). Obtaining data on stress responses in large free-swimming whales would require potentially disruptive invasive techniques.

Although data revealing the occurrence of acoustic injury in toothed whales is limited, some studies have found that in general, they are more sensitive than baleen whales. Acoustic testing performed on harbor porpoises have shown that the received level of airgun sound that elicited onset of TTS was lower than for baleen whales. A harbor porpoise was exposed to single pulses from a small (20 in^3) airgun, and auditory evoked potential methods were used to test the animal's hearing sensitivity at frequencies of 4, 32, or 100 kHz after each exposure (Lucke et al. 2009). Based on the measurements at 4 kHz, TTS occurred upon exposure to one airgun pulse with received level ~200 dB re 1 μPapk-pk or an SEL of 164.3 dB re 1 μPa2 s. If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (toothed whales). More recently, Kastlein et al. (2013) exposed a single harbor porpoise to a 1.5 kHz continuous tone at a mean received SPL of 154 dB re 1 lPa for 60min (cumulative SEL was 190 dB re 1 lPa2 s). TTS was measured at 1.5, 2, 4, 6.5, 8, 16, 32, 63, and 125 kHz, although statistically TTS only occurred at 1.5 and 2 kHz. One to four minutes after exposure, mean TTS was ~14 dB at 1.5 kHz and ~11dB at 2 kHz. Recovery occurred within 96 minutes. The hearing thresholds of harbor porpoises at the frequency at which they echolocate are not impacted by intense low frequency sounds, suggesting that these sounds would not affect foraging efficiency. Some cetaceans may incur TTS at lower sound exposures than are necessary to elicit TTS in beluga whales or bottlenose dolphins (Southall et al. 2007).

Section 4.2.6.3 outlines NMFS final revisions to auditory injury thresholds. NMFS applied these thresholds to the types of sources analyzed in this EIS (seismic airguns and drilling sources of similar size) and found that the resulting distances at which injurious exposures could not be ruled out (i.e., those at which PTS might be incurred) were similar to those calculated using the 180 and 190-dB historical thresholds (though actually notably smaller for mid-frequency cetaceans and otariids), meaning that the revisions to the auditory injury thresholds do not notably change any of the conclusions articulated in earlier versions of the EIS. As noted previously, most individual marine mammals are expected to avoid loud sounds at distances that would prevent PTS, and standard mitigation measures to shut down airguns if individuals approach within distances associated with injurious effects are expected to help minimize effects. That said, the potential for PTS cannot be ruled out for low-frequency cetaceans and phocids, though it is considered *highly* unlikely to occur for mid-frequency cetaceans and otariids.

The duration of impact would be temporary for TTS, but permanent if PTS were to occur. The extent of such impacts would be local and the context common to important, depending on the ESA-listing and status of the population.

Ship Strikes

Ship strikes are a major cause of mortality and serious injury in whales in North America (Knowlton and Kraus 2001). In a study of reported ship strikes from 1975 to 2002 (Jensen and Silber 2003), baleen whales were the most commonly struck; fin, humpback, gray, and minke whales were four of the five most commonly struck cetaceans. Toothed whales are much less commonly struck, with killer whales the only species identified from that group, in addition to being the least commonly struck of all 12 species identified.

The frequency and severity of ship strikes is influenced by vessel speed. The potential for collision increases at speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). Most source vessel speeds are relatively slow (approximately 3 to 5 kn) during oil and gas exploration activities. Transit speeds, however, are likely to be much higher. Seismic survey source vessel transit speeds are, for example, estimated at 8 to 12 kn (see Chapter 2, Alternatives for details), suggesting that, if collisions were to occur, they are more likely when vessels are in transit.

The reported incidence of ship strikes is low, but, since collisions have occurred in the past, the intensity of the effect should be considered medium. The likelihood of other types of injury arising from the described activities is low. The duration would be temporary to long-term for the impacted whale, depending on the injury. The extent of the effect would be local, given the infrequency of occurrence and the non-random distribution of both cetaceans and exploration activity in the EIS project area. The summary impact level resulting from hearing impairment, injury, or mortality is therefore minor for non-ESA-listed species and moderate for ESA-listed species.

Small Fuel Spill

There is the potential for other cetaceans to be exposed to small fuel spills of less than 50 bbl (see Section 4.2.7). The potential effects of a small fuel spill (<50 bbl) on other cetaceans are anticipated to be the same as those described for bowhead whales. No more than a negligible level of effect is anticipated. The potential effects of a very large oil spill are discussed in Sections 4.10.6 and 4.10.7.

Habitat Alterations

Alterations to marine mammal habitat could occur through physical changes, such as to the substrate or sea ice, pollution in the water column, alterations to prey species, or impacts on acoustic habitat relied upon by marine mammals for communication and other functions. This subsection describes the potential impacts of the various activity types on bowhead whale habitat (in the broader sense mentioned here).

Oil and gas exploration activities that may result in alteration of habitat include drill cuttings and drilling mud discharges from exploratory drilling. Drill cuttings and drilling mud discharges are regulated by the EPA NPDES General Permits or ADEC APDES permit as detailed in Section 4.5.1.5. The impact of drill cuttings and drilling mud discharges would be local and temporary. Drill cuttings and mud discharges could temporarily displace marine mammals a short distance from the drilling site. The EPA modeled a hypothetical 750 bbl/hr discharge of drilling fluids in 20 m (66 ft) of water in the Beaufort and Chukchi seas and predicted a minimum dilution of 1,326:1 at 100 m (330 ft) from the discharge point (Shell 2011a). Discharged drilling fluid should be well diluted within 100 m (330 ft) so that any impacts would be local and temporary assuming that whales continue to swim through and past the discharge plume. If toxic contaminants are present in discharges, only a small area of potential habitat and prey base might be contaminated. Population-level effects would, therefore, be negligible.

Bottom-founded drilling units or gravel islands could impact small areas of benthic habitat that support epibenthic invertebrates that baleen whales feed on, including through increased turbidity or sediment suspension in marine waters. Exploration drilling on past and current leases would add incrementally to potential discharges into the Beaufort and Chukchi seas, but would remain local to areas immediately surrounding exploration drilling activity.

Additionally, the acoustic habitat, within which whales use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the frequency bands of the signals of interest for the whales. Depending on the level, frequency, and duration of these sounds, these acoustic habitat alterations can result in reduced ability to detect or interpret important sounds.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order aggregate and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments on the DEIS and SEIS. Broadly, results suggest that even with the lower predicted activity levels in Alternative 2, substantial losses of listening area (up to 98%) will occur in the Beaufort Sea area from July-mid-October. As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area can negatively affect aquatic animals. And, while data are lacking to document links to population consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered.

4.5.2.4.12.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

Many of the species in this resource group are relatively uncommon within the EIS project area, particularly in the Beaufort Sea. Although fin and humpback whales are endangered, they are very rarely seen in the Chukchi Sea and almost never in the Beaufort Sea. Gray whales are the only species with an established range spanning the entire EIS project area that are encountered with any regularity, especially in the Chukchi Sea. Therefore, the probability of interactions from oil and gas exploration activities is low for most species, with the possible exception of gray whales.

There have been no documented impacts from previous oil and gas exploration activities within the EIS project area. The intensity and duration of the various effects and activities considered are mostly medium and interim. However, potential long-term effects from repeated disturbance are unknown. Although, individually, the various activities may elicit local effects on particular whales, the area and extent of the population over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout the EIS project area.

If seismic operations overlap in time, the zone of seismic influence could potentially be quite large, depending on the number, and the relative proximity of the surveys. The impact to individual gray whales would likely be related to the importance of the food source or resting area to the component of the population that would have utilized it had the disturbance not caused them to avoid the area. This is likely to remain unknown. Potential impacts to the population could be related to the numbers and types of individuals that were affected (e.g., juvenile males versus females with calves) and to the relative importance of the habitats from which they may be excluded.

The potential total adverse effects of long-term added noise, disturbance, and related avoidance of feeding and resting habitat in long-lived species such as whales are unknown. Available information does not indicate any long-term adverse effects on any of the existing cetacean populations resulting from the high level of seismic surveys and exploration drilling during the 1980s in the Beaufort and Chukchi seas. This is likely most relevant to gray whales that have used the Chukchi area, in particular, for a long time, certainly when early OCS activities occurred. Despite vessel and industrial activity throughout much of the range of eastern North Pacific gray whales, the population steadily increased to a level that warranted delisting (Rugh et al. 1999) and may even be approaching carrying capacity (Rugh et al. 2005). Many of the other baleen whales and the harbor porpoise occurrences appear to have increased in recent years and may be possible range extensions.

Sub-lethal impacts on health (such as reduced hearing or increased stress) cannot be measured. There has been no documented evidence that noise from previous OCS operations has served as a barrier to migration or any other spatial use resources within the EIS project area. Because whales respond behaviorally to loud noise, they are less likely to suffer hearing loss from increased noise. However, whales appear to be more tolerant of noise when feeding, and future work is needed to determine potential effects on hearing due to long periods over many years of exposure to loud noise at distances tolerated in feeding areas. Similarly, concern needs to be given to other potential physiological effects of loud noise, including the potential for increased noise to cause physiological stress responses.

Evaluated collectively, and with consideration given to reduced adverse impacts through the implementation of the standard and additional mitigation measures, as appropriate, the overall impact to other cetaceans, not including bowhead and beluga whales, is likely to be minor to moderate. For the most part, effects will be of low to medium magnitude, interim in duration, and local to regional in extent. The resources affected range from common to important, depending on species and type of effect.

Table 4.5-22 Effects Summary for Other Cetaceans

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	**Low**	Possible in low level scenarios that some of the species addressed might not be harassed or disturbed in a given year or few, however, likely that will be in most Alt 2 scenarios.
		Medium	Generally, behavioral disturbance of these species is anticipated for most Alternative 2 scenarios, though not to exceed 30% of the population.
		High	
	Duration	**Temporary**	At the lower levels of this Alternative effects are closer to temporary - could be only couple smaller activities with short-term effects on individuals – and possible could be years with none, plus the lower density of most species.
		Interim	In most Alternative configurations, all activity types last multiple months, and some level of activities are recurring over multiple successive years. Effects to individuals (especially gray whales) could occur across multiple months.
		Long-term	
	Geographic Extent	**Local**	Effects are local
		Regional	
		State-wide	
	Context	**Common**	With the exception of gray and humpback whales, species are considered common.
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death highly unlikely
		Medium	Though unlikely, cannot rule out PTS to small numbers
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	All species but humpbacks common
		Important	Humpbacks are ESA-listed species, with increasing trend
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	**Low**	Impacts to most habitat features are low in intensity
		Medium	When acoustic habitat impacts are considered, magnitude is medium (~28% of EIS area ensonified over 120 dB, up to 98% lost listening area in some areas of Beaufort), especially for gray whales that are low frequency specialists.
		High	
	Duration	**Temporary**	
		Interim	Because of their distribution and comparative lower density, with the exception of a few species, such as gray whales, these impacts are predominantly considered interim because individuals may not be exposed to these activities for many months, and further the same individuals may not be exposed in successive years.
		Long-term	However, for the higher-level scenarios, and for gray whales specifically, effects could be long-term
	Geographic Extent	**Local**	It is possible that very low-level versions of this Alternative may result in only local effects.
		Regional	When the total area ensonified above 120 dB by all sources is considered (used to indicate where animals will hear it and potential for masking exists), most scenarios will result in regional effects, though they are more impactful for gray whales.
		State-wide	
	Context	**Common**	With the exception of gray and humpback whales, species are considered common.
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	

4.5.2.4.13 Ice Seals

4.5.2.4.13.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 2 on four species often collectively called "ice seals:" ringed seal; spotted seal; ribbon seal; and bearded seal. These species are all highly dependent on sea ice for critical life functions, and their seasonal distributions are heavily influenced by seasonal ice movement in Arctic waters. They are treated collectively because they share many similar characteristics which are correlated with potential impacts from offshore oil and gas exploration activities. Where unique effects or susceptibilities exist, individual species are discussed separately.

Potential direct and indirect effects on ice seals from exploration activities authorized under Alternative 2 are similar to those discussed for other cetaceans (Section 4.5.2.4.12) and Pacific walruses (Section 4.5.2.4.14). These include disturbance in water and on the surface of the ice due to sounds and physical movements of vessels and equipment, risks of injury or mortality, and changes in habitat.

Behavioral Disturbance

There are several mechanisms for potential disturbance to ice seals associated with each of the different types of exploration activities considered under Alternative 2. Most of these mechanisms are common to both the Beaufort and Chukchi seas, and these potential effects are discussed together. Where activities or mechanisms are unique to one sea or the other, they are discussed separately.

Marine Vessels

Marine vessels associated with exploration activities all introduce sounds into the marine environment (see Acoustics, Section 4.5.1.4) and have a physical presence that could affect ice seals in the water or on sea ice. Many of these vessels have carried PSOs in the past, and the data they have collected about ice seals and other marine mammals forms the basis of much of this discussion. Ice seals are by far the most commonly observed marine mammals in both the Beaufort and Chukchi seas, with ringed seals making up the majority and ribbon seals being rare (Savarese et al. 2010, Haley et al. 2010a, Bisson et al. 2013, Lomac-MacNair et al. 2014). Seismic surveys often include PSOs on monitoring ships that are deployed at various distances from the seismic source ships, sometimes over 75 km (47 mi) away. Sightings from these ships when they are at great distance from the source vessel or when the seismic arrays are not active (non-seismic conditions) provide a measure of ice seal reactions to typical vessel traffic rather than the seismic source (discussed below). When monitoring ships are traveling under non-seismic conditions, the average closest point of approach to seals ranged from 160 to 180 m (525 to 590 ft) (Savarese et al. 2010, Haley et al. 2010a). Seismic source vessels traveling under non-seismic conditions appear to disturb seals at greater distances, perhaps in part because of their larger physical presence, with the average closest point of approach to seals ranging from 200 to 400 m (556 to 1,312 ft) (Savarese et al. 2010, Haley et al. 2010a). However, these averages are derived from seal observations that span a very wide range of distances at which the seals were first detected, which depends greatly on weather and sea conditions that determine visibility conditions. At least half of the seals observed did not swim away from an approaching vessel, and some seals actually swam toward the vessel, and a small number bow ride. There appears to be a range of sensitivities among seals to ships, including many that are not noticeably disturbed by their passing.

Icebreaking Vessels

Icebreaking vessels, whether used for in-ice seismic surveys or for ice management near exploratory drilling ships, introduce an additional type of disturbance to ice seals than non-icebreaking vessels. These activities would take place from early summer-early fall (for ice management related to exploratory drilling) and from late fall-early winter (for icebreaking related to in-ice seismic surveys) under Alternative 2, a time period when ice seals are often on top of sea ice and in the water but not in subnivean structures. Ringed seals give birth in lairs beginning in mid-March (Smith and Stirling 1975), months after the latest time icebreakers could operate in the Arctic. The process of breaking through ice increases the amount of sound produced by the ship, primarily by increasing cavitation from props under high power but restricted motion (Richardson et al. 1995). The sounds of the ship and breaking ice likely combine with the physical presence of the ship to disturb ice seals and cause them to move away from the path of the ship. Data on how close seals allow icebreakers to approach are limited, but ringed and bearded seals on pack ice typically dove into the water within 0.93 km (0.58 mi) of the vessel. Ringed seals have also been seen feeding among overturned ice floes in the wake of icebreakers (Brewer et al. 1993), so not all disruptions may be adverse. The pack ice is a highly dynamic environment in late fall to early winter when icebreaking activities would occur. Ice seals are adapted to moving frequently to accommodate changing ice conditions, so displacement due to a passing icebreaker is likely to be temporary and well within the normal range of ability for ice seals at this time of year.

Seismic Airgun Arrays

The greatest concern for seals and other marine mammals from exploration activities is the potential for disturbance from seismic airgun arrays, especially the larger and more powerful 2D/3D arrays (16 to 36 airguns) which cover large areas. OBC/OBN surveys and shallow hazard/site clearance seismic surveys cover smaller geographic areas but more intensely and thus present more local disturbance potential, although shallow hazard/site clearance surveys use much smaller seismic arrays (1 to 4 airguns). For the purposes of calculating “take by harassment” under the MMPA, NMFS considers any marine mammals exposed to pulsed sound levels at or above 160 dB to experience Level B behavioral harassment. Operators are required to monitor out to this distance for seismic surveys to record actual numbers of animals detected within the ensonified zone. They are also required to calculate how many animals may be exposed but were not detected, generally based on the density of animals in the area and the size of the ensonified zone. Because ice seals are common and widespread in the Beaufort and Chukchi seas, the numbers of seals detected and calculated to be within the 160 dB radii are quite large. However, as mentioned above, seals often do not react strongly to passing seismic ships, at least by what visual observers can detect. Seals keep further away from seismic source vessels with active arrays than they do monitoring vessels within the 160 dB zone but by about the same amount as they do when the array is inactive (Savarese et al. 2010, Haley et al. 2010a). This may be due to the more imposing physical characteristics of the source vessel, which causes the seals to maintain a greater distance, or the ability of PSOs on the taller source vessels to detect seals at greater distances than PSOs on the smaller monitoring vessels, resulting in a data set more skewed to greater distances. Seals have been noted to tolerate high levels of sounds from airguns (Arnold 1996, Harris et al. 2001, Moulton and Lawson 2002). In any case, the observable behavior of seals to passing active source vessels is often to just watch it go by or swim in a neutral way relative to the ship rather than swimming away. Seals at the surface of the water would experience less powerful sounds than if they were the same distance away but in the water below the seismic source. This may also account for the apparent lack of strong reactions in ice seals.

Site Clearance and High-Resolution Shallow Hazards Surveys

In addition to airguns, site clearance and high resolution shallow hazards surveys utilize smaller, higher frequency sound sources. Very few data are available on the reactions of pinnipeds to echosounder sounds or other devices at frequencies similar to those used during seismic operations. Hastie and Janik (2007) conducted a series of behavioral response tests on two captive gray seals to determine their reactions to underwater operation of a 375 kHz multibeam imaging echosounder that included signal components down to 6 kHz. Results indicated that the two seals reacted to the signal by significantly increasing their dive durations. However, because of the brevity of exposure of pinnipeds to such sound sources, pinniped reactions are anticipated to be limited to startle or otherwise brief responses of no lasting consequence to the animals.

Deep Penetration Seismic Surveys

Ice seals traveling across a broad area may encounter more than one exploration activity in a season and may therefore be disturbed repeatedly by the presence of vessels or seismic survey sound or both. If exploration activities are more concentrated near the pack ice edges where seals are more common, the chances are greater that more seals would experience multiple disturbances in a season than if exploration activities were clustered away from the ice. It is not known if multiple disturbances within a certain timeframe add to the stress of an animal and, if so, what frequency and intensity may result in biologically important effects. There is likely to be a wide range of individual sensitivities to multiple disturbances, with some animals being more sensitive than others. However, given the limited potential for multiple disturbances in the same general area from the level of activity authorized under Alternative 2 and the generally low to medium intensity and temporary to interim duration of effects on ice seals from any of these activities, it is not likely that additive effects from multiple activities will become a concern for any species of ice seals.

On-Ice Surveys

On-ice surveys (vibroseis) are typically conducted only in the shallower, near shore waters of the Beaufort Sea and take place during the winter months. Ringed seals are the only species likely to be in these areas at the time, although bearded seals may also be present in deeper waters further offshore. At this time of year, seals excavate a series of cavities under the snow (subnivean structures), accessed from holes they maintain in the ice from below, for pupping and to provide protection from predators (Smith and Stirling 1975). Ringed seals use multiple breathing holes (Smith and Stirling 1975, Kelly and Quakenbush 1990) and are not expected to be adversely affected by the loss of one to two breathing holes within the thickened ice road. Ringed seals near BP’s Northstar Island have demonstrated an ability to open new holes and create new structures throughout the winter, and ringed seal use of landfast ice near Northstar did not appear to be much different than that of ice 1.2 to 2.2 mi away (2 to 3.5 km; Williams et al. 2002).

Vibroseis surveys involve a large number of heavy tracked vehicles, but many of them are associated with camp facilities that are established on land-fast ice that does not support ringed seals. Survey vehicles with vibrators and sensors are often deployed in shallow water areas and may disturb seals in subnivean lairs or animals hauled out on top of the ice. Standard mitigation measures require advance scouting of routes and survey lines to minimize impacts to seals by avoiding areas more likely to have lairs (pressure ridges and deep snow accumulations). These mitigation measures also require use of various methods to detect and avoid seal lairs, thereby greatly reducing the chance of destroying an active lair from ice road construction or on-ice survey activities. If an active lair is not detected and is incidentally impacted by heavy survey equipment, the adult female could likely escape into the water, but the pup could be killed by crushing or premature exposure to the water or weather. Disturbed adults may remain in their lairs or move to other nearby lairs or swim to different breathing holes (Kelly et al. 1988). Because the survey vehicles move to new locations every few minutes, the disturbance would be temporary and unlikely to drive animals from their normal territory.

Aircraft Activity

Potential effects to pinnipeds from aircraft activity could involve both acoustic and non-acoustic effects. It is uncertain if the seals react to the sound of the aircraft or to its physical presence flying overhead. The available information describes reactions of hauled out pinnipeds and not of pinnipeds in the water. Typical observed reactions of hauled out pinnipeds to aircraft include looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water. Blackwell et al. (2004b) observed 12 ringed seals during low-altitude overflights of a Bell 212 helicopter at BP's Northstar Island in June and July 2000 (9 observations took place concurrent with pipe-driving activities). One seal showed no reaction to the aircraft while the remaining 11 (92%) reacted, either by looking at the helicopter (n=10) or by departing from their basking site (n=1). Blackwell et al. (2004b) concluded that none of the reactions to helicopters were strong or long lasting and that seals near Northstar in June and July 2000 probably had habituated to industrial sounds and visible activities that had occurred often during the preceding winter and spring. Born et al. (1999) determined 49% of ringed seals escaped (i.e., left the ice) from a helicopter flying at 492 ft. (150 m) altitude. Seals entered the water when the helicopter was 4,101 ft. (1,250 m) away if the seal was in front of the helicopter and at 1,640 ft. (500 m) away if the seal was to the side of the helicopter. The authors noted that more seals reacted to helicopters than to fixed-wing aircraft. The study concluded that the risk of scaring ringed seals by small-type helicopters could be substantially reduced if they do not approach closer than 4,921 ft. (1,500 m). Spotted seals hauled out on land in summer are unusually sensitive to aircraft overflights compared to other species. They often rush into the water when an aircraft flies by at altitudes up to 984 to 2,461 ft. (300 to 750 m). They occasionally react to aircraft flying as high as 4,495 ft. (1,370 m) and at lateral distances as far as 1.2 mi (2 km) or more (Frost and Lowry 1990, Rugh et al. 1997).

Exploratory Drilling

Exploratory drilling involves the establishment of a large drill ship or jackup rig in one location for some weeks and the deployment of numerous support vessels. The level of disturbance to seals is likely more intense in terms of the physical presence of the ships than any types of exploratory surveys, but the geographic area involved is much smaller. The sound generated from drilling is also not as loud as seismic airguns, but it is produced on an almost continual basis, making it more of a chronic sound source in one location. Given the mild reaction of seals to marine vessels, drilling activities are likely to deter seals from venturing too close to the rig and support vessels while it is in that particular area. This displacement would cover a very small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

Ship Strikes

Seal mortalities or injuries due to ship strikes have not been observed in the Beaufort and Chukchi seas. PSOs on many vessels in both seas have logged thousands of hours monitoring vessel transit and have recorded the presence of thousands of seals, but there have been no suspected or documented cases of seals being injured or killed by the type of large vessels used in Arctic oil and gas exploration activities.

These species are able to swim much faster than such ships and have been observed to easily swim away from vessels traveling at full speed. Some seals have even been observed to swim to the front of the vessels to bow ride on their wake (Reiser et al. 2011). Given these observations, the risk of ship strikes for ice seals is considered negligible.

Auditory Impairment

TTS is the mildest form of hearing impairment that can occur during exposure to loud sound (Kryter 1985). It is not considered to represent physical injury, as hearing sensitivity recovers relatively quickly after the sound ends. It is, however, an indicator that physical injury is possible if the animal is exposed to higher levels of sound. The onset of TTS is defined as a temporary elevation of the hearing threshold by at least 6 dB (Schlundt et al. 2000). Several physiological mechanisms are thought to be involved with inducing TTS. These include reduced sensitivity of sensory hair cells in the inner ear, changes in the chemical environment in the sensory cells, residual middle-ear muscular activity, displacement of inner ear membranes, increased blood flow, and post-stimulatory reduction in efferent and sensory neural output (Kryter 1994, Ward 1997).

Very few data are available regarding the sound levels and durations that are necessary to cause TTS in pinnipeds. TTS has been measured for only three pinniped species: harbor seals; California sea lions; and northern elephant seals, and only one study has examined TTS in response to exposure to underwater pulses (Finneran et al. 2003). No data are available for any free ranging marine mammals or for exposure to multiple pulses of sound during seismic surveys. Kastak et al. (1999) reported TTS of approximately 4 to 5 dB in three species of pinnipeds (harbor seal, California sea lion, and northern elephant seal) after underwater exposure for approximately 20 minutes to noise with frequencies ranging from 100 to 2,000 Hz at received levels 60 to 75 dB above hearing threshold. This approach allowed similar effective exposure conditions to each of the subjects, but resulted in variable absolute exposure values depending on subject and test frequency. Recovery to near baseline levels was reported within 24 hours of noise exposure (Kastak et al. 1999). Kastak et al. (2005) followed up on their previous work using higher sensitivity levels and longer exposure times (up to 50-min) and corroborated their previous findings. The sound exposures necessary to cause slight threshold shifts were also determined for two California sea lions and a juvenile elephant seal exposed to underwater sound for a similar duration. The sound level necessary to cause TTS in pinnipeds depends on exposure duration, as in other mammals; with longer exposure, the level necessary to elicit TTS is reduced (Schusterman et al. 2000; Kastak et al. 2005, 2007). For very short exposures (e.g., to a single sound pulse), the level necessary to cause TTS is very high (Finneran et al. 2003). For pinnipeds exposed to in-air sounds, auditory fatigue has been measured in response to single pulses and to non-pulse noise (Southall et al. 2007), although high exposure levels were required to induce TTS-onset (SEL: 129 dB re: 20 µPa2.s; Bowles et al. unpub. data).

Section 4.2.6.3 outlines NMFS final revisions to auditory injury thresholds. NMFS applied these thresholds to the types of sources analyzed in this EIS (seismic airguns and drilling sources of similar size) and found that the resulting distances at which injurious exposures could not be ruled out (i.e., those at which PTS might be incurred) were similar to those calculated using the 180 and 190-dB historical thresholds for low-frequency specialists and phocids, but were actually notably smaller for mid-frequency cetaceans and otariids. As noted previously, most individual marine mammals are expected to avoid loud sounds at distances that would prevent PTS, and standard mitigation measures to shut down airguns if individuals approach within distances associated with injurious effects are expected to help minimize effects. That said, the potential for PTS cannot be ruled out but is considered unlikely to occur.

Small Fuel Spill

There is the potential for seals to be exposed to small spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g., transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). Exposure of seals to oil products could lead to irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). The effects of an oil spill on ringed or bearded seals would depend largely on the size, season, and location of the spill. If a spill were to occur during the ice free, open water season, seals may be exposed to oil through direct contact, or perhaps through contaminated food items. However, St. Aubin (1990) notes that with their keen sense of olfaction and good sense of vision ringed and bearded seals may be able to detect and avoid oil spills in the open water season (St. Aubin 1990).

Immersion studies by Smith and Geraci (1975) found ringed seals may develop mild liver injury, kidney lesions and eye injury from immersion in crude oil. The eye damage was often severe, suggesting permanent eye damage might occur with longer periods of exposure to crude oil, and the overall severity of the injuries was most likely associated with the exposure duration to crude oil. Geraci and Smith (1976a) concluded the direct effects of an oil blow-out or spill may result in transient eye damage to healthy seals in open water.

However if breathing holes, polynyas, or leads become fouled with oil, permanent damage may occur. Geraci and Smith (1976a) noted their findings pointed to stress as instrumental in their convulsive behavior and subsequent death when exposed to crude oil, suggesting exposure to crude oil was additive to pre-existing stress levels in ringed seals in their experiment where all of the test animals died. Geraci and Smith (1976a) also found ringed seals exposed to a slick of light crude oil showed no impairment in locomotion or breathing.

Ringed seal pups in their lanugo coats could be vulnerable to the cold if they become oiled and have not yet established adequate fat reserves.

Reports of the effects of oil spills have shown that some mortality of seals may have occurred as a result of oil fouling; however, large-scale mortality has never been observed (St. Aubin 1990). Flippers of young harp seal pups were impeded by a coating of Bunker C fuel oil (Sergeant 1991). Oiling of both mother and pups does not appear to interfere with nursing (Lowry et al. 1994) although disturbances associated with oil spill response and clean-up may do so (Geraci and St. Aubin 1988). Jenssen (1996) reported oil has produced few visible effects to gray seal behavior, and there has been little mortality despite the fact that approximately 50% of gray seal pups at Norway's largest breeding rookery are polluted by oil annually.

Investigations into the effects of crude oil ingestion and exposure on ringed seals (Smith and Geraci 1976) indicate the probability of ringed seals accidentally ingesting large amounts of oil by way of contaminated food items is very low. Moreover, only small, transient effects were found to have occurred during necropsies of ringed seals deliberately fed potent fractions of carbon tetrachloride.

St. Aubin (1990) found ingestion of hydrocarbons can irritate and destroy epithelial cells in the stomach and intestine, affecting motility, digestion, and absorption, which may result in death or reproductive failure; however, after being returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978; 1982; 1985). Harbor seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994).

Subsequent studies (Engelhardt et al. 1977, Engelhardt 1982) indicate ringed seals may accumulate compounds from hydrocarbons in their tissues, but that they are rapidly excreted via renal pathways. Engelhardt (1983) further states that exposure studies in ringed seals revealed they have a great capability to excrete accumulated hydrocarbons via renal and biliary excretion mechanisms, clearing blood and most other tissues of the residues within seven days. Ringed seals probably have the ability to purge their bodies of some harmful oil residues, depending on the duration and extent of exposure. Based on morphological similarities, the physiological impacts in bearded, spotted, and ribbon seals are expected to be similar to those of ringed seals.

Direct ingestion of oil, ingestion of contaminated prey, or inhalation of volatile hydrocarbons transfers toxins to body fluids and tissues causing effects that may lead to death, as suspected in dead gray and harbor seals found with oil in their stomachs (Engelhardt et al. 1977, Engelhardt 1982, St. Aubin 1990, Frost et al. 1994, Lowry et al. 1994, Spraker et al. 1994, Jenssen 1996). Seals exposed to an oil spill and especially a blowout are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980; 1982) and any effects are probably reversible (Spraker et al., 1994). Zooplankton may engulf petroleum droplets when in direct contact and retain metabolized and unmetabolized petroleum for 7-10 days (Geraci and St. Aubin 1990).

Similarly, marine fish are able to metabolize hydrocarbons and are therefore not a significant source of hydrocarbon contamination for marine mammals during extended time periods.

Bivalve molluscs however, tend to accumulate hydrocarbons from prolonged or repeated exposure, posing a threat to benthic-feeders such as bearded seals. Spilled oil has caused major disruptions to benthic communities inducing substantial contamination of tissues, failed spawning, significantsubstantially lower densities, and transfer of oil through the food web from invertebrates to larger fish (Koyama et al. 2004, Elmgren et al.1983). Ingestion of small quantities of oil through feeding is usually not harmful to ringed seals since they metabolize hydrocarbons (Payne 1992).

Ice seals are commonly observed near oil and gas activities during the open-water season and could be exposed to spills in the water or on ice. If a small spill occurred, cleanup efforts would begin immediately and those activities would likely include the presence of PSOs to monitor for ice seals and other marine mammals and deter them from entering the spill area if possible. Given the mitigation measures in place to prevent and clean up spills, the risk of ice seals being exposed to small spills during exploration activities is considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alterations

There are five potential mechanisms for habitat changes that may affect ice seals: 1) disturbance/dispersion of prey species by seismic surveys; 2) disturbance of sea ice habitat from icebreakers; 3) disturbance of sea ice habitat from ice-road construction and on-ice survey activities; 4) contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities; and 5) impacts on acoustic habitat relied upon by ice seals for communication and other functions.

Seismic airgun technology has been adopted in part because of its lack of substantial effects on marine invertebrates and fish (see Sections 4.5.2.1 and 4.5.2.2, respectively). Prey fields for ice seals may experience temporary disturbance due to passing ships and towed seismic equipment, much as the seals themselves, but the marine waters are not altered so fish and invertebrates are expected to resume their normal behavior and movement patterns within minutes or a few hours after seismic vessels pass. Impacts on fish behavior are predicted to be inconsequential. Given the wide distribution and dynamic nature of prey fields for ice seals, it is unlikely that seals would experience any changes to their foraging success as a result of seismic surveys in open water.

Icebreaking ships intentionally disrupt ice floes in order to conduct in-ice seismic surveys or to help manage ice flows around exploratory drilling equipment. These activities would take place in late fall to early winter (with a smaller chance of such activities occurring at the very beginning of the open water season in early July) under Alternative 2, a time period when ice seals are often on top of sea ice but not in subnivean structures. If such activities occurred in early July, impacts would be minimal as seals are more likely to be in open water at this time. Seals have been observed to dive into the water and move out of the way well before icebreakers approach. Seals often appear in the open water/broken ice channels behind ice breakers, and some of them appear to be feeding on fish exposed by the broken ice (Haley et al. 2011). Sea ice in these seasons moves continually, opening leads and closing them very quickly at times. The channels cut by icebreakers often close up very soon after the ship passes, mimicking the natural dynamics of the ice in many respects.

Ringed, bearded, spotted, and ribbon seals are dependent on sea ice for at least part of their life history. Sea ice is important for life functions such as resting, breeding, and molting. These species are dependent on two different types of ice: pack ice and landfast ice. Ice management/icebreaking activities that might be necessary during exploratory drilling are typically only conducted in pack ice in either early to mid-July or mid- to late October, as landfast ice is not present at these times in the offshore lease sites.

The ringed seal is the most common pinniped species in the EIS project area. While ringed seals use ice year-round, they do not construct lairs for pupping until late winter/early spring on the landfast ice. Therefore, since exploratory drilling operations and demobilization typically conclude by late October/early November, Shell's activities would not impact ringed seal lairs or habitat needed for breeding and pupping in the Beaufort and Chukchi seas. Aerial surveys in the eastern Chukchi Sea conducted in late May-early June 1999-2000 found that ringed seals were four to ten times more abundant in nearshore fast and pack ice environments than in offshore pack ice (Bengtson et al. 2005). Ringed seals can be found on the pack ice surface in the late spring and early summer in the northern Beaufort and Chukchi seas, the latter part of which may overlap with the start of exploratory drilling activities. If an ice floe is pushed into one that contains hauled out seals, the animals may become startled and enter the water when the two ice floes collide. Bearded seals breed in the Bering and Chukchi Seas from mid-March through early May (several months prior to the start of operations), as the Beaufort Sea provides less suitable habitat for the species. Bearded seals require sea ice for molting during the late spring and summer period. Because this species feeds on benthic prey, bearded seals occur over the pack ice front over the Chukchi Sea shelf in summer (Burns and Frost 1979) but were not associated with the ice front when it receded over deep water (Kingsley et al. 1985). The spotted seal does not breed in the Chukchi or Beaufort seas. Spotted seals molt most intensely during May and June and then move to the coast after the sea ice has melted. Ribbon seals are not known to breed in the Chukchi or Beaufort seas. From July-October, when sea ice is absent, the ribbon seal is entirely pelagic, its distribution is not well known, and no ribbon seals have been documented east of the Barrow area (Burns 1981). Therefore, ice used by bearded, spotted, and ribbon seals needed for life functions such as breeding and molting would not be impacted as a result of exploratory drilling programs since these life functions do not occur in the EIS project area or at the same time as the operations. For ringed seals, ice management/icebreaking activities would occur during a time when life functions such as breeding, pupping, and molting do not co-occur in the EIS project area. Additionally, these life functions normally occur on landfast ice, which will is not impacted by exploratory drilling activities. The effects on ice seal habitat are therefore temporary. Additionally, impacts may be reduced if prey becomes easier to catch.

In the Beaufort Sea, on-ice seismic surveys (vibroseis) typically take place in mid-winter to early spring (January to May) because thick ice is required to support the vehicles and to ensure personnel safety. These surveys involve the use of large tracked vehicles to pull heavy seismic equipment and associated support facilities (crew camps) across the ice. Convoy travel routes and camp locations are selected based on ice conditions (land-fast for camps) and avoidance of pressure ridges and deep snow accumulations. Sensor cables and vibrator vehicles travel along pre-surveyed and groomed routes across the ice. Ringed seals are the only species likely to be encountered by these surveys, which are conducted relatively close to shore in the shallow waters of the Beaufort Sea. Bearded seals prefer deeper waters and broken ice, which must be avoided by the heavy vehicles. The potential for habitat effects during these surveys involve the potential destruction or damage to subnivean lairs and breathing holes in the ice (disturbance effects are discussed above). The operational and safety requirements for this type of seismic survey require industry to avoid the types of areas where seals are likely to build lairs. Ringed seals typically build and maintain a series of lairs and breathing holes and move between them on a regular basis to help avoid predation and accommodate changing ice conditions (Kelly and Quakenbush 1990, Lydersen and Hammill 1993). The potential loss or displacement of a small number of lairs and breathing holes because of on-ice survey activity would be temporary and readily replaceable by ringed seals in the same way as they relocate under natural conditions, which are highly dynamic.

The discharge of drilling muds and other waste streams from drilling rigs and other exploration vessels could affect ice seal habitat by contaminating ice floes, the water column, and prey. There have been no comprehensive studies conducted on the potential distribution and persistence of the many compounds and substances that could be released accidentally or under discharge permits by the myriad exploration vehicles and vessels involved in the activities authorized under Alternative 2. The potential effects on the habitats of the different ice seal species are therefore unknown. The scope of research needed to track any one discharge compound through the Arctic marine environment and to measure its potential effects in seals would likely be prohibitive and very difficult to interpret given the many other factors that can influence an animals' health.

Additionally, the acoustic habitat, within which pinnipeds use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the audible frequency bandwidths for seals. Depending on the decibel level, frequencies, and duration of these sounds, these acoustic habitat alterations may result in reduced ability to detect or interpret important sounds.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order aggregate and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments on the DEIS and SEIS. Broadly, results suggest that even with the lower predicted activity levels in Alternative 2, substantial losses of listening area (up to 98%) will occur in the Beaufort Sea area from July-mid-October. As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area can negatively affect aquatic animals. And, while data are lacking to document links to population consequences for long-lived and often wide-ranging marine mammal species, chronic noise may impair an animal's ability to detect critical acoustic cues over a relatively large area for 3.5 months, which must be carefully considered.

4.5.2.4.13.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have often been the most commonly encountered species of any marine mammals in past exploration activities, and their reactions have been recorded by PSOs onboard source vessels and monitoring vessels. These data indicate that seals tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away, and they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. Studies of ringed and bearded seals have noted the most common reaction to aircraft flying overhead is looking at the aircraft. Reactions become most pronounced when aircraft fly below 150 m (492 ft). However, reactions have been noted to be short-term in nature. None of the behavioral reactions observed to date indicate any ice seal species would be displaced from key areas or resources for longer than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Additionally, impacts from any discharges or small fuel spills are anticipated to be negligible. Ice seals are legally protected under the MMPA, have unique ecological roles in the Arctic, and are important subsistence resources and are considered to be important resources. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 2 on ice seals would likely be medium in magnitude (though potentially high for ringed seals), local to regional, and interim to longterm in duration. Reliable data with which to estimate population trends is not available. The effects of Alternative 2 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

Table 4.5-23 Effects Summary for Ice Seals

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	When maximum activities considered, more than 30% ringed seals may be taken
	Duration	Temporary	At the lower levels of this Alternative effects are closer to temporary - could be only couple smaller activities with short-term effects on individuals – and possible could be years with none
		Interim	In most Alternative configurations, all activity types last multiple months, and some level of activities are recurring over multiple successive years. Effects to individuals could occur across multiple months.
		Long-term	
	Geographic Extent	Local	Effects of activities considered local
		Regional	
		State-wide	
	Context	Common	Non-ESA-listed, notable impacts not occurring in specifically identified important areas
		Important	
		Unique	
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	Non-ESA-listed species, no known declining trends
		Important	
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	**Low**	Impacts to most habitat features are low in intensity
		Medium	When acoustic habitat impacts are considered, magnitude is medium (~28% of EIS area ensonified over 120 dB, up to 98% lost listening area in some areas of Beaufort).
		High	
	Duration	**Temporary**	
		Interim	At the lower levels of this Alternative effects are closer to interim – could be only couple smaller activities – and possible could be years with none
		Long-term	In most alternative configurations, all activity types last multiple months and some level of activities is recurring over multiple successive years.
	Geographic Extent	**Local**	It is possible that very low-level versions of this Alternative may result in only local effects.
		Regional	When the total area ensonified above 120 dB by all sources is considered (used to indicate where animals will hear it and potential for masking exists), most scenarios will result in regional effects.
		State-wide	
	Context	**Common**	Non-ESA-listed species with no important areas
		Important	
		Unique	

4.5.2.4.14 Pacific Walruses

4.5.2.4.14.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 2 on Pacific walruses (walruses). This species is highly dependent on sea ice for critical life functions, and seasonal distributions are heavily influenced by seasonal ice movement in Arctic waters. Potential direct and indirect effects on walruses from exploration activities authorized under Alternative 2 are similar to those discussed for cetaceans (Sections 4.5.2.4.10 to 4.5.2.4.12) and ice seals (Section 4.5.2.4.13). These include disturbance in water and on the surface of the ice due to sounds and physical movements of vessels and equipment, risks of injury or mortality, and changes in habitat. Impacts to walrus are also influenced by timing and geographical proximity of exploration activities to quality habitat such as Hanna Shoal, an area of particular importance for foraging walrus from June through September. Walruses hauled out on land also can be disturbed by vessels and aircraft. Pacific walruses are distributed widely across the Chukchi Sea but are uncommon in the deeper OCS waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact walruses.

This EIS considers a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals, especially bowhead whales and other species under the jurisdiction of NMFS, but these mitigation measures may also help to reduce adverse effects on walruses and polar bears, which are under the jurisdiction of the USFWS. In addition to the mitigation measures imposed by NMFS, the oil and gas industry operates under LOAs for incidental take of walruses and polar bears issued by the USFWS which contain mitigation measures specific to these species. The USFWS's incidental take regulations (ITRs) authorize the nonlethal, incidental, unintentional take of small numbers of walruses and polar bears during oil and gas industry exploration activities in the Chukchi Sea and adjacent western coast of Alaska. The USFWS has determined that the expected takings of walruses and polar bears during industry exploration activities will impact small numbers of animals and will have a negligible impact on these species, and will not have an unmitigable adverse impact on the availability of these species for subsistence use. The USFWS bases that finding on the results of 17 years of data on the encounters and interactions between polar bears, walruses, and industry; recent studies of potential effects of industry on these species; oil spill risk assessments;

potential and documented industry impacts on these species; and current information regarding the natural history and status of polar bears and walruses.

The USFWS issues LOAs upon request for activities proposed to be conducted in accordance with the ITRs. In addition to incidental LOAs, the USFWS also issues intentional take (or directed take) authorizations for deterrence purposes.

A series of LOAs have been issued since 1993 for the Beaufort Sea (USFWS 2011a) and since 1991 for the Chukchi Sea (USFWS 2008a). The following mitigation measures are typically required by the USFWS for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on walruses and are thus incorporated into the analysis of potential effects under Alternative 2:

- Seismic source and support vessels must be staffed with dedicated PSOs to alert the crew to the presence of walruses and initiate adaptive mitigation measures.
- Except under emergency situations, vessels must maintain the maximum distance possible from concentrations of walruses and never get closer than 805 m (0.5 mi) to walruses or 1,610 m (1 mi) from terrestrial walrus haulouts.
- Vessel operators must take every precaution to avoid harassment of concentrations of feeding walruses when a vessel is operating near these animals. Vessels should reduce speed and maintain a minimum 805 m (0.5 mi) operational exclusion zone around feeding walrus groups. Vessels may not be operated in such a way as to separate members of a group of walrus from other members of the group. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to walruses.
- Operators of support aircraft should, at all times, conduct their activities at the maximum distance possible from concentrations of walruses.
- Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 914 m (3,000 ft.) within 805 m (0.5 mi) of walruses observed on ice or land. Helicopters may not hover or circle above such areas or within 805 m (0.5 mi) of such areas. When weather conditions do not allow a 914 m (3,000 ft.) flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 914 m (3,000 ft.) altitude stipulated above. However, when aircraft are operated at altitudes below 914 m (3,000 ft.) because of weather conditions, the operator must avoid areas of known walrus concentrations and should take precautions to avoid flying directly over or within 805 m (0.5 mi) of these areas.
- All seismic surveys will establish and monitor an acoustically verified exclusion zone for walruses surrounding seismic airgun arrays or sound source where the received level would be ≥180 dB re 1 μPa and an acoustically verified walrus disturbance zone ahead of and perpendicular to the seismic vessel track where the received level would be ≥160 dB re 1 μPa.
- Immediately power-down or shut-down the seismic airgun array and/or other acoustic sources whenever any walruses are sighted approaching close to or within the area delineated by the 180 dB re 1 μPa walrus exclusion zone. If the power-down operation cannot reduce the received sound pressure level to 180 dB re 1 μPa the operator must immediately shut-down the seismic sound sources.
- Whenever an aggregation of 12 or more walruses are detected within the 160 dB re 1 μPa disturbance zone ahead of or perpendicular to the seismic vessel track, the holder of an LOA must: (A) Ensure sound pressure levels at the shortest distance to the aggregation do not exceed 160 dB re 1 μPa by powering down the seismic airgun array and/or other acoustic sources or by altering vessel course; and (B) Not proceed with powering up the seismic airgun array and/or other seismic sound sources, or resuming the original course, until it can be established that there

are no walrus aggregations within the 160 dB re 1 μPa walrus disturbance zone based upon ship course, direction and distance from last sighting.

- Ramp-up Procedures - (A) Prior to commencing ramp-up, the exclusion zone for walruses must be visible and observed by a MMO watch for at least 30 minutes when: At the commencement of operations using airguns or sound sources; a complete shut-down has occurred; any time operation of the airgun array or sound source(s) is discontinued for a period of 10 minutes or more; or the MMO watch has been suspended; (B) If the exclusion zones are not completely visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, ramp up may commence following established procedures which must include: Ramp-up airgun arrays slowly over a period of at least 30 minutes, start with one airgun or sound source in the array and then gradually add additional guns or sound sources, until the full array is firing.
- Poor Visibility Conditions - (A) During poor visibility conditions (fog, rain, snow, darkness, etc.), if the entire 180 dB re 1 μPa walrus exclusion zone is visible using vessel lights and/or night vision devices, then ramp-up procedures of airguns or sound sources may occur following a 30 minute period of observation by MMOs with no sighting of walruses in their exclusion zone; (B) If during poor visibility conditions, the full exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shutdown; (C) If, however, one or more airguns have been operational since before the onset of poor visibility conditions, they may continue to operate under the assumption that walruses will have been alerted by the sounds from the single airgun and have moved away.

In addition to these mitigation measures designed to reduce impacts on walruses, the MMPA contains provisions to protect subsistence hunting of walruses by requiring plans of cooperation and communication channels between industry and subsistence communities when activities have the potential to impact subsistence hunting. Industry is also required to participate in monitoring programs intended to measure the effectiveness of mitigation measures and advance knowledge about the species. LOAs also have established protocols for reporting interactions with walruses and the results of monitoring programs.

Behavioral Disturbance

There are several mechanisms for potential disturbance to walruses associated with each of the different types of exploration activities that would be authorized under Alternative 2.

Marine Vessels

Marine vessels associated with exploration activities all introduce sounds into the marine environment (see Section 4.5.1.4, Acoustics) and have a physical presence that could affect walruses in the water or on sea ice. Many of these vessels have carried PSOs in the past and the data they have collected about walruses and other marine mammals forms the basis of much of this discussion. Walrus are frequently observed from exploration ships in the Chukchi Sea but they are rarely observed in the Beaufort Sea. The majorities of all sightings are of animals in the water rather than on ice but sightings were more common the closer the vessel was to the pack ice. In the Beaufort Sea from 2006 through the 2008 open-water season, PSOs recorded only six sightings of walruses with a total of 10 individual walruses (Savarese et al. 2010). Five of these sightings occurred in 2007. In the Chukchi Sea from 2006 through the 2008 open-water season, PSOs recorded 575 walrus sightings comprised of 4821 individual walruses (Haley et al. 2010a). There were many more walrus sightings in the Chukchi in 2007 (n=351) than in other years, with about 40 percent of these being sighted in one day (24 August). This concentration of walruses was suspected of abandoning the ice pack after it retreated beyond the shelf break and heading to haulouts on the coasts of Alaska and Russia (Savarese et al. 2010). This situation may occur more frequently in the future as the ice pack thins and recedes further due to warming temperatures in the Arctic.

Seismic surveys often include PSOs on monitoring ships that are deployed at various distances from the seismic source ships, sometimes over 75 km (47 mi) away. Sightings from these ships when they are at great distance from the source vessel or when the seismic arrays are not active (non-seismic conditions, <120 dB rms) provide a measure of walrus reactions to typical vessel traffic rather than the seismic source (discussed below). When monitoring ships are traveling under non-seismic conditions, the average closest point of approach to walruses was 265 m (869 ft.) (Haley et al. 2010a). Seismic source vessels traveling under non-seismic conditions appear to disturb walruses at greater distances, perhaps in part because of their larger physical presence, with the average closest point of approach to a walrus being 822 m (2,700 ft.) (Haley et al. 2010a). However, these averages are derived from walrus observations that span a very wide range of distances at which they were first detected, and detection distances were greater from source ships probably because of their larger size and higher observation platforms above the sea surface relative to monitoring ships. Another measure of walrus reactions to vessels is their movements relative to an approaching vessel under non-seismic conditions. About half of the walruses observed showed no obvious movement pattern relative to a passing ship. Of those animals that did move, more than twice as many swam away from the vessel than swam toward the vessel (Haley et al. 2010a). This data indicates that there is a range of sensitivities among walruses to ships, including many that are not noticeably disturbed by their passing at some distance. Because they can easily swim faster than exploration vessels, it is likely that more sensitive walruses move away from approaching ships before they react more strongly to the disturbance. Disturbance of walruses in the water from passing vessels would be temporary and unlikely to cause meaningful displacement.

Icebreaking

Icebreaking vessels, whether used for in-ice seismic surveys or for ice management near exploratory drilling ships, introduce an additional type of disturbance to walruses than non-icebreaking vessels. These activities would take place in late fall to early winter under Alternative 2, a time period when walruses are often closely associated with the pack ice edge or are hauled out on coastal shores. Walruses resting on ice floes may also be disturbed by ice management vessels if the floe is too close to an exploratory drilling rig and needs to be moved. Past monitoring efforts indicated that most groups of hauled out walruses showed little reaction to icebreaking activities beyond 805 m (0.5 mi), although some walrus groups may be disturbed up to several kilometers away (Brueggeman et al. 1990). Given the dispersed distribution of walruses on the ice and the short time period and limited geographic extent of icebreaking activities authorized under Alternative 2, it is unlikely that many walruses would be affected in the Chukchi Sea and unlikely that any would be affected in the Beaufort Sea. Such disturbance would be temporary as the icebreaker moved through an area and the ice reformed relatively quickly. Only one in-ice seismic survey could be authorized in the Chukchi Sea under Alternative 2 so there would be no potential for multiple in-ice surveys to affect the same group of walruses.

Seismic Surveys

The greatest concern for most marine mammals from exploration work has been the potential for disturbance from seismic airgun arrays, especially the larger and more powerful 2D/3D surveys (16 to 36 airgun arrays) which cover large areas. Walruses hear sounds both in air and in water. Kastelein et al. (1996) tested the in-air hearing of a walrus from 125 Hz to 8 kHz and determined the best sensitivity was between 250 Hz and 2 kHz. Walruses were able to hear at all frequency ranges tested. Kastelein et al. (2002) tested the underwater hearing and determined that the best sensitivity was at 12 kHz. Their best range of hearing was between 1 and 12 kHz. Most of the noise sources discussed, other than the very high frequency seismic profiling, would be audible to walruses.

During the 2006 to 2008 open-water seasons, 10 walruses were observed in the water from seismic source or monitoring vessels in the Beaufort Sea. None of these animals were detected within the 180 dB re 1 μPa rms safety radius for walruses (Savarese et al. 2010). In the Chukchi Sea, 32 walruses were detected within this safety radius in 2006 and 53 walruses were seen within this radius in 2007 (Haley et al. 2010a). These situations triggered power-down responses of the seismic arrays. These data represent the minimum number of animals that were exposed to these sound levels because some animals detected outside of this radius could have moved away before being detected and some animals may not have been detected by observers. The great majority of observable behavioral reactions of walruses to passing active source vessels was either no reaction or to just watch it go by rather than swimming away (Haley et al. 2010a). Walruses at the surface of the water would experience less powerful sounds than if they were the same distance away but in the water below the seismic source. This may also account for the apparent lack of strong reactions in walruses that were visible to observers. Given the short time period in which seismic vessels would be operating in any one area, potential disturbance of walruses by seismic surveys would likely be temporary and affect very small numbers of animals.

Aircraft Traffic

The behavioral response of walruses to aircraft traffic varies with distance, type of aircraft, flight pattern, age, sex, and group size. Richardson et al. (1995) reviewed responses of walruses to aircraft and summarized that individual responses to aircraft can range from orientation (i.e., looking at the aircraft) to leaving a haulout. In general, small herds on haulout sites (terrestrial and pack ice) seem more easily disturbed than large groups, and adult females with calves are more likely to enter the water during an aircraft disturbance. Stronger reactions occur when the aircraft is flying low, passes overhead, or causes abrupt changes in sound. Walruses are easily frightened when on coastal haulouts and tend to pack closely together so that a flight response by one animal can quickly travel through the herd, resulting in a mass exodus to the water. Stampedes are the greatest potential impact of aircraft disturbance and may result in cow-calf separations or injuries and mortalities, particulary of calves and yearlings.. However, flight restrictions imposed by USFWS LOAs greatly reduce the risk of aircraft disturbance to walruses hauled out on ice or on land. Given the limited amount of activities likely to require over-ice aircraft support under Alternative 2, the numbers of walruses potentially affected would be very small.

On-ice Vibroseis Survey

On-ice vibroseis surveys only take place in the shallow near-shore waters of the Beaufort Sea in the winter when walruses are not present in the area. Therefore, no impacts to walruses from this activity are anticipated to occur.

Exploratory Drilling

Exploratory drilling involves the establishment of a large drill ship in one location for some weeks and the deployment of numerous support vessels. The physical presence and chronic noise from multiple ships in the same area may result in displacement of walruses from a small geographic area. The importance of that displacement would depend on the quality of the benthic habitat for feeding walruses and its proximity to the ice pack or haulouts on land. Potential displacements would be short-term, lasting a few weeks to a few months.

Hearing Impairment, Injury, and Mortality

The noise levels required to cause TTS or PTS have not been determined for walruses. USFWS has adopted a 180 dB re 1 μPa rms safety radius for walruses as a precautionary measure to reduce the risk of seismic sounds on walruses in lieu of actual data on TTS and PTS levels.

PSOs on many vessels in both seas have logged thousands of hours monitoring vessel transit and have recorded thousands of walruses in the water. There have been no suspected or documented cases of walruses being injured or killed by the type of large vessels used in Arctic oil and gas exploration activities. Given this historical record, the risk of ship strikes for walruses is considered negligible. It is also unlikely that any walruses would be exposed to very loud sounds from seismic operations to the point where they might be injured.

There is a potentially dangerous situation with walruses on land-based haulouts. Due to pack ice receding beyond the shelf break in low-ice years, thousands of walruses have been using haulouts on land in recent years, primarily on the Chukchi coast from Point Lay to Barrow. If they are strongly disturbed by polar bears or low-flying aircraft or nearby vessels, the herd may stampede into the water. Walruses may be injured during stampedes, and injuries may be severe enough to result in mortalities. Juveniles and calves are particularly susceptible, but adults may be injured or killed as well. USFWS LOA mitigation measures for exploration aircraft and vessels are intended to monitor and avoid such haulouts to avoid causing such deadly disturbance.

Small Fuel Spill

There is the potential for walruses to be exposed to small (<50 bbl) spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g., transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). The direct effect of oil on walruses is probably similar to other pinnipeds. This includes irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). Kidney and liver damage could occur from ingestion of petroleum products while feeding (Cornelius and Kaneko 1963, Geraci and Smith 1977, Holden 1978). Because walruses are gregarious, any one animal that is exposed to a spill could spread that contact to other walruses. Walruses could also be affected through damage to their benthic food sources. If a small spill did occur, cleanup efforts would begin immediately, and those activities would likely include the presence of PSOs to monitor for walruses and other marine mammals and deter them from entering the spill area if possible. Given the occurrence of walruses primarily on or near the pack ice rather than swimming in open water where most exploration activities take place and the mitigation measures in place to prevent and clean up spills, the risk of walruses being exposed to small spills during exploration activities is considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alterations

There are three potential mechanisms for habitat changes that may affect walruses: disturbance/mortality of prey species by exploration activities; disturbance of sea ice habitat from icebreakers; and contamination of the marine environment from discharge of drilling cuttings and other waste streams from ships and support facilities.

Benthic prey of walruses may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as OBC/OBN surveys, vessel anchors, and exploratory drilling. All of these activities could displace benthic mollusks and crustaceans temporarily and may cause small amounts of mortality. Given the wide distribution and dynamic nature of prey fields for walruses, these activities would be unlikely to affect the availability of prey to walruses. In addition, OBC/OBN surveys would only occur in the Beaufort Sea where few walruses feed.

Icebreaking ships intentionally disrupt pack ice in order to conduct seismic surveys or to help manage ice floes around exploratory drilling equipment. These activities would take place in late fall to early winter under Alternative 2, a time period when walruses are on the pack ice or on shore waiting for the ice to return. Sea ice in these seasons moves continually, opening leads and closing them very quickly at times. The channels cut by icebreakers often close up very soon after the ship passes, mimicking the natural dynamics of the ice in many respects, and would not offer any hindrance to walrus movement.

The discharge of drilling cuttings and other waste streams (such as ballast water, waste water, and sewage) from drilling rigs and other exploration vessels could affect walrus habitat by contaminating benthic prey and fouling ice floes. Exploration wells generally include digging a large mud line cellar (MLC) and the release of cuttings onto the seafloor. Benthic prey items, such as bivalves and other invertebrates, would be buried during this process. This may result in the loss of several acres of benthic feeding habitat until the area is recolonized. The size of the area covered by the MLC and cuttings would depend upon the depth of the well and the deposition pattern.

4.5.2.4.14.2 Conclusion

Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration activities and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walruses reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would minimize the risk of mortality from stampedes. Walruses are legally protected, fulfill an important ecological role in the Arctic, and are an important subsistence resource and are therefore considered to be a unique resource for NEPA purposes. For the level and type of exploration activities that would be authorized under Alternative 2, given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects on walruses would likely be low in magnitude, distributed over a wide geographic area, and temporary to interim in duration. The effects of Alternative 2 would therefore be considered minor for walruses according to the criteria established in Section 4.1.3.

4.5.2.4.15 Polar Bears

4.5.2.4.15.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 2 on polar bears. Polar bears were listed as a threatened species under the ESA in 2008 (73 FR 28211, 15 May 2008), primarily on the basis of concerns about shrinking ice cover in Arctic seas due to climate change. Polar bears depend on pack ice for much of their denning habitat and for hunting seals. Thinning and receding ice cover threatens to greatly reduce suitable habitat for polar bears and could have serious population-level effects.

This EIS considers a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals, especially bowhead whales and other species under the jurisdiction of NMFS, but these mitigation measures may also help to reduce adverse effects on polar bears and walruses, which are under the jurisdiction of the USFWS. In addition to the mitigation measures imposed by NMFS, the oil and gas industry operates under LOAs for incidental take of polar bears and walruses issued by the USFWS which contain mitigation measures specific to these species. A series of LOAs have been issued since 1993 for the Beaufort Sea (USFWS 2011a) and since 1991 for the Chukchi Sea (USFWS 2008a). The following mitigation measures are typically required by the USFWS for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on polar bears and are thus incorporated into the analysis of potential effects under Alternative 2:

- Seismic source and support vessels must be staffed with dedicated PSOs to alert the crew to the presence of polar bears and initiate adaptive mitigation measures.
- Except under emergency situations, vessels must maintain the maximum distance possible from polar bears and never get closer than 805 m (0.5 mi) from polar bears.
- Operators of support aircraft should, at all times, conduct their activities at the maximum distance possible from polar bears.

- Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 457 m (1,500 ft.) within 805 m (0.5 mi) of polar bears observed on ice or land. Helicopters may not hover or circle above such areas or within 805 m (0.5 mi) of such areas. When weather conditions do not allow a 457 m (1,500 ft.) flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 457 m (1,500 ft.) altitude stipulated above. However, when aircraft are operated at altitudes below 457 m (1,500 ft.) because of weather conditions, the operator must avoid areas of known polar bear concentrations and should take precautions to avoid flying directly over or within 805 m (0.5 mi) of these areas.
- All seismic surveys will establish and monitor an acoustically verified exclusion zone for polar bears surrounding seismic airgun arrays or sound source where the received level would be ≥190 dB re 1 μPa.
- Immediately power-down or shut-down the seismic airgun array and/or other acoustic sources whenever any polar bears are sighted approaching close to or within the area delineated by the 190 dB re 1 μPa polar bear exclusion zone. If the power-down operation cannot reduce the received sound pressure level to 190 dB re 1 μPa the operator must immediately shut-down the seismic sound sources.
- Ramp-up Procedures - (A) Prior to commencing ramp-up, the exclusion zone for polar bears must be visible and observed by a PSO watch for at least 30 minutes when: at the commencement of operations using airguns or sound sources; a complete shut-down has occurred; any time operation of the airgun array or sound source(s) is discontinued for a period of 10 minutes or more, or the PSO watch has been suspended; (B) If the exclusion zones are not completely visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, ramp up may commence following established procedures which must include: Ramp-up airgun arrays slowly over a period of at least 30 minutes, start with one airgun or sound source in the array and then gradually add additional guns or sound sources, until the full array is firing.
- Poor Visibility Conditions - (A) During poor visibility conditions (fog, rain, snow, darkness, etc.), if the entire 190 dB re 1 μPa polar bear exclusion zone is visible using vessel lights and/or night vision devices, then ramp-up procedures of airguns or sound sources may occur following a 30 minute period of observation by PSOs with no sighting of polar bears in their exclusion zone; (B) If during poor visibility conditions, the full exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shutdown; (C) If, however, one or more airguns have been operational since before the onset of poor visibility conditions, they may continue to operate under the assumption that polar bears will have been alerted by the sounds from the single airgun and have moved away.
- Holders of LOAs will be required to develop and implement an approved, site-specific polar bear interaction plan for on-shore and on-ice exploration activities. Polar bear awareness training will also be required of certain personnel. For on-ice surveys, trained polar bear monitors are often required to alert crew of the presence of polar bears and initiate adaptive mitigation responses.
- Activities in known or suspected polar bear denning habitat during the denning season (November to April) must include efforts to locate occupied polar bear dens within and near proposed areas of operation with FLIR imagery and/or polar bear scent-trained dogs.
- Operators must observe a 1.6 km (1 mi) operational exclusion zone around all known polar bear dens during the denning season. Should previously unknown occupied dens be discovered within one mile of activities, work in the immediate area must cease. The USFWS will evaluate these instances on a case-by-case basis to determine the appropriate action. Potential actions range from cessation or modification of work to conducting additional monitoring, and the holder of the authorization must comply with any additional measures specified.

In addition to these mitigation measures designed to reduce impacts on polar bears, the MMPA contains provisions to protect subsistence hunting of polar bears by requiring plans of cooperation and communication channels between industry and subsistence communities when the activities have the potential to impact subsistence hunting. Industry is also required to participate in monitoring programs intended to measure the effectiveness of mitigation measures and advance knowledge about the species. LOAs have also established protocols for reporting interactions with polar bears and the results of monitoring programs.

Behavioral Disturbance

There are several mechanisms for potential disturbance to polar bears associated with each of the different types of exploration activities that would be authorized under Alternative 2. Most of these mechanisms are common to both the Beaufort and Chukchi seas, and these potential effects are discussed together. Where activities or mechanisms are unique to one sea or the other, they are discussed separately.

Marine Vessels

Exploration activities during the open water season are limited to vessel-based exploration activities. Because most polar bears tend to remain on the ice pack as it moves north, there is a limited potential for exploration vessels to encounter polar bears on ice floes or swimming in open water. The physical presence of a vessel is more likely to cause disturbance to a polar bear rather than the airborne noise generated by the vessel but observer data indicates that bears generally do not react strongly to the presence of vessels, with most animals exhibiting neutral or ambiguous movements in relation to the ship (Savarese et al. 2010). In the Beaufort Sea, polar bear sightings from exploration vessels are uncommon and most of these have been of polar bears on or near barrier islands in the fall (Savarese et al. 2010). In the Chukchi Sea, polar bear sightings from vessels have been relatively rare (Haley et al. 2010a). About half of the sightings have been of bears in the water.

Icebreaking

Icebreaking vessels, whether used for in-ice seismic surveys or for ice management near exploratory drilling ships, introduce an additional type of disturbance to polar bears than non-icebreaking vessels. These activities would take place in late fall to early winter under Alternative 2, a time period when polar bears are often hunting seals along leads in the ice and in broken ice. Bears resting on ice floes may also be disturbed by ice management vessels if the floe is too close to an exploratory drilling rig (USFWS 2008b). However, given the dispersed distribution of bears on the ice and the short time period and limited geographic extent of icebreaking activities, it is unlikely that more than a few bears would be affected in either of the Arctic seas and such disturbance would be temporary to both the bears and their ice seal prey.

Seismic Surveys

There is limited information on the hearing of polar bears. Polar bears are not known to communicate underwater and studies have not been conducted to determine the effects, if any, on polar bears from underwater noise. The greatest concern for most marine mammals from exploration work has been the potential for disturbance from seismic airgun arrays, especially the larger and more powerful 2D/3D arrays (16 to 36 airguns) which cover large areas. During the 2006 to 2008 open-water seasons, 15 polar bears were observed in the water from exploration vessels in the Beaufort Sea (n=11) and the Chukchi Sea (n=4). Of these animals, one was observed within the 170 dB re 1 µPa rms safety radius (which initiated a power-down situation as a precaution before the bear potentially entered the 190 dB re 1 µPa rms safety radius) and the rest were outside the 160 dB re 1 µPa rms safety radius (Savarese et al. 2010, Haley et al. 2010a). Most of these animals exhibited neutral or ambiguous behavior rather than clear avoidance behavior (moving away from the exploration vessel). Given the short time period in which seismic vessels would be operating in any one area, potential behavioral reactions of bears to seismic surveys would likely be temporary.

Aircraft Traffic

Behavioral reactions of polar bears to aircraft depend on distance and type of aircraft. Polar bears may run away from aircraft passing at low altitudes. Most polar bears in dens continue to occupy the dens after close approaches by aircraft (Amstrup 1993). Although the snow attenuates some aircraft noise (Blix and Lentfer 1992), it is possible that repeated overflights may cause polar bears to abandon or depart their dens. However, minimum flight altitudes and flight restrictions around known polar bear dens would reduce the potential for bears to be disturbed by aircraft. Given the limited amount of activities likely to require over-ice aircraft support under Alternative 2, the numbers of bears potentially affected would be very small.

On-ice Vibroseis Survey (January to May)

On-ice vibroseis surveys are typically conducted only in the shallower, near shore waters of the Beaufort Sea and take place during the winter. This type of survey is the only type of exploratory activity authorized under Alternative 2 that has a realistic potential for direct human-bear encounters. The noise produced by on-ice activities such as ice-road construction and vibroseis surveys could attract curious bears rather than deter them. Encounters with humans can be dangerous for both polar bears and humans and are the subject of polar bear interaction plans developed in collaboration with and approved by the USFWS. The plans provide guidance for minimizing polar bear encounters through personnel training, polar bear guards, lighting, snow clearance, waste management and garbage control, agency communication, site clearance, and site-specific safety briefings for polar bear awareness. Employee training programs are designed to educate field personnel about the dangers of human-bear encounters and to implement safety procedures in the event of a bear sighting. Personnel are instructed to leave an area when bears are seen in the vicinity. As described in the LOA mitigation measures above, special emphasis is placed on finding and protecting polar bear dens with a 1.6 km (1 mi) buffer zone from all exploration activities. These efforts involve radio-collaring female bears, FLIR surveys, scent-trained dogs, and cooperative GIS efforts among the USFWS and all companies covered under exploratory and development LOAs.

Noise and vibrations produced by vibroseis activities could potentially result in impacts on denning and non-denning polar bears. The best available scientific information indicates that female polar bears entering dens, or females in dens with cubs, are more sensitive than other age and sex groups to noises. The proactive and adaptive nature of the LOA mitigation measures regarding den sites are designed to avoid and minimize the potential adverse effects on denning polar bears. Given the limited number and extent of the on-ice activities authorized under Alternative 2, the number of bears potentially affected would be very small.

Exploratory Drilling

Exploratory drilling involves the establishment of a large drill ship or ice island in one location for some weeks and the deployment of numerous support vessels. The physical presence of multiple ships in the same area may result in a greater potential for disturbance to polar bears than seismic surveys but the geographic area involved is much smaller. The noise generated from drilling is also not as loud as seismic airguns but it is produced on an almost continual basis, making it more of a chronic sound source in one location. Given the mild reaction of polar bears to marine vessels, drilling activities are unlikely to be a source of more than temporary displacement. (Polar bears are curious and will approach vessels and drilling vessels but do not appear to be particularly disturbed by their presence in most instances.) This displacement would be temporary and would not involve loss of feeding opportunity since bears typically do not hunt from the water.

Hearing Impairment, Injury, and Mortality

The noise levels required to cause TTS or PTS have not been determined for polar bears. However, polar bears typically swim with their heads above water or encounter exploration vessels while on ice or land, where sound levels from seismic surveys would be greatly reduced and they are unlikely to experience injurious sound levels.

PSOs on many vessels in both seas have logged thousands of hours monitoring vessel transit and have recorded only a few dozen polar bears in the water. There have been no suspected or documented cases of polar bears being injured or killed by the type of large vessels used in Arctic oil and gas exploration activities. Given the infrequency of polar bear observations at sea and the presence of observers on board, the risk of ship strikes for polar bears is considered negligible. It is also very unlikely that any polar bears would be exposed to very loud sounds from seismic operations to the point where they might be injured.

The main concern for the safety of polar bears during exploration activities is to minimize the risk of human-bear encounters and to manage encounters appropriately so neither bears nor humans suffer injury or death. Oil industry encounters with polar bears in Alaska that have resulted in mortality of bears have been rare, with one case in the winter of 1968 to 1969 and another in 1990 (USFWS 2008b). More recently, a female polar bear was shot and killed by a security guard near employee housing at the Endicott oil field (Reuters 2011). The USFWS began issuing LOAs for exploratory activities on the North Slope in the early 1990s that included mitigation measures and polar bear safety/interaction plans. Polar bears are curious about new things in their environment, however, so there is always the potential for human-bear interactions during oil and gas exploration in the Arctic, even if the activities are temporary. Continual preparation, training, and vigilance are required to maintain the excellent record of avoiding lethal encounters with polar bears, especially as more bears spend more time on shore as the ice pack recedes due to climate change and bears have to fast for longer time periods. It is in the industry's best interest to place a high priority on safety regarding polar bears and it is likely they will continue to work closely with the USFWS to improve and update their procedures to maintain the safest possible working conditions for the sake of people and bears.

Intentional take of polar bears (through USFWS authorizations under sections 101(a)(4)(A), 109(h), and 112(c) of the MMPA) occurs on the North Slope as well (USFWS 2011b). Intentional take is used as a mitigation measure to allow take of polar bears by harassment (nonlethal deterrence activities) for the protection of both human life and polar bears. These MMPA-specific authorizations have proven to be successful in preventing injury and death of humans and polar bears.

Small Fuel Spill

There is the potential for polar bears to be exposed to small (<50 bbl) spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g., transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). The USFWS has determined that, based upon the reported effects of crude oil and refined oil products exposure on polar bears, any bear that makes contact with such a spill would probably die (USFWS 2008b). However, few polar bears are likely to be near exploratory activities during the open-water season, and the spatial separation that vessels and on-ice vehicles are required to maintain between themselves and bears should minimize the potential for close contact. In addition, if a small spill did occur, cleanup efforts would begin immediately and, if it occurred on land or on ice, would require the presence of PSOs to monitor for polar bears and to deter them from a dangerous situation by means of approved hazing methods. The risk of polar bears being exposed to small spills during exploration activities is therefore considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alterations

There are three potential mechanisms for habitat changes that may affect polar bears: disturbance/dispersion of prey species (ice seals) by seismic surveys or other industry activities; disturbance of sea ice habitat from icebreakers; and ice-road construction and on-ice survey activities.

The analysis of effects on ice seals (Section 4.5.2.4.13) indicates that most of the effects on these species from seismic surveys, icebreaking, and vessel traffic under Alternative 2 would be temporary and would not have population-level effects. None of the effects are likely to displace ice seals for more than a few hours and typically much less. It is therefore unlikely that the availability of seals to polar bears would be affected at all and would continue to be determined primarily by ice conditions and distribution, which are not affected by exploration activities.

Icebreaking ships intentionally disrupt ice floes in order to conduct seismic surveys or to help manage ice flows around exploratory drilling equipment. These activities would take place in late fall to early winter under Alternative 2, a time period when polar bears are on the pack ice or on shore waiting for the ice to return. Sea ice in these seasons moves continually, opening leads and closing them very quickly at times. The channels cut by icebreakers often close up very soon after the ship passes, mimicking the natural dynamics of the ice in many respects, and would not offer any hindrance to polar bear movement. On-ice seismic surveys in the Beaufort Sea require the construction of ice-roads on shore-fast ice and the removal of snow in some places to prepare for vibroseis equipment but these activities would not affect the abundance of seal breathing holes or dens, which polar bears seek out for hunting purposes. The effects on polar bear habitat are therefore temporary and of low intensity.

4.5.2.4.15.2 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are an important subsistence resource and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 2 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 2 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.5.2.4.16 Standard Mitigation Measures for Marine Mammals

Standard Mitigation Measures are outlined in Section 2.4.10 and described in detail in Appendix E. These measures are required by all permits and authorizations issued under Alternative 2 for the noted activities. Many of them are similar or identical to mitigation measures required by the USFWS in the LOAs for polar bears and walruses. Therefore, while the measures considered by NMFS would only be included in authorizations for species under NMFS' jurisdiction, there is the potential for these measures to reduce impacts to polar bears and walruses, which are species under the jurisdiction of the USFWS. Application of these or similar measures for walruses and polar bears are discussed where appropriate. The following standard mitigation measures would be implemented to reduce adverse effects of oil and gas exploration activities on marine mammals. The decision to include the following mitigation measures as Standard Mitigation Measures in this FEIS is based on the analysis contained in the DEIS and SEIS and the public comments received on the measures during the comment periods for those documents.

Additionally, as noted above in the Conclusion sections for several species, because they are required under this alternative, the anticipated effects of the implementation of these Standard Mitigation Measures are included in the conclusions.

A1. Establishment and execution of 180 & 190-dB shutdown/power down radius for cetaceans & ice seals, respectively. The indicated radius is established, and monitored by PSOs, and the airguns are either powered down or shutdown if an animal approaches or comes within the distance associated with received levels of 180 or 190 dB rms (which is established either through acoustic modeling or on-site sound source verification tests).

This measure is applicable when conducting **2D/3D, in-ice, OBC/OBN, and VSP seismic surveys and site clearance and high resolution shallow hazards surveys**.

Purpose: The purpose of this measure is to avoid the injury of marine mammals through PTS and to reduce the likelihood of TTS or more intense behavioral responses that might be expected to occur as a result of exposures at these higher levels.

Science, Support for Reduction of Impacts, and Likely Effectiveness: Section 4.2.6 discusses NMFS' current acoustic thresholds and references upcoming revisions to the thresholds based on Southall et al. (2007), as well as Finneran and Jenkins (2012). Additionally, the sections above include more information regarding the levels above which and durations beyond which animals would be expected to incur acoustic injury. NMFS does not expect that every animal exposed to this level of sound would experience PTS, especially from periodic pulsed sounds that move through an area such as occur from seismic surveys. However, as noted above, hearing impairment can also result from exposure to lower levels over a longer time.

The 180-dB rms zone should contain the area of potential injury for cetaceans, with the possible exception of high-frequency cetaceans – for which the area may be slightly larger. For phocid seals, the 190-dB rms zone likely contains the majority of the area in which injury could occur, but the area could be slightly larger based on the draft revised acoustic thresholds (see Section 4.2.6 of this EIS). Because the metrics are different (cSEL vs. SPL rms), allowing for an accumulation of sound over time, and because frequency weighting should be applied to the specific sound source, it is difficult to pre-determine exactly how big the area of concern will be in advance of modeling for any particular source, but preliminary calculations suggest that the areas would not far exceed the 180 or 190-dB isopleths.

The safety radius serves to provide a basis for reducing the level of sound exposure before PTS occurs. Associated mitigation measures (e.g., ramp up and PSO requirements) are intended to either give marine mammals a chance to swim away from potentially harmful sound sources or to minimize their risk of accidental exposure to such sounds. Data from PSOs indicate that most seals tend to move out of the way before they enter this safety radius, and others do not appear to be disturbed to any noticeable extent as active seismic vessels approach close by, even as these close approaches require power-down/shutdown procedures.

The majority of marine mammals likely avoid the source at these distances. The majority of animals entering these zones are likely detected before they have been exposed above 180 or 190 dB for substantial amounts of time, and then further continued exposure at those levels is avoided by power-down or shutdown.

The ability of PSOs to effectively monitor these radii depends on their experience, state of alertness, and visibility/sea conditions, all of which vary over time, as well as the size of the zone. Distances out to which observers can detect marine mammals also depend on the height of the observation platform above water. For example, Haley et al. (2010b) calculated an effective strip half-width (the distance from the centerline of the transect outside of which the number of animals detected equals the number not detected inside) of 1,618 to 3,136 m (1,767 to 3,430 yds.) for vessels higher than 11 m (12 yds.) and 1,191 to

1,893 m (1,302 to 2,070 yds.) for those lower than 11 m (12 yds.). Additionally, although the 190-dB zone is smaller than the 180-dB zone, pinnipeds are often more difficult to detect visually than cetaceans.

One limitation and concern regarding monitoring of the exclusion radii is that the 180-dB zone may extend beyond the detection limits of the PSOs, so that cetaceans may enter within the exclusion radii and be exposed to sound sources ≥180 dB rms. Funk et al. (2010) found that the size of ≥180 dB rms exclusion radius around the seismic vessel *Gilavar* in the Chukchi Sea 2007 and 2008 approached the limit of the distance to which PSOs could reliably detect marine mammals. A protocol utilizing additional monitoring vessels was, therefore, employed to observe the exclusion zone. However, there is also the possibility of marine mammals avoiding or being disturbed by the presence of additional vessels, as noted earlier in this document.

For pinnipeds (except walruses), the 190 dB radius for 2D/3D seismic arrays (24 airguns) in the Beaufort Sea is 860 to 920 m (2,821 to 3,018 ft.) (Savarese et al. 2010). In the Chukchi Sea, the typical range for the 190 dB radius for 2D/3D seismic arrays (16 to 36 airguns) is 460 to 610 m (1,509 to 2,001 ft.) (Haley et al. 2010a). For site clearance and high resolution shallow hazards surveys (1 to 4 airguns) this radius typically ranges from 5 to 50 m (16 to 164 ft.) (Savarese et al. 2010, Haley et al. 2010a). Ice seals are the most common marine mammals sighted by PSOs, and the detection of seals within the 190 dB exclusion zone radius has resulted in numerous powerdown/shut down situations in both the Beaufort and Chukchi seas. During the most active years for seismic work in recent years, 35 seals were detected within the 190 dB radius in the Beaufort Sea in 2008 (Savarese et al. 2010) and 65 seals were detected within the radius in the Chukchi Sea in 2006 (Haley et al. 2010a). These numbers are likely underestimates of the number of seals exposed to these sound levels because some animals may have moved away before coming into the range of visual observers and others could have been underwater or otherwise escaped detection by PSOs.

Frequency of implementation of shutdown and powerdown zones varies but appears generally higher for pinnipeds (190 dB radius) than cetaceans. In 2008, 41 of 44 power downs requested during seismic surveys in the Beaufort Sea were for pinnipeds; the remainder was for one bowhead whale and two unidentified mysticetes (Ireland et al. 2009).

Despite observer effort to mitigate exposure to sounds ≥180 dB re 1 μPa rms, some cetaceans may enter within the exclusion radii. In the Chukchi Sea in 2006 to 2007, 13 cetaceans were sighted within the ≥180 dB re 1 μPa rms radius and exposed to noise levels above that range before appropriate mitigation measures could be implemented (Haley et al. 2010b). Acoustic impairment or injury is, therefore, unlikely for the cetaceans that briefly enter within the 180 dB exposure radius before the mitigation measure can be implemented.

History of Implementation: Power-down and shutdown procedures are currently used, and have been consistently used for years, during exploration activities in the Beaufort and Chukchi seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years.

Rationale: Based on the feasibility and likely avoidance of injury or more severe behavioral impacts, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

Walruses – USFWS adopted the 180-db safety radius for walruses as a precautionary measure *in lieu* of direct evidence regarding sound source characteristics that would cause TTS (NMFS 2000). NMFS does not expect that every animal exposed to this level of sound would experience TTS, especially from periodic pulsed sounds that move through an area such as occur from seismic surveys. The safety radius serves to provide a basis for reducing the level of sound exposure before TTS occurs. Associated mitigation measures (e.g., ramp up and PSO requirements) are intended to either give walruses a chance to swim away from potentially harmful sound sources or to minimize their risk of accidental exposure to such sounds. The 180 dB radius is established through acoustic modeling or on-site verification tests, which have become routine operational practices for the industry, and is monitored by PSOs on board the sound source vessels and sometimes on support vessels. This measure has been implemented many times in the past due to the presence of walruses in the water near seismic vessels, primarily in the Chukchi Sea.

***Polar Bears* –**USFWS adopted the 190-dB safety radius for polar bears as a precautionary measure *in lieu* of direct evidence regarding sound source characteristics that would cause TTS in polar bears. The 190 dB radius is established through acoustic modeling or on-site verification tests, which have become routine operational practices for the industry, and is monitored by PSOs on board the sound source vessels and sometimes on support vessels. There are no records of polar bears being exposed to this intensity of sound from seismic surveys.

A2. Specified ramp-up procedures for airgun arrays. This technique involves the gradual increase (usually approximately 5-6 dB per 5-minute interval or by doubling the number of guns firing at 5-minute intervals when very small arrays are used) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of 20 to 40 minutes, until the desired operating level of the full array is obtained.

This measure is applicable when conducting **2D/3D, in-ice, OBC/OBN, and VSP seismic surveys and site clearance and high resolution shallow hazards surveys**.

Purpose: The purpose of a ramp-up (soft-start) procedure when starting airgun operations is to provide a gradual (from low levels) increase of sound (vs. sudden high level sound) so that marine mammals near the vessel have the opportunity to move away before being exposed to sound levels that might be strong enough to cause injury. The 180- and 190-dB exclusion zones described in the previous measure are used for the ramp-up procedures as well. The means by which this mitigates injury is by causing deflection from or avoidance of the sound source so, in effect, causing disturbance to mitigate harm. Ramp-up procedures would be implemented any time the airgun array has been shutdown for a certain period of time (typically between 8 and 10 minutes depending on the size of the array) in order to account for animals that may have entered the area since cessation of airgun firing.

Science, Support for Reduction of Impacts, and Likely Effectiveness: There have been no documented cases where cetaceans have been observed to move away from a survey vessel during ramp-up. However, existing observations of marine mammals in the presence of airguns suggest that at least a subset will move away, which means that they will be exposed to lower levels than otherwise when the volume of the airgun is raised. Therefore, some level of efficacy is assumed, based on general studies of effects of airgun sounds on marine mammals,.

Single-airgun experiments show that bowheads typically move away when a single airgun starts firing nearby (Richardson et al. 1986, Ljungblad et al. 1988). Startup of a single airgun is equivalent to the start of a ramp-up, suggesting that bowhead whales would begin to move away during the initial stages of a ramp-up. Hannay et al. (2011b) conducted a model-based assessment of underwater noise from a soft-start operation. In shallow water (50 m [164 ft.] depth), the cumulative SEL levels for steps one through three (30 shots into the 230 shot ramp-up procedure) were below the proposed injury thresholds for cetaceans at 100 m (328 ft.) to the side of the sound source. Any bowhead whales in the vicinity would presumably move away during these early steps in the ramp-up procedure. NMFS requires that ramp-up of acoustic sources occur at a rate of no more than 6 dB per 5 min or a doubling of the number of operating airguns at 5-min intervals when small arrays are used. This ramp-up rate would prevent marine mammals from being exposed to high levels of noise without warning (75 FR 49760, August 13, 2010). The entire procedure generally takes 20 to 40 minutes to accomplish, depending on the size of the array, and is therefore easy to implement.

Mitigation Measure A2 could impact other cetaceans the same as it would bowhead whales. Single-airgun experiments with three species of baleen whales (gray, humpback, and bowhead) have shown that they tend to move away when a single airgun starts firing nearby, which simulates the onset of a ramp up (Malme et al. 1984, 1985, 1986, 1988; Richardson et al. 1986, Ljungblad et al. 1988, McCauley et al. 2000). Since startup of a single airgun is equivalent to the start of a ramp-up, this strongly suggests that many baleen whales will begin to move away during the initial stages of a ramp-up. It is assumed that toothed whales would react similarly. However, there have been no documented cases where ice seals have been observed to move away from a survey vessel during ramp up. The effectiveness of the measure and its reduction of adverse effects on ice seals are therefore unknown. NMFS has required this measure as a precautionary approach to conservation based on its potential for reducing adverse effects on a variety of species and its ease of application.

As noted above, logic and our understanding of how most marine mammals avoid loud sound would suggest that ramp up procedures would likely be effective to some degree in preventing the sudden exposure of marine mammals to injurious sounds. As noted above, cetaceans have been detected moving away from the sound source during a ramp up, but pinnipeds have not. Typically, though, not enough animals are detected during ramp ups of actual seismic surveys to perform a meaningful evaluation of the full effectiveness of the measure.

History of Implementation: Ramp-up procedures have been consistently required for years during exploration activities in the Beaufort and Chukchi seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years.

Rationale: Based on the feasibility and potential reduction of injury or more severe behavioral impacts, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

***Walruses* –** This standard mitigation measure applies to all seismic surveys and is the same as the USFWS LOA measures. The rationale for this measure is that walruses in the vicinity of a seismic survey would hear the low sound levels during ramp up and have a chance to move away before potentially damaging sound levels are reached. This procedure may take 20 to 40 minutes to accomplish depending on the size of the array, and is therefore easy to implement. There have been no documented cases where walruses have been observed to move away from a survey vessel during ramp up. The effectiveness of the measure and its reduction of adverse effects on walruses are therefore unknown.

***Polar Bears* –** This standard mitigation measure applies to all seismic surveys and is the same as the USFWS LOA measures. The rationale for this measure is that polar bears in the vicinity of a seismic survey would hear the low sound levels during ramp up and have a chance to move away before potentially damaging sound levels are reached. This procedure may take 20 to 40 minutes to accomplish depending on the size of the array, and is therefore easy to implement. There have been no documented cases where polar bears have been observed to move away from a survey vessel during ramp up. The effectiveness of the measure and its reduction of adverse effects on polar bears are therefore unknown.

A3. PSOs required on all seismic source vessels and icebreakers, as well as on dedicated monitoring vessels.

This measure is applicable when conducting **2D/3D, in-ice, OBC/OBN, and VSP seismic surveys and site clearance and high resolution shallow hazards surveys**.

Purpose: Presence of and observations by PSOs on the source vessels are crucial for implementing many of the other mitigation measures, such as the shutdown and power down measures, and for estimating potential impacts (see Measure A1 above). PSOs are also sometimes used to collect required monitoring information from sources vessels, although this requirement is separate and may be executed from a separate platform. PSOs are required to be trained in species identification and many other operational and data recording procedures. Data collected during visual observations include species identification, bearing and distance to the initial sightings, estimated closest point of approach of animals relative to source vessels or support vessels, movement of animals relative to vessel movements, and behavioral reactions of animals in response to vessel movements. Behavioral data are often limited by the brief time most marine mammals are at the surface where they can be observed and by distance from the vessel (Haley et al. 2010b). Crew members of all vessels are also instructed to watch for marine mammals and to notify the PSOs immediately if any are sighted. While it is not a job requirement, many PSOs are Iñupiat or Yupik hunters that live in Arctic coastal communities and bring a wealth of experience and traditional knowledge to the position.

Science, Support of Reduction of Impacts, and Likely Effectiveness: Distance out to which observers can detect marine mammals depends on the height of the observation platform above water. For example, Haley et al. (2010b) calculated an effective strip half-width (the distance from the centerline of the transect outside of which the number of animals detected equaled the number not detected inside) of 1,618 to 3,136 m (1,767 to 3,430 yds.) for vessels higher than 11 m (12 yds.) and 1,191 to 1,893 m (1,302 to 2,070 yds.) for those lower than 11 m (12 yds.).

Visually detecting marine mammals during periods of low to poor visibility, including fog and darkness, may also be challenging. Extensive ice cover, particularly during icebreaking activities, could hinder detectability of marine mammals in water. However, despite limitations, PSOs are invaluable for the purposes of mitigation implementation and data collection aboard industry vessels.

Experiences by subsistence hunters discuss the need for PSOs on all vessels during activities.

Willie Goodwin, representing the Alaska Beluga Whale Committee made comments at the Kotzebue Public Scoping Meeting for this EIS on February 18, 2010: *"I think you should require that any seismic work or any other work that's going to be done by the oil industry, you should require them to have MMOs, marine mammal observers. At the very least, to be able to not harm the marine mammals or their migration."*

Dora Leavitt remarked at Nuiqsut Public Scoping meeting for this EIS on March 11, 2010: *"I know that they [industry] - and they now use marine mammal observers, but they don't have them in each vessel. They have them in the -- maybe the main supply or whatever vessel. And then you have all these runners, the resupply runners that go on their own with no observers. So, you know, they [industry] need more marine mammal observers."*

History of Implementation: PSOs on source vessels have been consistently required for years during exploration activities in the Beaufort and Chukchi seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years. However, when smaller boats are utilitized to conduct operations, berthing space for additional personnel (such as PSOs) is often challenging. In such instances, a lower number of trained PSOs have been required. Additionally, trained crew members can assist in detecting marine mammals for mitigation implementation when not performing other duties.

Rationale: Based on the feasibility and likely reduction of injury or more severe behavioral impacts, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

***Walruses* –** The use of the phrase PSOs is synonymous with the term MMOs in the USFWS LOAs. This mitigation measure applies to seismic surveys and icebreaking. PSOs are trained in species identification and many other operational and data recording procedures. Their presence and observations are crucial for implementing many of the other mitigation measures. Crew members of all vessels are also instructed to watch for marine mammals and to notify the PSOs immediately if any are sighted. While it is not a job requirement, many PSOs are Iñupiat or Yupik hunters that live in Arctic coastal communities and bring a wealth of experience and traditional knowledge to the position.

***Polar Bears* –** The use of the phrase PSOs is synonymous with the term MMOs in the USFWS LOAs. This standard mitigation measure applies to seismic surveys and icebreaking. PSOs are trained in species identification and many other operational and data recording procedures. Their presence and observations are crucial for implementing many of the other mitigation measures. Crew members of all vessels are also instructed to watch for marine mammals and to notify the PSOs immediately if any are sighted. While it is not a job requirement, many PSOs are Iñupiat or Yupik hunters that live in Arctic coastal communities and bring a wealth of experience and traditional knowledge to the position.

A4. All activities must be conducted at least 152 m (500 ft.) from any observed ringed seal lair. No energy source may be placed over a ringed seal lair. Operators will use trained seal-lair sniffing dogs or a comparable method to locate the seal structures before initiation of activities. This measure requires survey crews to be trained in seal detection and to search for ringed seal lairs around intended seismic survey operation sites and prohibits seismic activities and impact work within a 152 m (500 ft.) radius of ringed seal subnivean lairs. Additionally, while traveling on ice roads, the area shall be monitored for marine mammals, especially ringed seal lairs. Vehicles must avoid any pressure ridges, ice ridges, and ice deformation areas where seal structures are likely to be present.

This measure is applicable when conducting **on-ice seismic surveys**.

Purpose: The purpose of this measure is to avoid mortality, injury, and/or severe disturbance of ice seals when they are in their lairs. Additionally, this requirement helps to ensure that machinery is not placed directly over a lair, thereby crushing the lair. If a lair is crushed, an animal inside the lair could be injured or killed. If the animal survives, it could be forced into the water. Pups are more susceptible to hypothermia, so forcing them into the water before their insulation layers are fully formed could result in mortality.

Science, Support of Reduction of Impacts, and Likely Effectiveness: At this 152 m (500 ft.) distance, sound source levels from vibroseis gear are not likely to appreciably affect ringed seals (Burns and Kelly 1982, Kelly et al. 1988). Crew at BP's Northstar Island have searched for and marked ringed seal lairs over the last decade prior to ice road construction activities.

Use of trained dogs improves the ability to detect ice seals under the snow and ice. It is not clear how many seals may be affected, but this measure would reduce the risk of disturbing/injuring ice seals in their lairs from close distances. If proposed on-ice surveys were in known ice seal concentration areas, this measure could reduce disturbance impacts for a substantial number of seals.

History of Implementation: Avoidance of ringed seal lairs has been consistently required for years during on-ice exploration activities in the Beaufort Sea. This measure has not been required in the Chukchi Sea and is not expected to be required in the Chukchi Sea since on-ice seismic surveys are not conducted there.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years. The logistics of securing the services of trained dogs and their handlers should be fairly straightforward, as this technique has been in use for decades. However, there are a limited number of dogs that are trained specifically for these purposes. Therefore, it might be difficult to implement if there are no dogs available that are well enough trained to be used. For that reason, we have included language that comparable methods are valid if dogs are not available for use.

Rationale: Based on the feasibility and likely reduction of injury or more severe behavioral impacts to ringed seals, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities. If tranined seal-lair sniffing dogs are unavailable, other practicable methods for locating and siting the structures will be required.

Polar Bears – This standard mitigation measure applies only to on-ice surveys and requires survey crews to be trained in seal detection and to search for ringed seal lairs around intended seismic survey operation sites and to prohibit seismic activities within a 152 m (500 ft.) radius of ringed seal lairs. This measure helps reduce potential effects on the main prey of polar bears in the Beaufort Sea.

B1. Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

This measure is applicable when conducting any aircraft operations in support of oil and gas exploration operations, including **2D/3D, in-ice, OBC/OBN, and VSP seismic surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities**.

Purpose: Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing marine mammals in the water or hauled out on the ice or land. Additionally, this mitigation measure is intended to ensure no unmitigable adverse impacts occur to subsistence hunters from the anticipated increases in levels of aircraft overflights during oil and gas exploration activities. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions (such as poor weather or low visibility).

Science, Support of Reduction of Impacts, and Likely Effectiveness: Studies of behavioral reactions of bowhead whales to aircraft are limited but indicate that whales react little, if at all, to fixed-wing aircraft operating at an altitude of 460 m (1,509 ft.) and that most reactions to helicopters occur when the helicopter was at altitudes of ≤150 m (500 ft.) (Patenaude et al. 2002, Richardson and Malme 1993). When conducting support operations (other than marine mammal monitoring), NMFS requires aircraft to operate at altitudes of 457 m (1,500 ft) or greater, except during approach, landing and take off, or unless in poor weather or an emergency situation. NMFS requires that marine mammal monitoring survey flights be conducted at 305 m (1,000 ft.) or greater to avoid adverse impacts to bowhead whales (and other marine mammal species). However, in areas of active subsistence use, aircraft engaged in marine mammal monitoring will not operate below 457 m (1,500 ft) in order to reduce impacts to subsistence hunters. The subsistence use areas will be identified through communication with Communication Centers (see Standard Mitigation Measure D2 in Section 4.5.3.2.3 for explanation). USFWS requires a minimum altitude of 914 m (3,000 ft.) in the LBCHU and when flying over walruses and polar bears on ice or land. In the LBCHU and when over walruses or polar bear, the oil and gas industry conducting operations under MMPA ITAs from both NMFS and the USFWS would be required to implement the more stringent flight altitude. The altitude restrictions associated with this mitigation measure should, therefore, adequately reduce most adverse impacts from aircraft overflights.

Reactions of beluga whales to aircraft vary. Richardson et al. (1991) reported no overt response of beluga whales, even when the aircraft was 100 to 200 m (328 to 656 ft.); other responses included looking up, diving abruptly, or turning sharply away from the aircraft. As summarized in Richardson et al. (1995), beluga whales often react to aircraft by swimming or diving. The altitude restrictions associated with this mitigation measure should, therefore, adequately reduce most adverse impacts from aircraft flyovers.

Typical observed reactions of hauled out pinnipeds to aircraft include looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water. Born et al. (1999) determined that 49% of ringed seals escaped (i.e., left the ice) as a response to a helicopter flying at 150 m (492 ft) altitude. Spotted seals hauled out on land in summer are unusually sensitive to aircraft overflights compared to other species. They often rush into the water when an aircraft flies by at altitudes up to 300 to 750 m (984 to 2,461 ft). They occasionally react to aircraft flying as high as 1,370 m (4,495 ft) and at lateral distances as far as 2 km (1.2 mi) or more (Frost and Lowry 1990, Rugh et al. 1997). The altitude restrictions associated with this mitigation measure should, therefore, adequately reduce most adverse impacts from aircraft flyovers.

Subsistence users have commented on the importance of aircraft altitude restrictions: *"Require aircraft to maintain a 1,000 ft. minimum altitude when flying over marine mammals observed on or near the* *surface"* - Alex Whiting and Linda Joule - Written comments representing Native Village of Kotzebue February 26, 2010.

Inclement weather may occasionally cause brief instances when aircraft are operated at altitudes below 305 m (1,000 ft.) and short term impacts to subsistence resources and users would then occur.

The complete removal of potential sources of aircraft disturbance to marine mammals during any subsistence uses (with exceptions noted above), is expected to reduce potential adverse impacts on subsistence uses from industry activities. Iñupiat hunters report that this measure is critical for reducing adverse impacts of industry activity on their subsistence hunts. This mitigation measure would be implemented when flying aircraft over the subsistence use areas for the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue to ensure no unmitigable adverse impact to the availability of subsistence resources for these eight communities.

History of Implementation: Altitude restrictions have been consistently required for years during exploration activities in the Beaufort and Chukchi seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years. The flight stipulations are standard operating procedures and coincide with normal safety considerations for air support of offshore activities, so they generally do not "cost" more to implement. Limitation of air activity around particular subsistence hunting activities can result in some additional costs to industry; however, industry has worked with the various communities along the Beaufort and Chukchi seas to establish Communication Centers during the open water season to avoid conflicts and have also included design measures in programs to move activities from one area to another to avoid conflicts.

Rationale: Based on the practicability and likely reduction of behavioral impacts to marine mammals, as well as the importance of this measure to ensuring no unmitigable adverse impact to subsistence uses of marine mammals, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

***Walruses* –** This standard mitigation measure applies to all exploration activities. Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing walruses and other marine mammals in the water or on the ice or land. This restriction would be especially important for avoiding walruses concentrations hauled out on land or on ice where panic reactions could cause injuries or mortality of animals. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions. There is no direct evidence about how effective this mitigation measure has been for reducing disturbance to walruses but the flight stipulations are standard operating procedures and coincide with normal safety considerations for air support of offshore activities.

***Polar Bears* –** This standard mitigation measure applies to all exploration activities. Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing polar bears and other marine mammals in the water or on the ice or land. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions. There is no direct evidence about how effective this mitigation measure has been for reducing disturbance to polar bears but the flight stipulations are standard operating procedures and coincide with normal safety considerations for air support of offshore activities. NMFS has required this measure as a conservative approach based on its potential for reducing adverse effects on a variety of species and its ease of application.

C1. Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals.

This measure is applicable when conducting **2D/3D, in-ice, OBC/OBN, and VSP seismic surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel operations**.

Purpose: This measure is primarily designed to mitigate vessel collision with marine mammals (i.e., injury), although it may also indirectly reduce the risk of disturbance to whales (and potentially other marine mammal species).

Science, Support of Reduction of Impacts, and Likely Effectiveness: The circumstances under which the few reported ship strikes and vessel injuries to bowhead whales occurred are unknown, but, given that speeds above 15 kn are known to increase the likelihood of vessel collisions elsewhere for other species (Laist et al. 2001, Vanderlaan and Taggart 2007), this mitigation measure should prove effective. Modeling of speed restriction impacts to lethality of vessel collision found that a speed restriction of 10 kn reduced the predicted probability of lethality by 56.7 percent (Wiley et al. 2011). The effectiveness of this measure is, however, partly dependent on the ability of PSOs to adequately detect whales at the distance within which these measures apply and the vessels can adequately reduce speed.

Reducing sudden or multiple changes in vessel direction and requiring vessels to slow down under conditions of poor visibility would also reduce noise levels and the sudden appearance of fast vessels approaching whales in poor visibility. There are no data by which to determine the effectiveness of this measure to indirectly reduce adverse effects of vessel disturbance on bowhead whales, but bowheads appear to be less reactive to and tolerant of slow-moving vessels (Richardson and Malme 1993).

Beluga whale reactions to vessels are highly variable and depend on the habitat, type and behavior of boat, the whales' previous experience with vessels, and the behavioral activities of the whales during the vessel interaction. It is not known whether there have been any ship strikes involving beluga whales and exploration vessels in the Arctic, but given that speeds above 15 kn are known to increase the likelihood of vessel collisions elsewhere (Laist et al. 2001, Vanderlaan and Taggart 2007), this mitigation measure should prove effective and have similar results for belugas whales as it would for bowhead whales (see Section 4.5.2.4.10).

While ship strikes are known to affect most of the cetaceans within the EIS project area, it is difficult to draw conclusions regarding causes. Behavior varies within and among species, and there is an overall lack of quality data surrounding ship strikes (Jensen and Silber 2003). However, this measure would be expected to be as helpful in avoiding ship strikes to other species as to bowheads and belugas.

The risk of vessel collisions with seals is much less than for slower moving whales. There is no evidence that any ice seals have been struck by any vessels associated with exploration activities in the Arctic.

History of Implementation: Use of speed or direction changes in the presence of marine mammals has been consistently required for years during exploration activities in the Beaufort and Chukchi Seas. In the early years of requiring this measure, specific speeds were not included; however, beginning in 2012, NMFS began including specific vessel speeds when in close proximity to whales or in low visibility conditions.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years. Additionally, it is in the best interest of any vessel not to hit a marine mammal or any other object in the water.

Rationale: Based on the practicability and likely reduction of injury or death of marine mammals, as well as a potential reduction in disturbance to some species, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

***Walruses* –** This standard mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. Although this mitigation measure is intended to reduce the risk of collisions with whales, it may also indirectly reduce the risk of disturbance to walruses by reducing sudden changes in vessel direction and requiring vessels to slow down under conditions of poor visibility, thereby reducing noise levels and the sudden appearance of vessels fast approaching walruses in the dark or obscured conditions.

Polar Bears – This standard mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. Although this mitigation measure is intended to reduce the risk of collisions with whales, it may also indirectly reduce the risk of disturbance to polar bears by reducing sudden changes in vessel direction and requiring vessels to slow down under conditions of poor visibility, thereby reducing noise levels and the sudden appearance of vessels fast approaching bears in the dark or obscured conditions.

4.5.2.4.16.1 Standard Mitigation Measures Summary for Marine Mammals

The incorporation of all of these standard mitigation measures discussed above into future permits and authorizations would work to reduce adverse impacts to marine mammals that could result from oil and gas exploration activities. Measures to reduce impacts on the availability of marine mammals for subsistence uses are discussed in detail in Section 4.5.3.2.3. Several measures are designed with a particular species in mind but could result in a reduction of adverse indirect impacts to other marine mammal species or other living marine species as well. As noted above, the requirement of Standard Mitigation Measures is considered in the conclusion sections of the marine mammal impact analyses included above.

4.5.2.4.17 Additional Mitigation Measures for Marine Mammals

Additional mitigation measures are outlined in Section 2.4.11 and described in detail in Appendix E. These measures may, or may not, be incorporated in future permits and authorizations, depending on the specific activity and the analysis conducted pursuant to the MMPA and the OCSLA. See Sections 2.4.2 and 4.3 for an explanation of how specific measures would be chosen for inclusion in any future permits or authorizations. While the measures considered here would only be included in authorizations for species under NMFS' jurisdiction, there is the potential for these measures to reduce impacts to polar bears and walruses, which are species under the jurisdiction of the USFWS. Application of these or similar measures for walruses and polar bears are discussed where appropriate. The following are applicable to mitigating effects of oil and gas exploration activities on marine mammals. The decision to include the following mitigation measures as Additional Mitigation Measures in this FEIS is based on the analysis contained in the DEIS and SEIS and the public comments received on the measures during the comment periods for those documents.

Additional Mitigation Measure A1. Prior to conducting the authorized survey or drilling program, the operator shall conduct sound source verification (SSV) tests for their airgun array configurations, drilling units, other acoustic sources, icebreakers engaged in icebreaking, and support vessels in the area in which the survey or drilling program is proposed to occur and report the broadband received levels of 190 dB, 180 dB, 160 dB, and 120 dB radii from the sound sources to the authorizing entity within 10 days of completion of the SSV tests.

This measure is applicable when conducting **2D/3D, in-ice, OBC/OBN, and VSP seismic surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and icebreakers engaged in icebreaking**. This measure may be applied to all, or only a subset, of the sound sources listed above.

Purpose: The purpose of this mitigation measure is to accurately establish the distances from the active sound sources of interest that a marine mammal will receive certain sound levels instead of relying on modeling and extrapolation from different known source levels or datasets. These measurements would be used to:

- refine the shutdown zone for that season, which would ensure that animals are not exposed to received levels associated with PTS (injury);
- allow for a more accurate post-operation estimate of the number of animals exposed to levels associated with Level B Harassment in that season;
- help systematically populate a body of similar estimates (for different airgun array sizes/types, drilling equipment, different areas, and different seasons) that could bound the likely propagation ranges and eventually allow for more reasonable and defensible estimates of shutdown and harassment zones in the future for surveys similar to those previously measured, so that SSVs need not be conducted prior to every survey or drilling operation; and
- inform a chronic or cumulative assessment of noise to better understand how marine species listening space or communication area may be affected by rising background noise and the temporal and spatial distribution of sound sources.

Science, Support for Reduction of Impacts, and Likely Effectiveness: Estimating underwater sound levels at different distances from the acoustic source should be based on empirical measurement where practicable. The radii of the monitoring zones will vary in size based on the characteristics of the devices and environmental features, such as bathymetry, bottom type, and water temperature and salinity.

It is generally acknowledged that modeled received levels will be more accurate if they are based on measurements taken of the given source in the same environment and season. However, the accuracy of predictions can vary based on the technology and methods used, so acoustic experts should be consulted. Although larger shutdown zones may be considered more conservative by theoretically increasing the area at which animals may not be exposed to sound, these larger zones are often difficult to monitor due to the extent of the area, poor visibility conditions, and difficulty in observing animals such as bowhead whales because of the amount of time they spend underwater. This measure would require operators to conduct measurements at the beginning of the exploration activity in order to provide industry a more useful zone for monitoring that season.

SSV measurements have been conducted for several years with similar types of vessels and sound sources in the same general locations. Over time, it may be possible to collect a broad set of sound source measurements that cover the range of variability in sound source and environmental characteristics (location, depth, bottom type, ice, etc.), which can then be applied in appropriate scenarios in the future without needing to collect new data prior to the beginning of every oil and gas exploration operation. NMFS is keeping records of the sound source verification measurements that have been taken and will use it to evaluate the need for source specific measurements in future authorizations.

Because of the high variability in measured isopleths for source vessels, it is not clear whether there is consistently a practical reduction of adverse effects to marine mammals. However, we have noted that as more SSVs have been conducted, and more measurements are available for reference, the difference between pre-season modeled/estimated isopleths and field measurements has decreased, allowing for better industry planning and a reduced likely of injurious take as a result of underestimated injury isopleths.

Additionally, although implementation has been limited, these measurements could contribute to chronic and cumulative noise modeling and assessments (such as the example presented earlier in this EIS) that allow us to better understand, and potentially modify, the spatial and temporal distribution of activities to mitigate the aggregate effects of multiple sound sources over time and their effects on acoustic habitat and the masking of critical acoustic cues for marine species.

History of Implementation: This mitigation measure has been required in the past for most oil and gas exploration projects in the Arctic. However, a 2011 University of Alaska seismic survey did not require an SSV. The previously implemented measure required results to be provided to NMFS within five days. However, because of an incident during the 2012 season where rushing the results caused an error in the data analysis, NMFS has determined that applicants have up to 10 days to submit the preliminary results.

Practicability: While there is existing expertise and adequate equipment available to implement this mitigation measure, there are substantial costs and planning associated with conducting an SSV test. Additionally, in certain instances, SSV tests can produce highly variable results, such as in extremely shallow water.

Rationale and Considerations for Future Implementation: Based on the analysis contained herein, we have determined that this measure should only be required on a case-by-case basis and therefore is listed in the Additional Mitigation Measure category of this FEIS. We would include this mitigation measure in authorizations where the project will occur in an area of the Chukchi or Beaufort seas where there are no pre-existing SSV test data and/or the expected sound propagation of the sources being used have not been adequately characterized in the U.S. Arctic. Therefore, we would make a case-specific decision regarding whether to require an SSV based on the airgun configuration of that survey or other sound sources to be used, the area, and the time of year. Once an appropriate representation of the likely propagation of a particular sound source has been estimated in a given region and season (which will take more than one measurement), additional measurements of that sound source will likely not be needed. To support this measure, BOEM and the industry should develop a systematic plan that identifies the categories of airgun configurations and other sound sources to be used during oil and gas exploration activities, area, and time that need to be populated with SSVs and indicate where data have already been gathered or still need to be collected. Once this effort is completed, it is likely that modeling will be the primary method for estimating the various sound isopleths.

***Walruses* –** The effects of this additional mitigation measure on walruses would be the same as described for ice seals in Section 4.5.2.4.13.

***Polar Bears* –** The effects of this additional mitigation measure on polar bears would be the same as described for ice seals in Section 4.5.2.4.13.

Additional Mitigation Measure A2. All PSOs shall be provided with and use appropriate ocular equipment in order to detect marine mammals within the exclusion zones. This may include the use of night-vision devices (e.g., FLIR imaging devices, 360° thermal imaging devices), Big Eyes, and reticulated and/or laser range finding binoculars.

This measure is applicable when conducting **any activity requiring PSOs**.

Purpose: The purpose of this measure is to improve the ability of a PSO to observe marine mammals in applicable exclusion zones. Some of the more specialized equipment such as FLIR and thermal imaging devices would be used during times of poor visibility (darkness or inclement weather), which would in turn result in shutdowns for a higher percentage of exposed animals and increased protection from injury (if effective).

Science, Support of Reduction of Impacts, and Likely Effectiveness: One FLIR system was tested by ION in summer 2012. Monitoring results suggest that the system was fairly good at detecting animals on the ice (i.e., pinnipeds) but less useful at detecting animals in the water (Beland et al. 2013).

In 2010, Statoil tested the use of an infrared camera to detect marine mammals and found that the usable view was 280 degrees, with blows of large whales visible out to 2,000 m (6,562 ft.) and smaller blows (porpoise) out to 500 m (1,640 ft.) (NMFS 2011b). The camera's effectiveness is weather dependent, with fog and poor sea state hampering visibility (white caps caused false positives), plus the narrow field of view and poor resolution diminish the effectiveness of FLIRs over broad areas. An advanced infrared (IR) camera system (Fast InfraRed Search and Track, or FIRST) tested in the Alaska Chukchi Sea in 2010 showed promise for improving the effectiveness of detecting marine mammals at the surface. Dall's porpoises were detected out to several hundred meters and blows of large baleen whales were detected at distances up to 7 km (4.3 mi). A reliable automatic detection function is needed for this to be valuable for marine mammal observations (Weissenberger et al. 2011). Continued development of the FIRST system led to the more recent Automatic Infrared Marine Mammal Mitigation System (AIMMMS) (Rheinmetall 2016). The AIMMMS technology is promising, but currently cost prohibitive. NMFS encourages industry to continue testing the use of such technologies. George (1999) reports that the surface of bowheads' skin is roughly the same temperature as the surrounding water, so only the blow would be useful for detection purposes – and that would only be useful under conditions with very little wind or if the animal is relatively close to the monitoring vessel. The smaller blows of beluga whales and other small cetaceans would not be detected at as great a distance as those of bowhead whales.

Discussions at the 2012 Open-water Meeting (March 6-8, 2012 in Anchorage, Alaska) suggest these devices can hamper near-source monitoring (the area of greatest radiated sound) because the PSO is attempting to observe more distant areas. Several methods have been attempted, but, as of yet, none have been shown to be effective. Plus, the efficacy of these various pieces of equipment in detecting marine mammals would likely vary substantially under different sets of conditions and with the experience of PSOs in operating them.

History of Implementation: As standard practice, NMFS has included language in authorizations about PSOs having access to Big Eyes, reticle binoculars, and night vision devices consistently for years during exploration activities in the Beaufort and Chukchi seas. NMFS has previously issued a few IHAs that required the authorization holder to use and evaluate the effectiveness of FLIR but has not yet required it as a mitigation measure that assumes effectiveness.

Practicability: The use of some of the ocular equipment devices noted above can be expensive to obtain and install, and several of the technologies (e.g., FLIR) are still developing with most still in the testing phase in the Arctic.

Rationale and Considerations for Future Implementation: Infrared technologies appear to be continuing to improve. Because of the limitations to otherwise detecting marine mammals in low-light situations, companies should continue to test these technologies and target their use to augment other methods of detection, where practicable, especially on ice. NMFS would continue to monitor and review developments with enhanced ocular equipment technologies and discuss appropriate use with potential operators. There likely needs to be an experimental component to monitoring and evaluating the usefulness of such technologies for the first couple of years. An additional consideration for future implementation of these technologies would be the time of year of the proposed oil and gas exploration activities. If activities are proposed to occur later in the season when daylight hours are minimal, requiring the use of such devices would be more likely.

***Walruses* –** The effects of this additional mitigation measure on walruses would be the same as described for ice seals in Section 4.5.2.4.13.

***Polar Bears* –** This measure is designed to better protect marine mammals in the water, especially cetaceans, and may improve the capacity of observers to detect polar bears in the water. However, polar bears are rarely encountered in the open water where most seismic surveys would occur and they swim at the surface of the water so they are less likely to be exposed to loud seismic sounds. The USFWS has required the use of FLIR through the LOA process during in-ice seismic surveys to test its utility in identifying polar bears in water or on ice in low light and low visibility conditions. Polar bears are more likely to be encountered during in-ice seismic surveys. However, few seismic surveys occur in ice covered waters. As FLIR systems become better, this measure may have some utility in decreasing the potential for interactions with polar bears during in-ice seismic surveys. FLIR testing during in-ice seismic activities had inconclusive results.

Additional Mitigation Measure A3. Operators shall limit seismic airgun operations in situations of low visibility when the entire exclusion radius cannot be observed (e.g., nighttime or bad weather) and ocular equipment, such as FLIR or 360° thermal imaging devices, are not being used to increase the probability of marine mammal detection. These limitations could mean the cessation of airgun operations entirely, a reduction of the time that operations are conducted in this limited visibility situation, or a reduction of the number of airguns operating so that the exclusion radius is minimized and entirely visible.

This measure is applicable when conducting **2D/3D seismic surveys**, including **in-ice surveys, VSP surveys, and site clearance and high resolution shallow hazards surveys**.

Purpose: The purpose of this measure is to limit airgun operations when darkness or inclement weather hampers PSO observations of marine mammals in exclusion zones, thus reducing the likelihood that a marine mammal would enter the exclusion radius unobserved, which could potentially result in an injury if the animal were exposed to high sound levels over a period of time.

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness: Although studies show that many marine mammals avoid close-approaches of seismic airguns (Richardson et al. 1999), studies also show that some subset of marine mammals have sometimes approached operating airguns at distances that may be within the exclusion zone, and previous IHA monitoring reports indicate that marine mammals have occasionally been detected within the exclusion zone (Savarese et al. 2010, Haley et al. 2010a, b). Additionally, although the relationship is not entirely linear, studies suggest that marine mammals are also more likely to have a more severe behavioral response if exposed to higher levels such as those within the exclusion zone.

While implementing this additional measure may prevent some number of marine mammals from being exposed to higher sound levels for longer times, it may also result in seismic surveys taking longer, requiring multiple seasons, or requiring some operators to work during periods when marine mammals are more common or sensitive. If a survey effort is delayed because of poor visibility due to light or weather conditions, some vessels may have to maintain their position until conditions improve. While reducing some types of effects, implementation of this measure could also increase other types of adverse effects to marine mammals.

History of Implementation: Because of the consideration of practicability in the mitigation requirements, measures of this sort have been applied differently in different situations. For example, nighttime operations have been prohibited entirely, prohibited unless accompanied by passive acoustic monitoring (PAM) detection capabilities (or FLIR or other nighttime enhancing devices), or allowed (with no PAM or other device) as long as they were initiated when the entire exclusion radius was visible. However, IHAs have included measures stating that airgun array operations could not be initiated from a shutdown position at night or during low-light hours (such as in dense fog or heavy rain/snow) when the PSOs could not view and effectively monitor the full relevant exclusion zones.

Practicability: In the beginning of the open water season (July/August), light conditions are usually sufficient to monitor a large area because the sun does not set. However, in the latter parts of the open water season (September to October), daylight decreases rapidly, which would reduce the amount of time for the activities. This measure would likely be expensive to implement and could cause logistical complications that affect survey completion, especially in one operational season.

Rationale and Considerations for Future Implementation: As noted above, this measure could result in some protection of marine mammals from exposure to higher levels of sound but could also potentially result in exposure to sounds over longer total periods of time or in periods of time of particular importance. Additionally, the continuing development of technologies to aid in the detection of marine mammals in low visibility influences how this measure can be implemented. The decision of how to best manage times of low visibility should be made on a case-by-case basis, and based on factors such as the total length of the survey, history of observations within the exclusion zone in the area, temporal and spatial habitat use of the area by the species being impacted, and whether supplemental equipment is available to assist with nighttime detections.

Walruses – The effects of this additional mitigation measure on walruses would be the same as described for ice seals in Section 4.5.2.4.13.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for ice seals in Section 4.5.2.4.13.

Additional Mitigation Measure A4. Seismic operators shall use passive acoustic monitoring systems, in addition to visual monitoring, to detect marine mammals approaching or within the exclusion zone and trigger the shutdown of airguns.

This measure is applicable when conducting **2D/3D seismic surveys**, including **in-ice surveys and site clearance and high resolution shallow hazards surveys**.

Purpose: The purpose of this mitigation measure is to improve the ability of a PSO to detect marine mammals prior to and during airgun surveys within the exclusion zone in times of low visibility (e.g., darkness or inclement weather), thus ensuring shutdowns, as appropriate, and further minimizing their exposure to higher levels of sound potentially associated with injury or more severe behavioral responses. By using PAM devices, operators can ramp-up and start/resume a seismic survey during times of reduced visibility when such ramp-up otherwise would not be permitted.

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness: PAM may serve as an effective tool for detecting submerged and vocalizing marine mammals when they are not detectable by visual observation (Hedgeland et al. 2012). Three key components are necessary in order for a PAM system to be able to function as a mitigation aid by triggering the shutdown: detection, localization, and classification. Certain hardware and software are needed in order to support real-time localization, and a regional call library is needed to support species classification (lack of an extensive library can be offset by experienced PAM operators). Also, depending on the sound sources in use in the vicinity of the PAM, it may be challenging to sort out marine mammal vocalizations real-time.

The efficacy of real-time PAM in the Arctic depends on species, frequency and source level of calls, how often the marine mammals vocalize, and choosing the right array and software to match these variables. PAM has been successful at detecting higher frequency clicks of toothed whales where the frequency is well above that of the seismic and tow ship. In the Arctic, most of the calls are low frequency calls, such as from bowheads, which overlap with the seismic sounds (NMFS 2011b – JASCO). Bearded seals often vocalize and can be detected during the spring-summer breeding season, but other seals do not vocalize frequently and could be missed even if present. These technologies have the potential to improve the detection of marine mammals, particularly in such a large area where visual sightings are often limited. However, there are substantial technical challenges for using this system from moving vessels with their own noise source within the frequency range of the bowhead whales. There has been success in detecting bowhead whale calls from long-term passive acoustic recording devices that are placed on the seafloor bottom for a certain amount of time. However, these devices are not monitored in real-time and therefore cannot be used to implement mitigation measures such as shutdowns of airgun arrays.

In the Gulf of Mexico, the oil and gas industry has successfully utilized systems with hardware and software that allow for real-time detection, localization (PAMGUARD), and classification such that shutdowns can be implemented as a result of real-time detections. Monitoring reports for oil and gas vessels in the Gulf of Mexico, as well as the R/V *Langseth* in different regions, show that PAM sometimes detects marine mammals that were not otherwise detected by visual observers. However, real time PAM was tried in the Arctic by ION in 2006 and Statoil in 2010 and was not found to be effective in detecting bowhead whales because the frequency range of bowhead vocalizations was the same as that of the ship engines. For this reason, unless the technology or methodology is improved, this method may be less effective in areas where the bowhead whale is the target species.

PAM systems only work if an animal produces a sound that can be detected by the system.

History of Implementation: PAM has been previously required, in a few cases, by NMFS for real-time use with seismic surveys both in the Arctic and in other areas (Langseth), although it has been used to augment visual detections and not to directly trigger shutdowns.

Practicability: As discussed at the 2012 Open-water Meeting (March 6-8, 2012) in Anchorage, Alaska;

University of Alaska 2011 seismic survey 90-day report:
http://www.nmfs.noaa.gov/pr/pdfs/permits/uagi_90day_report2011.pdf; and

Statoil 2011 marine survey program 90-day report:
http://www.nmfs.noaa.gov/pr/pdfs/permits/statoil_90day_report2011.pdf) these techniques have proven feasible, although in those two cases but have not achieved the anticipated mitigation benefits.

Rationale and Considerations for Future Implementation: The decision of whether to require real-time use of PAM systems to trigger shutdown should be made on a case by case basis in consideration of the continuing development of PAM systems and their ability to detect bowhead whales during operation, the specific environment/habitat that the airguns are operating in and its importance to particular species, and the availability and cost of the necessary equipment. Once PAM systems become available that prove useful for mitigation implementation, we would take certain factors of the seismic survey into consideration when deciding whether or not to require the use of such systems. Those factors include the size of the airgun array (i.e., larger arrays create larger exclusion zones which are more difficult to visually monitor), the time of year of the season (i.e., is there likely to be more darkness or inclement weather), and the duration of the survey. There likely needs to be an experimental component to monitoring and evaluating the usefulness of such technologies for the first couple of years.

***Walruses* –** The effects of this additional mitigation measure on walruses would be the same as described for ice seals in Section 4.5.2.4.13.

***Polar Bears* –** The effects of this additional mitigation measure on polar bears would be the same as described for ice seals in Section 4.5.2.4.13.

Additional Mitigation Measure A5. Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (for example, but not limited to, expansion of shutdown zone to 120 dB or 160 dB when cow/calf groups and feeding or resting aggregations are detected, respectively).

Applicable Activities: Any activity that implements standard shutdown zones.

Purpose: These specific additional measures were originally designed with the intent of detecting bowhead whales in feeding or social aggregations or with calves and then ceasing seismic airgun operations until the animals leave the area, potentially reducing the likelihood of interfering with cow/calf social interactions or incurring additional energetic costs during an important time period, such as when animals are specifically observably feeding or resting in larger groups.

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness: Disturbance that causes behavioral reactions that affect life functions, such as migration, feeding, and nurturing or parental care, can affect vital rates (e.g., survival and reproduction), which could, ultimately, lead to population level effects (NRC 2005). Disruption of cow-calf pairs, possibly through physical separation of dependent young from their mothers, or of feeding aggregations during late summer and fall when bowheads are building fat and energy reserves prior to migrating could, therefore, be considered effects with a higher potential biological significance than effects on transiting individual marine mammals.

However, during the few times that these types of measures were implemented in the Beaufort Sea beginning in 2006, there were no shutdowns of operations, as bowhead whales have not been detected in the groupings that would trigger the implementation of these measures. In particular, the 120 dB zone is often so large (>20 km [12.4 mi] radius, 126-km circumference, and an area of 1256 km^2) from the source, monitoring this large of an area from one or two aircraft is ineffective, if not impossible. Although much smaller than the 120 dB zone, the average distance to the 160 dB sound level threshold can be >10 km (6.2 mi) (Appendix G). The aircraft or additional monitoring vessels are sources of potential disturbance themselves, particularly when attempting to identify calves or feeding whales, when behavioral disturbance is more likely and potentially more biologically significant. If this measure has not been previously triggered during the necessary monitoring, then it did not reduce impacts to the species.

The example above illustrates the importance of considering specific known information about the effectiveness of specific measures, and in that example, the large size of the monitored zone likely inhibited the success of the measure. Alternately, monitoring of a smaller more manageable zone might reduce the potential reduction in effects, but result in more actual implemented shutdowns, potentially resulting in some small reduction in more severe effects. Case-by-case consideration of the importance of reducing sound exposure during certain biological situations and the likely success and costs of monitoring zones of different sizes will help inform decisions of when these types of measures might be more or less effective.

History of Implementation: Measures of this nature (specifically shutting down for 4 cow/calf pairs within the 120-dB isopleths, and shutting down for aggregations of feeding whales within the 160-dB isopleths) were required a couple of times in 2006 and 2007, but have not been required since in the Arctic. In Cook Inlet, some IHAs require shutdown when beluga cow-calf pairs or aggregations of more than five cetaceans of certain species are sighted are required, for example.

Practicability: The 120 dB zone is often so large that monitoring by one or two aircraft is ineffective, if not impossible. Additionally, industry has often noted that implementation of this measure is not practicable, as they have serious concerns regarding the overall safety of conducting fixed-wing aircraft monitoring flights in the Arctic, especially in the Chukchi Sea, where the nearest landing field can be quite distant from the location of the source vessel. However, similar biologically specific shutdowns could be required for smaller zones if an assessment suggested it would be effective.

Rationale and Considerations for Future Implementation: The two examples of this type of measure cited above have been shown to not be effective and should not be considered further. However, there could be other specific measures of this nature (highlighting different biological situations) that could be proposed by the public during the MMPA process that could be worthy of case-by-case consideration.

Other Cetaceans – This additional measure was designed with the intent of detecting bowhead whales in aggregations or with calves and could indirectly affect other cetaceans in the vicinity of these groups. However, groupings that would trigger implementation of these measures have not been detected in the Beaufort Sea since this was first required in 2006. In addition, the 120 dB zone is often so large (>20 km [>12.4 mi]) from the source, monitoring this large of an area from one or two aircraft is extremely difficult, if not impossible. The aircraft or additional monitoring vessels are sources of potential disturbance themselves, particularly when attempting to identifying calves or feeding whales, when behavioral disturbance is more likely and potentially more biologically important. The effectiveness of this mitigation measure for reducing potential adverse impacts on other cetaceans is questionable, given the infrequency with which large groups occur. Refer to Section 4.5.2.4.9 for a more thorough description and analysis of the efficacy and practicability of this mitigation measure.

Ice Seals – This additional mitigation measure is oriented primarily at avoiding impacts on groups of whales. Ice seals in the vicinity of these whale groups may have some indirect reduction of adverse impacts if nearby seismic surveys are halted or delayed. However, this situation is similar to that described for Additional Mitigation Measure A3 in that overall seismic efforts could remain the same but be stretched out over time. The indirect effects of the measure on ice seals cannot be determined ahead of time nor is it likely they could ever be measured in the field. This measure could necessitate additional aerial and/or vessel surveys which may be costly and would be potential sources of disturbance themselves.

***Walruses* –** The effects of this additional mitigation measure on walruses would be the same as described for ice seals in Section 4.5.2.4.13.

***Polar Bears* –** The effects of this additional mitigation measure on polar bears would be the same as described for ice seals in Section 4.5.2.4.13.

Additional Mitigation Measure A6. PSOs required on drill ships.

This measure is applicable when conducting **exploratory drilling operations**.

Purpose: The purpose is the same as standard mitigation measure A3, described above, to implement the mitigation measures and collect data for monitoring requirements.

Science, Support of Reduction of Impacts, and Likely Effectiveness: See discussion in standard mitigation measure A3, above. For drilling ships and jack-up rigs, historically the source level has been low enough that it has not been necessary to have power-down and shutdown zones to avoid injury (i.e., at no distance would a marine mammal be close enough to incur PTS). However, sometimes VSP seismic operations are conducted from the drilling platforms once wells are drilled to a certain depth. This component of the exploratory drilling operation typically includes mitigation measures such as ramp-ups, shutdowns, and power downs, as described in earlier mitigation measures in this document. PSOs would be needed to implement these measures.

History of Implementation: Use of PSOs on drillships/rigs and ice-breaking vessels has been consistently required for years during exploration activities in the Beaufort and Chukchi Seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years.

Rationale and Considerations for Future Implementation: For drilling ships/rigs, depending on the distance from the vessel to where injurious effects might be expected, the utility of PSOs for implementing mitigation may be limited, however, their value in collecting important monitoring information likely still remains. There are typically many vessels that are utilized during an exploratory drilling operation, as well as other platforms (such as aircraft). These other platforms may be more appropriate for deploying PSOs to collect monitoring data to assess impacts. Therefore, the drilling unit or ice management vessel may not be the optimum platform to collect the data. NMFS will work with applicants on a case-by-case basis to determine when it is appropriate to use drilling units and ice management/ice-breaking vessels to deploy PSOs.

Additional Mitigation Measure A7. Operators are required to implement specific procedures for use of the mitigation airgun during seismic activities. When utilizing the mitigation airgun, operators will use a reduced duty cycle (e.g., 1 shot/minute). The mitigation airgun will not be operated for an extended period of time (e.g., more than 2 or 3 hours). .

This measure is applicable when conducting **2D/3D, in-ice, OBC/OBN, and VSP seismic surveys and site clearance and high resolution shallow hazards surveys**.

Purpose: The purpose of this measure is to reduce the number of airgun shots introduced into the marine environment during periods when seismic data are not actively being acquired, thereby reducing disturbance to marine mammals.

Science, Support of Reduction of Impacts, and Likely Effectiveness: Operating the mitigation airgun at a reduced duty cycle would lessen the energy entering the water while likely still providing enough of a signal (in level and frequency between shots) between firings of the full array to likely ensure that marine mammals remain at some greater distance from array than they would if it were powered off. Allowing for use of mitigation airguns for up to a few hours will cover most instances when airguns are turning or there are brief maintenance needs to have the full array turned off.

History of Implementation: This measure has been included in IHAs in varying forms since 2012.

Practicability: To date, this measure has proven practicable to industry operators. However, it has not been implemented for a substantial amount of time, and the specific parameters have been evolving since first requiring its implementation in 2012.

Rationale and Considerations for Future Implementation: As noted, this measure is expected to reduce the overall amount of sound introduced into the marine environment as compared to a mitigation gun without a reduced duty signal, and to date it has been practicable for industry implementation. Some version of this measure will likely be recommended in most cases, however, flexibility may be needed regarding the exact duty cycles available to different operators and the time limitations for airgun use, given different turn times or other operational parameters.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Kaktovik, Cross Island, Barrow Canyon and the western Beaufort Sea, Hanna Shoal, the shelf break of the Beaufort Sea, Point Franklin to Barrow, Kasegaluk Lagoon, and Ledyard Bay. All, or a subset of, oil and gas activities would be limited (e.g., either completely prohibited, or the overall time reduced) in the areas specified here during the listed timeframes. Additionally, buffer zones around these time/area closures to avoid specific types of effects could potentially be included. Buffer zones could require, for example, that activities emitting pulsed sounds would need to operate far enough away from these closure areas so that sounds at 160 dB do not propagate into the area or that activities emitting continuous sounds would need to operate far enough away from these closure areas so that sounds at 120 dB do not propagate into the area. In the event that a buffer zone of this size was impracticable, a smaller buffer zone avoiding the ensonification of the important habitat above a higher level could be used (e.g., 180 dB, or something else that was thought to minimize the likelihood of auditory injurious exposures.).

This measure is applicable when conducting **all open-water season oil and gas exploration activities** (2D/3D seismic surveys, including in-ice, OBC/OBN, and VSP seismic, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities, as well as all support vessels and aircraft).

Purpose: These mitigation areas are each designed to achieve one or both of the following purposes: 1) to minimize the effects of acoustic disturbances on marine mammals by reducing either the *number* of individuals (in higher density areas) exposed to sound levels above certain thresholds or by reducing the duration or levels of sound that individuals are exposed to during times when they may be more susceptible to adverse impacts or the effects of masking (such as when inter-species communication is especially critical or when they are utilizing a preferred habitat and the inability to do so as a result of temporary displacement could result in adverse energetic impacts), or 2) to avoid or minimize adverse impacts to the availability of marine mammals for subsistence uses. Table 4.5-24 outlines the proposed dates for these time/area closure locations, as well as the reasons for the proposed closures (i.e., minimize effects on marine mammals or to avoid or minimize adverse impacts to subsistence uses of marine mammals).

Table 4.5-24 Proposed Time/Area closure locations under Additional Mitigation Measure B1. This table identifies the species and subsistence hunts that would be mitigated by implementing these closures

	Kaktovik and Cross Island	Barrow Canyon and the Western Beaufort Sea	Beaufort Sea Shelf Break	Hanna Shoal	Point Franklin to Barrow	Kasegaluk Lagoon and Ledyard Bay
Proposed closure period	August 25 - September 15	Mid-July - October	Mid-July - late September	September 15 - early October	June to September	Mid-June - mid-July for the Lagoon and July 1 – November 15 for the LBCHU
Bowhead Whale	Migrating and feeding: late August - October	Migrating and feeding: late August - October	Migrating: late August - October	Part of migratory corridor: September - October	Feeding and milling: September – October; May occur June-July	Do not occur (migrate offshore)
Beluga Whale	Uncommon	Migrating and feeding: mid-July - late August	Feeding: mid-July - late September	Unknown	Occasional: July, August, October	Feeding, molting, calving: June and July
Gray Whale	Uncommon	Feeding, milling: June – October	Present	Present	Feeding, calving, milling: June – October	Feeding, calving: June – October
Spotted Seal	Present	Present	Present	Present	Present	Present; Some feeding habitat
Pacific Walrus	Not present	Not present	Not Present	Feeding: July - August	Present: June, July, September	Resting habitat: Spring and early winter
Whaling Hunts	bowheads: late August - mid-September	Bowhead whales: September – October	Uncommon	None	bowheadsBowhead whales: September - October	Beluga whales: mid-June - mid-July in the Lagoon only
Sealing Hunts	Mostly October - June	Mostly November - January and spring	Uncommon	None	Mostly November – January and spring-summer	Mostly October - June

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness:

Kaktovik and Cross Island: Data collected during BWASP and ASAMM surveys in the Beaufort Sea from 2000-2012 noted feeding groups of bowhead whales in September most of those years, although there were no feeding sightings in 2001 and 2011 (Clarke et al. 2011b, c, 2012, 2013). Additionally, hunters from Kaktovik traditionally conduct hunts in the nearshore waters from the community in the fall, while hunters from Nuiqsut similarly base out of Cross Island during that time. Hunts typically begin in late August/early September and continue until mid- to late September, depending upon migration patterns, weather and ice conditions, etc. During a meeting with NMFS in 2013, a Kaktovik whaling captain explained that hunters typically scout for whales approximately 15-20 miles to the north first then to the east and only to the west as a final option. Scouting to the east is never farther than 15-30 miles from the village and never more than 20 miles to the west of the village. Although subsistence seal hunts could occur year-round, they are most commonly conducted in this area from October-June. Closing the area to oil and gas activities from late August until mid-September would reduce adverse impacts, particularly those associated with noise disturbance (e.g., displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area, as well as on bowhead whale hunting activities. Reducing impacts on concentrations of bowhead whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects during the closure period. Noise effects of activities occurring outside of this closure area could continue to impact bowhead whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of buffer zones around the closure area would help to reduce further impacts from occurring within this important fall feeding and hunting location.

Barrow Canyon and Western Beaufort Sea: Due to sub-sea topography and the ocean currents, the Barrow Canyon/Western Beaufort Sea is one of the two primary concentration areas for bowhead whales in the Beaufort Sea, particularly as a staging/feeding area during the westward fall migration of bowheads out of the Beaufort Sea. Physical and oceanographic features of Barrow Canyon promote a bowhead whale feeding "hotspot" here during late-summer and fall. Bowhead whales congregate in the area to exploit dense prey concentrations (Ashjian et al. 2010, Moore et al. 2010, Okkonen et al. 2011). Time/Area closures for this area are to mitigate effects on bowhead whales (late August to early October), belugas (mid-July to late August), and the fall bowhead whale subsistence hunt out of Barrow (September 15 to close of the hunt). Barrow Canyon may also serve as feeding habitat for ringed, bearded, and ribbon seals. Subsistence seal hunts typically occur in this area from November-January and then again in the spring. Closing the area to oil and gas activities during these time periods would reduce adverse impacts, particularly those associated with noise disturbance (e.g., displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area, as well as for belugas. Reducing impacts on concentrations of whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads and belugas could result in a decreased intensity of effects during the closure period. Reduced adverse impacts on whales would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of the buffer zones around the closure area would help to reduce further impacts from occurring within these biologically important areas.

Beaufort Sea Shelf: The shelf break of the Beaufort Sea has limited anectodal support to suggest it is potentially an important habitat for beluga whales. Active leases in the Beaufort Sea are generally on the shelf, inshore of the shelf break; drilling activities would, therefore, not be impacted through this closure. However, seismic activities and associated vessel traffic would be affected by the measure, which could potentially reduce adverse impacts on beluga whales, particularly those associated with noise disturbance.

The time and location of reduced adverse impacts would be limited to the area defined by the shelf break. Implementing buffer zones around the closure area could further reduce impacts of noise on the closure area generated by activities occurring in areas adjacent to the closure.

Hanna Shoal[6]: Hanna Shoal is an important feeding area for Pacific walrus (USGS 2011b) and was historically important as a feeding area for gray whales (Moore et al. 2000, Nelson et al. 1994). However, more recent data indicate that gray whales use this area much more infrequently than in the 1980s and 1990s (Clarke et al. 2015a). Additionally, the area is used as part of the bowhead whale fall migratory corridor. There is some evidence that bearded seals may use Hanna Shoal as a feeding area, since polynya systems typically develop there during winter months. However, tagging data from 2009-2012 indicated that the majority of tagged bearded seals moved close to and along the coast and rarely ventured into the Hanna Shoal area (Boveng and Cameron 2013). Closure of the area to all oil and gas exploration activities during September and October could reduce adverse effects of these activities, especially those associated with noise disturbance, such as displacement, on marine mammals migrating across the area. There are no leases within Hanna Shoal, therefore, there would be no impacts to drilling operations. However, the requirement to maintain a buffer zone around the area could reduce impacts from seismic surveys.

Kasegaluk Lagoon and Ledyard Bay: Kasegaluk Lagoon provides important habitat for beluga whales and spotted seals. Belugas of the eastern Chukchi Sea stock congregate in Kasegaluk Lagoon in June and July (Frost et al.1993, Huntington et al. 1999). Omalik Lagoon, south of Kasegaluk Lagoon, is also an important gathering area for belugas in June, except in years when there is heavy ice along the shore (Huntington et al. 1999). Observers conducting the ASAMM surveys in 2011 and 2012 noted feeding behavior by belugas in Kasegaluk Lagoon in July (Clarke et al. 2012, 2013), and the Lagoon is also an important reproductive area for eastern Chukchi Sea stock belugas (Clarke et al. 2015). Native Alaskan subsistence hunters conduct a summer beluga hunt in Kasegaluk Lagoon, typically from mid-June to mid-July. Kasegaluk Lagoon hosts the largest concentrations of spotted seals north of Point Hope, and, consequently, Ledyard Bay can be expected to be an important feeding area for spotted seals by virtue of its proximity to Kasegaluk Lagoon and its nearshore habitat. Subsistence seal hunts can occur in this area year-round but are most common from October to June. There have also been observations of gray whales feeding in the southern portion of Ledyard Bay just east of Cape Lisburne in most months from June to October (Clarke et al. 2015). This closure area does not contain any lease areas, and leases in the Chukchi Sea occur dozens of miles away; therefore, actual on-lease seismic or drilling operations would not be affected by the closure. Off-lease seismic surveys and associated vessel and aircraft traffic would, except in emergency situations, be required to divert around the closure area. This could decrease disturbance effects of vessel activity within these important habitats and closure areas, while shifting vessel activity further offshore. The buffer zone would require all components of the activities to occur at least some distance from these locations.

Point Franklin to Barrow: The area between Point Franklin and Barrow, including Peard Bay, is used frequently throughout the year by a variety of marine mammals, as well as for subsistence hunting of several species. Species occurring in this area include bowhead whales, gray whales, beluga whales, bearded seals, ringed seals, walrus, and polar bears. Of the cetaceans, this area is most consistently used by gray whales, as well as bowheads and some beluga whales. Bowheads are most highly concentrated in this nearshore area during the spring migration, with most whales past this area by sometime in May, well before the open water season (Quakenbush et al. 2012). Based on BWASP, COMIDA, and ASAMM survey data (Clarke et al. 2011a, 2012, 2013), including that incorporated into maps depicting Known Biologically Important Areas (Clarke et al. 2015), the northeastern half of this area is a feeding and milling area for bowheads primarily during September and October. Bowhead whales have been seen

[6] The area denoted here and in Figure 3.2-26 is smaller than the Hanna Shoal Walrus Use Area identified by the USFWS in the 2013-2018 MMPA Incidental Take Regulations.

between Point Franklin and Point Barrow during June, July, and August (Clarke et al 2011a). According to data compiled by Clarke et al. (2015), this area is one of the three primary feeding areas where gray whales are consistently observed from June to October. It is also an important cow-calf area for gray whales from June to September. Beluga whales are occasionally sighted in this area from June-October but are most prevalent offshore and on the Beaufort Sea shelf and slope at that time.

Data from 2008-2010 COMIDA surveys suggest that walrus are most prevalent and broadly distributed across this area in July, mostly near to Point Franklin in September, and less common in August and October (Clarke et al. 2011a). This distribution is variable, however. In 2011, June was the month of highest numbers of sightings in this area and, in 2012, that period spanned June and July (Clarke et al. 2012, 2013). Bearded seals and ringed seals also occur with regularity in this region from, at least, June to October (Clarke et al. 2011a, 2012, 2013).

Subsistence use of this area coincides with availability of marine mammals and includes bowheads, primarily by Barrow whalers in the northeast portion in the fall, as well as walrus, ringed, and bearded seal harvests. This area is also important to fall subsistence bowhead whale hunts for the community of Wainwright. Native Alaskan subsistence whalers from Wainwright landed the first bowhead whale in nearly 90 years in October 2010. Wainwright whalers also landed a whale in late October 2011 and three whales in fall 2013. With changing ice conditions, the nearshore waters just north and east of the community are again an important fall whaling area. Please refer to subsistence use area maps 3.3-20, 3.3-22, and 3.3-24.

History of Implementation: NMFS has consistently required a shutdown of activities in the Beaufort Sea in the vicinity of Kaktovik and Cross Island on August 25 until the close of the fall bowhead whale hunt by the communities of Kaktovik and Nuiqsut in IHAs. Temporary cessation of activities near the other locations noted in this mitigation measure has not been required in the last few years and has never been included in IHAs for all of these areas. Shutdowns near Barrow have also been required in IHAs in the past to accommodate the fall bowhead whale hunt. Although never required in NMFS IHAs, BOEM and USFWS require cessation of oil and gas exploration activities from July 1 to November 15 in the Ledyard Bay Critical Habitat Unit in G&G permits and LOAs, respectively.

Practicability: Avoidance of these time/area closure locations may be costly to industry, as many of the proposed closure periods occur at the same time and place as proposed industry operations. Moreover, federal lease sales within some of these proposed closure areas have already occurred, and companies have purchased leases in these areas. Without more refined closure periods to the most critical periods to protect important biological functions and/or subsistence hunts, these closures could eliminate more than 50 percent of the open water period to conducting oil and gas exploration activities. This could lead to additional costs to the industry, as it could take multiple seasons to drill even one well or collect seismic data. The Hanna Shoal time/area closure overlaps with ten lease blocks (four of which are completely inside the proposed time/area closure location and six of which are partially inside the proposed time/area closure location). However, some of these areas would be easier to avoid, such as Kasegaluk Lagoon and Ledyard Bay, since there are no active leases in that area. Restricting activities in the eastern portion of the U.S. Beaufort Sea during the fall bowhead whale hunts for the communities of Kaktovik and Nuiqsut has been successfully implemented by oil and gas industry operators for more than 10 years.

Rationale and Considerations for Future Implementation: At this time, it is difficult to weigh the costs and benefits of requiring this mitigation measure, either partially or in its entiretly, without more specific information, such as the nature and proximity of the proposed activities in combination with the comparative conservation value of the specificproposed time/area closure locations (for example, the value of a Beaufort Shelf closure is comparatively low, and the anticipated impacts of an OBC/OBN survey are comparatively low, so the value of a closure here for that activity is likely lower). In deciding whether to limit oil and gas exploration activities in these locations through the use of these time/area closures during times when marine mammals may be present to perform specific biologic life functions or during times when subsistence hunts occur when making decisions on individual MMPA ITA requests, NMFS will weigh the practicability for implementation against the reduction of adverse impacts to marine mammals and subsistence uses of marine mammals on a case-by-case basis. Additionally, it is important (as described in Chapter 5) to allow flexibility for changing environmental conditions that result in changing marine mammal distribution patterns or hunting practices, which could necessitate modification of area boundaries or times,

Walruses – Additional Mitigation Measure B1 applies to all exploration activities that occur during the open-water season. The time/area closure areas designated in this mitigation measure are primarily meant to protect whale habitat and to avoid conflicts with subsistence whaling. The reduction of exploration activity at the designated sites in the Beaufort Sea would have little mitigative value for walruses since they infrequently occur in those areas. However, Hanna Shoal is an important habitat for feeding walruses and any reduction in exploration activity in this area would reduce the potential for disturbance of walruses. However, the area designated by this FEIS is smaller than the Hanna Shoal Walrus Use Area designated by USFWS in 2013. Therefore, potential reductions to walruses would not extend as far as those contained in USFWS LOAs. This mitigation measure is not intended to reduce overall exploration activities so any reduction in impacts in one location and time could be displaced to another location and time and the total number of animals affected by exploration activities may not change with the implementation of this mitigation measure.

Polar Bears – The important areas designated in this mitigation measure are primarily meant to protect whale habitat during open-water season and to avoid conflicts with subsistence whaling. This measure would theoretically reduce disturbance impacts on polar bears by reducing seismic activities but there would likely be very few bears affected to any extent by open-water seismic surveys even without these additional restrictions. The time/area closures could be important to polar bears when pack ice is present but not during the open-water season. It is therefore unlikely that this measure would appreciably reduce the potential effects of seismic surveys or exploratory drilling operations on polar bears.

Additional Mitigation Measure C1. Specified transit routes of vessels and aircraft involved in oil and gas exploration activities with an associated MMPA Incidental Take Authorization to minimize impacts in particular important habitat in areas where marine mammals may occur in high densities.

This measure is applicable when conducting **all open-water season oil and gas exploration activities** (2D/3D seismic surveys, including in-ice, OBC/OBN, and VSP seismic, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities, as well as all support vessels and aircraft).

Purpose: The purpose of this measure is to minimize the potential for disturbance to marine mammals in areas where they occur in high densities (usually for reasons connected to vital life functions, such as feeding, resting, or calving) from repeated overflights or vessel trips when multiple back and forth trips are required to conduct oil and gas exploration operations.

Science, Support for Reduction of Impacts, and Likelihood of Effectiveness: Slowing vessel speeds and using standard transit routes and flight paths is a long established method used to decrease the spatial footprint of activities, in this case, to avoid impacting marine mammal concentration areas such as established pinniped haul outs; see Salter 1972, Gales et al 2003, Laist et al 2001, Marine Mammal Commission Report to Congress 2007, Kruse 1997, Lawler 2005, Maier 1998 and others. These designated routes would focus on avoiding some of the areas identified above in Additional Mitigation Measure B1 as important for marine mammals and subsistence hunting. Of note, in 2012, five Alaska Native Organizations came together to form the Arctic Marine Mammal Coalition, which concluded that, unless effectively managed, increasing ship traffic in Arctic waters has the potential to have adverse impacts on marine mammals and their subsistence uses. In October 2014, these same five Alaska Native Organizations, along with industry and other representatives, formed the Arctic Waterways Safety

Committee to implement lawful best practices to ensure a safe, efficient, and predictable operating environment for all Arctic waterway users.

This measure would require exploration vessels to use designated transit routes identified in the ITA while in transit to avoid concentrations of marine mammals. A designated route could result in decreased disturbance to animals in those important habitats. However, as seismic activities often cover wide regions, particularly for the 2D non-lease sale areas, designated transit routes may be difficult to establish. As long as routes are the same year to year, it would potentially be easier for vessels to avoid these areas, although it may result in increased transit time for some. The same would be required of aircraft going between shore and the exploration operations, such as for resupply operations.

Practicability: This mitigation measure is likely feasible; it has been successfully implemented for similar operations (for example, Northstar resupply trips). However, clear proposed routes have not been identified and additionally, less routine activities, such as new seasonal drilling or seismic operations will require further explanation as to how standard routes would be implemented.

Rationale and Considerations for Future Implementation: This sort of mitigation measure is well-supported by current scientific literature, and specific transit routes have been successfully implemented without apparent conflicts with safe operations in the past. However, because these areas have not been clearly delineated, it will be important to evaluate them on a case by case basis before requiring.

***Walruses* –** This additional mitigation measure requires transit routes to avoid high densities of marine mammals, including walruses. This measure is also identical to what would be required under a USFWS LOA to protect groups of walruses.

***Polar Bears* –** Additional Mitigation Measure C2 requires transit routes to avoid high densities of marine mammals. Because polar bears typically do not occur in “concentrations” in open water, it is not apparent that this measure would have any practicable effect on polar bears.

Additional Mitigation Measure C2. Requirements to ensure reduced, limited, or zero discharge of any or all of the specific discharge streams identified with potential impacts to marine mammals or marine mammal prey or habitat.

This measure is applicable when conducting **exploratory drilling activities**.

Purpose: The purpose of this measure is to decrease potential impacts to marine mammals and marine mammal prey species through habitat degradation. For example, benthic prey species in the immediate vicinity of a drill site could be smothered or crushed by cuttings, affected by increased suspended sediments, salinity or temperature. The spatial scale and duration of effects would depend upon the depth of the well, amount of discharges and dispersion rates (Section 4.5.1.5) but would likely be small, for example, the extent of the depositional footprint from a previous drill site in the Beaufort Sea was on the order of 30 m (98 ft.).

Science, Support for Reduction of Impacts, and Likely Effectiveness: See analysis in Section 4.5.1.5 of the EIS. BOEM studies to date in the Chukchi Beaufort Seas of past exploration wells indicate some increases in contaminants from cuttings in some cases, impacts to benthic invertebrates, fish larvae, fish eggs and possibly other lower trophic organisms in the immediate well site vicinity are likely in the short term. To date, this loss of prey and prey habitat has been limited to relatively small areas and has not been linked to decreases in benthic feeding mammals, such as walruses, bearded seals, or gray whales. Additionally, it is unclear whether moving the cuttings to another area may create a problem there.

This mitigation measure would also mitigate adverse impacts to subsistence uses and hunts of marine mammals, as discharges raise concerns by Native hunters of food tainting and a reduced willingness to eat animals that have been exposed to oil and gas exploration activity discharges.

The AEWC has previously made know desire for no discharge of pollutants to the ocean during exploratory drilling. They have remarked: *The communities of the AEWC, as they have for centuries, take* *great care to avoid discarding waste into the migratory path of the bowhead whales. Their observations have taught that whales will avoid areas where human waste of any kind has been dumped. Even coffee grounds and cooking waste are stored and returned to the towns for disposal rather than dumping them into the water during spring and fall whaling. Human waste is never put into the water during migratory and hunting times, for the same reasons. Discharges from industrial operations must similarly be avoided in areas where the water is used for hunting, both to avoid the disruption of the whales' migratory behavior and to ensure that our fresh food from the ocean is not tainted by chemical or human waste. The ocean is our garden and the addition of industrial waste creates fear that food will be tainted, which could create a very real and very significant threat to our people. The mere belief that foods have been tainted by the discharge of drilling cuttings and muds, chemicals, sewage, and other man made substances, can create a situation where these foods are avoided in favor of less nutritious foods, at great risk to our people's health and our culture... concerns about food tainting from manmade discharges to the ocean during whale migrations and subsistence hunting activities could lead to local communities failing to consume traditional foods leading to health problems and loss of culture. The appropriate technology to address this information is a zero discharge program."* (AEWC 2012a).

History of Implementation: Shell voluntarily included this measure in their proposed action in the Beaufort Sea in 2012; however, neither NMFS nor BOEM have otherwise required this measure previously.

Practicability: This measure is expensive to implement. However, in the Beaufort Sea, Shell voluntarily included this measure during the 2012 season, indicating that it may be practicable in some instances.

Rationale and Considerations for Future Implementation: We recommend further study and evaluation before requiring large scale implementation of this measure. Since two exploration drilling operations were conducted in 2012, only one of which removed cuttings, this presents a good opportunity to conduct follow up studies at both sites. No exploratory drilling programs were conducted in the 2013 or 2014 open water seasons. Only one well was drilled in the Chukchi Sea during the 2015 open water season.

***Walruses* –** This additional mitigation measure reduces discharge of potentially harmful substances. This measure would require reduced discharges of various waste streams from exploration vessels, drilling rigs, and facilities. No reduction levels are specified but, to the extent that any substances with potentially adverse effects on walruses or their prey could be kept out of the marine environment, this measure could reduce adverse effects on walruses by reducing the risk of injury/mortality and habitat changes.

***Polar Bears* –** This additional mitigation measure reduces discharge of potentially harmful substances. This measure would require reduced discharges of various waste streams from exploration vessels, drilling rigs, and facilities. No reduction levels are specified but, to the extent that any substances with potentially adverse effects on polar bears or their prey could be kept out of the marine environment, this measure could reduce adverse effects on polar bears by reducing the risk of injury/mortality and habitat changes.

Additional Mitigation Measure C3. Operators are required to recycle drilling muds to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further).

This measure is applicable when conducting **exploratory drilling activities**.

Purpose: The purpose of this measure is toreduce contaminant waste streams into the marine environment and potential impacts to marine mammal habitat and benthic prey.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* See analysis in Section 4.5.1.5 of the EIS, and Boesch and Rabelais 1987, Neff 2002, Neff 2008, Cranford et al. 1999, and others. Although water based drilling muds currently used are less toxic than earlier industry standards, scientific research continues to evaluate the long-term effects at drill sites of muds, cuttings and other discharges. This measure would be expected to result in potentially reduced impacts on food sources and habitat of bowhead whales on a localized scale where the discharge activity may occur. The level at which this measure would reduce impacts to bowhead whales (and other marine mammals) is, however, unknown (extent would be dependent on volume of discharge). Also of note, this measure removes one source of potential impacts from the waste stream; however, particulate matter from cuttings may have a higher impact (disruption of feeding, respiration or burial), see Hyland et al. (2003).

History of Implementation: This measure has not previously been required by BOEM or NMFS. NMFS included this measure in the 2012 IHA issued to Shell for the Beaufort Sea drilling program; however, Shell had already included this in the IHA application submitted to NMFS.

Practicability: Operators could incur additional costs with implementation of this measure; however, companies typically already attempt to re-use drilling muds to the degree possible.

Rationale and Considerations for Future Implementation: This measure is already mostly standard for industry operators but could be reinforced through inclusion in MMPA authorizations. However, in some instances, it may not be practicable for a particular operation.

***Walruses* –** This additional mitigation measure requires recycling of drilling muds and other waste reduction measures and is very similar to Additional Measure C2. To the extent that any substances with potentially adverse effects on walruses or their prey could be kept out of the marine environment, this measure could reduce adverse effects on walruses by reducing the risk of injury/mortality and habitat changes.

***Polar Bears* –** Additional Mitigation Measure C3 requires recycling of drilling muds and other waste reduction measures. This mitigation measure is very similar to Additional Mitigation Measure C2. To the extent that any substances with potentially adverse effects on polar bears or their prey could be kept out of the marine environment, this measure could reduce adverse effects.

4.5.2.4.17.1 Additional Mitigation Measures Summary for Marine Mammals

Additional mitigation measures that may possibly be incorporated into future authorizations and that could mitigate potential adverse impacts on marine mammals are discussed above. Efficacy and practicability of these measures are discussed to the extent possible, given the varying degrees of current availability and use. The information and analyses provided here will serve as tools in NMFS' and BOEM's future MMPA and OCSLA decision-making regarding whether to require these measures pursuant to specific projects.

A few of the measures, such as sound source verification, have been implemented in recent years. Others, such as acoustic and imaging technologies to enhance detectability of marine mammals during poor visibility conditions have been used with limited success for mitigation and monitoring; however, additional testing is recommended, as improvements in the technology may lead to useful applications for mitigation and monitoring. Augmenting visual observations by PSOs with acoustic detection could improve detectability of marine mammals at sufficient distances to avoid disturbance and auditory injury at a higher rate than is possible with visual observations alone—once the technology is available and effective for use in Arctic waters. Measures to mitigate impacts to subsistence harvests through time/area closures or to reduce or eliminate discharges would reduce adverse effects to bowhead whales and their habitat, respectively.

Most of the additional mitigation measures considered in this section would have very limited potential to reduce adverse effects on polar bears and ice seals. The temporal/spatial restrictions on exploration activities in the Hanna Shoal area could reduce adverse impacts to walruses, especially at times when the ice pack was nearby. However, given the mitigation measures that would be required by USFWS LOAs and the standard and additional mitigation measures required by NMFS, the effects on walruses would still likely be low in magnitude, distributed over a wide geographic area, and temporary in duration.

4.5.2.4.18 Mitigation Measures Considered but Not Carried Forward for Marine Mammals

Restriction of number of surveys (of same level of detail) that can be conducted in the same area in a given amount of time (i.e., to avoid needless collection of identical data). Require industry to organize a way to interact with one another to identify when and if duplicative surveys are likely to occur (survey type to gather same type of data within five years) and outline efforts to avoid or describe justification.

This measure was considered for implementation when conducting 2D/3D seismic surveys.

Suggested Purpose: This measure was considered to reduce disturbance of marine mammals through the reduction in the total amount of sound energy put in the water by alleviating duplicative seismic operations that would collect data already collected by another source.

Discussion of Science, Reduction of Adverse Effects, and Likelihood of Effectiveness: There is no specific science to support this mitigation measure. Rather, it is reasonable to expect that preventing or minimizing repeated perturbations in specific areas could reduce avoidance behavior, potential hearing injuries, and other sensitivities resulting from multiple exposures to disturbances. By lessening or removing chronic effects in the environment, fish and marine mammal species would not be subjected to harassment in the same area on multiple occasions. It is not clear how much this measure would reduce overall effort, if at all, but would appear to only affect area-wide surveys on non-lease sale areas. There is the potential for this measure to reduce repeated disturbance to bowhead whales in a particular area. However, Alternative 2 (and the other action alternatives) has a specified level of exploration activity that could be authorized, even with restrictions. Both BOEM and industry representatives have suggested that it is unlikely that much duplication of effort is occurring, as it would not likely be a profitable endeavor.

History of Implementation: Neither NMFS nor BOEM have ever restricted activities in this manner. However, it is also unclear what degree of duplication (if any) is currently occurring.

Discussion of Practicability: In order to implement this measure, it would be necessary to closely track existing and proposed surveys and the willingness of industry to share what may be considered proprietary information, which could potentially create business advantages for other companies. Legal issues would also likely prohibit implementation of this measure by BOEM or NMFS. NMFS is mandated to issue or not issue an ITA based on findings pursuant to the specific proposed action. Section 101(a)(5) of the MMPA does not allow NMFS to deny an ITA for a particular action prior to the case-specific analysis. BOEM does not have the authority under OCSLA to impose such a restriction either.

Companies typically only conduct a survey in an already-surveyed area if the value of the additional information to be provided would exceed the cost of acquisition. At times, new surveys are required in an already-surveyed location if newer technology has become available that would lead to better imaging of the ocean floor or if a new target zone has been identified.

Rationale: Due to the lack of evidence that duplicative surveys are occurring, the logistical effort that would be needed by industry and the federal agencies to implement such a measure, and the fact that neither MMPA nor OCSLA seem to allow for this type of restriction through the sections contemplated in this EIS, this measure is not considered further.

Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

This measure was considered for implementation when conducting 2D/3D seismic surveys, including in-ice surveys.

Suggested Purpose: The intended purpose of this measure, as put forth by the public in comment letters, is to avoid creating a large ensonified area between two surveys through which marine mammals are reluctant to pass (potentially barring them from areas they need to get to, or imposing additional energetic costs) and/or impacts are intensified. The 145 km (90 mi) separation appears to be loosely based on avoiding the overlap of the 120-dB isopleths of two large seismic airgun arrays.

Discussion of Science, Reduction of Adverse Effects, and Likelihood of Effectiveness: Currently, BOEM standard operational requirements for deep penetration seismic surveys include a minimum spacing of 24 km (15 mi) between source vessels when actively acquiring seismic data. This is an operational constraint to prevent acoustic interference during data acquisition and is not enforced for biological mitigation reasons. There is no evidence to support the idea that maintaining a gap will result in a reduction of impacts to marine mammals, either in number or severity. Although the body of literature is growing, there are limited field data clearly illustrating how marine mammals respond to single sound sources, far less information indicating how marine mammals would likely respond when exposed to multiple sound sources simultaneously, and none that we are aware of comparing responses to different configurations of multiple concurrent sound sources. Separating seismic surveys by farther distances decreases the overlap of ensonified space, increasing the total ensonified area, and potentially the likely effects.

History of Implementation: This measure has not previously been required by NMFS or BOEM.

Discussion of Practicability: In the Arctic, the Beaufort lease areas cover an area that is about 240 km (149 mi) from east to west and about out to 80 km (50 mi) off shore. The Chukchi leases cover an area that is about 240 km (149 mi) east to west and 80 km (50 mi) north to south. Due to available open water and subsistence limitations, almost all seismic surveys conducted in the Arctic will overlap in time to some degree. Separating two concurrent surveys within either the Beaufort or the Chukchi Sea creates serious logistical issues. Separating more than two surveys in this manner would be nearly impossible, thus resulting in the inability to authorize some surveys each year.

Rationale: Due to the lack of any evidence supporting that this measure will result in a reduction of adverse impacts to marine mammals, this measure is not considered further.

Vessel and aircraft avoidance (by 0.8 km [0.5 miles]) of concentrations of groups of ice seals.

This measure was considered for implementation when conducting 2D/3D seismic surveys, including in-ice surveys, OBC/OBN seismic surveys, and VSP surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities.

Suggested Purpose: This measure was considered to increase the distance between oil and gas related vessel and aircraft operations and ice seals, thereby decreasing the likelihood of causing disturbance or energetic stress to the seals. It was also considered to decrease the potential for collisions with ice seals.

Discussion of Science, Reduction of Adverse Impacts, and Likelihood of Effectiveness: Numerous studies have indicated an inverse relationship between distance to a vessel/ aircraft and the likelihood that ice seals, walruses or polar bears will be stressed or disturbed by the vessel/ aircraft (see Brueggeman et al. 1989, 1990, 1991, Salter 1972, Anderson and Aars 2008, Amstrup 1993 and others). Additional studies have indicated that reducing speed, avoiding separating conspecifics and giving a wide berth to marine mammals decreases the potential for collisions (see Silber et al. 2010, Thompson et al. 2010, Weinrich et al. 2010, and others).

This measure would require all vessels to slow down, steer around if possible, and not approach ice seals within 0.8 km (0.5 mi). It is not clear how much practical effect this would have on ice seals even if it is assumed that similar requirements would apply as they do for walrus groups in USFWS LOAs. Ice seals are difficult to see at 0.8 km (0.5 mi) under many weather/sea conditions, and they can swim much faster than most exploration vessels so there may be very few cases when a vessel might detect and then successfully maintain a 0.8 km (0.5 mi) safety buffer approaching groups of ice seals. In addition, the vast majority of seals observed during aerial surveys in the Chukchi Sea have been single animals rather than recognizable groups (Thomas et al. 2010). This measure may marginally reduce disturbance for ice seals but would probably only be effective for faster vessels if they had PSOs on board.

History of Implementation: This measure has been included pursuant to USFWS LOAs for walrus but has not previously been required in IHAs by NMFS for ice seals.

Discussion of Practicability: It could be difficult for vessel operators to implement this measure. As noted above, it may not be possible to visually detect the ice seals at a distance of 0.8 km (0.5 mi). Aircraft avoidance would likely be easier to implement; however, that is already required through Standard Mitigation Measure B1.

Rationale: This measure was dismissed from further consideration because the aircraft avoidance component is redundant to already included Standard Mitigation Measure B1. Additionally, the vessel avoidance component is unnecessary and impracticable for implementation. We do not require such avoidance measures for pinnipeds in any other body of water or region. The distance at which the animals must be detected and avoided is too large for effective implementation. Lastly, there are not major concerns over vessel strikes with ice seals.

4.5.2.5 Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-6). Based on the proposed action for this EIS, only caribou are expected to be potentially affected during critical periods of their life cycle; therefore, this analysis focuses only on caribou. Four caribou herds utilize habitats along Alaska's Arctic coast: the Western Arctic; the Porcupine; the Central Arctic; and the Teshekpuk herds (ADFG 2010a). Please refer to Section 3.2.5.1 for information regarding caribou distribution, abundance, reproduction, and life history.

The oil and gas exploration activities proposed in Alternative 2 that could affect caribou are one exploratory drilling program in the Beaufort Sea and one exploratory drilling program in the Chukchi Sea per year, as they require aircraft support for crew changes. Aircraft fly overs in support of exploration activities could result in disturbance to caribou while occupying preferred habitats or following preferred migration routes. The other possible effects that may occur as a result of oil and gas exploration would be disturbances caused by additional human activities (air or ground) in the EIS project area, due to the overall increase in human population due to support crews living in the North Slope area.

4.5.2.5.1 Direct and Indirect Effects

Behavioral Disturbance

Aircraft used for crew changes can either be helicopters or fixed wing aircraft. Caribou respond to flyovers and nearby landings in a variety of ways depending on the degree of their habituation, weather conditions, sex and age composition of the herd, and the aircraft itself (Calef et al. 1976, Horejsi 1981). The type of aircraft, altitude, airspeed and frequency of flyovers all play a role on the caribou's reaction. Disturbance of caribou is an important consideration because it can cause immediate physical injury or death by animals fleeing the disturbance, can result in increased expenditures of energy, or cause changes in the physiological condition of the animals, which reduces their rates of survival and reproduction, and can result in long-term changes in behavior, especially the traditional use of calving areas and insect relief areas (Calef et al. 1976). There is a higher likelihood of a behavioral disturbance along the Beaufort Sea coast where the Central and Teshekpuk herds use the area for calving and insect relief. There are no habitats along the Chukchi Sea that are recognized as caribou calving habitat; however, the Western Arctic Herd uses coastal areas and alpine ridges in the Brooks Range for insect relief.

Injury and Mortality

Another anticipated effect of oil and gas exploration is an increase in vehicle traffic from support crews in the vicinity of land-based facilities used for support of offshore activities. Vehicle strikes could also cause injury to caribou or even mortality.

There is the potential for terrestrial mammals to be exposed to small fuel spills of less than 50 bbl (see Section 4.2.7). Small fuel spills, discharges, and any air/water quality effects would be extremely small, if detectable at all, along the Alaskan coast, and vessel traffic will be far offshore, preventing any noise or other activities from having effects on terrestrial mammal resources. Therefore, negligible effects are anticipated for terrestrial mammals from small fuel spills.

Habitat Alterations

It is possible that road construction, as well as pipeline construction, will not only destroy vegetation within the footprint of the road but could also result in a reduction of habitat use within the adjacent areas. Cameron et al. (1992) found that calving caribou were displaced outward after construction of the Milne Point road system, resulting in underutilization of habitats adjacent to roads and overutilization elsewhere effectively diminishing the capacity of the area to support caribou. Other studies show conflicting results. Noel et al. (2004) documented caribou densities near Milne Point Road and suggests that distributions of calves and adult caribou are not strongly influenced by presence of a road.

4.5.2.5.2 Conclusion

The direct and indirect effect of oil and gas exploration activities on caribou resulting from implementation of Alternative 2 would be medium intensity, temporary to long-term duration, local extent, and the context would be common. Therefore, the summary impact level of Alternative 2 on caribou would be considered minor.

4.5.2.6 Mitigation Measures for the Biological Environment—Non-Marine Mammal Resources

Standard Mitigation Measures are outlined in Section 2.4.10 and Additional Mitigation Measures are outlined in Section 2.4.11, and both are described in detail in Appendix E. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. A combination of mitigation measures could be required for any one ITA. While the ultimate goal of the mitigation measures is to reduce impacts to marine mammals or subsistence hunts of marine mammals, there is the potential for some reduction of impacts to other biological resources. These standard and additional mitigation measures are evaluated within the context of those more targeted resources (i.e., marine mammals and subsistence uses) and are not repeated here.

4.5.3 Social Environment

4.5.3.1 Socioeconomics

The following discussion of direct and indirect effects of Alternative 2 evaluates effects on public revenues and expenditures, employment and personal income, demographic characteristics, and demand on social organizations and institutions.

The level of impacts on socioeconomics are based on levels of intensity, duration, geographic extent, and context, identified in Table 4.4-1 (see Alternative 1).

4.5.3.1.1 Direct and Indirect Effects

Public Revenue and Expenditures

Under Alternative 2, the following are categories of revenue generation (under the current tax system):

Federal Revenue: None. Federal lease payments were already made in advance of the proposed activities. The likelihood of exploration resulting in production cannot be predicted, but the potential for generating future revenue would not be foregone under this alternative. In 2015, the federal government cancelled Chukchi Sea Lease Sale 237 and Beaufort Sea Lease Sale 242, scheduled for 2016 and 2017, respectively. There are currently no scheduled sales of federal leases in the EIS project area. While the 2017-2022 Draft Proposed Program proposes one lease sale in the Beaufort Sea in 2020 and one in the Chukchi Sea in 2022, these sales are only proposed at this time. However, if those sales occur, they could result in substantial revenue for the federal government. For example, the federal government was estimated to receive approximately $89 billion in royalties from BOEM Lease Sale 193 oil and gas production (2015b).

State Revenue: Lease payments were already generated in advance of the proposed activities. The use of the proposed facilities would not generate additional property tax and no production activity would generate production revenue or corporate income tax. If new facilities were built to support offshore activities, such as a new support base at Wainwright, the facilities could generate additional state property tax revenues. However, the amount cannot be predicted at this time. The likelihood of exploration resulting in production cannot be predicted, but the potential for generating future revenue would not be foregone under this alternative.

Local Revenue: Sales or Special Taxes would be generated from the purchase of goods and services in the communities with stationed crew and support services. No new property taxes would be generated other than potential rental fees. If, unless new facilities were built to support offshore activitiesexampleexampleexampleexampleexampleexample, such asexample a new support base at Wainwright, the facilities could generate additional NSB property tax revenues. However, the amount cannot be predicted at this time. In addition to taxes and employment, there would be an increase in purchases of goods and services in communities where staging occurred.

A detailed list of communities that could receive local revenue from the proposed action alternatives is in Table 4.5-25. Table 3.3-1 lists coastal communities' tax regimes. Only cities with sales or special (bed, tobacco, alcohol, or gaming) taxes would generate local revenue from the stationing of crew, support, logistics, or supplies for survey/exploration vessels. This includes the North Slope Borough, Nome, and Unalaska/Dutch Harbor.

Table 4.5-25 Potential Revenue Sources Under Alternative 2

Alternative 2 (Activity Level 1)	Support/Crew Changes[1]	Owner	New Public Revenue from Services[2]
Up to four 2D/3D seismic surveys in the Beaufort Sea per year including One in-ice towed-streamer 2D (using icebreaker)	West Dock or Oliktok Dock near Prudhoe. Air support out of Prudhoe or Barrow.	Up to 3 in federal waters; one survey in state waters (nearshore)	Prudhoe Bay & **Barrow**
Up to three 2D/3D seismic surveys in the Chukchi Sea per year including One in-ice towed-streamer 2D (using icebreaker)	Nome or possibly Barrow & Wainwright	Federal waters, not associated with leases	**Nome** or **Barrow** & Wainwright
Up to three site clearance and high resolution shallow hazards survey programs in the Beaufort	West Dock or Oliktok only once per year	Federal & state active leases	Prudhoe Bay
Up to three site clearance and high resolution shallow hazards survey programs in the Chukchi per year	Wainwright or Nome only once per year	Federal active leases	Wainwright or **Nome**
One exploratory drilling program in the Beaufort per year	Unalaska/Dutch Harbor then Prudhoe Bay. Helicopter resupply and marine monitoring from Barrow	Federal active leases; drilling in state leases from land	**Unalaska/Dutch Harbor**, Prudhoe Bay & **Barrow**
One exploratory drilling program in the Chukchi per year	Unalaska/Dutch Harbor then Wainwright. Helicopter resupply and marine monitoring from Wainwright or Barrow	Federal active leases	**Unalaska/Dutch Harbor**, Wainwright & **Barrow**

Notes:

1) Search & Rescue is coordinated by the Coast Guard and the nearest vessels are deployed. Typically, resources are available out of Barrow and Deadhorse. Coast Guard does not typically reimburse for the cost of these efforts (Majors 2011).
2) Communities that implement sales or special taxes are in **bold**; these communities could capture revenue associated with goods and services.

The establishment of Communications Centers (Com Centers) could generate a small amount of property tax revenue for the city or borough if it resulted in construction of new facilities. The Com Centers are associated with Standard Mitigation D2:

- D2 – Establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season.

Employment and Personal Income

Under Alternative 2, there would be a limited number of (direct) new local hire employment opportunities associated with the standard mitigation measure D2, associated with jobs:

- A3 –PSOs required on all seismic source vessels, ice breakers, and support (chase) vessels when required.

The standard mitigation measures could create a limited number of (direct) new local hire employment opportunities associated with the PSO program Com Centers program, and Oil Spill Response (see Section 2.3.4 for more details). Employment activities associated with crew positions on vessels and the administration of the seismic, drilling, and survey activities are very specialized and would likely draw from a pool of workers statewide or the Lower 48. All new employment opportunities would draw regionally or nationally for qualified individuals. Table 4.5-26 outlines communities that may see larger numbers of local hire opportunities.

Table 4.5-26 Employment Opportunities Associated with the Standard Mitigation Measures

Required Standard Mitigation	Details	Communities Likely to Experience Higher Employment and New Revenue from Support Services
Protected Species Observers	Details on maximum seasonal part-time employment in Table 4.5-27	Prudhoe Bay, Barrow, Kaktovik, Nuiqsut, Wainwright
Oil Spill Response	Use of Village Response Team members trained in Hazwoper	Seasonal employment opportunities in all coastal villages
Communications Center	Staff hired to man radio transmissions from survey vessels, aircraft, and whaling crews in subsistence communities. Unclear whether collaboration between Plan holders would occur.	Seasonal employment opportunities in all coastal villages

Notes: Details about the required standard mitigation measures can be found in Chapter 2.

ITAs require biologically trained, on-site individuals to be onboard vessels. Table 4.5-27 demonstrates a hypothetical quantity of PSOs hired under Alternative 2. The total workforce in the NSB, NAB, and city of Nome is 14,691. Therefore, the maximum number of new seasonal, part-time positions (200) would represent less than two percent of new employment opportunities. Approximately half of the observers employed seasonally in the Arctic today are local hire, so it is more likely that around 100 new seasonal, part-time positions would be created. The multiplier effect of 4.8 new indirect jobs for each new direct job created by future OCS activity could have a net result of up to 960 jobs in the Alaska economy (NEI and ISER 2009). Regardless of this estimate (the multiplier would not be the same for seasonal, part-time work), out of 391,864 in Alaska's workforce in 2010, the multiplier effect would statistically generate 0.2 percent of new employment opportunities (for employment data see Table 3.3-2). This analysis does not discount the importance of local employment opportunities created.

Table 4.5-27 Maximum PSO Positions Under Alternative 2[1]

	Alternative 2 (Annual Activity Level 1)	Vessels Deployed (PSOs required)[2]	Aerial Observers	PSOs/survey	Total PSOs
Beaufort Sea	**<u>Four</u> 2D/3D seismic surveys**	Source (5) 2 chase/monitoring and/or icebreaker (3 each)	4	15	60
	<u>Three</u> site clearance and high resolution shallow hazards survey programs	Source (5)	4	9	27
	<u>One</u> exploratory drilling program	Drilling rig (5) 2 ice management (3 each) 3 other various (2 each)	4	21	21
Chukchi Sea	**<u>Three</u> 2D/3D seismic**	See Beaufort examples	4	15	45
	<u>Three</u> site clearance and high resolution shallow hazards survey programs		4	9	27
	<u>One</u> exploratory drilling program		4	21	21
			TOTAL per year	**88**	**201**

Notes:

1) Assumes all positions are unique; one PSO would not be hired for multiple surveys.
2) Numbers based on (Funk 2011) and (NMFS 2009 IHA permit)

Aside from the positions described in the mitigation measures, it is unclear what direct full-time employment benefits would materialize locally from the action alternatives. Companies like Shell and BPXA have committed to hiring local residents and have been obtaining services from subsidiaries of Alaska Native regional and village corporations. An economic analysis of future offshore oil and gas development assumed from historical trends that only a small share of direct jobs would go to local residents, and most direct positions would be filled by urban Alaska residents or non-Alaskan commuters (NEI and ISER 2009). The study did assume the government, infrastructure, and support jobs would likely be filled by local residents. About 35 percent of North Slope workers in the oil and gas industry are nonresidents of Alaska (Alaska Department of Labor and Workforce Development [ADLWD] 2014).

Employment and income would increase during exploration peak during development, and decrease as production declines over time. The indirect employment opportunities associated with Alternative 2 are shore-based, including: transport of equipment, room and board of survey/seismic crews, and administration of permits to conduct the surveys. Alaska Native Corporations and private entities may capitalize on these opportunities.

Demographic Characteristics

Alternative 2 would contribut directly or indirectly to demographics in the EIS project area communities. The seismic, site clearance, on-ice, and exploratory drilling activities are seasonal and short-term in nature. If workers associated with the surveys and programs do not already live in the EIS project area, they would not relocate permanently.

Social Organizations and Institutions

The implementation of Alternative 2 would result in relatively small revenues to municipal governments, primarily in sales, property, and special taxes, and employment and service contracts with regional and village corporations. In the communities where crew changes occur or vessels are based, there could be short-term, seasonal demand on institutions and social services for Barrow, Wainwright, Nome, and Unalaska/Dutch Harbor.

If a deflection or disturbance of subsistence resources occurs as a result of Alternative 2 and results in reduced subsistence harvests, the activities of non-profit organizations (see Table 3.3-6 in Chapter 3) could be impacted in order to coordinate adaptive strategies regarding potential economic and social implications of reduced harvest of subsistence resources. The Conflict Avoidance Agreement (CAA), Communication Centers, and Plans of Cooperation (POC) are mechanisms currently used for communication, cooperation, and conflict avoidance between industry and local groups like the AEWC. These are described more in Section 2.3.4 and evaluated in Chapter 5.

4.5.3.1.2 Conclusion

Based on the criteria identified in Table 4.4-1 (under Alternative 1), the magnitude of the socioeconomic impact associated with the mitigation measures of Alternative 2 would be positive, but low, because total personal income and local employment rates would not be increased by more than five percent. Revenues to the NSB would also not likely exceed five percent of their annual operating budgets. Standard mitigation measures could reduce potential for adverse effects on subsistence activities and associated social impacts.

The duration of the socioeconomic impacts would be interim because activities would not be year-round or full-time, but exploration activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity would be statewide and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat (minority population). The summary impact level for Socioeconomics under Alternative 2 is moderate.

4.5.3.2 Subsistence

This section discusses potential impacts on subsistence resources that could result from implementing Alternative 2.

4.5.3.2.1 Direct and Indirect Effects

The level of impacts on subsistence resources are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-28.

Table 4.5-28 Impact Criteria for Effects on Subsistence

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: No noticeable impact to subsistence use patterns	**Medium**: Minimal spatiotemporal overlap of activities with subsistence hunts; effects able to be mitigated	**High**: Large-scale overlap of activities with subsistence hunts; adverse effects on success of hunts
Duration	**Temporary**: Impacts would be intermittent, infrequent, and typically last less than a month	**Interim**: Impacts would be frequent or extend for longer time periods (an entire project season)	**Long-term**: Impacts would cause a permanent change in the resource that would perpetuate even if the actions that caused the impacts were to cease
Geographic Extent	**Local**: Effects realized by a single community	**Regional**: Effects realized by two or more communities	**State-wide**: Effects realized throughout the EIS project area and may extend beyond the EIS project area
Context	**Common**: Affects only locally abundant subsistence resources or little changes in harvest and sharing practices	**Important**: Affects subsistence resources/ access/ or harvest and sharing practices within the region	**Unique**: Affects subsistence resources/ access/ or harvest and sharing practices beyond the region

As a result of oil and gas activities under Alternative 2, disturbance and displacement of subsistence resources could occur and would be considered a direct impact from the activities. The following sources of disturbance may result in displacement of resources typically harvested or changes in their behavior such that the subsistence resources move away from coastal waters and become less readily available to subsistence hunters:

- Offshore noise from seismic and high resolution shallow hazard surveys and exploratory drilling;
- Offshore and nearshore noise from helicopter and fixed wing aircraft overflights;
- Increased levels of vessel traffic (including their noise contribution) associated with activities offshore and while transiting through nearshore areas;
- Ice management and icebreaking activities;
- Noise and vehicle movement from on-ice seismic surveys;
- Permitted discharges; and
- Small fuel spills.

These sources of disturbance have distinct characteristics in their effects on marine mammal and other important subsistence resource species. In the next seven sections, the literature on each of these types of disturbance is reviewed in relation to the distinctive impacts on particular species. Traditional knowledge observations from subsistence users and communities are offered alongside the summary from the scientific literature. This review forms the foundation for analysis in later sections of the intensity, duration, extent, and context for estimated impacts to subsistence uses of the major species.

Table 4.5-29 describes the different subsistence hunts that occur within the EIS project area by resource, where these subsistence hunts occur, the seasons of occurrence and the potential for overlapping with proposed activities of Alternatives 2 through 6. Detailed information regarding the seasonal cycles of subsistence resources and harvest patterns is described in Section 3.3.2.

Table 4.5-29 Description of Subsistence Hunts by Resource

Community	Bowhead whales	Beluga Whales	Seals	Walruses	Polar Bears	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 6)
Kaktovik	Fall – August to October about 20 miles off the coastline.	August to November - (opportunistically harvested with bowhead whaling and sealing in the fall) about 20 miles off the coastline.	Year round – peaks during whaling season. Occurs along coastline Kaktovik to Prudhoe Bay area. Northeastern Camden Bay and Point Griffin in the summer months.	June and July if present nearshore waters.	Year round along coastline - though not as common June, July and August.	Freshwater fish harvested January to mid-June and August through December at Hula Hula River, Kongakut River and into the Brooks Range. Marine fish July to November along the coast. Point Griffin, Kaktovik Lagoon, Camden Bay to Jago Spit in summer and the Canning Delta. Canning and Kuparuk rivers in the fall.	Harvested year round. Waterfowl arrive with open water in late spring and early summer months at Camden Bay and on barrier islands.	January to May and late summer/early fall months (September) if present. Inland fall and winter hunting occurs at the Hula Hula River and into the Brooks Range. Along the coast during summer hunting occurs when caribou are present at Point Griffin, Canning River, and Konganevik Point in the summer months.	Under Standard Mitigation Measure D1 proposed activities could not occur from Aug 25 until after bowhead harvest/quota is reached. Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvests (seals, walruses, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from the Prudhoe Bay area to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Nearshore summer and late fall seal, walrus, marine and coastal bird hunting could be impacted by nearshore vessel traffic. One on-ice survey could occur at the same time that seals and polar bears are harvested during the winter.
Nuiqsut	Base for fall whaling is at Cross Island which is 90 – 100 miles from the community. Whaling occurs August to October. Most intense periods of whaling begin in mid-September and occur along the coast as far east as the Canning River.	Opportunistically harvested during bowhead whaling activity and sealing in the fall) from August to October.	Hunts occur at Cross Island, Thetis Island and the barrier islands. Seals are taken on the sea ice during March through May. During summer, ringed and spotted seals are hunted near the Colville River to Ocean Point. During the fall (August to October) hunts occur near the Colville Delta and along the coast from Cape Halkett to Foggy Island.	Hunted in June and July if present nearshore waters.	Occasionally taken during bowhead whaling hunt. And occasionally taken on coast late October through March.	Fishing occurs from Nuiqsut east to the Sagavanirktok River, south to the middle Colville, west to Teshekpuk Lake, and along the coast to Pitt Point to the mouth of the Canning River. In June whitefish are taken in the Colville River. Summer fishing occurs farther up the Colville River and on Fish Creek. Summer coastal fishing occurs for whitefish and cisco. Fall and summer fish camps are on the Colville River and at Fish Creek.	Harvest is year round. Hunting occurs from Nuiqsut east to the Sagavanirktok River, south to the middle Colville, west to Teshekpuk Lake, and along the coast to Pitt Point to the mouth of the Canning River. Ducks in fall are taken while whaling offshore.	Caribou harvest is year round. Hunting occurs from Nuiqsut east to the Sagavanirktok River, south to the middle Colville, west to Teshekpuk Lake, and along the coast to Pitt Point to the mouth of the Canning River. Caribou hunting is the primary activity in late summer. Some hunting in the area of Fish Creek during the winter.	Under Standard Mitigation Measure D1 proposed activities could not occur from Aug 25 until after bowhead harvest/quota is reached. Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvests (seals, walruses, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from the Prudhoe Bay area to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Nearshore summer and late fall marine mammal harvests (seals, walruses, polar bears), marine and coastal bird hunting could be impacted by nearshore vessel traffic. One on-ice survey could occur at the same time that seals and polar bears are harvested during the winter.
Barrow	Spring whaling April through June is based from camps on the ice shelf northwest of the community and occurs west and east of Point Barrow. Hunting area is almost as far as Smith Bay to the east and as far as Skull Cliff to the west where there is an area of overlap with Wainwright whaling areas. Fall whaling occurs east or northeast of Cape Simpson on Smith Bay from August to October in an area that extends 16 km (10 mi) west of Barrow to 48 km (30 mi) north of Barrow, and southeast 48 km (30 mi) off Cooper Island with an eastern boundary on the east side of Dease Inlet. Occasionally, the hunt extends east as far as Smith Bay and Cape Halkett or Harrison Bay. October is preferred month to hunt.	The spring hunt for beluga whale occurs from April to June in the spring leads between Point Barrow and Skull Cliff. Later in the spring, whalers in Barrow hunt belugas in open water around the barrier islands off Elson Lagoon.	Seal hunting areas range from Peard Bay to Pitt Point in spring and summer months and winter. In the spring bearded seals may become available offshore west and north of Point Barrow in April. In June hunting camps are set up along the coast southwest to Peard Bay. Bearded seal hunts in the summer are conducted west of Barrow or from Pigniq. Ringed seals are hunted along the coast in the fall.	Walrus hunt areas range from west of Barrow and southwestward to Peard Bay. In April walruses may be hunted offshore west and north of Point Barrow. During summer to early fall, (June to September) hunts occur from west of Barrow southwestward to Peard Bay.	Hunts occur October to June if present at areas ranging west of Barrow southwestward to Peard Bay.	Fishing occurs April through early November. Fish are harvested in local rivers and lakes and in Elson Lagoon and west of Point Barrow during spring and summer. Historic site of Pulayaaq on the Meade River is used for summer fishing. During fall fishing occurs inland at such historic places as Iviksuk on the Inaru River and Nauyalik on the Meade River.	Hunting occurs primarily in the spring and fall. Historic site of Pulayaaq on the Meade River for taking waterfowl in the spring, Pulayatchiaq is also noted as a current and historical area for and spring waterfowl. By June, duck hunting camps are set up along the coast southwest to Peard Bay including the historic site of Pigniq, north of Barrow. In the fall duck hunting can continue into September at Pigniq.	Caribou hunting occurs year round. Historic site of Pulayaaq on the Meade River is used for trapping in late winter. Pulayatchiaq is also noted as a current and historical area for trapping. Majority of caribou hunting occurs by boat during the summer and fall months along the nearshore coast and inland along rivers.	Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvests (seals, walruses, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from the Prudhoe Bay area and Barrow to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Nearshore summer and late fall harvests for seals, walruses, marine and coastal bird hunting could be impacted by nearshore vessel traffic. One on-ice survey could occur at the same time that seals and polar bears are harvested during the winter.

Community	Bowhead whales	Beluga Whales	Seals	Walruses	Polar Bears	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 6)
Wainwright	Spring – In April, these whales are taken in open leads in the offshore ice as they pass close to shore near Point Belcher and Icy Cape. Whalers travel up the coast as far as Peard Bay to hunt bowheads in the spring. Whaling camps are sometimes located 10 to 15 mi (16 to 24 km) from shore. Whales are taken from April through to August. Fall whaling recently resumed in 2010.	The beluga whale hunt takes place in the spring lead system from April to June in the ice along leads or driven into inlets in summer and harvested. Belugas are hunted from late June through mid-July and sometimes later into the summer.	Bearded and harbor seals are harvested from spring through fall. Ringed seals, however, are hunted during the spring in open leads. Bearded seals are hunted in early summer southwest of the community. Spotted seals harvested in the late summer early fall.	Walruses may be taken in spring but most are taken in the summer (July and August) from drifting ice floes near Wainwright and along the coast to Peard Bay. From August to September at local haul-outs, with the main area being from Milliktagvik north to Point Franklin. Icy Cape is a known walrus haulout location.	Polar bear subsistence hunts occur in the fall and winter (October through February) around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.	Kuk River and Kuk River estuary is an area where fishing occurs. Smelt fishing is done in January through March in the Kuk Lagoon. In general fishing occurs year round. During midsummer, nets are set up in front of the community for salmon, trout, and whitefish. Fall fishing along the Kuk, Ivisaruk, and Avalik rivers.	Migratory waterfowl harvest occurs along the coast and along rivers beginning in late April and early May. Waterfowl are harvested in early summer until nesting and some egg collecting occurs along Kasegaluk Lagoon or Seahorse Island. Fall harvests are at Icy Cape and Point Belcher.	Caribou are harvested year round. Caribou migrate to the coast during summer and are harvested from Icy Cape to Peard Bay and along major rivers beginning in late August and into the fall.	Proposed offshore activities would not overlap with bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Air traffic originating from a Wainwright shorebase, could traverse routes reported as beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. These communities harvest belugas primarily in the spring, and the majority of harvest would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. Summer and early fall marine mammal harvests (seals, walruses, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from Barrow and Wainwright to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Nearshore summer and late fall marine mammal harvests (seals, walruses, polar bears), marine and coastal bird hunting could be impacted by nearshore vessel traffic.
Point Lay	Spring bowhead hunting resumed in 2009 in open leads.	Hunts occur from late June through mid-July herding them from the south to the shallows inside Kasegaluk Lagoon. Hunters are most familiar with beluga whale harvest in the area between Omalik Lagoon and Point Lay, although hunts can be as far north as Icy Cape. Summer harvest is from the middle of June to the middle of July. The summer hunting area is concentrated in Naokak and Kukpowruk Passes south of Point Lay. If the July beluga hunt is unsuccessful, Point Lay hunters y travel as far north as Utukok Pass and as far south as Cape Beaufort in search of beluga whales.	Ringed and bearded seals are available year-round. Ringed and bearded seals are hunted 20 miles (32 km) and 30 miles (48 km) north of Point Lay, respectively, with bearded seals concentrated in the Solivik Island area and up to three miles north off the island. Bearded seals are also hunted from south of Point Lay to the southern end of Kasegaluk Lagoon. Spotted seals are hunted mostly in the fall.	Summer walrus hunt occurs near Icy Cape. In June, the walruses migrate north past Point Lay, and the community conducts their annual hunt. Walruses are hunted from late May to late August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 mi (32 km) offshore.	Polar bears hunted from September to April along the coast with the hunting area rarely extending more than two miles offshore.	May through October. Summer months fishing occurs near river mouths (except Kokolik), at ocean passes, in Kasegaluk Lagoon, and at Sitkik Point. The season lasts from early July to late September. The nets are moved about 15 miles up the Kukpowruk River in September for grayling fishing.	Icy Cape area used for hunting waterfowl. Migratory waterfowl and eggs are harvested during May and June at coastal sites and along inland rivers. Eggs are harvested at the islands in Kasegaluk Lagoon and along the barrier islands. Fall hunting near icy Cape.	Hunted year round. Caribou hunting areas in the western Brooks Range in the southeast corner of the NPR-A are used by Point Lay and Wainwright hunters. In the summer hunted near as they move toward the coast or in the Amatusuk and Kiklupiklak hills. Also taken along the coast and around Icy Cape. Fall hunting from late August to October at inland locations.	Proposed offshore activities would not overlap with bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Air traffic originating from a Wainwright shorebase, could traverse routes reported as beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. These communities harvest belugas primarily in the spring, and the majority of harvest would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. Summer and early fall seals, walrus, marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from Wainwright to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Vessels would not be expected to be present in seal subsistence harvest areas during the summer and fall months. Polar bears are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.
Point Hope	Spring whaling occurs from the time the offshore leads form in the ice in late March or early April until June. Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of Point Hope when pack-ice lead is rarely more than 10-11 km (6-7 mi) offshore.	Spring - belugas are usually taken from late March through June in offshore leads. In summer whaling also occurs again in July, and some may be taken with nets from the beach areas. The second beluga hunt occurs later in the summer from July to August. During this second hunt, residents hunt beluga whales in the open water near the southern shore of Point Hope close to the beaches, as well as north of Point Hope as far as Cape Dyer.	Hunted year round. Main sealing season begins along the south shores of the peninsula after whaling has concluded in the late spring.	Spring – hunts are in south shore leads from May to July along the southern shore from Point Hope to Akoviknak Lagoon.	Hunting takes place from January to April and occasionally from October to January. Hunting occurs in the area south of Point Hope as far out as 16 km (10 mi) from shore.	Summer marine fishing for char and salmon is conducted with beach seines and nets along the north and south shores, and lagoons. Summer salmon and grayling are caught at the mouth of the Kukpuk River and at other fishing areas along the river. About three fourths of the total fish harvest is obtained in the fall at the Kukpuk River. Fishing is combined with caribou and moose hunting up to the mouth of the Ipewik River. Cod are harvested in the fall on the beaches.	Spring - Early migratory birds passing through the area are also harvested. The area of subsistence activities includes extensive sea ice usage along the north coast and around Point Hope north toward Cape Thompson. Inland areas along the Kukpuk and Ipewik rivers are used. Summer - Bird nesting sites at Cape Thompson and Cape Lisburne are visited by boat to collect eggs and harvest birds. Fall - harvests are along the south shore inland to an area beyond the Kukpuk River and part of the north coast.	Hunted year round. Summer - Caribou are harvested at several places inland along the coast, including the Kukpuk River area or towards the Pitmegea River. Fall - Caribou are hunted along the Kukpuk River and at coastal and inland areas around Cape Thompson.	Proposed offshore activities would not overlap with spring bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Air traffic originating from a Wainwright shorebase, could traverse routes reported as beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. However, the majority of harvest would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. Summer and early fall marine mammal harvests (seals, walruses, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from Wainwright to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Vessels would not be expected to be present in seal subsistence harvest areas during the summer and fall months. Polar bears are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.

Community	Bowhead whales	Beluga Whales	Seals	Walruses	Polar Bears	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 6)
Kivalina	Spring – Whalers participate on Point Hope crews.	Beluga whales may occur in the open leads along the coast as early as January and February due to the presence of a persistent polynya. North Kivalina coastline is used for beluga whales during spring and summer.	Winter, ringed seals and bearded seals are harvested on open leads. Spring and summer, Cape Krusenstern is an important use area for residents of Kivalina, Noatak, and Kotzebue when spring sealing takes place in the open leads. North Kivalina coastline is used for hunting ringed, bearded, and spotted seal during the spring. Summer – spotted seals along barrier island beaches and north Kivalina coast.	Spring – hunting occurs along the north Kivalina coast.	Polar bears are hunted in the spring along the north Kivalina coast.	Year round. Winter - Kivalina Lagoon is a subsistence use area that provides overwintering habitat for fish and serves as a migration pathway for anadromous fish bound for the Wulik and Kivalina Rivers. Summer - The Upper Kivalina River and its tributary streams are used for fishing.	The north Kivalina coast is an important resource use area where waterfowl hunting occurs during the spring and later in the fall. Fall - Cape Krusenstern area is used by waterfowl during fall migration.	Year round. Winter - Caribou winter use areas harvest occurs are along the north Kivalina coast and the Upper Kivalina River and its tributary streams. Summer - The Upper Kivalina River and its tributary streams are used for hunting.	Proposed offshore activities would not overlap with spring bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvest (seals,) marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths would be limited by altitude restrictions of Standard Mitigation Measure D3. Vessels would not be expected to be present in seal subsistence harvest areas during the summer and fall months. Polar bears and walruses are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.
Kotzebue	Spring – Whalers participate on Point Hope crews.	Spring – beluga harvest near Sisoalik Spit. Summer (June and July) at Eschscholtz Bay and the Elephant Point/Choris Peninsula area.	Spring – ringed seals near Sisoalik Spit. Summer – spotted seal hunting at Eschscholtz Bay and the Elephant Point/Choris Peninsula area.	Rarely harvested.	Rarely harvested.	Kobuk/Selawik Lakes are used year round for subsistence activities by residents of several communities mainly for sheefish hooking. Spring – harvest near Sisoalik Spit. The Kobuk River Delta is another important year-round subsistence use area.	Spring - Waterfowl hunting occurs in Paul's Slough and throughout the delta area. The Sisoalik Spit area is heavily used from June to freezeup (mid-September). Year round - The Kobuk River Delta. Summer – egg gathering at Eschscholtz Bay and the Elephant Point/Choris Peninsula area. Fall - hunting occurs in fall in the Kobuk River Delta and near the Omar River.	Winter - The lower North Fork River and all of the Omar River drainage receives heavy some years use by wintering caribou. The valleys of the Omar and North Forks Rivers provide north/south migration corridors for caribou moving to calving and summering areas in the spring and returning to winter range in the fall.	Proposed offshore activities would not occur offshore of Kotzebue. Flight paths and vessel traffic would not occur from Kotzebue to areas where offshore seismic survey activities and drilling operations are located.

Effects of Seismic and High Resolution Shallow Hazard Surveys and Exploratory Drilling Disturbance to Subsistence Resources

Bowhead Whales

The potential effects of noise from seismic and high resolution shallow hazard surveys and exploratory drilling on bowhead whales, which may result in changes in migration patterns or adverse effects on the bowhead population health and productivity is of great concern to the Iñupiat people due to possible effects on their culture. During seismic and high resolution shallow hazard surveys and exploratory drilling, noise is transmitted through the water and air from acoustic sound sources, helicopter and fixed-winged aircraft traffic, support-vessel traffic, and ice management activities. Section 4.5.2.4 (Marine Mammals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas that could directly or indirectly affect marine mammals are primarily those associated with noise exposure, possibly ship strikes and habitat degradation.

As discussed previously in this EIS (Section 4.5.2.4.10), noise from oil and gas exploration activities has been shown in certain instances to displace bowhead whales from certain habitat areas in the EIS project area. Should displacement occur and cause bowhead whales to migrate in areas too far offshore to be readily available to subsistence users, this may be considered an adverse direct impact to the bowhead subsistence hunt. Whaling crews would be required to travel greater distances from shore, which would mean spending more money on gas, additional travel time, and potentially putting crews at greater risk for adverse weather in order to intercept eastward and westward migrating whales (depending upon the time of year of the activity). Hunting at greater distances from shore also means longer distances to tow a whale to shore, following a successful harvest, during which time the meat can spoil. Braund and Moorehead (1995) report that whaling crews rarely pursue whales beyond 80 km (50 mi) from shore. At a workshop of the Arctic Waterways Safety Committee in December 2015, AEWC hunters described the timing and distances from shore that they typically travel to hunt bowhead whales. George Noongwook (Savoonga representative to the AEWC) stated that hunters remain close to shore when weather and ice conditions are such that the whales are close to shore. They typically hunt within 1-12 miles of shore. He noted that the furthest whales are typically caught no more than 20 miles from shore. At the same workshop, Harry Brower (Chairman and Barrow representative to the AEWC) noted that even when the ice edge is further from shore, Barrow hunters typically do not travel more than 15 miles offshore to hunt.

Another effect as described by hunters is that whales behave differently in the presence of sound in a manner that in turn makes them more difficult to harpoon. Traditional knowledge indicates that bowhead whales become increasingly “skittish” or “spooked” in the presence of seismic noise. Whales are more wary around the hunters and tend to expose a much smaller portion of their back when surfacing (which makes harvesting more difficult). Additionally, Alaska Natives report that bowheads exhibit angry behaviors in the presence of seismic, such as tail-slapping, which translate to danger for nearby subsistence harvesters (NMFS 2006). As described by Tom Albert, former Senior Scientist for the NSB, who related that: *“When a captain came in to talk to me, I knew he was going to say that the whales are displaced [by noise] farther than you scientists think they are. But some of them would also talk about ‘spookiness’; when the whales were displaced out there and when the whaler would get near them, they were harder to approach and harder to catch”* (MMS, 1997).

Edward Nukapigak at the Nuiqsut Public Scoping meeting for this EIS on March 11, 2010 remarked that vessel presence also affects bowhead whales: *“with all the interference, with all these vessels we have, it's difficult for us to harvest our quota because all those whales are being spooked, skittish, and hard to approach because they have been harassed from the east by these vessels that are traveling from east to west going to West Dock, maybe possibly further west.”*

Iñupiat hunters have for many years stated that bowhead and beluga whales can detect sounds at greater distances than can be measured by scientific instrumentation and methodology. Of great concern to residents of the EIS project area is that the increased levels of noise as a result of seismic and high resolution shallow hazard surveys and exploratory drilling could disrupt the normal migration routes of subsistence resources – in particular the bowhead whale, beluga whale, bearded seal, and walrus. At the Arctic Seismic Synthesis and Mitigating Measures Workshop held in March 1997 by MMS in Barrow, Alaska, with subsistence whalers from the communities of Barrow, Nuiqsut, and Kaktovik, whalers agreed on the following statement concerning the "zone of influence" from seismic-survey noise: *"Factual experience of subsistence whalers testify that pods of migrating bowhead whales will begin to divert from their migratory path at distances of 35 miles from an active seismic operation and are displaced from their normal migratory path by as much as 30 miles* (MMS 1997)*."*

The AEWC has commented extensively on the issue of noise impacts to bowhead whales, beluga whales, and other marine mammals: *"As has been documented time and time again, bowhead whales, beluga whales and other marine mammals react to very low levels of underwater noise. Studies conducted by Richardson and others, as have been discuss[ed] in the 2008 Arctic Regional Biological Opinion, document bowhead whale deflection when received sound levels are at or perhaps lower than 120 dB. More recently, we understand that monitoring activities from Shell's seismic activity in the Beaufort during 2007 and 2008 demonstrate that call detection rates drop significantly during airgun operation. Disruption of communication and migration patterns certainly meets the definition of "harassment" under the MMPA and therefore must be regulated by NMFS"* – Harry Brower, representing the AEWC, in written comments on this EIS dated April 9, 2010.

"Our observations, proven correct time and again by scientific research, are that bowhead whales change their behavior when industrial activity is taking place in their usual habitat. Because of these changes in behavior, the whales become less available or completely unavailable to our hunters during the time the activity is occurring, due both to noise disturbance and to pollution in the water. We also are very concerned that some habitats might be abandoned altogether if industrial activity increases or if it is undertaken in a way that creates ongoing disturbance" - Harry Brower, representing the AEWC, in written comments on this EIS dated April 9, 2010.

"If you put a drill ship there at Sivulliq Prospect, the whales are going to start migrating further north. I guarantee you that. They're not going to come in inside the islands. They're going to go up north and go around the drill ship. Then we have to travel 30-plus miles out to try and scout and harvest a whale. Just like one of our elders, one of our whaling elders mentioned earlier, that due to interference, they had travel 30-plus miles out. By the time the whale was harvested, the wind has already picked up. You have no ice out there to protect the swells" – Edward Nukapigak at the Nuiqsut Public Scoping meeting for this EIS on March 11, 2010.

"Barrow whalers and Nuiqsut whalers have encountered "unacceptable levels" of disturbance from industrial activities in these waters, where whales were harvested far from ideal locations. The result was putting the Iñupiat hunters in a greater danger by deflecting the whales as far as 30 miles off course; some boat[s] have succumbed to storms and greater wave actions and sunk; in some cases, individuals lost their lives. The harvest of the whale, therefore, was spoiled, after a 12-hour tow or more; the whale gasifies its internal organs and contaminates the meat, and the whale at this point cannot be eaten. This is a direct impact to feeding the indigenous Iñupiat people of the Arctic. In Barrow alone, it takes a minimum of 10 whales to feed the community for a day, for the season's events. Our culture is surrounded by the whale" - Gordon Brower, as stated in the Arctic Multiple-Sale EIS (MMS 2008) on November 1, 2008.

"Nuiqsut whalers have direct experience with disturbance of bowheads due to human activity in the ocean. In Camden Bay in the early 1980s, there was drilling at the Hammerhead Prospect (now known as Sivulliq). In those years, the bay was empty of marine mammals. The whalers did not see any whales in the usual areas where they find them. The bowhead whales headed north to avoid the disturbance. Whalers had to travel 30-35 miles straight out from Cross Island to get whales, which was a big risk. While drilling was occurring, whalers saw grayish mudballs floating on the surface of the ocean at times.

The mudballs were a few inches in diameter." – interviews with residents of Nuiqsut by Huntington (2013).

These direct impacts could result in whalers having to travel further offshore to hunt and an increase in the number of days it takes for whalers to be successful. As subsistence activities and wage economics are highly interdependent, the cost of expenditures for whaling activities could rise in terms of fuel costs and potential for loss of wages (time taken away from regular jobs) if increased time was spent away from work while engaged in subsistence resources harvest activities. It could also increase the safety risk to hunters if they are required to spend additional time on the water, further from shore. Direct effects could also result in a limited sharing of resources and in turn affects the quality of life, which can be summarized as:

"[talking about environmental justice] It has to do with sharing. If Point Lay catches a beluga whale, that beluga whale is shared with people as far away as Anchorage, Kotzebue, Nuiqsut; it just goes all over the place. So if we get 30 belugas, I wouldn't be surprised if that showed up in 30 villages. So when something affects Point Lay, little old Point Lay in the middle of north nowhere, it's felt in Anchorage in some way, in some fashion. So yes, if there is something big that happens offshore at Point Lay and it contaminates, say, our lagoon system, we're not catching the belugas anymore, people in the whole state of Alaska are going to feel that" - Bill Tracey at Point Lay Public Scoping Meeting for this EIS February 22, 2010.

"Even if the impact on the whales from noise during construction is low as expected, the sociocultural impact of the community is likely to be high. They are -- they are the single most important animal in the North Slope sociocultural system. Iñupiat whaling is a proud tradition that involves ceremonies, dancing, singing, visiting, and cooperation between communities in sharing of food" - Thomas Napageak at the April 19, 1990 public hearing in Nuiqsut on the Beaufort Sea Planning Area Oil and Gas Lease Sale 124.

For the spring bowhead hunt in the Chukchi Sea, the impacts of disturbance could be limited by mitigation measures. Seismic and high resolution shallow hazard surveys and exploratory drilling operations may not occur until the spring bowhead whale hunts of Wainwright, Point Lay, and Point Hope are completed in the Chukchi Sea. Subsistence hunters in the Chukchi Sea have a limited hunting range. These whalers prefer to take whales close to shore to avoid hauling a harvested whale over long distances during which time the whale can spoil. Subsistence hunters in the Chukchi Sea during the fall will pursue bowhead whales as far as 80 km (50 mi) from the coast in small, fiberglass boats (Comstock 2011). Subsistence whaling is unlikely to occur in areas far offshore in the Chukchi Sea where it is assumed that seismic and high resolution shallow hazard surveys and exploratory drilling operations would occur in the Chukchi Sea during the late summer and fall months where these communities are not actively whaling. However, Wainwright whalers have expressed concerns that offshore oil and gas activities have disrupted previous spring migrations (Quakenbush and Huntington 2010). Wainwright whalers are concerned that increases in the levels of oil and gas activities in the Beaufort Sea could push southward migrating whales away from the eastern coast of the Chukchi Sea where they become inaccessible to hunters during the fall (Quakenbush and Huntington 2010).

In regard to the fall bowhead hunt (largely in the Beaufort Sea), mitigation measures require that seismic surveys and drilling operations would be limited in time and space during the fall bowhead whale migration. The areas where the Beaufort Sea bowhead whale subsistence hunts of Kaktovik, Nuiqsut and Barrow occur (Figures 3.3-10) are unlikely to be affected when mitigation is applied due to reduced spatial and temporal overlap of activities. Mitigation is intended to reduce negative impacts occurring to subsistence hunting. Limitations of when activity can occur in the Beaufort Sea would continue until strike quotas have been filled by the coastal communities. Bowhead whaling at Barrow could continue into October. Standard and additional mitigation measures analyzed in this EIS could require shutdown of exploration activities in the Beaufort Sea for the Nuiqsut (Cross Island), Kaktovik, and Barrow bowhead whale hunts. Short- and long-term effects on the Beaufort Sea subsistence hunts are expected to range from no impact to negligible impacts if the mitigation is applied.

Any impacts of seismic and high resolution shallow hazard surveys and exploratory drilling noise that do affect bowhead whales are expected to result in some temporary deviation in migratory path in the vicinity of the disturbance. However, the level of the response may depend on whether the whales are feeding, aggregated, or spread out and responses could range from apparent tolerance to interrupted communication, minor displacement or avoidance of an area (Section 4.5.2.4.10). Impacts from exploratory drilling at well sites in both seas could range further than the immediate drill site area and extend to a broader area (potentially 25 miles) based on the presence of multiple support vessels that are involved with the drillship or drilling rig. Depending on where the disturbance activity occurred relative to the geography of the area the whales could move closer to the coastline or move offshore. Noises in shallow waters are more amplified and could result in bowhead whales moving further offshore. Local knowledge and comments by whaling captains indicate that subsistence whalers perceive deflection of bowhead whales as likely, resulting in the need to travel further for successful hunts. Disturbance effects are not expected to rise to the level of impacts on a population, such that the bowhead resource declines with long-term impacts to subsistence harvest. The impacts would be minimized or avoided given the mitigation measures considered and analyzed in this EIS. The impact of disturbance to subsistence hunters is estimated to be of low intensity and temporary to interim in duration, i.e., for the duration of the seismic surveys and exploratory drilling activities offshore lasting a month or longer. These effects involve a resource that is unique in context, due to its importance as a key subsistence resource. Direct impacts that do occur would be considered of low intensity, limited in extent to a local area, temporary to interim in duration but unique in context. Bowhead whales are an essential subsistence resource for Iñupiat of the Arctic coast and Yupik of the Bering Strait southward, which places them in the context of being a unique resource. The summary impact to subsistence harvest from disturbance of bowhead whales could be minor.

No effects from on-ice surveys are expected on bowhead subsistence hunts as those activities generally occur outside of the time frame of bowhead hunting. There is the potential for some late season on-ice surveys to occur during part of the spring bowhead whale hunt. However, the on-ice surveys would only occur in the Beaufort Sea, east of Point Barrow. Nuiqsut and Kaktovik do not conduct spring bowhead whale hunts. In the Beaufort Sea, Barrow is the only community to conduct such a hunt. Therefore, impacts from on-ice seismic surveys in the Beaufort Sea are anticipated to have either no effect or negligible impacts on bowhead subsistence harvests.

Beluga Whales

Section 4.5.2.4.11 (Beluga Whales) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect beluga whales. Beluga whales are reported by the Northwestern Alaska communities, including Point Lay, Point Hope, and Kivalina, to be especially sensitive to noise and motors. Huntington et al. (1999) reported that beluga whales avoid anthropogenic noise, although a certain degree of habituation occurs, mostly for noises that are constant.

As noted by the Alaska Beluga Whale Committee (in comments by Willie Goodwin at the public scoping meeting for this EIS on February 18, 2010): *"Now, in the belugas that we tag or the research that we've done, we know that the belugas are sensitive to noise, any noise. And I am concerned about that, because until we know exactly when they had their young, any kind of noise would cause stress in the female beluga and may abort their young beluga, or the mother may just not want to nurse it. So there's some involvement that noise affects the belugas, and we are concerned about that."*

In the Chukchi Sea, beluga whales could be displaced from or could avoid the vicinity of seismic and high resolution shallow hazard surveys and exploratory drilling operations in July through October during their spring and fall migrations. Impacts from exploratory drilling at well sites in both seas could range further than the immediate drill site area and extend to a broader area (potentially 25 miles) based on the presence of multiple support vessels that are involved with the drillship or drilling rig. This would have the potential to impact and disrupt some communal beluga subsistence hunts (mostly Point Lay which heavily depends on this resource) by disturbing and/or altering the course of these migrating whales. Some of the early season industry activities could overlap in time with the Point Lay beluga hunt. This could make belugas more difficult to herd into the lagoons for the harvest (as is the practice in Point Lay). The impacts would be minimized or avoided given the mitigation measures considered and analyzed in this EIS. As mitigated, the effects of disturbance would be considered to be of low intensity and temporary to interim in duration, occurring for the duration of the activities offshore lasting a month or longer though not likely the entire project season, and affecting a resource that is important in context. These impacts would not be expected to rise to the level of impacts on a population level that would have long-term impacts to subsistence harvest. Beluga whales are an essential subsistence resource for some Iñupiat and Yupik Eskimo communities of the Arctic coast. The summary impact to subsistence harvest from disturbance of belugas could be minor.

Seals

Bearded, ringed, and spotted seals comprise a large portion of subsistence harvest and could be affected by seismic and high resolution shallow hazard surveys, including on-ice seismic surveys and exploratory drilling activities. Impacts from exploratory drilling at well sites in both seas could range further than the immediate drill site area and extend to a broader area (potentially 25 miles) based on the presence of multiple support vessels that are involved with the drillship or drilling rig. Section 4.5.2.4.13 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect these seals.

Observations by subsistence hunters have contradicted conclusions that seals are not disturbed: *"Point Hope is having hard time catching seals. There was a little seismic operation that went on in the Arctic a few years back, and our seals haven't come back yet"* – Earl Kingik, Point Hope: at the 2011 Open Water Meeting in Anchorage, AK, March 7, 2011.

As a result of the short duration of the proposed activities and in consideration of the observed effects of offshore drilling on seals, measureable population level changes are not expected to seals. The short-term exposures of seals to airgun sounds are not expected to result in any long-term negative consequences for the individuals or their populations. In a study of subsistence hunting in Barrow, Nuiqsut, and Katktovik, Braund and Associates (2010) found that while ringed and bearded seals can be hunted year-round, there tends to be a peak in July for hunting by these communities. Additionally, while most of the identified hunting areas in the study were closer to shore, some hunters travelled between 32.2 and 40.3 km (20 and 25 mi) offshore to hunt seals, with the mouth of the Colville River and Thetis Island shown as popular seal hunting grounds (Braund and Associates 2010). While there is some potential for temporal overlap in the Beaufort Sea at the beginning of the open water season with seismic surveys and exploratory drilling activities, interactions are expected to be limited and temporary in duration. The effects of disturbance would be considered to be of low intensity and temporary in duration, local in extent and affect a resource that is common in context. Activities within the lease areas far offshore, such as in the Chukchi Sea, that are likely to be explored would have no impact on subsistence hunting for seals. Therefore, the summary impact of these activities on seal subsistence harvests is expected to be negligible, taking into account the standard mitigation measures.

Pacific Walrus

Effects to walruses could occur during the summer months if seismic and high resolution shallow hazard surveys and exploratory drilling operations were conducted when walruses are present. Impacts from exploratory drilling at well sites in both seas could range further than the immediate drill site area and extend to a broader area (potentially 25 miles) based on the presence of multiple support vessels that are involved with the drillship or drilling rig. Section 4.5.2.4.14 (Pacific Walrus) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect walruses. Should walruses leave or abandon areas where they could be harvested by subsistence hunters, then subsistence harvest patterns would be affected. However, subsistence harvest of walruses occurs predominately in the late spring and early summer in the Chukchi Sea prior to the time frame when seismic and high resolution shallow hazard surveys and exploratory drilling operations would be taking place. Walrus subsistence hunts in the Beaufort Sea are conducted infrequently and tend to occur during whaling.

Impacts of disturbance to walruses are expected to be limited as far as the resource becoming unavailable for subsistence harvest. As a result, the intensity of the impact is low, temporary in duration, local in extent, and affecting a resource that is common in context. The impact of disturbance to subsistence harvest of walrus would be negligible.

Polar Bears

Section 4.5.2.4.15 (Polar bears) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect polar bears. Seismic and high resolution shallow hazard surveys and exploratory drilling activities are likely to occur in areas offshore and in open water areas where polar bears are not expected to be present, and subsistence harvest is not likely to be affected. For seismic surveys, high resolution shallow hazard surveys, and exploratory drilling activities, the summary rating regarding the subsistence harvest of polar bears is no impact.

Fish

Disturbance from sound generated by seismic and high resolution shallow hazard surveys and exploratory drilling activities could result in the temporary avoidance of the vicinity of these sound sources by fish. The displacement of fish could indirectly result in the loss of feeding opportunity for other subsistence species harvested such as seals who feed on fish. As noted by one resident of the area *"Over the past two or three hearings we had expressed our concerns regarding the loss of tomcod from the seismic activity, and at one time it had a real major affect on our seals… we didn't catch any, absolutely zero tomcod for two to three years"* Jack Schaeffer at ICAS Government to Government Public Hearing for The Effects of Oil and Gas Activities in the Arctic Ocean SEIS dated April 13, 2013. Impacts to fish are described in Section 4.5.2.2 of this EIS. Fish are unlikely to remain in an area where intense sound sources are present long enough to be injured or killed at a level that make them unavailable as a prey species for other subsistence resources. Death could eventually result from a reduction in fitness due to hearing loss or tissue damage, but direct harm is generally limited to within 5 m (16 ft.) of the sound source, at levels in excess of 230 dB (Turnpenny and Nedwell 1994). There is no recorded evidence that airguns have killed fish or caused injuries during seismic survey operations (Turnpenny and Nedwell 1994). Mortality of fish or other population level effects are not anticipated. Subsistence fishing tends to occur in harvest areas located closer to shore and not in areas where seismic and high resolution shallow hazard surveys and exploratory drilling would affect subsistence activities.

Subsistence fishing has not been observed to occur in the areas likely to be subject to seismic and high resolution shallow hazard surveys and exploratory drilling activities. The sounds generated by seismic and high resolution shallow hazard surveys and exploratory drilling activities and their associated support vessels could result in temporary avoidance in the vicinity of these sound sources by fish but would be unlikely to result in adult fish mortality or other population effects thereby making the resource unavailable for harvest by users.

Fishing by residents of the Beaufort Sea communities occurs at inland fish camps and in nearshore areas along the beaches and would be unaffected by seismic and high resolution shallow hazard surveys and exploratory drilling activities. Fishing by residents of the Chukchi Sea communities occurs in the lagoons and inland along rivers in areas that are not expected to be affected by seismic and high resolution shallow hazard surveys and exploratory drilling activities. Offshore areas anticipated to be explored would be in locations that are not used in subsistence fishing harvest. There are no anticipated effects of disturbance to subsistence fishing and harvest therefore, no impact is expected.

Marine and Coastal Birds

No effects from seismic and high resolution shallow hazard surveys and exploratory drilling are expected to occur to the subsistence harvest of birds because of the distance of such activities from the coastlines of both seas. Subsistence harvest of birds and egg gathering occurs throughout the spring, summer, and fall, at inland areas and near coastal waters. The spring bird harvest is often at the same time as marine mammal hunts when seismic and high resolution shallow hazard surveys and exploratory drilling activities would not be occurring. The Nuiqsut eider hunt occurs in the OCS in association with seal hunting, peaking in July (Braund and Associates 2010). There is the potential for some overlap between oil and gas exploration activities and this hunt.

Subsistence bird harvest and egg gathering has not been observed to occur in the areas likely to be subject to seismic and high resolution shallow hazard surveys and exploratory drilling activities. The sounds that would be generated by these activities and their associated support vessels could result in temporary avoidance of the vicinity of these sound sources by birds. However, direct mortality or other population-level effects are not expected to result.

Bird harvest and egg gathering by residents of the Beaufort and Chukchi sea communities occurs in the lagoons and along the coastline, as well as some minimal hunts in the OCS, and would be unaffected by seismic and high resolution shallow hazard surveys and exploratory drilling activities which would occur father offshore. It is possible that shallow hazard surveys could occur along potential pipeline routes to onshore areas, although this activity would likely occur after the primary harvest, particularly egg gathering. Therefore, potential impacts would be negligible to minor.

Caribou

No effects from seismic and high resolution shallow hazard surveys and exploratory drilling activities are expected on caribou. Caribou are an important source (by percent of harvest) of meat for village residents. Offshore seismic and high resolution shallow hazard surveys and exploratory drilling activities are not likely to have any effect on land mammals, including caribou, in consideration of the distance of such activities from the coastlines of both seas.

Offshore seismic and high resolution shallow hazard surveys and exploratory drilling activities are not likely to have any impact from disturbance in consideration of the distance of such activities from the coastlines of both seas.

Effects of Aircraft Overflights to Subsistence Resources

Bowhead Whales

Bowhead whales have been observed to be less responsive to aircraft in comparison to vessel traffic. Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.1.4 and Section 4.5.2.4.10 (Bowhead Whales) of this EIS.

The sound emitted by aircraft overflights potentially could cause some disruption to bowhead whale harvest, but aircraft overflights as mitigated are not expected to make bowhead whales unavailable to (or more difficult to harvest by) subsistence hunters. Whales could be expected to temporarily deflect from overflights, but mitigation measures analyzed in and contemplated by this EIS would limit the probability and consequence of this impact. It is expected that helicopters servicing offshore seismic and high resolution shallow hazard surveys and exploratory drilling operations could traverse areas utilized by subsistence whalers during fall whaling in the Beaufort Sea and limited areas of the Chukchi Sea. Flight paths could originate from the Prudhoe Bay area, Barrow and Wainwright shorebases to areas where offshore seismic activity and exploratory drilling operations are located. Flight path and altitude restrictions are expected to reduce to a low level any such potential impacts.

If bowhead whales were affected by aircraft overflights, it is unlikely that large numbers or a large whaling area would be affected, so the impact would be considered low in intensity and temporary to interim (lasting a month or longer though not likely the entire project season) in duration. Effects of the impact would be local, affecting a resource that is important in context. The impact to bowhead whales is considered minor.

Beluga Whales

Beluga whales are reported to be sensitive and to exhibit short-term behavioral responses to the presence of helicopter and fixed wing overflights. Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.11 (Beluga Whales) of this EIS.

Aircraft traffic transiting the Beaufort and Chukchi seas out to support vessels and traffic between the shorebase and offshore drilling locations as part of activities under Alternative 2 would have the potential to disturb and/or alter the course of these migrating whales. In turn, this could make belugas more difficult to herd into the lagoons and harvest as belugas have previously been observed to react to helicopter overflights. The effects of this disturbance would be considered to be of low intensity and temporary to interim in duration, occurring for the duration of the overflights but would not be expected to have effects on a population level. The impacts would be minimized or avoided under the standard mitigation measures, such as mandatory flight elevations and offset distances. Additional Mitigation Measures would impose further area specific limitations on the areas where aircraft disturbance could potentially occur.

It is unlikely that helicopter traffic from Barrow to offshore areas would traverse routes where belugas are commonly harvested. For helicopter flights originating from a Wainwright shorebase, the routes could traverse reported beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. These communities harvest belugas primarily in the spring, and the majority of harvest activity would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. The spring/early summer beluga hunts in Wainwright, Point Lay, Point Hope, Kivalina and Kotzebue would occur in the months prior to the start of offshore exploration activities in the Chukchi Sea. Some summer beluga hunting could be impacted by aircraft overflights early in the open water season, though mitigation measures are expected to lessen the extent of disturbance, which would be considered low in intensity, temporary to interim in duration lasting a month or longer though not likely the entire project season, and local to a very specific area along the helicopter flight path affecting a locally important resource. Mitigation measures are expected to minimize or altogether avoid impacts to beluga whale subsistence harvests. The impact to subsistence harvest from aircraft disturbance of belugas is considered minor.

Seals

Information on the impacts of aircraft sounds to seals associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.13 (Ice Seals) of this EIS.

The sound emitted by aircraft overflights could cause disruption to subsistence seal harvest, but aircraft overflights as mitigated are not expected to make seals unavailable to subsistence hunters. The assumed aircraft overflights associated with seismic survey activities and exploratory drilling would occur during the open-water season after seals have pupped and molted, fast ice has melted away, and flowing ice has retreated north. The standard mitigation measures of this EIS, including for mandatory elevations and offset distances, would minimize or avoid impacts to seal subsistence harvests. At present, air traffic currently exists along the coastal areas of the Beaufort and Chukchi sea communities (Section 3.3.6). An increase in the levels of helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations would be limited due to the small number of flights and the altitude at which flights occur. The spring/early summer seal hunts in Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina and Kotzebue would occur in the months prior to the start of offshore exploration activities in the Beaufort and Chukchi seas. However, there is some potential for overlap with the seal hunts in July and August.

Aircraft overflights are unlikely to have an adverse effect on seal availability for subsistence harvest. Impacts that did occur would be considered low in intensity and temporary in duration. Effects of the impact would be local and affecting resources that are common in context. The impact to seals is considered negligible.

Pacific Walrus

Walruses on coastal haulout sites could be disturbed by aircraft overflights and stampede into the water. During a stampede, the calves would be the most vulnerable to mortality or injury by trampling. Brueggeman (et al. 1990) observed reactions of walruses to aircraft at an altitude of 305 m (1,000 ft.) over the pack ice and at 152 m (500 ft.) over land and reported that walruses hauled out on land or ice were more sensitive to overflights (Brueggeman et al. 1990). The implications to subsistence hunters would be that repeated overflights could cause disturbance at haul outs sites thereby limiting the availability of this resources for harvest. Information on the impacts of aircraft sounds to Pacific walrus associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.14 (Pacific walrus) of this EIS.

Limited numbers of walruses are likely to be present in the central and eastern Beaufort Sea. In the Chukchi Sea, walruses have recently hauled out in large concentrations during the open water period at the same time frame when seismic and high resolution shallow hazard surveys and exploratory drilling could occur. Mitigation measures for aircraft overflights would need to be applied to lessen the impact to this species.

The mitigation measures analyzed in and contemplated by this EIS, including restricting aircraft to above 457 m (1,500 ft.), unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off and conducting regular aerial and vessel monitoring surveys, would minimize or avoid impacts to walruses and subsistence harvests of this species. At present, air traffic transits the coastal areas of the Beaufort and Chukchi seas between the communities. An increase in the levels of helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations would be have limited impacts due to the small number of flights and the altitude at which flights occur. This is unlikely to affect the walrus hunting in the Chukchi communities, which occurs primarily in the spring and early summer.

Aircraft overflights are unlikely to have an adverse effect on walrus availability for subsistence harvest. Impacts that could occur would be considered low intensity and temporary in duration. The impact would be local in extent, affecting resources that are common in context. The impact to walruses is considered negligible.

Polar Bears

The responses of polar bears exposed to aircraft overflights are likely to be that bears initially move away from the area of ensonification but then resume their natural habits. Polar bears have not been observed to remain in open water areas over which aircraft overflights occur. Polar bears would be most affected by helicopter and fixed wing aircraft overflights during the months when they are nearest to the shore or unable to access the offshore ice pack. Information on the impacts of aircraft sounds to polar bears associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.15 (Polar bears) of this EIS.

In response to seismic and high resolution shallow hazard surveys and exploratory drilling, polar bears may display avoidance behavior resulting in short-term and local effects, which could reduce the availability of this resource for subsistence harvest. These behavioral responses to disturbance from aircraft would be expected to be brief and not expected to rise to the level of long-term impacts to individuals or adverse impacts at the population level. Mitigation measures regarding mandatory flight elevations and offset distances would be anticipated to reduce the likelihood of impacts to polar bears. Aircraft overflights and helicopter routes could be planned to avoid areas of known polar bear dens.

After mitigation is taken into account, aircraft overflights are unlikely to have an adverse effect on polar bear availability for subsistence harvest. Any unintended impact that did occur would be infrequent and would be considered of low intensity and temporary in duration. Effects of the impact would be local, affecting a resource that is important in context. The impact on polar bears is considered negligible.

Fish

No direct or indirect impacts to fish from aircraft overflights are expected. Aircraft traffic would have no impact on the availability of subsistence fish resources. However subsistence hunters may view increased aircraft traffic from seismic and high resolution shallow hazard surveys and exploratory drilling activities as disruptive within harvest areas. The mitigation measures would reduce the likelihood of this perceived disturbance. It would be expected that regular helicopter overflights to support offshore operations would occur through a limited area that overlaps with known fishing areas of Wainwright and Barrow subsistence users. However, no impacts are expected to subsistence fish resources or to subsistence fishing activities because of the required flight altitudes over these areas. Limited aircraft traffic is expected over the Point Hope, Kivalina, or Kotzebue subsistence fish harvest areas. However these areas would be further away from the normal air traffic routes for flights related to exploration activities offshore in the Chukchi Sea, and no impacts are expected to subsistence fish resources or to subsistence fishing activities in those areas. Nuiqsut fish hunts are conducted in rivers and at the mouths of the rivers with hunts for Arctic Cisco and burbot peaking in months when open water activities do not occur (Braund and Associates 2010). Although Nuiqsut and Kaktovik fish for several species in July and August, Nuiqsut hunts occur in the rivers, and fishing by Kaktovik hunters is conducted both inland and along the coast. Increased air traffic in the coastal areas could occur during the life of various oil and gas activities but is not anticipated to impact the availability of subsistence fish resources to subsistence users in these communities. Therefore, no impact is expected.

Marine and Coastal Birds

Repeated disturbance from aircraft overflights could prevent staging birds from acquiring or maintaining sufficient nutrients for later migration. Colonies of nesting birds in coastal waters would be the most susceptible to disturbance from repeated aircraft overflights. In the Chukchi Sea, the areas where potential disturbances of marine birds could occur in large numbers include Kasegaluk Lagoon, Peard Bay, and Ledyard Bay all of which are heavily used for molting or staging. Repeated disturbances could result in displacement of small numbers of birds from preferred habitat and induce stress to birds that would then result in birds becoming unavailable for subsistence harvest and egg gathering activities. Information on the impacts to marine and coastal birds from aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.3 (Marine and Coastal Birds) of this EIS.

Helicopter traffic between the shorebase and offshore drilling locations and fixed wing aircraft traffic between the shorebase and regional hub airports could potentially disturb birds and therefore subsistence hunts for birds during the summer and fall. The mitigation measures analyzed in and contemplated by this EIS would reduce the likelihood of impacts to marine and coastal birds by restricting aircraft to above 457 m (1,500 ft.). Aircraft overflights and helicopter routes could be planned to avoid areas of known bird subsistence harvest areas.

Birds are considered an important food source available during a limited seasonal window, and there could be a perception that repeated disturbances could threaten subsistence harvests. The probability of disturbance and displacement of birds occurring within subsistence harvest areas is considered low, given mitigation measures, and the timing of harvest and oil and gas activities. Impacts that did occur to subsistence hunting and egg collecting would be of low intensity and temporary in duration. Impacts would be local and affect resources that are common and /or important in context. The impact to marine and coastal birds is considered minor.

Caribou

Effects to caribou could range from no response to running away from the noise of aircraft overhead. Caribou are present along the nearshore coasts in the summer and have been observed at beach habitats where they congregate to minimize harassment by insects. Subsistence hunting for caribou is conducted along the coastal areas in summer time, using boats for access, and this practice could be affected if long-term disruption of caribou habitat causes displacement from a typical harvest area.

Subsistence hunters may view increased aircraft traffic as disruptive and as intruding on their traditional subsistence areas. Hunters have noted that caribou may avoid areas in which they can see and hear aircraft traffic: *"The amount of noise from the activities from these seismic -- from seismic work and by travel that they'll be doing by sea and by air will have a negative impact on our community, because I believe it will scare the caribou away"* – Carla Sims Kayotuk at the Public Scoping Meeting for this EIS on March 3, 2010.

In the Arctic Multiple-Sale EIS (MMS 2008), Nuiqsut residents noted that aircraft have diverted subsistence resources away from areas where hunters were actively pursuing them, directly interfering with harvests or causing harvests to fail. Nuiqsut subsistence hunters report that on-shore seismic activity displaces game, especially caribou, wolves and wolverine from the area being surveyed.

At present, air traffic exists along the coastal areas of the Beaufort and Chukchi sea communities. An increase in the levels of helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations would be limited due to the small number of flights and the altitude at which flights occur. It is likely that there would be a limited disturbance to caribou or to caribou subsistence hunting from helicopter traffic on the coast as the helicopters travel offshore from the shorebases. Thus only small proportions of available subsistence hunting areas would be affected. To address potential interference with marine mammal hunts, Communication Centers will be established and used in subsistence communities when oil and gas exploration activities and marine mammal subsistence hunts will occur at the same time.

Subsistence hunters could perceive increased levels of aircraft traffic as disruptive and intrusive in subsistence areas, resulting in hunters avoiding affected areas.

Use of mitigation measures would reduce the likelihood of aircraft overflight adverse effect on caribou availability for subsistence harvest. Impacts that did occur would be considered of low intensity and temporary duration. The impact would be local in extent, affecting a resource that is common in context. The impact to caribou is considered negligible.

Effects of Vessel Traffic to Subsistence Resources

Bowhead Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.10 (Bowhead Whales) of this EIS. Bowhead whales have been observed to avoid approaching marine vessels. Reactions have been noted to be less severe when marine vessels are slow moving and do not approach the whales in a direct path (NMFS 2008). Bowhead whales have been reported to respond by swimming rapidly away from approaching vessels with avoidance responses beginning when a vessel rapidly approaches from 1 to

4 km (0.62 to 2.5 mi) away. When vessels approach bowheads, their behavior changes, and they may alter surface time and dive patterns. It has been noted that vessel disturbance can disrupt activities and social groups (Richardson and Malme 1993). Bowhead whales have been reported to avoid marine vessels, altering their behavior during migration to avoid the area(s) within a few miles of vessel activity. Changes in behavior, such as swimming speed and orientation, respiration rate, and surface-dive cycles, could be temporary and last only minutes or hours. As a result of vessel disturbance, whales could scatter and become less readily available for subsistence whaling activities for a limited period of time.

These types of observations have been reported by whalers. As voiced by Thomas Brower, Sr. on October 1, 2008 in the Arctic Multiple Sale document (MMS 2008): *"The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, usually made from bearded seal skins. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales. In the fall, we have to go as much as 65 miles out to sea to look for whales. I have adapted my boat's motor to have the absolute minimum amount of noise, but I still observe that whales are panicked by the sound when I am as much as 3 miles away from them. I observe that in the fall migration, the bowheads travel in pods of 60 to 120 whales. When they hear the sound of the motor, the whales scatter in groups of 8 to 10, and they scatter in every direction."*

"We were impacted, us whalers were impacted out there, but in -- within the last 10 years, I observed, I was impacted along with all our whalers here, impacted by vessels that were out there. And it costs us to not harvest our whale" – Carl Brower at the Nuiqsut Public Scoping Meeting for this EIS on March 11, 2010.

In addition, vessel traffic (barge traffic) presently occurring in subsistence harvest areas, but unassociated with seismic and high resolution shallow hazard surveys and exploratory drilling, has been observed to affect subsistence hunting: *"Because I know when you go to Nuiqsut, you'll hear a lot of this other, you know, entities that's disturbing the hunt…. And then Crowley [a barge company delivering fuel] was the one that disturbed Nuiqsut's hunt"* - Thomas Nukapigak at the Point Lay Public Scoping Meeting for this EIS on February 22, 2010.

Vessels for seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels typically do not enter the Chukchi Sea until after July 1 when most of the spring bowhead migration is complete. Moreover, a standard mitigation measure restricts vessels from entering the Chukchi Sea until July 1. During the fall migration, vessel activity in the Beaufort Sea associated with seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels would not be present in the areas near Cross Island and Kaktovik from August 25 until after fall whaling is completed by Kaktovik and Nuiqsut subsistence whalers.

The mitigation measures would also protect subsistence harvest of bowhead whales by requiring vessels to reduce speed within 274 m (900 ft.) of whales and to avoid separating members from a group of whales from one another. Additionally, vessels would be required to avoid multiple course changes when within 274 m (900 ft.) of bowhead whales and other marine mammals and to steer around the whales if possible. During periods of poor weather, vessels would be required to reduce their speed to 10 knots while underway in order to avoid strikes or collisions with bowhead whales and other marine mammals.

A limited number of late migrating spring and fall bowhead whales could encounter seismic and high resolution shallow hazard surveys and exploratory drilling activities. However the mitigation measures would limit impacts from vessel traffic to late migrating bowhead whales and subsistence hunting. Impacts to subsistence hunting are likely to be of low intensity, temporary to interim in duration, local in extent, and affecting a resource that is important in context. The impact to subsistence harvest from disturbance of bowhead whales is considered minor.

Beluga Whales

Information on the impacts of vessel sounds to beluga whales associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.11 (Beluga Whales) of this EIS. Vessel traffic that causes whales to avoid subsistence harvest areas could result in them being unavailable for harvest – particularly for the Chukchi Sea communities, such as Point Lay, which harvest beluga whale intensively.

A limited number of late migrating spring beluga whales could encounter vessels during seismic and high resolution shallow hazard surveys and exploratory drilling activities and operations. The impact of disruption to beluga whales from vessel traffic could result in temporary deflection of beluga whales from subsistence harvest areas and impact the success of these hunts. Vessels typically do not begin transiting through the Bering Straits into the Beaufort and Chukchi seas for seismic and high resolution shallow hazard surveys and exploratory drilling until July 1 after the majority of the spring beluga hunting is completed in the Chukchi Sea villages. However, some villages, such Point Lay and Kotzebue, may continue hunting belugas into mid-July. A standard mitigation measure restricts vessel from transiting into the Chukchi Sea until July 1, thereby avoiding impacts to the early portion of the summer beluga hunt by the village of Point Lay. The impact to late migrating beluga whales that do encounter vessels would be of low intensity, temporary to interim in duration, local extent, and affecting a resource that is locally important in terms of the context. The impact to subsistence harvest of belugas from disturbance of the whales is considered minor.

Seals

Information on the impacts of vessel sounds to seals associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.13 (Ice Seals) of this EIS. Upon exposure to vessel noise, seals may show avoidance of vessels transiting through an area. Avoidance of vessels transiting through areas of subsistence hunting could make seals less available for subsistence harvest. Seals could be displaced or may avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities. However as a result of the mitigation measures for vessels transiting into the Beaufort and Chukchi seas for seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels, no unmitigable adverse impacts to seals and subsistence hunting activities are expected. Subsistence hunts for seals occur in nearshore coastal areas away from areas likely to be transited by vessels. Additionally, subsistence seal hunts that occur in the winter months prior to the onset of oil and gas exploration activities would not be impacted by vessel traffic associated with the exploration activities. Although there is the potential for some spatial and temporal overlap (mostly in the Beaufort Sea in the earlier part of the open water season), the impact to subsistence seal harvest would be of low intensity, temporary duration, local extent, and affecting resources that are common. The impact to subsistence harvest of seals from disturbance of seals is considered negligible to minor.

Pacific Walrus

Information on the impacts of vessel sounds to walruses associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.14 (Pacific Walrus) of this EIS. Effects to walruses from approaching vessel traffic may cause them to flee haulout locations and to avoid moving vessels that pass within less than a mile (or less than 1.6 km) (Richardson et al. 1995). However, walruses may also exit the water to look at, or approach vessels out of curiosity. Walruses that avoid vessel traffic may affect subsistence harvest by becoming less available for subsistence harvest.

Walruses could be displaced or avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities. By applying mitigation measures to vessels transiting into the Beaufort and Chukchi seas for these activities and their associated support vessels, no unmitigable adverse impacts to walrus and subsistence hunting activities would be expected. Subsistence walrus hunts would occur in nearshore coastal areas away from areas likely to be transited by vessels. In areas where walrus subsistence hunting occurs in the summer, as in Wainwright, vessels associated with these activities could be present in offshore subsistence harvest areas. The impact to subsistence walrus harvests would be of low intensity, temporary in duration, of local extent, and affecting a resource that is important in terms of the context. The impact to subsistence harvest of walruses from disturbance of walruses is considered negligible to minor.

Polar Bears

Reactions and responses to vessel traffic could range from walking, running, or swimming away to no response at all (Richardson et al. 1995). Information on the impacts of vessels to polar bears associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.15 (Polar Bears) of this EIS. Polar bears are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.

It would be unlikely that polar bears would be present in open-water areas where seismic and high resolution shallow hazard surveys and exploratory drilling activities would occur, as polar bears would most likely be in active ice zones during the late summer and early fall. Subsistence hunting for polar bears in nearshore areas during the spring and winter months would not be occurring when the proposed oil and gas exploration activities would be conducted. Based on the mitigation measures for vessels transiting into the Beaufort and Chukchi seas for these activities, no unmitigable adverse impacts to polar bears or subsistence hunting practices would be expected. The impact to subsistence harvest of polar bears is considered of low intensity, temporary duration, local extent, and affecting a resource that is important in context. The impact to subsistence harvest of polar bears is considered negligible, and, in some areas, no effect is anticipated.

Fish

Vessel traffic is not expected to affect subsistence fishing harvests. While fish may avoid a vessel transiting through an area, the disturbance would be expected to affect a very small portion of populations. Effects to subsistence fishing are likely below measurable thresholds.

Few impacts to subsistence fishing are anticipated as a result of vessel traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities. Vessels would likely be transiting areas that are offshore and removed from subsistence harvest areas. Crew and supply vessels transiting to or from a coastal community may pass through local subsistence fishing areas. Any impact that did result would be expected to occur for only the length of time the vessel is potentially transiting through a nearshore area where subsistence fishing is occurring. The impact to subsistence harvest of fish is considered of low intensity, temporary duration, local extent, and affecting resources that are common in context. The impact on subsistence fishing could be considered negligible in terms of the levels of subsistence fishing and sharing of the resource that would be affected.

Marine and Coastal Birds

In response to the presence of vessels, birds may flush from marine and coastal areas where they are foraging or resting. Birds in coastal areas that are engaged in breeding, brood rearing, or foraging in preferred habitat areas in the lagoons are less likely to be affected and displaced by vessels transiting farther offshore. The presence of vessels may also affect some species more than others. The risk for collision and strikes increases as more vessels transit through the nearshore waters where birds are expected to be present in higher numbers. Some species could be attracted to the presence of vessels. If birds were continually displaced from subsistence harvest areas, the levels of harvest could be affected. The effects of vessel traffic to marine and coastal birds are described in Section 4.5.2.3 of this EIS.

Vessel traffic would be expected to potentially cause temporary disruption and displacement of some foraging and resting birds. However, this displacement and disturbance would be limited to the flushing of birds away from vessels transiting through the areas in which the birds were present. Vessel passage closer to nearshore waters would likely cause higher levels of impacts and disturbance to subsistence hunters if birds were flushed and lower productivity results in reduced availability of the resource. However, the disturbance potentially caused from offshore vessel traffic should be temporary, occurring only as long as the activity takes place, and affecting only local areas. The impact from disturbance from vessel traffic is not anticipated to result in bird mortality, so this activity would not be expected to affect birds on a population scale. Only minimal overlap with bird hunting in the region is expected, as few communities hunt birds further offshore. Nuiqsut conducts some bird hunting in the Beaufort Sea OCS. The impacts to subsistence hunting and egg gathering are likely to be of low intensity, temporary duration, local extent, and affecting resources that are common in terms of context. The impact to subsistence of marine and coastal birds is considered negligible.

Caribou

No anticipated effects of vessel traffic to caribou and other land mammals that are harvested for subsistence purposes are expected. Vessel traffic would occur offshore, and vessels coming into nearshore areas would be expected to arrive at ports or docks that are already established and not located in subsistence harvest areas. Therefore, no measurable effects to subsistence hunting of caribou are anticipated from vessel traffic.

Given the distance offshore that vessels will transit relative to subsistence harvest areas, it is unlikely that adverse impacts would occur to caribou and other land mammals or would make them unavailable for harvest. Vessels would only come to established dock and port facilities for lightering or offloading supplies and personnel. Disturbances at onshore areas from vessel traffic noise associated with approaching vessels could cause caribou to avoid these areas. However vessels would be approaching established areas where caribou and land mammals would not be expected to be present in large enough numbers to impact subsistence harvests. The impacts to subsistence hunting are likely to be of low intensity, temporary in duration, of local extent, and affect a resource that is common. The impact to subsistence hunting of caribou is considered negligible.

Effects of Disturbance from Icebreaking and Ice Management

Section 4.5.2.4 describes the effects of icebreaking and ice management on marine mammals. Disturbance from icebreaking activities to marine mammal subsistence resources would depend upon the time of year that the activity occurs. Active icebreaking involved with seismic survey plans could occur from October to December when bowhead whales, beluga whales and seal harvests are not as concentrated. However, when daylight is very limited to nonexistent and visibility is reduced at this time of year.

Ice management activities would introduce less noise into the marine environment than full scale icebreaking (Section 4.5.2.4). Ice management would be associated with exploratory drilling operations in the summer and open water season and involve the use of smaller support vessels around the drill rig/ship to ensure the safety of the operation. Towards the end of the drilling season (i.e., late October), there is a greater chance of ice occurring in the drilling area. Icebreaking would only occur if the floe posed a risk to the drilling unit and needed to occur to safely cease operations and remove the equipment. Icebreaking would not be conducted for the express purpose to continue operations late in the season. The ice management vessels typically consist of an icebreaker and an anchor handler, as well as an auxiliary ice management vessel.

Bowhead Whales

As discussed in Section 4.5.2.4.10 the additional sound from icebreaking that accompanies seismic activity could cause temporary avoidance of bowhead whales from areas where the vessels are operating and potentially cause temporary deflection of the migration corridor (NMFS 2010c). Some operators have proposed to conduct seismic surveys during the in-ice or shoulder season (i.e., October through December). These surveys would require the use of an icebreaker to go ahead of the seismic survey vessel. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, and limited daylight and poor visibility would make it harder for onboard observers to visually observe whales and other marine mammals. The majority of these types of in-ice surveys requiring icebreaking would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas with minimal overlap in October.

Bowhead whales would be expected to avoid areas where icebreaking is occurring as a response to the noise generated by this activity. This could affect subsistence harvest if whales divert from normal migratory paths and thus become less readily available for harvest. Whale avoidance of icebreaking activity may be only temporary but could still have an effect on availability for harvest. It may make it necessary for whaling crews to travel further offshore to be successful or result in a hunt being unsuccessful and/or whales spoiling before being processed. However, many (but not all) of the icebreaking activities are anticipated to occur during times when there is no bowhead hunting. The likelihood of interaction diminishes by late October as most bowhead whales will have migrated out of the Beaufort Sea. The period of time over which icebreaking for seismic surveys could overlap with bowhead whales being present and subsistence whaling in the Beaufort Sea is short, and seismic surveys and exploratory drilling operations would not occur during fall whaling by the communities of Nuiqsut and Kaktovik. Wainwright resumed and has conducted a fall bowhead whale hunt since 2011 in October each year. Wainwright’s fall bowhead whale hunt typically occurs closer into shore than the seismic surveys; however, there is the potential for some impacts to the fall hunt by this Chukchi Sea community. The other Chukchi Sea communities do not hunt bowhead whales in the fall. The November bowhead whale hunts conducted by the communities on St. Lawrence Island in the Bering Strait would not be impacted by these in-ice seismic surveys, as the location of the surveys would be several hundred miles away from the island. In the event that icebreaking causes bowhead whales to avoid an area, the impact to subsistence resources is expected to be low in intensity, temporary to interim in duration, local in extent, and affecting a resource that is unique in context. This would be considered a minor impact to subsistence hunting of bowhead whales.

The majority of seismic and high resolution shallow hazard surveys and exploratory drilling activities would be expected to occur during the open water season (i.e., July through November) when seismic and high resolution shallow hazard surveys and exploratory drilling vessels would not encounter large amounts of sea ice. However ice management may be necessary during late fall or early winter when industry may still be engaged in seismic and high resolution shallow hazard surveys and exploratory drilling activities in order to protect equipment, vessels, and infrastructure. The mitigation measures limit the time frame in which these activities that may require ice management could occur. The majority of these types of surveys and exploratory drilling operations would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas. As a result, the likelihood of impacts to subsistence harvest as a result of ice management activities is reduced and unlikely to adversely affect subsistence harvest of bowhead whales. In the event that ice management does cause bowhead whales to avoid an area, the impact to subsistence resources is expected to be low in intensity, temporary to interim in duration, local in extent, and affecting a resource that is important in context. This would be considered a minor impact to bowhead whales.

Beluga Whales

Beluga whales are reported to be extremely sensitive to icebreaking (Section 4.5.2.4.11). Effects of icebreaking and ice management may cause belugas to avoid the vicinity of the activity. Therefore, if such activities were to occur in nearshore areas, the availability of this resource to subsistence hunters could be reduced.

Subsistence hunters have expressed concerns that belugas will "remember" the impacts of icebreaking and avoid specific areas where the impact occurred in subsequent years:

"…evidence of beluga being affected by noise. I have evidence but it is anecdotal. In 1989, Red Dog became operational. Before the port was built, every summer a beluga was harvested in July. Since 1989, Kivalina has never gotten whales in July" - Enoch Adams Jr., Kivalina Open Water Meeting in Anchorage on March 7, 2011.

Mitigation measures are expected to minimize and potentially avoid impacts on beluga whales so that no unmitigable adverse impacts occur to the subsistence harvest of beluga whales (i.e., subsistence users are able to conduct hunts that meet subsistence needs). There is a low probability that impacts could occur to subsistence users from late season activities. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, and limited daylight and poor visibility would make it harder for onboard observers to visually whales and other marine mammals. Point Lay conducts beluga hunts near its lagoon in the summer, while the other communities typically hunt belugas opportunistically while hunting bowhead whales. Therefore, this is little chance of much spatiotemporal overlap between in-ice seismic surveys and beluga hunting by Beaufort and Chukchi sea communities. Therefore, no effect is anticipated.

Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities when ice is encountered in the late fall or early winter months of exploration drilling operations. Ice management would be limited to areas where industry is actively drilling. Ice management activities would be conducted far removed from areas typically used as hunting grounds in the Chukchi Sea. No impacts are anticipated for beluga subsistence hunts in the Beaufort Sea, as beluga hunting is conducted opportunistically during the fall bowhead hunt. Mitigation measures would prohibit seismic and high resolution shallow hazard surveys and exploratory drilling activities (and associated ice management) from occurring during this time. Therefore no impact is anticipated.

Seals

Sealing efforts for subsistence are not a concentrated or intensive activity from October to December when in-ice seismic surveys would occur. Icebreakers could potentially collide with seals hauled out on the ice (Section 4.5.2.4.13). The probability of icebreakers colliding with seals and having lethal effects on seal populations is low. Seals are more likely to avoid areas where icebreaking is occurring. If large numbers were to be killed by collisions with icebreakers or to avoid areas important for subsistence hunting, then levels of seal harvest could be affected. In the event that icebreaking causes seals to avoid an area, the impact to subsistence harvest is expected to be low in intensity, temporary in duration, and local in extent, and affecting resources that are common to important in context. This would be considered a negligible impact to subsistence seal hunts.

Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities and would occur in the OCS waters during the open water season after sea ice has retreated and melted. Activities under Alternative 2 would occur after pupping and molting seasons for all ice seals, so there would be few seals expected in the area where the proposed activities would occur. Subsistence harvest of seals would not be expected to occur in areas of active ice management offshore. The mitigation measures are expected to avoid and minimize impacts on seals and in turn on subsistence harvesting so that no unmitigable adverse impacts occur. In the event that ice management causes seals to avoid an area, the impact to subsistence resources and subsistence users is expected to be low in intensity, temporary in duration, and local in extent, and affecting resources that are common in context. This would be considered a negligible impact on subsistence seal hunts.

Pacific Walrus

Icebreaking activities could cause walruses to avoid the areas where these activities would occur (Section 4.5.2.4.14). Walruses that are hauled out or feeding when icebreaking is occurring could avoid the area. In areas where subsistence hunting occurs for walruses, avoidance of the area could lead to reduced availability of this resource to hunters and reduced harvests. Given the dispersed distribution of walruses on the ice and the short time period and limited geographic extent of icebreaking activities authorized under Alternative 2, it is unlikely that many walruses would be affected in the Chukchi Sea and unlikely that any would be affected in the Beaufort Sea. Such disturbance would be temporary as the icebreaker moved through an area and the ice reformed relatively quickly. In the event that icebreaking causes walruses to avoid a subsistence use area and reduces the success of harvest, the impact to subsistence resources is expected to be low in intensity, temporary in duration, local in extent, and affecting a resource that is important in context. This would be considered a negligible impact to subsistence harvest of walruses.

Ice management activities, and associated vessel traffic, would not likely be conducted in OCS waters that are subsistence use areas for this species. Mitigation measures are expected to avoid and minimize impacts on walrus subsistence harvest. There is a low probability that impacts could occur to subsistence users. In the event that ice management activities cause walruses to avoid a subsistence use area and reduce the success of the harvest, the impact to subsistence is expected to be low in intensity, temporary in duration, local in extent, and affect a resource that is important in context. This would be considered a negligible impact to subsistence harvest of walruses.

Polar Bears

In response to the presence of icebreakers and icebreaking activities, polar bears may flee from the noise at the sight of icebreakers or be drawn to them. Icebreaking and ice management would likely occur when polar bears are on pack ice. In areas of polar bear subsistence hunting, avoidance of the area could lead to a reduced availability of this resource to hunters and reduced harvest.

Icebreaking could be necessary as part of late season survey activities. Given the dispersed distribution of bears on the ice and the short time period and limited geographic extent of icebreaking activities, it is unlikely that more than a few bears would be affected in either sea and such disturbance would be temporary to both the bears and their ice seal prey (Section 4.5.2.4.15). There is a low probability that impacts could occur to subsistence users, if late season icebreaking causes polar bears to avoid a subsistence use area and reduces the success of harvest. However, the impact to subsistence resources is expected to be low in intensity, temporary in duration, local in extent, and affecting a resource that is unique in context, due to listing under the ESA. This would be considered a minor summary impact.

Polar bears are unlikely to be present in the areas where seismic and high resolution shallow hazard surveys and exploratory drilling activities would occur during the open water season. Ice management activities would be conducted in OCS waters that are not subsistence use areas for polar bear harvest. The mitigation measures are expected to minimize and potentially avoid impacts on polar bear harvest so that no unmitigable adverse impacts occur. While there is a low probability that impacts could occur to subsistence users, if ice management does cause polar bears to avoid a subsistence use area and reduces the success of harvest the impact to subsistence resources is expected to be low in intensity, temporary in duration, local in extent, and affecting a resource that is important in context. This would be considered a minor summary impact.

Fishing

Icebreaking and ice management are not expected to affect subsistence fishing. Any effects to fish from icebreaking and ice management would be limited to avoidance in the area near the active ice management vessels during ice management activities. Avoidance would be expected to last a short period of time, and no impacts to subsistence fishing would be likely.

Ice breaking and ice management activities would likely occur in areas that are offshore and removed from subsistence fish harvest areas. The impacts to the subsistence harvest of fish would be considered to have no effect.

Marine and coastal birds

Effects of icebreaking and ice management could have similar effects to marine and coastal birds as the vessel traffic and cause birds present to flush or avoid the area where the activity is occurring. Avoidance of the area could lead to a lesser availability of birds for subsistence hunters and lower rates of harvest.

Icebreaking and ice management would not be expected to occur in areas of critical bird habitat and other areas of high bird concentrations. Due to the timing of subsistence harvest, icebreaking and ice management activities are not anticipated to impact the availability or distribution of birds and bird eggs for subsistence harvest. These activities would likely occur in areas that are offshore and removed from subsistence bird harvest areas. In addition, some of the mitigation measures associated with marine mammals would also mitigate potential effects on harvest of marine and coastal birds, particularly in the Chukchi Sea. The impacts to subsistence harvests of bird and egg gathering are considered of low intensity, temporary duration, local extent, and affecting resources that are common in context. The impact to subsistence hunting of marine and coastal birds could be considered negligible.

Caribou

Icebreaking and ice management activities would occur offshore and would not be expected to affect caribou, a terrestrial mammal. Therefore, no measurable effects to subsistence hunting of caribou are anticipated from icebreaking or ice management activity.

No impacts are anticipated to occur to caribou or caribou subsistence harvests from icebreaking and ice management for offshore seismic and high resolution shallow hazard surveys and exploratory drilling. Due to the distance of such activities from the coastlines of both seas, no impacts on the terrestrial habitat of caribou or on the availability of caribou for subsistence harvests would be expected.

Effects of noise and vehicle movement from on-ice seismic surveys

Bowhead Whales

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when bowhead whales are not present. Therefore, no impacts to bowhead whale subsistence harvest from on-ice seismic surveys are expected to occur.

Beluga Whales

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when beluga whales are not present. Therefore, no impacts to beluga whale subsistence harvest from on-ice seismic surveys are expected to occur.

Seals

Section 4.5.2.4.13 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. One on-ice seismic survey could be permitted in the Beaufort Sea under Alternative 2, but mitigation measures to limit adverse effects to seals and subsistence harvests could be applied. Subsistence harvest areas for ringed and bearded seals by Nuiqsut and Barrow hunters extend through the area east of Point Barrow where one on-ice survey could occur at the same time that seals are in their lairs during the winter. As a result of on-ice seismic survey activities seals could become displaced from their lairs and would then be unavailable for harvest or could become more difficult to harvest for the duration of the industry on-ice activity. Any impacts to seal subsistence harvests would be characterized as a low intensity, limited to a local area, temporary in duration, and affecting a resource that is common. The impact to subsistence seal hunts is considered negligible.

Pacific Walrus

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when walruses are not present. Therefore, no impacts to walrus subsistence harvest from on-ice seismic surveys are expected to occur.

Polar bears

Section 4.5.2.4.15 (Polar bears) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect polar bears. There is the potential for one on-ice seismic survey to occur in the Beaufort Sea, east of Point Barrow during January through May. Impacts to polar bear subsistence hunts in the Beaufort Sea communities could be affected as polar bears could become displaced from the on-ice survey area or disturbed while denning. Direct impacts that do occur would be considered of low intensity, limited in extent to a local area, temporary in duration but unique in context. Therefore, effects from on-ice seismic surveys in the Beaufort Sea are anticipated to have minor impacts on polar bear subsistence harvests.

Fishing

Noise and vehicle movement from on-ice seismic surveys are not expected to affect subsistence fishing. Any effects to fish from noise and vehicle movement during on-ice seismic surveys would be limited to avoidance in the area near the activities. Avoidance would be expected to last only minutes, and no impacts to subsistence fishing would be likely. On –ice seismic activity would occur in a marine area that is removed from subsistence fish harvest areas during the winter and early spring when marine subsistence fishing is not occurring in the Beaufort Sea communities. No impacts to marine subsistence fishing are anticipated.

Marine and Coastal Birds

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when marine and coastal birds are not present in large numbers on the coast. The likelihood of disturbance to marine and coastal birds resulting in lost opportunity for subsistence harvest would be of low intensity, temporary, local in extent and common in context. Therefore the impact to subsistence hunting of marine and coastal birds is considered negligible.

Caribou

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when caribou are not present in large numbers on the coast. The likelihood of disturbance to caribou resulting in lost opportunity for subsistence harvest would be of low intensity, temporary, local in extent and common in context. Therefore the impact to subsistence hunts of caribou is considered negligible.

Effects from Permitted Discharges

The effects of permitted discharges (including bilge and ballast water, non-contact cooling water, desalination wastes, domestic and sanitary wastes, excess cement slurry, and deck drainage) to marine waters could affect subsistence resources such as marine mammals and fish. These species may respond by avoiding the areas in the vicinities of the discharge. Drill cuttings and mud discharges may displace marine mammals and fish from a short distance from each drilling location. Fish eggs and larvae could be destroyed, but it is unlikely that population-level effects would occur or that the discharges would limit the availability of these resources to subsistence hunters. These measurable effects on benthic communities have the potential to impact fish resource, particularly benthic feeders. However, scientific evidence suggests that drilling discharges and cuttings have minor effects on adult fish health (Hurley and Ellis 2004) (See Section 4.5.2.2.).

Concerns of contaminants occurring in Arctic subsistence resources – in particular bowhead whales - as a result of industrial pollution, long distance vectors for transport and deposition in Arctic environments, and high rates of persistence were summarized by NMFS (2008). NMFS noted: *"Bowhead whale subsistence foods have been analyzed for their levels of contaminants, including PCBs, DDTs, OCs, and chlordanes and heavy metals. These contaminant levels varied with gender, length/age, and season, but were generally relatively low compared to other marine mammals. Reports by the Arctic Monitoring and Assessment Programme (AMAP) identified levels of contamination meriting closer public health attention in some parts of the Arctic, through generally not in Alaska (AMAP, 2002, 2003). At the same time, public health officials recognize that the loss of subsistence foods would have far-reaching consequences throughout the sociocultural system of small, predominantly indigenous communities."* NMFS (2008) concluded that *"the documented contaminant levels in bowhead whales in Alaska do not represent a threat to the health of subsistence users at current levels. Given the low levels of risk, public health officials conclude that the nutritional decline from loss of subsistence foods, like bowhead whale meat and blubber, would be far more adverse."* There is an important perception among subsistence hunters that contamination of these subsistence resources could result from the action alternatives. Hunters may harvest "perceived" affected resources in lesser amounts and in turn harvest other terrestrial mammal species or freshwater fish at higher levels. Section 4.5.3.3 describes the direct impacts of environmental contaminants to subsistence resources and implications and perceptions of these effects to public health.

Permitted discharges would be required to be conducted under the conditions and limitations of the required NPDES and APDES GPs, and the considerations with regard to meeting regulatory requirements and fate and transport are discussed in Section 4.5.2. The impacts of a major oil spill are discussed in Section 4.10.6 and 4.10.7. Permitted discharge could be mitigated by additional mitigation measures (Appendix E) which would place requirements and limitations on the levels of discharge and discharge streams that could affect marine mammal habitat, marine mammals, and eventually the diets of subsistence users.

These mitigation measures may not alleviate the concern that a small oil spill or regulated wastewater discharge might contaminate subsistence resources. There is a perception the foods could become contaminated by discharges and/or small fuels spills, resulting in impacts to human health from consumption of the resources.

"Our whaling captains have always observed that the whales will shy away from human smells. In the spring, we have to be very careful with our cooking when we're camping on the ice during the spring. The whales can pick up the smells of our cooking or even making coffee. It's the same for discharges into the water. We are taught from a young age never to dump anything into the water during whaling. If we do, we won't see the whales. We also worry about the health effects of trying to eat marine mammals that have migrated through areas of waste discharge. We eat our marine mammals right out of the ocean and we can't be feeding our people waste from drilling operations" – Harry Brower, pers. comm., March 12, 2013.

"Near Cross Island, we have observed the whales deflecting around discharges into the water. During the 1980s, we saw this at times when we could also see cuttings floating on the water. At these times, the whales were diverted over 30 miles north from shore. That is why, under our Conflict Avoidance Agreement, we now ask the companies not to discharge any drilling muds or cuttings or other waste into the waters of the near-shore Beaufort Sea, where the whales migrate in the fall time. The whales will deflect away from the areas where waste is being dumped and it makes it harder for our hunters to find them. Shell has agreed to zero discharge under the CAA because of this" - Isaac Nukapigak, pers. comm., March 12, 2013.

"Iñupiat take great care to avoid discarding waste into the ocean during bowhead whale migratory and hunting times. Our whaling captains and crews follow this guidance and we ask that EPA apply the same standards to offshore oil and gas operators. The reason is simple. Food tainting - whether real or perceived - is a major concern in our communities. Through traditional knowledge we are familiar with the food chain in the ocean and the consequences of having bowhead whales swimming through ocean

discharges or feeding upon contaminate zooplankton. Traditional foods are important because they are more healthy than store bought foods. They also provide important vitamins, minerals and antioxidants and "can lower rates of diabetes and heart disease and may help to prevent some forms of cancer." Despite these facts, the belief that subsistence resources have been tainted by manmade substances can lead Iñupiat to not consume traditional foods. As EPA recognizes food tainting can lead to health problems in our communities, such as increased obesity, higher rates of diabetes, and possible increases in heart disease and cancer. Food tainting also risks the loss of our culture which is based around traditional foods, sharing of subsistence resources and especially bowhead whales, and teaching youth about how to gather subsistence resources, when they are available, and why they are important to our people." - AEWC, letter to U.S. EPA and ADEC, March 30, 2012.

The AEWC specifically asked the US EPA and ADEC to consider zero discharge permitting in 2012 and observed: *"Shell Offshore Inc. agreed to a near zero discharge program for its Camden Bay operations. The company agreed to collect and barge to shore for treatment the following waste streams: water based muds, drill cuttings and fluids; sanitary and domestic waste; uncontaminated ballast water; and bilge water. These operations show that a near zero discharge program is feasible in the Arctic from a logistical and economic standpoint. Therefore, in order to address our subsistence communities' concerns over food tainting, we ask that EPA adopt final permits that result in zero discharges in the Beaufort Sea and the Chukchi Sea... we are advocating that the permits eliminate drilling and operational discharges to the water, including drilling muds and cuttings (beyond the top hole), or fluids, including produced water; sanitary and domestic waste; ballast water; bilge water or discharges... , as well as other proposed changes in the draft permits urtless discussed otherwise in these comments. In addition, we ask that the permit halt during subsistence hunting of bowhead whales the discharge of non-contact cooling water (and related chemicals) in the Beaufort Sea, because these waste streams risk deflecting bowhead whales from their migratory paths. Subsistence hunting of bowhead whales during the fall in the Beaufort Sea takes place broadly between August 25 and mid- to late-October or can be established during more narrow timeframes based upon the information conveyed to the Communications Centers that are established annually in the CAA"* - AEWC, letter to U.S. EPA and ADEC, March 30, 2012.

The likelihood of large concentrations of species used for subsistence encountering contamination is low, as is the likelihood of subsistence harvests occurring in areas where contamination may occur. In addition, fuel transfers, a common source of small spills, are not expected during transit between the Beaufort and Chukchi seas. The direct impact of drill cuttings and mud discharges may displace marine mammals and fish a short distance from each drilling location, and persist in the vicinity of exploration activities for a short time before being dispersed by currents and other natural forces. The impacts to subsistence users would be considered minor as they would be of low intensity, temporary to interim duration, local to regional extent, and affecting resources that are common to important in context.

Effects from Small Fuel Spills

As described in Section 4.2.7 small fuel spills associated with the vessels used for G&G and during exploration drilling operations activities could occur during fuel transfers. The most likely cause of a small fuel spill would be during exploration operationas, such as a hose rupture that can occur from vessels, leaking connections, ruptured lines and seal failures, and human error while refueling. Estimated ranges for small fuel spill volumes with respect to G&G activities and exploration activities are summarized in Table 4.2-8. Small fuel spills may be contained on a vessel or mobile off shore drilling units and spills reaching water may be contained by booms or absorbent pads. In water, ambient hydrocarbon concentrations of small refined fuel spills would persist for a shorter time than a crude oil spill of the same volume and a small fuel spill would be short-lived due to volatilization of light hydrocarbons but could still potentially affect fish and marine mammals used for subsistence. On land small refined spills would be primarily from aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil.

The effects to subsistence-harvest resources and harvest practices from small refined oil spills could include:

Marine mammals could be affected if the small refined fuel spill reaches the water, depending on location, timing, and duration of a small fuel spill. Concerns related to subsistence hunting would be related to small fuel spills occurring during the spring where bowhead whales migrate, resulting in contact with polynyas (open leads).

Fish would be affected if a small refined spill occurred during beach spawning events. Salmon, an important subsistence resource, for the NWAB, could sustain effects if a small spill occurred near salmon habitats. Other important subsistence fish that would be most affected if a small spill occurred in a very localized area include: Salmon, Arctic cod, saffron cod, Arctic char, pink salmon, chum salmon, rainbow smelt, least cisco, Bering cisco, broad whitefish, humpback whitefish, and dolly varden.

Impacts to marine and coastal birds from small refined spills may include fouling of feathers, ingestion, and skin irritation. Should a small fuel spill occur during refueling, a small number of birds in the immediate vicinity of the vessel could be affected, depending on current and wind patterns.

Caribou and other terrestrial subsistence resources could be affected by onshore construction activities during exploration activites due to contamination of surface water and vegetation utilized for food.

The impacts to subsistence users from small fuel spills (less than 50 bbl) would be of low intensity, temporary to interim duration, local in extent, and affecting resources that are common to important in context. The likelihood of large concentrations of species used for subsistence encountering contamination is low, as is the likelihood of subsistence harvests occurring in areas where small fuel spills may occur. In addition, fuel transfers, a common source of small spills, are not expected during transit between the Beaufort and Chukchi seas. The direct impact of a small fuel spill may displace marine mammals and fish a short distance from each drilling location, and persist in the vicinity of exploration activities for a short time before being dispersed by currents and other natural forces. The impacts to subsistence users would be considered minor.

4.5.3.2.2 Conclusion

Impacts of Disturbance from Seismic and High Resolution Shallow Hazard Surveys and Exploratory Drilling Activities to Subsistence Resources

The noise produced by the proposed seismic surveys, high resolution shallow hazards surveys, and exploratory drilling with standard mitigation measures that could be applied in order to minimize or avoid any adverse effects on all marine mammals and other subsistence resources, and other additional mitigation measures are evaluated here and potentially required in MMPA ITAs. In consideration of the standard and additional mitigation measures, seismic surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling are not expected to disturb or disrupt subsistence activities at a level that would make resources unavailable for harvest or substantially alter the existing levels of harvest. While individual animals could be affected, it is not anticipated to be at a level that would make the resource unavailable to hunters.

There may be rare instances where subsistence activities are interrupted. Only then would there be a direct impact from disturbance/disruption of or to the resource being harvested. Subsistence harvest patterns tend to be adaptive, and in the case of bowhead whaling, crews are likely to travel farther on longer trips to achieve harvest goals, which would result in higher costs and greater safety and spoilage risks. Bowhead whales are such a highly productive food resource that in the communities highly reliant on this species, a major decline in bowhead harvest could not be replaced by other subsistence species but could potentially be replaced by sharing with other communities that were able to conduct successful bowhead whale hunts. Apart from the special case of bowhead whale harvests, subsistence harvest composition shows inter-annual variation, and shortfalls in some species are replaced by increased harvests of others, so that overall annual production meets harvest targets. (For a recent quantitative demonstration of variation in subsistence fish harvests in the neighboring Northwest Arctic, see Magdanz et al. 2011).

By implementing mitigation measures, the impacts from disruption of subsistence harvest would be low in intensity and temporary to interim in duration. Impacts would be local to regional in extent and would affect resources that range from common to important in context. For instance, the loss of opportunity for a community to successfully harvest its full quota of bowhead whales for one season if the whales were deflected and hunters had a harder time reaching the whales as a result of seismic and high resolution shallow hazard surveys and exploratory drilling activities would be a direct impact of the activity. Additional effort to harvest bowhead whales or reduced harvests would be considered an impact that is medium in intensity, interim to long-term in duration, local to regional in extent (in view of sharing practices), and affecting a resource that is important in context. As a result, this summary impact would be considered moderate. Mitigation measures evaluated in relation to this alternative are considered effective in reducing impacts on subsistence resources to the lower levels noted above.

The summary impact of Alternative 2 in regard to disturbance to other subsistence resources is considered negligible to minor, depending on the species. The summary impact to belugas is considered minor. The summary impact to seal and walrus harvest are considered negligible. No impacts of disturbance are anticipated to subsistence harvests of polar bear, fish, marine and coastal birds, and caribou.

Impacts of Disturbance from Aircraft Overflights to Subsistence Resources

Increased aircraft traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities could cause some temporary behavioral disturbance and possibly deflection away from the sound source by terrestrial or marine mammals. The level of the disturbance would depend on the size of the aircraft and repeated exposure or displacement. However mitigation measures regarding minimum altitudes and offset distances would reduce these effects.

Given mitigation measures, aircraft overflights are unlikely to have an adverse effect on subsistence harvests. Impacts that did occur would be considered low in intensity but temporary to interim in duration. Effects of the impact would be local and affecting resources that are common to important in context. The summary impact of Alternative 2 in regard to impacts of air traffic to subsistence resources is considered negligible to minor depending on the species. The summary impact to bowhead whales is considered minor. The summary impact to belugas is considered minor. The summary impact to seal, walrus and caribou harvest are considered negligible. The summary impacts to polar bears and marine and coastal birds are considered minor. No impacts of disturbance are anticipated to subsistence harvests of fish.

Impact of Vessel Traffic to Subsistence Resources

As described above, the impact of vessel traffic on subsistence harvest of bowhead and beluga whales is expected to be minor,. The impact to subsistence harvest from vessel traffic on seals and walruses is considered negligible to minor. The impact to subsistence harvest of polar bears is considered minor. Negligible impacts to subsistence harvest of fish, bird hunting and egg gathering, and caribou hunting are expected as a result of vessel traffic.

Impacts of Icebreaking and Ice Management on Subsistence Resources

As described above, impacts to bowhead whales and polar bears from icebreaking and ice-management activities are expected to be minor. Impacts to seal, walrus, and bird hunting and egg gathering from icebreaking are expected to be negligible. No impacts to beluga whales, fish, caribou or caribou hunting are expected.

Impact of On-ice Seismic Surveys to Subsistence Resources

As described above, no impacts are anticipated subsistence harvests of bowhead whales, beluga whales, walruses, and fishing as a result of the on ice seismic survey. Impacts to seals, marine and coastal birds and caribou are expected to be would be negligible. The impacts to polar bears could be minor.

Indirect Impact to Subsistence Resources from Permitted Discharges

As described above, the impacts to subsistence users would be of low intensity, temporary in duration, local extent, and affecting resources that are common to unique in context. Therefore the impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Impact to Subsistence Resources from Small Fuel Spills

Mitigation measures may not alleviate the perception that a small fuel spill might contaminate subsistence resources. There is a perception the foods could become contaminated from a small fuel spills that could result in impacts to human health from consumption of the resources. The likelihood is low that subsistence resources or harvest would occur in the vicinity of the assumed areas where drilling and/or any associated small fuel spill might occur. In addition, fuel transfers are not expected during transit between the Beaufort and Chukchi seas. As described above, the impacts to subsistence harvest and users of low intensity, temporary in duration, local extent, and affecting resources that are common to unique in context. Therefore the impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of all oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 2 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 2 on subsistence resources and harvests would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance.

4.5.3.2.3 Standard Mitigation Measures for Subsistence

In order to analyze likely impacts to subsistence uses arising from the seismic survey and high resolution shallow hazard surveys and exploratory drilling activities under Alternative 2, it is also necessary to identify those mitigation measures that offset potential impacts. The sections that follow examine standard mitigation measures that were designed to mitigate impacts to subsistence hunting and would be required pursuant to all applicable activities under this alternative. Of note, the Marine Mammal section contains more standard mitigation measures that are intended to reduce impacts to multiple species (e.g., bowheads, belugas, and ice seals), and those measures would indirectly reduce impacts to subsistence hunts and uses.

D1. Shutdown of exploration activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts in Nuiqsut (Cross Island) and Kaktovik beginning on August 25.

This measure is applicable when conducting **2D/3D seismic surveys, including in-ice surveys and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity**.

Purpose: The purpose of this mitigation measure is to ensure no unmitigable adverse impacts occur to the fall subsistence harvest of bowhead whales for the communities of Kaktovik and Nuiqsut.

Science, Support of Reduction of Impacts, and Likely Effectiveness: This mitigation measure would require seasonal restrictions (shutdown) on activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts conducted at Cross Island by Nuiqsut whalers, and by Kaktovik whalers in the vicinity of their community. Operators would shut down their activities on August 25 and would not resume until the fall bowhead hunts were concluded for both of these communities.

As a result of the restrictions incorporated into this mitigation measure, industry activity would not occur until after the fall bowhead hunt is deemed closed (i.e., when the village Whaling Captains' Association declares the hunt ended or the village quota has been exhausted, as announced by the village Whaling Captains' Association or the AEWC). During the fall migration, only those whales that have not yet migrated westward of Kaktovik and Nuiqsut would be affected by noise disturbance and possible deflection from proposed activities. As vessels associated with activities transit the area beginning August 10 to August 25, industry participants will communicate and collaborate with AEWC on any planned vessel movement in and around Kaktovik and Cross Island to avoid impacts to the whale hunt (more detail provided in Standard Mitigation Measure D2 below). Whalers have reported that spooked/skittish whales become less available during the whaling season, and this mitigation measure would limit the potential for disturbance to occur to the whales or the hunt. This mitigation measure may also reduce impacts to subsistence whalers at Barrow as it would limit the potential for disruption of westward migrating whales as they pass Kaktovik and Nuiqsut, and, therefore, whales would be assumed to be following their normal migratory paths towards Barrow. This measure has been successfully implemented by industry operators for several years in the Beaufort Sea.

However as indicated by residents of these communities, conflicts can still exist with impacts on the success of the bowhead hunt: *"When there was a rig on the east side of Barrow, Point Barrow, in the fall, and I was there, and as a whaler for the community of Barrow. And when the rig was there, there was no whales within that area, so we had to go further out because the whales had been diverted to further out. The same thing is going to happen within our waters in the Chukchi Sea because they are experiencing that before here. They have to go further out"* Jimmy Oyagak at Nuiqsut Public Scoping meeting for this EIS on March 11, 2010.

Fenton Rexford, then President of Kaktovik Iñupiat Corporation (KIC), in a community meeting on August 14, 1996 stated that during exploratory drilling in Canadian offshore waters: *"We were not successful or had a very hard time in catching our whale when there was activity with the single steel drilling caisson, the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it very difficult for our whalers to get our quota."*

Carl Brower noted at the Nuiqsut Public Scoping meeting for this EIS on March 11, 2010: *"We were harassed by how many vessels and let us catch half our quota. And last year was a -- we barely saw whales. Most of the whales were up north, and we -- the whales we saw that were close to the island, we saw one, two a day, where we usually see, in one day, each boat chasing their own whale. So that's my question, what do you have to [do to] mitigate [disturbance to] a whale?"*

Iñupiat hunters report that this measure is critical for reducing adverse impacts of industry activity on their fall bowhead whale subsistence hunts.

History of Implementation: Limitation of activities in these areas and times has been consistently required for years during exploration activities in the Beaufort Sea.

Practicability: Although cessation of exploration activities around the particular subsistence hunting activities does incur some cost to industry and increases risk when requiring drilling operations to shut down and move off site into the middle of drilling a well, industry has worked with the various communities along the Beaufort and Chukchi seas to establish communication centers during the open water season (see Standard Mitigation Measure D2 below) to avoid conflicts and have also include design measures in programs to move activities from one area to another to avoid conflicts. Implementation of this time/area closure has proven practicable to date.

Rationale: Based on the importance of implementing this measure to ensure no unmitigable adverse impact to subsistence uses of bowhead whales in the communities of Kaktovik and Nuiqsut (and to a lesser extent in Barrow), we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

D2. Establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season.

This measure is applicable when conducting **2D/3D seismic surveys, including in-ice surveys and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity**.

Purpose: This mitigation measure requires the establishment and utilization of Communication Centers in subsistence communities in the Beaufort and Chukchi seas and Bering Strait to address potential interference with marine mammal hunts on a real-time basis throughout the season, as the Centers would be in operation 24 hours a day when industry operations are occurring. This measure also would allow for the potential implementation of other proposed mitigation measures that require real-time communication between hunters and industry operations.

Science, Support of Reduction of Impacts, and Likely Effectiveness: In order to be effective, it is necessary that industry and the affected communities both participate and implement the steps that would be taken to cooperate with one another. The Plan of Cooperation (POC) required by the MMPA ITA implementing regulations would identify and document potential conflicts and associated mitigation measures that would be taken to minimize any adverse effects on the availability of marine mammals for subsistence use. To be effective, the POC must be a dynamic document which is updated to incorporate new requirements for effective communications and consultation with the communities. The effectiveness of this mitigation measure is a subject of debate among some of the affected communities. Concerns have been expressed that the communication centers are not working as effectively in avoiding interference with subsistence hunters as had been expected.

As reported by one commenter: *"And for years now we've had a lot of impacts. We've run into a lot of vessels sometimes. Our boats are small, we're in the ice pack, and we have an ice breaker coming at us, we've had those incidents where we -- you know, we couldn't get to them on the radio…We have Badami right there that they have fuel runs, barge runs that are hauling fuel or hauling material when its barging season is open. And I've seen a lot of deflection, you know, because I'm tracking with GPS*[global position system]*, their GPS when they're giving me coordinates. And I keep -- I get coordinates every six hours from industry, and sometimes we say, no, don't go, we have activity there. But still they go because it's their time and money that they're talking about when they have to have these resupply runs to their vessels out there. That causes impact, and it's recorded"* – Dora Leavitt at the Nuiqsut Public Scoping March 11, 2010 for this EIS.

Iñupiathunters report that this measure is critical for reducing adverse impacts of industry activity on their subsistence hunts.

History of Implementation: Industry operators have been required to set up and support Communication Centers for many years.

Practicability: Past success indicates that this measure is practicable to industry operators.

Rationale: Based on the importance of implementing this measure to ensure no unmitigable adverse impact to subsistence uses, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

D3. For exploratory drilling operations in the Beaufort Sea east of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be onsite at any offshore drilling location east of Cross Island from August 25 until the close of the bowhead whale hunt in

Nuiqsut and Kaktovik. However, such equipment may remain within the Beaufort Sea in the vicinity of 71 degrees (deg.) 25 min. N and 146 deg. 4 min. W or at the edge of the Arctic ice pack, whichever is closer to shore.

This measure is applicable when conducting **exploratory drilling operations**.

Purpose: The purpose of this mitigation measure is to avoid conflict with the fall bowhead whale subsistence hunts by the communities of Kaktovik and Nuiqsut. The measure would also reduce impacts on westward migrating bowhead whales, as well as other marine mammals.

Science, Support for Reduction of Impacts, and Likely Effectiveness: This mitigation measure would require seasonal restrictions (shutdown) on exploratory drilling activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts conducted by Kaktovik whalers and at Cross Island by Nuiqsut whalers. Operators would shut down their activities on August 25 and would not resume until the fall bowhead hunts were concluded for both of these communities. The science, support for reduction of impacts, and likely effectiveness of this mitigation measure is encompassed in the more extensive discussion for Standard Mitigation Measure D1 above. However, in addition to temporarily ceasing operations during the fall bowhead whale hunts in the vicinity, removal of the drilling equipment outside of the traditional hunting areas helps to reduce conflicts even further.

History of Implementation: NMFS included this measure in the most recent IHA issued for an exploratory drilling program in the Beaufort Sea (i.e., the IHA issued to Shell in 2012). This is the only time we required this measure. However, it is the only IHA we have issued for an exploratory drilling program in this region of the Beaufort Sea since 2008.

Practicability: Although cessation of exploration activities around the particular subsistence hunting activities does incur some cost to industry and increases risk when requiring drilling operations to shut down and move off site into the middle of drilling a well, industry has worked with the various communities along the Beaufort and Chukchi seas to establish communication centers during the open water season (see Standard Mitigation Measure D2 below) to avoid conflicts and have also include design measures in programs to move activities from one area to another to avoid conflicts. Implementation of this time/area closure with the added requirement to move drilling equipment for the time period of the hunt has proven practicable in the past.

Rationale: Based on the importance of implementing this measure to ensure no unmitigable adverse impact to subsistence uses of bowhead whales in the communities of Kaktovik and Nuiqsut, we have determined that it is appropriate to require this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

D4. No transit of oil and gas exploration vessels into the Chukchi Sea prior to July 1. Any oil and gas exploration vessel transiting through the Chukchi Sea on or after July 1 should remain at least 8 km (5 mi) offshore during transit except for emergencies or human/navigation safety or for any vessel actively engaged in transit to or from a coastal community to conduct crew changes or logistical support operations.

This measure is applicable when conducting **2D/3D seismic surveys, including in-ice surveys and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity**.

Purpose: The purpose of the mitigation measure is to minimize conflict with the summer beluga whale hunt at Point Lay and Wainwright. It would also reduce disturbance from vessels on bowhead whales migrating east in that time frame, although most bowhead whales have already migrated past these areas by July.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* The science behind the mitigation measure is contained in Section 4.5.2.4.11, Beluga Whales, of the EIS. Deflection due to noise and vessel presence could cause whales to avoid subsistence harvest areas, which could make the whales less available for harvest.

The discussion in Section 4.5.3.2 , Subsistence, indicates that most of the beluga hunt occurs from late June to mid-July inside Kasegaluk Lagoon or other inshore locations inside the barrier islands. Delaying transit into the Chukchi Sea until the beginning of July and then requiring any vessels that enter starting on July 1 to remain out of inshore areas would reduce impacts on the beluga hunts and on the availability of the whales. From 2008 to 2012, hunters in Point Lay and Wainwright averaged about 56 beluga whales per year.

BOEM lease stipulation 7 and the standard requirement placed in G&G permits based on the FWS BO prohibits transit of exploration vessels and seismic activity in the LBCHU, which will keep those vessels outside of the harvest area. However, the concern still remains about affecting belugas farther offshore.

History of Implementation: NMFS has included a measure in IHAs for the last five to six years requiring oil and gas exploration vessels refrain from entering the Chukchi Sea until July 1 and that vessels remain as far offshore as ice and weather conditions allow but at least 8 km (5 mi) offshore when transiting after this date.

Practicability: Limiting entrance into the Chukchi Sea until after July 15 could shorten exploration periods during the open water period in both the Beaufort and Chukchi seas by preventing activity and staging prior to this time. Operators often begin entering the Chukchi Sea around July 1 (or as soon thereafter as ice conditions allow) so as to be at the activity location a few days or one week later (depending on site location).

Rationale: Based on the importance of implementing this measure to ensure no unmitigable adverse impact to subsistence uses, we have determined that it is appropriate to continue requiring this measure of industry operators as a Standard Mitigation Measure in future MMPA ITAs for the applicable activities.

D5. Shutdown of exploration activities in the Beaufort Sea and within 100 miles of the coastline in the Chukchi Sea from Pitt Point on the east side of Smith Bay (~ 152 deg. 15 min. W) to a location about half way between Barrow and Peard Bay (~ 157 deg. 20 min. W) from September 15 to the close of the fall bowhead whale hunt in Barrow.

This measure is applicable when conducting **2D/3D seismic surveys, including in-ice surveys, OBC/OBN surveys, and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity.**

Purpose: The purpose of the mitigation measure is to avoid conflict with the fall bowhead whale subsistence hunt and give both the hunters and companies certainty regarding when to stop activities in the vicinity of Barrow. On September 15, the exploration activity would move out of the area, resulting in lower levels of disturbance to bowhead whales from oil and gas exploration activities.

Science, Support for Reduction of Impacts, and Likely Effectiveness: As noted in other parts of this document, cessation of activities has the potential to reduce impacts on marine mammals and therefore to reduce the potential for interference with subsistence hunts of marine mammals. However, the geographic area in this measure does not correspond to the historic overall use area or the most important high use area for fall bowhead whale hunting by crews in Barrow. Data indicate that the hunting grounds do not extend to the west side of Smith Bay or to Peard Bay. The measure has the potential to be effective, as it replicates agreed to conditions for exploration activities by some oil and gas operators. However, the overall areal extent of the measure is not supported by available information on subsistence use areas.

History of Implementation: NMFS required a similar measure in past IHAs. However, this measure has not been required in recent years.

Practicability: Although industry could incur costs associated with shutting down operations, shutdowns for subsistence activities in the Beaufort Sea have proven practicable in the past.

Recommendation: NMFS recommends that if this measure is to be included in future ITAs, the geographic extent should be re-defined to more closely match with current fall whaling areas. Additionally, this measure may benefit from real-time communication instead of a fixed date, allowing for flexibility in the shutdown date. This measure would be assessed on a case-by-case basis, with spatiotemporal overlap of the activity playing a key role in whether or not it would be included in an authorization.

4.5.3.2.4 Standard Mitigation Measures Summary for Subsistence

In general, the Standard Mitigation Measures discussed above would avoid or reduce the disturbance of marine mammals and other resource harvests for subsistence purposes, or would avoid or reduce interference with subsistence activities. Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 2 would be of low intensity, temporary in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 2 on subsistence resources and harvests would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance.

4.5.3.2.5 Additional Mitigation Measures for Subsistence

Additional mitigation measures are outlined in Section 2.4.11 and described in detail in Appendix E. These measures may, or may not, be incorporated in future permits and authorizations, depending on the specific activity and the analysis conducted pursuant to the MMPA and the OCSLA. See Sections 2.4.2 and 4.3 for an explanation of how specific measures would be chosen for inclusion in any future permits or authorizations. The following are applicable to mitigating effects of oil and gas exploration activities on the availability of marine mammals for subsistence uses. The decision to include the following mitigation measures as Additional Mitigation Measures in this FEIS is based on the analysis contained in the DEIS and SEIS and the public comments received on the measures during the comment periods for those documents.

Of note, the Marine Mammal section contains more additional mitigation measures that are intended to reduce impacts to multiple species (e.g., bowheads, belugas, and ice seals), and those measures, if required and implemented, would indirectly reduce impacts to subsistence hunts and uses.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Kaktovik, Cross Island, Barrow Canyon and the western Beaufort Sea, Hanna Shoal, the shelf break of the Beaufort Sea, Point Franklin to Barrow, Kasegaluk Lagoon, and Ledyard Bay.

Section 4.5.2.4.17 contains the full analysis for this mitigation measure. As noted in that section, this additional mitigation measure would also help to reduce impacts to the following hunts: the fall bowhead whale hunt by the community of Kaktovik; the fall bowhead whale hunt by the community of Nuiqsut (conduct hunt from Cross Island); the fall bowhead whale hunt by the communities of Barrow and Wainwright; and the late spring/early summer beluga hunt by the community of Point Lay. Additionally, adverse impacts to some subsistence sealing would also potentially be reduced.

Additional Mitigation Measure D1. From August 25 until the close of the fall bowhead whale hunts by the communities of Kaktovik and Nuiqsut, vessels transiting east of Bullen Point to the Canadian border should remain at least 8 km (5 mi) offshore during transit along the coast, provided ice and sea conditions allow, except for emergencies or human/navigation safety or for

any vessel actively engaged in transit to or from a coastal community to conduct crew changes or logistical support operations.

This measure is applicable when conducting **2D/3D seismic surveys, including in-ice surveys, OBC/OBN surveys, and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity.**

Purpose: The purpose of this mitigation measure is to avoid conflict with the fall bowhead whale subsistence hunts conducted by the communities of Kaktovik and Nuiqsut in the nearshore region. However, the measure would also reduce the potential for vessel disturbance to marine mammals in the area.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* Subsistence mapping of Nuiqsut, Kaktovik, and Barrow (MMS OCS Study 2009-003) and described in the EIS indicates most intense use is in the nearshore area of the coast, although not all the area described in the mitigation measure is intensely used. The measure would likely be effective in preventing use conflicts during the fall bowhead whale hunt.

Nuiqsut residents in interviews gathering traditional knowledge have expressed concern that the Camden Bay area *"could be used as a refuge for vessels and drill ships during a storm, at precisely the same time it is used by whales as a refuge"* (Huntington 2013).

History of Implementation: NMFS began including this measure in relevant IHAs in 2012. However, the measure contained in the 2012 through 2015 IHAs did not include the timing component.

Practicability: Operators could incur costs and lost survey time associated with altering transit routes farther offshore. Some operations of oil and gas facilities east of Prudhoe Bay rely on regular coastal barge traffic, which is coordinated with whaling communities during the fall bowhead harvest. However, operators have shown that routes can be altered in the Chukchi Sea to remain farther offshore, and this measure has been implemented on a limited basis in the Beaufort Sea since 2012.

Rationale and Considerations for Future Implementation: This sort of mitigation measure is supported by current scientific literature, and specific transit routes have been successfully implemented without apparent conflicts with safe operations in the past. However, because specific transit routes in this particular area have not been required previously on a consistent basis, it would be important to evaluate this measure on a case-by-case basis before requiring as a Standard Mitigation Measure. Additionally, the location of some operations makes transits further offshore impractical. In those cases, adherence to Standard Mitigation Measure D2 (utilization of Communication Centers) is pivotal.

Additional Mitigation Measure D2. For exploratory drilling operations in the Beaufort Sea west of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be moved onsite at any location outside the barrier islands west of Cross Island from September 15 until the close of the fall bowhead whale hunt in Barrow.

This measure is applicable when conducting **exploratory drilling operations**.

Purpose: The purpose of this mitigation measure is to avoid conflict with the Barrow fall bowhead whale subsistence hunt. The measure would also reduce impacts on westward migrating bowhead whales, as well as other marine mammals.

Science, Support for Reduction of Impacts, and Likely Effectiveness: As noted earlier in this EIS, ceasing activities prior to and during a subsistence hunt reduces impacts to the individual animals and also eliminates the possibility of interference between the hunters and the operators. The measure would likely be effective at reducing or eliminating the potential for interference with the fall bowhead whale hunt conducted off Barrow. Equipment would need to be moved to a location agreed upon with the affected subsistence users to ensure that the "stand-by" location does not create impacts to the hunters.

Nuiqsut subsistence hunters note the importance of buffers around Cross Island to ensure the success of the bowhead whale harvest:

"On the Chukchi we have a big wide buffer, a 25-mile wide buffer zone that goes way down -- all the way down near Point Hope. That's there for us. That's -- we're the ones that's taking the impact. I mean all these years we've been asking, ever since the lease sales start occurring, to protect our subsistence whales. And so far up today that we haven't received a buffer [near Cross Island"] - Thomas Napageak Jr. Nuiqsut Public Scoping Meeting on March 11, 2010.

History of Implementation: NMFS has not required this measure in IHAs in the past.

Practicability: While the oil and gas operators have shown that they are able to conduct temporary shutdowns for subsistence hunts, there are extra costs that are incurred. NMFS has adjusted the language of this measure to indicate that activity could occur up until a certain point before the hunt begins. The cutoff date will allow hunters to prepare and also for whales to migrate through the area for a period of time before hunting begins.

Rationale and Considerations for Future Implementation: NMFS has redefined the parameters of this measure to make it more specific to the Barrow fall bowhead whale hunt. This sort of mitigation measure is supported by current scientific literature, and temporary shutdowns of operations have been successfully implemented without apparent conflicts with safe operations in the past. However, because a shutdown of operations in this particular area has not been required previously on a consistent basis, it would be important to evaluate this measure on a case-by-case basis before requiring as a Standard Mitigation Measure.

Additional Mitigation Measure D3. All oil and gas industry exploration vessels shall complete operations in time to allow such vessels to complete transit through the Bering Strait to a point south of 59 degrees N latitude no later than November 15. Any vessel that encounters weather or ice that will prevent compliance with the November 15 date shall coordinate its transit through the Bering Strait to a point south of 59 degrees N latitude with the appropriate Communication Centers (see Standard Mitigation Measure D2). All industry vessels shall, weather and ice permitting, transit east of St. Lawrence Island and no closer than 16 km (10 mi) from the shore of St. Lawrence Island.

This measure is applicable to **all vessels associated with oil and gas exploration activities**.

Purpose: The purpose of this measure is to minimize conflicts with the late fall bowhead whale hunts from St. Lawrence Island. It would also reduce impacts on bowhead whales migrating south through the Bering Strait that migrate through that region a little later than the first wave of whales.

Science, Support for Reduction of Impacts, and Likely Effectiveness: As has been described for the other Standard and Additional Mitigation Measures designed to minimize conflicts with bowhead whale subsistence hunts, ensuring vessel traffic is out of the hunting area prior to the start of the hunts will achieve this goal. If vessels are past the hunting area before it begins, this provides the hunters and opportunity to prepare and to hunt without interference from oil and gas vessels and also for whales to migrate into the area uninterrupted by such vessels.

History of Implementation: NMFS has included this measure in IHAs on a limited basis since 2013.

Practicability: While it may be difficult for some industry operators to completely shutdown activities in the Beaufort or Chukchi seas in order to transit south of 59 degress N latitude by November 15, most permits and authorizations require operations to cease further north by October 31. This would then provide vessel operators 15 days to transit south of this point. However, some operations, such as in-ice seismic surveys, continue later into the year, making this more difficult.

Rationale and Considerations for Future Implementation: This measure has proven practicable for implementation on a limited basis. Therefore, we will evaluate requiring this measure on a case-by-case basis until more information on practicability becomes available. If industry operators indicate that this can become a part of their operational plans, we may include this as a required Standard Mitigation Measure in all applicable authorizations at some point in the future.

4.5.3.2.6 Additional Mitigation Measures Conclusion for Subsistence

The additional mitigation measures considered in this section would have the potential to further reduce the potential of adverse effects on subsistence resources. Given the standard and additional mitigation measures, the effects on subsistence resources would likely be considered low in intensity, temporary in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 2 on subsistence resources and harvests with additional mitigation measures applied would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance.

4.5.3.2.7 Mitigation Measures Considered but Not Carried Forward for Subsistence

Shutdown of exploration activities in the Beaufort Sea for the Nuiqsut (Cross Island) and Kaktovik bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

This measure was considered for implementation when conducting 2D/3D seismic surveys, including in-ice surveys and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity.

Suggested Purpose: This measure was considered to avoid conflict with the fall bowhead whale subsistence hunts conducted by Kaktovik and Nuiqsut and give both the hunters and operators flexibility in when they stop activities in the vicinity of the hunts by these two communities. As the hunters commence whaling activities, the exploration activity would move out of the area. Therefore, there would be fewer disturbances to bowhead whales from exploration activities, increasing the likelihood of a successful hunt.

Discussion of Science, Reduction of Adverse Impacts, and Likelihood of Effectiveness: As noted earlier in this EIS, cessation of activities at the time of a whale hunt reduces the potential for conflicts between hunters and operators and also reduces impacts to the animals.

History of Implementation: NMFS has not required this measure in the past.

Discussion of Practicability: Although industry could incur costs associated with shutting down operations, basing closures on real time reporting could lead to shorter closure periods and reduced survey down time. Specific protocols for real-time communication would need to be determined in order for this measure to be practicable. However, real-time triggers can impose significant operational challenges. It is difficult to shut down operations quickly, especially exploratory drilling operations, and doing so can lead to safety issues.

Rationale: At this time, the infrastructure and mechanisms for real-time reporting of whale presence to determine the subsistence time/area closure does not exist. In Chapter 5, we discuss adaptive management strategies for altering mitigation measures in the future should new data or information become available regarding more appropriate dates to implement time/area closures to reduce conflicts with subsistence hunts.

Shutdown of exploration activities in the Chukchi Sea for the Barrow (the area circumscribed from the mouth of Tuapaktushak Creek due north to the coastal zone boundary, to Cape Halkett due east to the coastal zone boundary) and Wainwright (the area circumscribed from Point Franklin due north to the coastal zone boundary, to the Kuk River mouth due west to the coastal zone boundary) bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

This measure was considered for implementation when conducting 2D/3D seismic surveys, including in-ice surveys and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity.

Suggested Purpose: This measure was considered to avoid conflict with the fall bowhead whale subsistence hunt and give both the hunters and companies flexibility in when they stop activities in the vicinity of Barrow and Wainwright. As the hunters commence whaling activities, the exploration activity would move out of the area. Therefore, there would be fewer disturbances to bowhead whales from exploration activities, increasing the likelihood of a successful hunt.

Discussion of Science, Reduction of Adverse Impacts, and Likelihood of Effectiveness*:* The potential effectiveness of the mitigation measure is low, as it does not correspond to areas where most intense bowhead whaling takes place. However, any reduction in activity has the potential to reduce overall impacts.

History of Implementation: NMFS has not required this measure in the past.

Discussion of Practicability: Although industry could incur costs associated with shutting down operations, shutdowns for subsistence activities in the Beaufort Sea have proven practicable in the past. Specific protocols for real-time communication would need to be determined in order for this measure to be practicable. However, real-time triggers can impose significant operational challenges. It is difficult to shut down operations quickly, especially exploratory drilling operations, and doing so can lead to safety issues.

Rationale: This measure was dismissed from further consideration because it does not reflect current fall whaling areas by the communities of Barrow and Wainwright in the Chukchi Sea. Instead, we have added a measure to the Standard Mitigation Measure section that more closely aligns with the timing and spatial extent of the fall bowhead whale hunts by the communities of Barrow and Wainwright.

Moreover, at this time, the infrastructure and mechanisms for real-time reporting of whale presence to determine the subsistence time/area closure does not exist. In Chapter 5, we discuss adaptive management strategies for altering mitigation measures in the future should new data or information become available regarding more appropriate dates to implement time/area closures to reduce conflicts with subsistence hunts.

Shutdown of exploration activities in the Chukchi Sea for the fall Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

This measure was considered for implementation when conducting 2D/3D seismic surveys, including in-ice surveys and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity.

Suggested Purpose: This measure was considered to avoid conflict with the fall bowhead whale subsistence hunt and give both the hunters and companies certainty in when they stop activities in the vicinity of Point Hope and Point Lay.

Discussion of Science, Reduction of Adverse Impacts, and Likelihood of Effectiveness: The science behind the measure is not clear. Exploration generally cannot begin in the Chukchi Sea until the ice has retreated, which is well after the completion of the spring whale hunts by the communities of Point Hope and Point Lay. Successful fall whaling has not been historically undertaken from these communities. Hunters from Point Lay and Point Hope typically travel to Barrow or other communities that conduct fall bowhead whale hunts. Distance of the coastal buffer does not appear to correspond to reported use areas. Point Lay subsistence activities are currently "buffered" by BOEM Lease Stipulation 7, and requirements for exclusion of vessel traffic related to BOEM permitted and authorized activities in the FWS BO effectively curtails exploration activities from occurring within the LBCHU. It is not clear how effective the measure would be.

History of Implementation: NMFS has not required this measure in the past.

Discussion of Practicability: Although industry could incur costs associated with shutting down operations, shutdowns for subsistence activities have proven practicable in other parts of the U.S. Arctic in the past. Specific protocols for real-time communication would need to be determined in order for this measure to be practicable. However, real-time triggers can impose significant operational challenges. It is difficult to shut down operations quickly, especially exploratory drilling operations, and doing so can lead to safety issues.

Rationale: This measure was dismissed from further consideration because it does not align with current conditions and also does not provide enough specificity to be effectively implemented. Currently, most Point Hope and Point Lay bowhead whale hunters travel to other communities, such as Barrow, to conduct fall bowhead whaling. We have included several measures in this EIS to reduce conflicts with the fall bowead whale hunts near Barrow and Wainwright.

Moreover, at this time, the infrastructure and mechanisms for real-time reporting of whale presence to determine the subsistence time/area closure does not exist. In Chapter 5, we discuss adaptive management strategies for altering mitigation measures in the future should new data or information become available regarding more appropriate dates to implement time/area closures to reduce conflicts with subsistence hunts.

Transit restrictions into the Chukchi Sea were modified to allow offshore travel under certain conditions (e.g., 32 km [20 mi] from the coast), as long as beluga whale, fall bowhead whale (Barrow and Wainwright), and other marine mammal hunts would not be affected.

This measure was considered for implementation when conducting 2D/3D seismic surveys, including in-ice surveys and VSP surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessel activity.

Suggested Purpose: This measure was considered to avoid conflict with the subsistence hunts in Barrow and the Chukchi Sea communities.

Discussion of Science, Reduction of Adverse Impacts, and Likelihood of Effectiveness*:* The science behind the mitigation measure is contained in Section 4.5.3.2, Subsistence, of the EIS. Deflection due to noise and vessel presence could cause whales to avoid subsistence harvest areas, which would make the whales unavailable for harvest. Discussion indicates that not all marine mammals have pronounced avoidance behaviors or are hunted during the period in which transits would take place.

The potential effectiveness of the mitigation measure is marginal for beluga whale hunts. As the discussion in Section 4.5.3.2 , Subsistence, indicates, most of the beluga hunt occurs from late June to mid-July inside Kasegaluk Lagoon or other inshore locations inside the barrier islands. The terminology “travel under certain conditions” is vague as it defines neither the type of travel nor the conditions. The distance of 32 km (20 mi) appears to be arbitrary, with no definitive basis identified in the analysis.

History of Implementation: NMFS has not required this measure in the past.

Discussion of Practicability: While oil and gas operators have shown that they are able to abide by transit distances from shore in the past, the reason for this measure is unclear.

Rationale: This measure was dismissed from further consideration because it is not well-defined. It does not identify the conditions under which transit might be allowed. Additionally, if this related to all subsistence hunts of all species, it would significantly reduce the time for any oil and gas exploration vessel transits in the Chukchi Sea. We have included measures in the Standard and Additional Mitigation Measure sections that address transits nearshore and time/area closures for whale hunts.

4.5.3.3 Public Health

The level of impacts on public health and safety will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-30.

Table 4.5-30 Impact Levels for Effects on Public Health and Safety

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Above background conditions, but within normal variation of human health conditions or within current capabilities of infrastructure.	**Medium**: Above background conditions and predicted to result in a decline in individual human health and/or a deterioration of the capabilities of infrastructure.	**High**: Above background conditions, and predicted to result in a change in population health and/or exceeds capabilities of infrastructure.
Duration	**Temporary**: Impacts would be intermittent, infrequent, and typically last less than a month	**Interim**: Impacts would be frequent or extend for longer time periods (an entire project season).	**Long-term**: Impacts would cause a change in the resource that would perpetuate even if the actions that caused the impacts were to cease.
Geographic Extent	**Local**: Affects individuals in a single community	**Regional**: Affects two or more communities in the EIS project area	**State-wide**: Affects communities throughout the EIS project area
Context	**Common**: Affects communities that are not minority or low-income	**Important**: Not Applicable	**Unique**: Affects minority or low-income communities

4.5.3.3.1 Direct and Indirect Effects

This section describes the direct and indirect effects of Alternative 2 on six important pathways that may affect the health and well-being of the people who live in the study area:

- Diet and nutrition;
- Contamination;
- Safety;
- Acculturative stress;
- Economic impacts; and
- Health care services.

Figure 4.14 summarizes the complex relationships between the environmental and social factors that could be impacted by the action alternatives and the factors that comprise health and well-being in the affected communities.

Diet and Nutrition

Changes in diet and nutrition are common potential effects of oil and gas exploration activities where there are populations that rely on subsistence resources. These changes can lead to a number of important public health outcomes.

For indigenous populations, a traditional diet has been shown to be strongly protective against chronic diseases. The traditional diet in Alaska is associated with reduced risk of chronic diseases such as diabetes, high blood pressure, high cholesterol, heart disease, stroke, depression and arthritis (Chan et al.

2006, Dewailly et al. 2001, Dewailly et al. 2002, Din et al. 2004, ADHSS 2005, Murphy et al. 1995, Ebbesson et al. 2007, Reynolds et al. 2006, Murphy et al. 1995, Adler et al. 1994, Adler et al. 1996, Ebbesson et al. 1999).

Decreasing intake from subsistence diets is usually associated with an increased reliance on store-bought foods. Some studies have shown that the nutritional value of store-food available in rural Alaskan villages tends to be low (high in saturated fat, sugar and salt), and that the cost of buying nutrition-dense food (such as fruits, vegetables and whole grains) is often prohibitively expensive (Bersamin and Luick 2006). The result is that when subsistence resources become unavailable and people rely more heavily on store-bought foods to replace traditional sources, the nutritional value of the diet decreases, and the risk of developing problems such as diabetes increases (Murphy et al. 1997, Young et al. 1992, Bjerregaard et al. 2004). Therefore, any change away from a subsistence diet is likely to cause an increase in metabolic disorders such as obesity, heart disease, and diabetes.

Food insecurity is another potential outcome associated with a shift away from subsistence diets. Food insecurity refers to an inability to secure sufficient healthy food for a family. Studies of food insecurity and health have found a variety of detrimental health impacts including overweight/obesity, poor psychological functioning among children, poor cardiovascular health outcomes, and lower physical and mental health ratings (Olson 1999, Stuff et al. 2004, Seligman et al. 2010). The high cost of store-bought food, the costs associated with harvesting of subsistence resources, and the year-to-year variation in subsistence resource availability is all implicated in high rates of food insecurity in many northern indigenous populations.

As described in Section 3.3.3.5, the reliance on subsistence foods is very high in the NSB. In the 2010 NSB census, between 44 and 67 percent of households indicated that they get at least half of their meals from subsistence sources, and virtually all Iñupiat households reported relying on subsistence resources to some extent (Circumpolar Research Associates 2010). As described in Section 4.5.3.2 (Subsistence), in Kotzebue and Kivalina an estimated 78 to 95 percent of households actually harvest subsistence foods and 100 percent of households use subsistence foods. As described in Chapter 3, rates of obesity, diabetes and heart disease–all outcomes associated with dietary changes towards less-healthy foods—have been rising rapidly in the study area over the last several decades. This combination of a high reliance on subsistence foods and metabolic changes in the population means that changes to the availability or quality of subsistence resources could have severe detrimental impacts on nutritional health outcomes and food insecurity for the local population. As described in Chapter 3, food security is already a challenge in the affected communities. Indicators of food insecurity - households finding it difficult to get the foods they need for a healthy diet or households who at times did not have enough food to eat - range between 39 to 59 percent for the first measure and 14 to 40 percent for the latter measure. A compensating factor is that the wide variety of traditional food sources has provided most communities with the ability to adapt to transient changes in availability of single species. This has historically helped temper the dietary and nutritional impact of year-to-year variability in the success of the hunt. However, the State of Alaska has recently (in late 2013) developed the Alaska Food Resources Working Group – a group of state commissioners tasked with increasing consumption and availability of local food sources, with a main goal of addressing food security in the state (Caldwell 2013).

Summary

Activity levels pursuant to Alternative 2 are not expected to have a major impact on the numbers of marine mammals harvested in any community in the study area, as discussed in Section 4.5.3.2. Although dispersion of some animals may result in greater travel time and cost, the overall availability and subsequent consumption levels of traditional foods is not expected to change. Therefore, changes in diet and health outcomes resulting from decreased subsistence availability are not anticipated.

The potential for diet and nutrition to be affected via increased income to hunters is discussed under *Economic Impacts*. The potential for diet and nutrition to be affected via perceived safety of subsistence foods is discussed under *Contamination*.

Contamination

Offshore oil and gas activity has the potential to produce a number of environmental contaminants that may be harmful to human health. These include PAHs such as benzene, toluene, ethylbenzene, and xylene, and heavy metals such as arsenic, lead, cadmium and mercury. Chronic exposure to these substances can increase the risk of cancer and may have other effects on the respiratory, pulmonary, gastrointestinal, renal, or dermatologic systems (ATSDR 2009).

Whether any health effects manifest from exposure to environmental contaminants depends on several factors, including the nature of the contaminant, the amount and duration of exposure, and the sensitivity of the person who comes in contact with the contaminant. In the case of the NSB and NAB communities, exposure could occur through the consumption of contaminated subsistence food sources.

A number of studies have examined the current contaminant load in marine mammal species used for subsistence purposes in the North Slope communities, including bowhead whales, beluga whales, seals, walruses and polar bear. The range of contaminants examined has included PCBs; dichlorodiphenyltrichloroethane (DDT); heavy metals; organochlorines, including chlordanes; and PAHs.

Elevated levels of contaminants were found in several of these species (Becker 2000). However, the levels found in subsistence foods in the North Slope area appear at present to be generally low compared with other Arctic areas (NSB 2006). Bowhead whales in particular appear to have contaminant levels lower than those found in other whale species (USDC 2008). The current levels of contaminants in subsistence foods in the North Slope area are lower than what would trigger public health concern (NSB 2006) and “do not represent a threat to the health of subsistence users at current levels” (USDC 2008, Wetzel et al. 2008).

Aside from actual exposure to environmental contamination, the *perception* of exposure to contamination is also linked with known health consequences. Perception of contamination causes stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources (CEAA 2010, Loring et al. 2010), which may result in changes in nutrition-related diseases. It is important to note that these health results arise regardless of whether or not there is any “real” contamination at a level that could induce toxicological effects in humans; the effects are linked to the perception of contamination, rather than to measured levels.

However, many Iñupiat residents of the NSB have reported that they are concerned that current and/or future oil and gas activities could increase contaminant loads of subsistence foods to a level that would threaten human health (Poppel et al. 2007). Concerns center around oil spills, persistent leaks, and poor waste management practices. In a recent survey, 44 percent of Iñupiat village residents outside of Barrow reported concern that fish and animals may be unsafe to eat (Poppel et al. 2007). Residents have also indicated that they believe that established contaminant thresholds developed by regulatory bodies do not take into consideration the large amounts of fish or game consumed by the Iñupiat but rather were developed based on the consumption levels of the general population (BLM 2005).

Summary

Current levels of contamination in subsistence food sources are low. As described in Section 4.5.3.2, the permitted discharges associated with Alternative 2 are likely to result in only a minor change in the availability of subsistence resources, although the predicted contaminant load of marine mammals, fish, and seabirds is not discussed. Except in the event of a very large oil spill (discussed in Section 4.10), there are likely to be only negligible to minor health effects from contamination of food sources as a result of the activities associated with Alternative 2.

However, even at the current low levels of contaminants, perception of contamination is widespread in the EIS project area. The level and nature of the activity specified under Alternative 2 may add to this perception. Although any anticipated change in risk perception will likely be below the threshold required to see measurable changes in health outcomes, ongoing oil and gas exploration activity has the potential to reduce confidence in subsistence resources and subsequent consumption. The potential for these impacts is addressed in the cumulative impact assessment in Section 4.10.

Acculturative Stress

Acculturation is a commonly used concept to describe the psychological and cultural impacts of rapid modernization and loss of tradition. Studies have found rapid cultural change to be linked to a wide variety of health outcomes, ranging from impaired mental health and social pathology (such as substance abuse, violence and suicide) to cardiovascular disease and diabetes (Curtis et al. 2005, Bjerregaard 2001, Shephard and Rode 1996). While acculturation can affect any population experiencing rapid change, it is a particularly common problem in indigenous populations, including the Iñupiat, other Arctic populations such as the Inuit, and aboriginal populations in Australia (Inuit Tapirisat of Canada 2000, Smylie 2009).

The specific health impacts of acculturation in the Iñupiat are well documented; for example, the shift away from a nutrient-rich traditional diet and towards store bought and western foods is associated with cardiovascular risk and obesity (Curtis et al. 2005). Similarly, the transition from a traditional to a wage economy and lifestyle may play a role in cardiovascular disease and diabetes in part due to the associated decrease in physical activity (Murphy et al. 1992, Ebbesson et al. 1998, Jørgensen et al. 2002). However, equally if not more important is the loss of the sociocultural value of subsistence: traditional foods are highly valued among circumpolar populations, as they are considered to be “healthy and provide strength, warmth and energy in ways that store-bought food do not” (Arctic Climate Impact Assessment 2004). Subsistence foods contribute to cultural identity, tradition, and social cohesion. The enjoyment of traditional foods is seen to be of equal cultural value to speaking the native language (Kleivan 1996, Searles 2002).

Identity and involvement in cultural activities provide numerous benefits to Alaska Natives: improved self-esteem (Zimmerman et al. 1996); enhanced resiliency in harsh life circumstances (Belcourt-Dittloff 2006, Walters and Simoni 2002); and diminished feelings of historical loss (Whitbeck et al. 2004). Participation in American Indian traditional activities has been found to be protective against substance use problems and risk (Herman-Stahl et al. 2002, Lysne 2002, Winterowd et al. 2005) and suicide attempts (Garroutte et al. 2003, Lester 1999). Evidence suggests that focusing on culture to promote health and prevent disease in Arctic communities may provide value (Curtis et al. 2005); indeed, health promotion professionals often promote traditional culture as a population health intervention.

The importance of Iñupiat participation in subsistence activities and consumption of subsistence foods extends beyond their nutritional and dietary importance: the hunt and consumption of subsistence foods involve cultural, traditional, and spiritual activities that involve the entire community. Of particular importance among subsistence activities is the bowhead whale hunt. The Iñupiat have hunted the bowhead whale for over 2,000 years (Stoker and Krupnik 1993), and the whale hunt continues as a cornerstone of diet, social organization, and cultural survival (Brower et al. 1998, Michie 1979).

Oil and gas exploration in the Arctic, and the rapid modernization associated with the development of this resource, has led to many of these symptoms being observed in the NSB and similar communities (Ahtuangaruak 2003, BLM 2004). In *Gift of the Whale*, Bill Hess highlights an unsuccessful bowhead hunt in 1982 (Hess 1999). The news that no whales had been caught for the season was “greeted with frustration and anger”, whereas during years with a good hunt, social problems were described to virtually disappear. These sentiments, and the resulting social pathologies, are shared by this public testimony:

> *We had seismic activity in Camden Bay that caused us to lose two whaling boats. We did not harvest whale two seasons in a row. We went without whale those winters. Those were the*

> *deepest, darkest winters I faced as a community health aide. We saw an increase to the social ills, we saw domestic violence, we saw drug and alcohol abuse, we saw all the bad things that come when we are not able to maintain our traditional life activities.* (BLM 2004)

In the NSB, whaling is seen as a "physical, emotional, and spiritual experience" which provides self-confidence and unites the communities (Brower et al. 1998). A report analyzing potential restrictions on the bowhead hunt described that the bowhead hunt held particular importance to this culture and found that where societal changes had weakened cultural ties, particularly in younger Iñupiat, whaling had "revitalized interest in traditional culture" among this age group (Hankins 1990). Traditional skills are passed on to younger generations, and traditional social structure and the Iñupiat cultural identity are reinforced (Worl 1979, Braund and Associates 1997). The whale hunt is "one of the greatest concentrations of community-wide effort and time" (USDC 2008). Most of the village is involved in some part of the whale hunt, and the proceeds are shared and enjoyed in feasts and celebrations. Where in many aspects of Iñupiat life cultural changes have taken place at the expense of tradition, the whale hunt remains "key to the survival of [Iñupiat] culture" (Brower et al. 1998).

Although acculturative stress is a concern among the Iñupiat, the strength of traditional culture and local institutions, and in particular the value and stability of the bowhead hunt, provide a strongly protective effect against the health impacts of acculturation.

Summary

The communities that would be most impacted by industrial activity (crew changes and staging for offshore exploration) are Deadhorse and Barrow. Deadhorse is an enclave development specifically built for industrial use. Consequently, increased activity in Deadhorse associated with Alternative 2 will have no impact on health as a result of acculturative stress. Similarly, Barrow is accustomed to a transient and non-indigenous workforce and a wage economy. The small increase in activity level associated with Alternative 2 is unlikely to result in a substantial change in acculturative stress in Barrow and would not cause measurable changes in health in the community.

The use of Wainwright as a staging site for activity within the Chukchi Sea is likely to result in some acculturative stress, given the community's smaller size and more traditional nature. It is unlikely, however, that this stress would be great enough to cause measurable health impacts.

The greatest risk to the Iñupiat with regard to the health impacts of acculturative stress would arise from a major and persistent decline in the success of the bowhead hunt in any single community. This is not an anticipated result of the activity levels associated with Alternative 2, and, thus, the anticipated health impacts remain negligible.

Safety

In indigenous populations in Alaska and across North America, the rate of accidents and trauma is very high (ANTHC 2008; Day et al. 2006). This is particularly true in the Arctic populations of Alaska and Canada and is reflected in the statistics for hospitalizations and deaths from injuries (McAninch 2010). A large part of this burden is a result of the risks inherent to subsistence activities in an often hostile environment. Not surprisingly, the indigenous people of the Arctic have a strong concern for safety.

For the Iñupiat, harvesting of marine mammals requires travel in small open boats in the Beaufort and Chukchi seas, camping at the edge of shorefast ice, and travel by snow machines and sleds across sea ice. Local history provides numerous examples of both fatal accidents and near misses, the details of which are recounted and dissected to provide warnings and lessons for other hunters. Weather and ice conditions are constant topics of discussion. Traditional knowledge provides the base for interpretation of current conditions and risks and allows for adaptation and responses to help mitigate or avoid the dangers associated with subsistence activities.

Some hunters are concerned that safety has already been compromised by climate change and offshore exploration activity. Shorefast ice is less predictable in recent years (George C. 2011) and may be associated with an increased risk of break-offs (USDC 2008). Anecdotal reports suggest that hunters believe that offshore seismic activity has already caused deflection of whales from their migratory paths, requiring them to travel further to successfully complete an open water hunt. This could lead to a greater risk of hazardous open water incidents. For example, unfavorable weather conditions could suddenly arise while a crew is far offshore.

Icebreaking activity could result in the isolation of hunting groups or weakening of ice for those traveling over the sea ice to hunting areas (Brubaker et al. 2011). Changes in ice quality secondary to icebreaker travel would most likely impact communities during the early winter hunts for seals and polar bears. Icebreaking activity close to shore or to and from staging areas is of particular concern as it has the highest likelihood to intersect travel routes of local hunters.

Injury and trauma will continue to be a substantial public health concern, tempered primarily by the strong local search and rescue capacity, traditional knowledge and communication between hunters.

Summary

The main contributor to public safety impacts arising from Alternative 2 is the potential for water and ice safety issues during hunts. Water safety would be compromised should the dispersion of marine mammals occur, which will result in longer and riskier travel for subsistence activities.

Open water hunts for bowhead in the fall (occurring in Barrow, Kaktovik, Nuiqsut, and Wainwright) are likely to carry the greatest risk, along with greater travel for hunters in Point Lay if beluga are substantially dispersed from the lagoons.

The primary concern with regard to ice safety is if icebreaking activities were to result in disruption of sea access for winter hunting. Early winter hunting for seals and polar bears in areas of icebreaking could cause some increased risk, particularly during travel to and from hunting grounds. The limited amount of icebreaking activity and the separation of icebreaking from traditional hunting would minimize this risk, and the overall risk can be classified as minor. Additionally, the use of Com Centers (see Standard Mitigation Measure D2 in Section 4.5.3.2.3 for explanation) would reduce this risk.

Economic Impacts

Industrial development often impacts population health through changes to the economic environment. Income and employment are fundamental determinants of health (Cox et al. 2004). Increased income directly or indirectly resulting from oil and gas activity has the potential to reduce impacts to health in affected communities by raising the standard of living, reducing stress, and providing opportunities for personal growth and social relationships (ACPH 1999). Income and employment may also strengthen community and cultural ties by providing money to fund subsistence activities, the health effects of which are described above. Conversely, low-income increases risk of low birth weight babies, injuries, violence, most cancers, and chronic conditions (Yen and Syme 1999), and unemployment is associated with increased stress, depression, and anxiety, which are known contributors to cardiovascular disease (Doyle et al. 2005).

However, income and employment can also result in increased prevalence of social pathologies in some populations, including substance abuse, assault, domestic violence, as well as unintentional and intentional injuries. Fraternization of high-wage migratory workers with the local communities also has a tendency to increase rates of sexually transmitted infections in small communities (Goldenberg et al. 2008).

At present, most industrial activity in the study area has followed a model of enclave development with transient workers housed in camps in Deadhorse. Barrow provides most government and service jobs and has a mixed economy with a combination of wage employment and subsistence activities. Outside of

Barrow, most communities have a fairly traditional economy; although some communities have expressed a desire to see an increase in investment and jobs.

Although the rate of sexually transmitted infections in the NSB is high, the current focus on enclave development and isolation of most communities from transient workers is likely protective against exacerbation of these rates. Additionally, some Alaskan data support the argument that with strong social and political systems, income can be channeled to provide positive influences for a community, such as increased access to health care and educational opportunities (Haley 2004).

Summary

The economic benefits resulting from Alternative 2 are not great enough to anticipate measurable changes in health status at either the individual or community level and should be classified as negligible. Similarly, the adverse impacts of increased cash in a community (typically manifesting as the social pathologies described in Chapter 3) are not anticipated to result from the activity levels of Alternative 2.

The presence of transient workers in Wainwright may result in some increase in alcohol and drug use or sexually transmitted infections if transit times through the community are prolonged and fraternization with locals is allowed.

Health Care Services

Resource development projects around the world have demonstrated the potential for increased demand on local health and social services when workers migrate to an area or when the local burden of disease changes (Utzinger et al. 2004, Calain 2008, Barron et al. 2010). An influx of resource development workers into an area can strain local health resources for trauma, injuries, and illness. Resource development projects may also directly or indirectly cause the increase of certain conditions, including alcohol/drug-related issues, social pathology and increased rates of infectious disease (Utzinger et al. 2004, Goldenberg et al. 2008, Barron et al. 2010). If this increased demand exceeds the capacity of local services, then community health may be affected by reduced access to, and quality of, available health and social services (Calain 2008, Barron et al. 2010). However, resource development projects in some instances can improve local service provision in remote communities by providing additional tax revenue to local government (Calain 2008, Barron et al. 2010).

Outside of Barrow, healthcare provision in NSB communities is limited and has little capacity to deal with increased demand. Daily care and emergency services are provided by health care aides, and patients must either travel to see a physician or wait for a regularly scheduled physician visit. Acute injuries and trauma require local stabilization and air transfer to Barrow. These villages have little to no capacity to respond to increased demand or medical incidents. Barrow, which acts as the referral center for the NSB communities, has more adaptability and ability to respond should increased demand or an emergency occur (ASNA 2010). Search and rescue capacity, based out of Barrow, is strong.

Summary

Tax revenues from increased exploration activity in Alternative 2 may bolster the provision of health care services in the NSB; however, the impact would be negligible and would not be expected to result in any measurable change in population health outcomes. Acute care and search and rescue capacity in Barrow would be able to absorb any increase in demand that could be expected to result from illness and injury related to activity levels in Alternative 2.

Staging of crews in Wainwright could stress the limited resources of the local clinic, particularly if transit times through the community are prolonged, thereby potentially allowing for the spread of infectious disease. However, the most common way in which oil and gas crews interact with local health care facilities is as a result of injury, and the centralization of search and rescue operations in Barrow would minimize the impact on Wainwright's health care facilities.

4.5.3.3.2 Conclusion

The following table summarizes the public health and safety effects of Alternative 2. The definitions and rationale for each of the five criteria used can be found in Section 4.1.3 of this document.

Table 4.5-31 Summary of Effects on Public Health and Safety from Alternative 2

Impact Criterion	Effects Summary
Magnitude or intensity	Low: above background conditions, but within normal variation of human health conditions
Duration	Long-term: impacts would cause a change in that resource that would perpetuate even if the actions that caused the impacts were to cease
Geographic Extent	Regional: affects two or more communities in the EIS project area
Context	Unique: affects minority or low-income communities

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 2. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur, the duration of changes may be long-term , the geographic extent would be regional, as multiple communities could be affected, and the context would be unique.

4.5.3.4 Cultural Resources

This section describes potential impacts to cultural resources from each of the alternatives described in Chapter 2. The information presented below has been derived from a review of records on file with the Alaska Office of History and Archeology, which document previously recorded archaeological sites and the results of previous archaeological inventory efforts conducted within the vicinity of the EIS project area. These records largely concern on-shore resources. An appropriate level of investigation, including intensive on-shore and offshore surveys; evaluations of all resources potentially eligible for listing on the National Register of Historic Places; assessments of adverse effects; and applicable mitigation of identified impacts, would be completed before any potentially destructive activities could begin.

Activities associated with lease operations (exploratory drilling and site clearance high resolution seismic surveys) will only occur on active leases, along potential pipeline corridors, and on leases acquired in future lease sales (both federal and state). Seismic surveys not specifically associated with a lease (e.g., 2D and 3D surveys) would occur over large areas within the EIS project area, and could occur either on- or off-lease. Active State of Alaska leases occur in the Beaufort Sea from the coastline out to three nautical miles, except in the areas of Harrison Bay and Smith Bay, which are considered historical bays thus extending the area beyond three nautical miles from the coastline. Most of the State's active leases are concentrated between Harrison Bay and Bullen Point. There are currently no State of Alaska leases in the Chukchi Sea. As described in Section 3.3.1.1, several companies have conducted seismic and scientific surveys and exploratory drilling in 2012 on two lease tracts. In 2012, Shell commenced preliminary drilling activity at one well site on the Burger prospect. However, Shell announced in September 2015 it would seal the Burger well and would not conduct further drilling in the Arctic for the forseeable future (ADN 2015a). The USDOI also cancelled plans to put leases in the Beaufort and

Chukchi seas up for sale in 2016 and 2017, and did not give extentsions (5-year extensions) to existing leases held by Shell, ConocoPhillips Alaska, and Statoil in the Beaufort and Chukchi seas (ADN 2015b).

Future exploratory activities could include 2D and 3D seismic surveys, site clearance and high resolution shallow hazards survey, on-ice seismic surveys in the Beaufort Sea, exploratory drilling located in offshore portions of the Beaufort Sea, and exploratory drilling in the Chukchi Sea.

Seismic surveys and clearance and hazards surveys are conducted using towed arrays, in-ice arrays, and OBN seismic surveys. An OBC or OBN operation begins by laying cables or nodes connected by ropes off the back of a layout boat onto the seafloor, using line lengths of 4 to 6 km (2.5 to 3.7 mi) but occasionally up to 12 km (7.5 mi). Seismic-survey receivers (a combination of both hydrophones and vertical-motion geophones) are attached to the line in intervals of 12 to 50 m (39 to 164 ft.). Multiple cables or lines of nodes are laid on the seafloor parallel to each other, with a cable or line spacing of between hundreds of meters to several kilometers, depending on the geophysical objective of the seismic survey. When the cable or lines are in place, a vessel towing the source array passes over the cables or lines with the source being activated every 25 m (82 ft.). The source array may be a single or dual array of multiple airguns, which is similar to the 3D marine seismic survey. Laying an array of cables or receiver lines on the seabed could potentially adversely affect surface cultural resources, if any exist in that location.

Towed arrays or in-ice arrays demonstrate little or no potential to damage offshore archaeological resources. OBC and OBN seismic surveys could potentially impact both prehistoric and historic archaeological resources, because the cables or receivers are placed on the seafloor instead of towed behind a survey vessel.

Three principal forms of exploratory drilling platforms are currently used in offshore exploration: artificial or natural islands; bottom-founded structures; and floating vessels. Exploratory wells are generally drilled vertically to simplify well design and maximize benefits from subsurface data collection (e.g., well logs, cores). Directional wells (any well that is not vertical) may be drilled if a suitable surface location cannot be used or if there is a subsurface anomaly that should be avoided. Like seafloor seismic surveys, exploratory drilling potentially could impact both prehistoric and historic archaeological resources.

The level of impacts on cultural resources are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-32.

Table 4.5-32 Impact Criteria for Effects on Cultural Resources

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Disturbances in cultural resources may not be measurable or noticeable	**Medium**: Noticeable disturbances in cultural resources	**High**: Acute or obvious disturbance in cultural resources
Duration	**Temporary**: Impacts would be intermittent, infrequent, and typically last less than a month	**Interim**: Impacts would be frequent or extend for longer time periods (an entire project season)	**Long-Term**: Impacts would cause an enduring change in the resource that would perpetuate even if the actions that caused the impacts were to cease
Geographic Extent	**Local**: Affects cultural resources only locally	**Regional**: Affects cultural resources on a regional scale	**State-wide**: Affects cultural resources beyond a regional scale

Impact Component	Effects Summary		
Context	**Common**: Affects usual or ordinary resources; not depleted or protected by legislation	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Unique**: Affects unique resources or resources protected by legislation

4.5.3.4.1 Direct and Indirect Effects

Nearly all potential direct physical impacts to cultural resources would occur during the exploratory and construction phases of project activities. Cables or lines on the seafloor would disturb cultural resources on the surface of the seafloor, and any coring could affect buried archaeological sites (including geomorphological features) and paleontological resources. There could also be impacts resulting from ground-disturbing activities that encounter additional cultural materials that, based on previous archaeological studies, were either thought to occur only at the surface (on-shore resources) or were previously undetected because they were completely buried (onshore and offshore resources). Improved access to remote on-shore areas could also increase the likelihood of looting or other damage to archaeological properties during the construction and operation phases of the project. Another impact that could occur from construction of on-shore project facilities would be visual intrusion effects to potential traditional cultural properties.

Direct effects to archaeological resources include those activities that physically impact the condition or integrity of the resource. Sea-floor based seismic activities and exploratory drilling could directly affect submerged prehistoric sites or historic vessels on the seafloor.

Indirect effects to offshore resources are unlikely, given that impacts would likely result during the exploratory phase of the project. Previously undiscovered resources, however, could be inadvertently damaged during this phase of the project. On-shore resources are more susceptible to indirect effects and can include inadvertent damage, looting caused by the introduction of increased access and local activity; and visual impacts to historic or traditional cultural properties.

4.5.3.4.2 Conclusion

Compliance with existing federal, state, and local archaeological regulations and policies and the application of 30 CFR 550.194 regarding the protection of archaeological resources and 30 CFR 551.6 (a)(5) regarding G&G Explorations of the OCS and the provision to avoid disturbing archaeological resources, will reduce or eliminate most impacts to archaeological resources. Therefore, no impacts or only negligible impacts to archaeological resources are anticipated. To ensure compliance, prior to exploratory drilling of a well, lessees may be required to conduct surveys to detect archaeological resources. Lessees may also be required to conduct analyses and/or provide reports if proposed activities are of the type that have the potential to cause effects on historic properties. These surveys may be collected over portions of individual lease blocks or several contiguous lease blocks depending on the likelihood that historic or prehistoric resources may be present. These surveys would typically need to be completed at least one season in advance of a drilling operation. Alternatively, since it is difficult to assess effects in the absence of information, federal agencies may request archaeological reports of contiguous seismic areas or post-seismic archaeological reports rather than completion of a survey in advance of a drilling operation. Companies may also use high resolution geophysical equipment to survey off-lease areas for possible subsea pipeline routes. As a result of these studies, many submerged archaeological resources can be identified prior to seafloor disturbing activities and resources can be avoided.

Direct and indirect impacts to cultural resources resulting from the implementation of Alternative 2 would be low-intensity and interim in duration, but in a very local area and affecting resources that are common in context. Therefore, the summary impact level of Alternative 2 on cultural resources would be considered negligible.

4.5.3.5 Land and Water Ownership, Use, and Management

The level of impacts on land and water ownership, use, and management are based on levels of intensity, duration, geographic extent, and context, identified in Table 4.4-2 (Alternative 1).

4.5.3.5.1 Direct and Indirect Effects

Land and Water Ownership

Federal Ownership

Federal processes involved in seismic exploration and exploratory drilling (see Section 2.3.1) utilize leases and do not result in any change in existing leasing rights or the sale or transfer of any federal land or waters, and there is no anticipated direct or indirect change in underlying land or water ownership. This includes federal waters (from 3 to 200 nm), the ANWR, the NPR-A, Alaska Maritime National Wildlife Refuge, and Cape Krusenstern National Monument. Additional conditions may be attached to federal exploration activity authorizations and permits to avoid or mitigate adverse effects.

State Ownership

State processes involved in seismic exploration and exploratory drilling (see Section 2.3.1) utilize leases and do not result in any change in existing leasing rights, or the sale or transfer of any state land or waters. Therefore, there is no anticipated direct or indirect change in underlying land or water ownership. This includes state waters (shore to the 3 nm limit), state lands, and state selected lands. State land selections have already been established, and their conveyance would not be influenced by the implementation of this project alternative.

Private Ownership

The project does not involve any ANCSA corporation lands or Alaska Native allotments, and therefore no direct change in land ownership is expected. Support activities are anticipated to use existing facilities or new facilities built on private lands; however, no foreseeable indirect effects on land ownership would result. This private ownership includes Native corporation lands (village and regional [with some selections still under the ownership of the federal government]), and Native allotments. Alaska Native Corporation land selections have already been established, and their conveyance would not be influenced by the implementation of this project alternative.

Borough and Other Municipal Lands

The project does not involve or facilitate the sale or transfer of borough or municipal lands, and therefore no direct change in underlying municipal land or water ownership is expected. Likewise, since support activities are anticipated to use existing facilities or new facilities constructed on private lands, no foreseeable indirect effects on land ownership would result. This includes lands owned by the NSB and the NAB. No change in ownership is anticipated for other municipal lands. Municipal land selections have already been established, and their conveyance would not be influenced by the implementation of this project.

Land and Water Use

Recreation

Recreation occurs at generally low levels in the EIS project area. Key recreational activities include wildlife viewing and sightseeing from the air. Seismic exploration is already occurring in the EIS project area. Therefore, use conflicts would be low given the low level of recreation activity and existing exploration activities. Direct and indirect impacts on recreation are discussed in detail in Section 4.5.3.7.

Subsistence

Subsistence, which refers to harvest activities involving hunting, fishing, trapping, and gathering as a way of life, is a wide-spread land use throughout the EIS project area. Some seismic activities are already occurring in the EIS project area, utilizing standard mitigations described in Appendix E. Utilization of standard and additional mitigation would reduce the potential land conflicts with subsistence use, and would be considered low. Direct and indirect impacts on subsistence are discussed in detail in Section 4.5.3.2.

Industrial

Under Alternative 2, there is the potential for an increase in crew change and survey preparation activity in some areas as a result of increased ship traffic. If activity under this alternative requires the construction of new facilities such as a dock, warehouse, airstrip or other industrial facilities, zoning may change to accommodate the change in land use, and this is a direct impact. If a smaller community, such as Wainwright where no infrastructure yet exists, requires such construction, impacts would be considered more intense than in an area where such infrastructure is already found, such as Deadhorse, and depending on perspective, beneficial or adverse. Potential impacts would be low to medium, depending on the location. If activities under this alternative do not require new facilities or infrastructure or if only existing facilities are used, no direct or indirect impacts are expected.

Residential

There is the potential for an increase in the number of crew members and support staff in some areas as a result of the increase in ship traffic. Despite this, residential land use would not be affected because the activities under Alternative 2 are temporary and would not result in new permanent residents in need of housing.

Mining

This alternative would increase offshore exploratory and seismic activity; however the levels or extent of mining operations is not influenced by seismic exploration and would not result in any road construction or other infrastructure that would open new areas to mining. For this reason, no direct or indirect impacts are expected to affect mining land use in the EIS project area.

Protected Natural Areas

An increase in seismic exploration activity under Alternative 2 would have no expected direct or indirect impacts on wilderness areas or other protected natural land uses. There could be activities occurring offshore of designated wilderness in ANWR, but the land use is removed from areas of offshore seismic activity and exploratory drilling. In addition, such activities have occurred in the past. The primary potential for land use conflict would be associated with marine vessel and air traffic associated with crew changes and other support activities. Seismic and exploration activities as part of this alternative would be compatible with current protected land uses and compliant with the way they are currently managed. Impacts to lands designated as critical habitat, such as the LBCHU for ESA-listed spectacled eiders, were discussed in Section 4.5.2.3 Marine and Coastal Birds.

Transportation

Under Alternative 2, an increase in aircraft and vessel traffic along the North Slope is expected to and from the North Slope to transport people and supplies to support the survey vessels. If new docks and airstrips are needed to accommodate this increase, rezonings to industrial uses may result, as mentioned above. This increase in air and transportation use would occur primarily in areas that are currently being used for support activities such as Barrow, Deadhorse, Nome, and Dutch Harbor, and would constitute a minor increase in existing use. However, increases in transportation activity in Wainwright could constitute a moderate increase. No new roads or railroad lines are expected to be built under this alternative; therefore no changes are expected in land use to accommodate expanded land transportation systems.

Commercial

Under Alternative 2, an increase in seismic exploration would increase commercial activity associated with support activities. However, potential impacts to commercial land use are expected to be low because it would be temporary in nature, and no new facilities are likely to be built as a result of the project, with the possible exception of Wainwright, where the increase could be moderate. See Socioeconomic Section 4.5.3.1 for further discussion on employment opportunities under this alternative.

Land and Water Management

Federal Land and Water Management

BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS. The level of exploration activity in federal water under this alternative is consistent with management of the OCS. The USFWS submitted an updated version of the Comprehensive Conservation Plan for the Arctic National Wildlife Refuge in 2013, and a Record of Decision was issued in April 2015 to implement the plan (USFWS 2015b). The plan recommends the Brooks Range, Porcupine Plateau, and Coastal Plan Wilderness (1002 Area) to Congress for Wilderness designation. Seismic surveys, exploratory drilling, and leasing activities have been ongoing in the Beaufort and Chukchi seas for over 30 years, and their occurrence is already well established and not newly introduced by this project. Consequently, they are already part of the existing regulatory environment known in the area. Based on this, no inconsistencies or changes in federal land or water management are anticipated to result from this alternative, including federal waters (from 3 to 200 nm), Alaska Maritime National Wildlife Refuge, National Petroleum Reserve-Alaska, and Cape Krusenstern National Monument.

State Land and Water Management

The state prepares Best Interest Findings before allowing seismic exploration activities on state lands and waters, and each proposed activity must demonstrate individual consistency with state management policies before permits are issued on state lands or waters. Permitted exploration activities are consistent with the management of state waters. Therefore, no inconsistencies or changes in state land or waters management are anticipated as a result of this alternative. This includes state waters (shore to the three nautical mile limit), Area Plans, and lands subject to oil and gas lease sales.

Borough and Municipal Land and Water Management

While the level of exploration activity may increase under this alternative, no change in underlying land or water management is anticipated as a result of this project. This includes community planning, and the NSB and NAB comprehensive plans. The NSB Zoning ordinance (Title 19.70), in particular, includes policies related to offshore development and coastal management. However, compliance with local land management regulations within state and federal waters is undertaken on a voluntary basis. As indicated in Section 3.3.5.3 State Waters Managment, the Alaska Coastal Management Program was not reauthorized by the state legislature and has not been in effect since 2011. The NSB and NAB may recommend mitigation measures and permit/authorization conditions in response to new land-based projects proposed within its jurisdiction.

Private Land Management

Alaska Native corporation lands that could provide support for offshore oil and gas activities. This would apply to lands intended to provide support activities primarily in Wainwright, where there has been discussion of developing marine support facilities, and potentially in Barrow.

4.5.3.5.2 Conclusion

Based on Table 4.4-2, and the analysis provided above, there would be no direct or indirect impacts on land and water ownership under Alternative 2.

Based on Table 4.4-2 and the analysis provided above, the impacts of land and water use caused by Alternative 2 are described as follows. The magnitude of impact would be high where activity occurs in areas of little to no previous activity (such as Wainwright), and the magnitude of impact would be low where activity occurs in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be interim if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 2 on land and water use would be moderate because of the possibility for high intensity impact and interim structures in smaller communities.

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water management caused by Alternative 2 are described as follows. The magnitude of impact would be low because the action is consistent with existing management plans, subject to conditions of approval. The duration of impact would be interim because project activities would last an entire project season, but would not result in long-term conflicts with management plans. The extent of impacts would be local because proposed activities would not involve management plans beyond the local areas of exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 2 on land and water management would be negligible because they would be low intensity, temporary in nature, local, and common.

4.5.3.6 Transportation

The direct and indirect impacts for transportation are described by mode. Activity levels under Alternative 2 for seismic exploration and exploratory drilling in the EIS project area would increase, thereby influencing air, surface, and marine traffic.

The level of impacts on transportation are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-33.

Table 4.5-33 Impact Criteria for Effects on Transportation

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Change in transportation volume may not be measurable or noticeable	**Medium**: Noticeable change in transportation volume	**High**: Acute or obvious change in transportation volume
Duration	**Temporary**: Impacts would be intermittent, infrequent, and typically last less than a month	**Interim**: Impacts would be frequent or extended for longer time periods (an entire project season)	**Long-term:** Impacts would cause a permanent change in the recourse the would perpetuate even if the actions that caused the impacts were to cease
Geographic Extent	**Local**: Affects transportation volume only locally	**Regional**: Affects transportation volume on a regional scale	**State-wide**: Affects transportation volume beyond a regional scale
Context	**Common**: Affects usual or ordinary transportation opportunities and constraints	**Important**: Affects transportation opportunities and constraints within the locality or region protected by legislation	**Unique**: Affects unique transportation opportunities and constraints

4.5.3.6.1 Direct and Indirect Effects

Air Transportation

The levels of commercial and private aircraft transportation that currently exist within the coastal communities of the project area and the Prudhoe Bay area (including Deadhorse) are likely to continue at existing levels, as described in Section 3.3.6. Air traffic would increase, as associated with the programs listed in Table 2.4 in Chapter 2. The level and pattern of increase would be affected by the number of source and support vessels, the types of sound sources used, time periods when the activity could occur, number of days of active operations, and size of the program activity area. Increased levels of air traffic activity could require construction of new airstrips or hangars/warehouses or modifications to existing facilities.

Exploratory drilling located in offshore portions of the Beaufort Sea would likely occur initially in areas offshore of Camden Bay in the eastern portion of the Beaufort Sea during the initial year of this EIS's analysis window. For Beaufort Sea operations, it is expected that support flights would originate in Barrow, Deadhorse, or Prudhoe Bay. Helicopters stationed at Barrow would provide emergency or search and rescue (SAR) support, as needed. Exploratory drilling in the Beaufort Sea is assumed to include the use of helicopters (4 to 12 air operations per week) to provide support for crew changes, provision resupply, and SAR operations for each drilling program. Fixed winged aircraft operating daily out of Barrow or Deadhorse would support marine mammal monitoring and scientific investigations.

Exploratory drilling in the Chukchi Sea would likely occur initially in areas on federal leases for which exploration plans have recently been submitted or expected to be submitted during the timeframe of this EIS, and where there have been recent requests to authorize ancillary activities. For surveys in the Chukchi Sea, air support operations would occur primarily out of Nome but could also occur out of Wainwright and/or Barrow. Exploratory drilling in the Chukchi Sea is assumed to require up to 24 air operations per week, for transit from Wainwright or Barrow to each of the drilling sites. For emergencies, SAR helicopters would operate out of Barrow.

The increased levels of air traffic that result from activities under Alternative 2 are considered to be a direct impact to existing local and regional transportation. Air travel that is necessary to support seismic surveys and exploration drilling programs would be required to comply with the required mitigation measures in order to conduct aerial monitoring for marine mammals and provide flights in support of crew changes, expansion of shore based infrastructure, and for lightering supplies to offshore support vessels.

Aircraft overflights associated with oil and gas seismic surveys and exploratory activities would occur in the nearshore areas of the Beaufort and Chukchi seas. Aircraft traffic associated with seismic surveys and exploratory drilling would likely be limited to an area where infrastructure for air traffic/commercial travel already exists (e.g., Prudhoe Bay, Barrow and potentially Wainwright). The levels of aircraft using Prudhoe Bay, Barrow, and Wainwright shore based infrastructure may increase for short durations while offshore seismic survey and exploratory drilling operations are occurring. A limited fleet of industry support aircraft would use existing airport infrastructure and is unlikely to interrupt the patterns of existing air traffic or strain the capacity of existing carriers within the region. It is possible but unlikely that increased aircraft use would require construction of new infrastructure.

Subsistence users have noted that aircraft overflights can disturb subsistence resources making it more difficult for hunters to obtain these resources. Aircraft disturbance in caribou migratory pathways from industry operations and recreational hunters (tourism) near the coast has been observed:

> *"We have a lot of air traffic, not just from the oil companies but from tourist stuff going on. Hunters traveling along the coast, too, so we we're having to deal with that on top of the helicopters and stuff doing their routes to Point Thompson already. They're flying in the same migration -- or the times as the migration of the caribou and stuff, and I'd just really hate to see more of it happen because I think it's going to -- the cumulative impact is going to have a great negative impact on our community." –* As commented by Carla Sims Kayotuk at the Kaktovik Public Scoping Meeting for this EIS, March 12, 2010.

> *"These are our only times during the summer [on calm days] that we have access to hunting caribou that go down to the coast. If activity, support activity, such as aircraft or helicopters or other support activities are near the coast -- and we have many people that can make oral statements that during the summer when they're getting close to caribou, either a small plane or helicopter show up and drive the caribou further inland".* As commented by Fenton Rexford, representing Native Village of Kaktovik at the Kaktovik Public Scoping Meeting for this EIS, March 12, 2010.

Surface Transportation

Increased use of airstrips and docks by aircraft and vessels under Alternative 2 would require ground support to transfer passengers and supplies, refuel aircraft and vessels, or provide other support that would increase vehicle traffic on local roadways. Additionally, increased use of aviation and vessel fuel could result in overland shipments of fuel via trucks on ice roads or by Rolligons.

The on-ice seismic survey that would be permitted under this alternative would likely require the construction of ice roads for surface transportation. Transportation of supplies and crews would occur via winter ice roads and are expected to originate from the Prudhoe Bay area. Therefore, there would be no direct or indirect impact from aircraft overflights in the winter. Construction of ice roads and equipment traveling the roads could disturb marine mammals during January to May exploration activities.

Marine Transportation

The levels of local marine vessel traffic are expected to continue at their present rate, as described in Section 3.3.6. This includes localized small vessel, tug, and barge traffic between the communities located near the Beaufort and Chukchi seas. Vessel traffic in nearshore coastal waterways encompasses sealift and tug/barge traffic to and from the Prudhoe Bay area, and through the eastern Beaufort Sea towards Canada. Activities proposed under Alternative 2 would result in an increase in the present levels of vessel traffic in the nearshore waters and in the offshore areas of the Beaufort and Chukchi seas.

It is assumed that marine-based support for seismic surveys, shallow hazard surveys, and support vessel traffic would increase, and Beaufort Sea operations would originate from the West Dock area, or Oliktok Dock near Prudhoe Bay. For seismic surveys in the Chukchi Sea, vessel-support operations, including crew changes, would occur primarily out of Nome, and possibly Barrow or Wainwright as well. Increased vessel activity could result in the need for new or improved docks and other marine related infrastructure along the coast.

Chase/monitoring vessels would provide transport for crew changes and resupply, as well as for acoustic study and marine mammal monitoring support. They would also assist in ice management operations if required. These vessels would not introduce sounds into the water beyond those associated with standard vessel operations. These activities could occur several times during a season, involving transit to onshore support areas.

Vessel traffic associated with exploratory drilling in offshore portions of the Beaufort Sea would likely occur initially in areas offshore of Camden Bay in the eastern portion of the Beaufort Sea during the initial year of this EIS' analysis window. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions of increased vessel traffic related to exploratory drilling in the Beaufort Sea would include:

- For each exploratory drilling program, a drillship with up to 11 support vessels would be deployed that would be used for ice management, anchor handling, oil spill response, refueling, resupply, and servicing the drilling operations. The ice management vessels will consist of an icebreaker and anchor handler.
- At the start of the program, the drillship and support vessels would transit the Bering Strait into the Chukchi Sea, and then transit further on to the Beaufort Sea drill site(s). Vessels could transit from marine bases in the Canadian Beaufort Sea (e.g., Tuktoyaktuk) or Russian Arctic.
- Timing of operations would commence on or after approximately July 1 and typically end by early November.
- Drilling could occur on multiple drill sites per drilling program per year with the analysis assumption being up to three wells drilled per program per year.
- Resupply vessels would operate from both Dutch Harbor (using ocean going vessels) and West Dock at Prudhoe Bay using a coastwise qualified vessel. Ten resupply trips per drilling program are estimated.
- At the end of the drilling season, the drillship and associated support vessels would exit the area by traveling west into and through the Chukchi Sea.

Under Alternative 2 the exploratory drilling programs in the Chukchi Sea would likely occur initially in areas on federal leases for which exploration plans have recently been submitted and where there have been recent requests to approve ancillary activities. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for vessels associated with the exploratory drilling in the Chukchi Sea would include:

- For each exploratory drilling program, a drillship or jackup rig with six to eight support vessels would be deployed. Support vessels would be used for ice management, anchor handling, oil spill response, refueling, resupply, and servicing the drilling operations. The ice management vessels would consist of an icebreaker and anchor handler. Oil spill response vessels would be staged near the drillship or jackup rig. The icebreaker and anchor handler would be staged away from the drill site when not in use but would move closer to perform duties when needed.

- Drillship and support vessels would be deployed on or about July 1, traveling from Dutch Harbor, Alaska, through the Bering Sea, or from the east through the Beaufort Sea from marine bases in the Canadian Beaufort Sea (e.g., Tuktoyaktuk), arriving on location in the Chukchi Sea in early July.
- Timing of drilling operations would commence soon after arriving at the drill site in early July and typically end by early November.
- Drilling could occur on multiple drill sites with up to four wells drilled per drilling program per year.
- Marine resupply vessels would operate between the drill sites and Dutch Harbor or Wainwright. Ten resupply trips per drilling program are estimated.
- At the end of the drilling season, the drillship or jackup rig, and associated support vessels will transit south out of the Chukchi Sea.

Marine vessel traffic has been noted by residents to impact subsistence bowhead hunters as a result of whales being deflected from the area, thereby limiting potential strike opportunities for subsistence harvest. Subsistence bowhead hunters voiced concern during the scoping process for this EIS that impacts of increased vessel traffic, and regulating vessel traffic, be a part of mitigation. This is so that interference from vessel traffic does not disturb hunting activities. A North Slope resident noted that past and existing levels of barge traffic have led to disturbance:

> *I've seen barge activity that's over the past 15 years diverted bowhead whales. As a whaler, I've seen it all my life.* As commented by Thomas Napageak, Jr. at the Nuiqsut Public Scoping Meeting for this EIS, March 11, 2010.

Shipping routes through the Bering Straits and into the Beaufort and Chukchi seas are similar to the routes of migratory marine mammals. There is a remote possibility that vessel collisions that result in the death or serious injury of marine mammals could occur as a result of increased vessel traffic in the project area. At present there are relatively few known incidents of Arctic or ice-adapted marine mammal species being involved in ship strikes (Arctic Council 2009). The relatively infrequent occurrence is likely a result of low vessel traffic in high latitudes as compared to major trading routes and human population centers in lower latitudes (Arctic Council 2009). However, an increase in the number of ships transiting the Bering Straits (considered a bottleneck for Arctic shipping routes) could be expected to increase the likelihood of ship strikes.

4.5.3.6.2 Conclusion

Under Alternative 2 there would be an increase in the level of air traffic in the regional air transportation system. However, the increase in air traffic to regional transportation would be of low intensity, and the duration would be interim (length of survey or exploratory drilling activities for the entire project season). The impacts would be local in extent and affect resources that are considered common in context. As a result, the impact of increased aircraft traffic by implementing Alternative 2 would be considered negligible.

Only one on-ice seismic survey would be permitted in the Beaufort Sea under this alternative. While surface travel via snowmachine is a method of transportation during the winter months, it is unlikely that there would be a direct impact to surface transportation routes between coastal communities as the on-ice survey would occur in a very local area. Impacts to surface transportation via ice roads would be characterized as a low intensity, limited in spatial extent, interim in duration (length of project season) affecting a resource that is common in context. Increased vehicle traffic on local roadways would also be characterized as interim, and affecting a resource that is common in context. The impact is considered negligible.

The increase in vessel traffic as a result of seismic and exploratory drilling operations in Alternative 2 would be a direct impact to the existing levels of vessel traffic in the Beaufort and Chukchi seas. Considering the standard and additional mitigation measures, direct impacts from increased vessel traffic in these seas would be interim and occur regionally. The intensity of increased marine vessel traffic is considered medium, as it would be interim in duration, regional in extent, and common in context. The implementation of Alternative 2 would be unlikely to adversely affect existing nearshore transportation or displace current levels of marine transportation. Direct and indirect impacts on regional vessel transportation would be of low intensity, interim in duration, regional in extent, and affecting resources that are common in context. Direct impacts from the anticipated increases in vessel traffic are considered minor.

4.5.3.7 Recreation and Tourism

Recreation and tourism occur at generally low levels of use in the EIS project area and are more common onshore (hiking, river float trips) than offshore (small cruise ships, kayaking). It is important to distinguish between recreation and subsistence uses. The vast majority of fishing, hunting, and boating that occurs in the project area are *subsistence*-based, managed completely apart from *recreation*-based activities, with separate rights and privileges (see Section 4.5.3.2, Subsistence for further discussion). This section discusses only recreation-based activities, a small portion of the human uses in the area.

The direct and indirect impacts for recreation and tourism will be described by setting and activities. Activity levels for seismic exploration and exploratory drilling in the EIS project area would increase; however, recreation in the area is generally low and is not expected to be considerably impacted.

The level of impacts on recreation and tourism are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-34.

Table 4.5-34 Impact Criteria for Effects on Recreation and Tourism

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Changes in recreation setting or activities may not be measurable or noticeable	**Medium**: Noticeable changes in recreation setting or activities	**High**: Acute or obvious changes in recreation setting or activities
Duration	**Temporary**: Changes in recreation setting or activities last less than one month	**Interim**: Changes in recreation setting or activities extend an entire season	**Long-term**: Changes in recreation setting or activities persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects recreation setting or activities only locally	**Regional**: Affects recreation setting or activities on a regional scale	**State-wide**: Affects recreation setting or activities beyond a regional scale
Context	**Common**: Affects usual or ordinary recreation opportunities and constraints	**Important**: Affects recreation opportunities and constraints within the locality or region protected by legislation	**Unique**: Affects unique recreation opportunities and constraints

4.5.3.7.1 Direct and Indirect Effects

Setting

As indicated in Section 3.3.7.1, the area is largely undeveloped, with low population levels and few facilities to accommodate recreation and tourism. The setting for recreation and tourism could potentially be impacted by Alternative 2. The primary direct impact would be on the recreation setting and the visitor experience of that setting. The presence of industrial vessels or drilling rigs could alter the experience of the setting or the sense of place (Williams & Stewart 1998); visitor expectations for a fairly isolated and undeveloped recreation setting would not be met. The expectation for an isolated and undeveloped setting could be held by people traversing the project area in personal vessels or commercial tours.

Implementation of Alternative 2 could have a potential indirect impact on the recreation setting including impacts on existence and bequest values (Schuster et al. 2005). Existence value refers to the knowledge that a particular resource exists and an emotional attachment to the resource is held, even if the place is never visited in person (Cordell et al. 2003, Rolston 1985) and bequest value refers to a desire to bequeath a natural resource to future generations (Cordell et al. 2003, Rolston 1985). A person who does not physically recreate in the EIS project area could hold existence or bequest values related to the Arctic Ocean environment. An increase in oil and gas exploration in the area would alter the recreation setting from a primitive or undeveloped setting to a developed setting with industrial activity. The experience of the recreation setting would also likely be altered, including the experience of recreationists that hold existence and bequest values related to the Arctic Ocean environment.

Activities

Under Alternative 2, little direct or indirect impact is expected on recreation activities. Offshore wildlife viewing may be impacted by an increase in survey vessels or drilling rigs if wildlife avoids these vessels or industrial sites. Nearshore recreation activities are generally engaged in by residents of local communities, and levels of activity are low compared to subsistence activities as discussed in Section 3.3.7.2; little impact is expected on levels or types of recreation use. Recreation activities could also be displaced; recreationists may avoid areas during the period seismic survey and exploratory drilling programs are taking place, choosing instead to recreate someplace else to avoid project activities. While exploration program activities would occur during a season, they would not be continuous during the season.

Under Alternative 2, one on-ice seismic survey per year is expected in the Beaufort Sea; recreation use is more probable in the vicinity of the existing leases in the Beaufort Sea. Recreation uses would not likely occur near the lease sales in the Chukchi Sea, as they are much farther offshore. The on-ice survey would not likely impact recreation activities in the project area as it would not occur during the visitor season.

4.5.3.7.2 Conclusion

Based on the criteria given in Section 4.1.3, the intensity of direct and indirect effects on recreation and tourism are expected to be low; the alternative would not noticeably alter recreation in the EIS project area. Direct impacts to the recreation setting would be interim as they would last only for the duration of the survey season or exploratory drilling program. Indirect impacts to existence and bequest values would be interim; the survey activity or exploratory drilling would affect the setting for the length of the seismic or drilling program. The direct impacts to visitor setting would be local, and limited to the area where the project activity is taking place. Indirect impacts to existence and bequest values would be considered state-wide (and potentially nationally or internationally) based on the criteria because recreationists beyond the EIS project area could hold existence and bequest values for the area. Recreation opportunities are not scarce in the project area and are not protected by legislation. Therefore recreation and tourism would be considered common in context.

The direct impacts would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 2 on recreation and tourism would be minor.

4.5.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 2 of the proposed project.

The level of impacts on visual resources are based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-35.

Table 4.5-35 Impact Criteria for Effects on Visual Resources

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Disturbances in visual resources may not be measurable or noticeable resulting from weak visual contrast.	**Medium**: Noticeable disturbances in visual resources resulting from moderate visual contrast.	**High**: Acute or obvious disturbance in visual resources resulting from high visual contrast.
Duration	**Temporary**: Disturbances in visual resources would be intermittent, infrequent, and typically last less than one month.	**Interim**: Disturbances in visual resources would be frequent or extend for long time periods, such as an entire project season.	**Long-Term**: Disturbances in visual resources would be permanent and persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects cultural visual only locally	**Regional**: Affects visual resources on a regional scale	**State-wide**: Affects visual resources beyond a regional scale
Context	**Common**: Affects usual or ordinary visual resources; not protected by legislation	**Important**: Affects visual resources within the locality or region or resources protected by legislation	**Unique**: Affects unique visual resources or resources protected by legislation

4.5.3.8.1 Impact Assessment Methodology

The analysis area for visual resources includes onshore and offshore areas. Onshore areas include Alaska Native communities located along the shoreline between Kotzebue, on the western side of the Arctic Coastal Plain (ACP), across the northern edge of the ACP to the U.S.-Canadian border. This portion of the analysis area was established to assess views of the EIS project area from these locations. Offshore areas include the Beaufort Sea, located north of the ACP, between Point Borrow and the U.S.-Canadian border, and the Chukchi Sea, located between Point Borrow and Kotzebue. Both the Beaufort and the Chukchi seas are located in the Arctic Ocean. The geographic extent of the offshore portion of the analysis area was defined by the EIS project area.

Potential impacts to visual resources that may result from the proposed project were measured by the estimated level of visual contrast created by the project.Additional qualitative indicators included the expected level of change to the existing landscape aesthetic, such as movement, activity (measured in terms of change in vehicular traffic and amount of people), noise, or naturalness.

Methods for determining the anticipated level of contrast were developed based on the BLM's Contrast Rating procedure (BLM 1986). This method assumes that the extent to which the project results in adverse effects to visual resources is a function of the visual contrast between the project and the existing landscape character. Impact determinations are typically based on the level of contrast identified using visual simulations and are not a measure of the overall attractiveness of the project. As no visual simulations were prepared for the proposed project, the level of contrast has been estimated based on analysis factors, including: distance from the project; predominant angle of observation; dominant use (i.e., recreation, subsistence, industry); and duration of typical views. Contrast was evaluated using the basic components of form, line, color, and texture. The levels of contrast are defined as follows:

- ***None*:** The element contrast is not visible or perceived.
- ***Weak*:** The element contrast can be seen but does not attract attention.
- ***Moderate*:** The element contrast begins to attract attention and begins to dominate the characteristic landscape.
- ***Strong*:** The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

An overall impact determination was made based on the anticipated contrast, the duration and geographic extent of affected views, and context of the proposed action.

Effect determinations were based on the parameters listed below:

NO EFFECT would occur if the facilities would be isolated, not noticed in the view, most often seen from background distance zones, temporary, or where no visually sensitive resources would be affected.

Effect would be considered **MINOR** where project components would result in weak contrast against the existing landscape; where project design is consistent with existing planning goals, temporary, and/or where viewers located in the background (5 to 15 miles) distance zone would be affected.

Effect would be considered **MODERATE** where project components would result in moderate contrast against the existing landscape; where project design is not consistent with existing planning goals, temporary or long-term, and where viewers located in the foreground/middle ground distance zones (5 to 8 km [3 to 5 mi]) would be affected.

Effect would be considered **MAJOR** where project components would result in strong contrast against the existing landscape; where project design is not consistent with existing planning goals, interim or long-term, and where viewers located in the immediate foreground (<5 km [3 mi]) and foreground/middle ground distance zones (5 to 8 km [3 to 5 mi]) would be affected.

The following assumptions were used when analyzing effects of the project on visual resources:

All the potential operations-related impacts to visual resources that were examined as part of each Action Alternative analysis are considered interim impacts and would not extend beyond the life of the EIS.The assessment of construction-related impacts was limited to actions associated with exploratory drilling. Because open water / on-ice seismic surveys and hazard surveys do not require construction of facilities (i.e., artificial islands, jackup rigs), construction-related impacts do not pertain to these actions and are not considered in this analysis.

For the purposes of this analysis and for comparison of alternatives, it is assumed that all vessels and project-related infrastructure (i.e., drill sites) would be removed at the end of the permit cycle.

It is assumed that existing roads would be used to transport material used to construct artificial-islands if obtained from on-land quarries. It is further assumed that no new quarries would be constructed to support this action.

The effect determination was based on the highest impact identified across all portions of the analysis area.

4.5.3.8.2 Direct and Indirect Effects

Alternative 2 would include vessel-based surveys implemented in the Beaufort and Chukchi seas, and a single exploratory drilling program in both the Beaufort and Chukchi seas. Project-related actions would primarily be seen by residents of communities in the project, extending from Kivalina to the Canadian border (including the ANWR), should exploration activities occur within viewing distance of potential affective communities or offshore subsistence harvest activities. Due to the distances between potential affected communities and where offshore activities are taking place, views of the proposed project in the Chukchi Sea would be restricted to those of industrial workers or commercial marine traffic occurring in offshore locations in the Chukchi Sea and would generally not be detected by any viewer groups located in on-land or near-shore locations, with two potential exceptions (see Section 3.3.8.4 for a description of viewer groups). Vessel and aircraft traffic associated with crew changes could be temporarily be visible, as could be shallow hazard vessel surveys along potential pipeline routes as those activities get closer to shore. The degree of project-related visual contrast will depend on site-specific factors, including: viewer distance; viewer's angle of observation; duration of their view; and atmospheric conditions. It is assumed for the purposes of this analysis that the landscape/seascape type is described as a large-scale panoramic. Landscape analysis factors are summarized for both the Beaufort and Chukchi seas in Table 4.5-36.

Table 4.5-36 Description of Analysis Factors by Sea

	Beaufort Sea	Chukchi Sea
Distance from Project	Up to approximately 50 miles	>50 miles
Predominant Angle of Observation	Variable within a 180º arc	Variable within a 180º arc
Dominant Land Use	On land and near shore Industrial near Prudhoe Bay; residential/commercial near communities; predominantly undeveloped On-land ANWR and between communities	Predominantly Undeveloped, but including the NPRA[1] on shore
Duration of View	Prolonged, but short-term	Prolonged, but short-term

Notes:

1) NPRA = National Petroleum Reserve Alaska

Because predominant viewer distance in the Chukchi Sea is greater than 80 km (50 mi), it is assumed that the project would not be detected when viewed from this vantage point. Viewers situated in onland and nearshore areas of the Chukchi Sea (i.e., Cape Krusenstern National Monument, or the Alaska Native communities of Wainwright, Point Lay, Point Hope, Kivalina, or Kotzebue) may experience views of survey vessels and/or support vessels transiting to/from the proposed EIS project area via the Bering Straits or within the Chukchi Sea for resupply trips. Operations-related survey vessel traffic occurring in the Chukchi Sea is expected to be seen only by industrial workers stationed offshore. In both cases, viewing of transiting and operations-related vessels would be temporary and local and therefore is not considered further in this analysis.

The operation of survey and support vessels would not return to the surveyed area once work is completed. Operations-related vessel traffic would be transient, restricted to short time periods, and occur in local areas. For these reasons, the operation of survey and support vessels is expected to result in an overall weak visual contrast where actions occur at close proximity (within Foreground-Middleground [FM] zone) to on-land and near-shore locations for state waters of the Beaufort Sea. Visual contrast is expected to attenuate beyond 8 km (5 mi) due to the scale of the vessels relative to the landscape and the transient nature of the proposed action.

The exploratory drilling program included in this alternative would include deployment, operation, and disembarking phases. Deployment-related impacts to visual resources and scenic quality would vary based on the type of infrastructure used to support the well. For example, drillships and jack-up rigs can be erected on site with no sea bottom preparation; however structures such as artificial islands or caisson-retained islands would require dredging and transport to the drill site to establish the foundation for the drilling unit. Exploratory drilling in federal waters of the Beaufort and Chukchi seas would be implemented using a drillship, or a jackup rig, and consequently no deployment-related impacts to visual resources are expected.

Deployment-related impacts may occur as part of exploratory drilling programs situated in state waters (located within 5 km [3 mi]) of the Beaufort Sea. It is assumed that an artificial island would be used to support exploratory drilling and that this facility would be constructed between Harrison Bay and Bullen Point. This geographic area includes the Alaska Native community of Nuiqsut and the industrial centers of Deadhorse and Prudhoe Bay. Deployment-related actions would result in a temporary increase in marine barge, vehicle, and potentially air traffic around localized drill site(s). Such actions would contribute color, angular lines, and movement to the landscape; however, because oil and gas activity is underway in this area, change in visual resources and scenic quality as a result of construction of drill site(s) is not expected to create visual contrast or attract attention of the casual observer. It is assumed that actions associated with decommissioning of the ice island would be similar to those incurred during construction.

During the operational phase, the overall moderate visual contrast may result from operation of drill sites, particularly where situated within five miles of viewers. Each drill site would require up to eleven support vessels, resulting in a noticeable increase in industrial marine traffic from this distance. The greatest contrast is expected to occur during summer daylight conditions, or during winter months when periods of low-light may result in a bold silhouette of the facility due to back-lighting. During periods of darkness, facility lighting could be detected up to and beyond the background distance zone (24 km [15 mi]). Like vessel traffic, visual contrast of drilling facilities (i.e., ice islands) and lighting would be maximized where viewed from proximate locations and would attenuate with distance from the viewer. Project-related actions in the nearshore Beaufort Sea could be viewed by both viewers from the Alaska Native community of Nuiqsut and viewers located in the industrial centers of Deadhorse and Prudhoe Bay.

4.5.3.8.3 Conclusion

In conclusion, implementation of Alternative 2 is expected to result in moderate effects to scenic quality and visual resources. However, potential impacts could be of low to medium intensity depending on specific location of drill sites, as visual contrast of these actions would attenuate with distance. The geographic extent of potential impacts would be local, as actions are not expected to be detectable beyond the project area; however they could affect an important resource in the ANWR.

4.5.3.9 Environmental Justice

The coastal communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue are predominantly Alaska Native communities. Nome also has a substantial Alaska Native population. In the analysis of environmental effects (including human health, economic and social effects), there is the requirement under Executive Order 12898 to identify and address “disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” Therefore, the purpose of this section is to analyze potential impacts to these communities and their sociocultural systems resulting from the implementation of the alternatives.

Scoping comments (Appendix C) regarding environmental justice included:

- Ensure the requirements of Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority and Low-Income Populations) are being met;
- Evaluation of any disproportionate impacts placed upon the Iñupiat people should take into account the unique interests of local Iñupiat communities; and
- Particular attention must be given to consideration of the dependence of local communities on local and regional subsistence resources, access to those resources, and perception of the quality of those resources.

The discharges associated with Alternative 2 that could impact human health and subsistence resources are detailed in Chapter 2. These may include wastes from exploration drilling, deck drainage, platform discharges, air emissions, human discharges from vessels, and/or non-permitted releases and minor oil spills. Displacement of subsistence resources or disruption of subsistence activities associated with noise and vessel traffic are described in Chapter 2, Marine Mammals Section 4.5.2.4, and Subsistence Section 4.5.3.2.

4.5.3.9.1 Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

As described in the Subsistence Section 4.5.3.2, the seismic surveys, overflights, vessel traffic, and icebreaking activities associated with Alternative 2 would have a low intensity impact on subsistence resources and be temporary to interim in duration. Impacts would be local to regional in extent and affect resources that range from common (fish) to important (marine mammals) in context. Standard and additional mitigation measures for activity levels associated with Alternative 2 are not expected to make resources unavailable for harvest or substantially alter the existing levels of harvest.

As described in the Public Health Section 4.5.3.3 activities associated with Alternative 2 are not expected to have a substantial impact on the numbers of marine mammals harvested in any community in the study area. Dispersion of some animals may result in greater travel time, cost, and safety risk to the hunters, but not overall availability or consumption of traditional foods. A variety of health indicators affected by Alternative 2 activities would have a low intensity impact on human health because possible changes to health outcomes (e.g., chronic disease and trauma) would be above background conditions but within normal variation. Health changes may be long-term and multiple communities could be affected for a regional extent. Alternative 2 may have an indirect effect of adding to the perception that subsistence foods are contaminated and alter confidence in their consumption, affecting diet and nutrition. However, increased contamination levels in subsistence food sources are likely to be negligible.

4.5.3.9.2 Conclusion

Environmental justice analysis considers impacts to subsistence, sociocultural systems, and public health. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Alternative 2 is expected to have a minor impact to subsistence resources and a minor impact to public health. Alternative 2 with Standard Mitigation Measures would also create some local employment and economic support activities, and would reduce adverse effects. There would be an overall minor impact to Alaska Native communities under Alternative 2.

4.5.3.10 Standard Mitigation Measures for the Social Environment

Standard and Additional Mitigation Measures are outlined in Sections 2.4.10 and 2.4.11, respectively, and described in Appendix E. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. A combination of these measures could be required for any one ITA. While the ultimate goal of the mitigation measures is to reduce adverse impacts to marine mammals and subsistence hunts of marine mammals, some of the mitigation measures have the potential to impact resources within the social environment. For example, the requirement to hire PSOs and establish Com Centers will create jobs on the North Slope. Sections 4.5.2.4.16 and 4.5.2.4.17 provide discussion and analysis of the standard and additional mitigation measures aimed at reducing impacts to marine mammals, and Sections 4.5.3.2.3 and 4.5.3.2.5 provide discussion and analysis of the standard and additional mitigation measures aimed at reducing impacts to subsistence hunts. Those analyses include a discussion of potential economic impacts as well, and those discussions are not repeated here.

4.6 Direct and Indirect Effects for Alternative 3 – Authorization for Level 2 Exploration Activity

4.6.1 Physical Environment

4.6.1.1 Physical Oceanography

4.6.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

Under Alternative 3, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled. Relative to Alternative 2, water depth would be affected over a larger area. The effects of Alternative 3 on water depth would be low-intensity, long-term, and would affect a common resource. Changes in water depth from discharged material would have only minor effects on the physical resource character of the proposed action area. Although common resources would be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 3 on water depth would be minor.

Currents, Upwellings, and Eddies

Seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys would have only negligible effects on currents, upwellings, and eddies within the EIS project area under Alternative 3. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 3, would result in medium-intensity, temporary or long-term (temporary if ice or long-term if gravel), local effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial islands are constructed to support exploratory drilling activities. Exploratory drilling activities in the Chukchi Sea are anticipated to occur from temporary structures, as opposed to artificial islands that could be built in the Beaufort Sea. Therefore, exploratory drilling activities in the Chukchi Sea would have only negligible effects on currents, upwellings, and eddies within the proposed action area.

Tides and Water Levels

The activities described under Alternative 3 would be temporary in nature and would have only a seasonal presence of extremely limited size and geographic distribution, and would not affect tides or water levels within the proposed action area.

However, wind, waves and storm surge would potentially impact seismic and exploratory drilling activities, and could influence human safety.

Stream and River Discharge

The activities described under Alternative 3 would not affect stream and river discharge within the EIS project area. Exploratory drilling in state waters on grounded ice could occur from manmade reinforced ice "islands" but would have negligible effects on stream and river discharge within the EIS project area.

Sea Ice

Under Alternative 3, impacts to sea ice resulting from the proposed activities would be the same in nature as those described for Alternative 2. Repeated icebreaking within a given channel may lead to formation of 'brash ice' and an overall thickening of ice within the channel (Ettema and Huang 1990).., Thomas and Dieckmann 2010). Noticeable changes to the character of the ice would result from marking the ice in order to designate source receiver locations and from construction of snow ramps to smooth rough ice within the survey area. Construction of ice islands would result in medium intensity, temporary, local effects on sea ice. Alternative 3 would allow additional drilling programs and additional artificial islands in the proposed action area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled. Relative to Alternative 2, sea ice would be affected over a larger area due to more extensive icebreaking activity and thermal inputs associated with exploratory drilling activities.

Although Alternative 3 would allow additional seismic surveys in both the Beaufort and Chukchi seas relative to Alternative 2, each action alternative would authorize only one survey per year in each of the seas to involve icebreaking activity. Likewise, only one on-ice seismic survey per year would be authorized under each of the action alternatives. Therefore, the level of activity contemplated for these specific types of exploration activities under Alternative 3 is the same as what is contemplated under Alternative 2.

The effects of these activities on sea ice would be medium intensity, local, temporary, and would affect a resource that is common in the EIS project area. The presence of sea ice in lease and non-lease areas targeted for open water seismic exploration and exploratory drilling could result in changes to the schedule, location, and duration of exploratory activities. The presence of ice also represents a potential hazard to vessels and exploratory drilling platforms. Industry operators in offshore areas have developed procedures for managing sea ice, including changes to schedule, vessels dedicated to ice management, and procedures for taking drill platforms off location until potential hazards subside.

Within ice and on ice exploration activities could experience similar and additional hazards from sea ice, including the potential for ice override events. In-ice exploration activities would use ice breakers and other vessels for the purpose of ice management and/or ice breaking, and protocols would be established for response to potential ice hazards. Drilling on grounded ice from artificial ice islands would not be subject to potential hazards from moving ices, but could experience potential effects from storm surge and ice override events. Within the Beaufort Sea, where drilling on constructed artificial ice islands could occur in state waters, much of the area is protected from ice override by barrier islands. Individual drilling operations would need to assess the potential for ice related hazards and develop appropriate design and operation protocols.

Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on sea ice would be minor.

4.6.1.1.2 Conclusion

The overall effects of the proposed actions on physical ocean resources would be of medium intensity (due to the increased levels of icebreaking activity), temporary in duration, local in extent, and would affect common resources as defined in the impact criteria in Section 4.5.1 of this EIS. The overall effects of the proposed activity described in Alternative 3 on physical ocean resources in the proposed action area would be minor.

4.6.1.2 Climate

Under this alternative, emissions of GHGs would be higher when compared to Alternative 2 because the alternative proposes additional surveys and exploration plans described as Level 2 Exploration Activity on the Arctic OCS. In the U.S. Chukchi Sea OCS Planning Area, two additional seismic surveys are planned along with two additional site clearance surveys, and an additional EP is included. In the U.S. Beaufort Sea OCS Planning Area, two additional seismic surveys are considered along with two additional site clearance surveys, and an additional EP. The majority of additional GHG emissions are from the additional EP proposed for Level 2 Exploration Activity.

Refer to Section 3.1.2.4, Climate Change in the Arctic, for a thorough discussion of climate systems and the effects of GHG emissions.

4.6.1.2.1 Direct and Indirect Effects

Direct Effects

Direct effects under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

Indirect Effects

Indirect Effects under this alternative would be the same as those described under Alternative 2, although levels of GHG emissions would be higher with the additional surveys and exploration plans.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plan.

CO_2e Projected Emissions Inventory

The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*), and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*). The estimated potential annual emissions of CO_2e for each type of activity and program proposed under this alternative are provided in Table 4.6-1. The data in this table assumes no controls to reduce emissions.

Effects of this Alternative on Climate Change

Reporting emissions of CO_2e under this alternative would be the same as described under Alternative 2, although levels of projected emissions would be higher with the additional surveys and exploration plans.

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2.

Table 4.6-1 Projected CO_2e Emissions by Activity and Program Type for the Arctic OCS

Activity/Program Types	U.S. Chukchi Sea OCS Annual CO_2e Emissions (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	72,048
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
Exploration Plan	186,013
Total	**270,454**
Activity/Program Types	**U.S. Beaufort Sea OCS Annual CO_2e Emissions (metric tons per year)**
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	85,692
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
On-Ice Seismic Survey	25
Exploration Plan	186,013
Total	**284,123**

Sources: EPA. October 1996. Compilation of Air Pollutant Emission Factors (AP-42) 5th ed., Volume I, Chapter 3, Table 3.3-1 and Table 3.4-1.

EPA. July 2010. Median Life, Annual Activity and Load Factor Values for Nonroad Engine Emissions Modeling (EPa-420-R-10-016, NR-005d).

BOEM 2012b. ION Seismic Survey.

EPA. 2012. EPA and NHTSA Set Standards to Reduce GHG and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks. Table 1. http://www.epa.gov/oms/climate/documents/420f12051.pdf

4.6.1.2.2 Conclusion

It is difficult to separate the impacts of this particular alternatives actions from other impacts seen around the world. The proposed actions under Alternative 3 would contribute incrementally to a global problem, however, the contribution is so small it is challenging to asses the actions exact impact. In this case it is appropriate to evaluate total projected emissions from the proposed actions for comparison purposes. Under this alternative, the estimated annual emissions of CO2e would be 270,454 metric tons in the Chukchi Sea OCS area, and 284,123 metric tons in the Beaufort Sea OCS area. Projected emissions of CO2 and other greenhouse gasses under Alternative 3 could potentially contribute to changes in global climate. However, the amount to which changes in global climate are attributable to any single anthropogenic source is very small, and it is not currently useful to attempt to link specific climate impacts to the particular activities proposed under Alternative 3, as such direct linkage is difficult to isolate and to understand. In this case it is appropriate to evaluate and disclose estimated CO2e emissions by activity and program type for the Arctic OCS under Alternative 3. These data are provided in Table 4.6-1.

Regarding effects of climate change on the proposed actions, the decrease in sea ice thickness and extent could affect timing and location of in-ice seismic and on-ice vibroseis surveys, as well as extend the season for drilling activities requiring ice-free conditions. Activities under this alternative may require unique planning and engineering, but are not expected to adversely affect the implementation of this alternative.

4.6.1.3 Air Quality

Under this alternative, projected criteria pollutant emissions would be higher when compared to Alternative 2 because the alternative proposes additional surveys and exploration plans described as Level 2 Exploration Activity on the Arctic OCS. In the U.S. Chukchi Sea OCS Planning Area, two additional seismic surveys are planned along with two additional site clearance surveys, and an additional EP is included. In the U.S. Beaufort Sea OCS Planning Area, two additional seismic surveys are considered along with two additional site clearance surveys, and an additional EP. The majority of additional criteria pollutant emissions are from the additional EP proposed for Level 2 Exploration Activity.

4.6.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of GHG, HAP, and criteria pollutant emissions as described under Alternative 2 in Section 4.5.1.3.

Greenhouse Gases and Hazardous Air Pollutants

The sources of emissions and the types of impacts to air quality would be the same as those considered under Alternative 2. However, relative to Alternative 2, the increased level of activity considered under this alternative would result in proportionate increases in the amounts of the emissions, and corresponding changes in the magnitudes of the resulting impacts.

Fugitive Emissions and Oil Spills

The sources of VOC emissions and the types of impacts to air quality would be the same as those considered under Alternative 2. However, relative to Alternative 2, the increased level of activity considered under this alternative would result in a proportionate increase in the amounts of VOC emissions, and corresponding changes in the magnitudes of the resulting impacts.

Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

Level of Effect

The level of effect under this alternative would be the same as discussed under Alternative 2.

4.6.1.3.2 Conclusion

Projected emissions from exploratory drilling activities proposed under this alternative would be higher than those estimated for Alternative 2. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the NAAQS to be exceeded onshore. The Level 2 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A high level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a medium level of effect.

4.6.1.4 Acoustics

Under Alternative 3, the number of seismic survey programs envisioned is increased from Alternative 2 by two exploration surveys and two site clearance or high resolution shallow hazards surveys in each of the Chukchi Sea and Beaufort Sea (Tables 4.2-1 and 4.2-2), using the same types of sound-generating sources. This represents an increase in seismic survey activities of approximately 65 percent in the Chukchi Sea and 50 percent in the Beaufort Sea. The amount of drilling activity has also doubled in each sea between Alternatives 2 and 3. A detailed discussion of the acoustic properties of the sound sources is given in Section 4.5.1.4; that discussion is relevant also to Alternative 3 operations.

4.6.1.4.1 Direct and Indirect Effects

Estimates of Total Surface Areas of Ensonification at Threshold Levels

Table 4.6-2 contains estimates of surface areas ensonified above given threshold levels under Alternative 3. For the purpose of computing these notional areas, the seismic survey activities listed in Table 4.2-2 for Activity Level 2 are distributed among the three environments considered in this EIS. The five exploration surveys and five site clearance or high resolution shallow hazard surveys in the Chukchi Sea are all assumed to be in the mid-depth shelf region; the six exploration surveys and five site clearance or high resolution shallow hazard surveys in the Beaufort Sea are divided between the mid-depth shelf and the shallow-depth coastal regions in the proportions of 4:2 and 3:2 respectively (giving greater representation to the shelf region makes the estimates more precautionary). The source array sizes in the three zones reflect the prevailing configurations for seismic surveys conducted in each region. The percentages are based on nominal surface areas of 263,500 km^2 for the Chukchi portion of the EIS project area and 255,350 km^2 for the Beaufort portion. The surface areas presented in Table 4.6-2 indicate the total area of each sea that would be ensonified if the maximum number of surveys allowed under this alternative were to be performed concurrently. Of note, the total surface areas do not subtract out either overlap with other isopleths of concurrent source operation, or land area where activities are closer to shore, for that reason, the area ensonified over 120 dB is likely a substantial overestimate (see Figures 4.7 through 4.12 and 4.15 through 4.17 illustrating conceptual examples to get a sense of this).

Table 4.6-2 Total Surface Areas Ensonified Above Sound Level Thresholds Under Alternative 3, From Averages Listed in Table 4.5-11.

		Total Surface Areas (km^2) to sound level (90% rms SPL (dB re 1 µPa rms))			
		190	**180**	**160**	**120**
Chukchi Sea Shelf 40 to 52 m depth					
	5x ~3200 in^3	4.41	48.7	1,798	141,764
	5x 40 in^3	0.03	0.29	25.3	10,619
	2x drill/support*			1044	1,044
	% Chukchi	**0.00%**	**0.02%**	**1.09%**	**58%**
Beaufort Sea Shelf, 15 to 40 m depth					
	4x ~3200 in^3	9.96	82.9	1,633	45,238
	3x 20 in^3	0.003	0.03	5.59	2,535
	2x drill/support*			1044	1,044
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	2x 880 in^3	0.46	2.02	46.9	2,206
	2x 20 in^3	0.02	0.12	4.35	268
	% Beaufort	**0.00%**	**0.03%**	**1.07%**	**20%**
Entire Region					
		15	**134**	**5601**	**204,718**
	% EIS area	**0.00%**	**0.03%**	**1.08%**	**39%**

Notes: *drill/support indicates area within 13-km radius around drill rig, notionally encompassing support vessels. Indicated area is within 120-dB radius, included in 160-dB column for assessment.

Chronic and Aggregate Effects on Acoustic Habitat

As described in Section 4.5.2.4.9, modeled chronic and aggregate effects on acoustic habitat from July through mid-October were substantial at several modeled sites in the Beaufort Sea, with losses of up to 98% of the broadband listening area for mid- and low frequency species and up to 24% of bowhead whale communication space. The relevance of these modeled results to specific marine mammal species and their acoustic habitat is discussed in Section 4.5.2.4.

4.6.1.4.2 Conclusion

The intensity rating of this alternative is high, as additional exploration activities will introduce more sources with source sound levels that exceed 200 dB re 1 µPa. Because the exploration activities could continue for several months over successive years, the duration is considered long-term. The spatial extent of these activities is regional, since the distribution of exploration activities over the project areas will lead to 39 percent of the EIS area being exposed to sound levels in excess of 120 dB re 1 µPa . Therefore, the overall impact rating for direct and indirect effects to the acoustic environment would be moderate.

4.6.1.5 Water Quality

Impacts to water quality from Alternative 3 are expected to be very similar to those described above for Alternative 2. The only difference between the two alternatives is the level of activity, which would double. However, the relatively small volumes of potential discharges would be diluted in a large volume of water. and thus have a negligible effect to the Arctic Ocean water quality. Any differences in impacts between the two alternatives are noted below.

4.6.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys under Alternative 3 would not expected to have any measureable impact on temperature or salinity in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys under Alternative 3 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys under Alternative 3 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

Exploratory Drilling Programs

Under Alternative 3, changes in water quality related to temperature and salinity resulting from exploratory drilling programs would be similar in nature as those described for Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be doubled. Relative to Alternative 2, salinity and temperature may be affected over a larger area. However, the effects of Alternative 3 on water quality resulting from changes in temperature and salinity would be low intensity, temporary, and local. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 3 on water quality related to temperature and salinity resulting from exploratory drilling programs would be minor.

Turbidity and Total Suspended Solids

Seismic Surveys

Effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 3, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

Site Clearance and Shallow Hazards Surveys

Effects on water quality resulting from potential increases in turbidity and total suspended solids from site clearance and shallow hazard surveys under Alternative 3, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of suspended solids in the proposed action area. As they occur on the ice and not in the open-water environment, no contact is made with the seafloor during these types of surveys.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may be effectively doubled. Relative to Alternative 2, turbidity and concentrations of suspended solids may be affected over a larger area. However, the effects of Alternative 3 on water quality resulting from changes in turbidity and concentrations of suspended solids would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on water quality related to turbidity and concentrations of suspended solids resulting from exploratory drilling programs are expected to be minor.

Metals

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys are not expected to have any measureable impact on dissolved metal concentrations in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys are not expected to affect dissolved metal concentrations in the proposed action area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys would not affect dissolved metal concentrations in the EIS project area.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of metals from exploratory drilling programs are described in detail under Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be doubled. Relative to Alternative 2, metal concentrations may be affected over a larger area. However, the effects of Alternative 3 on water quality resulting from changes in metal concentrations would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on water quality related to metal concentrations resulting from exploratory drilling programs would be minor.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Similar to the impacts under Alternative 2, while the level of activity would double, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, while the level of activity would double, site clearance and shallow hazards surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys are expected to have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area under Alternative 3. Alternative 3 contemplates the same level of on-ice seismic activity as Alternative 2; therefore, the level of impacts is anticipated to be the same. Contaminants from fluids entrained in the ice roads would be discharged every spring during breakup. Any entrained hydrocarbons and other organic contaminants from vehicle exhaust, oil, grease, and other vehicle-related fluids not recovered would pass into the Beaufort and/or Chukchi Sea system at each breakup as a result of on-ice seismic surveys. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys under Alternative 3 are expected to be minor.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of hydrocarbons and other organic contaminants from exploratory drilling programs are described in detail under Alternative 2. Relative to Alternative 2, Alternative 3 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be doubled. Relative to Alternative 2, concentrations of hydrocarbons and other organic contaminants would be affected over a larger area. Impacts to water quality resulting from hydrocarbons and other organic contaminants would be temporary and would dissipate soon after the discharge is stopped. Such impacts would be local in nature due to rapid dilution of discharged compounds into the ocean. It seems probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 3 would have minor to moderate effects on water quality outside of the discharge plume area. However, due to lack of applicable water quality criteria for some organic compounds in drilling fluids (EPA 2006b), it is problematic to determine whether or not inputs of hydrocarbons and other organic compounds from the proposed activity would exceed water quality regulatory limits.

Although unlikely, it is plausible that accidental or emergency events may occur within the proposed action area. Due to the rarity of such unforeseen events, and the potential magnitude and extent of their impacts relative to the effects of normal operation and maintenance activities, such accidental or emergency events are not addressed in this section and are covered in Section 4.10 of this EIS. Standard mitigation measures requiring operators to have plans in place to minimize the likelihood of a spill would reduce the potential for adverse impacts to water quality.

4.6.1.5.2 Conclusion

After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 3 on water quality in the EIS project area are expected to be minor.

4.6.1.6 Environmental Contaminants and Ecosystem Functions

4.6.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 3 would be the same as those described for Alternative 2. Because Alternative 3 would authorize a greater level of activity relative to Alternative 2, the amounts of contaminants introduced to the EIS project area would potentially be greater under Alternative 3.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 3 would be the same as those described for Alternative 2. The area of habitat and biological resources exposed to potential contaminants would be larger under Alternative 3.

Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 3 on the four categories of ecosystem functions are assessed below.

Regulation Functions

The nature of the effects of the activities proposed under Alternative 3 on regulation functions would be the same as described under Alternative 2. The effects of greatest concern would be associated with exploratory drilling programs. Alternative 3 would authorize up to two exploratory drilling programs per year in the Beaufort Sea and up to two exploratory drilling programs per year in the Chukchi Sea, whereas Alternative 2 would authorize only one exploratory drilling program per year in each sea. Thus, the magnitude of the effects on regulation functions would be greater under Alternative 3 compared to Alternative 2. The magnitude and extent of effects of Alternative 3 on regulation functions would depend upon interrelationships between impacts to biological and physical resources, which are addressed in other sections of this EIS.

Habitat Functions

The nature of the effects of the activities proposed under Alternative 3 on habitat functions would be the same as described under Alternative 2. Effects of Alternative 3 on habitat functions would include impacts to refugium functions and nursery functions (provision of suitable reproduction habitat) associated with benthic habitats resulting from discharges from exploratory drilling. Overall effects to benthic habitat functions would be interim, local, and low-intensity. Effects would also occur to functions associated with pelagic and epontic habitats. Functions associated with terrestrial habitats would be affected to a lesser degree. Overall, effects of Alternative 3 on habitat functions would be medium-intensity, interim, and local. The functions affected could be common, important, or unique depending on the spatial location of the impact.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts to habitat functions.

Production Functions

The nature of the effects of the activities proposed under Alternative 3 on production functions would be the same as described under Alternative 2. Impacts to production functions related to provision of raw materials and food (i.e., subsistence) would be affected by the activities proposed under Alternative 3. These impacts are described in the subsistence section of this EIS. In addition to introducing contaminants to secondary and tertiary consumers via trophic transfer processes, contaminants of concern could interrupt trophic transfer processes resulting in shorter food chains (less complex food webs), and reduced throughput of energy and nutrients at higher trophic levels. In response to system-level stress the couplings between trophic levels become less organized and nutrients are lost from the system as a result. Exported or unused primary production tends to increase in response to system-level stress (Odum 1985). Oil and gas are ecosystem goods, and the flows of energy that they represent are ecosystem services. These ecosystem goods and services could potentially be derived from historical production functions in the EIS project area under Alternative 3.

Information Functions

Information functions contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002). The effects of Alternative 3 on information functions in the EIS project area would depend upon interrelationships between impacts to cultural resources, social resources and aesthetic resources, which are addressed in other sections of this EIS.

4.6.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 3 would be medium-intensity, interim, local, and would affect common resources. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e., resistant to stressors) than are species composition and other structural properties. A relatively detailed analysis of the effects of Alternative 2 on fate and persistence of potential contaminants entrained in sediments is included in Section 4.5.1.6.1. The potential effects of Alternative 2 on the distributions of metals and petroleum hydrocarbons, both in the water and in seafloor sediments, are also discussed under Section 4.5.1.5 (Water Quality). Because Alternative 3 would authorize a greater level of activity than Alternative 2 there is potential for an increased volume of contaminants to be introduced to the project area. Introduction of contaminants would interrupt some trophic transfer processes, resulting in impacts to production functions due to reduced throughput of energy and nutrients at higher trophic levels. However, the overall level of effect of Alternative 3 on ecosystem functions would be considered minor.

4.6.1.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.6.2 Biological Environment

4.6.2.1 Lower Trophic Levels

4.6.2.1.1 Direct and Indirect Effects

The direct and indirect impacts previously discussed for Alternative 2 are also applicable for this alternative. The increased levels of activity associated with Alternative 3 would not generate different types of impacts to lower trophic levels.

4.6.2.1.2 Conclusion

Given the implementation of the standard mitigation measures considered in this EIS, the direct and indirect effects on lower trophic levels associated with Alternative 3 would likely be low in intensity, temporary to long-term in duration, of local extent and could affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.6.2.2 Fish and Essential Fish Habitat

4.6.2.2.1 Direct and Indirect Effects

Under Alternative 3, the types of oil and gas exploration activities undertaken in the EIS project area would be the same as those in Alternative 2, but the level of activity would be higher. An increase from Level 1 to Level 2 would result in an overall increase in activity of approximately 40 percent, distributed unevenly among the different activities. It would double some activity levels while leaving others unchanged. There would be no increase in icebreaking or on-ice seismic surveys, an increase of 50 percent in seismic surveys and site clearance and high resolution shallow hazard surveys, and a doubling of exploratory drilling programs. This uneven nature of the increase would also apply to the impacts on different fish resource groups.

The types and mechanisms of effects would remain the same in Alternative 3 as in Alternative 2. For a complete discussion of the types and mechanisms of effects on fish resources, see Section 4.5.2.2.

Marine Fish

The direct and indirect effects on marine fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 2. Demersal assemblages, on the other hand, would be exposed to the additional effects from the increase in seismic survey levels and exploratory drilling, both in terms of habitat loss and the effects from noise. Pelagic assemblages would be impacted by the increase in surveys but less so by the increased drilling programs. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain, given the limited area affected compared to the distribution of fish populations. Impacts on juvenile and adult fish would be temporary and low in intensity. Based on the small footprint of the seismic surveys relative to the amount of habitat over the entire EIS project area, the effect would be local and temporary.

For a complete discussion of the effects on Marine Fish, please see Section 4.5.2.2.

Migratory Fish

The direct and indirect effects on migratory fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 2, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 2, those anadromous species known to inhabit the area where project activities would occur are not very abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same.

For a complete discussion of the effects on Migratory Fish, please see Section 4.5.2.2.

Essential Fish Habitat

The direct and indirect effects on essential fish habitat resulting from Alternative 3 would be very similar to those described under Alternative 2, with an increase in effects due to the increase in oil and gas exploration activities. In particular, the increase in exploratory drilling programs would result in increased habitat loss and alteration, potentially to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 3 is small and only incrementally larger than for Alternative 2. Most impacts would be of low intensity and of small geographic extent.

For a complete discussion of the effects on Essential Fish Habitat, please see Section 4.5.2.2.

4.6.2.2.2 Conclusion

The overall impact of Alternative 3 on Fish and EFH would be minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in the overall impact level, due to the very small scale of any potential effects relative to overall population levels and available habitat and the temporary nature of the majority of the activities associated with Alternative 3.

4.6.2.3 Marine and Coastal Birds

4.6.2.3.1 Direct and Indirect Effects

Alternative 3 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on marine and coastal birds under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. The difference between alternatives concerning marine and coastal birds is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2. These activities involve the same standard mitigation measures, however could involve a larger geographic extent over a more continuous timeframe. This EIS includes a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals but may also reduce adverse effects on birds. In addition to the mitigation measures imposed by NMFS, the USFWS requires certain mitigation measures specific to ESA-listed species under its jurisdiction, including spectacled and Steller's eiders (USFWS 2009c). Measures implemented to minimize take of listed eiders also protect other migratory birds as required by the MBTA. Section 4.5.2.3 summarizes the mitigation measures typically required by the USFWS and other agencies for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on birds and these measures are incorporated into the analysis of potential effects under Alternative 3.

The direct and indirect effects of oil and gas exploration activities on marine and coastal birds would be very similar under Alternative 3 as those described under Alternative 2. Marine birds would be subject to increased disturbance from vessels and seismic sources due to the increase in seismic surveys that could be authorized under Alternative 3 in both Arctic seas. However, disturbance effects would be temporary even if they occurred over a wider area and birds could fly or swim away from acute disturbance.

With more exploration activities authorized under Alternative 3, the increased number of vessels required to conduct the activities could increase the likelihood of a vessel encountering and disturbing birds. The Ledyard Bay closure period would be the same under Alternative 3 as under Alternative 2 so this area would be unaffected by increases in exploration elsewhere.

The risk of birds colliding with vessels would increase incrementally. A full complement of vessels for a full season as considered under this alternative may result in a greater number of strikes than occurred during the 2012 drilling season. Based on the existing preliminary bird strike reports from 2012, four simultaneous future drilling operations could result in an estimated 356 bird strikes per open-water season—this could include an estimated 197 passerines, 45 shearwaters/storm petrels/auklets, 17 shorebirds, and 96 seaducks. Of the seaducks, 47 could be king eiders, 32 could be long-tailed ducks, and 16 could be common eiders. This potential mortality for each species is small by comparison with the post-breeding population; thus, no species would experience a population-level effect. However, small flocks of eiders can strike a vessel, suggesting that the authorized incidental take of listed eiders could be exceeded in one strike event.

4.6.2.3.2 Standard Mitigation Measures

Standard and additional mitigation measures that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). Additional mitigation measures are not required under any of the alternatives and do not affect the summary conclusion below.

4.6.2.3.3 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles in the Arctic and many are important subsistence resources. Depending on the species, some are considered to be important or unique resources in a NEPA perspective. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary, local, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 3 on marine and coastal birds would therefore be considered minor according to the impact criteria in Table 4.5-16.

4.6.2.4 Marine Mammals

4.6.2.4.1 Bowhead Whales

4.6.2.4.1.1 Direct and Indirect Effects

The types of oil and gas exploration activities undertaken in the EIS project area under Alternative 3 would be the same as those discussed under Alternative 2, with an increased level of activity for all but in-ice or on-ice seismic (vibroseis) surveys (Table 4.2-2). The types and mechanisms of direct and indirect effects on bowhead whales would, therefore, be the same under Alternative 3 as discussed for Alternative 2 in Section 4.5.2.4.10. The difference between alternatives is a matter of degree. An increase from Level 1 to Level 2 would result in an overall increase in activity of approximately 40 percent, distributed unevenly among the different activities. It would double some activity levels while leaving others unchanged. There would be no increase in icebreaking or on-ice seismic surveys, an increase of 50 percent in seismic surveys and site clearance and shallow water hazard surveys, and a doubling of exploratory drilling programs. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures under both alternatives.

Behavioral Disturbance

Each of the exploration activities that would be authorized under Alternative 3 includes several mechanisms for potential disturbance to bowhead whales. Most result from noise generated by oil and gas exploration equipment and associated vessels and aircraft. The mechanisms for disturbance and the suite of potential reactions by bowheads to disturbance under Alternative 3 are as described in detail for Alternative 2 in Section 4.5.2.4.10.

There could be a substantial increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. Exploration activity and associated effects may increase in time and space under Alternative 3, but the resulting direct and indirect effects on bowhead whales would be similar in nature to those described under Alternative 2. Potential effects of in-ice seismic surveys with icebreaker support and on-ice vibroseis surveys would be identical to Alternative 2, since activity level would remain the same under Alternative 3.

Disturbance effects of seismic activity on bowhead whales under Alternative 3 would be of medium to high intensity. Some whales may be displaced but would not leave the EIS project area entirely. The duration is expected to be interim. Long-term effects are unknown. The extent of the impact would depend on the number of seismic activities and associated support vessels in an area. Individual sound source vessels may produce local impacts, especially if one considers potential harassment of some percentage of bowhead whales exposed to sound levels below 120 dB. Historical take estimates from seismic studies do not suggest that these surveys alone would warrant a “high” intensity rating, however, our draft revisions of the acoustic thresholds suggest that takes resulting from these surveys might be somewhat more extensive than previously calculated. Multiple seismic activities in one area or in several areas across the migratory corridor could lead to more widespread, regional impact. Bowhead whales are considered a unique resource, due to their endangered species status.

Anticipated impacts of an additional OBC or OBN survey in the Beaufort Sea, in terms of magnitude (medium), duration (interim), extent (local), and context (unique), may be similar to those described for one OBC/OBN survey under Alternative 2. Since disturbance effects may extend 20 to 30 km (12 to 19 mi) from the sound source, the zone of impact could be expected to expand spatially in the presence of multiple OBC/OBN surveys. This could result in the geographic extent of impact broadening from local to regional.

Direct and indirect effects of site clearance and high resolution shallow hazards surveys under Alternative 3 would be similar to those described for Alternative 2. Magnitude of effects would be medium, and duration would be temporary or interim. Given the increase in the number of surveys in each sea under this alternative, the extent could increase from local, as it was under Alternative 2, to more regional, depending on the spatial and temporal distribution of activities.

For bowhead whales, historical take estimates suggest that exploratory drilling results in more take of bowhead whales than other categories of activities (Tables 4.2-5 and 4.2-6 in Section 4.2.6). Alternative 3 doubles the level of potential drilling, which results in a substantial increase in intensity. Anticipated impacts of two exploratory drilling programs under Alternative 3 would be similar to that for Alternative 2 in terms of magnitude (medium), duration (interim), extent (local), and context (unique) but will ultimately contribute to an increase in intensity when the combined effects of all activities are considered. The extent of impact resulting from the addition of a second drilling program in each sea would depend on the spatial and temporal distribution of the activities within the open water season. Extent could potentially increase from local to regional.

Disturbance effects resulting from vessel and aircraft activity under Alternative 3 would be similar to Alternative 2. Disturbance effects of vessel and aircraft activity would likely be of medium intensity, and the duration of disturbance is expected to be interim to long-term. The extent of impact would depend on the number of support vessels in an area. Impacts are expected to be local for individual activities;

multiple activities in one area or in several areas across the migratory corridor could result in a broader, regional impact.

Please refer to Section 4.5.2.4.10 for a complete discussion of the disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.10. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in bowhead whales. The potential effects of ship strikes under Alternative 3 are similar to that discussed under Alternative 2. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact would be local, given the relative infrequency of occurrence and the non-random distribution of both bowhead whales and exploration activity in the EIS project area. The context would be important, based on the ESA status and increasing population of bowheads.

Please refer to Section 4.5.2.4.10 for a complete discussion of potential injury or mortality effects on bowhead whales. Although it seems difficult to rule out the potential for TTS or PTS completely, the majority of the standard mitigation measures are geared towards minimizing the likelihood of injury, and are expected to be relatively successful.

Habitat Alterations

The potential effects on bowhead whale habitat in the EIS project area under Alternative 3 would likely be similar to those summarized under Alternative 2, with the exception of acoustic habitat. Additional exploratory drilling could, however, increase the number of localized sites experiencing possible habitat effects of drilling activities.

As noted in Section 4.6.1.4, with the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels that bowheads are expected to respond behaviorally, but also above the levels at which masking might be expected to potentially occur for some types of signals, increases substantially. When the larger 120-dB zones around all of the potential sound sources are considered (not suggesting that all individuals exposed to this would be taken, but suggesting that they would all have to deal with a sound that is audible and potentially in the range where it would mask another important sound (including inter-species communication), the area of effect is quite large and, depending on the location of the individual activities, could (for months) span a large portion of the north-south extent of the area through which migrating bowheads, with their calves, must traverse.

Please refer to Section 4.5.2.4.10 for a complete discussion of the potential effects on bowhead whale habitat.

4.6.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.1.3 Conclusion

For Alternative 3, when all of the potential categories of activities combined are considered, and the maximum level of each is considered, the increase in potential impacts on bowheads, through a combination of behavioral harassment and loss of acoustic habitat, is potentially substantial, although only reflected as changing to high from medium/high.. If the example take estimates from Tables 1 and 2 in Section 4.2.6 are used, the difference in maximum activity levels results in almost a two-fold increase in takes. Bowhead whales are listed as endangered, and the Beaufort and Chukchi seas are important areas for them, through which the entire population migrates with calves, occasionally stopping to feed, which places them in the context of being a unique resource. The intensity and duration of the various effects and activities considered are mostly high and longterm. Although the various individual activities may affect bowhead whales on a local to regional level, the area and extent over which the combined effects occur would likely increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Considering these factors, along with potential reduced adverse impacts through the imposition of required standard mitigation measures, the overall impact of Alternative 3 on bowhead whales would be considered moderate to major.

Table 4.6-3 Effects Summary for Bowhead Whales

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	
		High	Behavioral harassment take of bowheads exceeds 30% of population
	Duration	**Temporary**	
		Interim	Depending on the distribution of activities and animals, and for bowheads because they are primarily migrating through, some animals would not necessarily be impacted for more than 6 months in a year or in multiple consecutive years.
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Some individuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14c), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding and resting
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	**Local**	Since unlikely, any impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	
		Important	ESA-listed species, but population is increasing
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	Impacts to non-acoustic habitat features are generally low, but higher than Alternative 2.
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~44% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort, and up to 25% lost bowhead communication space in some areas of Beaufort).
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding and resting

4.6.2.4.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.17).

4.6.2.4.1.5 Additional Mitigation Measures Conclusion

Conclusions regarding the potential for these additional measures to reduce adverse impacts of oil and gas activities on bowhead whales allowed under Alternative 3 are the same as under Alternative 2. Refer to Section 4.5.2.4.17 for details.

4.6.2.4.2 Beluga Whales

4.6.2.4.2.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 3 on beluga whales. Alternative 3 includes the same types of exploration activities as in Alternative 2, so the discussion of potential direct and indirect effects on beluga whales under Alternative 3 is the same as those discussed in Section 4.5.2.4.11. The exploration activities discussed in Alternatives 2 and 3 take place in the same geographic areas and timeframes and also consider the same standard and additional mitigation measures. The difference between the alternatives is simply a matter of degree; Alternative 3 includes a larger number of authorized exploration activities than Alternative 2.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.11.

Behavioral Disturbance

The same number of 2D (in-ice) and vibroseis surveys would be authorized under Alternative 3 as for Alternative 2. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on beluga whales.

There would be a substantial increase in the amount of open-water activities under Alternative 3 compared to Alternative 2 (meaning especially 2D/3D seismic surveys and drilling operations with their associated support vessels). These activities could affect beluga whales over a large area, and the disturbance effects would be interim in duration and medium in magnitude, characterized by avoidance of vessels. The addition of one or more seismic surveys to either the Beaufort or Chukchi seas would increase the likelihood that two or more different surveys could be operating in the same general area at the same time and the effect of the disturbances could be synergistic – with the net impact being greater than the sum of the individual impacts, or, it could be that an animal exposed to one source in a given time would not be further impacted by the vicinity of another; thus, the impact would be local to regional in extent and important in context.

Based on the historical take estimates used for beluga whales, in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of beluga whales (see Tables 4.2-5 through 4.2-7 in Section 4.2.6). Since the number of in-ice seismic surveys (1 each in Beaufort and Chukchi) did not increase above Alternative 2, if one considers the combined impacts of all activity types, the overall increase in anticipated behavioral takes was only about 15%.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, the primary mechanism of potential injury or mortality to beluga whales due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. The duration of an impact from an auditory impairment would be temporary for TTS, but permanent if PTS were to occur. The extent of such impacts would be local and the context common. It is not known whether there have been any ship strikes involving beluga whales and exploration vessels in the Arctic, but the intensity of the impact should be considered medium. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale.

Habitat Alteration

Potential impacts on beluga whale habitat in the EIS project area under Alternative 3 would likely be similar to those described under Alternative 2, with the exception of acoustic habitat. As noted in the Section 4.6.1.4 with the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels to whichbelugas are expected to respond behaviorally has increased substantially. Additionally, although the lower frequencies of these sources are not in the area of highest sensitivity for belugas or at frequencies likely to mask interspecies communication, these sounds, which are covering large areas for months, are audible and potentially in frequency ranges that could mask other important sounds.

4.6.2.4.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.2.3 Conclusion

The overall impact to beluga whales is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but there are a couple of areas in the action area that are of specific importance to this population (Barrow Canyon and Beaufort Sea Shelf Break). The intensity and duration of the various effects and activities considered range from low to high and mostly are longterm. Although, individually, the various activities may elicit local effects on beluga whales, the area of extent over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of this population and would be considered regional.

For Alternative 3, when all of the potential categories of activities combined are considered, and the maximum level of each is considered, the increase in potential impacts on belugas, through a combination of behavioral harassment and loss of acoustic habitat, is potentially moderate. If the example take estimates from Table 4.2-7 in Section 4.2.6 are used, the difference in maximum activity levels results in about a 12% increase in takes from Alternative 2. Beluga whales are not ESA-listed in the EIS project area, although activities will occur in some important feeding areas and, although, there is not enough information to indicate a trend, Chukchi data suggest that that population is not decreasing (Allen and Angliss 2011).

Table 4.6-4 Effects Summary for Beluga Whales

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	In lower level scenarios for this alternative, take of belugas might not exceed 30% of population
		High	In higher level scenarios for this alternative, behavioral harassment take of belugas exceeds 30% of population
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many individuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14c), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	Not ESA-listed. Population status not well known for Chukchi, but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas and wide migratory corridor likely not heavily impacted by activities
		Important	Stocks overlap known migratory corridor and activities may occasionally impact important feeding areas.
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though highly unlikely, PTS would be permanent if incurred.
	Geographic Extent	**Local**	Since unlikely, any impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Not ESA-listed, populations not thought to be decreasing
		Important	
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	Impacts to non-acoustic habitat features are generally low, but higher than Alternative 2
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~44% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort).
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	Not ESA-listed. Population status not well known for Chukchi, but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas and wide migratory corridor likely not heavily impacted by activities
		Important	Stocks overlap known migratory corridor and activities may occasionally impact important feeding areas.
		Unique	

4.6.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.17).

4.6.2.4.3 Other Cetaceans

Under Alternative 3, the types of oil and gas exploration activities undertaken in the EIS project area would be the same as those in Alternative 2, but the level of activity would be considerably higher.

The types and mechanisms of effects would remain the same in Alternative 3 as in Alternative 2. The activities involved with Level 2 exploration activity take place in the same areas and timeframes and also consider the same standard and additional mitigation measures as Level 1 activity presented in Alternative 2. Therefore, the difference between the two alternatives is a matter of scale, with an increased activity level leading to a corresponding, incremental increase in effects. For a complete discussion of the types and mechanisms of effects on other cetaceans, please see Section 4.5.2.4.12.

4.6.2.4.3.1 Direct and Indirect Effects

Behavioral Disturbance

Under Alternative 3, disturbance effects of oil and gas exploration activity on other cetaceans would be of low (for those species that were not encountered or exposed) to medium intensity, based on determinations for Alternative 2. The substantial increase in level of activity over Alternative 2 would likely result in a notable increase in impact level. Some cetaceans may be displaced a short distance, but they would not be anticipated to leave the EIS project area entirely. The duration is expected to be interim. Long-term effects are unknown. The extent of the impacts would depend on the number of seismic activities and associated support vessels in an area. Individual sound source vessels may produce local impacts. Multiple activities in one area or in several areas across migratory corridors could lead to more widespread, regional impacts.

Based on the historical take estimates used for these other cetacean species, if one considers the combined impacts of all activity types at max levels, the overall increase in anticipated behavioral takes between Alternative 2 and 3 ranges from 75-100% (see Tables 4.2-5 through 4.2-7 in Section 4.2.6). However, since these species are rare or have low densities in these areas, the numbers are still relatively low.

Please refer to Section 4.5.2.4.12 for a complete discussion of disturbance effects on Other Cetaceans.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.12. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in other cetaceans. The potential effects of ship strikes under Alternative 3 are similar to that discussed under Alternative 2. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact will be local, given the relative infrequency of occurrence and the non-random distribution of other cetacean species and exploration activity in the EIS project area.

Please refer to Section 4.5.2.4.12 for a complete discussion of potential injury or mortality effects on Other Cetaceans.

Habitat Alterations

The potential effects on cetacean habitat in the EIS project area under Alternative 3 would likely be similar to that described under Alternative 2, with the exception of acoustic habitat. As noted in Section 4.6.1.4, with the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels that other cetaceans (and especially mysticetes) are expected to respond behaviorally, but also above the levels at which masking might be expected to potentially occur for some types of signals and species (especially mysticetes), increases significantly. When the larger 120-dB zones around all of the potential sound sources are considered (not suggesting that all individuals exposed to this would be taken, but suggesting that they would all have to deal with a sound that is audible and potentially in the range where it would mask another important sound (including inter-species communication), the area of effect is quite large. However, this area is not densely populated by these other species, and represents the edge of several of their ranges, so the impacts are not expected to be great.

Please refer to Section 4.5.2.4.12 for a complete discussion of the potential effects on Other Cetacean habitat.

4.6.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.3.3 Conclusion

Evaluated collectively, the overall impact of Alternative 3 on Other Cetaceans is minor to moderate (the latter more likely for gray whales_. Despite a substantial increase in level of activity over Alternative 2, resulting in a notable increase in potential behavioral and acoustic habitat impacts, the overall anticipated impacts are still relatively low because of the comparatively low density of most of these species in this area and their large ranges. For Alternative 3, impacts on the resource would be low to medium in intensity, of temporary to interim duration, and of local to regional extent. .

4.6.2.4.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.17).

Table 4.6-5 Effects Summary for Other Cetaceans

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	Behavioral harassment expected to be < 30% of population
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14c), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	With the exception of gray and humpback whales, species are considered common.
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	**Local**	Since unlikely, any impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	All species but humpbacks common
		Important	Humpbacks are ESA-listed
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	Impacts to non-acoustic habitat features are generally low, but higher than Alternative 2
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~44% of EIS area ensonified over 120dB, up to 99% lost listening area in some areas of Beaufort)
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	With the exception of gray and humpback whales, species are considered common
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	

4.6.2.4.4 Ice Seals

4.6.2.4.4.1 Direct and Indirect Effects

Alternative 3 includes all of the same type of exploration activities as in Alternative 2, so the discussion of potential direct and indirect effects on ice seals under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.13. The difference between alternatives concerning ice seals is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2 (Table 4.2-2). These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.13.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 3 include several mechanisms for potential disturbance to ice seals in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The two types of surveys which take place on or in sea ice, the preferred habitat of ice seals and where they are most likely to be concentrated, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 3 as for Alternative 2. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on ice seals.

There would be a moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect ice seals over a large area, especially for the 2D/3D seismic streamer surveys, but the disturbance effects would be of interim duration and of medium intensity, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of ice seals.

Alternative 3 could authorize up to two exploratory drilling programs in both Arctic seas. The level of disturbance to seals is likely more intense in terms of the physical presence of the ships than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location and seals could become habituated to it. Given the mild reaction of seals to marine vessels and the close distances to which they often approach vessels, it is unlikely that having two drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular seals, although more seals could be affected than would occur with only one drilling program. Any disturbance and displacement of seals would cover a very small area and be considered short-term.

Based on the historical take estimates used for ice seals (see Tables 4.2-5 through 4.2-7 in Section 4.2.6), in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of ringed seals, with open water 2D/3D seismic surveys contributing to the majority of the behavioral disturbance takes for other species. Although no additional in-ice surveys were added in this alternative, the number of open water surveys did increase, and total take numbers between Alternative 2 and 3 increased from anywhere from 20 to 80%. For bearded, spotted, and ribbon seals, the total takes represent a relatively small portion of the population; however, for ringed seals magnitude is medium.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any ice seals being injured as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. There is a lack of data on the physiological thresholds for acoustic injury in ice seals but that information could only be obtained through captive studies involving potential injury to the animals and, given the behavioral avoidance of wild animals to loud seismic sources, this lack of data is not crucial for this analysis.

There is the potential for seals to be exposed to small spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g., transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). Exposure of seals to oil products could lead to irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). Ice seals are commonly observed near exploratory activities during the open-water season and could be exposed to spills in the water or on ice. A small phocid such as a 50 kilograms (kg) ringed or harbor seal would have to ingest several hundred milliliters of crude oil to be at risk. It is “unrealistic to assume that pinnipeds would consume such large volumes of oil during the course of normal feeding” (St. Aubin 1988, 1990). Likewise grooming would not present much of a risk for ingesting oil because it is a relatively uncommon activity among pinnipeds (McLaren 1988, 1990). McLaren (1990) concluded pinnipeds, with the exception of benthic feeders and species that prey upon birds or other seals, are unlikely to consume substantial quantities of hydrocarbons since their prey species are unlikely to accumulate residues. Smith and Geraci (1975) concluded that ringed seals in their study had a very low likelihood of ingesting large amounts of oil accidentally or through oiled food items. Geraci and Smith (1976a) found that up to 75 ml of ingested crude oil is not irreversibly harmful to seals, finding only transient liver enzyme release and negligible liver damage. Geraci and Smith (1977) noted “Reports which suggest that oil might affect seals by acute intoxication through ingestion should be viewed cautiously. Our experience has shown that immersed seals ingest very small quantities. Seals are not known to be carrion feeders, and any oil which they might consume from live prey would be negligible”. If a small spill did occur, cleanup efforts would begin immediately and those activities would likely include the presence of PSOs to monitor for ice seals and other marine mammals and deter them from entering the spill area if possible. Alternative 3 could authorize a greater level of exploration activity than Alternative 2 and the resulting risk of small spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills, the risk of ice seals being exposed to small spills during exploration activities authorized under Alternative 3 is considered to be minor. The potential effects of a very large oil spill caused by a well blowout are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11. Please refer to Section 4.5.2.4.13 for a complete discussion of potential injury or mortality effects on ice seals.

Habitat Alterations

The two types of activities that involve potential changes to ice habitat, icebreaking and vibroseis, would be at the same level as discussed under Alternative 2, and they were considered to have temporary effects that are similar in scope as those occurring due to natural forces in the dynamic sea ice environment. The increase from one exploratory drilling program in each Arctic sea under Alternative 2 to two drilling programs in each sea under Alternative 3 would increase the amount of intentional and unintentional discharges of drilling muds and other wastes. There is a lack of information about how any of these discharges could interact directly with ice seals or be carried through the environment to affect the food supply of ice seals (primarily fish and crustaceans). Given this lack of ecological information on the effects of these discharges on ice seal habitat, it is not possible to say whether two drilling programs constitute a substantially larger risk to habitat quality for ice seals than one drilling program. Unfortunately, the types of ecological monitoring studies required to address these issues are very difficult to conduct in the Arctic and even more difficult to interpret given the vast number of complicating factors. With the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels that ice seals are expected to be behaviorally disturbed, as well as the areas ensonified to levels that might be expected to mask sounds that are important to ice seals, has increased (see Section 4.6.1.4).

4.6.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to ice seals are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.4.3 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities and their reactions have been recorded by PSOs on board source vessels and monitoring vessels. These data indicate that seals do tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away and they do not appear to react strongly even as ships pass fairly close with active arrays. They also primarily appear to react to icebreaking or on-ice surveys by keeping their distance or moving away at some point to an alternate breathing hole or haulout. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected (ringed are also listed as depleted), and are therefore considered to be important resources. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 3 on ice seals would likely be medium to high in magnitude, distributed over a local to regional geographic area, and interim to long-term in duration. The effects of Alternative 3 would therefore be considered moderate for ice seal species according to the criteria established in Section 4.1.3.

Table 4.6-6 Effects Summary for Ice Seals

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	More than 30% ringed seals expected to be taken by Level B harassment
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14c), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	Non-ESA-listed , notable impacts not occurring in specifically identified important areas
		Important	
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	If it occurred, PTS would be permanent
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Non-ESA-listed species
		Important	
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	Impacts to non-acoustic habitat features are generally low, but higher than Alternative 2
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~44% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort)
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	Non-ESA-listed, notable impacts not occurring in specifically identified important areas
		Important	
		Unique	

4.6.2.4.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to ice seals are discussed under Alternative 2 (Section 4.5.2.4.17).

4.6.2.4.5 Pacific Walruses

4.6.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 3 on walruses. This species is dependent on pack ice and coastal shores for haul outs. Alternative 3 includes all of the same types of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on walruses under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.14. The difference between alternatives concerning walruses is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. Walruses are distributed widely across the Chukchi Sea but are uncommon in the deeper OCS waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact walruses. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.14.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 3 include several mechanisms for potential disturbance to walruses in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The one type of survey that takes place on or in sea ice (the preferred habitat for walruses and where they are most likely to be concentrated) is the in-ice 2D survey with icebreakers. On-ice vibroseis surveys would only occur in the Beaufort Sea at times when walruses would not be present. Only one such in-ice survey could be authorized for each Arctic sea under any of the action alternatives. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on walruses.

There would be a moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect walruses over a large area, especially for the 2D/3D seismic streamer surveys, but the disturbance effects would be temporary and low in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of walruses. Under standard operating procedures, seismic surveys would need to be separated by at least 24 km (15 mi). At this distance, concurrent and adjacent surveys are unlikely to disturb the same walruses at the same time, although some animals could be exposed to more than one survey vessel over time as it travels through an area. The addition of one or more seismic surveys to either the Beaufort or Chukchi seas would increase the likelihood that two or more different surveys could be operating in the same general area at the same time but the minimum distance requirement would still apply and therefore effectively minimize the concern for increased disturbance to any one group of walruses.

Alternative 3 could authorize up to two exploratory drilling programs in each sea. The level of disturbance to walruses is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location and walruses could become habituated to it. Given the mild reaction of walruses to marine vessels it is unlikely that having two drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular walruses, although more walruses could be temporarily affected than would occur with only one drilling program. Any disturbance and displacement of walruses would cover a very small area and be considered of interim duration.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any walrus being injured or killed as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any walrus would be exposed to very loud sounds from seismic operations to the point where they might be injured.

There is a potentially dangerous situation with walruses on land-based haulouts primarily on the Chukchi coast from Point Lay to Barrow. Disturbance by low-flying aircraft or nearby vessels could cause stampedes and crushing deaths. USFWS LOA mitigation measures for exploration aircraft and vessels are intended to monitor and avoid such haulouts to avoid causing such deadly disturbance.

As discussed in Section 4.5.2.4.14 exposure to small spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities could have substantial health effects on walruses and could spread among animals in a close herd. Alternative 3 could authorize a greater level of exploration activity than Alternative 2 and the resulting risk of small spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills and the occurrence of walruses primarily on or near the pack ice rather than swimming in open water where most exploration activities take place, the risk of walruses being exposed to small spills during exploration activities is considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Please refer to Section 4.5.2.4.14 for a complete discussion of potential injury or mortality effects on walruses.

Habitat Alterations

Benthic prey of walruses may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as OBC and OBN surveys in the Beaufort Sea, vessel anchors, and exploratory drilling. All of these activities could displace benthic mollusks and crustaceans temporarily and may cause small amounts of mortality. Alternative 3 could authorize higher levels of exploration activities that involve benthic disturbance than Alternative 2. However, given the very small areas of benthic surface that could be impacted by all of these activities and the wide distribution of prey fields for walruses, these activities would be unlikely to affect the availability of prey to walruses.

Icebreaking ships intentionally disrupt pack ice in order to conduct seismic surveys or to help manage ice floes around exploratory drilling equipment. The amount of icebreaking activity and potential impacts to under Alternative 3 would be similar to Alternative 2.

Alternative 3 could authorize a greater level of exploration activity than Alternative 2, including double the amount of exploratory drilling, and the resulting risk of small spills and discharges occurring would be proportionally greater. The potential effects on the quality of walrus habitat would depend primarily on the amount of sub-surface benthic habitat disturbed during drilling operations and the richness of the invertebrate fauna at that location. Please refer to Section 4.5.2.4.14 for further discussion of potential effects on walrus habitat.

4.6.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to walrus are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.5.3 Conclusion

Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. This data indicates that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of mortality from stampedes.

Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for purposes of this analysis. Given the level and type of exploration activities that would be authorized under Alternative 3, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 3 would therefore be considered moderate for walruses according to the criteria established in Section 4.1.3.

4.6.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to walruses are discussed under Alternative 2 (Section 4.5.2.4.17).

4.6.2.4.6 Polar Bears

4.6.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 3 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 3 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on polar bears under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.15. The difference between alternatives concerning polar bears is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures as Alternative 2. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.15.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 3 include several mechanisms for potential disturbance to polar bears along leads in the ice and in broken ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment including the potential for direct human-bear encounters. The two types of surveys which take place on or in sea ice, the hunting and denning habitats for polar bears, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 3 as for Alternative 2. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on polar bears.

There would be a moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect polar bears over a larger area, especially for the 2D/3D seismic airgun arrays; however, few polar bears are encountered in open water, so the disturbance effects would be temporary and low in magnitude, characterized by neutral or ambiguous behavioral reactions of polar bears. Some polar bears could be exposed to more than one survey vessel over time as it travels through an area, but most encounters with exploration vessels typically occur while polar bears are on ice or land. The addition of one or more seismic surveys to either the Beaufort or Chukchi seas would increase the likelihood that two or more different surveys could be operating in the same general area at the same time.

Alternative 3 could authorize up to two exploratory drilling programs in each sea. The level of disturbance to polar bears is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location and polar bears could become habituated to it. Given the mild reaction of polar bears to marine vessels it is unlikely that having two drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular bears, although more bears could be temporarily affected than would occur with only one drilling program. Any disturbance and displacement of polar bears would cover a very small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any polar bears being injured or killed as a result of noise levels or ship strikes used in oil and gas exploration activities because of the infrequency of polar bears being observed in the open-water areas where most exploration is conducted, and their ability to detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any polar bears would be exposed to very loud sounds from seismic operations to the point where they might be injured. Exposure to spills of fuel, oils, and other compounds from exploration vessels and equipment could injure or kill a polar bear (USFWS 2008b), but given the small volume of typical spills and clean-up requirements that would include deterrence of polar bears if necessary,. the risk of polar bears being exposed to oil spills is considered negligible. Polar bears are curious, so there is always the potential for human-bear interactions during oil and gas exploration in the Arctic, even if the activities are temporary, but continuation of diligent polar bear monitoring and safety management will decrease the risk of injury or death for humans and bears. The potential effects of a very large oil spill caused by a well blowout are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alterations

The two types of activities that involve potential changes to polar bear habitat, ice breaking and vibroseis, would be at the same level under Alternative 3 as discussed under Alternative 2. These activities would have only temporary effects on the physical characteristics of the ice and are not likely to displace polar bear prey species (ice seals) for more than a few hours. Seal distribution and abundance would continue to be determined by ice conditions and other natural factors rather than the presence of exploration activities. Polar bear habitat quality would therefore not be affected by exploration activities. The increase from one exploratory drilling program in each sea under Alternative 2 to two drilling programs in each sea under Alternative 3 would increase the amount of intentional and unintentional discharges of drilling cuttings and other wastes. The amount of increase would depend upon the depth of the wells and other factors. However, polar bears are unlikely to be affected by discharges to the seafloor.

4.6.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.6.3 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 3 on polar bears would likely be medium in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 3 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.6.2.4.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.17).

4.6.2.5 Terrestrial Mammals

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.5.2.5 for Alternative 2 are also applicable for this alternative. The increased levels of activity would not generate different types of impacts to terrestrial mammals. The conclusions for Alternative 2 are applicable to Alternative 3. While the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to terrestrial mammals from aircraft activity would be minor.

4.6.2.6 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.6). Although an increased level of activity could be authorized under Alternative 3 from that considered under Alternative 2, the suite of standard and additional mitigation measures analyzed would be applied to any MMPA ITA issued. Therefore, any level of activity would include measures to mitigate impacts on the biological environment (although primarily aimed at reducing impacts to marine mammals).

4.6.3 Social Environment

4.6.3.1 Socioeconomics

The following discussion of direct and indirect effects of Alternative 3 evaluates effects on public revenues and expenditures, employment and personal income, demographic characteristics, and demand on social organizations and institutions associated with an increased Level 2 of oil and gas exploration activity.

4.6.3.1.1 Direct and Indirect Effects

Public Revenue and Expenditures

Under Alternative 3 (Level 2 activity), the categories of revenue generation are the same as Alternative 2. There could be an increased level of economic activity generated in communities hosting vessel crew changes or purchasing/staging support materials, particularly if they have a tax regime to capture direct revenue (see Table 4.5-2). If new facilities were built to support offshore activities – for example a new support base at Wainwright – additional state and local property tax revenues could be generated , but the amount can not be predicted at this time.

Employment and Personal Income

Under Alternative 3, there would be similar types of (direct) new local hire opportunities associated with the standard mitigation measure D2 to reduce subsistence interference, and A3 and A6 to reduce marine mammal disturbance and deflection. The level of (direct) new local hire employment opportunities may increase under Level 2 activity or remain relatively the same as Level 1, if certain positions are duplicative in nature. For example, a Com Center position would be staffed continuously during the open-water season whether there are 1 or 2 exploratory drilling operations occurring in the Chukchi Sea, and PSOs may work for multiple programs, schedule permitting. The establishment of Com Centers, prescribed in standard mitigation measure D2, would not change the employment opportunities described under Alternative 2. However, the duration of employment, and therefore income, could increase.

Table 4.6-7 demonstrates a maximum hypothetical quantity of PSOs hired under Alternative 3. It represents an increase of less than three percent of the potential work force for the region for seasonal, part-time labor.

Table 4.6-7 Maximum PSO Positions Under Alternative 3[1]

	Alternative 3 (Annual Activity Level 2)	Vessels Deployed (PSOs required)[2]	Aerial Observers	PSOs/survey	Total PSOs
Beaufort Sea	**Six 2D/3D seismic surveys**	Source (5) 2 chase/monitoring and/or icebreaker (3 each)	4	15	90
	Five site clearance and high resolution shallow hazards survey programs	Source (5)	4	9	45
	Two exploratory drilling program	Drilling rig (5) 2 ice management (3 each) 3 other various (2 each)	4	21	42
Chukchi Sea	**Five 2D/3D seismic**	See Beaufort examples	4	15	75
	Five site clearance and high resolution shallow hazards survey programs		4	9	45
	Two exploratory drilling		4	21	42
		TOTAL PSOs per year		**88**	**339**

Notes:

1) Assumes all positions are unique; one PSO would not be hired for multiple surveys.
2) Numbers based on (Funk 2011) and (NMFS 2009 IHA permit)

The indirect employment opportunities associated with Alternative 3 may increase marginally under Level 2 activity because shore-based support and logistical service demands would increase, including: transport of equipment; room and board of survey/seismic crews; and administration of permits to conduct the surveys. Native Corporations and private entities may capitalize on these opportunities. As described under Alternative 2, these services would be seasonal and temporary in nature.

Demographic Characteristics

As described under Alternative 2, Alternative 3 would not have a direct or indirect contribution to demographics in the EIS project area communities because Level 1 and 2 activities would be seasonal and short-term in nature. It is not anticipated any workers would move themselves or their families to any of the coastal communities.

Social Organizations and Institutions

The implementation of Alternative 3 would result in modest increases in revenues to municipal governments associated with sales and special taxes and employment and service contracts with regional and village corporations. In the communities where crew changes occur or vessels are based, there could be modest increases in short-term, seasonal demand on institutions and social services in Barrow, Wainwright, Nome and Unalaska/Dutch Harbor.

4.6.3.1.2 Conclusion

The magnitude of the socioeconomic impact under Alternative 2 would be positive and greater than a Level 1 activity. However, the magnitude of increase of total personal income and local employment rates would still not increased by more than five percent. The duration of the socioeconomic impacts would be interim- lasting a fixed number of years, but not year-round. The positive economic impacts of the activity would be statewide and national. Standard mitigation measures could reduce potential for adverse effects on subsistence activities and associated social impacts. The context of the socioeconomic impacts is considered unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat (minority population) communities. The summary impact level for socioeconomic resources under Alternative 3 is moderate.

4.6.3.2 Subsistence

4.6.3.2.1 Direct and Indirect Effects

The potential effects to subsistence resources and harvest from disturbance of the seismic survey (both open-water and on-ice) and exploratory drilling, aircraft and vessel traffic, icebreaking and ice management, permitted discharges under Alternative 3 would be the same as those described under Alternative 2 (Section 4.5.3.2). Table 4.5-29 describes the different subsistence hunts that occur within the EIS project area by resource, where these subsistence hunts occur, the seasons of occurrence and the potential for overlapping with proposed activities of Alternatives 2 through 6. Detailed information regarding the seasonal cycles of subsistence resources and harvest patterns is described in Section 3.3.2.

Even with the increase in the number of activities/programs that could potentially occur under Alternative 3, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity, and comparable duration, but occurring in more locations to those discussed in Alternative 2.

Assumptions regarding the level of activity used in the analysis of impacts to subsistence for Alternative 3 are described in Section 2.4.6. Under Alternative 3, only these activities would be permitted. In the Beaufort and Chukchi seas, it is assumed that the activity/programs described in Table 2.4 would involve the sound sources and sound levels associated with individual sources, the same types of source and support vessels, and the same types of icebreakers for ice management and/or icebreaking. However, there would be more vessels conducting the activities in more sites with more support vessels and more aircraft traffic from the addition of more programs being potentially permitted. Given operating conditions, the number of days the activities could occur in a season would be the same as those as Alternative 2. Under Alternative 3, the activity area(s) and or number of wells to be drilled could be increased with up to two exploratory drilling programs potentially permitted in both the Beaufort and Chukchi seas.

4.6.3.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.5.3.2).

4.6.3.2.3 Conclusion

Impacts of Seismic, High Resolution Shallow Hazard Surveys and Exploratory Drilling Noise Disturbance to Subsistence Resources

Bowhead Whales

Section 4.5.2.4.10 and Section 4.6.2.4.1 (Bowhead Whales) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect bowhead whales. Any impacts of seismic and high resolution shallow hazard surveys and exploratory drilling noise that affect behavior of bowhead whales are expected to result in some temporary deviation in migratory path in the vicinity of the disturbance. However when the standard and additional mitigation measures contemplated in this EIS are applied, the impact of disturbance to subsistence resources and hunters would be of low intensity and temporary to interim in duration (i.e., for the duration of the activities, lasting a month or longer though not likely the entire project seasonseason). The geographic extent could be local to regional, affecting a resource of unique context, due to listing under the ESA. Impacts would not be expected at the population level, reducing long-term opportunities to subsistence harvest bowhead whales. The level of oil and gas exploration activities and potentially the geographic area affected would increase from Alternative 2. The summary impact to subsistence harvest from disturbance of bowhead whales could be considered moderate.

Beluga Whales

Sections 4.5.2.4.11 and 4.6.2.4.2 (Beluga Whales) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect beluga whales. In the Chukchi Sea, beluga whales could be displaced, i.e., would avoid areas in the vicinity of seismic survey and exploratory drilling operations in July through October during their spring and fall migrations. This would have the potential to impact and disrupt some communal beluga subsistence hunts (particularly Point Lay which heavily depends on this resource) by disturbing and altering the course of these migrating whales. In turn this could make belugas more difficult to herd into the lagoons and harvest (as in the case of Point Lay).

However, the impacts would be minimized or avoided by the required mitigation measures of this EIS. As mitigated, the effects of disturbance would be considered to be of low intensity and temporary to interim in duration, occurring for the duration of the activities offshore lasting a month or longer though not likely the entire project season. These impacts are considered regional in geographic extent and affecting a resource that is locally important in context. There would not be expected impacts on a population level that would result in long-term impacts reducing the subsistence harvest. The summary impact to subsistence harvest from disturbance of beluga whales could be moderate based upon the fact that the resource is considered locally important in context.

Seals

Sections 4.5.2.4.13 and 4.6.2.4.4 (Ice Seals) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect these seals. Subsistence hunts of seals occur either in nearshore coastal areas or onshore in the spring and winter seasons when seismic and high resolution shallow hazards surveys and exploratory drilling operations would not be present. Most ringed and bearded seals are harvested in the winter or in the spring before these assumed activities would occur. While spotted seals are harvested during the summer, the activities of seismic survey and exploration drilling activities would be expected to occur offshore from subsistence use areas. Activities within the lease areas offshore that that are likely to be explored during the open water season would have no impact on subsistence hunting for seals. One on-ice seismic survey could have the potential to disturb or displace seals in their lairs but this survey would be mitigated to lessen the impact to seals. Any impacts to seal subsistence harvests from the on-ice seismic survey would be characterized as a low intensity, limited to a local area, temporary in duration, and important in context. Therefore the summary impact to subsistence seal harvests is negligible.

Walruses, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be the same as described under Alternative 2.

There would be little overlap in timing and location of many of these harvest activities. In addition, mitigation measures would be required to be implemented to minimize or completely avoid adverse effects on all marine mammals and other subsistence resources and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses. In consideration of timing and the standard and additional mitigation measures, these activities are not expected to disturb or disrupt subsistence activities at a level that would make these resources unavailable for harvest or substantially alter the existing levels of harvests. Summary impacts to seals, walruses, polar bears, subsistence fishing, bird harvest and egg gathering, and harvest of caribou are the same as those described in Alternative 2.

Impacts of Disturbance from Aircraft Overflights to Subsistence Resources

Bowhead Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The amount of support activity associated would likely increase over Alternative 2. The sound emitted by aircraft overflights potentially could cause some disruption to bowhead whale harvest, but aircraft overflights as mitigated are not expected to make bowhead whales unavailable to subsistence hunters. Whales could be expected to temporarily deflect from overflights, but mitigation measures analyzed in and contemplated by this EIS would limit the probability of this impact occurring. It is expected that helicopters servicing offshore seismic and high resolution shallow hazard surveys and exploratory drilling operations could traverse areas utilized by subsistence whalers during fall whaling in the Beaufort Sea and limited areas of the Chukchi Sea. Mitigation measures prescribing flight path and altitude restrictions are expected to reduce any such potential impacts to a low level.

If bowhead whales were affected by aircraft overflights, it is unlikely that large numbers or a large area used by active whaling crews would be affected, so the intensity of the impact would be considered low, and the duration would be temporary to interim (lasting a month or longer though not likely the entire project season). Effects of increased levels of activity permitted under Alternative 3 are low in intensity, temporary to interim in duration, local to regional in extent, and affecting a resource that is unique in context, due to listing under the ESA. The summary impact is considered moderate based upon the fact that the resource is considered unique in context.

Beluga Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.11 and 4.6.2.4.2 (Beluga Whales) of this EIS. Summer beluga hunting could be impacted by increased numbers of trips/aircraft overflights given the levels of activity associated with Alternative 3. Mitigation measures applied to this impact would lessen the disturbance to a point that it would be considered low in intensity, temporary to interim in duration, local or regional in extent, and affecting a resource that is important in context.

The required mitigation measures are expected to minimize and/or avoid impacts to beluga whales and their subsistence harvest as the mitigation measures for flight path and altitude restrictions are expected to reduce impacts to the point that the summary rating is considered moderate based upon the fact that the resource is considered locally important in context.

Caribou Hunting

The higher levels of activity permitted under Alternative 3 would result in increased helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations. There is a potential for disturbance to caribou subsistence hunting from the helicopter traffic that may disturb caribou on the coast. Helicopters would be traversing routes offshore from the shorebases and small proportions of available subsistence hunting areas would be affected at altitudes of less than 305 m (1,000 ft.) – most likely during takeoff and landings.

With implementation of mitigation measures, including flight altitude restrictions and use of Communication Centers, aircraft overflights are unlikely to have an adverse effect on caribou availability for subsistence harvest. Impacts that did occur would be considered low in intensity and temporary in duration. The impact would be local to regional in extent and affecting a resource that is common to important in context. The summary impact is considered moderate.

Seals, Walruses, Polar Bears, Subsistence Fishing, Bird Hunting and Egg Gathering

Impact to these subsistence resources and their harvests are expected to be same as under Alternative 2.

The higher levels of activity permitted under Alternative 3 would increase aircraft traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause some temporary behavioral disturbance and possibly deflection away from the sound source by terrestrial or marine mammals. The level of the disturbance would depend on the size of the aircraft and repeated exposure or displacement occurring to the resources, as well as whether or not the overflights overlap in time and space with subsistence hunting grounds.

Aircraft overflights are unlikely to have an adverse effect on subsistence harvest as mitigated, and given that they may not overlap with subsistence activities in time and space. Impacts that did occur would be considered of low intensity but temporary in duration. The impact would be local to regional in extent, affecting resources that range from common to unique in context. Impacts to seals, walruses, polar bears, subsistence fishing, bird harvest and egg gathering are the same as those described in Alternative 2.

Impact of Vessel Traffic to Subsistence Resources

Bowhead Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The higher levels of activity permitted under Alternative 3 would increase vessel traffic and vessels present in the area associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause bowhead whales to alter their behavior during migration and avoid the area(s) within a few kilometers of vessel activities. However the required mitigation measures would limit impacts to late migrating bowhead whales and subsistence hunting from vessel traffic. The levels of activity permitted under Alternative 3 increase the potential for disturbance on a more regional level. Impacts to bowhead whale subsistence hunting are likely to be of low intensity, temporary to interim in duration, though could be local to regional extent, and affecting a resource that is unique terms of the context, due to the listing under the ESA. The summary impact could be considered moderate in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Beluga Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.11 and 4.6.2.4.2 (Beluga Whales) of this EIS. A limited number of late migrating spring beluga whales could encounter increased numbers of vessels and higher levels of activity permitted under Alternative 3 for seismic and high resolution shallow hazard surveys and exploratory drilling activities and operations. The impact of disruption to beluga whales from vessel traffic could result in temporary deflection of beluga whales from subsistence harvest areas and reduced success of these hunts. However, standard mitigation measure D4 prohibits transit of exploration vessels into the Chukchi Sea prior to July 1, and all transits in the Chukchi Sea must remain at least 8 km (5 mi) offshore. Moreover, additional mitigation measure B1 would not allow any exploration activity in Kasegaluk Lagoon during the Point Lay summer beluga hunt. However the increased levels of activity permitted under Alternative 3 include the potential for disturbance on a regional level (impacts extending throughout the EIS project area) as defined in Section 4.1.3. The impact to beluga whales that do encounter vessels would be of low intensity, temporary to interim in duration, local to regional extent, and affect a resource that is important in terms of the context. The summary impact could be considered moderate in terms of a resource that is locally important, levels of subsistence hunting, and sharing of the resource that would be affected.

Seals

Sections 4.5.2.4.13 and 4.6.2.4.4 (Ice Seals) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Seals could be displaced or avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities. However, under the required mitigation measures for vessels transiting into the Beaufort and Chukchi seas for these activities, impacts to seals would not be such as to adversely impact subsistence hunting activities. Subsistence seal hunts would occur in nearshore coastal areas away from areas likely to be transited by vessels. The majority of seal subsistence hunting occurs in the spring and winter seasons when vessels associated with seismic survey and exploratory drilling would not be expected to be present in subsistence harvest areas. However with the increased levels of activity permitted under Alternative 3 there would greater potential for disturbance on a regional level (impacts extending throughout the EIS project area as defined in Section 4.1.3). With spatial and seasonal separations, the impact to subsistence seal harvest would be of low intensity, temporary duration, local to regional extent, and affecting resources that are important in terms of the context. The summary impact could be considered minor in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Walruses, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be the same as under Alternative 2.

The summary impact for walruses and polar bears is considered minor. Negligible summary impacts to subsistence harvest of fish, bird hunting and egg gathering, and caribou are expected as a result of vessel traffic and the same as Alternative 2.

Impacts of Icebreaking and Ice Management on Subsistence Resources

Bowhead Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.1 (Bowhead Whales) of this EIS. Seismic and high resolution shallow hazard surveys and exploratory drilling activities would be expected to occur during the open water season when seismic and high resolution shallow hazard surveys and exploratory drilling vessels would not encounter large amounts of sea ice. However icebreaking and ice management may be necessary during late fall or early winter when industry is still engaged in seismic and high resolution shallow hazard surveys and exploratory drilling activities in order to protect equipment, vessels, and infrastructure. Additionally, some operators have recently proposed to conduct seismic surveys during the in-ice or shoulder season (i.e., October through December). These surveys would require the use of an icebreaker to go ahead of the seismic survey vessel. The required mitigation measures limit the time frame in which these activities occur in, and, as a result, the likelihood of impacts to subsistence harvest as a result of ice management activities is reduced and unlikely to adversely affect subsistence harvest of bowhead whales. The majority of these types of in-ice surveys would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas. With the increased levels of activity permitted under Alternative 3 the potential for disturbance on a more regional level becomes greater (impacts extending throughout the EIS project area as defined in Section 4.1.3). In the event that icebreaking does cause bowhead whales to avoid an area the impact to subsistence resources is expected to be low in intensity, temporary to interim in duration, local to regional in extent, and affecting a resource that is unique in context. This would be considered a moderate impact to subsistence harvest of bowhead whales based upon the fact that the resource is considered unique in context.

Beluga Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.11 and 4.6.2.4.2 (Beluga Whales) of this EIS. Icebreaking activities could increase under Alternative 3 with the greater level of permitted activity allowed for seismic survey and exploratory drilling activities. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities when ice is encountered in the late fall through early winter months of exploration activities. Icebreaking and ice management would be limited to areas where industry is actively exploring or drilling. These activities would occur in the OCS waters and would not be expected to affect beluga whale subsistence hunting. Icebreaking and ice management activities would be conducted far removed from areas typically hunted in the Chukchi Sea. No impacts are anticipated for beluga subsistence hunts in the Beaufort Sea, as beluga hunting is conducted opportunistically during the bowhead hunt, and the required mitigation measures of this project would prohibit seismic survey and exploratory drilling activities (and associated ice management) from occurring during this time.

The required mitigation measures are expected to minimize and potentially avoid impacts on beluga whales so that no adverse impacts occur to subsistence harvest. There is a low probability that impacts could occur to subsistence users in the Chukchi Sea. With the increased levels of activity permitted under Alternative 3 there is greater potential for disturbance on a regional level (i.e., across the EIS project area). In the event that icebreaking or ice management does cause beluga whales to avoid an area the impact to subsistence resources is expected to be low in intensity, temporary in duration, local to regional in extent, and affecting a resource that is important in context. This would be considered a moderate summary impact to the subsistence harvest of beluga whales based upon the fact that the resource is considered locally important in context.

Seals

Sections 4.5.2.4.13 and 4.6.2.4.4 (Ice Seals) describe the mechanisms by which icebreaking and ice management activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Icebreaking could be associated with seismic survey plans that extend into the late open water season late fall to early winter (October to December) when daylight is very limited to absent and visibility is reduced making seals more difficult to spot although. At this time of year sealing efforts for subsistence are not concentrated or intense. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling and would occur in the OCS waters during the open water season after sea ice has retreated and melted. Although a greater level of activity would occur under Alternative 3, these proposed activities would occur after the end of pupping and molting seasons for all ice seals. There would be few seals expected in the area of where the proposed activities would take place. Subsistence harvest of seals would not be expected to occur in areas of active ice management offshore. The required mitigation measures are expected to avoid and minimize impacts on seals and in turn on subsistence harvests so that no adverse impacts occur. There is a low probability that impacts would occur to subsistence users. In the event that icebreaking does cause seals to avoid an area, the impact is expected to be low in intensity, temporary in duration, local to regional in extent, and affecting resources that are common to important in context. This would be considered a minor summary impact to subsistence harvest of seals.

Walruses, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be same as under Alternative 2.

Summary impacts to subsistence harvest of polar bears are considered to be minor. Summary Impacts to walruses and bird hunting and egg gathering from icebreaking are expected to be negligible and the same as under Alternative 2. No impacts to fish or caribou are expected.

Impacts of noise and vehicle movement from on-ice seismic surveys

No impacts are anticipated subsistence harvests of bowhead whales, beluga whales, walruses, and fishing as a result of the on ice seismic survey. Summary impacts to seals, marine and coastal birds and caribou are expected to be the same as under Alternative 2 and are considered negligible. The summary impacts to polar bears could be minor.

Indirect Impact to Subsistence Resources from Permitted Discharges

Permitted discharges would be conducted under the conditions and limitations of the required NPDES and/or APDES General Permits. Permitted discharge would be mitigated by additional mitigation measures C2 and C3, which would place requirements and limitations on the levels of discharge and discharge streams that could affect marine mammal habitat and eventually the diets of subsistence users. Under Alternative 3, there could be a higher level of activity, which would increase the levels of permitted discharges.

Mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources. There is a perception the foods could become contaminated by discharges and/or small fuels spills could result in impacts to human health from consumption of the resources. The likelihood is low that subsistence resources or harvest would occur in the vicinity of the assumed areas where drilling and/or any associated discharge or spill might occur. In addition fuel transfers are not expected during transit between the Beaufort and Chukchi seas. The indirect impact of drill cuttings and mud discharges may displace marine mammals and fish a short distance from each drilling location. The impacts to subsistence users would be of low intensity, short term in duration, local in extent, and affecting resources that are common to unique in context. Therefore the summary impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Impact to Subsistence Resources from Small Fuel Spills

Mitigation measures may not alleviate the perception that a small oil spill might contaminate subsistence resources. There is a perception the foods could become contaminated a small fuel spills that could result in impacts to human health from consumption of the resources. The likelihood is low that subsistence resources or harvest would occur in the vicinity of the assumed areas where drilling and/or any associated small fuel spill might occur. In addition fuel transfers are not expected during transit between the Beaufort and Chukchi seas. As described above, the impacts to subsistence harvest and users of low intensity, temporary in duration, local extent, and affecting resources that are common to unique in context. Therefore the impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Summary

Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 3 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales and polar bears are considered unique in context as these resources are protected by legislation (e.g., MMPA, ESA) or are considered an important subsistence resource (beluga whales). Therefore the summary impact level of Alternative 3 on subsistence resources and harvests would range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance.

4.6.3.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.5.3.2).

4.6.3.3 Public Health

4.6.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 3 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.5.3.3.

4.6.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 3. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur they would affect minority or low-income communities, the duration of changes may be long-term, and multiple communities could be affected.

4.6.3.4 Cultural Resources

4.6.3.4.1 Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.5.3.4 for Alternative 2 are the same for Alternative 3. The overall impact to cultural resources would be negligible.

4.6.3.4.2 Conclusion

Direct and indirect impacts to cultural resources resulting from the implementation of Alternative 2 would be the same in Alternative 3. For a complete discussion of direct and indirect impacts on cultural resources, please see Section 4.5.3.4.

4.6.3.5 Land and Water Ownership, Use, and Management

4.6.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership caused by Alternative 3 are similar to those caused by Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics. This includes federal, state, private, borough, and municipal owned lands and waters.

Land and Water Use

The actions in Alternative 3 are the same as for Alternative 2. However, the activity levels are increased; numbers of allowed seismic surveys, shallow hazards survey programs, and exploratory programs are increased in the Beaufort and Chukchi seas. The amount of on-ice seismic surveys and icebreaking would remain the same. Taking into consideration these increases, direct and indirect effects to the recreation, residential, mining, and protected land uses would be similar to Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics.

With an increase in activity levels, the possibility for conflict would increase between subsistence use and surveys. Section 4.6.3.2 discusses the direct and indirect impacts of Alternative 3 in detail.

The direct and indirect impacts caused by Alternative 3 for industrial, transportation, and commercial land uses would be similar to those discussed under Alternative 2 in Section 4.5.3.5 but use would increase incrementally as survey activity levels go up. Beyond what is discussed in Section 4.5.3.5, there is a slightly higher possibility of new facilities and infrastructure, higher levels of air and vessel traffic, and commercial activity associated with survey support. No new roads or railroad lines are expected to be built under this alternative; therefore no changes are expected in land use to accommodate expanded land transportation systems. See Section 4.6.3.1 Socioeconomics for further discussion on economic opportunities under this alternative.

Land and Water Management

BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS. The level of exploration activity in federal water under Alternative 3 is consistent with management of those waters. Similarly, the state applies Best Interest Findings before allowing seismic exploration activities and each must demonstrate individual consistency with state management policies before permits are issued on state lands or waters. Therefore, no inconsistencies or changes in federal or state land or water management are anticipated as a result of this alternative. The effects would be similar to those discussed under Alternative 2, Section 4.5.3.5.

While no change in underlying land or water management is anticipated as a result of this project, compliance with NSB and NAB comprehensive plans and Land Management Regulations coastal management policies is undertaken on a voluntary basis for activities in state and federal waters; permit applicants for offshore exploration activities in state waters may attempt to be consistent with Borough Land Management Regulations. As activities increase under Alternative 3, the possibility for conflicts with borough offshore development and coastal management zoning policies goes up as well. As indicated in Section 3.3.5.3 State Waters Managment, the Alaska Coastal Management Program was not reauthorized by the state legislature and has not been in effect since 2011.

4.6.3.5.2 Conclusion

Based on Table 4.4-2, and the analyses provided in Section 4.5.3.5.2, there would be no direct or indirect impacts on land and water ownership under Alternative 3.

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5.2, the impacts of land and water use caused by Alternative 3 are described as follows. The magnitude of impact would be high where activity occurs where there is previously little to no activity (such as Wainwright), and the magnitude of impact would be low where activity occurs where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be interim because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be long-term if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 3 would be moderate because of the possibility for high intensity and long-term impact in smaller communities.

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5, the impacts on land and water management caused by Alternative 3 are described as follows. The magnitude of impact would be low because, while the level of activity would increase, they are consistent with existing management plans, subject to conditions of approval. The duration of impact would be interim because project activities would last an entire project season, but would not result in long-term conflicts with management plans. The extent of impacts would be local because proposed activities would not involve management plans beyond the local areas of exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 3 on land and water management would be minor because they would be low intensity, would be interim in nature, local, and common.

4.6.3.6 Transportation

4.6.3.6.1 Direct and Indirect Effects

The effects to transportation in Alternative 3 would be similar to those described under Alternative 2 (Section 4.5.3.6). Alternative 3 would have an elevated level of intensity with an increased number of seismic surveys, site clearance surveys and would allow for an additional exploration program. The direct effect to transportation from Alternative 3 would be an increase in levels of air traffic and vessels present in these areas associated with the seismic survey and exploratory drilling activities in comparison to levels projected under Alternative 2. The intensity of the impact would still be considered low and temporary to interim in duration (length of survey or exploratory drilling activities each year). The extent of increased aircraft presence may be on a local to regional scale given the increased number of seismic survey and exploratory drilling programs that could occur under Alternative 3. Impacts from the increased levels of air traffic would be low in intensity, interim in duration, and local to regional in extent and affect a common resource. The impact level could be considered minor.

4.6.3.6.2 Conclusion

Increased levels of marine vessel traffic in Alternative 3 associated with the seismic survey and exploratory drilling programs would be expected to occur at offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when lightering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence would be low in intensity, temporary to interim in duration, limited in geographic extent to a local to regional area, and common in context. The summary impact from increases in vessel traffic would be considered minor.

4.6.3.7 Recreation and Tourism

4.6.3.7.1 Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.5.3.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 3; the overall impact to recreation and tourism would be minor.

4.6.3.7.2 Conclusion

The direct impacts to recreation and tourism would be low intensity, interim in duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 3 on recreation and tourism would be minor.

4.6.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 3 of the proposed project.

4.6.3.8.1 Direct and Indirect Effects

Implementation of Alternative 3 would be similar to that described in Section 4.5.3.8, however there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in interim moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 3, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, local and occur in an important context.

4.6.3.8.2 Conclusion

In conclusion, implementation of Alternative 3 is expected to result in interim moderate effects to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites, as visual contrast of these actions would attenuate with distance. The geographic extent of potential impacts would be local, as actions are not expected to be detectable beyond the project area; however they could affect an important resource in the ANWR to the extent they are visible by visitors.

4.6.3.9 Environmental Justice

4.6.3.9.1 Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

Even with the increase in the number of activities/programs that could potentially occur under Alternative 3, the impacts to subsistence resources and harvest are anticipated to be similar in type and comparable duration (interim, lasting a month or longer, but not likely the entire open season), but occurring in more locations. The activity levels associated with Alternative 3 are expected to result in could result in increased intensity levels of disruption to subsistence hunts by disturbing and altering the course of marine mammals harvested in the EIS project area (described in Subsistence Section 4.5.3.2 for

Alternative 2). Impacts to subsistence would range in intensity from negligible to moderate depending upon the resource under Alternative 3.

Alternative 3 activity levels are not expected to have a substantial impact on the numbers of marine mammals harvested. Dispersion of some animals may occur in more locations, resulting in greater travel time, cost, and safety risk to the hunters, but not overall availability or consumption of traditional foods. Health indicators affected by Alternative 3 activities would be similar to those described under Alternative 2 (described in the Public Health Section 4.5.3.3); health outcomes would be above background conditions, but within normal variation. Health changes may be long-term and multiple communities could be affected. Alternative 3 would cause a negligible increase in contamination levels of subsistence food which could have the indirect effect of altering confidence in their consumption.

4.6.3.9.2 Conclusion

Activities related to implementation of Alternative 3 would have a neglibible to moderate impact on subsistence resources and minor impact on human health. Subsistence foods and human health are unique resources and they are protected under the MMPA and EO 12898. There would also be an overall minor impact to Alaska Native communities under Alternative 3.

4.6.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.7 Direct and Indirect Effects for Alternative 4 – Authorization for Level 3 Exploration Activity

4.7.1 Physical Environment

4.7.1.1 Physical Oceanography

4.7.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

Under Alternative 4, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 3. Alternative 4 would allow two additional drilling programs in each OCS Planning Area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled, relative to Alternative 3. The effects of Alternative 4 on water depth would be low-intensity, long-term, and would affect a common resource. Changes in water depth from discharged material would have only minor effects on the physical resource character of the proposed action area. Although common resources would be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 4 on water depth would be minor.

Currents, Upwellings, and Eddies

Seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys would have only negligible effects on currents, upwellings, and eddies within the EIS project area under Alternative 4. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 4, would result in medium-intensity, temporary (ice), local effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial ice islands are constructed to support exploratory drilling activities. Exploratory drilling activities in the Chukchi Sea are anticipated to occur from temporary structures, as opposed to artificial ice islands that could be built in the nearshore Beaufort Sea. Therefore, exploratory drilling activities in the Chukchi Sea would have only negligible effects on currents, upwellings, and eddies within the proposed action area.

Tides and Water Levels

The activities described under Alternative 4 would be temporary in nature and would have only a seasonal presence of extremely limited size and geographic distribution, and would not affect tides or water levels within the proposed action area. However, wind, waves and storm surge would potentially impact seismic and exploratory drilling activities, and could influence human safety.

Stream and River Discharge

The activities described under Alternative 4 would not affect stream and river discharge within the EIS project area. Exploratory drilling in state waters on grounded ice could occur from manmade reinforced ice “islands” but would have negligible effects on stream and river discharge within the EIS project area.

Sea Ice

Under Alternative 4, impacts to sea ice resulting from the proposed activities would be the same in nature as those described for Alternative 2. Alternative 4 would allow additional drilling programs and additional artificial ice islands in the proposed action area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled. Relative to Alternative 2, sea ice would be affected over a larger area due to more potential ice management activity and localized thermal inputs associated with exploratory drilling activities.

Although Alternative 4 would allow additional seismic surveys in both the Beaufort and Chukchi seas relative to Alternative 2, each action alternative would authorize only one survey per year in each of the seas to involve icebreaking activity. Likewise, only one on-ice seismic survey per year would be authorized under each of the action alternatives and only in the Beaufort Sea. Therefore, the level of activity contemplated for these specific types of exploration activities under Alternative 4 is the same as what is contemplated under Alternative 2.

The effects of these activities on sea ice would be medium intensity, local, temporary, and would affect a resource that is common in the EIS project area. The presence of sea ice in lease and non-lease areas targeted for open water seismic exploration and exploratory drilling could result in changes to the schedule, location, and duration of exploratory activities. The presence of sea ice also represents a potential hazard to vessels and exploratory drilling platforms. Industry operators in offshore areas have developed critical operation and curtailment procedures for managing sea ice, including changes to schedule, vessels dedicated to ice management, and procedures for taking drill platforms off location until potential hazards subside.

Within ice and on ice exploration activities could experience similar and additional hazards from sea ice, including the potential for ice override events. In-ice exploration activities would use icebreakers and other vessels for the purpose of ice management and/or ice breaking, and protocols would be established for response to potential ice hazards. Drilling on grounded ice from artificial ice islands would not be subject to potential hazards from moving ice but could experience potential effects from storm surge and ice override events. Within the Beaufort Sea, where drilling on constructed artificial ice islands could occur in state waters, much of the area is protected from ice override by barrier islands. Individual drilling operations would need to assess the potential for ice related hazards and develop appropriate design and operation protocols.

Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 4 on sea ice would be minor.

4.7.1.1.2 Conclusion

The overall effects of the proposed actions on to physical oceanography attributes would be of medium intensity (due to the increase in impacts to sea ice), temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of the proposed activity described in Alternative 4 on physical ocean resources in the proposed action area would be minor.

4.7.1.2 Climate

Under this alternative, emissions would be higher when compared to either Alternative 2 or Alternative 3 because the alternative proposes additional exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The number of annual EPs proposed for each Arctic OCS planning area would increase to four. The number of proposed seismic and other surveys would remain the same as described in Alternative 3. The majority of additional emissions are from the additional EPs proposed for Level 3 Exploration Activity.

Refer to Section 3.1.2.4 (Climate Change in the Arctic) for a thorough discussion of climate systems and the effects of GHG emissions.

4.7.1.2.1 Direct and Indirect Effects

Direct effects under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

Indirect Effects under this alternative would be the same as those described under Alternative 2, although emissions would be higher with the additional surveys and exploration plans.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

CO_2e Projected Emissions Inventory

Under this alternative, projected emissions would be higher when compared to either Alternative 2 or Alternative 3 because the alternative proposes additional exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The number of annual EPs proposed for each Arctic OCS planning area would increase to four. The number of proposed seismic and other surveys would remain the same as described in Alternative 3. The majority of additional emissions are from the additional EPs proposed for Level 3 Exploration Activity. The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*). The estimated potential annual emissions of CO_2e for each type of activity and program proposed under this alternative are provided in Table 4.7-1. The data in this table assume no controls to reduce emissions.

Effects of this Alternative on Climate Change

Reporting emissions of CO_2e under this alternative would be the same as described under Alternative 2.

Table 4.7-1 Estimated CO_2e Emissions by Activity and Program Type for the Arctic OCS

Activity/Program Types	U.S. Chukchi Sea OCS Annual CO_2e Emissions (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	72,048
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
Exploration Plan	372,026
Total	**456,467**
Activity/Program Types	**U.S. Beaufort Sea OCS Annual CO_2e Emissions (metric tons per year)**
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	85,692
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
On-Ice Seismic Survey	25
Exploration Plan	372,026
Total	**470,136**

Sources:
EPA. October 1996. Compilation of Air Pollutant Emission Factors (AP-42) 5th ed., Volume I, Chapter 3, Table 3.3-1 and Table 3.4-1.
EPA. July 2010. Median Life, Annual Activity and Load Factor Values for Nonroad Engine Emissions Modeling (EPa-420-R-10-016, NR-005d).
BOEM 2012b. ION Seismic Survey.
EPA. 2012. EPA and NHTSA Set Standards to Reduce GHG and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks. Table 1. http://www.epa.gov/oms/climate/documents/420f12051.pdf

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

4.7.1.2.2 Conclusion

It is difficult to separate the impacts of the pproposed actions of Alternative 4 from other impacts seen around the world. The proposed actions under Alternative 4 would contribute incrementally to a global problem, however, the contribution is so small it is challenging to asses the projects exact impact. In this case it is appropriate to simply evaluate total projected emissions from the proposed action for comparison purposes. Under Alternative 4, the estimated annual emissions of CO_2e would be 456,467 metric tons in the Chukchi Sea OCS area, and 470,136 metric tons in the Beaufort Sea OCS area. Projected emissions of CO_2 and other greenhouse gasses under Alternative 4 could potentially contribute to changes in global climate. However, the amount to which changes in global climate are attributable to any single anthropogenic source is very small, and it is not currently useful to attempt to link specific climate impacts to the particular activities proposed under Alternative 4, as such direct linkage is difficult to isolate and to understand. In this case it is appropriate to evaluate and disclose estimated CO_2e emissions by activity and program type for the Arctic OCS under Alternative 4. These data are provided in Table 4.7-1.

Regarding effects of climate change on the project, the decrease in sea ice thickness and extent could affect timing and location of in-ice seismic and on-ice vibroseis surveys, as well as extend the season for drilling activities requiring ice-free conditions. Activities under this alternative may require unique planning and engineering, but are not expected to adversely affect the implementation of this alternative.

4.7.1.3 Air Quality

Under this alternative, projected emissions would be higher when compared to either Alternative 2 or Alternative 3 because the alternative proposes additional EPs described as Level 3 Exploration Activity on the Arctic OCS. The number of annual EPs proposed for each Arctic OCS planning area would increase to four. The number of proposed seismic and other surveys would remain the same as described in Alternative 3. The majority of additional emissions are from the additional EPs proposed for Level 3 Exploration Activity.

4.7.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of GHG, HAP, and criteria pollutant emissions as described under Alternative 2 in Section 4.5.1.3.

Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

Level of Effect

The level of effect under this alternative would be the same as discussed under Alternative 2.

4.7.1.3.4 Conclusion

Projected emissions from exploratory drilling activities proposed under this alternative would be higher than those estimated for Alternatives 2 and 3. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the NAAQS to be exceeded onshore. The Level 3 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A high level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a medium level of effect.

4.7.1.4 Acoustics

4.7.1.4.1 Direct and Indirect Effects

Under Alternative 4, the number and types of seismic surveys and site clearance and high resolution shallow hazards survey programs is identical to Alternative 3. This alternative differs from Alternative 3 in that it adds two additional EPs to each Arctic OCS Planning Area per year for a total of four in each Planning Area. Because the acoustic output from drillships and drill rigs is typically below 180-185 dB re 1 µPa (rms), the addition of these activities will not increase sound levels above these thresholds. As noted in Table 4.5-12, the 120 dB re 1 µPa (rms) from a drillship is estimated at 2 km (1.2 mi) from the source and at 210 m (689 ft.) for a jack-up rig from the source. For the sake of a more comprehensive assessment, the table below (and those in the Acoustic section descriptions in previous alternatives) delineates a circle around a drilling rig with a 13-km radius that is meant to encompass the 120-dB ensonification created by both the rig and the support vessels associated with it (which are all producing noise and generally creating an area that would suggest animals are exposed to disturbance from multiple stimuli). However, the addition of two EPs per season in each sea would only increase the total percentage of total area ensonified per season by about one percent versus Alternative 3. Refer to Section 4.6.1.4.1 for additional information on the direct and indirect effects of this resource.

Table 4.7-2 Total Surface Area Ensonified Above Sound Level Thresholds Under Alternative 4, From Averages Listed in Table 4.5-11

		Total Surface Areas (km^2) to sound level (90% rms SPL (dB re 1 µPa rms))			
		190	**180**	**160**	**120**
Chukchi Sea Shelf 40 to 52 m depth					
	5x ~3200 in^3	4.41	48.7	1,798	141,764
	5x 40 in^3	0.03	0.29	25.3	10,619
	4x drill/support*			2088	2,088
	% Chukchi	**0.00%**	**0.02%**	**1.48%**	**59%**
Beaufort Sea Shelf, 15 to 40 m depth					
	4x ~3200 in^3	9.96	82.9	1,633	45,238
	3x 20 in^3	0.003	0.03	5.59	2,535
	4x drill/support*			2088	2,088
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	2x 880 in^3	0.46	2.02	46.9	2,206
	2x 20 in^3	0.02	0.12	4.35	268
	% Beaufort	**0.00%**	**0.03%**	**1.48%**	**20%**
Entire Region					
		15	**134**	**7,689**	**206,806**
	% EIS area	**0.00%**	**0.03%**	**1.48%**	**40%**

*drill/support indicates area within 13-km radius around drill rig, notionally encompassing support vessels. Indicated area is within 120-dB radius, included in 160-dB column for assessment.

Chronic and Aggregate Effects on Acoustic Habitat

As described in Section 4.5.2.4.9, modeled chronic and aggregate effects on acoustic habitat from July through mid-October were substantial at several modeled sites in the Beaufort Sea, with losses of up to 98% of the broadband listening area for mid- and low frequency species and up to 28% of bowhead whale communication space. The relevance of these modeled results to specific marine mammal species and their acoustic habitat is discussed in Section 4.5.2.4.

4.7.1.4.2 Conclusion

The intensity rating of this alternative is high, as additional exploration activities will introduce sources with source sound levels that exceed 200 dB re 1 µPa. Because the exploration activities could continue for several years, the duration is considered as long-term. The spatial extent of these activities is regional, since the distribution of exploration activities over the project areas will lead to approximately 40 percent of the EIS area being exposed to sound levels in excess of 120 dB re 1 µPa. Therefore, the overall impact rating for direct and indirect effects to the acoustic environment would be moderate.

4.7.1.5 Water Quality

Impacts to water quality from Alternative 4 are expected to be similar to those described for Alternative 2. The difference between the two alternatives is the level of activity, which would double. However, the relatively small amounts of potential discharges would occur and be diluted in a large volume of water.

Differences in impacts between the two alternatives are noted below. The same level of seismic surveys and site clearance and high resolution shallow hazards survey programs contemplated under Alternative 3 are contemplated in this alternative.

4.7.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys under Alternative 4 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys under Alternative 4 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys under Alternative 4 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

Exploratory Drilling Programs

Under Alternative 4, changes in water quality related to temperature and salinity resulting from exploratory drilling programs would be similar in nature as those described for Alternative 2. Alternative 4 would allow additional drilling programs in the EIS project area, and as a result of those programs the intensity as well as the spatial extent of the impact may effectively be quadrupled. Relative to Alternative 2, salinity and temperature may be affected over a larger area. However, the effects of Alternative 4 on water quality resulting from changes in temperature and salinity would be low intensity, temporary, and local. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 4 on water quality related to temperature and salinity resulting from exploratory drilling programs would be minor.

Turbidity and Total Suspended Solids

Seismic Surveys

Effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 4, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

Site Clearance and Shallow Hazards Surveys

Effects on water quality resulting from potential increases in turbidity and total suspended solids from site clearance and shallow hazard surveys under Alternative 4, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of suspended solids in the proposed action area. As they occur on the ice and not in the open-water environment, no contact is made with the seafloor during these types of surveys.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternative 2. Alternative 4 would allow additional drilling programs in the EIS project area. As a result of the additional drilling programs the intensity as well as the spatial extent of the impact may be effectively quadrupled. Relative to Alternative 2, turbidity and concentrations of suspended solids may be affected over a larger area. However, the effects of Alternative 4 on water quality resulting from changes in turbidity and concentrations of suspended solids would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 4 on water quality related to turbidity and concentrations of suspended solids resulting from exploratory drilling programs are expected to be minor.

Metals

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys are not expected to have any measureable impact on dissolved metal concentrations in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys are not expected to affect dissolved metal concentrations in the proposed action area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys would not affect dissolved metal concentrations in the EIS project area.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of metals from exploratory drilling programs are described in detail under Alternative 2. Alternative 4 would allow additional drilling programs in the EIS project area. As a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be quadrupled. Relative to Alternative 2, metal concentrations may be affected over a larger area. However, the effects of Alternative 4 on water quality resulting from changes in metal concentrations would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 4 on water quality related to metal concentrations resulting from exploratory drilling programs would be minor.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Impacts under this alternative would be similar to the impacts under Alternative 2. While the level of activity would approximately double, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

Site Clearance and Shallow Hazards Surveys

Impacts under this alternative would be similar to the impacts under Alternative 2. While the level of activity would approximately double, site clearance and shallow hazards surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys are expected to have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area under Alternative 4. Alternative 4 contemplates the same level of on-ice seismic activity as Alternative 2; therefore, the level of impacts is anticipated to be the same. Contaminants from fluids entrained in the ice roads would be discharged every spring during breakup. Any entrained hydrocarbons and other organic contaminants from vehicle exhaust, oil, grease, and other vehicle-related fluids not recovered would pass into the Beaufort and/or Chukchi Sea system at each breakup as a result of on-ice seismic surveys. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys under Alternative 4 are expected to be minor.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of hydrocarbons and other organic contaminants from exploratory drilling programs are described in detail under Alternative 2. Relative to Alternative 2, Alternative 4 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be quadrupled. Relative to Alternative 2, concentrations of hydrocarbons and other organic contaminants would be affected over a larger area. Impacts to water quality resulting from hydrocarbons and other organic contaminants would be temporary and would dissipate soon after the discharge is stopped. Such impacts would be local in nature due to rapid dilution of discharged compounds into the ocean. It is probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 4 would have minor to moderate effects on water quality outside of the discharge plume area. However, due to lack of applicable water quality criteria for some organic compounds in drilling fluids (EPA 2006b), it is problematic to determine whether or not inputs of hydrocarbons and other organic compounds from the proposed activity would exceed water quality regulatory limits.

Although unlikely, it is plausible that accidental or emergency events may occur within the proposed action area. Due to the rarity of such unforeseen events, and the potential magnitude and extent of their impacts relative to the effects of normal operation and maintenance activities, such accidental or emergency events are not addressed in this section and are covered in Section 4.10 of this EIS. Regulations requiring operators to have plans in place to minimize the likelihood of a spill would reduce the potential for adverse impacts to water quality.

4.7.1.5.2 Conclusion

After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 4 on water quality in the EIS project area are expected to be minor.

4.7.1.6 Environmental Contaminants and Ecosystem Functions

4.7.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 4 would be the same as those described for Alternative 2. Because Alternative 4 would authorize a greater level of activity relative to Alternative 2, the amounts of contaminants introduced to the EIS project area would potentially be greater under Alternative 4.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 4 would be the same as those described for Alternative 2. The area of habitat and biological resources exposed to potential contaminants would be larger under Alternative 2.

Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 4 on the four categories of ecosystem functions (defined in Section 4.5.1.6) are assessed below.

Regulation Functions

The nature of the effects of the activities proposed under Alternative 4 on regulation functions would be the same as described under Alternative 2. The effects of greatest concern would be associated with exploratory drilling programs. Alternative 4 would authorize up to four exploratory drilling programs per year in the Beaufort Sea and up to four exploratory drilling programs per year in the Chukchi Sea, whereas Alternative 2 would authorize only one exploratory drilling program per year in each sea. Thus, the magnitude of the effects on regulation functions would be greater under Alternative 4 compared to Alternative 2. The magnitude and extent of effects of Alternative 4 on regulation functions would depend upon interrelationships between impacts to biological and physical resources, which are addressed in other sections of this EIS.

Habitat Functions

The nature of the effects of the activities proposed under Alternative 4 on habitat functions would be the same as described under Alternative 2. Effects of Alternative 4 on habitat functions would include impacts to refugium functions and nursery functions (provision of suitable reproduction habitat) associated with benthic habitats resulting from discharges from exploratory drilling. Overall effects to benthic habitat functions would be interim, local, and low-intensity. Effects would also occur to functions associated with pelagic and epontic habitats. Functions associated with terrestrial habitats would be affected to a lesser degree. Overall, effects of Alternative 4 on habitat functions would be medium-intensity, interim, and local. The functions affected could be common, important, or unique depending on the spatial location of the impact.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts to habitat functions.

Production Functions

The nature of the effects of the activities proposed under Alternative 4 on production functions would be the same as described under Alternative 2. Impacts to production functions related to provision of raw materials and food (i.e., subsistence) could be affected by the activities proposed under Alternative 4. These impacts are described in the subsistence section of this EIS. In addition to introducing contaminants to secondary and tertiary consumers via trophic transfer processes, contaminants of concern could interrupt trophic transfer processes resulting in shorter food chains (less complex food webs), and reduced throughput of energy and nutrients at higher trophic levels. Oil and gas are ecosystem goods, and the flows of energy that they represent are ecosystem services. These ecosystem goods and services could potentially be derived from historical production functions in the EIS project area under Alternative 4.

Information Functions

Information functions contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002). The effects of Alternative 4 on information functions in the EIS project area would depend upon interrelationships between impacts to cultural resources, social resources and aesthetic resources, which are addressed in other sections of this EIS.

4.7.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 4 would be medium-intensity, interim, local, and would affect common resources. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e., resistant to stressors) than are species composition and other structural properties. A relatively detailed analysis of the effects of Alternative 2 on fate and persistence of potential contaminants entrained in sediments is included in Section 4.5.1.6.1. The potential effects of Alternative 2 on the distributions of metals and petroleum hydrocarbons, both in the water and in seafloor sediments, are also discussed under Section 4.5.1.5 (Water Quality). Because Alternative 4 would authorize a greater level of activity than Alternative 2 there is potential for increased volume of contaminants introduced to the project area. However, the overall effects of Alternative 4 on ecosystem functions would be considered minor.

4.7.2.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.7.2 Biological Environment

4.7.2.1 Lower Trophic Levels

4.7.2.1.1 Direct and Indirect Effects

The direct and indirect impacts discussed in Section 4.5.2.1 for Alternative 2 are also applicable for this alternative. The increased levels of activity associated with Alternative 4 would not generate different types of impacts to lower trophic levels.

4.7.2.1.2 Conclusion

Given the implementation of the standard mitigation measures considered in this EIS, the direct and indirect effects on lower trophic levels associated with Alternative 4 would likely be low in intensity, temporary to long-term in duration, of local extent and could affect common resources. The resulting summary impact level would be negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.7.2.2 Fish and Essential Fish Habitat

4.7.2.2.1 Direct and Indirect Effects

The types and mechanisms of effects would remain the same in Alternative 4 as in Alternative 2. For a complete discussion of the types and mechanisms of effects on fish resources, see Section 4.5.2.2.

Marine Fish

The direct and indirect effects on marine fish resulting from Alternative 4 would be similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities most likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 3. Demersal assemblages would also have no increase in effects from seismic survey levels, but effects from the doubling of the numbers of exploratory drilling operations would create habitat loss and effects from noise. Effects to pelagic assemblages would be identical in terms of icebreaking and on-ice surveys but result in an increase in effects from doubling the number of drilling programs. These effects would be an increase in effluents and resultant effects on water quality, although likely to be short term and local. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain the same given the limited area affected compared to the distribution of fish populations. Impacts on juvenile and adult fish would be temporary and low in intensity. Based on the small footprint of the seismic surveys relative to the amount of habitat over the entire EIS project area, the effect would be local and temporary

For a complete discussion of the effects on Marine Fish, please see Section 4.5.2.2.

Migratory Fish

The direct and indirect effects on migratory fish resulting from Alternative 4 would be similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 2, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 2, those anadromous species known to inhabit the area where project activities would occur are not abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same.

For a complete discussion of the effects on Migratory Fish, please see Section 4.5.2.2.

Essential Fish Habitat

The direct and indirect effects on essential fish habitat resulting from Alternative 4 would be similar to those described under Alternative 3, with an increase in effects due to the doubling of oil and gas exploration activities. In particular, the increase in exploratory drilling programs would result in increased habitat loss and alteration to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 4 would be double than that for Alternative 3. However, most impacts would be of relatively low intensity for the environments of the species of concern and of small geographic extent.

For a complete discussion of the effects on Essential Fish Habitat, please see Section 4.5.2.2.

4.7.2.2.2 Conclusion

The overall impact of Alternative 4 on Fish and EFH is minor. Despite a substantial increase in level of activity over Alternative 2, there would be little corresponding increase in the overall impact level, due to the small scale of any potential effects relative to overall population levels and available habitat and the temporary nature of the majority of the activities associated with Alternative 4.

4.7.2.3 Marine and Coastal Birds

4.7.2.3.1 Direct and Indirect Effects

Alternative 4 includes all of the same types of exploration activities as Alternatives 2 and 3, so the discussion of potential direct and indirect effects on marine and coastal birds under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. The difference between alternatives concerning potential effects on marine and coastal birds is a matter of degree. Alternative 4 includes a larger number of some authorized exploration activities than do Alternatives 2 and 3. These activities involve the same standard mitigation measures, however could involve a larger geographic extent over a more continuous timeframe. This EIS includes a number of standard mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals but may also reduce adverse effects on birds. In addition to the mitigation measures imposed by NMFS and BOEM, ESA Section 7 consultations with USFWS require certain mitigation measures specific to ESA-listed species under USFWS jurisdiction, including spectacled and Steller's eiders (USFWS 2012 [May 8 2012 Biological Opinion]). Measures implemented to minimize take of listed eiders also protect other migratory birds. Section 4.5.2.3 summarizes the mitigation measures typically required for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on birds, and these measures are incorporated into the analysis of potential effects under Alternative 4. A discussion of additional mitigation measures is also included.

The direct and indirect effects of oil and gas exploration activities on marine and coastal birds from seismic surveys under Alternative 4 would be similar to those described under Alternatives 2 and 3. Marine birds could be subject to increased disturbance from vessels and seismic sources due to the increase in seismic surveys that could be authorized under Alternative 4 in both Arctic seas. However, disturbance effects would be temporary even if they occurred over a wider area—birds could fly or swim away from acute disturbance.

With more exploratory drilling activities authorized under Alternative 4, the potential for adjacent activities to magnify effects on birds could be increased. The Ledyard Bay closure period would be the same under Alternative 4 as under Alternative 2, so this area would likely be unaffected by increases in support activities for increased exploratory drilling elsewhere.

Marine and coastal birds could experience some disruption of prey resources if multiple seismic operations operate in the same general area for an extended period of time. Seismic operations are required, however, to operate at specific distances from each other, which disperses effects across a wider area. Seismic operators also leave an area once the information has been collected, so it is unlikely that multiple operators would operate in the same area for an extended period of time. Also, seabirds are constantly seeking out new prey concentrations; therefore, if seismic operations were to displace a prey patch, this is equally likely to facilitate the seabirds' search for prey as it is to hinder it. Furthermore, such effects are temporary in space and time and do not persist from one season to another.

The risk of birds colliding with vessels associated with exploratory drilling operations under Alternative 4 is likely to increase as a consequence of the greater level of support vessel traffic. As an example, Shell had many vessels in the Bering, Chukchi, and Beaufort seas during the 2012 open water season but not the full complement—approximately eight larger vessels were in operation during the truncated open-water work season in 2012. Preliminary analysis of bird strike data from the 2012 season suggests that bird mortality from striking vessels may be greater than originally considered.

The bird strikes reported generally fall into four broad categories: tubenoses/alcids (shearwaters, storm petrels, and auklets), ducks (long-tailed ducks and eiders), shorebirds (phalaropes), and passerines (i.e., wagtails, pipits, arctic warbler, Northern wheatear, American tree sparrow, and dark-eyed junco). Reports of several ducks and storm petrels striking vessels at one time confirmed that strikes can be episodic. On August 30, 2012, the drillship *Kulluk* crew reported 12 strikes from a position 43.5 km (27 mi) offshore of the Chukchi Sea coastline. The *Kulluk* crew also reported eight strikes on September 2, 2012, when 96.6 km (60 mi) offshore. The icebreaker *Fennica* crew reported nine king eiders striking their vessel on October 22, 2012, when located 37 km (23 mi) offshore in the Beaufort Sea.

A full complement of vessels for a full season as considered under this alternative may result in a greater number of strikes than occurred during the 2012 drilling season. Based on the existing preliminary bird strike reports from 2012, eight simultaneous future drilling operations could result in an estimated 713 bird strikes per open-water season—this could include an estimated 395 passerines, 90 shearwaters/storm petrels/auklets, 35 shorebirds, and 192 seaducks. Of the seaducks, 95 could be king eiders, 64 could be long-tailed ducks, and 33 could be common eiders. This potential mortality for each species is small by comparison with the post-breeding population; thus, no species would experience a population-level effect. However, small flocks of eiders can strike a vessel, suggesting that the authorized incidental take of listed eiders could be exceeded in one strike event.

4.7.2.3.2 Mitigation Measures

Standard and additional mitigation measures that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). Additional mitigation measures are not required under any of the alternatives and do not affect the summary conclusion below.

4.7.2.3.3 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles in the Arctic and are therefore considered to be important or unique resources. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be medium intensity, temporary or interim in duration, and of local extent. The overall effects of oil and gas exploration activities authorized under Alternative 4 on marine and coastal birds would therefore be considered moderate according to the impact criteria in Table 4.5-16. This is due primarily to the increased potential for bird strikes due to increased vessel presence.

4.7.2.4 Marine Mammals

4.7.2.4.1 Bowhead Whales

4.7.2.4.1.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on bowhead whales. Alternative 4 includes all of the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on bowhead whales under Alternative 4 involves all of the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.10. The only difference between alternatives 3 and 4 is the addition of drilling programs, levels of all other activity types stay the same. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.10.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 includes several mechanisms for potential disturbance to bowhead whales. Most result from noise generated by oil and gas exploration equipment and associated vessels and aircraft. The mechanisms for disturbance and the suite of potential reactions by bowheads to disturbance under Alternative 4 are as described in detail for Alternative 2 in Section 4.5.2.4.10.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternatives 2 and 3 as a result of the added drilling programs. Anticipated impacts from all types of activities, except drilling, would remain the same as in Alternative 3.

Alternative 4 could authorize up to four exploratory drilling programs in each sea, which would double the amount of exploratory drilling programs contemplated under Alternative 3. For bowhead whales, historical take estimates suggest that exploratory drilling results in more take of bowhead whales than other categories of activities (Tables 4.2-5 through 4.2-7). Alternative 4 doubles the level of potential drilling beyond alternative 3, which results in a substantial increase in intensity; the impact magnitude is high. Anticipated impacts of four exploratory drilling programs in each sea under Alternative 4 would be similar to that for Alternative 3 in terms of magnitude (medium), duration (interim), extent (local to regional), and context (unique). The extent of impact resulting from the addition of one or two drilling programs in each sea would depend on the spatial and temporal distribution of the activities within the open water season.

Disturbance effects resulting from vessel and aircraft activity under Alternative 4 would be similar to Alternative 3. However, with the increase in the number of exploratory drilling programs, this could require additional vessels and aircraft overflights for resupply and crew change, as well as for marine mammal monitoring. Disturbance effects of vessel and aircraft activity would likely be of medium intensity, and the duration of disturbance is expected to be temporary (long-term effects are unknown). The extent of impact would depend on the number of support vessels in an area. Please refer to Section 4.5.2.4.10 for a complete discussion of the disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.10. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in bowhead whales. The potential effects of ship strikes under Alternative 4 are similar to that discussed under Alternatives 2 and 3. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact would be local to regional, given the relative infrequency of occurrence and the non-random distribution of both bowhead whales and exploration activity in the EIS project area. Context would be considered important.

Please refer to Section 4.5.2.4.10 for a complete discussion of potential injury or mortality effects on bowhead whales.

Habitat Alterations

Doubling the number of potential drilling programs could increase the number of localized sites experiencing possible habitat effects of drilling activities. However, this addition only makes a relatively small change in the impacted acoustic habitat (an increase of 1% of EIS area ensonified) (see Table 4.7-3 in Section 4.7.1.4).

Please refer to Section 4.5.2.4.10 for a complete discussion of the potential effects on bowhead whale habitat.

4.7.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.1.3 Conclusion

Impacts of individual activities associated with oil and gas exploration in the EIS project area under Alternative 4 are similar to Alternative 3, with the exception of the added drilling programs, which increase the impacts to acoustic habitat slightly beyond those anticipated in Alternative 3 and increase the anticipated behavioral disturbance. Bowhead whales are listed as endangered, and the Arctic slope is an important area for them, through which the entire population migrates with calves, occasionally stopping to feed, which places them in the context of being a unique resource, except in instances of mortality or serious injury, which they are considered an important resource. The intensity and duration of the various effects and activities considered are high and interim to long-term, respectively. Although the various individual activities may affect bowhead whales on a local to regional level, the area and extent over which the combined effects occur, would likely increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population and at that point would be considered regional. Considering these factors, along with potential reduced adverse impacts through the imposition of required standard mitigation measures, the overall impact of Alternative 4 on bowhead whales would be considered moderate to major.

4.7.2.4.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.17).

4.7.2.4.1.5 Additional Mitigation Measures Conclusion

Conclusions regarding the potential for these additional measures to reduce adverse impacts of oil and gas activities on bowhead whales allowed under Alternative 4 are the same as under Alternative 2. Refer to Section 4.5.2.4.10 for details.

Table 4.7-3 Effects Summary for Bowhead Whales

Type of effect	Impact Component		Effects Summary
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	
		High	Behavioral harassment take of bowheads exceeds 30% of population
	Duration	**Temporary**	
		Interim	Depending on the distribution of activities and animals, and for bowheads because they are primarily migrating through, some animals would not be necessarily be impacted for more than 6 months in a year or in multiple consecutive years.
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Some individuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	**Local**	Since unlikely, any impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	
		Important	ESA-listed species, but population is increasing
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~48% of EIS area ensonified over 120dB, up to 99% lost listening area in some areas of Beaufort., and up to 28% lost bowhead communication space in some areas of Beaufort)
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years.
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding and resting

4.7.2.4.2 Beluga Whales

4.7.2.4.2.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on beluga whales. Alternative 4 includes the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on beluga whales under Alternative 4 is the same as those discussed in Section 4.5.2.4.11. The exploration activities discussed in Alternatives 2 and 3 take place in the same geographic areas and timeframes and also consider the same standard and additional mitigation measures. The difference between the alternatives is simply a matter of degree; Alternative 4 includes a larger number of authorized exploratory drilling activities than Alternative 3, but all other activity types remain at the same levels as Alternative 3.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.11.

Behavioral Disturbance

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3 but only in the addition of exploratory drilling programs, which are expected to result in comparatively minor increases in impacts to belugas. Potential effects of seismic surveys and site clearance and high resolution shallow hazards survey programs would be identical to Alternative 3, since activity level would remain the same for these types of activities under Alternative 4.

Based on the historical take estimates used for beluga whales, in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of beluga whales (Tables 4.2-5 through 4.2-7). Since neither the number of in-ice seismic surveys (1 each in Beaufort and Chukchi), nor the larger 2D/3D seismic surveys increased above Alternative 3, if one considers the combined impacts of all activity types, the overall increase in anticipated behavioral takes above Alternative 3 was only about 2%.

These activities could affect beluga whales over a large area, especially with regard to the 2D/3D seismic streamer surveys, and the disturbance effects would be interim in duration and medium in magnitude, regional in extent, important in context, and characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of beluga whales.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, the primary mechanism of potential injury or mortality to beluga whales due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. The duration of an impact from an auditory impairment would be temporary for TTS, but permanent if PTS were to occur. The extent of such impacts would be local and the context common. It is not known whether there have been any ship strikes involving beluga whales and exploration vessels in the Arctic, but the intensity of the impact should be considered medium. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale.

Habitat Loss/Alteration

Potential impacts on beluga whale habitat in the EIS project area under Alternative 4 would likely be slightly greater than those in Alternative 3. Additional exploratory drilling could increase the number of localized sites experiencing possible habitat effects of drilling activities and also increase the area of acoustic habitat impacts by about 1% within the EIS area (see Section 4.7.1.4). Please refer to Section 4.5.2.4.11 for a complete discussion of the potential effects on beluga whale habitat.

4.7.2.4.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.2.3 Conclusion

The overall impact to beluga whales from Alternative 4 is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but there are a couple of important feeding areas in the Arctic that are important for this population. The intensity and duration of the various effects and activities considered are mostly medium/high and interim/long-term. Although, individually, the various activities may elicit local effects on beluga whales, the area and extent over which the combined effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of this population and are considered regional.

4.7.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.17).

Table 4.7-4 Effects Summary for Beluga Whales

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	In lower level scenarios for this alternative, take of belugas might not exceed 30% of population
		High	In higher level scenarios for this alternative, behavioral harassment take of bowheads exceeds 30% of population
	Duration	Temporary	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	Local	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	Common	Not ESA-listed. Population status not well known for Chukchi, but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas and wide migratory corridor likely not heavily impacted by activities
		Important	Stocks overlap known migratory corridor and activities may occasionally impact important feeding areas.
		Unique	
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	
		Long-term	Though highly unlikely, PTS would be permanent if incurred.
	Geographic Extent	Local	Since unlikely, any impacts would be considered local
		Regional	
		State-wide	
	Context	Common	Not ESA-listed, populations not thought to be decreasing.
		Important	
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~48% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort)
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	Not ESA-listed. Population status not well known for Chukchi, but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas and wide migratory corridor likely not heavily impacted by activities
		Important	Stocks overlap known migratory corridor and activities may occasionally impact important feeding areas.
		Unique	

4.7.2.4.3 Other Cetaceans

4.7.2.4.3.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on cetaceans in the EIS project area other than bowhead and beluga whales. Alternative 4 includes all of the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on bowhead whales under Alternative 4 involves all of the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.12. The difference is that Alternative 4 includes a larger number of exploratory drilling operations than Alternative 3. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.12.

Behavioral Disturbance

Under Alternative 4, disturbance effects of oil and gas exploration activity on other cetaceans would be of low intensity (for those species that were not encountered or exposed) or medium, based on determinations for Alternative 2. Despite an increase in the level of exploratory drilling activity by a factor of two over Alternative 3, there would be little increase in the overall impact level for the species that occur in low densities (see Tables 4.2-5 through 4.2-7). Some whales may be displaced a short distance, but they would not be anticipated to leave the EIS project area entirely. The duration is expected to be interim. Context would be considered important to unique. Long-term effects are unknown. The extent of the impacts would depend on the number of seismic and exploratory drilling activities and associated support vessels in an area. Individual sound sources may produce local impacts. Multiple activities in one area or in several areas across migratory corridors would be expected to lead to more widespread, regional impacts.

Please refer to Section 4.5.2.4.12 for a complete discussion of disturbance effects on Other Cetaceans.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.12. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in other cetaceans. The potential effects of ship strikes under Alternative 4 are similar to that discussed under Alternative 2. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact will be local, given the relative infrequency of occurrence and the non-random distribution of other cetacean species and exploration activity in the EIS project area. Context would be considered important.

Please refer to Section 4.5.2.4.12 for a complete discussion of potential injury or mortality effects on Other Cetaceans.

Habitat Alterations

The potential effects on cetacean habitat in the EIS project area under Alternative 4 would likely be similar to those under Alternative 3. Additional exploratory drilling could increase the number of localized sites experiencing possible habitat effects of drilling activities and increase the area over which temporary impacts to acoustic habitat could occur by about 1% (see Section 4.7.1.4).

Please refer to Section 4.5.2.4.12 for a complete discussion of the potential effects on Other Cetacean habitat.

4.7.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.3.3 Conclusion

Evaluated collectively, the overall impact of Alternative 4 on Other Cetaceans is minor to moderate, with gray whales more likely to be moderate.. Despite an increase in the level of exploratory drilling activity over Alternative 3, there would be little increase in the impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the interim nature of the majority of the activities associated with Alternative 4, impacts on the resource would be low to medium in intensity, of interim duration, and regional extent. Long-term impacts are unknown, but anticipated to be minor or moderate.

4.7.2.4.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.17).

Table 4.7-5 Effects Summary for Other Cetaceans

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	**Low**	
		Medium	Behavioral harassment expected to be < 30% of population disturbed
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	With the exception of gray and humpback whales, species are considered common.
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	All species but humpbacks common
		Important	Humpbacks are ESA-listed
		Unique	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~44% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort)
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	With the exception of gray and humpback whales, species are considered common
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	

4.7.2.4.4 Ice Seals

4.7.2.4.4.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on ice seals. Alternative 4 includes all of the same type of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on ice seals under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.13. The difference between alternatives concerning ice seals is a matter of degree. Alternative 4 includes a larger number of drilling activities, specifically, four programs in both the Beaufort and Chukchi seas instead of two programs in each sea (Table 4.2-2). These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.13.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 include several mechanisms for potential disturbance to ice seals in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The two types of surveys which take place on or in sea ice, the preferred habitat of ice seals and where they are most likely to be concentrated, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 4 as for Alternatives 2 and 3. The level of disturbance from these types of surveys would therefore be the same for Alternative 4 as is discussed for Alternative 3, which was considered to have temporary and low magnitude effects on ice seals.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3. These activities could affect ice seals over a large area, but the disturbance effects would be of interim duration and medium in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of ice seals.

Alternative 4 could authorize up to four exploratory drilling programs in both Arctic seas. The level of disturbance to seals is likely more intense in terms of the physical presence of the ships than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location, and seals could become habituated to it. Given the mild reaction of seals to marine vessels and the close distances to which they often approach vessels, it is unlikely that having up to four drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular seals, although more seals could be affected than would occur with only one or two drilling programs operating at any one time. Any disturbance and displacement of seals would cover a very small area and be considered short-term.

Based on the historical take estimates used for ice seals (Tables 4.2-5 through 4.2-7), in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of ringed seals, with open water 2D/3D seismic surveys contributing to the majority of the behavioral disturbance takes for other species. Because the level of activity for these survey types did not increase in Alternative 4, total behavioral take numbers between Alternatives 3 and 4 only increased by a small amount.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any ice seals being injured as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. There is a lack of data on the physiological thresholds for acoustic injury in ice seals, but that information could only be obtained through captive studies involving potential injury to the animals, and, given the behavioral avoidance of wild animals to loud seismic sources, this lack of data is not crucial for this analysis.

As discussed in Section 4.5.2.4.13, there is the potential for seals to be exposed to small spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g., transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). Exposure of seals to oil products could lead to irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). Ice seals are commonly observed near exploratory activities during the open-water season and could be exposed to spills in the water or on ice. If a small spill did occur, cleanup efforts would begin immediately, and those activities would likely include the presence of PSOs to monitor for ice seals and other marine mammals and deter them from entering the spill area if possible. Alternative 4 could authorize a greater level of exploratory drilling activity than Alternative 3, and the resulting risk of small spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills, the risk of ice seals being exposed to small spills during exploration activities authorized under Alternative 4 is considered to be minor. The potential effects of a very large oil spill caused by a well blowout are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11. Please refer to Section 4.5.2.4.13 for a complete discussion of potential injury or mortality effects on ice seals.

Habitat Alterations

The two types of activities that involve potential changes to ice habitat, icebreaking and on-ice vibroseis, would be at the same level as discussed under Alternative 2, and they were considered to have temporary effects that are similar in scope as those occurring due to natural forces in the dynamic sea ice environment. The increase from two exploratory drilling programs in each Arctic sea under Alternative 3 to four drilling programs in each sea under Alternative 4 would increase the amount of intentional and unintentional discharges of drilling muds and other wastes. There is a lack of information about how any of these discharges could interact directly with ice seals or be carried through the environment to affect the food supply of ice seals (primarily fish and crustaceans). Given this lack of ecological information on the effects of these discharges on ice seal habitat, it is not possible to say whether four drilling programs constitute a substantially larger risk to habitat quality for ice seals than one or two drilling programs. Unfortunately, the types of ecological monitoring studies required to address these issues are very difficult to conduct in the Arctic and even more difficult to interpret given the vast number of complicating factors. The addition of the drilling programs would also add to a slight increase in acoustic habitat impacts.

4.7.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to ice seals are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.4.3 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities, and their reactions have been recorded by PSOs onboard source vessels and monitoring vessels. These data indicate that seals tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away, and they do not appear to react strongly even as ships pass fairly close with active arrays. They also appear to primarily react to icebreaking or on-ice surveys by keeping their distance or moving away at some point to an alternate breathing hole or haulout. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected (one is also protected under the ESA) and are therefore considered to be important resources. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 4 on ice seals would likely be medium to high (the latter for ringed seals) in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 4 would therefore be considered moderate for ice seal species according to the criteria established in Section 4.1.3.

4.7.2.4.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.17).

Table 4.7-6 Effects Summary for Ice Seals

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	When maximum activities considered, more than 30% ringed seals may be taken
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	Non-ESA-listed,
		Important	
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	If it occurred, PTS would be permanent
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Non-ESA-listed species
		Important	
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be medium (~44% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort)
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	Non-ESA-listed, b notable impacts not occurring in specifically identified important areas
		Important	
		Unique	

4.7.2.4.5 Walruses

4.7.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on walruses. This species is dependent on pack ice, barrier islands, and coastal shorelines for haul outs. Alternative 4 includes all of the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on walruses under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternatives 2 and 3 in Section 4.5.2.4.14. The difference between alternatives concerning walruses is a matter of degree. Alternative 4 includes a larger number of some authorized exploration activities than Alternative 3. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. Walruses are distributed widely across the Chukchi Sea but are uncommon in the deeper OCS waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact walruses. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.14.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 include several mechanisms for potential disturbance to walruses in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The one type of survey that takes place on or in sea ice (the preferred habitat for walruses and where they are most likely to be concentrated) is the in-ice 2D survey with icebreakers. Only one such in-ice survey could be authorized for each Arctic sea under any of the action alternatives. On-ice vibroseis surveys would only occur in the Beaufort Sea at times when walruses would not be present. The level of disturbance from these types of surveys would therefore be the same for Alternative 4 as is discussed for Alternative 3, which was considered to have temporary and low magnitude effects on walruses.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3. The increase in exploration drilling activities could affect walruses over a larger area, but the disturbance effects would be temporary and low in magnitude, characterized by avoidance of vessels associated with drilling and of the drill sites but with mild or unnoticeable behavioral reactions of walruses. Exploration drilling activities have a foot print of a few square kilometers. Alternative 4 increases the footprint of benthic foraging habitat that would be unavailable to walruses during exploration operations. Some walruses could be exposed to or displaced from more than one exploratory drilling site over time as it travels through an area. The addition of one or two additional exploration drilling operations to the Beaufort and /or Chukchi seas would slightly decrease the benthic foraging habitat available to walruses during drilling and afterward until the sea floor is recolonized by the benthic invertebrates which are primary food sources for walruses. This decrease in available habitat would be very small when compared with the available foraging habitat within the Chukchi Sea. Past exploration drilling activities in the Chukchi Sea have not been shown to impact either individual walruses or the walrus population.

Alternative 4 could authorize up to four exploratory drilling programs in each sea. The level of disturbance to walruses is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location, and walruses could become habituated to it. Given the mild reaction of walruses to marine vessels, it is unlikely that having four drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular walruses, although more walruses could be temporarily affected than would occur with only two drilling programs. Any disturbance and displacement of walruses would cover a small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any walrus being injured or killed as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any walruses would be exposed to very loud sounds from seismic or exploratory drilling operations to the point where they might be injured.

There is a potentially dangerous situation with walruses on land-based haulouts, primarily on the Chukchi coast from Point Lay to Barrow. Disturbance by low-flying aircraft or nearby vessels could cause stampedes and crushing deaths. USFWS LOA mitigation measures for exploration aircraft and vessels are intended to monitor and avoid such haulouts to avoid causing such deadly disturbance.

As discussed in Section 4.5.2.4.14 exposure to small spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities could have substantial health effects on walruses and could spread among animals in a close herd. Alternative 4 could authorize a greater level of exploration activity than Alternative 3, and the resulting risk of small spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills and the occurrence of walruses primarily on or near the pack ice rather than swimming in open water where most exploration activities take place, the risk of walruses being exposed to small spills during exploration activities is considered to be negligible. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Please refer to Section 4.5.2.4.14 for a complete discussion of potential injury or mortality effects on walruses.

Habitat Alterations

Benthic prey of walruses may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as OBC or OBN surveys in the Chukchi Sea, vessel anchors, and exploratory drilling. All of these activities could disturb benthic mollusks and other invertebrates temporarily and may cause mortality. Alternative 4 could authorize higher levels of exploration activities that involve benthic disturbance than Alternative 3. However, given the very small areas of benthic surface that could be impacted by all of these activities and the wide distribution of prey fields for walruses, these activities would be unlikely to affect the availability of prey to walruses.

Icebreaking ships intentionally disrupt pack ice in order to conduct seismic surveys or to help manage ice floes around exploratory drilling equipment. The amount of icebreaking and ice management activity and potential impacts to walruses under Alternative 4 would increase from that discussed in Alternatives 2 and 3. These impacts would primarily be limited to displacement of walruses from preferred sea ice habitat.

Alternative 4 could authorize a greater level of exploration activity than Alternative 3, including doubling the amount of exploratory drilling, and the resulting risk of small spills and discharges occurring would be proportionally greater. The potential effects on the quality of walrus habitat would also increase. Please refer to Section 4.5.2.4.14 for further discussion of potential effects on walrus habitat.

4.7.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to walruses are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.5.3 Conclusion

Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs onboard seismic source vessels and monitoring vessels. These data indicate that walruses do not react strongly to vessels and active seismic arrays, and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walruses reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes.

Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for purposes of this analysis. Given the level and type of exploration activities that would be authorized under Alternative 4, and considering the mitigation measures that would be required by USFWS LOAs, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim to long-term in duration. The effects of Alternative 4 would therefore be considered moderate for walruses according to the criteria established in Section 4.1.3.

4.7.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to walruses are discussed under Alternative 2 (Section 4.5.2.4.17).

4.7.2.4.6 Polar Bears

4.7.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 4 includes all of the same type of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on polar bears under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternatives 2 and 3 in Section 4.5.2.4.15. The difference between alternatives concerning polar bears is a matter of degree. Alternative 4 includes a larger number of some authorized exploration activities than Alternative 3. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures as Alternatives 2 and 3. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.15.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 include several mechanisms for potential disturbance to polar bears along leads in the ice and in broken ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment including the potential for direct human-bear encounters. The two types of surveys which take place on or in sea ice, the hunting and denning habitats for polar bears, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 4 as for Alternatives 2 and 3. The level of disturbance from these types of surveys would therefore be the same for Alternative 4 as is discussed for Alternatives 2 and 3, which were considered to have temporary and low magnitude effects on polar bears.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3. These activities could affect polar bears over a larger area, but the disturbance effects would be temporary and low in magnitude, characterized by neutral or ambiguous behavioral reactions of polar bears. Some polar bears could be exposed to more than one exploration drilling operation over time as they travel through an area, but most encounters with exploration drilling operations and vessels typically occur while polar bears are on ice or land. The addition of one or more exploration drilling projects to either the Beaufort or Chukchi seas would increase the likelihood that two or more different projects could be in the same general area at the same time. Few polar bears are likely to be moving through offshore drilling areas during the open water season. Polar bears routinely move through the Prudhoe Bay oil field areas and do not appear to be excluded from available habitat by drilling operations taking place nearby.

Alternative 4 could authorize up to four exploratory drilling programs in both Arctic seas. The level of disturbance to polar bears is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location, and polar bears could become habituated to it. Given the mild reaction of polar bears to marine vessels or drilling rigs it is unlikely that having four drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular bears, although more bears could be temporarily affected than would occur with only one or two drilling programs. Any disturbance and displacement of polar bears would cover a very small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any polar bears being injured or killed as a result of noise levels or ship strikes from oil and gas exploration activities because of the infrequency of polar bears being observed in the open-water areas where most exploration is conducted and their ability to detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any polar bears would be exposed to very loud sounds from seismic operations to the point where they might be injured. Exposure to spills of fuel, oils, and other compounds from exploration vessels and equipment could kill a polar bear (USFWS 2008b), but given the small volume of typical spills and clean-up requirements that would include PSOs to deter polar bears if necessary, the risk of polar bears being exposed to oil spills is considered minor. Polar bears are curious, so there is always the potential for human-bear interactions during oil and gas exploration in the Arctic, even if the activities are temporary, but continuation of diligent polar bear monitoring and safety management will decrease the risk of injury or death for humans and bears. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alteration

One of the two types of activities that involve potential changes to polar bear habitat, icebreaking and ice management, could increase under Alternative 4 as compared to Alternatives 2 and 3. Ice management activities are sometimes necessary to move ice floes away from drilling rigs in OCS waters. These activities would have only temporary effects on the physical characteristics of the ice and are not likely to displace polar bear prey species (ice seals) for more than a few hours. Seal distribution and abundance would continue to be determined by ice conditions and other natural factors rather than the presence of exploration activities. Polar bear habitat quality would therefore not be affected by exploration activities. The increase from two exploratory drilling programs in each sea under Alternative 3 to four drilling programs in each sea under Alternative 4 would increase the footprint of the drilling operations and associated fleets of vessels and could increase the amount of ice management necessary. The effects of ice management would be short term and isolated to a small footprint and are not anticipated to impact the availability of sea ice for polar bears as habitat.

4.7.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.6.3 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays or to exploration drilling operations, and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point, but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs, the effects of exploration activities that could be authorized under Alternative 4 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 4 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.7.2.4.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.17).

4.7.2.5 Terrestrial Mammals

Activity levels in Alternative 4 are the same as in Alternative 3, except for the allowance of four exploratory drilling operations in the Beaufort and Chukchi seas in each season. By doubling the number of potential drilling operations, support activity such as air travel could be expected to increase. However, the effects of the additional drilling and corresponding support activities proposed under Alternative 4 would add very little to the direct and indirect effects of Alternative 4 on terrestrial mammals and their habitat in the EIS project area. Consequently, the impacts discussed in Section 4.5.2.5 and Section 4.6.2.5 for Alternatives 2 and 3, respectively, are slightly less than those for Alternative 4; however, overall level of effects on terrestrial mammals from the implementation of Alternative 4 would remain minor.

4.7.2.6 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.6).

4.7.3 Social Environment

4.7.3.1 Socioeconomics

The following discussion of direct and indirect effects of Alternative 4 evaluates effects on employment and personal income, public revenues and expenditures, demographic characteristics, and demand on social organizations and institutions associated with an increased Level 3 of oil and gas exploration activity.

4.7.3.1.1 Direct and Indirect Effects

Alternative 4 (Level 3 activity) would generate the same categories of activity as Alternative 3 (Section 4.6.3.1), with marginal increases in direct and indirect effects in each category. Alternative 4 would generate increases in the level of activity in communities hosting vessel crew changes and purchasing/staging of support materials and increases in direct revenues from property taxes derived from potential new onshore infrastructure.

The indirect employment opportunities associated with Alternative 4 may increase marginally under Level 3 activity because shore-based support and logistical service demands would increase, including: transport of equipment; room and board of survey/seismic crews; and administration of permits to conduct the surveys. Native Corporations and private entities may capitalize on these opportunities. As described under Alternative 2, these services are seasonal and temporary in nature.

4.7.3.1.2 Conclusion

The magnitude of the socioeconomic impact under Alternative 4 would be positive and greater than a Level 2 activity. The socioeconomic impact under Alternative 4 is similar to Alternative 3, with Level 3 activities generating increased socioeconomic benefits from additional employment, income, and revenues. The increased socioeconomic benefits associated with Level 3 activity under Alternative 4 could be somewhat offset by potential time/area closures that could reduce total local employment rates and personal income, leading to a lower intensity of beneficial socioeconomic impact to communities, and a low to medium intensity economic impact to lease holders that incur costs or lose productivity. The duration of the socioeconomic impacts would be interim, lasting a fixed number of years, but not year-round. The positive economic impacts of the activity would be statewide and national. Standard mitigation measures could reduce potential for adverse effects on subsistence activities and associated social impacts. The context of the socioeconomic impacts would be considered unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for Socioeconomics under Alternative 4 is moderate.

4.7.3.2 Subsistence

4.7.3.2.1 Direct and Indirect Effects

The potential effects to subsistence resources and harvest from disturbance of the seismic survey (both open-water and on-ice) and exploratory drilling, aircraft and vessel traffic, icebreaking and ice management, and permitted discharges under Alternative 4 would be the same as those described under Alternative 2 (Section 4.6.3.2). Table 4.5-29 describes the different subsistence hunts that occur within the EIS project area by resource, where these subsistence hunts occur, the seasons of occurrence, and the potential for overlapping with proposed activities of Alternatives 2 through 6. Detailed information regarding the seasonal cycles of subsistence resources and harvest patterns is described in Section 3.3.2.

Even with the increase in the number of activities/programs that could potentially occur under Alternative 4, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity and comparable duration, but occurring in more locations to those discussed in Alternative 2.

Assumptions regarding the level of activity used in the analysis of impacts to subsistence for Alternative 4 are described in Section 2.4.7. Under Alternative 4, only these activities would be permitted. In the Beaufort and Chukchi seas, it is assumed that the activity/programs described in Table 2.4 would involve the sound sources and sound levels associated with individual sources, the same types of source and support vessels, and the same types of icebreakers for ice management and/or icebreaking. However, there would be more vessels conducting the activities in more sites with more support vessels and more aircraft traffic from the addition of more programs being potentially permitted. Given operating conditions the number of days the activities could occur in a season would be the same as those in Alternative 3. Under Alternative 4, the activity area(s) and or number of wells to be drilled could be increased with up to four exploratory drilling programs potentially permitted in both the Beaufort and Chukchi seas.

4.7.3.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.6.3.2).

4.7.3.2.3 Conclusion

Impacts of Seismic, High Resolution Shallow Hazard Surveys and Exploratory Drilling Noise Disturbance to Subsistence Resources

Bowhead Whales

Section 4.5.2.4.10 (Bowhead Whales) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect the behavior of bowhead whales. Any impacts of seismic and high resolution shallow hazard surveys and exploratory drilling noise that affect bowhead whales are expected to result in some temporary deviation in migratory path in the vicinity of the disturbance. However when the standard and additional mitigation measures contemplated in this EIS are applied, the impact of disturbance to subsistence resources and hunters would be of low intensity and temporary to interim in duration (i.e., for the duration of the activities, lasting a month or longer though not likely the entire project season). The geographic extent could be local to regional, affecting a resource of unique context, due to listing under the ESA. Impacts would not be expected at the population level, reducing long-term opportunities to subsistence harvest bowhead whales. The level of oil and gas exploration activities and potentially the geographic area affected would increase from Alternative 2. The summary impact to subsistence harvest from disturbance of bowhead whales could be considered moderate.

Beluga Whales

Sections 4.5.2.4.11 (Beluga Whales) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect beluga whales. In the Chukchi Sea, beluga whales could be displaced, i.e., would avoid areas in the vicinity of seismic survey and exploratory drilling operations in July through October during their spring and fall migrations. While belugas are harvested during late June through mid-July at Point Lay, the activities of seismic survey and exploration drilling activities would be expected to occur offshore from subsistence use areas. As described previously, Traditional Knowledge asserts that beluga whales have a keen sense of hearing; thus, activities would have the potential to impact and disrupt some communal beluga subsistence hunts (particularly Point Lay, which heavily depends on this resource) by disturbing and altering the course of these migrating whales. In turn this could make belugas more difficult to herd into the lagoons and harvest (as in the case of Point Lay).

However, the impacts would be minimized or avoided by the required mitigation measures of this EIS. As mitigated, the effects of disturbance would be considered to be of low intensity and temporary to interim in duration, occurring for the duration of the activities offshore, and affecting a resource that is important in context. These impacts are considered regional in geographic extent. There would not be expected impacts on a population level that would result in long-term impacts reducing the subsistence harvest. The summary impact to subsistence harvest from disturbance of beluga whales could be moderate.

Seals

Section 4.5.2.4.13 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect these seals. Subsistence hunts of seals occur either in nearshore coastal areas or onshore in the spring and winter seasons when seismic and high resolution shallow hazards surveys and exploratory drilling operations would not be present. Most ringed seals, an ESA-threatened species, are harvested in the winter or in the spring before these assumed activities would occur. While bearded and spotted seals are harvested during the summer, the activities of seismic survey and exploration drilling activities would be expected to occur offshore from subsistence use areas. Activities within the lease areas offshore that are likely to be explored during the open water season would have no impact on subsistence hunting for seals. One on-ice seismic survey could have the potential to disturb or displace ringed seals in their lairs but would be mitigated to lessen the impact to seals. Any impacts to seal subsistence harvests from the on-ice seismic survey would be low intensity, limited to a local area, temporary in duration, and unique in context. The geographic extent could be local to regional, affecting a resource of unique context due to the threatened status under the ESA for these two seal species. Therefore the summary impact to subsistence ice seal harvests is moderate.

Walruses, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impacts to these subsistence resources and their harvests are expected to be the same as described under Alternative 3.

The potential impact of the noise produced by the proposed seismic and high resolution shallow hazards surveys and exploratory drilling on subsistence resources and harvest activities under Alternative 4 could be major in the absence of mitigation measures. However there would be little overlap in timing and location of many of these harvest activities. In addition, mitigation measures would be required to be implemented to minimize or completely avoid adverse effects on all marine mammals and other subsistence resources and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses. In consideration of timing and the standard mitigation measures, these activities are not expected to disturb or disrupt subsistence activities at a level that would make these resources unavailable for harvest or substantially alter the existing levels of harvests. The summary impact of Alternative 4 is considered moderate to subsistence harvests of bowhead, ice seals, walruses, and polar bear; due to the candidate or ESA status of these species, they are in the unique context, which means that any effect would likely be a moderate effect. The summary impact to beluga whales is also assessed at the moderate level due to traditional knowledge (TK) observations that they possess keen senses of hearing and are easily disturbed. Summary impacts to subsistence fishing, bird harvest and egg gathering, and harvest of caribou are the same as those described in Alternative 3.

Impacts of Disturbance from Aircraft Overflights to Subsistence Resources

Bowhead Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The amount of support activity associated would likely increase over Alternative 2. The sound emitted by aircraft overflights potentially could cause some disruption to bowhead whale harvest, but aircraft overflights as mitigated are not expected to make bowhead whales unavailable to subsistence hunters. Whales could be expected to temporarily deflect from overflights, but mitigation measures analyzed in and contemplated by this EIS would limit the probability of this impact occurring. It is expected that helicopters servicing offshore seismic and high resolution shallow hazard surveys and exploratory drilling operations could traverse areas utilized by subsistence whalers during fall whaling in the Beaufort Sea and limited areas of the Chukchi Sea. Mitigation measures prescribing flight path and altitude restrictions are expected to reduce any such potential impacts to a low level.

If bowhead whales were affected by aircraft overflights, it is unlikely that large numbers or a large area used by active whaling crews would be affected, so the intensity of the impact would be considered low, and the duration would be temporary. Effects of increased levels of activity permitted under Alternative 4 are low in intensity, temporary to interim in duration, local to regional in extent, and affecting a resource that is unique in context, due to listing under the ESA. The summary impact is considered moderate.

Beluga Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.11 and 4.6.2.4.2 (Beluga Whales) of this EIS. Summer beluga hunting could be impacted by increased numbers of trips/aircraft overflights given the levels of activity associated with Alternative 4. Mitigation measures applied to this impact would lessen the disturbance to a point that it would be considered low in intensity, temporary to interim in duration, local or regional in extent, and affecting a resource that is important in context.

The required mitigation measures are expected to minimize and/or avoid impacts to beluga whales and their subsistence harvest as the mitigation measures for flight path and altitude restrictions are expected to reduce impacts to the point that the summary rating is considered moderate.

Caribou Hunting

The higher levels of activity permitted under Alternative 4 would result in increased helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations. There is a potential for disturbance to caribou subsistence hunting from the helicopter traffic that may disturb caribou on the coast. Helicopters would be traversing routes offshore from the shorebases and small proportions of available subsistence hunting areas would be affected at altitudes of less than 305 m (1,000 ft.) – most likely during takeoff and landings.

With implementation of mitigation measures, including flight altitude restrictions and use of Communication Centers, aircraft overflights are unlikely to have an adverse effect on caribou availability for subsistence harvest. Impacts that did occur would be considered low in intensity and temporary in duration. The impact would be local to regional in extent and affecting a resource that is common to important in context. The summary impact is considered moderate.

Seals, Walruses, Polar Bears, Subsistence Fishing, Bird Hunting and Egg Gathering

Impacts to these subsistence resources and their harvests are expected to be the same as under Alternative 2.

The higher levels of activity permitted under Alternative 4 would increase aircraft traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause some temporary behavioral disturbance and possibly deflection away from the sound source by terrestrial or marine mammals. The level of the disturbance would depend on the size of the aircraft and repeated exposure or displacement occurring to the resources, as well as whether or not the overflights overlap in time and space with subsistence hunting grounds.

Aircraft overflights are unlikely to have an adverse effect on subsistence harvest as mitigated. Impacts that did occur would be considered of low intensity but temporary to interim in duration. The impact would be local to regional in extent, affecting resources that range from common to unique in context. The impacts are considered moderate for bowhead whales, beluga whales, and caribou. Impacts to seals, walruses, polar bears, subsistence fishing, bird harvest and egg gathering are the same as those described in Alternative 2.

Impact of Vessel Traffic to Subsistence Resources

Bowhead Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The higher levels of activity permitted under Alternative 4 would increase vessel traffic and vessels present in the area associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause bowhead whales to alter their behavior during migration and avoid the area(s) within a few kilometers of vessel activities. However the required mitigation measures would limit impacts to late migrating bowhead whales and subsistence hunting from vessel traffic. The levels of activity permitted under Alternative 4 increase the potential for disturbance on a more regional level. Impacts to bowhead whale subsistence hunting are likely to be of low intensity, temporary to interim in duration, though could be local to regional extent, and affecting a resource that is unique in terms of the context (due to the listing under the ESA). The summary impact could be considered moderate in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Beluga Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.11 and 4.6.2.4.2 (Beluga Whales) of this EIS. A limited number of late migrating spring beluga whales could encounter increased numbers of vessels and higher levels of activity permitted under Alternative 4 for seismic and high resolution shallow hazard surveys and exploratory drilling activities and operations. The impact of disruption to beluga whales from vessel traffic could result in temporary deflection of beluga whales from subsistence harvest areas and reduced success of these hunts. However, standard mitigation measure D4 prohibits transit of exploration vessels into the Chukchi Sea prior to July 1, and all transits in the Chukchi Sea must remain at least 8 km (5 mi) offshore. Moreover, additional mitigation measure B1 would not allow any exploration activity in Kasegaluk Lagoon during the Point Lay summer beluga hunt. However the increased levels of activity permitted under Alternative 3 include the potential for disturbance on a regional level (impacts extending throughout the EIS project area) as defined in Section 4.1.3. The impact to beluga whales that do encounter vessels would be of low intensity, temporary to interim in duration, local to regional extent, and affect a resource that is important in terms of the context. The summary impact could be considered moderate in terms of a resource that is locally important, the levels of subsistence hunting and sharing of the resource that would be affected.

Seals

Section 4.5.2.4.13 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Seals could be displaced or avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities. However, under the required mitigation measures for vessels transiting into the Beaufort and Chukchi seas for these activities, impacts to seals would not be such as to adversely impact subsistence hunting activities. Subsistence seal hunts would occur in nearshore coastal areas away from areas likely to be transited by vessels. The majority of seal subsistence hunting occurs in the spring and winter seasons when vessels associated with seismic survey and exploratory drilling would not be expected to be present in subsistence harvest areas. However, with the increased levels of activity permitted under Alternative 4 there would greater potential for disturbance on a regional level (impacts extending throughout the EIS project area as defined in Section 4.1.3). With spatial and seasonal separations, the impact to subsistence seal harvest would be of low intensity, temporary duration, local to regional extent, and affecting resources that are important in terms of the context. The summary impact to ice seals could be considered minor in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Walrus, Polar Bears Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be the same as under Alternative 2.Negligible summary impacts to subsistence harvest of walruses, fish, bird hunting and egg gathering, and caribou are expected as a result of vessel traffic and the same as Alternative 2. Summary impacts to subsistence harvest of polar bears are considered to be minor and the same as Alternative 2.

Impacts of Icebreaking and Ice Management on Subsistence Resources

Bowhead Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.10 (Bowhead Whales) of this EIS. Seismic and high resolution shallow hazard surveys and exploratory drilling activities would be expected to occur during the open water season when seismic and high resolution shallow hazard surveys and exploratory drilling vessels would not encounter large amounts of sea ice. However icebreaking and ice management may be necessary during late fall or early winter when industry is still engaged in seismic and high resolution shallow hazard surveys and exploratory drilling activities in order to protect equipment, vessels, and infrastructure. Additionally, some operators have recently proposed to conduct seismic surveys during the in-ice or shoulder season (i.e., October through December). These surveys would require the use of an icebreaker to go ahead of the seismic survey vessel. The required mitigation measures limit the time frame in which these activities occur, and, as a result, the likelihood of impacts to subsistence harvest as a result of ice management activities is reduced and unlikely to adversely affect subsistence harvest of bowhead whales. The majority of these types of in-ice surveys would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas. With the increased levels of activity permitted under Alternative 4 the potential for disturbance on a more regional level becomes greater (impacts extending throughout the EIS project area as defined in Section 4.1.3). In the event that icebreaking does cause bowhead whales to avoid an area the impact to subsistence resources is expected to be low in intensity, temporary to interim in duration, local to regional in extent, and affecting a resource that is unique in context. This would be considered a moderate impact to subsistence harvest of bowhead whales.

Beluga Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.11 (Beluga Whales) of this EIS. Icebreaking activities could increase under Alternative 4 with the greater level of permitted activity allowed exploratory drilling activities. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities when ice is encountered in the late fall through early winter months of exploration activities. Icebreaking and ice management would be limited to areas where industry is actively exploring or drilling. These activities would occur in the OCS waters and would not be expected to affect beluga whale subsistence hunting, particularly since, as migratory species, they are not found in these waters during the late fall and winter. Icebreaking and ice management activities would be conducted far removed from areas typically hunted in the Chukchi Sea. No impacts are anticipated for beluga subsistence hunts in the Beaufort Sea, as beluga hunting is conducted opportunistically during the fall bowhead hunt, and the required mitigation measures of this project would prohibit seismic survey and exploratory drilling activities (and associated ice management) from occurring during this time.

The required mitigation measures are expected to minimize and potentially avoid impacts on beluga whales so that no adverse impacts occur to subsistence harvest. There is a low probability that impacts could occur to subsistence users in the Chukchi Sea. With the increased levels of activity permitted under Alternative 4 there is greater potential for disturbance on a regional level (i.e., across the EIS project area). In the event that icebreaking or ice management does cause beluga whales to avoid an area the impact to subsistence resources is expected to be low in intensity, temporary in duration, local to regional in extent, and affecting a resource that is important in context. This would be considered a moderate summary impact to the subsistence harvest of beluga whales.

Seals

Section 4.5.2.4.13 (Ice Seals) describes the mechanisms by which icebreaking and ice management activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Icebreaking could be associated with seismic survey plans that extend into the late open water season late fall to early winter (October to December) when daylight is very limited to absent and visibility is reduced, making seals more difficult to spot. At this time of year sealing efforts for subsistence are not concentrated or intense. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling and would occur in the OCS waters during the open water season after sea ice has retreated and melted. Although a greater level of activity would occur under Alternative 4, these proposed activities would occur after the end of pupping and molting seasons for all ice seals. There would be few seals expected in the area where the proposed activities would take place. Subsistence harvest of seals would not be expected to occur in areas of active ice management offshore. The required mitigation measures are expected to avoid and minimize impacts on seals such that no adverse impacts to subsistence harvests of seals would occur. In the event that icebreaking does cause seals to avoid an area, the impact is expected to be low in intensity, temporary in duration, local to regional in extent, and affecting resources that are common to important in context. This would be considered a moderate summary impact to subsistence harvest of seals because of their unique context attributable to the threatened status for two of the species.

Walruses, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Summary impacts to subsistence harvest of polar bears are considered to be minor. Summary **i**mpacts to walrus and bird hunting and egg gathering from icebreaking are expected to be negligible and the same as under Alternative 3. No impacts to fish or caribou are expected.

Impacts of noise and vehicle movement from on-ice seismic surveys

No impacts are anticipated to subsistence harvests of bowhead whales, beluga whales, walruses, and fishing as a result of the on ice seismic survey. Summary impacts to marine and coastal birds, and caribou are expected to be the same as under Alternative 3 and are considered negligible. The summary impacts to seals and polar bears are expected to be minor.

Indirect Impact to Subsistence Resources from Permitted Discharges

Permitted discharges would be conducted under the conditions and limitations of the required NPDES General Permits. Permitted discharge would be mitigated by additional mitigation measures C3 and C4, which would place requirements and limitations on the levels of discharge and discharge streams that could affect marine mammal habitat and eventually the diets of subsistence users. Under Alternative 4, there could be a higher level of activity, which would increase the levels of permitted discharges.

Mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources. There is a perception the foods could become contaminated by discharges and/or small fuels spills could result in impacts to human health from consumption of the resources. The likelihood is low that subsistence resources or harvest would occur in the vicinity of the assumed areas where drilling and/or any associated discharge or spill might occur. In addition fuel transfers are not expected during transit between the Beaufort and Chukchi seas. The indirect impact of drill cuttings and mud discharges may displace marine mammals and fish a short distance from each drilling location. The impacts to subsistence users would be of low intensity, temporary in duration, local in extent, and affecting resources that are common to unique in context.

Therefore the summary impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Impact to Subsistence Resources from Small Fuel Spills

Mitigation measures may not alleviate the perception that a small oil spill might contaminate subsistence resources. There is a perception the foods could become contaminated a small fuel spills that could result in impacts to human health from consumption of the resources. The likelihood is low that subsistence resources or harvest would occur in the vicinity of the assumed areas where drilling and/or any associated small fuel spill might occur. In addition fuel transfers are not expected during transit between the Beaufort and Chukchi seas. As described above, the impacts to subsistence harvest and users of low intensity, temporary in duration, local extent, and affecting resources that are common to unique in context. Therefore the impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Summary

Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 4 would be of low to medium intensity, temporary to interim in duration, local to regional in extent, and the context would be common to unique. Therefore the summary impact level of Alternative 4 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance.

4.7.3.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.6.3.2).

4.7.3.3 Public Health

4.7.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 4 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.6.3.3.

4.7.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 4. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur they would affect minority or low-income communities, the duration of changes may be long-term, and multiple communities could be affected.

4.7.3.4 Cultural Resources

4.7.3.4.1 Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased levels of exploratory drilling activity. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.6.3.4 for Alternative 2 are the same for Alternative 4. The overall impact to cultural resources would be negligible.

4.7.3.4.2 Conclusion

Direct and indirect impacts to cultural resources resulting from the implementation of Alternatives 2 and 3 would be the same in Alternative 4. For a complete discussion of direct and indirect impacts on cultural resources, please see Section 4.6.3.4.

4.7.3.5 Land and Water Ownership, Use, and Management

4.7.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership caused by Alternative 4 are similar to those caused by Alternative 2. Refer to Section 4.6.3.5 for a discussion on these topics. This includes federal, state, private, borough, and municipal owned lands and waters.

Land and Water Use

The actions in Alternative 4 are the same as for Alternative 2. However the activity levels are increased; numbers of allowed seismic surveys, shallow hazards survey programs, and exploratory programs are increased in the Beaufort and Chukchi seas. The amount of on-ice seismic surveys and icebreaking would remain the same. Taking into consideration these increases, direct and indirect effects to the recreation, residential, mining, and protected land uses would be similar to Alternative 2. Refer to Section 4.6.3.5 for a discussion on these topics.

With an increase in activity levels, the possibility for conflict increases between subsistence use and surveys. Section 4.7.3.2 discusses the direct and indirect impacts of Alternative 4 in detail.

The direct and indirect impacts caused by Alternative 4 for industrial, transportation, and commercial land uses would be similar to those discussed under Alternative 2 in Section 4.6.3 but use would increase incrementally as survey activity levels go up. Beyond what is discussed in Section 4.6.3, there is a slightly higher possibility of new facilities and infrastructure, higher levels of air and vessel traffic, and commercial activity associated with survey support. No new roads or railroad lines are expected to be built under this alternative; therefore no changes are expected in land use to accommodate expanded land transportation systems. See Section 4.7.3.1 Socioeconomics for further discussion on economic opportunities under this alternative.

Land and Water Management

BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS. The level of exploration activity in federal water under Alternative 4 is consistent with management of those waters. Similarly, the state applies Best Interest Findings before allowing seismic exploration activities and each must demonstrate individual consistency with state management policies before permits are issued on state lands or waters. Therefore, no inconsistencies or changes in federal or state land or water management are anticipated as a result of this alternative. The effects would be similar to those discussed under Alternative 2, Section 4.6.3.5.

While no change in underlying land or water management is anticipated as a result of this project, compliance with NSB and NAB comprehensive plans and Land Management Regulations coastal management policies is undertaken on a voluntary basis for activities in state and federal waters; permit applicants for offshore exploration activities in state waters may attempt to be consistent with Borough Land Management Regulations. As activities increase under Alternative 3, the possibility for conflicts with borough offshore development and coastal management zoning policies goes up as well. As indicated in Section 3.3.5.3 State Waters Managment, the Alaska Coastal Management Program was not reauthorized by the state legislature and has not been in effect since 2011.

4.7.3.5.2 Conclusion

Based on Table 4.4-2, and the analyses provided in Section 4.5.3.5.2, there would be no direct or indirect impacts on land and water ownership under Alternative. Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5.4, the impacts of land and water use caused by Alternative 4 are described as follows. The magnitude of impact would be high where activity occurs where there is previously little to no activity (such as Wainwright), and the magnitude of impact would be low where activity occurs where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be interim because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be long-term if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 4 would be moderate because of the possibility for high intensity impact.

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5.6, the impacts on land and water management caused by Alternative 4 are described as follows. The magnitude of impact would be low because, while the level of activity would increase, they are consistent with existing management plans, subject to conditions of approval. The duration of impact would be interim because project activities are short term in duration and would not result in long-term conflicts with management plans. The extent of impacts would be local because proposed activities would not involve management plans beyond the local areas of exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 4 on land and water management would be minor because they would be low intensity, would be interim in nature, local, and common.

4.7.3.6 Transportation

4.7.3.6.1 Direct and Indirect Effects

The effects to transportation in Alternative 4 would be similar to those described under Alternative 2 (Section 4.5.3.6). Alternative 4 would have an elevated level of intensity with an increased number of seismic surveys, site clearance surveys and would allow for an additional exploration program. The direct effect to transportation would be an increase in levels of air traffic and vessels present in these areas associated with the seismic survey and exploratory drilling activities in comparison to levels projected under Alternative 2. The intensity of the impact would be considered low and temporary to interim in duration (length of survey or exploratory drilling activities each year). The extent of increased aircraft presence may be on a local to regional scale given the increased number of seismic survey and exploratory drilling programs that could occur under Alternative 4. Impacts from the increased levels of air traffic would be low in intensity, interim in duration, and local to regional in extent and affect a common resource. The impact level would be considered minor.

4.7.3.6.2 Conclusion

Increased levels of marine vessel traffic in Alternative 4 associated with the seismic survey and exploratory drilling programs would be expected to occur in offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when lightering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence would be low in intensity, temporary to interim in duration, limited in geographic extent to a local to regional area, and common tin context. The summary impact from increases in vessel traffic would be considered minor.

4.7.3.7 Recreation and Tourism

4.7.3.7.1 Direct and Indirect Effects

Alternative 4 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.5.3.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 4; the overall impact to recreation and tourism would be minor.

4.7.3.7.2 Conclusion

The direct impacts to recreation and tourism would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 4 on recreation and tourism would be minor.

4.7.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 4 of the proposed project.

4.7.3.8.1 Direct and Indirect Effects

Implementation of Alternative 4 would be similar to that described in Section 4.5.3.8.1; however, there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in interim moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 4, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, local and occur in an important context.

4.7.3.8.2 Conclusion

In conclusion, implementation of Alternative 4 is expected to result in interim moderate effects to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites, as visual contrast of these actions would attenuate with distance. The geographic extent of potential impacts would be local, as actions are not expected to be detectable beyond the project area; however they could affect an important resource in the ANWR to the extent they are visible by visitors.

4.7.3.9 Environmental Justice

4.7.3.9.1 Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

The activity levels associated with Alternative 4 are expected to result in similar levels of effects to subsistence hunts by potential deflection of marine mammals harvested in the EIS project area (described in Subsistence Section 4.5.3.2 for Alternative 2). These are a low intensity impact on subsistence resources and be temporary to interim in duration. Impacts would be local to regional in extent and affect resources that range from common (fish) to important (marine mammals) in context. Standard and additional mitigation measures for activity levels associated with Alternative 2 are not expected to make resources unavailable for harvest or substantially alter the existing levels of harvest.

As described in the Public Health Section 4.5.3.3 for Alternative 2, Alternative 4 activities are not expected to have a substantial impact on the numbers of marine mammals harvested in any community in the study area. Dispersion of some animals may result in greater travel time, cost, and safety risk to the hunters, but not overall availability or consumption of traditional foods. A variety of health indicators affected by Alternative 4 activities would have a low intensity impact on human health because possible changes to health outcomes (e.g., chronic disease and trauma) would be above background conditions but within normal variation. Health changes may be long-term and multiple communities could be affected for a regional extent. As with Alternative 2, Alternative 4 may have an indirect effect of adding to the perception that subsistence foods are contaminated and alter confidence in their consumption, affecting diet and nutrition. However, increased contamination levels in subsistence food sources are likely to be negligible.

4.7.3.9.2 Conclusion

Environmental justice analysis considers impacts to subsistence, sociocultural systems, and public health. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Alternative 4 is expected to have a minor impact to subsistence resources and a minor impact to public health. Alternative 4 with Standard Mitigation Measures would create some more local employment and economic support activities than Alternative 4, and would reduce adverse effects. There would be an overall minor impact to Alaska Native communities under Alternative 4.

4.7.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.8 Direct and Indirect Effects for Alternative 5 – Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures

4.8.1 Physical Environment

4.8.1.1 Physical Oceanography

4.8.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

The effects of Alternative 5 on water depth and general circulation would be the same as those described for Alternative 4.

Currents, Upwellings, and Eddies

The effects of Alternative 5 on currents, upwellings, and eddies would be the same as those described for Alternative 4.

Tides and Water Levels

The activities described under Alternative 5 would be temporary in nature and would have only a seasonal presence of extremely limited size and geographic distribution, and would not affect tides or water levels within the proposed action area.

However, wind, waves and storm surge would potentially impact seismic and exploratory drilling activities, and could influence human safety.

Stream and River Discharge

The time/area closures described under Alternative 5 would not affect stream and river discharge within the EIS project area.

Sea Ice

The effects of Alternative 5 on sea ice would be mostly the same as those described for Alternative 4. The time area closures included as additional mitigation measures in Alternative 5 would not substantially change the effects of the alternative on sea ice resources in the proposed action area.

4.8.1.1.2 Conclusion

The effects of Alternative 5 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of the proposed activity described in Alternative 4 on physical ocean resources in the EIS project area would be minor.

4.8.1.2 Climate

Under this alternative, emissions would be the same as for Alternative 4 because the alternative proposes exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*).

Refer to Section 3.1.2.4 (Climate Change in the Arctic) for a thorough discussion of climate systems and the effects of GHG emissions.

4.8.1.2.1 Direct and Indirect Effects

Direct Effects

Direct effects under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

Indirect Effects

Indirect effects under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

CO_2e Projected Emissions Inventory

The CO_2e emissions inventory is the same for this alternative as given for Alternative 4.

Effects of this Alternative on Climate Change

The effects of this alternative are the same as those described for Alternative 4.

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2.

4.8.1.2.2 Conclusion

The conclusion of the assessment under this alternative is the same as for Alternative 4.

4.8.1.3 Air Quality

Under this alternative, GHG, HAP, and criteria pollutant emissions would be the same as described for Alternative 4 and proposes Level 3 Exploration Activity on the Arctic OCS, which is four EPs for each planning area. The majority of additional emissions are from the EPs proposed for Level 3 Exploration Activity.

4.8.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of emissions as described under Alternative 2 in Section 4.5.1.3.

4.8.1.3.2 Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

4.8.1.3.3 Level of Effect

The level of effect under this alternative would be the same as discussed under Alternative 4.

4.8.1.3.4 Conclusion

Projected emissions from exploratory drilling activities proposed under this alternative would be higher than those estimated for Alternative 4. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the NAAQS to be exceeded onshore. The Level 3 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A high level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a medium level of effect.

4.8.1.4 Acoustics

Under Alternative 5, the number and types of exploration programs envisioned could either be identical to Alternative 4 (see Section 4.7.1.4) because all of the activities that would otherwise have occurred in the closure area are displaced to other areas, or could be slightly fewer because activities that would have happened in closure areas were not conducted at all. A detailed discussion of the acoustic properties of the noise sources is given in Section 4.5.1.4.

Alternative 5 differs from Alternative 4 only in that it implements time/area closures for avoidance of higher marine mammal densities during migration or periods of feeding or subsistence use. The chronic and aggregate assessment of effects on acoustic habitat detailed in section 4.5.2.4.10 suggests only minor improvement in the amount of lost bowhead whale communication space or broadband listening area (<2%) when time/area closures are applied at the one receiver site (Barrow Canyon) located where losses were otherwise seen (modeled recivers were also located within the Hanna Shoal area and the Ledyard Bay closure, but zero losses were modeled, so no improvements were possible). However, this lack of improvement was likely heavily influenced by the modeling method of removing the top 10% closest seismic shots, which is used to ensure that near-field seismic shots do not dominate the measured noise.

In other words, and we would expect some relatively higher level of improvement, at least for relatively large time/area closures (while still effective for reducing acute effects, smaller areas are less effective for reducing chronic effects of noise).

4.8.1.4.1 Direct and Indirect Effects

Implementation of time closures does not reduce the spatial distribution of sound levels. The distances and areal extent to the pertinent thresholds for Alternative 5 are identical to those provided in Alternative 4 in the case of time closures. Area closures would reduce the sound levels in the closure area, but may result in higher sound levels should the activities be concentrated to an area outside of the closure.

4.8.1.4.2 Conclusion

While Alternative 5 presents the same level of activity as Alternative 4, lower levels of exploration activities may actually occur under Alternative 5 due to inclusion of periods of closure. The amount by which activity will be reduced depends on the ability of seismic operators to schedule around blackouts. One potential effect of the time/area closures associated with Alternative 5 would be that available exploration time in certain locations will be compressed. As a consequence, there could be less ability for different exploration operators to schedule activities to avoid working in close vicinity of each other. Operations in close vicinity could lead to higher exposures for marine mammals that happen to be near the activities outside of the closure periods or areas.

Alternative 5 could represent a smaller increase in activity in certain areas over current levels than Alternatives 2, 3, and 4, but less in others. The intensity rating of this alternative is high, as the exploration activities in non-closure periods will introduce sources with source sound levels that exceed 200 dB re 1 µPa. Because the exploration activities could continue for several years, the duration is considered as long-term. Under a closure the sound levels will be decreased at a regional scale, however the spatial extent for Alternative 5 is still considered to be regional, as in Alternatives 2, 3, and 4. Therefore, the overall impact rating for direct and indirect effects to the acoustic environment under Alternative 5 would be moderate.

4.8.1.5 Water Quality

Impacts to water quality from Alternative 5 are expected to be very similar to those described above for Alternative 4. The only difference between Alternative 4 and Alternative 5 is the addition of required time/area closures; the level of activity would stay the same, but may vary by area and when the activity will occur. Any differences in impacts between Alternative 4 and Alternative 5 are noted below.

4.8.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, seismic surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, site clearance and shallow hazards surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

On-ice Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, on-ice seismic surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

Exploratory Drilling Programs

Effects on water quality resulting from increases in temperature and salinity from exploratory drilling programs would be similar to those described under Alternatives 2, 3, and 4. Time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. Overall, the effects of Alternative 5 on water quality resulting from changes in temperature and salinity would be low intensity, temporary, and local. The overall effects of Alternative 5 on water quality related to temperature and salinity resulting from exploratory drilling programs are expected to be minor.

Turbidity and Total Suspended Solids

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 5, if any, are expected to be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be the same described under Alternative 2.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, effects on water quality resulting from potential increases in turbidity and total suspended solids from site clearance and shallow hazard surveys under Alternative 5, if any, are expected to be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be the same described under Alternative 2.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of suspended solids in the proposed action area.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternatives 2 and 3. Time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality resulting from changes in turbidity and concentrations of suspended solids are expected to be low intensity, temporary, and local. The overall effects of Alternative 5 on water quality related to turbidity and concentrations of suspended solids resulting from exploratory drilling programs are expected to be minor.

Proposed mitigation measures intended to reduce/lessen non-acoustic impacts on marine mammals have the potential to further reduce adverse impacts to water quality.

Metals

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, seismic surveys are not expected to have any measureable impact on dissolved metal concentrations in the proposed action area.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, site clearance and shallow hazards surveys would not affect dissolved metal concentrations in the proposed action area.

On-ice Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, on-ice seismic surveys would not affect dissolved metal concentrations in the proposed action area.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternatives 2, 3, and 4. Time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality resulting from changes in metal concentrations are expected to be low intensity, temporary, and local. The overall effects of Alternative 5 on water quality related to metal concentrations resulting from exploratory drilling programs are expected to be minor.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Despite being negligible, time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, site clearance and shallow hazards surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Despite being negligible, time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times.

On-ice Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, on-ice seismic surveys are expected to have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area under Alternative 5. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys under Alternative 5 are expected to be minor (i.e., effects are below regulatory thresholds for marine water quality).

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of hydrocarbons and other organic contaminants from exploratory drilling programs are described in detail under Alternatives 2, 3, and 4. Time/area closures established under Alternative 5 as mitigation measures would reduce adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality resulting from changes in concentrations of hydrocarbons and other organic compounds are expected to be temporary and local. It is probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 5 would have minor to moderate effects on water quality outside of the discharge plume area. However, due to lack of applicable water quality criteria for some organic compounds in drilling fluids (EPA 2006b), it is problematic to determine whether or not inputs of hydrocarbons and other organic compounds from the proposed activity would exceed water quality regulatory limits.

4.8.1.5.2 Conclusion

After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 5 on water quality in the EIS project area are expected to be minor.

4.8.1.6 Environmental Contaminants and Ecosystem Functions

4.8.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 5 would be the same as those described for Alternative 2, but the levels would be closer to those for Alternative 4.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 5 would be the same as those described for Alternative 2. The area of habitat and biological resources exposed to potential contaminants wold be larger under Alternative 5.

Potential Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 5 on the four categories of ecosystem functions (defined in Section 4.5.1.6) are assessed below.

Regulation Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to regulation functions relative to Alternative 4. The capacity of natural systems to maintain essential ecological processes (such as nutrient cycles) and life support systems (such as provision of clean water) is not distributed evenly over space and time (Naidoo et al. 2008). Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in the maintenance of essential ecological processes. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times and therefore have the potential to reduce adverse impacts to regulation functions.

Habitat Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to habitat functions relative to Alternative 4. The capacity of natural systems to provide refuge and reproduction habitat is not distributed evenly over space and time. Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in the provision of refuge and reproduction habitats. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times, and therefore have the potential to reduce adverse impacts to habitat functions.

Production Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to production functions relative to Alternative 4. The capacity of natural systems to convert energy and nutrients into biomass and support subsequent trophic transfers and biogeochemical processes is not distributed evenly over space and time (Naidoo et al. 2008). Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in energy conversion and production processes. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times and therefore have the potential to reduce adverse impacts to production functions.

Oil and gas are ecosystem goods, and the flows of energy that they represent are ecosystem services. These ecosystem goods and services could potentially be derived from historical production functions in the EIS project area under Alternative 5.

Information Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to information functions relative to Alternative 4. The capacity of natural systems to contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience is not distributed evenly over space and time. Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in providing the opportunities associated with information functions. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times, and therefore have the potential to reduce adverse impacts to information functions.

4.8.1.6.2 Conclusions

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 5 would be medium-intensity, interim, and local. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e., resistant to stressors) than are species composition and other structural properties. A relatively detailed analysis of the effects of Alternative 2 on fate and persistence of potential contaminants entrained in sediments is included in Aection 4.5.1.6.1. The potential effects of Alternative 2 on the distributions of metals and petroleum hydrocarbons, both in the water and in seafloor sediments, are also discussed under Section 4.5.1.5 (Water Quality). Overall effects of Alternative 5 on ecosystem functions would be minor.

4.8.1.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.8.2 Biological Environment

4.8.2.1 Lower Trophic Levels

4.8.2.1.1 Direct and Indirect Effects

The direct and indirect impacts discussed in Section 4.5.2.1 for Alternative 2 are also applicable for this alternative. Activity levels in Alternative 5 are the same as in Alternative 4, but this alternative includes the creation and application of time/area closures that would be required for all activities. These time/area closures would not measurably affect lower trophic levels in the EIS project area, so the impacts for Alternative 5 are the same as for Alternative 4.

4.8.2.1.2 Conclusion

Given the potential for implementation of the standard mitigation measures considered in this EIS, the direct and indirect effects on lower trophic levels associated with Alternative 5 would likely be low in intensity, temporary to long-term in duration, of local extent and could affect common resources;

resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.8.2.2 Fish and Essential Fish Habitat

4.8.2.2.1 Direct and Indirect Effects

Alternative 5 assumes the same level of oil and gas exploration activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity types in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. The analyses for direct and indirect effects are the same for Alternative 5 as for Alternative 4.

Alternative 5 differs from Alternative 4 in the creation and application of time/area closures that would be required for all activities as opposed to being considered on a case-by-case basis under the Additional Mitigation Measures for Alternatives 2, 3, 4, and 5. Time/area closures are intended to reduce impacts to marine mammals during sensitive times and locations in their life cycle and to decrease conflict with Alaska Native marine mammal subsistence activities. Specific locations have been identified and will be closed to oil and gas exploration activities during periods of high use by marine mammals.

It is important to note that under this alternative, there would be no reduction in the overall amount of activity occurring. The total noise emitted or habitat lost or altered would remain the same, only the times and locations of those impacts would change. However, fish are not evenly distributed across the EIS project area and instead congregate in desirable habitats. Many of the areas identified as being important to marine mammals are also likely to be important to other marine species as well. Productive marine environments are shared by many animal groups; therefore, the time/area closures will likely correspond to locations and periods important to fish species and will result in unintended beneficial impacts to fish resources. A seismic survey performed in an area of low fish density will have lower adverse impacts on fish resources than a seismic survey performed in an area of high fish density. If activities can be reduced or eliminated in areas of high fish density, the overall number of fish likely to be impacted will be smaller by reducing the total number of fish exposed to high sound levels.

An analysis of each time/area closure area is included here, as well as the anticipated mitigating impact each closure could have on fish and fish resources. Any benefits or mitigated effects described would only occur if exploration activities in other, less productive areas replaced activities that would otherwise occur within the time/area closures. Additionally, impacts in these areas would be reduced if the exploration activity occurred at other times of year when fewer marine mammals (and possibly other marine species) were present in those locations. The temporal offset of activity within these areas is unlikely to result in any discernible reduction in overall impact levels.

For a complete discussion of the effects of direct and indirect effects on fish resources, please see Section 4.5.2.2.

4.8.2.2.2 Time/Area Closures

Kaktovik and Cross Island

There is little published information on fish habitat in the vicinity of the proposed time area closures in the Beaufort Sea near Kaktovik and Cross Island. Reducing oil and gas exploration activities in this area would reduce overall impacts to fish that use the shallow, nearshore habitats in the vicinity of Kaktovik and Cross Island.

Barrow Canyon/Western Beaufort Sea

The northwest corner of the Beaufort Sea, near the Chukchi Sea, has been shown to be the most productive fish habitat in the region (see Section 3.2.2.1; Logerwell and Rand 2010). Although Barrow Canyon sits on the southern boundary of this highly productive area, it is still much more productive than surrounding areas of the Beaufort Sea. Fish densities are higher here and to the north than in surrounding areas. This closure area does not contain any lease areas, eliminating drilling from the list of activities potentially impacting the resources. Therefore, the main consideration to fish resources would be a reduction in sound emitted from seismic surveys, with a small amount of habitat loss or alteration potentially mitigated through the elimination of anchoring and icebreaking in the area.

Reducing oil and gas exploration activities in this area would reduce overall impacts to fish resources primarily by decreasing the overall amount of exposure to sound by fish on a population level. The elimination of all exploration activities would benefit all assemblages of marine fish the most, with some anticipated benefit to migratory fish.

Shelf Break of the Beaufort Sea

The shelf break of the Beaufort Sea has been shown to be the most productive fish habitat in the region, particularly the northwest corner near the Chukchi Sea (see Section 3.2.2.1, Logerwell and Rand 2010). As such, reducing oil and gas exploration activities in this area would reduce overall impacts to fish resources by decreasing the overall amount of exposure to sound by fish on a population level. The elimination of all exploration activities would benefit all assemblages of marine fish the most, with some anticipated benefit to migratory fish.

Point Franklin to Barrow

Point Franklin to Barrow, including Peard Bay, is a shallow, nearshore area of the Chukchi Sea. This closure area does not contain any lease areas, eliminating drilling from the list of activities potentially impacting the resources. Therefore, the main consideration to fish resources would be a reduction in sound emitted from surveys, with a small amount of habitat loss or alteration potentially mitigated through the elimination of anchoring and icebreaking in the area.

According to the Nearshore Fish Atlas of Alaska, developed by NMFS' Alaska Region, sand/gravel-substrate habitat is found in the nearshore area between Peard Bay and Barrow. Several species of fish are found in this habitat including capelin, Pacific sand lance, yellowfin sole, longhead dab, Alaska plaice, Arctic flounder, saffron cod, Arctic cod, pink salmon, Arctic cisco, and several species of stickleback, sculpin, and prickleback. Larval, juvenile, and adult fish are all found in this area (Johnson et al. 2012).

Kasegaluk Lagoon and Ledyard Bay

Kasegaluk Lagoon and Ledyard Bay are shallow, nearshore areas of the Chukchi Sea. These closure areas do not contain any lease areas, eliminating drilling from the list of activities potentially impacting the resources. Therefore, the main consideration to fish resources would be a reduction in sound emitted from surveys, with a small amount of habitat loss or alteration potentially mitigated through the elimination of anchoring and icebreaking in the area.

Migratory fish are likely to benefit from this closure. Juvenile salmon are known to congregate in shallow estuaries near river mouths before moving off to sea, and many amphidromous species also use brackish water for substantial portions of their lives (see Section 3.2.2.3). Therefore, increased protection of these areas would be beneficial to the migratory species that use these habitats regularly. Nearshore marine species would also benefit from this closure, due to the shallow habitat characterizing the area.

4.8.2.2.3 Conclusion

Although the time/area closures associated with Alternative 5 would not change the total noise emitted or habitat lost/altered, these closures could lessen the effects of exploration activities on fish resources by reducing the total number of fish exposed to potentially deleterious sound levels. These closures would generally be less effective at reducing adverse effects on fish and EFH than they would be at protecting marine mammals or subsistence hunting. The temporal offset of activity within these areas is unlikely to result in any discernable reduction in overall impact levels. Therefore, the exploration activities authorized under Alternative 5 would result in minor impacts to fish and EFH.

4.8.2.3 Marine and Coastal Birds

4.8.2.3.1 Direct and Indirect Effects

Alternative 5 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on birds under Alternative 5 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. Rather than repeating the same information presented in Section 4.5.2.3, the following discussion will focus on the differences between Alternative 2 and Alternative 5.

The difference between alternatives concerning birds is a matter of degree. Alternative 5 includes a larger number of some authorized exploration activities than Alternative 2. Alternative 5 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 4, including the same suite of standard mitigation measures with the addition of mandatory time/area closures. The closure areas are the same as those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, Kasegaluk Lagoon, and Ledyard Bay. The difference between Additional Mitigation Measure B1 and Alternative 5 is that specific time periods have been specified under Alternative 5 corresponding to periods of high biological productivity or important life functions for some species, primarily bowhead and beluga whales. However, the most important of these areas to birds, the LBCHU, would be subject to the same closure period as any of the other alternatives, after July 1, because this restriction is one of the mitigation measures imposed by the USFWS and BOEM to protect ESA-listed spectacled eiders. The other closure areas would be important to certain species, such as Barrow Canyon for Ross's gull in the fall, but these closures would generally be less effective at reducing adverse effects on birds as they would be to protect marine mammals or subsistence hunting. The effects of Alternative 5 would therefore be essentially the same as for Alternative 4.

The direct and indirect effects of oil and gas exploration activities on marine and coastal birds would be very similar under Alternative 5 as those described under Alternative 2. Marine birds would be subject to increased disturbance from vessels and seismic sources due to the increase in seismic surveys that could be authorized under Alternative 5 in both Arctic seas. However, disturbance effects would be temporary even if they occurred over a wider area and birds could fly or swim away from acute disturbance. With more exploration activities authorized under Alternative 5, the potential for adjacent activities to magnify effects on birds could be increased. The Ledyard Bay closure period would be the same under Alternative 5 as under Alternative 2 so this area would be unaffected by increases in exploration elsewhere.

The risk of birds colliding with vessels would increase incrementally but, given mitigation measures to adjust lighting strategies to reduce those effects, fatal collisions are still expected to be rare and not likely to affect the population of any species. The risk of small oil spills would also increase incrementally as the number of vessels increase but these effects are also mitigated and considered to present very small risks to birds unless the spill occurred in or persisted in a lead or polynya system. A very large oil spill due to an exploration well blowout could have much more serious effects on birds and is discussed in Section 4.10.

4.8.2.3.2 Standard Mitigation Measures

Standard and additional mitigation measures that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3.2). Additional mitigation measures are not required under any of the alternatives and do not affect the summary conclusion below.

4.8.2.3.3 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles in the Arctic and many are important subsistence resources. Depending on the species, they are considered to be important or unique resources from a NEPA perspective. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be medium intensity, temporary or interim in duration, and of local extent. The overall effects of oil and gas exploration activities authorized under Alternative 5 on marine and coastal birds would therefore be considered moderate according to the impact criteria in Table 4.5-16.

4.8.2.4 Marine Mammals

Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures that would be required for all oil and gas exploration activities within a particular time and location. The closure areas are similar to those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay. No oil and gas industry exploration activities would be permitted to occur in the areas specified here during the listed timeframes. Under this alternative, buffer zones around these time/area closures would be included. Buffer zones would require that activities emitting pulsed sounds would need to operate far enough away from these closure areas so that sounds at 160 dB re 1 µPa rms do not propagate into the area or that activities emitting continuous sounds would need to operate far enough away from these closure areas so that sounds at 120 dB re 1 µPa rms do not propagate into the area. The purpose of Time/Area Closures is twofold: 1) to reduce adverse impacts to marine mammals (in either number or severity) in areas (and times) of known importance to marine mammals (e.g., feeding or calving areas), in which behavioral disturbance could potentially result in a reduction in the fitness of the disturbed individuals, either through energetic effects or direct interference with critical behaviors (e.g., cow/calf communication). Table 4.8-1 summarizes the resources and mitigated functions associated with each area. Analyses of the Time/Area Closure areas, along with the anticipated mitigating impact each closure could have on the indicated species, are described in the species sections below.

Of note, in this alternative, only the buffer zone noted above is considered, and only the implementation of *all* the areas is considered. However, when time/area limitations are considered as additional mitigations in the other alternatives, we may consider the implementation of some subset of the areas or a smaller buffer, depending on the situation and practicability for the specific project in consideration.

Table 4.8-1 Required Time/Area closure locations under Alternative 5. This table identifies the species and subsistence hunts that would be mitigated by requiring these closures.

Species/Subsistence Activity	Kaktovik and Cross Island	Barrow Canyon and the Western Beaufort Sea	Beaufort Sea Shelf Break	Point Franklin to Barrow	Kasegaluk Lagoon and Ledyard Bay
Proposed closure period under Alternative 5	August 25 - September 15	Mid-July - October	Mid-July - late September	June to September	Mid-June - mid-July for the Lagoon and July 1 – November 15 for the LBCHU
Bowhead Whale	Migrating and feeding: late August - October	Migrating and feeding: late August - October	Migrating: late August - October	Feeding and milling: September – October; May occur June-July	Do not occur (migrate offshore)
Beluga Whale	Uncommon	Migrating and feeding: mid-July - late August	Feeding: mid-July - late September	Occasional: July, August, October	Feeding, molting, calving: June and July
Gray Whale	Uncommon	Feeding, milling: June – October	Present	Feeding, calving, milling: June – October	Feeding, calving: June – October
Spotted Seal	Present	Present	Present	Present	Present; Some feeding habitat
Pacific Walrus	Not present	Not present	Not Present	Present: June, July, September	Resting habitat: Spring and early winter
Whaling Hunts	Bowhead whales: late August - mid-September	Bowhead whales: September - October	Uncommon	Bowhead whales: September – October; Beluga whales: June to September	Beluga whales: mid-June - mid-July in the Lagoon only
Sealing Hunts	Mostly October - June	Mostly November - January and spring	Uncommon	Mostly November – January and spring-summer	Mostly October - June

4.8.2.4.1 Bowhead Whales

4.8.2.4.1.1 Direct and Indirect Effects

Alternative 5 includes the same level of oil and gas exploration activity as Alternative 4 (Level 3 Exploration). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 5 are also identical to those for Alternatives 2, 3, and 4 except that the time/area closures discussed as additional measures in Alternatives 2, 3, and 4 are required in this alternative. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4, with the exception of the anticipated effects of restricting activities from occurring in the time/area closure areas. The time/area closures expected to affect impacts on bowhead whales (Kaktovik and Cross Island and the Western Beaufort Sea) are discussed below.

Time/Area Closures Required Under Alternative 5

Kaktovik and Cross Island

The Kaktovik and Cross Island area is considered a time/area closure location by NMFS for analysis purposes in this EIS (Figure 3.2-29) and would be closed to all exploration activities from August 25 to September 15. Data collected during ASAMM surveys in the Beaufort Sea from 2008-2011 noted feeding groups of bowhead whales in September most of those years (Clarke et al. 2011b, c, 2012). Additionally, hunters from Kaktovik and Nuiqsut traditionally conduct hunts from the community and Cross Island, respectively, in the fall. Hunts typically begin in late August/early September and continue until mid- to late September, depending upon migration patterns, weather and ice conditions, etc. Closing the area to oil and gas activities during this time period would reduce adverse impacts, particularly those associated with noise disturbance (e.g., displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area. Reducing impacts on concentrations of bowhead whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects during the closure period. Reduced adverse impacts on bowhead whales would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact bowhead whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of the buffer zones around the required closure areas would help to reduce further impacts from occurring within this important location.

The use of nearshore waters of Kaktovik and Cross Island for bowhead hunting during this time period is discussed in further detail in Section 4.8.3.2.

Barrow Canyon/Western Beaufort Sea

Barrow Canyon/Western Beaufort Sea is considered a time/area closure location by NMFS for analysis purposes in this EIS (Figure 3.2-29) and would be closed to all exploration activities from mid-July – October. Due to sub-sea topography and the ocean currents, Barrow Canyon is one of the two primary concentration areas for bowhead whales in the Beaufort Sea, particularly as a staging/feeding area during the fall migration of bowheads out of the Beaufort Sea. Physical and oceanographic features of Barrow Canyon promote a bowhead whale feeding "hotspot" here during late-summer and fall. Bowhead whales congregate in the area to exploit dense prey concentrations (Ashjian et al. 2010, Moore et al. 2010, Okkonen et al. 2011). Barrow Canyon is also an important feeding area for beluga whales (Clarke et al. 2011b, 2011c, Moore et al. 2000). Time/Area closures for this area proposed under Alternative 5 are to mitigate effects on bowhead whales (late August to early October), belugas (mid-July to late August), and the fall bowhead whale subsistence hunt out of Barrow (September 15 to close of the hunt). Closing the area to oil and gas activities during these time periods would reduce adverse impacts, particularly those associated with noise disturbance (e.g., displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area, as well as for belugas. Reducing impacts on concentrations of bowhead whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects during the closure period. Reduced adverse impacts on bowhead whales would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact bowhead whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of the buffer zones around the required closure areas would help to reduce further impacts from occurring within these biologically important areas.

This area and time is also important for beluga feeding (Section 4.8.2.4.2), as well as the fall bowhead hunt (Section 4.8.3.2).

Behavioral Disturbance

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the types and mechanisms for disturbance to bowhead whales would be the same. As discussed above, though, implementation of time/area closures has the potential to reduce the intensity of behavioral disturbance to bowhead whales through potential reduction in the numbers of disturbed whales (if whales were more densely congregated in these areas) or reduction in the severity by avoiding potential adverse energetic effects that might result from displacement from preferred feeding habitat. The degree of reduced impacts would depend on the level of activities which would otherwise have occurred in these areas, which is difficult to predict (of note, these areas do not overlap any leases), however, the same total level of activities would still be expected to occur outside of these closures (still in the bowhead migratory corridor), so the degree of reduced impacts, as compared to the whole, would be relatively minor and would not change the impact criteria conclusions, which are of high intensity, interim duration, regional extent, and unique context.

Please refer to Section 4.5.2.4.10 for a complete discussion of disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for injury and mortality to bowhead whales would be the same. Because the proposed time/area closures are not expected to reduce the likelihood of injury or mortality, these remain identical to those discussed for Alternative 4 in Section 4.7.2.4: medium intensity, generally interim in duration (except in instances of mortality or serious injury), regional in extent and of important context.

Please refer to Section 4.5.2.4.10 for a complete discussion of potential injury or mortality effects on bowhead whales.

Habitat Alterations

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for habitat alteration would be the same. However, the implementation of these time/area closures could create some level of reduced effect on acoustic habitat in an area/time where interspecies communication and interpretation of acoustic cues may be of increased importance (i.e., for feeding), although, when compared to the overall level of effects outside these areas, the level of effects on bowhead whale habitat from Alternative 5 could be slightly less, but not substantially different than those discussed for Alternative 4 in Section 4.7.2.4.

Please refer to Section 4.5.2.4.10 for a complete discussion of the potential effects on bowhead whale habitat.

4.8.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.8.2.4.1.3 Conclusion

As described above, effects of disturbance on bowhead whales, as well as impacts on acoustic habitat, from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 5 relative to how much exploration activity would have occurred there if permitted to do so. Exploration activities could, however, occur during different time periods within these areas, leading to a short-term reduction of effects. In addition, industry may relocate exploration activities to other, possibly adjacent, areas until the closure areas are available. Overall, exploration effort would not likely be reduced, but, rather, redistributed and possibly concentrated in other areas. Time/Area closures that mitigate adverse impacts on feeding bowhead whales could reduce impacts to a lower intensity. However, bowhead whale habitat use in the EIS project area is dynamic and extensive, and, when migration corridors are considered (through which mothers and calves are passing), it includes large portions of the Beaufort and Chukchi seas not included in the Time/Area closures that could coincide with oil and gas exploration activities throughout the region. Effects of concurrent closures also need to be considered. Time/area closures in the Beaufort Sea (Kaktovik and Cross Island, Barrow Canyon and Beaufort Sea Shelf Break) overlap in September and, for the former two, in October as well. Concurrent closures could result in excluded activities concentrating in areas not included in the closure areas, such as on the Beaufort shelf between Harrison Bay and Camden Bay, during those time periods. Although the Time/Area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on bowhead whales of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4 (Section 4.7.2.4) however, with a slight decrease, and would be considered moderate.

4.8.2.4.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.17). All time/area closures included in Additional Mitigation Measure B1 would be required under Alternative 5.

4.8.2.4.1.5 Additional Mitigation Measures Conclusion

Conclusions regarding the potential for these additional measures to reduce adverse impacts of oil and gas activities on bowhead whales allowed under Alternative 5 are the same as under Alternative 2. Refer to Section 4.5.2.4.17 for details.

Table 4.8-2 Effects Summary for Bowhead Whales

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	
		High	Behavioral harassment take of bowheads exceeds 30% of population, though with potential for less severe effects if important areas avoided via time area closures
	Duration	**Temporary**	
		Interim	Depending on the distribution of activities and animals, and for bowheads because they are primarily migrating through, some animals would not be necessarily be impacted for more than 6 months in a year or in multiple consecutive years.
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Some individuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	**Local**	Since unlikely, any impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	
		Important	ESA-listed species, but population is increasing
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be high (~48% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort., and up to 28% lost bowhead communication space in some areas of Beaufort), though with potential for slightly less severe impacts as result of time/area closures
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years.
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calf pairs traverse, potential disruption of feeding and resting

4.8.2.4.2 Beluga Whales

4.8.2.4.2.1 Direct and Indirect Effects

Alternative 5 includes the same level of oil and gas exploration activity as Alternative 4 (Level 3 Exploration). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 5 are also identical to those for Alternatives 2, 3, and 4 except that the time/area closures discussed as additional measures in Alternatives 2, 3, and 4 are required in this alternative. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4, with the exception of the anticipated effects of restricting activities from occurring in the time/area closure areas. The time/area closures expected to affect impacts on beluga whales (Barrow Canyon and the Western Beaufort Sea, the Beaufort Sea Shelf, and Kasegaluk Lagoon) are discussed below.

Time/Area Closures Required Under Alternative 5

Barrow Canyon/Western Beaufort Sea

Barrow Canyon/Western Beaufort Sea is considered a time/area closure location by NMFS for the purposes of analysis in this EIS and would be closed to all oil and gas exploration activities from mid-July – October. Barrow Canyon is an important feeding area for beluga whales, primarily during summer to early fall (Clarke et al. 2011b, 2011c, Moore et al. 2000). Closing the area to oil and gas activities during these time periods could reduce adverse impacts, particularly those associated with noise disturbance (e.g., displacement, avoidance, potential adverse energetic impacts from interrupted feeding). Reduced adverse impacts on beluga whales would likely be limited to the closure area. Implementing buffer zones around the required closure areas could, however, help to reduce impacts of noise from activities occurring in areas adjacent to the closure areas.

Shelf Break of the Beaufort Sea

The shelf break of the Beaufort Sea is considered a time/area closure location by NMFS for the purposes of analysis in this EIS and would be closed to all oil and gas exploration activities from mid-July – to late September. It is an important feeding habitat for belugas whales, prompting proposed closure of the area. Active leases in the Beaufort Sea are generally on the shelf, inshore of the shelf break; drilling activities would, therefore, not be impacted through this closure. Seismic activities and associated vessel traffic would be affected, thereby reducing potential adverse impacts on beluga whales, particularly those associated with noise disturbance. The time and location of reduced adverse impacts would be limited to the area defined by the shelf break. Implementing buffer zones around the required closure areas could further reduce impacts of noise on the closure area generated by activities occurring in areas adjacent to the closure areas.

Kasegaluk Lagoon and Ledyard Bay

Kasegaluk Lagoon and Ledyard Bay are considered a biologically important area for analysis purposes in this EIS (Figure 3.2-30). Kasegaluk Lagoon provides important habitat for beluga whales and spotted seals. Belugas of the eastern Chukchi Sea stock congregate in Kasegaluk Lagoon in June and July (Frost et al.1993, Huntington et al. 1999). Omalik Lagoon, south of Kasegaluk Lagoon, is also an important gathering area for belugas in June, except in years when there is heavy ice along the shore (Huntington et al. 1999). This closure area does not contain any lease areas, so drilling activities would not be affected by the closure. Seismic surveys and associated vessel and aircraft traffic would, except in emergency situations, be required to divert around the closure area. This could decrease disturbance effects of vessel activity within these important habitats and closure areas, while shifting vessel activity further offshore.

Behavioral Disturbance

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the types and mechanisms for disturbance to beluga whales would be the same. As discussed above, though, implementation of time/area closures has the potential to reduce the intensity of behavioral disturbance to beluga whales through potential reduction in the numbers of disturbed whales (if whales were more densely congregated in these areas) or reduction in the severity by avoiding potential adverse energetic effects that might result from displacement from preferred feeding or calving habitat. The degree of reduced impacts would depend on the level of activities which would otherwise have occurred in these areas, which is difficult to predict (of note, these areas do not overlap any leases), however, the same total level of activities would still be expected to occur outside of these closures, so the degree of reduced impacts, as compared to the whole, would be relatively minor and would not change the impact criteria conclusions, which are medium intensity, interim duration, regional extent, and important context.

Hearing Impairment, Injury, and Mortality

As discussed under Alternatives 2 and 3 (Sections 4.5.2.4.11 and 4.6.2.4.2), the primary mechanism of potential injury or mortality to beluga whales due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for injury and mortality to beluga whales would be the same. Because the proposed time/area closures are not expected to reduce the likelihood of injury or mortality, these remain identical to those discussed for Alternative 4 in Section 4.7.2.4, medium intensity, interim in duration (except in instances of mortality or serious injury), regional in extent and of important context.

Habitat Alteration

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for habitat alteration would be the same. However, the implementation of these time/area closures could create some level of reduced effect on acoustic habitat in an area/time where interspecies communication and interpretation of acoustic cues may be of increased importance (i.e., for feeding), although, when compared to the overall level of effects outside these areas, the level effects on beluga whale habitat from Alternative 5 could be slightly less, but not substantially different than those discussed for Alternative 4 in Section 4.7.2.4.

4.8.2.4.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.8.2.4.2.3 Conclusion

As described above, effects of disturbance on beluga whales, as well as impacts on acoustic habitat from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 5 relative to how much exploration activity would have occurred there if permitted to do so. In addition, industry may relocate exploration activities to other, possibly adjacent, areas until the closure areas are available. Overall, exploration effort would not be reduced, but, rather, redistributed and possibly concentrated in other areas.

Time/Area closures that mitigate adverse impacts on concentrations of beluga whales (feeding and calving areas) could reduce impacts to a lower intensity. However, beluga whale habitat use in the EIS project area is dynamic and extensive and, includes large portions of the Beaufort and Chukchi seas not included in the Time/Area closures that could coincide with oil and gas exploration activities throughout the region. Although the Time/Area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on beluga whales of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4 (Section 4.7.2.4) however, could be slightly reduced, and would be considered minor to moderate.

4.8.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.17).

Table 4.8-3 Effects Summary for Beluga Whales

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	In lower level scenarios for this alternative, take of belugas might not exceed 30% of population
		High	In higher level scenarios for this alternative, behavioral harassment take of elugass exceeds 30% of population, however impacts might be less severe if time area closures were observed
	Duration	Temporary	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	Local	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	Common	Not ESA-listed. Population status not well known for Chukchi, but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas and wide migratory corridor likely not heavily impacted by activities
		Important	Stocks overlap known migratory corridor and activities may occasionally impact important feeding areas.
		Unique	
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	
		Long-term	Though highly unlikely, PTS would be permanent if incurred.
	Geographic Extent	Local	Since unlikely, any impacts would be considered local
		Regional	
		State-wide	
	Context	Common	Not ESA-listed, populations not thought to be decreasing.
		Important	
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be high (~48% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort), although impacts might be slightly less severe if time area closures were observed.
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	**Local**	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	**Common**	Not ESA-listed. Population status not well known for Chukchi, but thought to be stable or increasing in Beaufort. Few overlaps with feeding areas and wide migratory corridor likely not heavily impacted by activities
		Important	Stocks overlap known migratory corridor and activities may occasionally impact important feeding areas.
		Unique	

4.8.2.4.3 Other Cetaceans

Alternative 5 assumes the same level of oil and gas exploration activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity types in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4.

Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures. Time/Area Closures are intended to reduce impacts to certain marine mammal species during sensitive times and locations in their life cycle, and to decrease conflict with Native subsistence. The Time/Area Closures have been chosen to coincide with periods and locations important for marine mammal development and subsistence activities. Specific locations have been identified, and will be closed to oil and gas exploration activities during periods of high use. The closure areas are similar to those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay. Oil and gas exploration activities also would not be allowed to occur outside of these areas within a certain distance (i.e., buffer zones).

The table below indicates the occurrence of other cetacean species in the specified Time/Area Closures. However, these areas do not coincide with areas that are of specific importance for these other cetacean species, with the exception of gray whales, which use some of the same feeding areas as bowheads (see Bowhead Barrow Canyon in Section 4.8.2.4.1), although they are not generally present during the time that the Kaktovik area is closed. Therefore, addition of these Time/Area closures in Alternative 5 is not expected to notably change the anticipated impacts to these other species, and the analysis remains identical to Alternative 4.

Table 4.8-4 Other Cetaceans Presence in Closure Areas Required Under Alternative 5

Species	Shelf Break of the Beaufort Sea	Kaktovik and Cross Island	Barrow Canyon	Point Franklin to Barrow	Ledyard Bay
Baleen whales (Mysticetes)					
Gray whale	Uncommon -- July-September	Unknown – very rare, if present	Present July-September, possibly overwintering	Present June - October	Not present
Humpback whale	Rare – August to October	Unknown – very rare, if present	Rare – August to October	Rare – August to October	Not present
Fin whale	Rare – August to October	Not present	Not present	Unknown – very rare, if present	Not present
Minke whale	Rare – August to October	Unknown – very rare, if present	Unknown – very rare, if present	Rare – August to October	Not present
Toothed whales (Odontocetes)					
Harbor porpoise	Present	Present	Present	Present	Present
Killer whale	Occasionally present during open water season	Occasionally present during open water season	Occasionally present during open water season	Occasionally present during open water season	Occasionally present during open water season
Narwhal	Very rare, likely extra-limital	Very rare, likely extra-limital	Very rare, likely extra-limital	Very rare, likely extra-limital	Very rare, likely extra-limital

4.8.2.4.3.1 Direct and Indirect Effects

As Alternative 5 has the same level of activity as Alternative 4, the Direct and Indirect Effects for the two alternatives are identical. For a complete discussion of the effects of Direct and Indirect Effects on other cetaceans, please see Section 4.5.2.4.12.

4.8.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16). Because the activity levels in both alternatives are identical, the effects of the Standard Mitigating Measures will also be the same.

4.8.2.4.3.3 Conclusion

As noted above, these measure are not expected to change the anticipated impacts to other cetacean species, with the possible exception of a slight reduction of impacts to feeding gray whales (see section 4.8.2.4.1). Gray whales are the most common species of the baleen and toothed whales (excluding bowhead and beluga whales) within the EIS project area, and share many migratory, feeding and life history traits with bowhead whales. Although the Time/Area closures specified in Alternative 5 could potentially mitigate adverse impacts in Barrow Canyon and the northeastern Chukchi Sea between Pt Franklin and Barrow when gray whales are feeding there or nearby, the overall impact on Other Cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4 (see Section 4.7.2.4.12) and would be considered minor.

4.8.2.4.3.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.17). Because the activity levels in both alternatives are identical, the effects of the additional mitigating measures will also be the same. For a complete discussion of the effects of additional mitigation measures on other cetaceans, please see Section 4.5.2.4.12.

Table 4.8-5 Effects Summary for Other Cetaceans

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	Behavioral harassment expected to be < 30% of population disturbed
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	**Local**	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	**Common**	With the exception of gray and humpback whales, species are considered common.
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	
		Long-term	Though unlikely, PTS would be permanent if incurred
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	All species but humpbacks common
		Important	Humpbacks are ESA-listed
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be high (~44% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort)
		High	
	Duration	Temporary	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	Local	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	Common	With the exception of gray and humpback whales, species are considered common
		Important	Although not ESA-listed, important feeding and reproductive areas for gray whales may be impacted. Humpback whales are ESA-listed.
		Unique	

4.8.2.4.4 Ice Seals

4.8.2.4.4.1 Direct and Indirect Effects

Alternative 5 assumes the same level of oil and gas exploration activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity types in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4.

Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures. Time/Area Closures are intended to reduce impacts to certain marine mammal species during sensitive times and locations in their life cycle. The Time/Area Closures have been chosen to coincide with periods and locations important for marine mammal development and subsistence activities. Specific locations have been identified, and will be closed to oil and gas exploration activities during periods of high use. The closure areas are similar to those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay. Oil and gas exploration activities also would not be allowed to occur outside of these areas within a certain distance (i.e., buffer zones).

Although the time/area closures are primarily designed to protect bowhead and beluga whales, Kasegaluk Lagoon and Ledyard Bay are noted as an important haulout/feeding area for spotted seals. The other areas also support ice seals so time/area closures would reduce potentially adverse effects on seals in those areas.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for disturbance to ice seals would be the same. The level of disturbance and potential direct and indirect effects on pinnipeds would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.4, the components of which were considered to be of medium to high intensity, interim duration, local to regional in extent, and of important context. See Section 4.5.2.4.13 for a complete discussion of disturbance effects, by activity type, on ice seals.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to ice seals would be the same. The level of potential direct and indirect physical effects on ice seals would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.4. See Section 4.5.2.4.13 for a complete discussion of potential injury or mortality effects on ice seals.

Habitat Alterations

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on pinniped habitat would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.4. See Section 4.5.2.4.13 for a discussion of potential effects oil and gas exploration activities on ice seal habitat.

4.8.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to ice seals are discussed under Alternative 2 (Section 4.5.2.4.16). They would all function to the same level in regard to minimizing disturbance to ice seals as discussed under Alternative 2. The key mitigation measures in this respect concern on-ice activities.

4.8.2.4.4.4 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. The time/area closures would also have variable capacities to reduce effects on different species proportional to their presence and abundance in the area. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 5 on ice seals would likely be medium to high in magnitude, interim in duration, local to regional in extent, and important in context. The effects of Alternative 5 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.8.2.4.4.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.17).

Table 4.8-6 Effects Summary for Ice Seals

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	When maximum activities considered, more than 30% ringed seals may be taken
	Duration	Temporary	
		Interim	
		Long-term	All activity types last multiple months and some number would reoccur over multiple successive years. Many ndividuals would be affected over 6 months and/or for multiple months over multiple years.
	Geographic Extent	Local	When the total area ensonified above behavioral harassment thresholds (160 dB for seismic and 120 dB for drilling) is considered (Table 4.5-14d), the impacts are local.
		Regional	
		State-wide	
	Context	Common	Non-ESA-listed
		Important	
		Unique	
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	
		Long-term	If it occurred, PTS would be permanent
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	Non-ESA-listed species
		Important	
		Unique	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	When acoustic habitat impacts are considered, magnitude is expected to be high (~44% of EIS area ensonified over 120 dB, up to 99% lost listening area in some areas of Beaufort)
		High	
	Duration	Temporary	
		Interim	
		Long-term	Activity types last multiple months and reoccur over multiple successive years, acoustic habitat affected over multiple years
	Geographic Extent	Local	
		Regional	When the total area ensonified by all sources above 120 dB is considered (used to indicate where animals will hear it and the potential for masking exists) regional effects are expected.
		State-wide	
	Context	Common	Non-ESA-listed, notable impacts not occurring in specifically identified important areas
		Important	
		Unique	

4.8.2.4.5 Walruses

4.8.2.4.5.1 Direct and Indirect Effects

Alternative 5 includes the same level of oil and gas exploration activity as Alternative 4 (Level 3 Exploration). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 5 are also identical to those for Alternatives 2, 3, and 4 except that the time/area closures discussed as additional measures in Alternatives 2, 3, and 4 are required in this alternative. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4, with the exception of the anticipated effects of restricting activities from occurring in the time/area closure areas.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for disturbance to walruses would be the same. The level of disturbance and potential direct and indirect effects on walruses would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of disturbance effects, by activity type, on walruses can be found in Section 4.5.2.4.14.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to walruses would be the same. The level of potential direct and indirect physical effects on walruses would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential injury or mortality effects on walruses can be found in Section 4.5.2.4.14.

Habitat Alterations

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on walrus habitat would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential impacts on walrus habitat can be found in Section 4.5.2.4.14.

4.8.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to walruses are discussed under Alternative 2 (Section 4.5.2.4.16). They would all function to the same level in regard to minimizing disturbance to walruses as discussed under Alternative 2. The key mitigation measures in this respect concern in-ice activities and the presence of PSOs.

4.8.2.4.5.3 Conclusion

Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. This data indicates that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walruses' reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes.

Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 4, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim to long term in duration. The effects of Alternative 5 would therefore be considered moderate for walruses according to the criteria established in Table 4.5-18.

4.8.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to walruses are discussed under Alternative 2 (Section 4.5.2.4.17). They would all function to the same level in regard to minimizing the risk to walruses and their habitats as discussed under Alternative 2 except that Additional Mitigation Measure B1 would be further defined to include specific closure dates or time periods determined by real-time information. The key additional mitigation measures in this respect concern in-ice activity, the reduction or elimination of discharges from drilling, and the presence of PSOs.

4.8.2.4.6 Polar Bears

4.8.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 5 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 5 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on polar bears under Alternative 5 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

Alternative 5 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 4, including the same suite of standard mitigation measures with the addition of mandatory time/area closures. The closure areas are similar to those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay. Oil and gas exploration activities also would not be allowed to occur outside of these areas within a certain distance (i.e., buffer zones). Specific time periods have been specified for each closure area corresponding to periods of high biological productivity or important life functions for some species. Additional discussion of the time/area closures follows the summary information on direct and indirect effects and standard mitigation measures.

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for disturbance, injury and mortality, and habitat alteration to polar bears would be the same. The level of disturbance and potential direct and indirect effects on polar bears would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.6. A more thorough discussion of disturbance effects of oil and gas exploration activities on polar bears, and potential impacts to polar bear habitat can be found in Section 4.5.2.4.15.

4.8.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.16). They would all function to the same level in regard to minimizing disturbance to polar bears as discussed under Alternative 2. The key mitigation measures in this respect concern on-ice activity and the presence of PSOs or bear monitors to monitor for polar bears and help reduce the risk of human-bear encounters.

4.8.2.4.6.3 Conclusion

The specified time/area closures under Alternative 5 are primarily intended to reduce impacts on bowhead and beluga whales and not to reduce overall exploration activity. The overall effects on polar bears would therefore be similar to what would occur under Alternative 4 but it may occur in somewhat different times and places. Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 5 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 5 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.8.2.4.6.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.17). They would all function to the same level in regard to minimizing the risk to polar bears and their habitats as discussed under Alternative 2 except that Additional B1 would be further defined under Alternative 5 to include specific closure dates or time periods determined by real-time information. The key mitigation measures in this respect concern on-ice activity and the presence of PSOs or bear monitors to monitor for polar bears and help reduce the risk of bear-human encounters.

4.8.2.5 Terrestrial Mammals

Activity levels in Alternative 5 are the same as in Alternative 4, with the added requirement for seasonal closures for certain areas. These required closures under Alternative 5 do not affect terrestrial mammals in the EIS project area, so the impacts discussed in Section 4.5.2.5 for Alternatives 2 and 3 are the same for Alternative 5; the overall impact to terrestrial mammals would be minor.

4.8.2.6 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.6).

4.8.3 Social Environment

4.8.3.1 Socioeconomics

4.8.3.1.1 Direct and Indirect Effects

Time/area closures may cause a reduction in or shift the timing of some support service activities described under Alternative 4 (Level 3 activity). To the extent that time/area closures provide additional benefits to marine mammals and reduce impacts on subsistence activities, there would be some potential socioeconomic benefits. This would apply to all time/area closure areas. Time/area closures may result in productivity costs to lease holders. For example, the underutilization of equipment and the employment of caretaker crews to maintain idle equipment, vessels, and camps during closures.

4.8.3.1.2 Conclusion

The socioeconomic impact under Alternative 5 is similar to Alternative 4, except there could be a lower intensity beneficial impact to local communities because time/area closures could reduce total local employment rates and personal income, and a low to medium intensity economic impact to lease holders that incur costs or lose productivity. The duration of the socioeconomic impacts would be interim, the activity would occur over a fixed number of years, but not year-round. The positive economic impacts of the activity would be statewide and national. The context of the socioeconomic impacts would be considered unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat (minority population) communities. The summary impact level for Socioeconomics under Alternative 4 is moderate, not exceeding the significance threshold.

4.8.3.2 Subsistence

4.8.3.2.1 Direct and Indirect Effects

Direct and indirect effects to subsistence resources and subsistence harvest would be expected to be at reduced levels relative to those discussed under Alternative 2 (Section 4.5.3.2.). Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures that would be required for all oil and gas exploration activities within a particular time and location. The closure areas are the same as those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, Kasegaluk Lagoon and Ledyard Bay. The intent of Time/Area Closures is to reduce adverse impacts to marine mammals in areas (and times) important to biological productivity and life history functions and to minimize conflicts with Alaskan Native marine mammal subsistence hunting activities. Section 4.8.2.4 contains a full description of the importance of these required closures to individual marine mammal species. In addition to their importance to life functions of certain marine mammal species, some of the areas are also important subsistence hunting grounds, as noted in Section 4.8.2.4. The areas of Kaktovik, Camden Bay, northeast of Smith Bay, north of Dease Inlet to Smith Bay, the area around Barrow and the Barrow Canyon and the Western Beaufort Sea are important areas for fall bowhead whaling. The area along the coastline of the Chukchi Sea (up to approximately 50 miles) is important for bowhead whale hunts. Hunters from Point Lay hunt beluga whales in Kasegaluk Lagoon from mid-June to mid-July. Seal hunts also occur at various times of the year near Kaktovik and in the waters of Barrow Canyon and the Western Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay. Limiting activities in these locations during times when hunts also occur would reduce impacts to subsistence resources in those areas.

4.8.3.2.2 Standard Mitigation Measures

The same Standard Mitigation Measures described for subsistence harvest and subsistence resources in Alternative 2 (Section 4.5.3.2) would be contemplated in Alternative 5. However, under Alternative 5, required time/area closures would be applied in all circumstances instead of being considered as additional mitigation measures, as is the case for Alternatives 2, 3, 4, and 6. These required closures would be considered beneficial as they would further limit potential impacts to subsistence harvests and users. The required time/area closures for Kaktovik, Barrow Canyon, the Western Beaufort Sea, and the Shelf Break in the Beaufort Sea would reduce potential impacts from disturbance on specific subsistence harvests areas utilized by the communities of Kaktovik and Barrow for marine mammal harvest of bowhead whales, seals, walruses, and polar bears.

As noted by Harry Brower of the AEWC in written comments submitted for this EIS on April 9, 2010:

> *We strongly encourage NMFS to implement protective measures for critical subsistence use areas, including: - areas used by the Village of Kaktovik in the eastern Beaufort; - areas around Cross Island used by the Village of Nuiqsut; - areas used by the Village of Barrow in the western Beaufort; and - areas used by Wainwright and Point Lay along the Chukchi Sea coast. NMFS should consider deferring these areas from industrial activity or implementing seasonal closure and restrictions … Because of the potential impacts to bowhead whales, we encourage NMFS to implement specific protections for areas that provide important habitat characteristics, including deferring industrial activity in these areas or implementing seasonal closures and restrictions. In particular, NMFS must provide proven protections for the following areas: - critical feeding and resting grounds near Camden Bay in the mid-Beaufort; and - critical feeding grounds in the eastern Beaufort and near Barrow Canyon in the western Beaufort. NMFS should also focus on key behavioral characteristics and vulnerable members of the population, including feeding and resting during the migration, communication, and impacts to mothers and calves.*

The time/area closures required under Alternative 5 for Kasegaluk Lagoon and Ledyard Bay in the Chukchi Sea would be reduce any potential adverse impacts from distribution of subsistence harvest and use for the communities of Wainwright, Point Lay, and Point Hope. These are areas where marine mammal hunting is concentrated and where important bird hunting and fishing occur. Kasegaluk Lagoon and Ledyard Bay are areas where Point Lay subsistence hunts occur for harvest of beluga whales, walruses, bearded, ringed and spotted seals, and polar bears, as well as birds and fish. Point Hope subsistence users would benefit from this time/area closure, as they hunt in Ledyard Bay for seals and walruses. However, the protection would be in addition to that provided by BOEM OCS Lease Stipulation 7, which requires that “except for emergencies or human/navigation safety, surface vessels associated with exploration and delineation of drilling operations will avoid travel within the LBCHU between July 1 and November 15.”

4.8.3.2.3 Conclusion

Direct and indirect impacts to subsistence harvest and subsistence resources are likely to be similar or less than those of Alternative 2 as discussed in Section 4.5.3.2. The impacts of implementing Alternative 5 could be considered beneficial to subsistence harvests and users as the time and area closures would be applied in all circumstances instead of being considered as additional mitigation measures. Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 5 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 5 on subsistence resources and harvests would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance, as there is the potential for these time/area closures to reduce the impact levels from those for Alternative 4.

4.8.3.2.4 Additional Mitigation Measures

The same Additional Mitigation Measures described for subsistence harvest and subsistence resources in Alternative 2 (Section 4.5.3.2) would be contemplated in Alternative 5.

4.8.3.3 Public Health

4.8.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 5 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.5.3.3. The effect of the time/area closures on subsistence resources is described in Section 4.8.3.2, which concludes that the closures would have a beneficial effect on subsistence harvests in Kaktovik and Barrow of bowhead whales, seals, walruses, and polar bear. Section 4.8.3.2 concludes that there would be beneficial effects for the communities of Wainwright, Point Lay, and Point Hope because of the closure of Kasegaluk Lagoon and Ledyard Bay. To the extent that these time/area closures improve the likelihood of maintaining a strong subsistence harvest, there would also be resulting benefits to public health. Similarly, insofar as time and area closures minimize dispersion of marine mammals and allow hunters to complete their hunts with less travel time, the potential impact to safety should be reduced. However, these benefits do not affect the overall impact criteria rating, as the anticipated results to public health are considered negligible.

4.8.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 5. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur they would affect minority or low-income communities the duration of changes may be long-term, and multiple communities could be affected.

4.8.3.4 Cultural Resources

4.8.3.4.1 Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.5.3.4 for Alternative 2 are the same for Alternative 5. The overall impact to cultural resources would be negligible.

4.8.3.4.2 Conclusion

Direct and indirect impacts to cultural resources resulting from the implementation of Alternatives 2, 3, and 4 would be the same in Alternative 5. For a complete discussion of direct and indirect impacts on cultural resources, please see Section 4.5.3.4.

4.8.3.5 Land and Water Ownership, Use, and Management

4.8.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership resulting from Alternative 5 are similar to those resulting from Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics. This includes federal, state, private, borough, and municipal owned lands and waters.

Land and Water Use

As time/area closures are implemented, the likelihood of conflicts decreases because the closures would lessen the exposure of subsistence species to seismic activities and exploratory drilling at critical locations and during critical seasons of the year. See Section 4.8.3.2, Subsistence for further discussion.

The direct and indirect impacts to land and water use resulting from Alternative 5 are similar to those resulting from Alternative 2 for recreational, residential, and mining land uses. Refer to Section 4.5.3.5 for a discussion on these topics.

Alternative 5 includes the same activity level as Alternative 2 but with required time/area closures during important biological and subsistence activities. This would effectively remove these areas from uses other than subsistence activities during the closure season and temporarily increase the area of land and water devoted to ecological and subsistence purposes.

The direct and indirect impacts caused by Alternative 5 for industrial, transportation, and commercial land uses are similar to those discussed under Alternative 2 in Section 4.5.3, except that time/area closures would shorten the timeframe available for oil and gas exploration activities and potentially impede exploration activity. As a result, there may be a reduction in transportation and commercial uses during certain times of the year.

Land and Water Management

Constraining exploration to certain times and locations may have varied effects on state and federal management policies. On the one hand, the use of time/area closures may result in more moderate state and federal resource development goals, while on the other hand promoting management practices to protect the human, marine and coastal environments, and improve consistency with North Slope Borough and Northwest Arctic Borough comprehensive plans and Land Management Regulations. Therefore, because these techniques reflect one approach to balanced management and do not prohibit resource development, no inconsistencies or changes in federal or state land or water management are anticipated as a result of this alternative. The effects are the same as discussed under Alternative 2, Section 4.5.3.5.

The direct and indirect impacts to borough land and water management caused by Alternative 5 are similar to those caused by Alternative 4. Refer to Section 4.6.3.5 for a discussion on these topics.

4.8.3.5.2 Conclusion

Based on Table 4.4-2 and the analyses provided in Section 4.5.3.5.2, there would be no direct or indirect impacts on land and water ownership under Alternative 5.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts of land and water use caused by Alternative 5 are described as follows. The magnitude of impact would be high when activity occurs in areas of little to no previous activity (such as Wainwright), and the magnitude of impact would be low in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be interim because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be long-term if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright.

The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 5 would be moderate because of the possibility for high magnitude activities and long-term construction in smaller communities.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts on land and water management caused by Alternative 5 are described as follows. The magnitude of impact would be low because the action is consistent with existing management plans. The duration of impact would be long-term because area closures would happen annually for several years. The extent of impacts would be local because proposed activities would not involve management plans beyond the local areas of seismic exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare, or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 5 on land and water management would be minor because they would be low intensity, long-term in nature, local, and common.

4.8.3.6 Transportation

4.8.3.6.1 Direct and Indirect Effects

The effects to transportation in Alternative 5 would be similar to those described under Alternative 2 (Section 4.5.3.6) though of elevated intensity and over a wider range of the spatial and temporal orientations given the potential simultaneous occurrence of activities that could occur under Alternative 5 versus Alternative 2. Increased traffic outside of the time/area closures could be the result.

Under Alternative 5, the required time/area closures associated with Kaktovik and Cross Island, Barrow Canyon and the Western Beaufort Sea, the Beaufort Sea shelf break, Hanna Shoal, Kasegaluk Lagoon, and Ledyard Bay would prevent activities from occurring in these areas and would therefore limit the amount of aircraft overflights in these areas associated with seismic survey and exploratory drilling programs. Because of the additional requirements associated with Alternative 5, aircraft could be prevented from overflying and/or operating in these areas, and there would therefore be no direct or indirect impact from transportation in these areas. In the event that inclement weather necessitated emergency flights through these special use areas, the intensity of the action would be low and interim in duration. Any direct impact would be limited in geography and local to regional in extent and common in context. The probability of occurrence would be low, and direct impacts would be considered minor.

The direct impact in an increase in the amount of oil and gas exploration activities would be an increase in levels of air traffic and vessels present in these areas associated with seismic survey and exploratory drilling activities in comparison to levels projected under Alternative 2. The intensity of the impact would be considered low and interim in duration (length of survey or exploratory drilling activities each season). The extent of increased aircraft presence may be on a local to regional scale given the increased number of seismic survey and exploratory drilling programs that could occur. Impacts from the increased levels of air traffic would be common in context and the impact level could be considered minor.

4.8.3.6.2 Conclusion

It is assumed that vessel traffic associated with the seismic survey and exploratory drilling programs would be prevented from transiting or operating in these closed areas under Alternative 5. Any direct impact to regional marine transportation would be low in intensity, interim in duration, and limited in geographic extent to a local to regional area and common in context. The probability of occurrence would be low, and impacts would be considered minor.

4.8.3.7 Recreation and Tourism

4.8.3.7.1 Direct and Indirect Effects

To the extent that the required time/area closures contemplated in Alternative 5 provide benefit to marine mammals, they would be beneficial to tourism based on wildlife viewing, and similar to the benefits of other standard and additional mitigation measures. The potential impacts discussed in Sections 4.5.3.7 and 4.6.3.7 for Alternatives 2 and 3 are the same for Alternative 5; the overall impact to recreation and tourism would be minor.

4.8.3.7.2 Conclusion

The direct impacts would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 4 on recreation and tourism would be minor.

4.8.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 5 of the proposed project.

4.8.3.8.1 Direct and Indirect Effects

Implementation of Alternative 5 is expected to result in interim moderate effects to scenic quality and visual resources identical to those described in Alternative 4. Potential impacts could be of low to medium intensity, depending on the geographic separation of programs. In either case, actions would be temporary, local and occur in an important context.

4.8.3.8.2 Conclusion

In conclusion, implementation of Alternative 6 is expected to result in interim moderate effects to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites, as visual contrast of these actions would attenuate with distance. The geographic extent of potential impacts would be local, as actions are not expected to be detectable beyond the project area; however they could affect an important resource in the ANWR to the extent they are visible by visitors.

4.8.3.9 Environmental Justice

4.8.3.9.1 Direct and Indirect Effects

With the incorporation of time/area closures, the impacts to subsistence activities could be reduced from levels described under Alternative 2, but would remain as overall minor impacts to subsistence (see Subsistence Section 4.8.3.2 for Alternative 5). These impacts include dispersion of subsistence resources from seismic surveys, overflights, vessel traffic, and icebreaking activities in a local to regional extent, affect resources that range from common to important in context, and last for approximately a month or up to a season.

Activities associated with Alternative 5 are not expected to have substantial impacts on the numbers of marine mammals harvested in any community in the study area, but it may reduce the dispersion of some animals which may reduce the additional travel time, cost and safety risk to hunters, described under Alternative 2. Health indicators under Alternative 5 are expected to be similar as those described under Alternative 2; low intensity, long-term health changes in multiple communities across the region.

Contamination of subsistence foods and the indirect perception of contamination could alter confidence in their consumption, affecting diet and nutrition, the same as discussed under Alternative 2.

4.8.3.9.2 Conclusion

Environmental justice analysis considers impacts to the unique resources of subsistence foods and human health, which are protected under the MMPA and EO 12898. Alternative 5 is expected to have a minor impact to Alaska Native communities.

4.8.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.9 Direct and Indirect Effects for Alternative 6 – Authorization for Level 3 Exploration Activity with Use of Alternative Technologies

This section analyzes how the alternative technologies described in Section 2.3.5 of this EIS could potentially reduce impacts to the physical, biological, and social environments, especially for marine mammals and subsistence uses of marine mammals. Under Alternative 6, the number of exploration programs envisioned is identical to Alternatives 4 and 5 (see Sections 4.7.1.4 and 4.8.1.4), but allows for the use of alternative technologies to replace or augment traditional airgun-based seismic exploration techniques used for some of these surveys. Alternative 6 contemplates Level 3 activities with the number of activity types to be considered for analysis purposes defined in Table 4.2-2.

The level of reduction in impacts is dependent upon how many traditional seismic surveys (i.e., use of airgun arrays) can be replaced or augmented by these alternative technologies. Because the majority of these technologies have not yet been built and/or tested, it is difficult to fully analyze the level of impacts from these devices. Therefore, additional NEPA analyses (i.e., tiering) will likely be required if applications are received requesting to use these technologies during seismic surveys. Additional detail on the implementation of this EIS is discussed in Chapter 5.

4.9.1 Physical Environment

4.9.1.1 Physical Oceanography

4.9.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

The effects of Alternative 6 on water depth and general circulation would be the same as those described for Alternative 4 and remain minor.

Currents, Upwellings, and Eddies

The effects of Alternative 6 on currents, upwellings, and eddies would be the same as those described for Alternative 4.

Tides and Water Levels

The activities described under Alternative 6 would be temporary in nature and would have only a seasonal presence of extremely limited size and geographic distribution, and would not affect tides or water levels within the proposed action area.

However, wind, waves and storm surge would potentially impact seismic and exploratory drilling activities, and could influence human safety.

Stream and River Discharge

The activities described under Alternative 6 would not affect stream and river discharge within the EIS project area.

Sea Ice

The effects of Alternative 6 on sea ice would be the same as those described for Alternative 4. The additional mitigation measures included in Alternative 6 would not substantially change the effects of the alternative on sea ice resources in the proposed action area.

4.9.1.1.2 Conclusion

The effects of the proposed actions on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of the proposed activity described in Alternative 6 on physical ocean resources in the proposed action area would be minor.

4.9.1.2 Climate

Under this alternative, emissions would be the same as for Alternative 4 and Alternative 5 because the alternative proposes exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*).

Refer to Section 3.1.2.4 Climate Change in the Arctic for a thorough discussion of climate systems and the effects of GHG emissions.

4.9.1.2.1 Direct and Indirect Effects

Direct Effects

Direct effects under this alternative would be the same as those described under Alternative 2, although levels of GHG emissions would be higher with the additional surveys and exploration plans.

Indirect Effects

Indirect effects under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2, although levels of emissions would be higher with the additional surveys and exploration plans.

CO_2e Projected Emissions Inventory

The CO_2e emissions inventory is the same for this alternative as given for Alternative 4.

Effects of this Alternative on Climate Change

The effects of this alternative are the same as those described for Alternative 4.

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2.

4.9.1.2.2 Conclusion

The conclusion of the assessment under this alternative is the same as for Alternative 4.

4.9.1.3 Air Quality

Under this alternative, GHG, HAP, and criteria pollutant emissions would be the same as described for Alternative 4 and Alternative 5 and proposes any level of EPs up to the maximum which is four EPs for each planning area. The majority of additional emissions are from the EPs proposed for Level 3 Exploration Activity.

4.9.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of emissions as described under Alternative 2 in Section 4.5.1.3.

4.9.1.3.2 Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

4.9.1.3.3 Level of Effect

The level of effect under this alternative would be the same as discussed under Alternative 4.

4.9.1.3.3 Conclusion

Projected emissions from exploratory drilling activities proposed under this alternative would be higher than those estimated for Alternative 2. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the NAAQS to be exceeded onshore. The Level 2 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A high level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a medium level of effect.

4.9.1.4 Acoustics

Under Alternative 6, the number of exploration programs envisioned is the same as for Alternatives 4 and 5 (see Sections 4.7.1.4 and 4.8.1.4), but this alternative considers the use of alternate technologies to replace airgun array systems used in these surveys.

Section 2.3.5 provides a discussion of possible alternate technologies that are in various stages of development. The benefits of using these sources would primarily be at reducing impulsive sound levels near seismic survey sources. Some of the alternate technologies use longer-duration signals at lower amplitude. Extended duration signals may be more audible to marine mammals than short duration impulsive signals having the same amplitude. Nevertheless, the possible reduction in ensonification zone radii corresponding to reductions in source signal amplitude only is considered for this alternative.

The source pressure level reductions that will be achieved using alternate sources are presently unknown, but might expect reductions by approximately 10 to 20 dB from current airgun array source levels. For this analysis it will be assumed that source pressure level can be reduced by up to 10 dB. The received SPL at distance from the source depends on sound transmission loss between the source and receiver. Transmission loss is frequency dependent and also influenced by source depth and source directivity. If the alternate source operates at a different depth than standard airguns or has different directivity or spectral density function (sound energy at different frequencies), then received SPL will be different than that of an airgun array with the same broadband source level. A further complicating factor is that the 90% rms SPL metric used for impulsive source pressure signals is dependent on the pulse duration. Three assumptions have to be made to estimate reductions in received SPL for alternate source types: (a) the alternate source operates at the same depth as the airgun array source, (b) the alternate source has the same spectral distribution and directivity as the airgun array source and (c) the pulse duration remains the same as that of the airgun array.

Under the above assumptions, the reduction in distances to sound level thresholds can be made based on the sound level versus distance functions that have been measured for all of the seismic survey programs listed in Table 4.5-8. As an example, the function for Statoil's 2010 3-D survey near their Amundsen prospect in the Chukchi Sea is defined by L_{P90}. = 235.1 – 17.5 Log(r) – 0.00051 r, where L_{P90} is the 90% rms received SPL and r is the distance from the source in meters (O'Neill et al., 2011). Using this formula, and a 10 dB source level reduction factor, the distance reductions to several acoustic thresholds is given in Table 4.9-1.

Table 4.9-1 Acoustic threshold radii reductions from use of an alternate source operating with source level 10 dB less than a 3000 in^3 airgun array (see text)

SPL Threshold 90% rms (dB re 1 µPa)	Original radius (m)	Reduced radius (m)
190	370	100
180	1290	370
160	10000	4000
120	61000	46000

It is helpful to consider the change in ensonified area arising from assumed reductions in sound for various source intensity reductions under different acoustic propagation conditions. Table 4.9-2 shows the total ensonified surface area (as a percentage of the full EIS project area) to threshold levels of 120 and 160 dB for the case of no reduction (Alternative 3) and reductions of 3, 5 and 10 dB. The influence of the sound reduction on the area depends on the acoustic propagation regime; transmission loss rates (drop in dB level with distance from the source) of 25, 20 and 15 log (range) are shown in the table, encompassing conditions potentially encountered in the EIS project area. When considering the notional results shown in this table it should be noted that sound propagation at long ranges is subject to losses that may exceed the predictions of a geometric spreading law k log(r) applicable at shorter ranges. Because of this, the reduction in ensonified area size associated with a given decrease in source level may be not as pronounced as shown in the table.

Table 4.9-2 Ensonified area (as % of EIS project area) for assumed reductions in source level using alternative technologies. Estimates are shown for three propagation loss rates

	Percent Surface Area Ensonified to 120 dB re 1 µPa (90% rms SPL)			Percent Surface Area Ensonified to 160 dB re 1 µPa (90% rms SPL)		
Reduction in source intensity	25 log R	20 log R	15 log R	25 log R	20 log R	15 log R
0 dB (none)	40%	40%	40%	0.67%	0.67%	0.67%
3 dB	22%	20%	15%	0.39%	0.34%	0.27%
5 dB	15%	12%	8%	0.27%	0.21%	0.15%
10 dB	6%	4%	2%	0.11%	0.07%	0.03%

4.9.1.4.1 Direct and Indirect Effects

Table 4.9-1 provides examples of sound level threshold distance reductions that would result from an alternate source type capable of lowering the source levels of a standard 3000 in^3 airgun array by 10 dB. The 190 dB re 1 µPa radius is reduced by 73 percent, while the 120 dB re 1 µPa radius is reduced by 24 percent. The reduction of surface area ensonified to 120 dB re 1 µPa assuming a 10 dB in source level varies from an 85 percent reduction assuming 25logR geometric spreading loss to a 95 percent reduction for a spreading loss of 15logR.

4.9.1.4.2 Conclusion

Alternative 6 proposes the same level of exploration activities as Alternative 4 but suggests the implementation of alternative technologies that reduce sound emission levels from seismic survey sources. The intensity rating of this alternative is maintained at high because it is unlikely the technologies will entirely preclude the generation of source sound levels exceeding 200 dB re 1 µPa. Likewise the duration is unchanged from the other alternatives and remains long-term, as no change in activity duration is anticipated. The extent for this alternative is still considered to be regional if the alternate source has a source sound level that is lower than that for a 3,000 in^3 airgun array by less than 10dB. However, the estimates in Table 4.9-2 indicate that a 10dB reduction in source intensity would change the extent for this alternative to local since less than 10 percent of the EIS project area would be exposed to sound levels in excess of 120 dB re 1 µPa in this case. Because implementation of these technologies is not certain within the timeframe for this EIS, the overall impact rating for direct and indirect effects to the acoustic environment would be moderate.

4.9.1.5 Water Quality

Impacts to water quality resulting from the activities proposed under Alternative 6 are expected to be very similar to those described above for Alternatives 4 and 5. Alternative 6 includes mitigation measures that focus on the use of alternative technologies to replace or augment traditional airgun-based seismic exploration techniques. However, these mitigation measures are not expected to affect the level of water quality impacts. Any differences in impacts between Alternative 5 and the previous alternatives are noted below. See Chapter 2 for descriptions of the mitigation measures included under Alternative 6.

4.9.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, seismic surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

Turbidity and Total Suspended Solids

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 6, if any, are expected to be low-intensity, temporary, local, and would affect a common resource.

Proposed mitigation measures intended to reduce/lessen non-acoustic impacts on marine mammals have the potential to further reduce adverse impacts to water quality.

Metals

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, seismic surveys are not be expected to have any measureable impact on dissolved metal concentrations in the proposed action area.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area.

4.9.1.5.2 Conclusion

Alternative 6 could potentially require the use of alternative technologies that may replace or augment traditional airgun-based seismic exploration techniques. Such alternative technologies are not expected to affect impacts to water quality. After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effect of the proposed activity described in Alternative 6 on water quality in the proposed action area would be minor.

4.9.1.6 Environmental Contaminants and Ecosystem Functions

4.9.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 6 would be the same as those described for Alternative 2.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 6 would be the same as those described for Alternative 2. The area of habitat and biological resources exposed to potential contaminants wold be larger under Alternative 6.

Potential Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 6 on the four categories of ecosystem functions (defined in Section 4.5.1.6) are assessed below.

Regulation Functions

The effects of the activities proposed under Alternative 6 on regulation functions would be the same as those described under Alternative 4.

Habitat Functions

Alternative technologies associated with Alternative 6 have the potential to decrease adverse impacts to habitat functions that could result from traditional airgun-based exploration techniques. The extent and nature of the reduction to adverse impacts to habitat functions are described in detail in the sections of this EIS related to acoustics and marine mammals.

Production Functions

The effects of the activities proposed under Alternative 6 on production functions would be the same as those described under Alternative 4.

Information Functions

The effects of the activities proposed under Alternative 6 on information functions would be the same as those described under Alternative 4.

4.9.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 6 would be medium-intensity, interim, and local. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e., resistant to stressors) than are species composition and other structural properties. A relatively detailed analysis of the effects of Alternative 2 on fate and persistence of potential contaminants entrained in sediments is included in Section 4.5.1.6.1. The potential effects of Alternative 2 on the distributions of metals and petroleum hydrocarbons, both in the water and in seafloor sediments, are also discussed under Section 4.5.1.5 (Water Quality). Overall effects of Alternative 6 on ecosystem functions would be minor.

4.9.1.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.9.2 Biological Environment

4.9.2.1 Lower Trophic Levels

4.9.2.1.1 Direct and Indirect Effects

The direct and indirect impacts discussed in Section 4.5.2.1 for Alternative 2 are also applicable for this alternative. Activity levels in Alternative 6 are the same as in Alternative 4, but this alternative includes the option of using alternative technologies for seismic exploration. This requirement would not affect lower trophic levels in the EIS project area, so the impacts discussed previously for Alternative 4 is the same for Alternative 6.

4.9.2.1.2 Conclusion

The direct and indirect effects associated with Alternative 6 would likely be low in intensity, temporary to long-term in duration, of local extent and would affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.9.2.2 Fish and Essential Fish Habitat

4.9.2.2.1 Direct and Indirect Effects

Alternative 6 applies the same levels of activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity categories in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and

Additional Mitigation Measures are also identical. Alternative 6 differs from Alternative 4 in the application of alternative technologies.

Five different technologies are currently being developed, and all are at different stages in the testing process, although none of the systems with the potential to augment or replace airguns as a seismic source are currently commercially available. For the purposes of this EIS, it is assumed that they will be implemented over time as further testing and refinement makes them available for general application.

The analysis for this alternative focuses on the mitigating effects of each of the individual alternative technologies and how they would reduce impacts from the levels described in Alternative 4. Many of these technologies are in the early stages of development or have not yet been developed, and it is therefore difficult to offer a thorough analysis. Instead, general impacts based on limited information have been provided.

For a complete analysis of the effects on fish and fish resources, see Section 4.5.2.2.

4.9.2.2.2 Alternative Technologies

Marine Vibrators

The replacement of each airgun with a marine vibrator would likely reduce adverse impacts through the manner in which sound is emitted into the marine environment. Marine vibrators emit sounds at lower pressure levels than airguns and over a narrower range of frequencies than do airguns, thereby potentially reducing the amount of damage caused to any fish in the immediate vicinity of the source, and reducing the number of fish able to hear the sound.

Low Frequency Acoustic Source (LACS)

This technology is still in the early phases of development and therefore difficult to analyze. However, in theory, the LACS uses a sound generating method that results in lowered amounts of energy put into the water compared to a traditional airgun array. This would reduce potentially adverse impacts to fish by decreasing the number of fish exposed to high sound levels and potentially reduce the impacts from high sound levels as the maximum levels would be lower.

Deep-Towed Acoustics/Geophysics System (DTAGS)

For the purposes of analysis under this alternative, it is assumed that a DTAGS system could someday replace a single airgun array. Based on an analysis of its operations, it is possible that it could increase adverse impacts by increasing the total amount of exposure by fish resources to sound energy. By offsetting the location of the sound source from the near surface to the vicinity of the seafloor, the number of fish exposed to high sound levels would increase, provided the sound levels emitted were similar to airguns. Demersal habitats are typically more productive than pelagic ones, with higher fish densities and more feeding and spawning regions susceptible to sonic damage.

4.9.2.2.3 Conclusion

The effect of the alternative technologies outlined in Alternative 6 on fish resources and EFH are difficult to determine with any certainty but are anticipated to result in a reduction in the overall impact. However, the limited number of airgun arrays that could be replaced by any of these technologies is fairly limited, thereby resulting in minimal reductions of overall impact levels. Therefore, there would be no measurable effect on the resource as a result of the use of alternative technologies, and overall impact is considered to be minor.

4.9.2.3 Marine and Coastal Birds

4.9.2.3.1 Direct and Indirect Effects

Alternative 6 includes all of the same types of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on marine and coastal birds under Alternative 6 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. This EIS includes a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals but may also reduce adverse effects on birds. In addition to the mitigation measures imposed by NMFS, the USFWS requires certain mitigation measures specific to ESA-listed species under its jurisdiction, including spectacled and Steller's eiders (USFWS 2009c). Measures implemented to minimize take of listed eiders also protect other migratory birds as required by the MBTA. Section 4.5.2.3 summarizes the mitigation measures typically required by the USFWS and other agencies for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on birds and these measures are incorporated into the analysis of potential effects under Alternative 6.

The number of different exploration activities authorized under Alternative 6 would be the same as under Alternatives 4 and 5. However, implementation of Alternative 6 could potentially encourage industry to gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Because birds are able to fly away from approaching seismic source vessels as they approach and thus effectively avoid potentially adverse effects from the seismic arrays, changes in technology to reduce seismic sound levels would not change the effects of seismic surveys on birds. The direct and indirect effects of oil and gas exploration activities on marine and coastal birds would therefore be the same under Alternative 6 as those described under Alternatives 4 and 5. Marine birds would be subject to disturbance from vessels and seismic sources but these effects would be temporary. With more exploration activities authorized under Alternative 6, the potential for adjacent activities to magnify effects on birds could be increased. However, the requirement to maintain a minimum distance of 24 km (15 mi) between two seismic surveys conducted concurrently would effectively limit the intensity of seismic survey effects on birds no matter where the activities take place during the open water season. The Ledyard Bay closure period would be the same under Alternative 6 as under Alternative 2 so this area would be unaffected by increases in exploration elsewhere.

The risk of birds colliding with vessels would be mitigated and fatal collisions are expected to be rare and not likely to affect the population of any species. The risk of small oil spills would also be mitigated and considered to present very small risks to birds unless the spill occurred in or persisted in a lead or polynya system. A very large oil spill could have much more serious effects on birds and is discussed in Section 4.10.

4.9.2.3.2 Mitigation Measures

Standard and additional mitigation measures that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). Additional mitigation measures are not required under any of the alternatives and do not affect the summary conclusion below.

4.9.2.3.2 Conclusion

Most marine and coastal birds are legally protected under the MBTA and two are protected under the ESA. Birds fulfill important ecological roles and many are important subsistence resources. Depending on the species, they are considered to be important or unique resources from a NEPA perspective. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be medium intensity, temporary or interim in duration, and of local extent. The overall effects of oil and gas exploration activities authorized under Alternative 6 on marine and coastal birds would therefore be considered moderate according to the impact criteria in Table 4.5-16.

4.9.2.4 Marine Mammals

4.9.2.4.1 Bowhead Whales

4.9.2.4.1.1 Direct and Indirect Effects

Alternative 6 includes the same level of oil and gas exploration activity as Alternative 4. The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 6 are also identical to those considered for Alternative 4. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 6 as for Alternative 4. These are briefly summarized below.

Alternative 6 differs from Alternative 4 in the application of alternative technologies. Alternative 6 considers the gradual augmentation or replacement of current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment. Five technologies are considered in this EIS (Table 2.3). All are in different stages of research or testing and development, and could be implemented over time if they become available for general application. Commercial availability at some point in the future is assumed for the purposes of this EIS. This, however, depends on research, development, and commercial implementation schedules.

The analysis for this alternative focuses on the potential mitigating effects of each of the individual alternative technologies and how they could reduce adverse impacts from levels described in Alternative 4. Many of these technologies are in the early stages of development and are difficult to assess. For example, Table 4.9-2 illustrates the estimated change in *near-field* ensonified area above different thresholds if certain incremental source level reductions are considered likely, from which we could infer some quantitative reduction of impacts. However, because of the early stages of development that many of these technologies are in, it is not always possible to know exactly what the operational trade-off of using the alternative technology might be (for example, is it 10 dB quieter, but needs to survey an area with twice the density of survey lines). Possibly of more importance though, is the potential substantial reduction in far-field effects on acoustic habitat and how that reduction could reduce chronic noise impacts to marine mammals. An analysis of each alternative technology follows the summary information on direct and indirect effects and standard mitigation measures.

Behavioral Disturbance

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for disturbance to bowhead whales would be the same. However, if several seismic surveys utilizing airguns are eventually able to be replaced by alternative technologies, some of which have much lower source levels than traditional airguns, behavioral disturbance to bowhead whales could also be reduced as the areas ensonified above behavioral disturbance thresholds could be reduced by anywhere from half to 50 times (i.e., only 2% the former area). The behavioral disturbance of marine mammals is quantitatively evaluated based on the number of animals likely to be exposed above a certain received level, which means that anticipated impacts from any given activity could majorly decrease (i.e., by an order of magnitude or more) if the technology were replaced. Because of the current state of the technology, it is unlikely that enough activitieswould change within the life of this EIS, to make a difference in our overall assessment of effects.

The level of disturbance and potential direct and indirect effects on bowhead whales would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4, the components of which were considered to be of medium intensity, interim duration, local to regional extent, and unique context.

Please refer to Section 4.5.2.4 for a complete discussion of disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4; therefore, the mechanisms for hearing impairment, injury, and mortality to bowhead whales would be the same. Because of the low likelihood of injury from Alternative 4 activities, combined with the fact that the use of alternative technologies would only slightly lower injury risk of an acoustic nature, and would not lower the likelihood of ship-strike or other injury, and the fact that only a small amount of alternate technology use would be anticipated pursuant to this alternative, the level of hearing impairment, injury, and mortality effects on bowhead whales would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4, the components of which were primarily considered to be of high intensity, interim in duration (except in instances of mortality or serious injury), local in extent and important in context

Please refer to Section 4.5.2.4 for a complete discussion of potential injury or mortality effects on bowhead whales.

Habitat Alterations

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4; therefore, the mechanisms for habitat alteration would be the same. The effects of alternative technology on acoustic habitat and chronic effects on marine mammals (especially mysticetes) could be more substantial than the more immediately quantifiable and near-field reduction in behavioral disturbance. High level, low frequency sounds (like those produced by airguns) contribute to growing ambient noise levels at great distances from the source (hundreds of miles). This increased noise can contribute to chronic, long-term effects on the ability of animals to effectively interact with their environment and conspecifics. Even small reductions in source levels can make big differences in the far-field reductions at lower levels and over very large areas. The level of potential direct and indirect effects on bowhead whale habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.

Please refer to Section 4.5.2.4 for a complete discussion of the potential effects on bowhead whale habitat.

4.9.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.1.3 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

The intent of implementing alternative technologies is to reduce impulsive sound levels generated during seismic exploration. As discussed in Section 4.9.1.4, Acoustics, sound pressure level reductions resulting from using these proposed technologies are not currently known, although reductions of 10 to 20 dB might be expected. Alternate sound sources with source levels 10 dB lower than standard 3,000 in^3 airgun arrays, could, theoretically, substantially reduce acoustic threshold radii and areas of ensonification (Tables 4.9-1 and 4.9-2).

Marine Vibrators

Replacing an airgun with a hydraulic marine vibrator could reduce adverse impacts by the manner and level in which sound is emitted into the marine environment. Marine vibrators emit sounds at lower pressure levels and over a narrower range of frequencies than do airguns. The low frequency (10 to 250 Hz) produced is within the hearing range of bowhead whales (7 Hz to 22 kHz [Southall et al. 2007]), so it could therefore still be in the range of detectability by this species. Potential auditory impacts to bowhead whales, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced through reduced noise output. Any reduction in adverse impacts would be on a limited and localized scale with the current schedule of implementation. The use of this system by industry is currently uncertain as previous use did not result in increased data quality, reduced operation costs, or penetrate as deeply as some companies require.

The replacement of each airgun with an electric marine vibrator could reduce adverse impacts by the manner in which sound is emitted into the marine environment. Marine vibrators emit sounds at lower pressure levels and over a narrower frequency range than do airguns (6 to 100 Hz). This is within the hearing range of bowhead whales (7 Hz to 22 kHz [Southall et al. 2007]), so it could therefore still be in the range of detectability by this species. Potential auditory impacts to bowhead whales, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced. Any reduction in adverse impacts would be on a limited and localized scale with the currently uncertain schedule of implementation. In addition, industry interest in this system may be limited by its inability to penetrate as deeply as some companies require for exploration. For more detailed information regarding marine vibrators, see Section 2.3.5.1.

Low Frequency Acoustic Source (LACS)

This technology is still in the early phases of development and currently impossible to analyze and compare with airgun arrays for effectiveness and noise generation. The shallow water system has been tested a few times, with only fair data quality. The larger system that could produce frequencies low enough to penetrate to exploration depths has not yet been developed. The LACS, theoretically, uses a sound generating method that results in lowered amounts of energy put into the water compared to a traditional airgun array. This could potentially reduce adverse acoustic impacts to bowhead whales, but the level of reduced impacts and efficacy for mitigating impacts cannot presently be determined.

Deep-Towed Acoustics/Geophysics System (DTAGS)

This system was developed by the Navy and is not currently available for commercial use. It has been used extensively to map out deep-water gas hydrate systems. The DTAGS system generates very high frequencies, so it cannot be used as a source for exploration seismic data collection. It is theoretically possible to create a DTAGS system that could penetrate to exploration depths below the seafloor, but the deep-tow configuration of the source would make it logistically difficult to use with a streamer array. This would need to be adjusted for the much shallower depths of the Beaufort and Chukchi seas where it could possibly augment shallow hazards data collection. The potential acoustic impacts or possible mitigation of auditory impairment or disturbance of bowhead whales through the use of DTAGS is impossible to assess without further information regarding sound level output and transmission in the EIS project area or in a comparable environment.

4.9.2.4.1.4 Conclusion

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on bowhead whales are difficult to determine but could reduce adverse impacts (both behavioral impacts and acoustic habitat impacts, as described in the sections above) associated with the use of airgun arrays (see Section 4.5.2.4 for details on effects of airgun noise on bowhead whales). Because of the current state of the technology, however, the overall reduction during the life of this EIS would likely be minimal. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment and the impacts on marine mammals. Airgun noise would not be eliminated, however, since these alternative technologies would not completely replace the existing technology, and what may be replaced is limited. In addition, surveys conducted with alternative technologies would still use marine vessels to tow or deploy equipment which could disturb bowhead whales as described in Section 4.5.2.4. A sizable ramp-up in the development and implementation of alternative technologies could potentially reduce behavioral and acoustic habitat impacts to the degree that the rating in the impact criteria might change. However, based on our understanding of the degree to which these technologies are expected to come into use in the next five to ten years, we expect that the impact categorization would not change. Effects of existing technology on bowhead whales, as described in Alternative 4, would be mostly of high intensity, interim duration, be of regional extent, and important to unique in context. Alternative technologies could reduce the extent to localized areas on a small scale; it is not currently possible to assess potential behavioral reactions and determine if intensity level would change, as a result. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 6 on bowhead whales is considered to be moderate to major.

4.9.2.4.1.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.17).

4.9.2.4.2 Beluga Whales

Alternative 6 includes the same types of exploration activities described in Alternative 2, and the same number of exploration activities as Alternative 4. Alternative 6 differs, however, from Alternatives 2, 3, and 4 as it considers the gradual augmentation or replacement of current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment. Five technologies are considered (Table 2.3). All are in different stages of research, testing and development and could be implemented over time if they become available for general application. Commercial availability at some point in the future is assumed for the purposes of this EIS.

The analysis for this alternative focuses on the potential mitigating effects of each of the individual alternative technologies and how they could reduce adverse impacts from levels described in previous alternatives. Many of these technologies are in the early stages of development and are difficult to assess. For example, Table 4.9-2 illustrates the estimated change in *near-field* ensonified area above different thresholds if certain incremental source level reductions are considered likely, from which we could infer some quantitative reduction of impacts. However, because of the early stages of development that many of these technologies are in, it is not always possible to know exactly what the operational trade-off of using the alternative technology might be (for example, is it 10 dB quieter, but needs to survey an area with twice the density of survey lines). Of potentially more important note, though, is the potential substantial reduction in far-field effects on acoustic habitat and how that reduction could reduce chronic noise impacts to marine mammals. An analysis of each alternative technology follows the summary information on direct and indirect effects and standard mitigation measures.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4. Therefore, the types and mechanisms for disturbance to beluga whales would be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.2, as would the resulting level of disturbance and potential direct and indirect effects on beluga whales. Potential effects were considered to be of medium intensity, interim duration, regional in extent, and of important context. Refer to Sections 4.5.2.4.11 and 4.6.2.4.2 for complete discussions of disturbance effects, by activity type, on beluga whales.

Hearing Impairment, Injury, and Mortality

The level of exploration that would be authorized under Alternative 6 is identical to Alternative 4. Because of the low likelihood of injury from Alternative 4 activities, combined with the fact that the use of alternative technologies would only slightly lower injury risk of an acoustic nature and would not lower the likelihood of ship-strike or other injury, and the fact that only a small amount of alternate technology use would be anticipated pursuant to this alternative, the primary mechanisms of hearing impairment, injury, or mortality due to oil and gas exploration activities are anticipated to be the same. The potential direct and indirect physical effects on beluga whales would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.

Habitat Alteration

The exploration activities that would be authorized under Alternative 6 are the same as under Alternative 4. The effects of alternative technology on acoustic habitat and chronic effects on marine mammals could be more substantial than the more immediately quantifiable and near-field reduction in behavioral disturbance. High level, low frequency sounds (like those produced by airguns) contribute to growing ambient noise levels at great distances from the source (hundreds of miles). This increased noise can contribute to chronic, long-term effects on the ability of animals to effectively interact with their environment and conspecifics. Even small reductions in source levels can make big differences in the far-field reductions at lower levels and over very large areas. The potential direct and indirect effects on beluga whale habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.

4.9.2.4.2.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.2.2 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.9.2.4.1) above for an analysis of the efficacy and practicability of using the proposed alternative technologies to reduce effects of noise from seismic exploration on marine mammals. Only technologies for which there is information specific to beluga whales (e.g., hydraulic and electric marine vibrators) are included below. Refer to the above bowhead whales section for information on LACS, DTAGS, and Low Frequency Passive Seismic Methods for Exploration.

Marine Vibrators

The low frequency (10 to 250 Hz) sounds produced by hydraulic marine vibrators are at the lower end of the estimated auditory bandwidth of belugas whales (150 Hz to 160 kHz [Southall et al. 2007]), so they could still be in the range of detectability by this species. Potential auditory impacts to beluga whales, as well as behavioral disturbance and displacement due to noise exposure, could be reduced through reduced noise output. Any reduction in adverse impacts would likely be on a limited and localized scale with the current schedule of implementation. The use of this system by industry is currently uncertain as previous use did not result in increased data quality, reduced operation costs, or penetrate as deeply as some companies require.

Marine vibrators emit sounds at lower pressure levels and over a narrower frequency range than do airguns (6 to 100 Hz). This is below the estimated auditory bandwidth of belugas whales (150 Hz to 160 kHz [Southall et al. 2007]), so it might not be detectable by this species. Potential auditory impacts to beluga whales, as well as behavioral disturbance and displacement due to noise exposure, could, therefore, be reduced. Any reduction in adverse impacts would likely be on a limited and localized scale with the current schedule of implementation. In addition, industry interest in this system may be limited by its inability to penetrate as deep as some companies require for exploration. For more detailed information regarding marine vibrators, see Section 2.3.5.1.

4.9.2.4.2.3 Conclusion

The use of alternative technologies would reduce noise impacts to beluga whales (both behavioral impacts and acoustic habitat impacts, as described in the sections above) as many of them produce sound outside the frequency range audible by belugas. The gradual introduction of these alternative technologies could eventually reduce the amount of seismic noise introduced into the marine environment and impacts to marine mammals. Airgun noise would not be completely eliminated, however, since these alternative technologies would not completely replace the existing technology, and what may be replaced is limited. In addition, surveys conducted with alternative technologies would still use marine vessels to tow or deploy equipment which could disturb beluga whales as described in Section 4.5.2.4.11. A sizable ramp-up in the development and implementation of alternative technologies could potentially reduce behavioral and acoustic habitat impacts to the degree that the rating in the impact criteria might change. However, based on our understanding of the degree to which these technologies are expected to come into use in the next five to ten years, we expect that the impact categorization would not change.

The overall impact to beluga whales is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but are found feeding in certain essential areas, which places them in the context of being an important resource for behavioral disturbance. The intensity and duration of the various effects and activities considered are mostly medium and interim. However, potential long-term effects from repeated disturbance are unknown. Although, individually, the various activities may elicit local effects on beluga whales, the area and extent of the population over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of this population.

4.9.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.17).

4.9.2.4.3 Other Cetaceans

Alternative 6 applies the same levels of activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity categories in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. Alternative 6 differs from Alternative 4 in the application of Alternative Technologies.

Alternative 6 considers the gradual augmentation or replacement of current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment. Five technologies are considered (Table 2.3). All are in different stages of research, testing and development and could be implemented over time if they become available for general application. Commercial availability at some point in the future is assumed for the purposes of this EIS.

The analysis for this alternative focuses on the potential mitigating effects of each of the individual alternative technologies and how they could reduce adverse impacts from levels described in Alternative 4. Many of these technologies are in the early stages of development and are difficult to assess. For example, Table 4.9-2 illustrates the estimated change in *near-field* ensonified area above different thresholds if certain incremental source level reductions are considered likely, from which we could infer some quantitative reduction of impacts. However, because of the early stages of development that many of these technologies are in it is not always possible to know exactly what the operational trade-off of using the alternative technology might be (for example, is it 10 dB quieter, but needs to survey an area with twice the density of survey lines). Of potentially more important note, though, is the potential substantial reduction in far-field effects on acoustic habitat and how that reduction could reduce chronic noise impacts to marine mammals.

An analysis of each alternative technology follows the summary information on direct and indirect effects and standard mitigation measures.

4.9.2.4.3.1 Direct and Indirect Effects

As Alternative 6 has the same level of activity as Alternative 4, the direct and indirect effects for the two alternatives are identical. For a complete discussion of the effects of direct and indirect effects on other cetaceans, please see Section 4.5.2.4.12.

4.9.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.3.3 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.9.2.4.1) above for an analysis of the efficacy and practicability of using the proposed alternative technologies to reduce effects of noise from seismic exploration on marine mammals. Only technologies for which there is information specific to beluga whales (e.g., hydraulic and electric marine vibrators) are included below. Refer to the above bowhead whales section for information on DTAGS and Low Frequency Passive Seismic Methods for Exploration.

Marine Vibrators

The low frequency (10 to 250 Hz) sound produced by hydraulic marine vibrators is within the hearing range of baleen whales (7 Hz to 22 kHz) and at the lower edge of most toothed whales (150 Hz to 160 kHz or 200 Hz to 180 kHz for mid- and high- frequency functional hearing groups, respectively) [Southall et al. 2007]), so could still be in the range of detectability. Potential auditory impacts to cetaceans, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced through reduced noise output. Any reduction in adverse impacts would be on a limited and localized scale with the current schedule of implementation. The use of this system by industry is currently uncertain as previous use did not result in increased data quality, reduced operation costs, or penetrate as deeply as some companies require.

Electric marine vibrators emit sounds at lower pressure levels and over a narrower frequency range than do airguns. The low frequency (6 to 100 Hz) produced is within the hearing range of baleen whales (7 Hz to 22 kHz) but outside the range of most toothed whales (150 Hz to 160 kHz or 200 Hz to 180 kHz for mid- and high- frequency functional hearing groups, respectively) [Southall et al. 2007]). Therefore, baleen whales would be able to detect the sound, but toothed whales would likely not. Potential auditory impacts to baleen whales, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced due to the lower frequency. Any reduction in adverse impacts would be on a limited and localized scale with the current schedule of implementation. In addition, industry interest in this system may be limited by its inability to penetrate as deep as some companies require for exploration. For more detailed information regarding marine vibrators, see Section 2.3.5.1.

Low Frequency Acoustic Source (LACS)

This could potentially reduce adverse acoustic impacts to cetaceans, but the level of reduced impacts and efficacy for mitigating impacts cannot presently be determined. See Section 4.9.2.4.1 for further details. Depending on the exact frequencies used, it is possible that baleen and toothed whales would have divergent benefits due to their different auditory ranges, similar to the implementation of marine vibrators.

4.9.2.4.3.4 Conclusion

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on Other Cetaceans are difficult to determine, but could reduce adverse impacts (both behavioral impacts and acoustic habitat impacts, as described in the sections above) associated with the use of airgun arrays (see Section 4.5.2.4 for details on effects of airgun noise on marine mammals and other cetaceans). Because of the current state of the technology, however, the overall reduction during the life of this EIS would likely be minimal. The gradual introduction of these alternative technologies might reduce the frequency, although not the duration, of seismic noise introduced into the marine environment and the impacts to marine mammals. Airgun noise would not be eliminated, however, since these alternative technologies would not completely replace the existing technology and what may be replaced is limited. In addition, surveys conducted with alternative technologies would still use marine vessels to tow or deploy equipment which could disturb bowhead whales as described in Section 4.5.2.4. A sizable ramp-up in the development and implementation of alternative technologies could potentially reduce behavioral and acoustic habitat impacts to the degree that the rating in the impact criteria might change. However, based on our understanding of the degree to which these technologies are expected to come into use in the next five to ten years, we expect that the impact categorization would not change. Effects of existing technology on cetaceans, as described in Alternative 4, would be mostly of low to medium intensity and interim duration and be of regional extent. Alternative technologies could reduce the extent to localized areas on a small scale; it is not currently possible to assess potential behavioral reactions and determine if intensity level would change, as a result. Species within the Other Cetacean group are considered common to unique, depending on the species and trype of impact, but many are very rarely encountered due to infrequent use of the habitat. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 6 on Other Cetaceans is considered to be minor to moderate.

4.9.2.4.3.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.17).

4.9.2.4.4 Ice Seals

4.9.2.4.4.1 Direct and Indirect Effects

Alternative 6 includes the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on ice seals under Alternative 6 involves the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

The number of the different exploration activities authorized under Alternative 6 would be the same as under Alternatives 4 and 5. However, under Alternative 6, NMFS could potentially require the industry to (or the industry could voluntarily) gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Cetaceans are the primary focus for consideration of these alternative technologies because they are the most susceptible of marine mammals to underwater noise disturbance. These technologies and their potentials for reducing impacts to cetaceans are described in section 4.9.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on ice seals is incorporated into the following subsections.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 6 include several mechanisms for potential disturbance to ice seals in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The two types of surveys which take place on or in sea ice, the preferred habitat of ice seals and where they are most likely to be concentrated, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 6 as for Alternative 2. The physical presence of the icebreakers and vibroseis tracked vehicles likely have as much or more to do with the disturbance of ice seals during these surveys as does the introduced seismic sounds. Alternative seismic technologies for in-ice surveys would likely still require the use of ice breakers and would therefore have similar disturbance effects on ice seals as those technologies currently in use. Additional development and testing would be needed prior to use of any of the alternative technologies under consideration in sea ice. The level of disturbance from these types of in-ice/on-ice surveys would therefore be similar for Alternative 6 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on ice seals.

The level of open-water activities under Alternative 6 would be the same as for Alternative 4. These activities could affect ice seals over a large area, especially for the 2D/3D seismic streamer surveys. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology and most of the alternative technologies still emit sound into the ocean. As described for Alternative 2 in Section 4.5.2.4, disturbance effects using the existing technology would be temporary and low in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of ice seals. Any surveys conducted with alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which could disturb seals in the water. The effects on ice seals would still be considered temporary and low in magnitude with the same types of mild behavioral reactions.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to pinnipeds would be the same. The level of potential direct and indirect physical effects on pinnipeds would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.4. Refer to Section 4.5.2.4.13 for a discussion of potential injury or mortality effects of oil and gas exploration activities on ice seals.

Habitat Alterations

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, so the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on ice seals' habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.4. Refer to Section 4.5.2.4.13 for a discussion of potential effects oil and gas exploration activities on pinniped habitat.

4.9.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.4.3 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.9.2.4.1) above for an analysis of the efficacy and practicability of using the proposed alternative technologies to reduce effects of noise from seismic exploration on marine mammals. There is no specific information regarding how these technologies may reduce impacts to ice seals at this time. However, because of the different hearing frequencies of ice seals from mysticetes, impacts would likely be slightly different.

4.9.2.4.4.4 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities and their reactions have been recorded by PSOs on board source vessels and monitoring vessels. These data indicate that seals do tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away and they do not appear to react strongly even as ships pass fairly close with active arrays. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology and most of the alternative technologies still emit sound into the ocean. Any surveys conducted with alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which are at least as important for disturbance to seals in the water. Seals do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected (all under the MMPA and one under the ESA as well). Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 6 on ice seals would likely be medium to high in magnitude (the latter for ringed seals), distributed over a wide geographic area, and interim in duration. The effects of Alternative 6 would therefore be considered minor to moderate (the latter for ringed seals) for ice seal species according to the criteria established in Section 4.1.3.

4.9.2.4.4.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.17).

4.9.2.4.5 Pacific Walruses

4.9.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 6 on walruses. This species is dependent on pack ice and coastal shores for haul outs. Alternative 6 includes all of the same types of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on walruses under Alternative 6 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

The number of different exploration activities authorized under Alternative 6 would be the same as under Alternatives 4 and 5. However, under Alternative 6, NMFS could potentially require the industry to (or the industry could voluntarily) gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Cetaceans are the primary focus for consideration of these alternative technologies because they are the most susceptible of marine mammals to underwater noise disturbance. These technologies and their potentials for reducing impacts to cetaceans are described in sections 4.9.2.4.1 and 4.9.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on walruses is incorporated into the following subsections.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 6 include several mechanisms for potential disturbance to walruses in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The one type of survey that takes place on or in sea ice (the preferred habitat for walruses and where they are most likely to be concentrated) is the in-ice 2D survey with icebreakers. On-ice vibroseis surveys would only occur in the Beaufort Sea at times when walruses would not be present. Only one such in-ice survey could be authorized for each Arctic sea under any of the action alternatives. In-ice seismic surveys also have the potential to avoid periods when walruses are present (i.e., late fall-early winter) or early spring which could be advantageous. The physical presence of the icebreakers likely has as much or more to do with the disturbance of walruses during these surveys as does the introduced seismic sounds. Alternative seismic technologies for in-ice surveys would likely still require the use of ice breakers and would therefore have similar disturbance effects on walruses as do technologies currently in use. Additional development and testing would be needed prior to use of any of the alternative technologies under consideration in sea ice. The level of disturbance from these types of in-ice surveys would therefore be similar for Alternative 6 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on walruses.

The number of open water activities authorized under Alternative 6 would be the same as under Alternative 4 and likely to elicit similar disturbance effects. These activities could affect walruses over a large area, especially for the 2D/3D seismic streamer surveys. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology. As described for Alternative 2 in Section 4.5.2.4, disturbance effects using the existing technology would be temporary and low in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of walruses. Any surveys conducted with alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which could disturb walruses in the water. The effects on walruses would still be considered temporary and low in magnitude with the same types of mild behavioral reactions.

Hearing Impairment, Injury, and Mortality

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for injury and mortality to walruses would be the same. The level of potential direct and indirect physical effects on walruses would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential injury or mortality effects on walruses can be found in Section 4.5.2.4.14.

Habitat Alterations

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on walrus habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential impacts on walrus habitat can be found in Section 4.5.2.4.14.

4.9.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to walruses are discussed under Alternative 2 (Section 4.5.2.4.16). All mitigation measures required under the USFWS LOA will be applicable here.

4.9.2.4.5.3 Conclusion

Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. This data indicates that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walruses' reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes.

Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for analysis purposes in this EIS. Given the level and type of exploration activities that would be authorized under Alternative 6, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim to long term in duration. The effects of Alternative 6 would therefore be considered moderate for walruses according to the criteria established in Table 4.5-18.

4.9.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to walruses are discussed under Alternative 2 (Section 4.5.2.4.17).

4.9.2.4.6 Polar Bears

4.9.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 6 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 6 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on polar bears under Alternative 5 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

The number of different exploration activities authorized under Alternative 5 would be the same as under Alternatives 4 and 5. However, under Alternative 6, NMFS could potentially require the industry to (or the industry could voluntarily) gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Cetaceans are the primary focus for consideration of these alternative technologies because they are the most susceptible of marine mammals to underwater noise disturbance. These technologies and their potentials for reducing impacts to cetaceans are described in sections 4.9.2.4.1 and 4.9.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on polar bears is incorporated into the following subsections, where relevant.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 6 include several mechanisms for potential disturbance to polar bears along leads in the ice and in broken ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment including the potential for direct human-bear encounters. The two types of surveys which take place on or in sea ice, the hunting and denning habitats for polar bears, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 6 as for Alternative 2. The physical presence of the icebreakers and vibroseis, tracked vehicles likely have as much or more to do with the disturbance of polar bears during these surveys as does the introduced seismic sounds. Alternative seismic technologies for in-ice surveys would likely still require the use of ice breakers and would therefore have similar disturbance effects on polar bears as those technologies currently in use. The level of disturbance from these types of in-ice/on-ice surveys would therefore be similar for Alternative 6 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on polar bears.

The number of exploration activities that would be authorized under Alternative 6 is identical to those under Alternative 4, so the types and mechanisms for disturbance to polar bears would be the same. Introduction of alternative technologies would likely have little impact on polar bears, so the overall level of disturbance and potential direct and indirect effects on polar bears would be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.6. A more thorough discussion of disturbance effects of oil and gas exploration activities on polar bears can be found in Section 4.5.2.4.15.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to polar bears would be the same. The level of potential direct and indirect physical effects on polar bears would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.6. A more thorough discussion of potential injury or mortality effects of oil and gas exploration activities on polar bears can be found in Section 4.5.2.4.15.

Habitat Alterations

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on polar bear habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.6. A more thorough discussion of potential impacts on polar bear habitat can be found in Section 4.5.2.4.15.

4.9.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.6.3 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. However, in 2012, Shell recorded a total of 49 sightings of 61 polar bears in the Chukchi Sea and a total of 29 sightings of 104 individuals in the Beaufort Sea during monitoring efforts in conjunction with exploratory drilling activities (Bisson et al. 2013). During the activities associated with the exploratory drilling programs, Bisson et al. (2013) noted the most common reactions to the presence of both moving and stationary vessels as looking at the vessel or no observable reaction. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology. Any surveys conducted with alternative technologies would presumably reduce the amount of noise introduced, but would still use marine vessels which are at least as important for disturbance to polar bears in the water. Polar bears do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered unique resources. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 6 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 6 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.9.2.4.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.17).

4.9.2.5 Terrestrial Mammals

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures that focus on alternative technologies for seismic exploration. These mitigation measures do not affect terrestrial mammals in the EIS project area, so the impacts discussed in Section 4.5.2.5 are the same for Alternative 6; the overall impact to terrestrial mammals would be minor.

4.9.2.6 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.6).

4.9.3 Social Environment

4.9.3.1 Socioeconomics

4.9.3.1.1 Direct and Indirect Effects

Impacts to the socioeconomic categories of public revenue and expenditures, employment and personal income, demographic characteristics, and social organizations and institutions would be the same as those discussed under Alternative 4 (Level 3 activity). With the incorporation of alternative technologies, there would be negligible impact to the monetized economy. It is feasible that the effectiveness and practicability of alternative technologies may result in longer surveys to get equivalent data, and as such result in additional costs to lease holders. The description of alternative technologies for hydrocarbon exploration (Section 2.3.5) discusses how alternative acoustic source technologies generally put the same level of useable energy into the water as airguns, but over a longer period of time with a resulting reduced acoustic footprint. Therefore, the lease holders could be surveying for a longer period of time which would cause greater associated cost. For a discussion of reduced impacts to the non-monetized economy, see the Subsistence Section 4.9.3.2.

4.9.3.1.2 Conclusion

The socioeconomic impacts under Alternative 6 would be similar to Alternative 4 except there could be additional costs incurred by lease holders associated with lost productivity. The duration of the socioeconomic impacts would be interim because it would not be year-round, but the activity would be scheduled to occur over a fixed number of years. The positive economic impacts of the activity would be statewide and national. The context of the socioeconomic impacts would be considered unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat (minority population) communities. The summary impact level for Socioeconomics under Alternative 6 is moderate.

4.9.3.2 Subsistence

4.9.3.2.1 Direct and Indirect Effects

Direct and indirect effects to subsistence resources and subsistence harvest would be expected to be the same as those discussed under Alternative 2 (Section 4.5.3.2). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and additional mitigation measures for Alternative 6 are also identical to those for Alternative 4. Alternative 6 differs from Alternative 4 in the application of alternative technologies. The implementation of alternative technologies depends on research and development schedules, and usage during the timeframe of this EIS is unknown.

The use of alternative technology to either replace or traditional seismic surveys or augment the use of airguns in traditional seismic surveys would be introduced slowly if available during the timeframe of this EIS. At present, none of these alternative technologies are fully tested or developed. The number of airgun surveys these technologies could potentially replace or augment cannot be estimated until the technology is beyond the testing phase.

Hydraulic marine vibrators could be used as technologies that replace airguns or augment traditional seismic surveys for certain prospects in limited environments. This system is the only one that has been offered commercially. However, it is currently not considered successful because there was no increase in data quality or reduction in operations cost. The system does not have the low frequencies to penetrate as deep as some companies require for exploration. Low frequency passive seismic methods (not yet proven in all environments) may be used to enhance recovery through better resolutions than magnetic or gravimetric methods but would not replace airgun surveys. However, there is no evidence that this is a reliable new alternative technology reliable and therefore it is not likely to be used.

Electric marine vibrators would not be available to replace existing technologies. There has been no industry interest in supporting the development of this system. The system does not have the low frequencies to penetrate as deep as some companies require for exploration and electric marine vibrators would be available for use in only limited environments.

LACS would not be available to replace or augment existing technologies. There has been no industry interest in supporting the development of this system. The system does not have the low frequencies to penetrate as deep as some companies require for exploration. The LACS 8A system has not yet been built and/or tested; therefore its availability to be used as an alternative technology to airguns and considered in this EIS is difficult.

The DTAGS is not designed for conducting deep penetration for oil and gas explorations. Only one DTAGS currently exists. There is no projection of a timeframe in which a low-frequency DTAGS would be fully developed or available. However, it is impossible to compare this system to currently used airgun arrays, and the effectiveness of this alternative technology is unknown.

The effectiveness of these alternative technologies to be used to further reduce adverse impacts to subsistence uses is at present unknown. These alternative technologies are only expected to be employed in certain environments, and some are not yet proven in all environments.

Alternative 6 proposes the same level of exploration activities as Alternative 4 but suggests the implementation of alternative technologies that reduce sound emission levels from seismic survey sources. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment. The intention is that the use of these alternative technologies would reduce the likelihood of disturbance to marine mammals (Section 4.9.1.4 and Section 4.9.2.4), which in turn could be beneficial in reducing any subsequent impacts to subsistence users.

Airgun noise would not be eliminated, however, since these alternative technologies would not completely replace the existing technology, and what may be replaced is limited. In addition, surveys conducted with alternative technologies would still use marine vessels to tow or deploy equipment which could disturb marine mammals (Section 4.5.2) and in turn affect subsistence resources. Effects of existing technology on subsistence would be of low intensity and temporary duration and range from local to regional in extent. The context would range from common to unique. Bowhead whales, beluga whales, polar bears, bearded and ringed seals would be considered unique in context. Despite possible local mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the impact of Alternative 5 on subsistence resources would be considered to be negligible to moderate.

4.9.3.2.2 Conclusion

The summary impacts to subsistence harvest and subsistence resources from alternative technologies under Alternative 6 are likely to be similar to Alternative 3 as discussed in Section 4.5.3.2.

4.9.3.3 Public Health

4.9.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 6 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.5.3.3.

In addition, there could potentially be requirements for the use of alternative technologies under Alternative 5. The intention is that the use of these alternative technologies would reduce the likelihood of disturbance to marine mammals, which in turn could be beneficial in reducing detrimental impacts to subsistence users. However, as discussed in Section 4.9.3.2, the effectiveness of these alternative technologies in reducing adverse impacts to subsistence uses is at present unknown, and thus the benefits of the use of these technologies are theoretical.

Therefore, these additional mitigations do not affect the overall impact criteria rating for public health for Alternative 6. If, however, the alternative technologies are demonstrated to be effective and feasible to implement, there is the possibility that additional benefit to public health may accrue.

4.9.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 6. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur they would affect minority or low-income communities, the duration of changes may be long-term, and multiple communities could be affected.

4.9.3.4 Cultural Resources

4.9.3.4.1 Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures for that focus on alternative technologies for seismic exploration. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.5.3.4 for Alternative 2 are the same for Alternative 6. The overall impact to cultural resources would be negligible.

4.9.3.4.2 Conclusion

Direct and indirect impacts to cultural resources resulting from the implementation of Alternatives 2, 3, and 4 would be the same in Alternative 6. For a complete discussion of direct and indirect impacts on cultural resources, please see Section 4.5.3.4.

4.9.3.5 Land and Water Ownership, Use, and Management

4.9.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership caused by Alternative 6 are similar to those caused by Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics. This includes federal, state, private owned, borough, and municipal lands and waters.

Land and Water Use

The direct and indirect impacts to land and water use resulting from Alternative 6 are similar to those resulting from Alternative 2 for recreational, residential, and mining land uses. Refer to Section 4.5.3.5 for a discussion on these topics.

The direct and indirect impacts to land and water use resulting from Alternative 6 are similar those resulting from Alternative 2 for protected lands, subsistence, industrial, transportation, and commercial land uses. Refer to Section 4.6.3.5 for a discussion on these topics

Land and Water Management

The direct and indirect impacts to land and water management resulting from Alternative 6 are similar to those resulting from Alternative 2 for federal, state and borough and lands and waters. Refer to Section 4.7.3.5 for a discussion on these topics.

Alternative 6 also includes mitigation measures that focus on the use of alternative technologies that have the potential to augment or replace traditional airgun-based seismic exploration activities. Some of this technology may be impracticable or not yet available, which could violate lease compliance terms for the timing of exploration. Impact criteria would remain the same as Alternative 2.

4.9.3.5.2 Conclusion

Based on Table 4.4-2, and the analyses provided above and in Section 4.5.3.5, there would be no direct or indirect impacts on land and water ownership under Alternative 6.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts of land and water use caused by Alternative 6 are described as follows. The magnitude of impact would be high where activity occurs in areas of little to no activity (such as Wainwright), and the magnitude of impact would be low in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be interim because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be long-term if construction of a new facility or infrastructure to accommodate increased shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 6 would be moderate because of the possibility for high intensity impact and long-term structures in smaller communities.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts on land and water management caused by Alternative 6 are described as follows. The magnitude of impact would be low because the action is consistent with existing management plans. The duration of impact would be interim because project activities would last an entire project season, but would not result in long-term conflicts with management plans. The extent of impacts would be local because proposed activities would not involve management plans beyond the localized areas of seismic exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 6 on land and water management would be minor because they would be low intensity, would be interim in nature, local, and common.

4.9.3.6 Transportation

4.9.3.6.1 Direct and Indirect Effects

Direct and indirect regional transportation systems and existing infrastructure would be expected to be the same as those discussed under Alternative 2 as discussed in Section 4.5.3.2. Alternative technologies are likely to use the same types of transportation equipment and infrastructure at the same levels as that currently used for seismic surveys, on-ice surveys and exploratory drilling as Alternatives 2, 3, 4, and 5.

4.9.3.6.2 Conclusion

The impacts of using alternative technologies would occur slowly. It is assumed that these new alternative technologies would require the same levels of aircraft and surface and vessel support as under Alternatives 2 through 5, and, therefore, the impacts would be expected to be minor.

4.9.3.7 Recreation and Tourism

4.9.3.7.1 Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures for that focus on alternative technologies for seismic exploration. These mitigation measures do not affect recreation or tourism in the EIS project area, so the impacts discussed in Section 4.5.3.7 for Alternative 2 are the same for Alternative 6; the overall impact to recreation and tourism would be minor.

4.9.3.7.2 Conclusion

The direct impacts would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 6 on recreation and tourism would be minor.

4.9.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 6 of the proposed project.

4.9.3.8.1 Direct and Indirect Effects

Implementation of Alternative 6 is expected to result in interim moderate effects to scenic quality and visual resources identical to those described in Alternative 4. Potential impacts could be of low to medium intensity, depending on the geographic separation of programs. In either case, actions would be temporary, local and occur in an important context.

4.9.3.8.2 Conclusion

Implementation of Alternative 6 is expected to result in interim moderate effects to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be local; however they would affect an important resource.

4.9.3.9 Environmental Justice

4.9.3.9.1 Direct and Indirect Effects

With the incorporation of alternative technologies, the impacts to subsistence foods and human health could be further minimized from the level of activity associated with Alternative 4, but the effectiveness of these alternative technologies is unknown (see Subsistence Section 4.9.3.2). Activity levels associated with Alternative 4 are low intensity impacts on subsistence resources, temporary to interim in duration, affecting local communities as well as the region, and affect important marine mammal resources. Contamination of subsistence foods would be negligible, the same as discussed under Alternative 4. It is unknown whether alternative technologies associated with Alternative 6 would minimize the impact on the numbers of marine mammals harvested in any community, but the impacts would not disappear. Therefore the time, cost and safety risk to hunters would still occur associated with marine mammal dispersion. Low intensity, long-term health changes would occur at a regional extent because of possible changes to health outcomes. The perception that subsistence foods are contaminated would still occur with the use of alternative technologies.

4.9.3.9.2 Conclusion

Activities related to implementation of Alternative 6 could have a lower intensity impact on subsistence resources and human health due to the incorporation of alternative technologies than Alternatives 4 and 5, but not eliminate all impacts. Subsistence foods and human health are unique resources protected under the MMPA and EO 12898. Alternative 6 is expected to have a minor impact to Alaska Native communities.

4.9.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.10 Very Large Oil Spill Scenario

This section contains a discussion of the potential environmental effects of a low-probability, high impact event, a hypothetical very large oil spill (VLOS) in the Chukchi Sea and also one in the Beaufort Sea. The analysis of a VLOS also allows NMFS and BOEM to understand possible effects of spills of smaller sizes as well. New rules and rulemaking procedures, as described below, have been instituted to help reduce even further the probability of a VLOS from occurring. Additionally, conditions at potential drill sites in the Beaufort and Chukchi seas are quite different from those at the site of the Deepwater Horizon (DWH) oil spill event in the Gulf of Mexico (i.e., shallower water depths and lower formation pressures in the Beaufort and Chukchi seas), thereby reducing the likelihood of loss of well control in the EIS project area. Lastly, as described in Section 2.3.3 of this EIS, oil and gas operators are required to complete plans that reduce the likelihood of an oil spill from occurring.

The discussion of oil spill scenarios relies heavily on the recent BOEM Lease Sale 193 Final Second Supplemental EIS (BOEM 2015b) and the Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017 Final Programmatic EIS (BOEM 2012). Much (although not all) of the information summarized in Sections 4.10.1 through 4.10.5 has been taken verbatim from these two documents.

4.10.1 Background and Rationale

The discussion provided in Section 4.10.1 is taken from the BOEM (2015b) Lease Sale 193 analysis and discussion. Summaries of this information are provided in the resource discussions below. As allowed by

CEQ regulations in 40 C.F.R. 1502.21, NMFS has incorporated the information presented in the BOEM FSEIS into this EIS by reference.

4.10.1.1 Government Reports and Recommendations

Since the DWH event, several entities within or commissioned by the federal government have offered formal recommendations regarding review and regulation of OCS oil and gas activities.

Council on Environmental Quality (CEQ).

As a direct result of the DWH event, the CEQ reviewed the MMS NEPA policies, practices and procedures relating to OCS oil and gas exploration and development and issued a report on August 16, 2010 (CEQ 2010b). This report recommended that MMS, now renamed BOEM, "ensure that NEPA documents provide decision makers with a robust analysis of reasonably foreseeable impacts, including an analysis of reasonably foreseeable impacts associated with low probability catastrophic spills for oil and gas activities on the Outer Continental Shelf." This report also asked BOEM to "Consider supplementing existing NEPA practices, procedures, and analyses to reflect changed assumptions and environmental conditions, due to circumstances surrounding the [Macondo] Oil Spill.

As described by BOEM (2015b) in the aftermath of Deepwater Horizon event, President Obama directed the Secretary of the Interior to identify new precautions, technologies, and procedures needed to improve safety of oil and gas development on the Outer Continental Shelf. At the same time, the Secretary directed BOEMRE (now BOEM) to exercise its authority under the OCSLA to suspend certain drilling activities so the Bureau could (1) ensure that drilling operations similar to those that led to the Deepwater Horizon event could operate in a safe manner when drilling resumed, (2) ensure extensive spill response resources directed toward the spill would be available for other spill events, and (3) provide adequate time to obtain input for enhancing intervention and containment capability and promulgate regulations that address issues described in the Increased Safety Measures for Energy Development on the Outer Continental Shelf report (USDOI 2010).

The Deepwater Horizon incident investigations provided numerous other recommendations detailed in reports including the National Oil-spill Commission (OSC) report; the National Academy of Engineering (NAE) and the National Research Council (NRC) report Macondo Well—Deepwater Horizon Blowout: Lessons for Improving Offshore Drilling Safety; the Deepwater Horizon Joint Investigation Team (JIT) Report consisting of the USCG's Report of Investigation into the Circumstances Surround the Explosion, Fire, Sinking, and Loss of Eleven Crew Members Aboard the mobile Offshore Drilling Unit Deepwater Horizon in the Gulf of Mexico; and USDOI's Report Regarding the Causes of the April 20, 2010 Macondo Well Blowout; the USCG Incident Specific Preparedness Review BP Deepwater Horizon Oil Spill; and the USDOI OCS Safety Oversight Board Report to the Secretary of the Interior Ken Salazar. All of the above listed reports are described in the Outer Continental Shelf, Oil and Gas Lease Program: 2012-2017, Final Programmatic Environmental Impact Statement (BOEM 2012). Also, regulatory reforms are described in the 2012-2017, Final Programmatic Environmental Impact. These reports and regulatory reforms are incorporated by reference (BOEM 2012).

4.10.1.2 Regulatory Reform and Rule Changes Following the Deepwater Horizon Event

In light of the Deepwater Horizon explosion, loss of life, oil spill, and response, the federal government, along with industry, increased their rules and safety measures related to oil-spill prevention, containment, and response. Additionally, the federal government and industry have increased their research and reform in response to the Deepwater Horizon explosion, oil spill, and response through government-funded research, industry-funded research, and joint partnerships.

BOEM and BSEE have instituted regulatory reforms in response to many of the recommendations expressed in the various reports prepared following the Deepwater Horizon explosion, oil spill, and response. To date, regulatory reform has included both prescriptive and performance-based regulation and guidance, as well as OCS safety and environmental protection requirements. The reforms strengthen the requirements for all aspects of OCS operations. Ongoing reform and research endeavors of BSEE to improve workplace safety and to strengthen oil-spill prevention, planning, containment, and response are described in the 2012-2017 Programmatic EIS (BOEM 2012).

Final Drilling Safety Rule.

Effective October 22, 2012, the Final Drilling Safety Rule refines the Interim Final Rule by addressing requirements for compliance with documents incorporated by reference (77 *FR* 50856, August 22, 2012). The Final Rule:

- Establishes new casing installation requirements
- Establishes new cementing requirements
- Requires independent third party verification of blind-shear ram capability
- Requires independent third party verification of subsea BOP stack compatibility
- Requires new casing and cementing integrity tests
- Establishes new requirements for subsea secondary BOP intervention
- Requires function testing for subsea secondary BOP intervention
- Requires documentation for BOP inspections and maintenance
- Requires a Registered Professional Engineer to certify casing and cementing requirements
- Establishes new requirements for specific well control training to include deepwater operations

This Final Rule changes the Interim Final Rule (IFR) in the following ways:

- Updates the incorporation by reference to the second edition of API Standard 65—Part 2, which was issued December 2010. This standard outlines the process for isolating potential flow zones during well construction. The new Standard 65—Part 2 enhances the description and classification of well control barriers, and defines testing requirements for cement to be considered a barrier.
- Revises requirements from the IFR on the installation of dual mechanical barriers in addition to cement for the final casing string (or liner if it is the final string), to prevent flow in the event of a failure in the cement. The Final Rule provides that, for the final casing string (or liner if it is the final string), an operator must install one mechanical barrier in addition to cement, to prevent flow in the event of a failure in the cement. The Final Rule also clarifies that float valves are not mechanical barriers.
- Revises 30 CFR § 250.423(c) to require the operator to perform a negative pressure test only on wells that use a subsea blowout preventer (BOP) stack or wells with a mudline suspension system instead of on all wells, as was provided in the IFR.
- Adds new 30 CFR § 250.451(j) stating that an operator must have two barriers in place before removing the BOP, and that the BSEE District Manager may require additional barriers.
- Extends the requirements for BOPs and well-control fluids to well completion, well-workover, and decommissioning operations under Subpart E—Oil and Gas Well-Completion Operations, Subpart F—Oil and Gas Well-Workover Operations, and Subpart Q—Decommissioning Activities to promote consistency in the regulations.

Safety and Environmental Management Systems Rule

BSEE issued a Final Rule effective in June 2013 (78 *FR* 20423, April 5, 2013). This Final Rule (Workplace Safety Rule) includes refinements to the existing SEMS program. The SEMS II Final Rule amends the existing regulations to require operations to develop and implement additional provisions involving stop work authority and ultimate work authority, establishes requirements for reporting unsafe working conditions, and requires employee participation in the development and implementation of their

SEMS programs. In addition, the Final Rule requires the use of independent third parties to perform the audits of the operators' programs.

The SEMS II Final Rule provides greater protection by supplementing operators' SEMS programs with employee training, empowering field level personnel with safety management decisions, and strengthening auditing procedures by requiring them to be environmental management systems. The SEMS is a nontraditional, performance-focused tool for integrating and managing offshore operations. The purpose of SEMS is to enhance the safety and operations by reducing the frequency and severity of accidents. The four principal SEMS objectives are:

- Focus attention on the influences that human error and poor organization have on accidents
- Continuous improvement in the offshore industry's safety and environmental records
- Encourage the use of performance-based operating practices
- Collaborate with industry in efforts that promote the public interests of offshore worker safety and environmental protection (78 *FR* 20423, April 5, 2013)

Operators had until June 4, 2014, to comply with the provisions of the SEMS II Rule, except for the auditing requirements. All SEMS audits must be in compliance with the SEMS II Rule by June 4, 2015 (78 *FR* 20423, April 5, 2013).

In addition, on April 30, 2013, BSEE and the USCG entered into a Memorandum of Agreement (MOA) entitled "Safety and Environmental Management Systems (SEMS) and Safety Management Systems (SMS)." The purpose of this MOA is to:

- Establish a process to determine areas relevant to safety and environmental management within the jurisdiction of both the USCG and BSEE where joint policy or guidance is needed
- Ensure that any future OCS safety and environmental management regulations do not place inconsistent requirements on industry
- Establish a process to develop joint policy or guidance on safety and environmental management systems (78 *FR* 20423, April 5, 2013)

In July 2016, BSEE and BOEM issued regulations to ensure that future exploratory drilling activities on the U.S. Arctic OCS are done safely and responsibly, subject to strong and proven operational standards. The Arctic-specific regulations focus solely on offshore exploration drilling operations within the Beaufort Sea and Chukchi Sea Planning Areas. The regulations codify requirements that all Arctic offshore operators and their contractors are appropriately prepared for Arctic conditions and that operators have developed an integrated operations plan that details all phases of the exploration program for purposes of advance planning and risk assessment. With an emphasis on safe and responsible exploration, the final rule requires operators to submit region-specific oil spill response plans, have prompt access to source control and containment equipment, and have available a separate relief rig to timely drill a relief well in the event of a loss of well control. The rule continues to allow for technological innovation, as long as the operator can demonstrate that the level of its safety and environmental performance satisfies the standards set forth in the final rule.

NTL (Notice to Lessees)

Effective August 10, 2012, BSEE issued NTL No. 2012-N06 to provide clarification, guidance, and information concerning the preparing and submittal of regional Oil-Spill-Response Plan (OSRP) for owners and operators of oil handling, storage, or transportation facilities, including pipelines, located seaward of the coast line (facilities) (BSEE 2012a).

Effective November 16, 2012, BSEE issued NTL No. 2012-N07 to provide clarification about the type of information industry may provide for compliance with written follow-up report requirements in 30 CFR 254.46(b)(2) (BSEE 2012b).

Effective August 26, 2013, BSEE issued NTL No. 2013-N02 to clarify BSEE intent regarding significant change in Oil-spill-Response Plan (OSRP) worst case discharge (WCD) scenario that requires the submittal of a revised OSRP for BSEE approval (BSEE 2013).

Effective on September 8, 2015, BOEM issued NTL No. 2016-N06 to provide clarification on the procedures and requirements for Right-of-Use and Easement Requests for Platforms, Artificial Islands, Installations and Other Devices Attached to the Seabed.

Effective January 14, 2014, BOEM issued NTL No. 2015-N01 describing information requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS for Worst Case Discharge and Blowout Scenarios.

For more information on *National Notice to Lessees and Operations of Federal Oil and Gas Leases and Pipeline Right-of-Way Holders* see http://www.bsee.gov/Regulations-and-Guidance/Notices-to-Lessees-and-Operators/.

4.10.2 Very Large Oil Spill (VLOS) Scenario

In the BOEM Final Secondary SEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEM 2015b), The VLOS scenario is predicated on an unlikely event—a loss of well control during exploration drilling that leads to a long duration blowout and a resulting VLOS. hese analyses from BOEM are incorporated into Sections 4.10.3 and 4.10.4 below.

Implicit in these analyses is the view that different hypothetical spill sizes are not expected to affect a particular individual of a species differently. The basic mechanisms by which individuals of the various Arctic species are affected by spilled oil are known to some extent and are not dependent on spill size. That is to say that if a bird were oiled from a crude oil spill, the effect on the particular bird would likely be essentially the same regardless of the size of the spill. A key difference that spill size makes is how many individuals of a species would have potential contact with a spill, be expected to die or be adversely affected, the extent of effects on their habitat, and whether those impacts would be significant under NEPA. Further investigation on fate and effects of dispersed crude oil on Arctic species is ongoing through a Joint Industry Program (Word et al. 2008).

4.10.3 General Assumptions

The discussion provided in Section 4.10.3 is taken from the BOEM Final Second SEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEM 2015b), which is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2012). Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEM Final Second SEIS into this EIS by reference.

4.10.3.1 Very Large Spill Scenario vs. Worst Case Discharge

To facilitate analysis of the potential environmental impacts of a VLOS in the Beaufort and Chukchi seas, it is first necessary to develop VLOS scenarios. Scenarios are conceptual views of the future and represent possible sets of activities. They serve as planning tools that make possible an objective and organized analysis of hypothetical events. These VLOS scenarios are not to be confused with what would be expected to occur as a result of any of the action alternatives.

The VLOS scenario is sometimes confused with worst-case discharge (WCD) analyses which are used to evaluate an EP or Development and Production Plan (DPP). Both calculations are alike to the extent that they are performed by BOEM using similar assumptions and identical analytical methods and software. However, these calculations differ in several important ways:

Very Large Oil Spill: Rather than analyzing a specific drilling proposal, the VLOS model selected a prospect within an area that potentially maximizes the variables driving high flow rates. Therefore, the VLOS scenario in the Chukchi Sea represents an extreme case in flow rate and discharge period that, in turn, represents the largest discharge estimated from any site in the [EIS project area].

Worst-Case Discharge: Site-specific WCDs at locations identified in a submitted plan in the [EIS project area] would typically result in much lower initial rates and aggregate discharges if discharge periods are held equal. The calculations also differ in their purpose. Whereas the VLOS scenario is a planning tool for NEPA environmental impacts analysis, a WCD is the calculation required by 30 CFR Part 250 to accompany an Exploration Plan or Development and Production Plan and provide a basis for an Oil-spill Response Plan.

The VLOS scenario is predicated on an unlikely event—a loss of well control during exploration drilling that leads to a long duration blowout and a resulting VLOS. Information on OCS well control incidents was addressed in Section 4.4.1. It is recognized that the frequency for a VLOS on the OCS from a well control incident is very low. Recent analyses have estimated the frequency ranges from $>10^{-4}$ – $<10^{-5}$ (BOEM 2012; Bercha Group, Inc. 2014).The low chance that the exploration well would successfully locate a large oil accumulation, coupled with the observed low incidence rates for accidental discharges in the course of actual drilling operations, predicts a very small, but not impossibly small, chance for the occurrence of a VLOS event. But this consideration of probability is not, nor should it be, integrated into the VLOS model. The VLOS discharge quantity is "conditioned" upon the assumption that all of the necessary chain of events required to create the VLOS actually occur (successful geology, operational failures, escaping confinement measures, reaching the marine environment, etc.). The VLOS discharge quantity is, therefore, not "risked" or reduced by the very low frequency for the occurrence of the event.

4.10.3.2 Rate, Time and Composition of Hypothetical Spill

The [Chukchi Sea] VLOS scenario assumes a blowout leading to a very large oil spill. In developing this scenario, BOEM first generated a hypothetical oil discharge model that estimates the highest possible uncontrolled flow rate that could occur from any known prospect in the Lease Sale 193 area, given real world constraints. The discharge model was constructed using a geologic model for a specific prospect in conjunction with a commercially-available computer program (AVALON/MERLIN) that forecasts the flow of fluids from the reservoir into the well, models the dynamics of multiphase (primarily oil and gas) flow up the wellbore, and assesses constraints on flow rate imposed by the open wellbore and shallower well casing. This model utilized information and selected variables that, individually and collectively, provided a maximized rate of flow. The most important variables for the discharge model included reservoir thickness, permeability, oil viscosity, gas content of oil, and reservoir pressure. Many other variables of lesser importance were also required.

The oil discharge climbs rapidly to over 61,000 bbls/day during Day 1. After peaking in Day 1, (BOEM 2015b: Figure 4-17) the oil discharge declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 pounds per square inch (psi) (BOEM 2015b: Table 4-55). The decline in the flow rate flattens somewhat after Day 40, falling to 20,479 bbls/day (33 percent of the Day 1 peak rate) by Day 74 when the near-wellbore reservoir pressure has fallen to [2,567 psi which is] 58 percent of the initial reservoir pressure (4,392 psi). The total oil discharge by the end of the flow period on Day 74 is 2,160,200 bbls.

4.10.3.3 Additional Parameters

The following discussion describes additional parameters of the Chukchi Sea VLOS scenario. These parameters are based on reasonably foreseeable factors related to oil spills based on past VLOS events (e.g, the Exxon Valdez Oil Spill [EVOS], DWH event, and the Ixtoc oil spill), published scientific reports, consideration of Arctic-specific conditions, and application of best professional judgment. The result is a framework for identifying the most likely and most substantial impacts of the hypothetical VLOS event. Key aspects of the scenario are listed below:

- A loss of well control during exploration drilling leads to a blowout and an ongoing, high volume release of crude oil and gas that continues for up to 39-74 days;
- Oil remains on the surface of the water for up to a few weeks after flow has stopped or after meltout from sea ice during the Arctic spring;
- The total volume of the oil is nearly 2.2 million barrels (MMbbls) and the volume of the gas is [51 million cubic meters or] 1.8 billion cubic feet (Bcf)—within 74 days;
- Roughly 30 percent of the VLOS evaporates. A small portion of the spill remains in the water column as small droplets. The remaining oil could be physically or chemically dispersed, sedimented, beached, weathered into tar balls, or biodegraded; and
- Information about where a very large spill could go and how long it takes to contact resources is estimated by an oil spill trajectory model.
- For the Beaufort Sea, summer is defined as July 1-September 30 and winter October 1-June 30. For the Chukchi Sea, summer is defined as June 1-October 31 and winter as November 1-May 31.

4.10.4 VLOS Scenario for the Chukchi Sea

The discussion provided in Section 4.10.4 is taken from the BOEM Final Second SEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEM 2015b), which is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2012). Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEM documents (2015b, 2012) into this EIS by reference.

4.10.4.1 Cause of Spill

This scenario begins with an unlikely event – a loss of well control during exploration drilling that leads to a long duration blowout and a VLOS in the Chukchi Sea.

For the purpose of analysis in this EIS, an explosion and subsequent fire are assumed to occur. A blowout associated with the drilling of a single exploratory well could result in a fire that would burn for one or two days. The exploration drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deeper water, the rig or platform could land a great distance away. For example, the DWH drilling rig sank, landing [457 m or] 1,500 feet from the subsea wellhead. Water depths in the majority of the Lease Sale 193 area range from about [29 m or] 95 feet to approximately [80 m or] 262 feet; this range is considered shallow water. A small portion of the northeast corner of the Lease Sale 193 area deepens to approximately [2,987 m or] 9,800 feet.

For the purpose of modeling flow rates, the location of the blowout and leak was specified as occurring near the mudline (at the top of the BOP [blowout preventer]). For the purpose of environmental effects analysis, it is acknowledged that a blowout could occur in other locations, such as at the sea surface, along the riser anywhere from the seafloor to the sea surface, or below the seafloor (outside the wellbore). The forthcoming environmental effects analysis encompasses all these possibilities. As different blowout and leak locations may have bearing on spill response and intervention options, additional discussion of these issues is provided [below in] Opportunities for Intervention and Response.

DOI determines the risk of such an event occurring on a per EP basis; therefore, increasing the number of EPs increases the potential amount of risk. The amount of risk of such an event occurring can also increase when an operator needs to disconnect in the middle of operations.

4.10.4.2 Timing of the Initial Event

For purposes of analysis, the hypothetical VLOS in the Chukchi Sea is estimated to commence between July 15 and October 31. These dates coincide with the open water drilling season.

4.10.4.3 Volume of Spill

Well blowouts generally involve two types of hydrocarbons, namely crude oil (or condensate) and natural gas. The volume ratio of these two fluids is a function of the characteristics of the fluids and the producing reservoir.

Table 4-55 in BOEM (2015b) summarizes the results of the discharge model for the hypothetical VLOS. The oil discharge climbs rapidly to over 61,000 bbls/day during day one. After peaking in Day 1, Figure 4-17 shows that the oil discharge declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 psi (BOEM 2015b: Table 4-55). The decline in the flow rate flattens somewhat after Day 40. As shown in BOEM (2015b) Table 4-55, the cumulative oil discharge over a 74-day spill is 2,160,200 bbls.

To simplify the analysis, it is estimated 2.2 MMbbls of oil are spilled in the VLOS scenario.

4.10.4.4 Duration of Spill

The duration of the offshore spill from a blowout depends on the time required for successful intervention. Intervention may take a variety of forms. . . . [T]here exists a variety of methods by which an operator or responder can stop the flow of oil. The availability of some of these techniques could vary under individual drilling plans. [A]ll exploration plans must specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well. For purposes of analysis within this VLOS scenario, it is estimated the discharge would be stopped within 74 days of the initial event. This duration reflects the longest of three estimated time periods for completing a relief well as described in Table 4 in BOEM (2015b, Table 4-54).

4.10.4.5 Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of spreading depends on the type of oil and volume that is spilled. A spill of the size analyzed here would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Estimates of where the oil spill would go were taken from the OSRA [Oil Spill Risk Analysis] trajectory analysis [see Appendix A of BOEM (2015b)].

4.10.4.6 Oil in the Environment: Properties and Persistence

The fate of oil in the environment depends on many factors, such as the source and composition of the oil, as well as its persistence (National Research Council [NRC] 2003c). Persistence can be defined and measured in different ways (Davis et al. 2004), but the NRC generally defines persistence as how long oil remains in the environment (NRC 2003c). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (NRC 2003c). These processes may interact and affect the properties and persistence of the oil through:

- evaporation (volatilization);
- emulsification (the formation of a mousse);

- dissolution;
- oxidation; and
- transport processes (National Research Council 2003c, Scholz et al., 1999).

Horizontal transport takes place via spreading, advection, dispersion, and entrainment, while vertical transport takes place via dispersion, entrainment, Langmuir circulation, sinking, overwashing, partitioning, and sedimentation (MMS 2007a, [FEIS, Appendix A, Figure A.1-1 Fate of Oils Spills in the Ocean During Arctic Summer, and Figure A-2. Fate of Oil Spills in the Ocean During Arctic Winter]). The persistence of an oil slick is influenced by the effectiveness of oil-spill response efforts and affects the resources needed for oil recovery (Davis et al. 2004). The persistence of an oil slick may also affect the severity of environmental impacts as a result of the spilled oil.

Crude oils are not a single chemical but instead are complex mixtures with varied compositions. Thus, the behavior of the oil and the risk the oil poses to natural resources depends on the composition of the specific oil encountered (Michel 1992). Generally, oils can be divided into three groups of compounds: (1) light-weight, (2) medium-weight, and (3) heavy-weight components.

The oil discharged from the hypothetical Chukchi Sea VLOS well is 35° API [American Petroleum Institute] crude oil. This oil would be considered light-weight as shown in Table 4-56 in BOEM (2015b). On average, light-weight crude oils are characterized as outlined in Table 4-56 in BOEM (2015b).

Previous studies (Boehm and Fiest 1982) supported the estimate that most released oil in shallow waters similar to the Chukchi Sea would reach the surface of the water column. A small portion (one to three percent) of the Ixtoc oil remained in the water column (dispersants were used), although limited scientific investigation occurred and analytical chemical methods 30 years ago may not have been as sensitive as today (Boehm and Fiest 1982, Reible 2010). [BOEM (2015b) does not indicate how long the oil would remain in the water column. The purpose of dispersants is to put the oil in suspension in the water column where it stays until diluted to the point of not being measurable and/or is ingested by bacteria.]

4.10.4.7 Release of Natural Gas

The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. The oil in the VLOS reservoir is assumed to be initially saturated (with gas) at a gas-oil ratio of [26 cubic meters or] 930 cubic feet/barrel (cf/bbl) (quantities at standard conditions of 60°F and 1.0 atm.) and this is reflected by the fact that the initial (Day 0.1) produced gas-oil ratio in the model (BOEM 2015: Table 4-55) is also 930 cf/bbl. As shown in Table 4-55 in BOEMRE (2015b), the produced gas-oil ratio falls to a minimum of 757 cf/bbl between Day 15 and Day 27—while early oil and gas production rates fall rapidly with de-pressurization of the reservoir near the wellbore—but then rises to 1,202 cf/bbl by Day 74 of the discharge.

Gas discharge reaches a peak of 50,677 Mcf/d [1 Mcf/d equals 1000 cf per day] in Day 1 of the flow, falls to a minimum rate of 19,513 Mcf/d by Day 45, then rises to 24,608 Mcf/d by Day 74. The pattern of gas flow reflects the process of gas break-out in the reservoir that progressively converts the initial oil reservoir into a gas reservoir. The cumulative gas discharge over the 74-day period (use of new platform and drilling equipment) estimated for completion of a relief well (very large discharge case) is 1,808 MMcf [1MMcf equals 1,000,000 cf]. For purposes of analysis, it is estimated 1.8 Bcf. Natural gas is primarily made up of methane (CH_4) and ethane (C_2H_6) which make up 85-90 percent of the volume of the mixture.

4.10.4.8 Duration of Subsea and Shoreline Oiling

The duration of the shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining surface oil dissipates offshore. Depending on the spill's location in relation to winds, ice, and currents and the well's distance to shore, oil could reach the coast within 10 days to 360 days based on BOEM oil spill trajectory analysis (BOEM 2015b). While it is estimated that the majority of spilled surface oil would evaporate and naturally disperse offshore within 30 days of stopping the flow or after meltout in the Arctic spring, some oil may remain in coastal areas until cleaned, as seen following the EVOS and DWH event (the State of Louisiana 2010a-d). The generation of oil suspended particulate material or subsurface plumes from the well head would stop when the well was capped or killed. Subsurface plumes would dissipate over time due to mixing and advection (Boehm and Fiest 1982).

4.10.4.9 Volume of Oil Reaching Shore

In the event of a VLOS, not all of the oil spilled would contact shore. The volume of oil recovered and chemically or naturally dispersed would vary. For example, the following are recovery and cleanup rates from previous high-volume, extended spills (Wolfe et al. 1994, Gundlach and Boehm 1981, Gundlach et al. 1983, Lubchenco et al. 2010):

- 10-40 percent of oil recovered or reduced (including burned, chemically dispersed, and skimmed);
- 25-40 percent of oil naturally dispersed, evaporated, or dissolved; and
- 20-65 percent of the oil remains offshore until biodegraded or until reaching shore.

[In the case of the DWH event] it is estimated that burning, skimming and direct recovery from the wellhead removed one quarter (25 percent) of the oil released from the wellhead. One quarter (25 percent) of the total oil naturally evaporated or dissolved, and just less than one quarter (24 percent) was dispersed (either naturally or as a result of operations) as microscopic droplets into Gulf waters. The residual amount— just over one quarter (26 percent)—is either on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments (Inter- agency 2010a). For planning purposes, USCG estimates that 5-30 percent of oil will reach shore in the event of an offshore spill (33 CFR Part 154, Appendix C, Table 2).

4.10.4.10 Length of Shoreline Contacted

While larger spill volumes increase the chance of oil reaching the shoreline, other factors that influence the length and location of shoreline contacted include the duration of the spill and the well's location in relation to winds, ice, currents, and the shoreline. The length of oiled shoreline increases over time as the spill continues. Dependent upon winds and currents throughout the VLOS event, already impacted areas could have oil refloated and oil other areas, increasing the oiled area.

A VLOS from a nearshore site would allow less time for oil to be weathered, dispersed, and/or recovered before reaching shore. This could result in a more concentrated and toxic oiling of the shoreline. A release site farther from shore could allow more time for oil to be weathered, dispersed, and recovered. This could result in a broader, patchier oiling of the shoreline.

4.10.4.11 Severe and Extreme Weather

Wind and wave action can drive oil floating on the surface into the water column, and oil stranded on shorelines can be moved into nearshore waters and sediment during storms. Episodes of severe and extreme weather over the Arctic could affect the behavior of sea-surface oil, accelerate biodegradation of the oil, impact shoreline conditions, and put marine vessels at risk. For instance, recovery of sea-surface oil could be impeded by the formation of sea ice during severe cold outbreaks that occur typically over the Arctic winter. In addition, episodes of severe storms characterized by strong winds (25 to 30 miles per hour) and precipitation can dictate the movement of sea-surface oil drift and also direct oil toward the coastline following a VLOS occurring during summer or winter. The severe storms, referred to as mesoscale cyclones (MCs), form when a cold air mass over land (or an ice sheet) moves over warmer open water (Nihoul and Kostianoy 2009). These storms are usually small-scale and short-lived; and the lower the atmospheric pressure in the storm center, the stronger the storm. More intense versions of MCs occur mainly during the Arctic winter when the lowest pressure polar mesoscale cyclones (PMCs) are associated with the semi-permanent Aleutian low. These storms can cause extreme weather conditions in areas near ice/ocean or land/ocean boundaries (Jackson and Apel 2004). While less common, these storms cover a larger area and can cause surface winds at or near gale force, up to 45 miles per hour, with waves [4.6 to 6 meters or] 15 to 20 feet. As such, a PMC is sometimes characterized as an arctic hurricane. Wind and wave action caused by these extreme storms can pose a risk to marine vessels, drive sea-surface oil into the water column, enhance weathering of the oil, or cause oil stranded on the coastline to move into nearshore waters and sediment. Any of these conditions could temporarily delay or stop the response and recovery effort.

4.10.4.12 Recovery and Cleanup

The hypothetical VLOS scenario outlined thus far would trigger an extensive spill recovery and cleanup effort. It is anticipated that efforts to respond to a VLOS in the Chukchi Sea would include the recovery and cleanup techniques and estimated levels of activities described below. It is noted that severe weather and/or the presence of ice could interfere with or temporarily preclude each of these methods. The effect of ice is analyzed in greater detail below in "Effect of Ice on Response Actions." For a comprehensive list of Arctic oil-spill response research projects that BSEE has funded, the reader is referred to BSEE Arctic Oil-spill Response research (BSEE 2014).

In the event of a VLOS, two governmental organizations would assume prominent roles in coordinating response efforts: the FOSC and the ARRT. The ARRT is an advisory board to the FOSC that provides federal, state, and local governmental agencies with means to participate in response to pollution incidents. During a response, the FOSC would consult with the ARRT on a routine basis for input regarding response operations and priorities. In addition to their advisory role during a response event, the ARRT is responsible for developing the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases (Unified Plan) which details governmental incident response planning and responsibilities for the State of Alaska and 10 Subarea Contingency Plans that provide region-specific response planning information for establishing operations in the event of a major response effort to an oil spill or hazardous material release. The Subarea Contingency Plans identify notification requirements, emergency response command structures, response procedures, community profiles, in-region response assets, logistics guidance, spill scenarios that could be encountered in the region and sensitive areas identification along with geographic response strategies which provide suggested response actions to protect the resources at risk from a release of oil. For exploration activities in the Chukchi Sea, the North Slope Subarea Contingency Plan and the Northwest Arctic Subarea Contingency Plan are the applicable documents for addressing oil spill response in the region.

Mechanical Recovery. Both mechanical and non-mechanical methods of oil spill response can be utilized in the Chukchi Sea to mitigate the impacts of an oil spill on the environment. The preferred means of spill response is mechanical recovery of the oil, which physically removes oil from the ocean. Mechanical recovery is accomplished through the use of devices such as containment booms and skimmers. A containment boom is deployed in the water and positioned within an oil slick to contain and concentrate oil into a pool thick enough to permit collection by a skimmer. The skimmer collects the oil and transfers it to a storage vessel (storage barges or oil tankers) where it will eventually be transferred to shore for appropriate recycling or disposal.

Dispersants. Use of chemical dispersants is a response option for the Chukchi Sea. Research has shown that dispersants can be effective in cold and ice infested waters when employed in a timely manner (S.L. Ross Environmental Research Ltd., 2002, 2003, 2006, 2007; Belore 2003). Recently completed field scale tests conducted by Sintef (Sintef 2010) as part of the Oil in Ice Joint Industry Project (JIP) in the Barents Sea has demonstrated that results from lab scale and large wave tank tests hold true in actual ocean conditions. Oil released into the ocean during broken ice conditions was readily dispersed, and the dispersion was enhanced with the addition of vessel propeller wash for more energy in these conditions. It was also demonstrated that in these cold conditions, weathering of the oil was substantially slowed, providing a greater window of opportunity in which to successfully apply dispersants. Dispersant application can be accomplished by means of injection at the source or through aerial or vessel based application. There are dispersant stockpiles located in Prudhoe Bay, Anchorage, and the Lower 48 states [dispersants can be flown to Alaska from the Lower 48 if stockpiles are inadequate]. Dispersant use is limited to ocean application in waters generally deeper than 10 meters; this depth restriction is used to avoid or reduce potential toxicity concerns to nearshore organisms.

The State of Alaska does not have preapproved dispersant application zones for the Chukchi Sea, so each request for dispersant application would be evaluated and approved or disapproved on a case-by-case basis by the FOSC with the concurrence of the EPA representative to the RRT and, as appropriate, the concurrence of the RRT representative from the State of Alaska and COC and DOI natural resource trustees. The decision regarding how and when dispersants would be applied would also reside with the FOSC and the above listed agency representatives. Procedures governing the application of dispersants are provided in "The Alaska Federal and State Preparedness Plan for Response to Oil and Hazardous Substance Discharges and Releases" (Unified Plan) (ARRT 2010). However, the FOSC is not limited to this procedure and may utilize other sources of information in determining what the most appropriate dispersant method would be given a specific situation.

In-situ Burning. In-situ burning is also a viable response method for the Chukchi Sea and could be approved by the FOSC in consultation with the Unified Command and the above listed agency representatives. Any in-situ burning would be conducted in accordance with the Alaska Unified Plan In-situ Burn Guidelines (ARRT 2010). In-situ burning is a method that can be used in open ocean, broken ice, near shore, and shoreline cleanup operations. In broken ice conditions, the ice serves to act as a natural containment boom, limiting the spread of oil and concentrating it into thicker slicks, which aid in starting and maintaining combustion. In-situ burning has the potential to remove in excess of 90 percent of the volume of oil involved in the burn. In-situ burning experiments of oil in ice conducted as part of the Sintef JIP (Sintef 2010) has likewise demonstrated that cold temperatures serve to slow weathering of the oil, in turn expanding the window of opportunity for in-situ burning application over that experienced in more temperate regions.

Effect of Ice on Response Actions. For all response options, the presence of ice can both aid and hinder oil spill response activities. Ice acts as a natural containment device, preventing the rapid spread of oil across the ocean surface. It also serves to concentrate and thicken the oil, allowing for more efficient skimming, dispersant application, and in-situ burning operations. Once shore fast ice is formed, it serves as a protective barrier, limiting or preventing oil from contacting shorelines. Cold temperatures and ice will slow the weathering process by reducing volatilization of lighter volatile compounds of the oil, reducing impact of wind and waves, and extending the window of opportunity in which responders may utilize their response tools.

Conversely ice can limit a responder's ability to detect and locate the oil, access the oil by vessel, prevent the flow of oil to skimmers, require thicker pools to permit in-situ burning, and eventually encapsulate the oil within a growing ice sheet making access difficult or impossible. Once incorporated into the ice sheet, further recovery operations would have to cease until the ice sheet becomes stable and safe enough to support equipment and personnel to excavate and/or trench through the ice to access the oil. The other response option is embedding tracking devices in the ice and monitoring its location until the ice sheet begins to melt and the oil surfaces through brine channels at which time it could be collected or burned.

Levels of Recovery and Cleanup Activities. The levels of activities required to apply the techniques described above are dependent on the specific timing and location of a spill. As weather, ice, and logistical considerations allow, the number of vessels and responders would increase exponentially as a spill continues. The levels of activities described below are reasonable estimates provided as a basis for analysis. These estimates are based on Subarea Contingency Plans for the North Slope and Northwest Arctic subareas, past spill response and cleanup efforts, including the EVOS and DWH events, and the best professional judgment of BOEM spill response experts:

- Between five and 10 staging areas would be established;
- About 15 to 20 large skimming vessels (such as the Nanuq, Endeavor Barge, Tor Viking, other barges from Prudhoe Bay, USCG skimming vessels, vessels from Cook Inlet and Prince William Sound) could be used in offshore areas. The majority of open ocean vessels would be positioned relatively close to the source of the oil spill to capture oil in the thickest slicks, thus enabling the greatest rate of recovery;
- Thousands of responders (from industry, the federal government, private entities) could assist spill response and cleanup efforts as the spill progresses. Weather permitting, roughly 300-400 skimming, booming, and lightering vessels could be used in areas closer to shore. Based on the trajectory of the slick, shallow water vessels would be deployed to areas identified as priority protection sites;
- Booming would occur, dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. About 100 booming teams could monitor and operate in multiple areas;
- Use of dispersants and/or in-situ burning could occur if authorized by the FOSC. Use of dispersants would likely concentrate on the source of the flow or be conducted so as to protect sensitive resources. In-situ burning operations would likewise be conducted in the area of thickest concentration to ensure the highest efficiency for the effort. In-situ burning may also be utilized in nearshore and shoreline response where approved by FOSC;
- Dozens of planes and helicopters would fly over the spill area, including impacted coastal areas. Existing airport facilities along the Arctic coast (including airports at Kotzebue, Point Hope, Point Lay, Wainwright, Barrow, and any other suitable airstrips) would be used to support these aircraft. If aircraft are to apply dispersants, they could do so from altitudes of [15 to 30.5 m or] 50 to 100 ft.; and
- Workers could be housed offshore on vessels or in temporary camps at the staging areas.

Depending on the timing and location of the spill, the above efforts could be affected by seasonal considerations. In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to cover the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. At this point, operations could shift to in-situ burning if sufficient thicknesses are encountered. The lack of daylight during winter months would increase the difficulties of response.

As ice formation progresses, the focus of the response would shift to placing tracking devices in the forming ice sheet to follow the oil as it is encapsulated into the ice sheet. Once the ice sheet becomes solid and stable enough, recovery operations could resume by trenching through the ice to recover the oil using heavy equipment. This would most likely occur in areas closer to shore because the ice will be more stable. In late spring and early summer, as the ice sheet rots, larger ice-class vessels could move into the area and begin recovery or in-situ burning operations as the oil is released from the ice sheet. The ice would work as a natural containment boom keeping the oil from spreading rapidly. As the ice sheet decays, oil encapsulated in the ice would begin surfacing in melt pools at which time responders will have additional opportunities to conduct in-situ burn operations. Smaller vessels could eventually re-commence skimming operations in open leads and among ice flows, most likely in a free skimming mode (without boom) along the ice edge.

While it is estimated that the majority of spilled oil on the water's surface would be dissipated within a few weeks of stopping the flow (Interagency 2010a) during open water or after meltout in the Arctic spring, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill (Etkin, McCay, and Michel 2007). On coarse sand and gravel beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms (USFWS 2010g).

Effectiveness of intervention, response, and cleanup efforts depend on the spatial location of the blowout, leak path of the oil, and amount of ice in the area. For the purpose of analysis, effectiveness of response techniques is not factored into the spill volume posited by this scenario and considered during OSRA modeling.

4.10.4.13 Scenario Phases and Impact-Producing Factors

The events comprising the VLOS scenario are first categorized into five distinct phases. These phases, which range from the initial blowout event to long-term recovery, are presented chronologically. Within each phase are one or more components that may cause adverse impacts to the environment. These components are termed "Impact Producing Factors," (IPFs) and will be used later to guide the environmental impacts analysis. The specific IPFs listed here are intended to inform, rather than limit, the discussion of potential impacts.

4.10.4.13.1 Well Control Incident (Phase 1)

Phase 1 of the hypothetical VLOS scenario is comprised of the catastrophic blowout and its immediate consequences. Potential IPFs associated with Phase 1 include the following:

- **Explosion**. Natural gas released during a blowout could ignite, causing an explosion.
- **Fire**. A blowout could result in a fire that could burn for one to two days.
- **Re-distribution of Sediments**. A blowout could redistribute sediment along the seafloor.
- **Sinking of Rig.** The drill rig could sink to the sea floor.
- **Psychological/Social Distress**. News and images of a traumatic event could cause various forms of distress.

4.10.4.13.2 Offshore Spill (Phase 2)

Phase 2 of the scenario encompasses the continuing release of an oil spill in federal and state waters. Potential IPFs associated with Phase 2 include the following:

- **Contact with Oil**. Offshore resources (including resources at surface, water column, and sea floor) could be contacted with spilled oil.
- **Contamination**. Pollution stemming from an oil spill may contaminate environmental resources, habitat, subsistence resources, and/or food sources.
- **Loss of Access**. The presence of oil could prevent or disrupt access to and use of affected areas.

4.10.4.13.3 Onshore Contact (Phase 3)

Phase 3 of the scenario focuses on the continuing release of an oil spill and contact to coastline and state nearshore waters. Potential IPFs associated with Phase 3 include the following:

- **Contact with Oil**. Onshore resources could come into direct contact with spilled oil.
- **Contamination**. Pollution stemming from an oil spill may contaminant environmental resources, habitat, and/or food sources.
- **Loss of Access**. The presence of oil could prevent or disrupt access to and use of affected areas.

4.10.4.13.4 Spill Response and Cleanup (Phase 4)

Phase 4 of the scenario encompasses spill response and cleanup efforts in offshore federal and state waters as well as onshore federal, state and private lands along the coastline. Potential IPFs associated with Phase 4 include the following:

- **Vessels**. Vessels could be used in support of spill response and cleanup activities.
- **Aircraft**. Aircraft could be used in support of spill response and cleanup efforts.
- **In-situ burning**. Remedial efforts may include burning of spilled oil.
- **Animal Rescue**. Animals may be hazed or captured and sent to rehabilitation centers.
- **Dispersants**. Dispersants could be introduced into the environment.
- **Skimmers**. Boats equipped to skim oil from the surface.
- **Booming**. Responders could deploy booms—long rolls of oil absorbent materials that float on the surface and corral oil.
- **Beach cleaning**. Cleanup efforts including hot water washing, hand cleaning using oil absorbent materials, and placement and recovery of absorbent pads, could be used on beaches and other coastal areas contacted by an oil spill.
- **Drilling of Relief Well**. A relief well could be drilled by the original drilling vessel or by a second vessel with additional support.
- **Co-opting of resources**. Funds, manpower, equipment, and other resources required for spill response and cleanup would be unavailable for other purposes.
- **Bioremediation**. Contaminated material could be removed or treated by adding fertilizers or microorganisms that “eat” oil.

4.10.4.13.5 Post-Spill, Long-Term Recovery (Phase 5)

Phase 5 of the scenario focuses on the long-term. The exact length of time considered during this phase will vary by resource. Potential IPFs associated with Phase 5 include the following:

- **Unavailability of environmental resources**. Environmental resources and food sources may become unavailable or more difficult to access or use.
- **Contamination**. Pollution stemming from an oil spill may contaminate environmental resources, habitat, and/or food sources.
- **Perception of contamination**. The perception that resources are contaminated may alter human use and subsistence patterns.
- **Co-opting of human resources**. Funds, manpower, equipment, and other resources required to study long-term impacts and facilitate recovery would curtail availability for other purposes.
- **Psychological/Social Distress**. Distress stemming from a VLOS could continue into the long-term.

4.10.4.14 Opportunities for Intervention and Response

In providing a duration for the hypothetical oil spill described above, it is stated for the purposes of analysis that the discharge would cease within 74 days of the initial event. The use of 74 days corresponds to the longest of three time periods estimated for a second drilling vessel to arrive on scene from the far east and complete a relief well (see BOEM 2015b: Table 4-54). This is a reasonable but conservative estimate because it does not take into consideration the variety of other methods that would likely be employed to halt the spill within this period. Moreover, specific exploration plans may include intervention and response methods that could control or contain the flow of oil sooner than 74 days. This point is illustrated by recent exploration plans submitted for the Alaska OCS, such as the Shell Revised OCS Lease Exploration Plan, Chukchi Sea (Shell, 2014). The Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan (cPlan) (Shell, 2011) utilizes:

- Enhanced BOP mechanisms;
- Criteria and procedures for moving the drilling unit off location in event of abnormal conditions;
- Pre-positioning of response vessels at the drill site and close to the shoreline;
- Use of an Oil-spill Response Vessel capable of deploying and operating recovery equipment within an hour of notification;
- Availability of a second BOP stack; and
- Maintaining supplies and equipment for relief well purposes

Potential intervention and response methods are qualitatively analyzed below because their inclusion in individual exploration plans could serve to substantially decrease the duration, volume, and environmental effects of a VLOS. These methods are not mutually exclusive; several techniques may be employed if necessary. It may also be possible to pursue multiple techniques contemporaneously. Again, these opportunities for intervention and response could be employed prior to drilling a relief well, and are not factored into the estimated spill duration as described in the VLOS scenario above. The availability and effectiveness of these techniques may vary depending on the nature of the blowout, as well as seasonal considerations. For instance, an operators' ability to complete a relief well during winter months could be compromised by severe weather and cold, ice, darkness, and other factors.

Well Intervention. If a blowout occurred, the original drilling vessel would initiate well control procedures. The procedures would vary given the specific blowout situation, but could include:

- Activating blowout preventer equipment;
- Pumping kill weight fluids into the well to control pressures;
- Replacing any failed equipment to remedy mechanical failures that may have contributed to the loss of well control; and/or
- Activating manual and automated valves to prevent flows from coming up the drill string.

These techniques cure loss-of-well-control events the vast majority of the time without any oil being spilled.

Natural bridging or plugging could also occur. These terms refer to circumstances where a dramatic loss of pressure within the well bore (as could occur in the event of a blowout) causes the surrounding formation to cave in, thereby bridging over or plugging the well. While natural bridging or plugging could render certain forms of operator-initiated well control infeasible, it could also impede or block the release of hydrocarbons from the reservoir from reaching the surface.

Containment Domes. In the event that well intervention is unsuccessful and the flow of oil continues, a marine well containment system (MWCS) could be deployed with associated support vessels. The design for a MWCS specific to Arctic operations is currently in progress and will be required to receive BOEM review under future permitting activities. The MWCS is anticipated to provide containment domes, well intervention connections, remotely operated vehicle capabilities, barge with heavy lift operations, separation equipment, and oil and gas flaring capabilities.

Relief Wells. If the above techniques are unavailable or unsuccessful, a relief well could be drilled. The relief well is a second well, directionally drilled, that intersects the original well at, near, or below the source of the blowout. Once the relief well is established, the operator pumps kill weight fluids into the blowout well to stop the flow and kill the well. Both wells are then permanently plugged and abandoned.

Some exploratory drilling vessels are capable of drilling their own relief well. Mobile Offshore Drilling Units, or MODUs, can disconnect from the original well, move upwind and up current from the blowout location, and commence the drilling of a relief well. Bottom-founded vessels are by definition not capable of maneuvering in this manner.

Second Vessel. Should the original drilling vessel sustain damage or prove otherwise incapable of stopping the blowout, a second vessel could be brought in to terminate or otherwise contain the blowout. A second vessel, with support from additional vessels as needed, could employ similar techniques to those described above. The time required by a second vessel to successfully stop the flow of oil must factor in the time needed for travel to the site of the blowout. The location of a second vessel is thus critical when considering a scenario in which same vessel intervention or response is unavailable. The estimate used in the VLOS scenario described above conservatively allots 30 days for transporting a second vessel across the Pacific Ocean. The availability of a second vessel in-theater (within the Chukchi Sea or possibly the Beaufort Sea) or on site would substantially reduce transport time and, therefore, the time needed for successful intervention. This could equate to shorter spill duration and smaller overall spill volume.

As previously mentioned, the availability and/or effectiveness of certain response and intervention techniques can depend on the type and exact location of the blowout. Five major distinctions with respect to the specific location of a blowout are important to consider. A blowout and leak could occur: (1) at the sea surface (but the rig is not destroyed or sunk on location), (2) along the riser anywhere from the seafloor to the sea surface, (3) at the seafloor through leak paths on the BOP/wellhead, (4) below the seafloor, outside the wellbore, or (5) at the sea surface (but the rig is destroyed and sinks at the location). Opportunities for operational intervention and response vary in each of these circumstances (BOEM 2015b: Table 4-57).

4.10.5 VLOS Scenario for the Beaufort Sea

The 2012-2017 OCS Oil and Gas Leasing Program Final Programmatic EIS (BOEM 2012) contains the first post-DWH event scenario for the Beaufort Sea. Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEM Final Programmatic EIS (2012) into this EIS by reference.

Arctic Risk Profile. An ongoing concern in the Arctic is the environmental effects of a very large oil spill on sensitive marine and coastal habitats that occur there within a land sea-ice biome that supports a traditional subsistence lifestyle for Alaska Native populations and provides important habitats for migratory and local faunal populations. The ability to respond to and contain a very large discharge event under the extreme climatic conditions and seasonal presence of ice is of particular concern.

Loss of Well Control. While some formation properties of the Arctic OCS are expected to have pressures, temperatures, and volumes sufficient to produce a discharge that could result in catastrophic consequences, drilling risks associated with these formation characteristics are not directly related to issues of extreme cold and presence of ice. Instead, the fact that the Arctic OCS is largely a frontier geologic province contributes risk to Arctic drilling operations (USGS 2011a).

Human error while working under extreme weather conditions on the Arctic OCS could increase the risk of loss of well control in certain circumstances where established procedures are not followed. However, when accounting for other Arctic specific variables, the incident rate of loss of well control is expected to be lower than for exploration and development operations in the GOM (Bercha et al. 2008).

To address some of the risk inherent in Arctic operations, the BOEM regulations include specific requirements for conducting operations in the Arctic, such as locating the BOP in a well cellar (a hole constructed in the sea bed) to position the top of the BOP below the maximum potential ice gouge depth, using special cements in areas where permafrost is present, enclosing or protecting equipment to assure it will function under subfreezing conditions, and developing critical operations and curtailment procedures which detail the criteria and process through which the drilling program would be stopped, the well shut in and secured and the drilling unit moved off location before environmental conditions (such as ice) exceed the operating limits of the drilling vessel.

Containment and Response. Much of risk from a catastrophic event that is particular to the extreme climate of the Arctic is associated with containment and response issues at the well site. The time needed to drill a relief well in the Beaufort Sea under the scenario varies from 60 to 300 days depending on the timing of the event relative to the ice free season, since the well site may become inaccessible when solid or broken ice is present. During that time, the ability to mount effective containment and response efforts under broken or solid ice conditions is a critical factor.

Fate and Consequence. Response away from the well site could also be hindered and/or aided by broken and solid ice. In addition, some options available to manage fates of spills have not been previously used in larger-scale operations the Arctic to fully evaluate their effectiveness, such as burning and dispersant use, although state-of-the art research on these response techniques suggest they could decrease the volume of oil in the water (SINTEF 2010).

In summary, the Catastrophic Discharge Scenarios developed for the Beaufort Sea estimates a discharge rate of 1.7 to 3.9 Mbbl over a duration of 60 to 300 days. Factors affecting duration are timing of the event relative to the ice free season and/or the availability of a rig to drill a relief well. The foundation for the analysis in Section 4.10.7 of this EIS is taken from the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2012), which contains the first post-DWH event scenario for the Beaufort Sea. Summaries of this information are provided in the applicable resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the Draft Programmatic EIS (BOEM 2012) into this EIS by reference.

Summaries of information from the former MMS (now BOEM) Final Environmental Impact Statement (FEIS) for the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (MMS 2003) are also provided in this EIS where applicable.

4.10.6 Chukchi Sea – Analysis of Very Large Oil Spill Impacts

The foundation of the analysis provided in Section 4.10.6 of this EIS is taken from the BOEM (2015b) analysis for Lease Sale 193. Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEM FSEIS into this EIS by reference. The specific sections from BOEM (2015b) that are referenced in this EIS are noted in the sections below. BOEM (2015b) is available online at: http://www.boem.gov/ak-eis-ea. Additional information pertinent to this project is presented in each resource section as well. The information taken from BOEM (2015b) is identified as "Existing Analysis," and the analysis beyond what was presented in that document is listed as "Additional Analysis."

The scenario in BOEM (2015b) is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Final Programmatic EIS (BOEM 2012). NMFS has incorporated the information presented in the BOEM Draft Programmatic EIS into this EIS by reference. The specific sections from BOEM (2012) that are referenced in this EIS are noted in the sections below.

4.10.6.1 Physical Oceanography

4.10.6.1.1 Existing Analysis (BOEM 2015b and BOEM 2012)

BOEM uses an OSRA (Oil Spill Risk Analysis) model to simulate estimated oil spill trajectories; in other words, the OSRA model is a method for estimating where a VLOS may go. Input for the OSRA model includes calculated values of wind, ice, currents, vectors, and numerous other physical, social, and economic parameters. A summary of the OSRA model structure, input, and output are provided in Appendix A of BOEM (2015b), and are incorporated here by reference.

The BOEM (2012) analysis describes the effects of sea ice and currents on the movement and weathering of spilled oil in the Beaufort Sea planning area. This information is incorporated herein by reference.

4.10.6.1.2 Additional Analysis for Physical Oceanography

Phase 1 (Initial Event)

Impact producing factors associated with a well control incident, such as explosion, fire, and redistribution of sediment would have minor effects on physical ocean resources within the EIS project area. Uncontrolled combustion of petroleum hydrocarbons in the environment would result in an increase in water temperature in the immediate vicinity of the fire. It is difficult to quantify the increase in water temperature that would result from fire associated with a well control incident, but it is likely that the geographic extent of changes in water temperature would be limited to areas immediately adjacent to the fire, and the duration of such thermal effects would be temporary. Redistribution of seafloor sediments would have minor impacts on the seafloor topography in the immediate vicinity of the well control incident. Although effects resulting from redistribution of seafloor sediment would likely be permanent, the intensity of the effects would be low and the geographic extent would be limited (BOEM 2015b). Sinking of the drilling rig to the sea floor would effectively create an artificial reef2015b, which would have permanent, local, low-intensity effects on the physical character of the EIS project area. If the rig were to sink in shallow water it could be considered a navigational hazard. Overall, effects of the initial well control incident on the physical character of the EIS project area would be minor.

Phase 2 (Offshore Oil)

Oil in the water from a VLOS event would affect the physical character of the sea surface in the EIS project area. An oil slick covering hundreds of square kilometers of ocean surface would influence ocean-atmosphere interactions, including exchange of gasses across the air-water interface and the generation of wind driven waves in the affected area. The presence of an oil slick at the sea surface would impede normal gas exchange across the air-water interface, but the impacts of such effects would likely be surpassed by the release of large quantities of methane, ethane, propane and other hydrocarbon gasses into the water column (Kessler et al. 2011). The natural gas mixture released into the water during a VLOS event would have temporary effects on the dissolved gas content of seawater in the affected area. The fate and effects of dissolved hydrocarbons are discussed in more detail in Section 3.1.5 (Water Quality) and Section 3.1.6 (Environmental Contaminants and Ecological Processes) of this EIS. The presence of an oil slick at the sea surface would likely lead to decreases in the magnitude of wind-driven waves in the affected area. Effects on waves resulting from a VLOS would be low intensity, local, and temporary. Such effects would decrease concurrently with clean-up or partitioning of the oil into environmental compartments other than the sea surface. Due to limited water depths on the Chukchi Sea shelf, most fractions of the released oil would float to the surface, and effects on the physical character of pelagic and epibenthic zones would be expected to be minor during this phase of the VLOS. However, effects of an oil slick on the viscosity of the sea surface would be high-intensity and regional. The sea surface could be considered an important physical resource within the EIS project area because of its critical role in myriad chemical, physical, and biological processes. Due to the viscosity and stickiness of spilled oil, the overall effects of offshore oil on the physical character of the ocean would be major. In addition, an oil slick would effectively decrease the freezing point of the affected seawater and may have impacts on the formation of sea ice in affected areas.

Phase 3 (Onshore Contact)

Spilled oil could adhere to the shoreline and affect the composition of beach substrates by creating oil and sediment conglomerates.

Phase 4 (Spill Response and Cleanup)

Spill cleanup operations could have adverse impacts on the physical character of the ocean and shoreline. Minor impacts due to differential shoreline erosion would be possible if the removal of contaminated substrates affects beach stability.

In situ burning of oil would result in high-intensity effects on sea surface temperature, but these effects would be temporary and spatially limited to the area of *in situ* burning operations. The use of dispersants would effectively move the impacts associated with spilled oil from the sea surface into the water column. Dispersed oil in the pelagic environment would affect the density and viscosity of the water, but these effects would be low-intensity and would decrease as the dispersed oil is weathered, diluted, and degraded.

Phase 5 (Long-term Recovery)

Long-term direct effects on the physical character of the ocean would be negligible. Oil is a mixture comprised mostly of volatile and hydrophobic compounds. As a result of its volatility and hydrophobicity, oil has a strong tendency to associate with non-aqueous phase materials. Oil associated with solid phase particles may remain on beaches and in sediments on the sea floor for extended periods of time, but the long-term effects of weathered oil in the environment are expected to be related to the chemical properties and potential toxicity of certain hydrocarbon compounds.

4.10.6.1.3 Conclusion

The overall effects of the VLOS on the physical character of the ocean would initially be high-intensity due to the viscosity and stickiness of oil floating at the sea surface. The duration of these impacts would be limited by the properties of oil that cause it to associate with non-aqueous phase materials. If *in situ* burning is used as a response technique, high-intensity short term impacts would occur to the physical character of the sea surface. Formation of oil-sediment conglomerates on beaches could result in long-term low-intensity impacts to the physical environment. However, the overall effects of the VLOS on the physical character of the ocean in the EIS project area would be high-intensity, temporary, and would affect an area of hundreds of square kilometers. Such effects are classified as moderate due to their high-intensity and temporary duration.

4.10.6.2 Climate

4.10.6.2.1 Existing Analysis (BOEM 2015b and BOEM 2012)

Discussions on GHG emissions from BOEM (2015b, 2012) can be found in Section 4.10.6.4 (Air Quality) of this EIS.

4.10.6.2.2 Additional Analysis for Climate

A VLOS within the U.S. Chukchi Sea has the potential to impact climate change, especially during Phases 1 (Initial Event) and 4 (Spill Response and Cleanup) of the oil spill scenario.

During Phase I of a VLOS, the fire associated with the initial explosion of gas and oil would emit CO_2 and black carbon (BC). CO_2 is a GHG, and its emissions have been linked to climate change. BC, which could result from soot particles as a consequence of the initial fire, could have a warming effect which could lead to accelerated melting of sea and land ice and snow, also called radiative forcing. This is due to reflective ice and snow being covered by the blackness of black carbon, which has a greater ability to absorb heat rather than reflect it (BOEM 2015b). During Phase 4, impacts to climate change would be associated with in-situ burning and emissions from cleanup response equipment. In-situ burning would result in a plume of black smoke containing air pollutants including CO_2. The use of offshore vessels, aircraft, and surface vehicles used for removal of spilled oil and support of oil removal operations could result in thousands of tons of air pollutants including the GHG, CO_2 (BOEM 2015b).

During Phase 5, support vessels may be required to assist in a long-term recovery effort which would emit CO_2. Emissions from this phase are expected to be lower than those resulting from Phases 1 and 4 (BOEM 2015b).

The magnitude of impacts is a function of the mass of GHGs and amount of reflective surface covered by heat absorbing black carbon. Although these values are not specifically quantified, it is surmised that the magnitude would be largest in Phase 4 for GHG emission and Phase 1 for radiative forcing. The magnitude of effects associated with radiative forcing would also depend on the amount of daylight and amount of ice and snow present that could be covered by black carbon. Since CO_2 emissions and black carbon deposition resulting from a VLOS would occur in a relatively short timeframe, the magnitude of effects is expected to be less than those associated with the actual oil exploration activities (see Section 4.5.1.2).

The duration of actual activities leading to climate change impacts (deposition of BC and CO_2 emissions) would be short-term or temporary, however, as mentioned in Section 4.5.1.2, GHGs could remain in the atmosphere for decades up to centuries, and their effects are considered long-term.

Extent of impacts to climate change would be the same as those identified for the actual oil exploration activities (Section 4.5.1.2), and therefore would be considered at a minimum state-wide, but could extend beyond state boundaries.

The context of the impacts associated with climate change would be the same as those identified for the actual oil and gas exploration activities (Section 4.5.1.2), and are considered to be unique.

As mentioned in Section 4.5.1.2 of this EIS, any activity emitting GHGs would be expected to contribute to an increase in global warming which, in turn, is believed to contribute to climate change. Direct impacts of a VLOS are assumed to be minor, due to their low magnitude and low contribution to GHG emissions on a state level. Indirect effects are considered minor to moderate, since the outcome of activities associated with a VLOS could lead to a greater continued increase in GHG emissions which is not in alignment with the goal to reduce GHG sources and emissions in an effort to minimize impacts to global climate change.

4.10.6.3 Air Quality

4.10.6.3.1 Existing Analysis (BOEM 2015b and BOEM 2012)

BOEM (2015b) describes potential impacts to air quality during the five phases of a possible VLOS within the U.S. Chukchi Sea Planning Area. This information is incorporated herein by reference, and a summary of that information is provided here.

A VLOS could emit large amounts of regulated potentially harmful pollutants into the atmosphere. This will cause major air quality impacts during some phases of the event. The greatest impacts to air quality conditions would occur during Phase 1 and Phase 4, particularly if the spill occurs in the winter. Impacts continue for days during Phase 1 but could continue for months under Phase 4. Therefore, while the impacts are estimated to be major during these two phases, the emissions from the VLOS would be temporary and over time, air quality in the Arctic would return to pre-oil-spill conditions.

Likewise, the BOEM (2012) analysis provides an analysis of the impacts of a catastrophic discharge event on air quality in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that evaporation of oil from a catastrophic discharge event, and emissions from spill response and cleanup activities including in situ burning, if used, have the potential to affect air quality in Arctic Alaska. The greatest impacts on air quality would occur during the initial explosion of gas and oil and during spill response and clean up, particularly if the event occurs during the winter. Impacts could continue for days during the initial event and could continue for months during spill response and clean up. Therefore, while the impacts may be large during these two phases, overall, the emissions from a catastrophic discharge event would be temporary and, over time, air quality in Arctic Alaska would return to pre-oil spill conditions (BOEM 2015b, 2012).

4.10.6.3.2 Additional Analysis for Air Quality

The magnitude of pollutant emissions and resultant impact levels are the two basic measurements for assessing the level of effects of a project on air quality. The potential magnitude for pollutant emissions is greatest during both Phase 1 of the spill scenario (initial explosion emissions of PM and combustion products) and Phase 4 of the spill scenario (spill response and cleanup using large amounts of fuel burning equipment). Both of these phases have the potential for large amount of emissions which could have a major effect on air quality, at least during the event and in the vicinity of the emissions.

The duration of air pollution impacts is dependent on several factors, including duration of the emissions from the source, meteorological conditions (wind), and chemical transformations for specific pollutants. In general, there are no long-term, recurring effects from short-term releases, such as those associated with any of the potential VLOS phases. The expected short-term or temporary period of emissions from any of the phases indicates that the overall effects on air quality would also only be temporary and therefore considered minimal to moderate, even for phases with larger magnitudes of emissions.

The extent of air pollution impacts is dependent on several factors, including source location, duration of the emissions, and meteorological conditions. Increases in levels of air pollutants at different distances are attributed to the type of emissions, which are covered by the magnitude indicator. Typically, as a potential VLOS evolves, direct emissions from the spill itself are rapidly dissipated. The extent of emissions from Phase 4 activities may be more spread out, however the effects of this on overall air quality are expected to be only minimal to moderate as there would not be large concentrations of equipment emissions over the full extent of a potential spill.

As discussed in Section 3.1.3.2, there are no Class I air quality designations in or around the EIS project area. The potential for VLOS-related air quality effects at unique or sensitive locations would be attributed to Phase 4 activities, where equipment may be staged. Staging activities would include equipment transport and is expected to have low emissions and only a short-term occurrence. Therefore, the context of air quality effects is common.

4.10.6.3.3 Conclusion

Impacts to air quality resultant from a VLOS could be of minimal to moderate extent and duration, due to the short-term or temporary time frame when emissions would be strongest associated with the spill. There are no Class I air quality designations in or around the EIS project area, and overall effects on air quality would be temporary. Therefore, according to the criteria laid out in Section 4.1.3, the summary impact level would be minor.

4.10.6.4 Acoustics

4.10.6.4.1 Existing Analysis (BOEM 2012)

The BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on the acoustic environment in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis concludes that the pressure wave and noise generated from an incident involving a loss of well control would affect marine mammals and could be large enough to harass or disturb them if they were close enough to the site of the event. In addition, accident response and support activities, including support aircraft and vessel activity, have the potential to cause noise impacts. These impacts would occur both at the site of the response activity and along the routes of support vessels and aircraft. The duration and magnitude of the impacts would depend on the volume, location, duration, and weather conditions during the catastrophic discharge event, and the response and cleanup activities (BOEM 2012).

4.10.6.4.2 Additional Analysis for Acoustics

In the event of a VLOS, the acoustic environment could be changed by noise generating sources associated with the initial well control incident and with the subsequent cleanup effort.

Impact producing factors associated with the initial well control incident such as explosion and fire would have minor effects on the acoustic environment within the EIS project area. Although quantitative estimation of the sound pressure levels (SPLs) associated with an explosion is difficult, initial effects on the acoustic environment could be high-intensity. However, these effects would be restricted to areas in the immediate vicinity of the well control incident, and would be extremely temporary. Due to the limited geographic extent and temporary nature of the impacts, overall effects of the initial well control incident on the acoustic environment would be considered minor.

Increases in aircraft and vessel traffic associated with oil spill cleanup activities would result in impacts to the acoustic environment similar to those described in Section 4.5.1.4 of this EIS under ‘Acoustic Footprints of Non-Airgun Sources.’ Aircraft are used extensively during oil spill response to map and track real-time oil spill extent, to coordinate spill clean-up operations, to track marine wildlife affected by oil, and for deployment of dispersants. Fixed wing aircraft would typically be used for many of the more-offshore operations due to their extended flight capabilities. Helicopters would be used for near-shore operations and for personnel transport from shore to-and-from offshore vessels both near-shore and further offshore. Aircraft sounds are dominated by tonal harmonics of engine/turbine and blade rates and are largely within the frequency range of cetacean hearing. Due to limited sound transmissibility from air to water, except at steep incidence angles, aircraft underwater noise levels are low relative to vessel noise outside limited areas beneath the aircraft. The level of aircraft noise reaching the sea surface and transmitting into the water depends on the aircraft flight altitude and flight speed, with higher received levels at low flight altitudes and increased flight speed. Because aircraft travel at high speeds, the duration of aircraft noise events is typically just a few tens of seconds (Patenaude et al. 2002). However, aircraft involved in oil spill response duties may circle or remain in limited areas and thereby produce more prolonged noise than would straight-line flight paths.

Oil spill response would involve multiple vessels, including vessels for deploying booms, floating storage vessels, DP platforms for wellsite mechanical repair, observation vessels, drillships, tugs personnel transfer vessels and icebreakers. A response operation in the Chukchi or Beaufort seas could be limited to pre-purposed vessels due to the large amount of time required for other vessels to transit into the arctic. Section 4.5.1.4 provides information on the noise footprints of several vessel types. Standard support vessels could produce 120 dB re 1 µPa sound levels to distances near 1.6 km (1 mi) (see Table 4.5-11). Vessels or drillships on DP would produce higher noise emissions and would consequently have larger noise footprints with 120 dB re 1 µPa zones extending up to 10 km (6.2 mi) from the vessel. Ice breaking vessels would also produce high levels of sound due mainly to the very high thrust required to drive the vessel onto ice being broken. Icebreaker sound levels may be similar to or greater than large vessels on DP. Cosens and Dueck (1993) measured sound levels of three icebreakers during icebreaking activity. The measurements at 0.4 and 0.5 km range showed peak spectral levels near 110 dB re 1 $\mu Pa^2/Hz$ between 25 and 50 Hz. The broadband sound levels were not provided.

Impacts on the acoustic environment associated with spill response and cleanup would be medium-intensity, temporary, and regional. Due to the intensity, duration, and geographic extent associated with these impacts, the overall effects of spill response and cleanup on the acoustic environment would be considered moderate. In addition, impact producing factors associated with a VLOS could include the drilling of a relief well, which would result in effects on the acoustic environment similar to those described in Section 4.5.1.4 of this EIS.

4.10.6.5 Water Quality

4.10.6.5.1 Existing Analysis (BOEM 2015b and BOEM 2012)

BOEM (2015b) describes potential impacts to water quality resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

A VLOS and gas release would present sustained degradation of water quality from hydrocarbon contamination in exceedence of state and federal water and sediment quality criteria. These effects would be substantial. Additional effects on water quality would occur from response and cleanup vessels, in-situ burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with clean-up, booming, beach cleaning, and monitoring.

Likewise, the BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on water quality in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event in either coastal or marine waters could present sustained degradation of water quality from hydrocarbon contamination in exceedence of state and federal water and sediment quality criteria, and that these effects could be substantial depending upon the duration and area impacted by the spill. Additional effects on water quality could occur from response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring (BOEM 2012).

4.10.6.5.2 Additional Analysis for Water Quality

The effects of a 2.2 MMbbl oil spill on water quality in the Chukchi Sea would include sustained exceedences of state and federal water quality criteria due to the introduction of large quantities of petroleum hydrocarbons and associated compounds to the environment. The magnitude of the effects of a VLOS on water quality in the Chukchi Sea could be high. The duration of such effects could be long-term, and the geographic extent of the effects could be either regional or state-wide depending on the specific launch area, meteorological conditions at the time of the spill, and effectiveness of the response effort. Chemical response techniques, such as the use of dispersants, could result in additional degradation of water quality, which may or may not offset the benefits of dispersant use. Although water is generally considered a common resource, a VLOS could impact water quality in sensitive areas that are protected by legislation. Overall, a VLOS could have major effects on water quality in the Chukchi Sea.

4.10.6.6 Environmental Contaminants and Ecosystem Functions

4.10.6.6.1 Existing Analysis (BOEM 2015b, 2012)

The BOEM (2012) analysis provides some information about the impacts of a catastrophic discharge event on ecosystem functions in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis states that sensitive benthic habitats could suffer long-term loss of ecological function because of both hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at lethal and sublethal concentrations in sediments for decades, and sensitive habitats (i.e., kelp beds, intertidal zones; live-bottom and coral reef) damaged by a spill would likely recover slowly and possibly not recover at all. However, hydrocarbons would be broken down by natural processes, and most benthic habitats are likely to eventually recover. Pelagic habitats would eventually recover their habitat value as hydrocarbons broke down and were diluted. Recovery time would vary with local conditions and the degree of oiling. Overall, impacts on habitats from hydrocarbon spills in open water could range from negligible to moderate, and impacts could be short term to long-term; no permanent degradation of pelagic habitat would be expected (BOEM 2012).

4.10.6.6.2 Additional Analysis for Environmental Contaminants and Ecosystem Functions

For the purposes of this section, ecosystem functions refer to the capacity of natural components and processes to provide goods and services that satisfy human needs directly or indirectly (DeGroot et al. 2002).

This section uses a typology for four classes of ecosystem functions proposed by DeGroot et al. (2002) to describe potential impacts that could occur to ecosystem functions as a result of a 2.2 million barrel oil spill in the Chukchi Sea. These classes include: regulation functions; habitat functions; production functions; and information functions.

Phase 1 (Initial Event)

Regulation Functions

Impact producing factors resulting from the initial well control incident such as fire and explosion would have local effects on the ability of natural systems to maintain essential ecological processes. Inputs of heat and petroleum hydrocarbons would inhibit the use of water and nutrients by some organisms. The dampening capacity of the ecosystem in response to perturbation (i.e., resilience) would be overwhelmed in the immediate vicinity of the event. Trophic interactions would be disrupted, and the role of biota in the storage and cycling of nutrients would be perturbed in the vicinity of the event.

Release of large quantities of ethane, propane, and other hydrocarbon gasses into the water column would result in increased levels of respiration in microbial communities (Valentine et al. 2010). In response to perturbation, the respiration to biomass ratio (R/B) would increase, and production to respiration ratios (P/R) would decrease (Odum 1985). Efficiency of trophic transfers would decrease as a result of the initial well control incident. Valentine et al. (2010) reported oxygen depletion in plumes of oil and gas subsequent to the Deepwater Horizon oil spill caused by increased microbial respiration driven by hydrocarbon gasses. Propane and ethane were the primary drivers of microbial respiration in the plumes, resulting in local depletion of dissolved oxygen in the water. Low-diversity bacterial blooms resulted from biodegradation of some hydrocarbon fractions. Decreased diversity of microbial communities and reduced energy flow at higher trophic levels could be expected to occur in response to the initial well control incident (Valentine et al. 2010, Odum 1985).

Habitat Functions

Effects of the initial well control incident on habitat functions would be local and high intensity. Spawning and refuge habitat functions would be affected for most communities in the immediate vicinity of the well control incident. The effects could be adverse with regard to habitat functions for most multi-celled organisms. However, the initial well control incident may have positive effects on habitat functions for bacteria with the ability to metabolize short-chain hydrocarbons (Valentine et al. 2010).

Production Functions

The initial well control incident would have both beneficial and adverse effects on production functions related to conversion of energy and nutrients into biomass. Levels of photosynthesis would likely decrease in the immediate vicinity of the event due to releases of heat and hydrocarbon compounds into the environment. In contrast, respiration would likely increase at the microbial level as a result of increased temperatures and bioavailability of carbon in the vicinity of the well control incident. Subsequent to the Deepwater Horizon oil spill, Hazen et al. (2010) reported enrichment of communities of hydrocarbon degrading bacteria in the vicinity of the oil spill. Metabolism of hydrocarbons would signify increased respiration in response to perturbation, and some measureable increases in biomass would likely occur in the vicinity of a VLOS in the Chukchi Sea. However, it is unlikely that the energy from hydrocarbons incorporated into lower trophic level organisms would be available for utilization by primary and secondary consumers due to toxic effects of petroleum hydrocarbon compounds at higher trophic levels (Peterson et al. 2003). Thus, the length of the food chain (or complexity of the food web) would decrease in response to inputs of oil and gas. Although some hydrocarbon compounds would be utilized as nutrients at lower trophic levels, flows of energy and nutrients would decrease at higher trophic levels in response to physical and chemical stress on primary and secondary consumers.

Information Functions

The effects of the initial well-control incident on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in this EIS (see Sections 4.5.3.2 for Subsistence and 4.5.3.3 for Public Health).

Phase 2 (Offshore Oil)

Regulation Functions

Efficiency of trophic transfers would be impacted across regional scales. Hundreds of square kilometers of ocean area would be affected. Changes in the microbial community structure would occur in the oiled area. While populations of some bacteria would increase in response to the presence of offshore oil, transfer of nutrients and biomass to higher trophic levels would be impeded as a result of stress and physical effects on primary and secondary consumers. Species diversity would decrease in the affected area, resulting in decreases in food web complexity (Odum 1985).

It is likely that gas regulation functions (CO_2/O_2 balance) and climate regulation functions would be impacted (Kessler et al. 2011). Oxygen depletion was observed in large areas of the Gulf of Mexico as a result of metabolism of hydrocarbons released during the Deepwater Horizon oil spill (Valentine et al. 2010, Kessler et al. 2011). Although the impacts of this oxygen depletion are not likely to be measureable in the atmosphere, oxygen depletion would be likely to affect marine ecosystems in the Chukchi Sea. In addition, perturbation of the Chukchi Sea ecosystem could inhibit the growth of phytoplankton that produce dimethyl sulfide and other climate regulating gasses. Functions related to maintenance of water quality and assimilation of wastes would be adversely affected as a result of offshore oil and gasses released during a VLOS.

Habitat Functions

The effects of offshore oil on habitat functions would be high-intensity and regional in scale. Spawning and refuge habitats would be affected for most communities in the vicinity of the well control incident.

Production Functions

Offshore oil would have adverse effects on production functions in the Chukchi Sea. Photosynthesis would be limited by both a decrease in availability of light, as well as by chemical inhibition, both of which would result from exposure of primary producers to large quantities of petroleum hydrocarbons. Low concentrations of petroleum hydrocarbons could have a stimulatory effect on photosynthesis in some species of marine algae; however, photosynthesis would be inhibited at higher concentrations (Chan and Chiu 1985).

The effects of offshore oil on production functions associated with subsistence and cultural resources are discussed in other sections of this EIS.

Information Functions

The effects of offshore oil on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this EIS.

Phase 3 (Onshore Contact)

Regulation Functions

For planning purposes, the USCG estimates that 5 to 30 percent of the spilled oil (110,000 to 660,000 bbl) would reach the shore in the event of an offshore VLOS (BOEM 2015b). Coastlines, and especially coastal wetlands, are important areas for regulation functions, such as nutrient cycling, water regulation, and soil retention, and these areas generally support higher levels of biodiversity and species richness relative to either offshore or other onshore areas. Onshore contact of spilled oil would have adverse effects on regulation functions by impacting coastal biological communities and changing the natural patterns of nutrient cycling, water regulation, and soil retention to which biological communities are adapted.

Habitat Functions

Physical and chemical changes to the shoreline environment would impact spawning and refuge habitat functions for all shoreline communities; these impacts are discussed in other sections of this EIS.

Impacts to coastal wetlands, tidal flats, and sheltered beaches would generally be greater than impacts to exposed gravel or cobbled beaches (Gundlach and Hayes 1978), and the relative sensitivities of different shoreline types would be a consideration in establishing response priorities subsequent to a VLOS.

Production Functions

Impact producing factors associated with oil on the shoreline, such as contact with coastal wetlands and vegetation, would have long-term adverse effects on production functions. Marine algae and coastal vegetation respond variably to petroleum hydrocarbons. Presence of oil would likely inhibit the germination and growth of many species; however, in areas with persistent inputs of naturally-occurring hydrocarbons (e.g., natural oil seeps), some species of marine algae develop the ability to acclimate to the presence of otherwise toxic hydrocarbon compounds (Carrera-Martinez et al. 2011). Similarly, robust coastal plants such as Arctic Kelp (*Laminaria solidungula*) would be likely to recover subsequent to clean-up. Some studies show that complete recovery of high-arctic boulder communities in the Beaufort Sea may take a decade or more, especially if entire organisms are removed. However, if removal is partial, recovery can be quicker, particularly in low sediment areas (Konar 2013). Thus, overall levels of photosynthesis and primary production would decrease temporarily but would likely return to pre-VLOS levels within several years after the cessation of clean-up activity. Perturbations to community structure may result in *structural* changes to biological communities in nearshore areas, but functional properties of the system related to primary production and nutrient fixation would likely return to their pre-spill states within several years after cessation of clean-up activities.

Impacts of the VLOS on production functions related to subsistence and cultural resources (Sections 4.10.7.15 and 4.10.7.17, respectively) are discussed in other sections of this document, and those discussions are not duplicated here.

Information Functions

The effects of onshore contact of a VLOS event on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this document.

Phase 4 (Spill Response and Cleanup)

Regulation Functions

Activities associated with spill response and clean-up would have a variety of effects on regulation functions within the Chukchi Sea ecosystem. Effects on nutrient cycles, biological energy flows, and biological control of population cycles would depend heavily on the methods used to respond to spilled oil.

Dispersants would change the location of the impact of the spilled oil from the surface of the water to areas deeper in the water column. Application of dispersants would likely decrease the magnitude of impacts on the sea surface microlayer where gas exchange processes occur, leading to decreased impacts on gas regulation functions in the affected area. Distributing the oil deeper in the water column would also decrease the magnitude of impacts on marine nutrient cycles, which are largely driven by photosynthesis and respiration occurring in the photic zone (sunlit waters generally in the upper 50 m (164 ft.) of the water column). Dispersion of oil out of the photic zone would limit the potential for phototoxic effects, which can occur as a result of sunlight driven photochemical reactions that increase the bioavailability and toxicity of certain petroleum hydrocarbon compounds including some PAHs and their derivatives. However, dispersants themselves would contribute to short term adverse effects on regulation functions by increasing the bioavailability of petroleum hydrocarbons, which could lead to increased respiration rates and oxygen depletion in some marine areas (Hazen et al. 2010). Some surfactants and solvents present in commercially available dispersant formulations would have toxic effects at high concentrations that could occur immediately after the application of the dispersants. Overall, dispersants would likely decrease the magnitude and duration of effects of spilled oil on regulation functions in the Chukchi Sea, although the intensity and spatial distribution of effects would be likely to increase for a short period of time immediately following dispersant application.

The effects of *in situ* burning on regulation functions would be similar to those described for dispersants. *In situ* burning would introduce large quantities of smoke and gasses into the atmosphere, which would result in temporary effects on gas regulation processes. Gasses released as products of the combustion reaction would also influence the climate regulation functions of the atmosphere; such effects are expected to be short-term and would become negligible as the released gasses become diluted in the atmosphere. Incomplete combustion of crude oil on the surface of the water would generate large quantities of toxic products; however, the impacts of the combustion products on regulation functions would be less than those of the greater quantities of unburned oil present prior to *in situ* burning.

Mechanical recovery in the offshore environment would have net positive impacts on regulation functions resulting from the removal of the spilled oil. However, beach cleaning could destabilize biological communities and physical substrates leading to temporary oscillations in the nutrient and energy cycles associated with regulation functions.

Application of fertilizer to enhance biodegradation of spilled oil would temporarily destabilize nutrient cycles in the treated area. By modifying nutrient stoichiometry (expressed as ratios of bioavailable carbon to nitrogen to phosphorus, or C:N:P) in the affected area, application of fertilizer would temporally concentrate assimilation of the oil into the environment. This assimilation of the spilled oil is itself an example of a regulation function. Rapid assimilation and detoxification of the oil resulting from augmented biodegradation processes would increase the intensity of effects on nutrient cycles in the affected area, but would decrease the duration of those effects.

Habitat Functions

Response and clean-up activities could have intense effects on habitat functions in sensitive areas. For example, the use of hot water hydraulic washing to clean oiled shoreline could destabilize physical substrates causing adverse impacts to spawning and refuge habitats for coastal species. Shoreline sensitivity indices would be used to establish oil spill response priorities and to help determine the most appropriate clean-up methods to be used in sensitive areas.

Production Functions

The effects of oil spill clean-up activities on production functions would depend on the particular response techniques used. As discussed above, the use of dispersants could effectively move oil out of the photic zone, thereby decreasing adverse effects on photosynthesis. Dispersants would also increase the bioavailability of the oil to organisms living deeper in the water column, leading to increased respiration in some classes of heterotrophs (Hazen et al. 2010), as well as toxic effects in most pelagic organisms. The use of dispersants would decrease the duration of VLOS impacts on production functions, but would increase the intensity of the effects.

In situ burning would have adverse effects on production functions. Release of heat and combustion products into the water would have adverse effects on primary producers. The duration of these effects would likely be short term. While cascades of indirect effects could lead to structural changes in biological communities over decadal timescales (Peterson et al. 2003), the functional properties of the ecosystem responsible for primary production would be expected to recover within several years after the cessation of cleanup activities.

Information Functions

The effects of spill cleanup operations on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this document.

Phase 5 (Long-term Recovery)

Regulation Functions

Regulation functions related to nutrient cycles, regulation of water and gasses, and waste assimilation would likely recover within several years of the cessation of clean-up activities. With regard to regulation functions at the system level, respiration to biomass ratios would likely return to pre-spill values within several years after the spill, and ratios of production to respiration would approach unity over a similar timescale. Species composition and community structure may change as a result of a VLOS in the Chukchi Sea, but the functions performed by interactions of biological communities with their chemical and physical environment would be more resistant to the stress associated with a VLOS event. Although the structural properties of the ecosystem may experience lasting effects, functional properties of the ecosystem would be expected to recover more rapidly from the effects of the perturbation (Odum 1985).

Recovery of biological control functions related to dynamic trophic interactions would be less certain. Fourteen years after the *Exxon Valdez* oil spill, Peterson et al. (2003) described ongoing impacts to biological control functions resulting from cascades of indirect effects triggered by the oil spill. The magnitude of natural oscillations in predator-prey population cycles would be expected to increase as a result of the VLOS event. For example, Peterson et al. (2003) report that cascades of indirect effects triggered by the *Exxon Valdez* oil spill were responsible for cyclic instability in the population cycles of several species in onshore communities. Although the species and habitats present in the EIS project area are different from those in Prince William Sound, the following account is useful for understanding how cascades of indirect effects may persist for decades following a VLOS event:

> *"Indirect interactions lengthened the recovery process on rocky shorelines for a decade or more. Dramatic initial loss of cover by the most important biogenic habitat provider, the rockweed* ***Fucus gardneri****, triggered a cascade of indirect impacts. Freeing of space on the rocks and the losses of important grazing (limpets and periwinkles) and predatory (whelks) gastropods combined to promote initial blooms of ephemeral green algae in 1989 and 1990 and an opportunistic barnacle,* ***Chthamalus dalli****, in 1991. Absence of structural algal canopy led to declines in associated invertebrates and inhibited recovery of* ***Fucus*** *itself, whose recruits avoid desiccation under the protective cover of the adult plants. Those* ***Fucus*** *plants that subsequently settled on tests of* ***Chthamalus dalli*** *became dislodged during storms because of the structural instability of the attachment of this opportunistic barnacle. After apparent recovery of* ***Fucus****, previously oiled shores exhibited another mass rockweed mortality in 1994, a cyclic instability probably caused by simultaneous senility of a single-aged stand. The importance of indirect interactions in rocky shore communities is well established, and the general sequence of succession on rocky intertidal shores extending over a decade after the Exxon Valdez oil spill closely resembles the dynamics after the Torrey Canyon oil spill in the UK. Expectations of rapid recovery based on short generation times of most intertidal plants and animals are naıve and must be replaced by a generalized concept of how interspecific interactions will lead to a sequence of delayed indirect effects over a decade or longer (Peterson et al. 2003)."*

Similar cascades of indirect effects could be expected to occur in both onshore and offshore communities in response to a VLOS in the Chukchi Sea. While most properties of the Chukchi Sea ecosystem responsible for performance of regulation functions could be expected to recover within several years of a VLOS event, the post-spill ecosystem would be less resilient to the effects of additional perturbations. Increased magnitude of oscillations in the populations of key species would likely destabilize the established system of trophic interactions in the Chukchi Sea ecosystem, putting the system at greater risk for major impacts from any subsequent perturbations.

Habitat Functions

Persistence of oil in sediments may have negative long-term effects on habitat functions within the affected area. Subsequent to the *Exxon Valdez* oil spill in Prince William Sound, Peterson et al. (2003) reported long-term impacts to habitat functions resulting from persistence of 3-5 ring PAHs (e.g., phenanthrene, anthracene, pyrene, triphenylene, and associated derivatives). Lighter non-aromatic hydrocarbon compounds released during a VLOS are more readily degraded in the environment as a result of physical weathering processes and biodegradation. Long-term effects on habitat functions would be limited to areas where oil may become trapped in sediments or other substrate, and shielded from weathering and degradation. Long-term effects on habitat functions would be local and medium intensity, but would have the potential to affect unique resources depending upon the location of the discharge and the efficacy of the response effort.

Changes in the structure of biological communities and food webs could result in long-term changes in habitat usage and resource utilization. Prediction of the direction and magnitude of such changes is problematic; however it is likely that small, short-lived organisms would begin to utilize habitat and resources that were previously used by larger, longer-lived organisms (Odum 1985).

Production Functions

Levels of primary production in the Chukchi Sea would be expected to return to pre-spill levels within several years of the cessation of clean-up activities associated with a VLOS event. However, lasting impacts on production functions at the system level would be related to human utilization of natural resources in the area. Long-term effects of a VLOS event on subsistence, cultural resources, and human health are discussed in other sections of this document.

Information Functions

The long-term effects of a VLOS event on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this document.

4.10.6.6.3 Conclusion

Effects of a VLOS on ecosystem functions in the Chukchi Sea would be high intensity, long-term, regional, and could affect unique resources. Overall, the effects of a VLOS on ecosystem functions in the Chukchi Sea would be considered major. However, with few exceptions, the ecosystem functions in the VLOS area would likely recover within several years of the cessation of clean-up activities. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e., resistant to stressors) than are species composition and other structural properties. As suggested by Peterson et al. (2003), a VLOS event would be likely to affect ecosystem structure over timescales of decades; ecosystem functions, from which humans derive value, would be likely to recover more quickly.

4.10.6.7 Lower Trophic Levels

4.10.6.7.1 Existing Analysis (BOEM 2015b and BOEM 2012)

Section 4.5.4 of BOEM (2015b) describes potential impacts to lower trophic level resources during the five phases of a possible VLOS in the Chukchi Sea. In addition, BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on invertebrates and lower trophic levels in the Chukchi Sea. This information from these two documents is incorporated herein by reference, and a summary of that information is provided below.

A VLOS would likely have less than a one year effect on phytoplankton populations in the Chukchi Sea due to the influx of phytoplankton carried into the Chukchi Sea by the waters of the Gulf of Anadyr, the Bering Sea, and the Alaska Coastal currents that would supplement remaining endemic populations. However, short-term, local-level effects would have greater potential to affect local food webs. Severity of effects would be determined by duration of oil spill, weather patterns, and the resultant distribution and geographic coverage of surface oil slicks. Ice algae population effects would be determined by similar factors, as the presence of oil within polynyas and reaches, and if incorporated into first year ice would likely have at least a one-year effect on local populations due to effects on primary productivity and the probable inability of epontic communities reliant on ice algae to survive within oil-influenced ice.

Invertebrate populations within benthic, pelagic, and onshore environments are at greater risks from a VLOS due to their slower reproductive rate, longer life spans, and the potential of adult breeding populations being negatively affected by the VLOS and leading to a longer recovery rate. If population level effects resulting from a VLOS occur in breeding stocks of invertebrates of these Chukchi Sea environments, the recovery potential of populations would not be enhanced by the flow of Bering Sea and Anadyr waters as it is with phytoplankton populations. Phytoplankton and zooplankton populations extirpated by oil slicks that are constantly shifting and forming in new areas due to influences of wind, weather, and waves, would not be available to organisms that depend on them for food and survival. Food webs can be very short in the Arctic, with interactions between megafauna (i.e., whales, seals, walruses) and lower trophic organisms often comprising one or two trophic levels due to the tight benthic and pelagic coupling on the shallow continental shelf off the Alaskan Arctic coast (Dunton et al. 2005; Grebmeier et al. 2006a). Bioaccumulation and biomagnification in these foodwebs is a concern. Long lived copepods (such as *Calanus glacialis*) may live two to three years, store lipids in the body cavity, undergo diapause (a form of hibernation), and be consumed by upper level predators (APacificA cod, bowhead whales, etc.) at a later date (MMS 2004). Toxicity studies carried out with benthic crabs and shrimp indicate they may not immediately die from toxins (living 24-96 hours, depending on exposure and oil type), thus allowing greater opportunities for consumption by upper-level predators and biomagnification to occur (Brodersen 1987). Phytoplankton themselves may not die immediately from the effects of exposure to oil; therefore, advective drift following bioaccumulation in their populations may allow them to be consumed by other organisms in locations away from contamination sites (Jiang et al. 2010). Recovery rates of one or more years may result from these effects on invertebrate populations.

4.10.6.7.2 Additional Analysis for Lower Trophic Levels

As outlined in BOEM (2015b), a VLOS of approximately 2.2 MMbbl has the potential to adversely impact lower trophic levels. The scale of these impacts could vary greatly, depending on when, where, and how much oil would directly affect the given areas. The Oil Spill Trajectory Analysis described in BOEM (2015b, Appendix A.) provides an outline of various theoretical events, with detailed geographic summaries. The important conclusion is that oil has the potential to reach the entire EIS project area under certain conditions. Therefore, all lower trophic levels within the Chukchi Sea are vulnerable to long-term impacts. The most likely impacts include:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Impact to food web and resultant bioaccumulation and biomagnification as a result of the close interactions between megafauna (i.e., whales, seals, walruses) and lower trophic organisms (Dunton et al. 2005; Grebmeier et al. 2006) (see Section 4.10.6.11 for more information regarding the effects of bioaccumulation and biomagnification on marine mammals);
- Longer recovery rates due to species traveling outside the original contamination site or being consumed later, thereby prolonging the recovery, as a result of drift or diapause, respectively. This would delay recovery since these species surviving the initial incident would store toxins and be consumed at a later date by higher trophic level organisms (MMS 2004; Jiang et al. 2010; Brodersen 1987); and
- Habitat loss due to oiling of ice or benthic substrate and the resultant mortality events or decrease in primary productivity.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Duration and volume of the spill;
- Distribution and geographic coverage of surface oil slicks;
- Persistence and dispersion of oil in the water column (epontic, pelagic, or benthic);
- Chemical composition of the oil;
- Efficacy of chemical dispersants;
- Incorporation of spill into first year ice; and

- Weather patterns, including hours of daylight and UV intensity, and presence or absence of ice, presence or absence of polynyas and reaches.

Depending upon the factors discussed above, the VLOS could have a summary impact level of major, should the spill persist in the environment or affect unique resources. However, should the spill not persist or affect unique resources, the impacts to the lower trophic levels would be of low to medium magnitude, temporary, local to regional geographic extent, and common context, with the exception of the time/area closures mentioned above. In this case, the impact criteria listed in Table 4.5-16 would lead to a summary impact level of moderate due to the shorter duration and regional impacts to common resources.

4.10.6.8 Fish and Essential Fish Habitat

4.10.6.8.1 Existing Analysis (BOEM 2015b and BOEM 2012)

Fish

Section 4.5.5 of BOEM (2015b) describes potential impacts to fish and fish resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

The level of effects of a very large oil spill in the Chukchi Sea on a fish species and its population would depend on many factors including:

- life stage affected (egg, larvae, juvenile, adult);
- species distribution and abundance (widespread, rare);
- habitat dependence (ocean water column, sea surface, benthos, sea ice, estuarine, freshwater);
- life history (anadromous, migratory, reproductive behaviors and cycle, longevity, etc.);
- extent and location of spawning areas in the estuarine or riverine systems;
- species exposure and sensitivity to oil and gas (toxicology, swimming ability);
- effect on prey species; and
- location of the oil spill (nearshore, further offshore), depth at which the hydrocarbon release occurs (seafloor, mid-column, or surface), ratio of the mixture of oil and gas released, and time of year the oil spill occurs.

Considering all these factors, some species or life stages of a species could be substantially affected (defined here as greater than three generations to return) at a population level.

The species that would be particularly vulnerable to effects at individual and population levels include: pink and chum salmon, saffron cod, Arctic cod, Pacific sand lance, capelin, nearshore sculpin species, nearshore flounders and plaice, migratory least cisco, migratory Dolly Varden, migratory Arctic char, rainbow smelt, stickleback species, and migratory whitefish. Other fish species that would be affected by a VLOS include: Pacific herring; coho, sockeye, and king salmon; snailfish species; eelblenny species; eelpout species; poacher species; offshore sculpin species; Arctic lamprey; and alligatorfish species.

In addition, BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on fish in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have population-level consequences on some fish populations if vital habitat areas were affected or if the spill occurred in spawning areas or juvenile feeding grounds when fish populations are highly concentrated. In such cases, catastrophic spills could cause substantial reductions in population levels for one or more years.

Essential Fish Habitat

Section 4.5.5 of BOEM (b2015b) describes potential impacts to EFH during the five phases of a possible VLOS in the Chukchi Sea. Likewise, Section 4.5.115 of BOEM (2015b) describes potential impacts to subsistence resources. This information is incorporated herein by reference, and a summary of that information is provided here.

The level of effects of a very large oil spill in the Chukchi Sea on EFH would depend on several factors including:

- location of the oil spill (nearshore, further offshore); depth at which the release occurs (seafloor, mid-column, or surface), ratio of the mixture of oil and gas released, and time of year oil spill occurs;
- extent and location of spawning areas in the estuarine or riverine systems;
- species abundance and distribution (widespread, rare);
- the species and the sensitivity of their life stage affected (egg, larvae, juvenile, adult); and
- life history and reproductive cycle.

Considering these factors, EFH of some species' life stages could be substantially impacted by a VLOS.

Likewise, BOEM (2012) analysis provides an analysis of the impacts of a catastrophic discharge event on EFH in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could cause long-term declines of fish species that rely on shallow coastal, intertidal, and freshwater areas. Spills occurring under ice could result in long-term degradation of EFH because of the cleanup difficulties; severity of effects of hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH (BOEM 2012).

4.10.6.8.2 Additional Analysis for Fish and Essential Fish Habitat

As outlined in the discussion, 2011ba VLOS of approximately 2.2 MMbbl has the potential to impact fish and fish resources. The scale of these impacts could vary greatly, which is primarily determined by the location of the spill. The Oil Spill Trajectory Analysis described by BOEM (2015b, Appendix A) provides an outline of various theoretical events with detailed geographic summaries. The important conclusion from this exercise is that oil has the potential to reach the entire EIS project area under certain conditions. long–term. The most likely impacts include:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Reduction of individual fitness and survival due to physiological contaminant effects. These effects can, in turn, affect swimming, feeding, reproductive and migratory behaviors and the physiologic adjustment for anadromous fish as they move between freshwater and saltwater environments; and
- Onshore and offshore habitat loss due to oiling, resulting in displacement and stress. Displacement could result in blocked or impeded access to spawning, rearing, feeding, and migratory habitats important for survival.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Location and time of year of the oil spill;

- Life stage affected (egg, larvae, juvenile, adult) and life history (anadromous, migratory, reproductive behaviors and cycle, longevity);
- Species distribution and abundance;
- Species exposure and sensitivity to oil and gas (toxicology, swimming ability); and
- Habitat dependence (marine vs. freshwater, onshore vs. offshore, location of spawning habitat, depth).

Based on the five oil spill phases described in BOEM (2011b2015b), the greatest impacts could be felt during Phases 2 and 3, particularly in benthic and nearshore regions. The fish typically found in these areas are more susceptible to impacts from a VLOS due to their increased dependence on relatively limited habitat when compared to pelagic fish, or decreased swimming ability resulting in an inability to escape impacted areas. Most impacts to habitat could be short-term in duration, with shoreline and substrate impacts lasting longer. The fish assemblages with an increased susceptibility include:

- Migratory and juvenile fish that use nearshore habitat, shallow lagoons, estuaries, and bays;
- Benthic fish, which are typically poor swimmers; and
- Cryopelagic species such as Arctic cod, should the spill occur in winter or get entrained in seasonal pack ice.

Most fish and EFH within the EIS project area are common or important resources. The impacts from a VLOS could be of high intensity, long-term duration, and occur over a broad, regional extent. Therefore, according to the criteria laid out in Table 4.5-16, the summary impact level could be major.

4.10.6.9 Marine and Coastal Birds

<u>4.10.6.9.1 Existing Analysis (BOEM 2015b2015b and BOEM 2012)</u>

Section 4.5.6 of BOEM (2015b) describes potential impacts to marine and coastal bird resources during the five phases of a possible VLOS in the Chukchi Sea. In addition, BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on birds in Arctic Alaska. The information from these two analyses is incorporated herein by reference, and a summary of that information is provided here.

A VLOS has the greatest potential for affecting large numbers of birds in part due to its toxicity to individuals and their prey and the amount of time these birds spend on the surface of marine and coastal waters. Under a hypothetical VLOS scenario, marine and coastal birds in key areas or at key times could experience a variety of negative effects from petroleum exposure and habitat loss. Key areas evaluated included:

- Kasegaluk Lagoon;
- Ledyard Bay;
- Peard Bay;
- barrier islands;
- the spring open-water lead systems;
- Cape Lisburne; and
- Cape Thompson.

All of the areas above provide important nesting, molting, or migration habitat to a variety of seabirds, waterfowl, and shorebirds. The Ledyard Bay Critical Habitat Unit is especially important to spectacled eiders that molt there in dense flocks from July to November.

A VLOS during periods of peak use could affect large numbers of marine and coastal birds, including loons, seabirds, and waterfowl, including listed eiders. As a typical example, up to 45 percent of the estimated Pacific Flyway population of Pacific brant could be affected, if an oil spill reaches Kasegaluk Lagoon. Effects could range from direct mortality of approximately 60,000 brant to sublethal effects on an equal or smaller number of brant. The loss of up to 45 percent of the Pacific Flyway population would have conspicuous population-level effects.

A hypothetical VLOS could impact large numbers of murres, puffins, and kittiwakes at the Cape Lisburne and Cape Thompson colonies. The magnitude of potential mortality could result in substantial adverse impacts to the colonies. Large-scale mortality could occur to migrating or molting concentrations of marine and coastal birds, including adult male and juvenile murres in the late summer molting area. Mortality from a hypothetical VLOS could result in population-level effects for most marine and coastal bird species that would take more than three generations to recover.

Large-scale mortality could occur with respect to pelagic distributions of auklets and shearwaters during the open-water period.

4.10.6.9.2 Additional Analysis for Marine and Coastal Birds

Direct and indirect exposure to oil is an impact producing factor that can adversely affect marine and coastal birds. The level of impact is dependent upon the timing of the VLOS, the seasonal effects of currents and subsequent advection of oil, timing and duration of the oil spill, presence or absence of fast or pack ice, location (within important habitat areas or outside), and general weather patterns (wind and storm events). If a VLOS occurs in important habitat areas, the magnitude of impacts to marine and coastal birds could be medium to high, with displacement from the area, impacts to prey resources and habitat quality, and a likelihood of injury or mortality from either direct contact with or ingestion of oil and associated contaminants. The duration of the impacts could be long-term because habitat areas could be abandoned or large portions of the population could be affected. The geographic extent could occur state-wide due to migrating, molting, and breeding bird populations. If the VLOS were to occur outside important habitat areas, the effects could be the same except the duration could be interim rather than long-term. The chance of recovery could be greater due to less birds likely being affected, compared to a higher concentration of birds that could be found in many important habitat areas at certain periods of time.

Population level effects are likely, given the high concentration of migrating, molting, and breeding bird populations. The impacts from a VLOS could be of high intensity, long-term duration, and occur over a broad, regional extent. Therefore, a VLOS in the Chukchi Sea during the lifetime of this EIS could result in a major impact to marine and coastal birds. This is due to the potential adverse effects to population levels, habitat, molting and breeding areas, important habitat areas, toxicity to prey and individuals, and mortality of individuals.

Ledyard Bay Critical Habitat Area

The Ledyard Bay Critical Habitat Unit (LBCHU) was designated as a critical habitat for ESA-listed spectacled eiders in 2001 due to its importance for the persistence and recovery of spectacled eiders, its marine aquatic flora and fauna in the water column, and its abundant benthic community. The oil spill analysis from BOEM (2015b) reported the following model results for impacts to Ledyard Bay:

> ***Summer within 60 and 360 Days:*** *The OSRA model estimates that 38 percent and 22 percent of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could*

contact spectacled eiders molting in the LBCHU (ERA 10) during the summer within the 60 and 360 day periods.

Winter within 360 Days: *The OSRA model estimates that 16 percent and 10 percent of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could contact spectacled eiders molting in the LBCHU (ERA 10) during the winter within 360 days.*

Spectacled eiders make use of the spring lead system when they migrate from their wintering area in the Bering Sea. The spring lead system includes the LBCHU and typically has represented the only open-water area along their path. Once tundra nesting habitats are sufficiently melted to allow nesting (historically around June 10), most breeding pairs of spectacled eiders leave nearshore coastal areas to begin nesting on the Arctic Coastal Plain as far east as Canada. All three breeding populations of spectacled eiders molt in Ledyard Bay from July through October, including most females that nest on the North Slope (Petersen et al. 1999). Many post-breeding male spectacled eiders slowly begin to converge in offshore aggregations in Ledyard Bay starting in July and begin an extended molt. While molting they are flightless for several weeks. Female spectacled eiders whose nests fail early on go to the coast and eventually end up in Ledyard Bay for flightless molt. Females with broods are the last to arrive at Ledyard Bay around the end of the first week of September, and they may be present into November. The post-breeding molt is an energetically demanding period and Ledyard Bay provides an abundant and accessible food supply with low levels of disturbance and predation.

Ledyard Bay is also important habitat for many other species of waterfowl and tundra nesting seabirds, including ESA-listed Steller's eider and ESA candidate species yellow-billed loon. Marine mammals are also important components of the ecosystem, with major migrations of bowhead whales and beluga whales coming through the area in spring. Ice seals and walruses are present all year but especially when sea ice is present. Spotted seals and walruses also use the coastline for haulouts.

4.10.6.9.3 Conclusion

Ledyard Bay is undoubtedly rich habitat for a variety of benthic invertebrates and fish species and it is an important habitat for many key marine mammal and bird species. It derives its special designation and protected status, however, from its tremendous importance to the threatened spectacled eider. All of the species from all taxa could be affected by a VLOS in Ledyard Bay to various degrees but the conclusion about the overall effect of a VLOS on this area is driven by the effects on spectacled eider. For this threatened species, Ledyard Bay is a unique habitat and one that is crucial to their continued existence because most of the population stages here in spring and spends their flightless molt period there in the fall. Molting eiders are especially vulnerable to oil spills because they cannot fly away. Molting eiders are present in Ledyard Bay from July through October, almost the entire open-water period when exploratory drilling and spills are most likely to occur. Because of the potentially devastating effects on the world population of spectacled eiders, the overall effects of a VLOS on Ledyard Bay would be considered high in magnitude and intensity, long-term in duration (lasting more than five years), and state-wide in geographic extent. Similar but smaller effects could be expected for other populations of migrating birds and marine mammals. This would be considered a major effect on this important habitat area according to the criteria established in Table 4.5-16.

Kasegaluk Lagoon Time/Area Closure

Kasegaluk Lagoon is an estuary important to rearing fish, including out-migrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers. Salmon, other fish, and abundant invertebrate populations are a major attractant for very large numbers of migratory birds that make use of Kasegaluk Lagoon during May to October. Threatened spectacled and Steller's eiders are among the many species of tundra-nesting waterfowl that stage in the lagoon in the spring and post-breeding periods. About half of the Pacific flyway population of brant use Kasegaluk Lagoon during the post-breeding period. Large numbers of phalaropes, dunlins, and other species of shorebirds also use the area during the open-water period.

Concentrations of beluga whales use Kasegaluk Lagoon in the spring/summer for molting, where the relatively warm waters and gravelly substrate helps the process.

4.10.6.9.4 Conclusion

The effects of a VLOS on coastal vegetation and wetlands could involve hundreds of miles of shoreline and, if influenced by strong winds and waves, could be blown or washed some distance inland. Although barrier islands could protect lagoon areas to some extent, if oil entered a lagoon in substantial amounts, the barrier islands could inhibit weathering and flushing by waves, thereby leading to a more extended exposure of the lagoon environment to the oil than if it was on an outer coast. Kasegaluk Lagoon has a number of entrances to the open ocean and would thus be susceptible to oil spill penetration. BOEM (2015b) VLOS analyses are prefaced with assumptions about when, where, and how much oil would directly affect given areas. Of great importance to biological resources is the timing of the spill and how it would overlap with migration and other critical life functions. If oil enters Kasegaluk Lagoon and persists for up to 10 years, as is projected in the BOEM model, most of the animals that use the area at any time of the year could be exposed at least one time and perhaps repeatedly over the years, with potentially long-term effects on all of the populations with intensive use of the lagoon, including many species of fish, waterfowl, shorebirds, beluga whales, and spotted seals. Kasegaluk Lagoon is a unique resource in the Chukchi Sea and the effects of a VLOS would be considered high in magnitude and intensity, long-term in duration (lasting more than five years), and state-wide in geographic extent because it would affect populations of migrating birds. This would be considered a major effect on this time/area closure location according to the criteria established in Table 4.5-16.

4.10.6.10 Marine Mammals

4.10.6.10.1 Existing Analysis (BOEM 2015b and 2012)

Section 4.5.7 of the BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on marine mammals in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would impact marine mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects would be substantial, causing a multitude of acute and chronic effects. Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbances from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A catastrophic discharge event has the potential to increase the area and duration of an oil spill, thereby increasing the potential for population-level effects, or at a minimum, an increase in the number of individuals killed. For example, a catastrophic discharge event contaminating ice leads or polynyas in the spring could have devastating effects, trapping bowhead whales where they may encounter fresh crude oil. Beluga whales that also use the spring lead system to migrate would also be susceptible to a spill that concentrates in these leads (BOEM 2012). Polar bears are most often found near open leads and polynyas where they hunt for seals, making them vulnerable to ingestion of oil through grooming or ingesting oiled prey.

Section 4.5.7 of BOEM (2015b) describes potential impacts to marine mammal resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Cetaceans

Direct contact with spilled oil resulting from a VLOS would have the greatest potential to adversely affect cetacean species when toxic fumes from fresh oil are inhaled at times and places where aggregations of cetaceans may be exposed. Cetaceans likely would avoid oil spill response and cleanup activities, potentially causing displacement from preferred feeding habitats, and could deter from migration paths for the duration of those activities. Presence of oil on and in the water may be avoided by some and not other cetaceans. Cetaceans as a general group would likely experience some loss of seasonal habitat, reduction of prey, and contamination of prey. Consumption of contaminated prey may adversely affect distribution, abundance, and health of cetaceans. Human activities brought about by implementation of Oil Spill Response Plans, cleanup and remediation, and post-spill event follow-up treatment and research and monitoring efforts may displace cetaceans. A variety of adverse effects on cetaceans could result from contact with and exposure to a VLOS event ranging from simple avoidance to mortality of cetaceans depending on timing, location, cetacean species involved, and circumstances unique to a given spill event.

Bowhead Whale

Bowhead whales could experience contact with fresh oil during summer and fall feeding event aggregations and migration in the Chukchi Sea and western Beaufort Sea. Skin and eye contact with oil could cause irritation and various skin disorders. Toxic aromatic hydrocarbon vapors are associated with fresh oil. Prolonged inhalation within fresh oil could result in impaired endocrine system function that may result in reduced reproductive function and/or bowhead mortality in situations where prolonged exposure to toxic fumes occurs. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh oil and disturbance from response related noise and activity limits potential exposure of whales to prolonged inhalation of toxic fumes. Exposure of aggregations of bowheads, especially if calves are present could result in multiple mortalities. It would be likely that surface feeding bowheads would ingest surface and near surface oil fractions with their prey, which may or may not be contaminated with oil components. Incidental ingestion of oil factions that may be incorporated into bottom sediments can also occur during near-bottom feeding. Ingestion of oil may result in temporary and permanent damage to bowhead endocrine function and reproductive system function; and if sufficient amounts of oil are ingested mortality of individuals may also occur. Population level effects are not expected; however, in a very low probability, high impact circumstance where large numbers of whales experience prolonged exposure to toxic fumes and/or ingest large amounts of oil, injury and mortality could potentially affect population growth rates.

Exposure of bowheads could occur in the spring lead system during the spring calving and migration period. Exposure to aged winter spill oil (which has had a portion or all of the toxic aromatic compounds dissipated into the atmosphere through the dynamic open water and ice activity in the polynya) presents a much reduced toxic inhalation hazard. Some inhalation, feeding related ingestion of surface and near surface oil fractions may occur during this period and may result in temporary and/or permanent effects on endocrine and reproductive performance. It is possible that a winter spill would result in a situation where toxic aromatic hydrocarbons would be trapped in ice for the winter period and released in toxic amounts in the spring polynya system when bowheads are migrating through in large numbers. In this low probability situation, large number of calves could die and recovery from the loss of a substantial portion of an age class cohort and its contribution to recruitment and species population growth could take decades.

Bowhead whales could be exposed to a multitude of short and longer term additional human activity associated with initial spill response, cleanup and post event human activities that include primarily increased and local vessel and aircraft traffic associated with reconnaissance, media, research, monitoring, booming and skimming operations, in-situ burning, dispersant application and drilling of a relief well. These activities would be expected to be intense during the spill cleanup operations and expected to continue at reduced levels for potentially decades post event. Specific cetacean protection actions would be employed as the situation requires and would be modified as needed to meet the needs of the response effort. The response contractor would be expected to work with NMFS and state officials on wildlife management activities in the event of a spill. The two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed activities and monitor their impact on cetaceans. As a member of the team, NFMS personnel would be largely responsible for providing critical information affecting response activities to protect cetaceans in the event of a spill.

Bowheads would be expected to avoid vessel supported activities at distances of several kilometers depending on the noise energy produced by vessel sound sources; drill rig; numbers and distribution, size and class of vessels. Migrating whales would be expected to divert up to as much as 20-30 km around relief well drilling operations and up to a few km around vessels engaged in a variety of activities. Temporary and non-lethal effects are likely from the human activities that would be related to VLOS response, cleanup, remediation, and recovery. Displacement away from or diversion away from aggregated prey sources could occur, resulting in important feeding opportunity relative to annual energy and nutrition requirements. Frequent encounters with VLOS activities and lost feeding opportunities could result in reduced body condition, reproductive performance, increased reproductive interval, decreased in vivo and neonatal calf survival, and increased age of sexual maturation in some bowheads. Effects from displacement and avoidance of prey aggregations and feeding opportunities as a result of human activities associated with spill response, clean-up, remediation and recovery are not expected to result in population level effects.

Beluga Whale

Beluga whales are vulnerable to contact with a VLOS when large aggregations are gathered in the lagoons and nearshore habitats along the Alaska Chukchi Sea coast during molting and nursing. The fate of beluga prey, especially Arctic cod and other Arctic fisheries, would affect seasonal habitat use, determine if toxic amounts of contaminated fish are ingested, or possibly change distribution of these whales until fisheries recovery occurs. Temporary and/or permanent injury and non-lethal effects are likely. Toxic levels of ingestion could alter endocrine system function and reproductive system function and in severe cases result in mortality of individual whales.

Belugas would come into contact with the human activities associated with cleanup operations when near shore, where localized intensive boom and skimming efforts to protect lagoons and other coastal resources occur. Avoidance behavior and stress to belugas (that have also experienced small boat supported subsistence hunting) in coping with concentrated cleanup activities is likely. Once offshore, belugas could experience inhalation of fumes of fresh spilled oil. Prolonged inhalation of toxic fumes or accidental inhalation of surface oil could result in temporary and/or permanent injury or mortality to some individuals. Displacement from or avoidance of important nearshore habitats could occur in subsequent years after a spill, and could redistribute seasonal use of the Chukchi Sea nearshore areas to less optimal molting and nursing areas and potentially reduce population productivity and recruitment. Should cleanup activities occur in or near lagoons or nearshore feeding areas, molting, or birthing habitats, beluga could potentially abandon these areas for as long as spill related activities persisted. Post spill recovery of belugas to pre-spill abundance and habitat use patterns would be dependent upon the recovery periods necessary to restore pre-spill levels of prey populations and the quality of near-shore preferred habitats. Recovery would also depend on the level of human activity in and adjacent to preferred habitats.

Fin Whale

A few individual fin whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Fin whale prey (schooling forage fish and zooplankton) could be reduced or contaminated, leading to modified distribution of fin whales and/or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects are likely and mortality or population level effects are considered to be unlikely.

Fin whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities similar to that noted for bowhead whales.

Humpback Whale

A few individual humpback whales could experience effects similar to those noted for bowheads above if contacted by oil during the ice free period. Humpback whale prey (primarily schooling forage fish) could be reduced and/or contaminated, leading to modified distribution of humpback whales or ingestion of oil contaminated prey. iInjury and non-lethal effects are likely, but mortality or population level effects are considered unlikely. If prey populations, presence, productivity and distribution are reduced due to VLOS effects, humpback habitat value would be reduced unless the humpbacks in the Alaska Beaufort and Chukchi seas originate from the Western North Pacific stock. In the latter case, mortality may take three generations or more to restore. The few individual humpbacks in the Alaska OCS and nearshore may be exhibiting pioneer behavior, and recovery of even a few animals may require similar pioneer behavior from areas of the Bering Sea and southwestern Chukchi Sea where these whales are more abundant.

Humpback whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities in a manner similar to that noted for bowhead whales.

Gray Whale

Gray whale aggregations have consistently occurred near shore along the Alaska Chukchi Sea coast from west of Wainwright to northeast of Barrow. This zone would likely be the location of much of the cleanup operations to protect the coastline, lagoons, and river mouths. Avoidance of intense activities could displace gray whales from preferred feeding areas. Oil contamination of benthic sediments and/or mortality of benthic invertebrates that these whales require could result in a recovery period of many years, and result in abandonment of these primary summer feeding areas that provide the majority of the annual nutritional and energy requirement of these whales. Reduction in body condition, and potential mortality from insufficient body energy to complete the long distance migration of this species to and from as far south as Mexico could occur. Reduction or loss of the portion of the Western North Pacific stock of gray whales using the Chukchi Sea would likely take three generations or more to recover. Population level effects from loss or reduction of prey resources nearshore could result in changes in distribution, habitat use, and/or presence in the Chukchi Sea. Loss of food sources could be reflected in individual body condition and mortality during the long stressful migrations this species endures.

Minke Whale

Individual minke whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Minke whale prey could be reduced or contaminated, leading to a modified distribution of minke whales or ingestion of oil contaminated prey. Temporary and/or permanent and non-lethal effects are likely and mortality or population level effects are considered to be unlikely. Changes in distribution of minke whales in the Alaska Chukchi Sea are not likely.

Minke whales would likely avoid the noise related to VLOS response, cleanup, and post-event human activities they may encounter in a manner similar to that noted for bowhead whales.

Killer Whale

Individual killer whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Killer whale prey abundance and distribution could be reduced or contaminated, leading to modified distribution of killer whales and/or ingestion of oil contaminated prey. Injury and non-lethal effects could occur, but mortality or population level effects are considered to be unlikely.

Killer whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities they may encounter in a manner similar to that noted for bowhead whales.

Harbor Porpoise

Individual harbor porpoise could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Harbor porpoise prey could be reduced or contaminated, leading to modified distribution of harbor porpoise or ingestion of oil contaminated prey. Injury and non-lethal effects could occur, but mortality or population level effects are considered to be unlikely.

Harbor porpoise would likely avoid the noise related to VLOS response, cleanup, and post-event human activities. The apparent distribution of the porpoises near shore and in the various lagoons where forage fish are abundant puts these animals at risk of frequent contact with spill clean up activities. Such activities are concentrated (to place booms and skim oil) near the mouths of rivers and near lagoons to protect coastline resources. A reduction of coastal fisheries could reduce the capacity of the Chukchi Sea near shore to support harbor porpoise and, consequently, redistribution of porpoises could occur. Ingestion of contaminated fish could reach toxic levels and result in impaired endocrine function, reproductive impairment, or mortality. Reduction or loss of harbor porpoise in this region requires pioneering individuals or the memory of individuals now using the area to “teach” others that the region is available. A substantial reduction in the low numbers that occur in offshore Alaska Chukchi Sea may take greater than three generations to recover due to the remoteness of this part of their range and the pioneering behavior required to recover.

Ice Seals

Section 4.5.7 of BOEM (2015b) describes potential impacts to ice seals during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

In the event of a VLOS, ice seals could be adversely affected to varying degrees depending on distribution, activity, number affected, season, and various spill characteristics.

Spotted seals are the only phocid species in the analysis area that habitually use shore-based haulouts. Their principle haulout locations that could be affected by a VLOS, ranked from largest to smallest, are Kasegaluk Lagoon, Peard Bay/Franklin Spit, Dease Inlet/Admiralty Bay, Smith Bay, and the Colville River Delta. Kasegaluk Lagoon is the largest haulout location that could be affected, and is several times larger than all of the others combined. Although spotted seals may forage for fishes in nearshore areas, their presence is not known to be strongly correlated with pelagic areasand the ice front during summer. Consequently, their presence is associated with haulout areas and nearshore areas with open water.

In contrast, ribbon seals are the most pelagic seal species in the area, remaining in the open ocean for most of the year except for spring whelping and molting in the Bering and southern Chukchi seas. Based on the very low numbers of ribbon seals documented in biological surveys of the Chukchi Sea, they are assumed to occur in very low numbers, and to be widely spread across the Chukchi Sea, virtually absent from the Beaufort Sea, and mostly concentrated in the southern Chukchi Sea and in the Bering Sea during summer. Consequently, ribbon seal populations are not expected to be affected by a VLOS from any of the OSRA Launch Areas.

Both bearded and ringed seals closely associate with sea ice throughout the year, and rarely use shore habitat. Both species prefer to forage in proximity to the southern ice edge during the summer months, although some may be found in the open ocean away from areas of sea ice. Bearded seals feed on benthic organisms on the relatively shallow Chukchi continental shelf, while ringed seals forage for fishes and some invertebrates in the water column. These differences in food selection and foraging behavior help determine the presence or absence of each of these species in an area. Bearded seals are essentially restricted to areas over the continental shelf and the ice front where they can reach the seafloor to feed on benthic organisms. Ringed seals may be found under areas of solid ice as well as in the ice front where they predate fishes such as Arctic and saffron cod.

Presently there are no areas identified as important ringed, bearded, or ribbon seal habitat during the summer months. However, during the winter, conditions change drastically with the southward advance of sea ice, when only bearded and ringed seals persist in the Beaufort and Chukchi seas. During winter, bearded seals loosely congregate around polynyas, and lead systems, generally avoiding areas of shorefast ice. Ringed seals, however, select shorefast ice zones as their primary habitat where they survive by making and maintaining breathing holes through the ice and by constructing subnivean lairs, particularly under pressure ridges where they are somewhat protected from predators. If lead systems or polynyas occur near the shorefast zone, ringed seals may often maintain a presence in proximity to the lead or polynya. However, because of their site fidelity and need for stable ice, they are strongly linked with stable shorefast ice. Any VLOS reaching a polynya or lead system could have serious effects on local ringed and bearded seal sub-populations, potentially oiling or even killing a number of bearded and/or ringed seals.

Pacific Walruses

Section 4.5.7 of BOEM (2015b) describes potential impacts to walruses during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

In the event of a VLOS, the OSRA model estimates most of the contact between oil and walrus habitat would occur on the U.S. side of the Chukchi Sea, while the bulk of the walrus population hauls out on the Russian side of the Chukchi Sea. Contact with oil on the U.S. side of the Chukchi Sea would be most likely to occur at Herald or Hanna shoals, or at coastal haulouts near Wainwright or Point Lay. Walruses are less vulnerable to injury from contact than are furred seals, but more likely to be subjected to long-term chronic ingestion of hydrocarbons from eating benthic prey than are seals that eat fish. In the event of a VLOS, key habitats to protect for walruses would include the Herald and Hanna Shoal polynyas and the Wainwright and Point Lay areas. Substantial impacts to the walrus population would be most likely to occur if large scale contamination of prey and habitat persisted for years; or if a VLOS contacted a large concentration of walruses at a foraging area or while the population is concentrated on sea ice or terrestrial haulouts.

Polar Bears

Section 4.5.7 of BOEM (2015b) describes potential impacts to polar bears during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

The majority of pregnant females in the Chukchi/Bering Sea Stock (CBS) are believed to den and come ashore on the Russian side of the Chukchi Sea, particularly at Wrangel Island. The majority of pregnant females in the Southern Beaufort Sea stock (SBS) of polar bears come ashore and den further eastward in the Beaufort Sea, However there is a large area of overlap between the CBS and the SBS out on the sea ice in the northeastern portion of the Chukchi Sea. Both stocks are believed to be in decline. If a VLOS were to occur, it could result in the loss of large numbers of polar bears. This would have a substantial impact on the SBSs and/or CBSs of polar bears. Contact with oil on the U.S. side of the Chukchi Sea would be most likely to occur along the U.S. Chukchi Sea coastline or the U.S. Chukchi Sea barrier islands. In the event of a VLOS, key habitats to protect for polar bears would include the barrier islands and shoreline, and Wrangel Island.

4.10.6.10.2 Additional Analysis for Marine Mammals

Cetaceans

Conclusions regarding potential effects of a VLOS on cetaceans in the Chukchi Sea will be addressed separately for each species below. Narwhals, included in previous sections of this EIS, were omitted from BOEM (2015b) analysis. Narwhals in the Chukchi Sea are exceedingly rare. Because the co-occurrence of narwhals and a VLOS in the Chukchi Sea is highly unlikely this species is not considered in this additional analysis.

Bowhead Whale

Bowhead whales are most vulnerable to oil spills in the Chukchi Sea while feeding during late summer and fall and during the westward migration throughout the fall. A winter spill, or if oil persists in ice over winter, could impact bowheads migrating through the lead system during the spring.

Injury and mortality are most likely during Phase 1 (initial event) of a VLOS. Contact through the skin, eyes, or through inhalation and ingestion of fresh oil could result in temporary irritation or long-term endocrine or reproductive impacts, depending on the duration of exposure. Based on criteria described in Section 4.1.3, the magnitude of the resulting impact could be high. The duration of impacts could range from temporary (such as skin irritations or short-term displacement) to long-term (e.g., endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as off Barrow, or along the migratory corridor, especially in the spring lead system, the impacts may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of bowhead whales. Bowhead whales are a unique resource, as they are a centerpiece of the Iñupiat subsistence lifestyle and listed as endangered under the ESA. Population level impacts are possible if a VLOS event coincided with and impacted a large feeding aggregation of bowhead whales during the open water season, particularly if calves were present. Mothers with young calves are also vulnerable to potential exposure to oil in the lead system during the spring migration. A VLOS could result in major impacts on bowhead whales.

Beluga Whale

Beluga whales of the eastern Chukchi Sea stock could be particularly vulnerable to a VLOS during June and July when congregating in the nearshore waters near Kasegaluk Lagoon and along the Alaskan Chukchi Sea coast. Belugas from this stock and the Beaufort Sea stock could encounter spilled oil during migrations through the Chukchi Sea in the spring and again later in the fall, although distribution is generally more dispersed during the fall. Impacts of a VLOS on beluga whales, especially while concentrated in lagoons and nearshore areas, are similar to those described for other cetaceans and include prey and habitat destruction and contamination, potential injury, illness, and mortality from contact with or ingestion of oil or dispersants, and displacement caused by avoidance of spills and clean-up activities. Using criteria described in Section 4.1.3, the magnitude of impacts could range from medium to high, depending on habitat and prey impairment and level of injury or mortality. Durations could range from temporary skin irritations to long-term endocrine or reproductive failure or long-term displacement, and the extent could be state-wide due to the migratory nature of belugas. Belugas are considered unique because of their importance as a subsistence resource. An impact to the eastern Chukchi Sea stock, particularly in the vicinity of Kasegaluk Lagoon and Point Lay, could substantially impact local subsistence hunters. Population level impacts would depend on the extent of the spill, damage to molting and calving areas and prey resources, how long it takes for resources to recover, and whether displacement from important habitat is long-term. A VLOS could have a major impact on beluga whales in the Chukchi Sea, particularly on the eastern Chukchi Sea stock.

Fin Whale

Fin whales are only present in the Chukchi Sea in small numbers during summer months. If, however, they were to encounter an oil spill during that time, physiological impacts of oiling may occur. Prey could also be impacted through reduced abundance or contamination that could lead to longer term habitat alterations, displacement, or contaminant loading in fin whales. In accordance with criteria established in Section 4.1.3 of this EIS, the magnitude of impacts to individual fin whales could be medium to high, with displacement from the area, impacts to prey resources and habitat quality, and a possibility of injury from either direct contact with or ingestion of oil or associated contaminants, such as dispersants. Duration could range from temporary to long-term, depending on the type of injury incurred or extent of habitat alteration. The geographic extent could be state-wide, since the fin whale is a migratory species and, as they are listed as endangered under the ESA, fin whales are considered a unique resource. Population level impacts are unlikely, given the low numbers of fin whales in the EIS project area, yet a VLOS could still result in a major impact to individual fin whales.

Humpback Whale

The impacts of a VLOS on humpback whales in the Chukchi Sea are anticipated to be similar to those described for fin whales.

The potential for population level impacts depends on the stock from which humpbacks in the Chukchi Sea originate. It is currently unknown whether they come from the Central North Pacific or the Western North Pacific stock. The Western North Pacific stock is more likely, given its known geographic range, and is a substantially smaller stock with an estimated minimum population estimate of 732 whales (Allen and Angliss 2010). As noted in BOEM (2015b) Section 4.5.7., recovery of the Western North Pacific stock from mortality resulting from a VLOS could take three or more generations. Therefore, the Western North Pacific stock of humpback whales could experience a major impact from a VLOS at the population level. BOEM further state that, if humpbacks in the Chukchi Sea Lease Sale 193 area originate from the Central North Pacific stock, then a negligible number would be expected to experience temporary and non-lethal effects from a VLOS. The Central North Pacific stock is more robust than the Western North Pacific stock, with an estimated minimum population of 7,469 whales (Allen and Angliss 2010). Population level impacts are, therefore, unlikely for this stock, but a VLOS could still result in a major impact to individual humpback whales.

Gray Whale

Gray whales may be particularly vulnerable to impacts from a VLOS in the Chukchi Sea. Summer feeding aggregations commonly occur nearshore between Wainwright and Barrow, where they are likely to experience displacement caused by increased vessel traffic in the aftermath of a spill, and/or physical impacts from direct contact with oil and contamination of benthic prey resources. The resulting impacts could be similar to those described for bowhead and fin whales. Reduced prey availability and loss of feeding habitat could have long-term impacts on body condition and fitness. Based on criteria described in Section 4.1.3, the magnitude of impact from a VLOS on gray whales could be medium to high, depending on level of injury or mortality. The duration could range from temporary (minor skin irritations) to long-term (loss of habitat), and impacts could extend state-wide, given that gray whales migrate well beyond the Chukchi Sea to as far south as Mexico. The species is no longer listed as endangered, so could be considered a common to important resource. Whether population level impacts occur depends on the extent of the spill and loss of nearshore prey resources and habitat, as well as availability of alternate habitat. A VLOS in the Chukchi Sea could have an overall moderate to major impact on gray whales.

Minke Whale

Minke whales are seen in low numbers and in small groups during the open water season in the Chukchi Sea. The likelihood of encountering a VLOS may, therefore, be low and would only occur in the event of a summer spill. If encountered, however, a VLOS could result in similar impacts to that described for bowhead, fin, and humpback whales. A difference in assessing overall impacts, as per the criteria in Section 4.1.3, would be that minke whales are not listed as depleted under the MMPA or listed under the ESA, so are not considered a unique resource. A population level impact is unlikely given the low sighting rate in the Chukchi Sea and apparent broad distribution in the North Pacific. The overall impact of a VLOS on minke whales could be moderate.

Killer Whale

Killer whales occur in the Chukchi Sea during the open water season. If they were to encounter an oil spill during that time, they could experience impacts similar to that described for other cetaceans. Duration of impacts resulting from consuming contaminated prey could be prolonged through bioaccumulation of toxins through the food chain, since killer whales in the Chukchi Sea are mammal-eating transients and considered apex predators. Killer whales are not listed as depleted under the MMPA or listed under the ESA, so, in accordance with criteria of Section 4.1.3 of this EIS, are not considered a unique resource. A population level impact of a VLOS on killer whales is unlikely given the low occurrence rate in the Chukchi Sea. The overall impact of a VLOS on killer whales could be moderate.

Harbor Porpoise

Harbor porpoise are present in the Chukchi Sea during the open water season and have been sighted with increasing frequency in both the nearshore and offshore areas in recent years. This may indicate a range extension (Funk et al. 2010). Increasing frequency of occurrence may leave harbor porpoise more susceptible to an encounter with a VLOS and subsequent clean-up activities at the point of origin offshore, if the spill trajectory included nearshore waters, and nearshore clean-up activities. Impacts on harbor porpoise could be similar to that described for other cetaceans – displacement due to prey loss and vessel activity, potential injury, illness or mortality from contact with oil, consuming oiled prey, or otherwise consuming oil and associated chemicals. Impacts on individual porpoises, based on criteria described in Section 4.1.3 of this EIS, could range from medium to high intensity and from temporary to long-term duration, depending on level of injury or mortality, as well as long-term impacts on prey resources through reduced availability or contamination. The extent could be broad, reaching to the level of state-wide, given that harbor porpoise seasonally occur in the area and are a migratory species. Harbor porpoise, however, are not listed under the ESA so would be considered a common resource. Population level impacts are not likely, although BOEM (2015b) states in Section IV.E.7., that recovery from a major reduction in numbers of harbor porpoise in the OCS waters of the Chukchi Sea may take longer than three generations. This may curtail the range extension but not necessarily the population as a whole. A VLOS could have a moderate impact on harbor porpoise in the Chukchi Sea.

Ice Seals

The impact of a VLOS on ice seals in the Chukchi Sea could vary by habitat requirements, prey preferences, and seasonality of occurrence in the area, among other factors. Potential impacts are, therefore, discussed separately for each species.

Bearded Seal

Bearded seals occur in the Chukchi Sea year round and could, thus, be vulnerable to impacts from fresh oil and overwintering residual oil from a VLOS. Direct contact with oil could result in injury or mortality events, particularly if it occurred in a polyna or lead system in which bearded seals aggregated (BOEM 2015b). Bearded seals are benthic feeders and are restricted to shallow shelf areas for feeding. Damage to these areas and prey resources could cause long-term displacement and possible loss of fitness due to inadequate prey availability. Based on criteria described in Section 4.1.3, impacts of a VLOS on bearded seals could be of medium to high intensity and of temporary to permanent duration, depending on extent of habitat loss, injury, or level of mortality. The geographic extent could be regional to state-wide, depending on how far bearded seals could be displaced or need to search for alternative habitat. Bearded seals are a unique resource in the Chukchi Sea due to their importance as a subsistence resource for coastal communities and recent proposal to be listed as threatened under the ESA. Population level impacts are possible if large portions of important benthic habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. A VLOS in the Chukchi Sea could have a major impact on bearded seals.

Ringed Seal

Ringed seals may also occur in the Chukchi Sea year round, where they are closely associated with sea ice. During the open water season, they spend more time in the water foraging, leaving them vulnerable to impacts of a VLOS during that time of the year. During winter and spring, they associate with shorefast ice where ice entrained oil may persist. The intensity, duration, and extent of impacts of a VLOS on ringed seals are similar to those anticipated for bearded seals. A large-scale impact on prey resources could result in displacement, at a minimum, or even compromised fitness. Ringed seals are hunted for subsistence by Alaska Natives from communities along the coasts of the northern Bering, Beaufort and Chukchi seas, so are considered a unique resource. Population level impacts are possible if large portions of important habitat and prey are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. Based on criteria described in Section 4.1.3 of this EIS, a VLOS in the Chukchi Sea would have a major impact on ringed seals.

Ribbon Seal

Ribbon seals are infrequently seen in the northern or eastern Chukchi Sea and, based on satellite tags, disperse broadly with retreating sea ice. This leaves them less vulnerable to a VLOS in the Chukchi Sea. A small proportion of individuals that do contact oil from a VLOS could die (BOEM 2015b). On an individual level, impacts could be similar in intensity, duration, and extent to that described for other ice seals, but population level impacts are unlikely. Ribbon seals are harvested by Alaska Native subsistence hunters, primarily from villages along the Bering Strait and to a lesser extent at villages along the Chukchi Sea coast, so are considered a unique resource, based on criteria described in Section 4.1.3. As a result, a VLOS could result in a major impact on individual ribbon seals.

Spotted Seal

Spotted seals are particularly vulnerable to impacts of a VLOS, as they are the only ice seal species in the Chukchi Sea that regularly hauls out on shore and concentrates nearshore in lagoons, such as Kasegaluk Lagoon. Spotted seals could be susceptible to impacts of floating oil in foraging areas in open water, oil that came ashore the Chukchi Sea coast, and the multitude of activities associated with clean-up, from boom deployment to vessels and airplanes. Displacement from important habitat areas is possible, as is direct impacts from contact with oil and dispersants. Based on criteria described in Section 4.1.3, impacts of a VLOS on spotted seals could be of medium to high intensity and of temporary to permanent duration, depending on extent of habitat loss, injury, or level of mortality and whether oil reached nearshore haul out concentrations. The geographic extent could be state-wide, given the migratory behavior of spotted seals. Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions, so are considered a unique resource. Population level impacts are possible if large portions of important habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. A VLOS in the Chukchi Sea could have a major impact on spotted seals.

Pacific Walruses

Walruses are most susceptible to impacts of a VLOS during the summer months and can be impacted at sea, on ice floes, or onshore. In recent years, walruses have been hauling out in large numbers (up to >15,000 animals [Clarke et al. 2011a]) between Wainwright and Point Lay during late summer to early fall. Disturbance to such a large concentration could result in stampedes and subsequent trampling deaths and injury caused by increased overflights and vessels during spill response efforts. Oil coming ashore where walruses are densely concentrated could also impact large numbers of animals, including young of the year, through physical contact with the skin and membranes, inhalation of fumes, and impacts on benthic prey. Impacts of oil and dispersants on benthic prey resources (such as contamination or mortality) could have lasting impacts on prey and habitat availability for walruses in the Chukchi Sea. Based on criteria described in Section 4.1.3 of this EIS, impacts of a VLOS on walruses could be of medium to high intensity, with intensity greatest if the VLOS and subsequent clean-up activities coincide with dense aggregations of walruses, duration could range from temporary displacement to long-term injury or displacement from important habitat, the geographic extent could be state-wide due to the migratory behavior of walruses and potential for decreased fitness and a need to seek alternate forage locations of benthic habitat and prey are severely altered. Walruses are an important subsistence species for several communities along the Bering and Chukchi Sea coasts of Alaska and the coast of Chukotka (Russia), so are considered a unique resource. Population level impacts are possible if young of the year are impacted or access to important habitat is curtailed. A VLOS in the Chukchi Sea could have major impacts on walruses.

Polar Bears

Polar bears are vulnerable to impacts of a VLOS in the Chukchi Sea, particularly if it occurred during the summer open water period or the broken ice period during the fall; most denning occurs on either the Russian side of the Chukchi Sea or in the Beaufort Sea. A VLOS in the Chukchi Sea could involve either the SBS or CBS in the region of overlap near Point Lay and the northeastern Chukchi Sea, but CBS are most likely to be impacted by a spill in the Chukchi Sea either nearshore, on land, at sea, or on offshore ice floes. Both populations are small and apparently not increasing. Based on criteria described in Section 4.1.3, impacts of a VLOS on polar bears could be of medium to high intensity, particularly if the fur were sufficiently fouled to result in loss of insulation, if oil were ingested, or if displacement from important habitats affected overall fitness. Duration of impacts could range from temporary displacement to permanent habitat loss, reproductive impairment, or even death. Contamination and toxic impacts from either directly consuming oil or through consuming marine mammal prey in which contaminants accumulated could be long-lasting. The geographic extent of impacts could be state-wide, given the migratory movements of bears and possible need to relocate if local habitats are severely altered. It is also possible that, if the oil discharge were widespread, denning areas could be impacted. Polar bears are considered unique due to their threatened status and importance as a subsistence resource. Population level impacts are possible and dependent on numbers of polar bears directly injured or killed, extent of habitat loss, and chronic long-term impacts on reproduction and survival. Impacts of a VLOS on polar bears in the Chukchi Sea could be major.

4.10.6.11 Terrestrial Mammals

4.10.6.11.1 Existing Analysis (BOEM 2015b and BOEM 2012)

Section 4.5.8 of BOEM (2015b) describes potential impacts to terrestrial mammals during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Terrestrial mammals should not be substantially affected by a VLOS event. Caribou are the only species occurring onshore in the proposal area that might be affected in numbers greater than 1,000; however, this level of impact is unlikely. If a worst case scenario was to occur and several thousand caribou were to succumb to the effects of oil contamination, the herd sizes are sufficient to recover from losses within one and no more than two years. Grizzly bears in the Alaskan Arctic require extremely large home ranges to meet their needs. Consequently a VLOS is unlikely to involve more than a few bears at most. If those bears were to die as a result of consuming an oiled marine mammal carcass, contaminated salmon, or through grooming oiled fur, their home ranges could be reoccupied by other bears within that same season, and the population recovery would most likely occur within a year or two.

Effects on local muskox populations should also be small since they do not occur in large numbers, spending much of their time inland and away from the coast. The effects on furbearers such as foxes, wolves, and wolverines would also be short-term since they either produce large litters (foxes), or occur in very low densities (wolverines, wolves). Any losses to fox populations would quickly be replenished, while the low population density and large home-ranges of wolverines and wolves would act to prevent more than a very few individuals from being exposed to a VLOS.

The presence of oil spill cleanup crews and the associated oil spill response activity (aircraft, landing craft, nearshore boats, etc.) should effectively haze most terrestrial mammal species from contaminated areas or sites. By unintentionally disturbing the animals, responders may provide a positive benefit by forcing those animals away from the spill and potential contamination.

In addition, Section 4.4.7.1.3 of the BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on terrestrial mammals in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would result in sustained degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact terrestrial mammals from direct contact, inhalation, and ingestion. These effects could be severe where persistent, heavy oil makes contact with important habitat and prey base, causing a multitude of acute and chronic effects (BOEM 2012).

4.10.6.11.2 Additional Analysis for Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-6). Among these species, it is expected that only barren-ground caribou (*Rangifer tarandus granti*) may experience interactions with oil and gas exploration activities associated with this EIS during critical periods of their life cycle; therefore, this analysis will focus solely on caribou. Descriptions of distribution, life cycle, and habitat characteristics of other species are not included in this EIS.

The effects of a VLOS would be of medium intensity, temporary duration, local extent, and common context. While there could be a perceptible change to the caribou population, it would likely be temporary in duration, with a local impact, and the caribou population would be expected to recover within one to two years even with a direct loss of several thousand animals (BOEM 2015b). For more information regarding the impact to subsistence or recreational hunting see Sections 4.10.6.15 and 4.10.6.20 in this EIS, respectively. Utilizing the impact criteria listed in Section 4.1.3, there would be a summary impact level of minor to moderate, depending on the magnitude and duration of the VLOS.

4.10.6.12 Time/Area Closure Locations

A low probability, high impact VLOS could affect marine mammals and marine and coastal birds in areas recommended for time/area closure in the Chukchi Sea. Discussion of impacts to marine mammals in Hanna Shoal and Kasegaluk Lagoon can be found in Section 4.10.6.11 and impacts to marine and coastal birds in Ledyard Bay Critical Habitat Area and Kasegaluk Lagoon can be found in Section 4.10.6.10.

4.10.6.12.1 Hanna Shoal Time/Area Closure

Hanna Shoal is a relatively shallow area of the offshore Chukchi Sea that is rich in marine life and adjacent to many existing oil lease areas. Phytoplankton, amphipods, polychaete worms, crab larvae, fish larvae, and other benthic invertebrates form the foundation of the marine food web and are abundant in the muddy substrate of Hanna Shoal. Numerous species of seabirds and waterfowl spend time feeding in Hanna Shoal at some point during the year, especially during post-breeding and fall migration periods.

Gray whales have historically used Hanna Shoal to feed on mud-dwelling benthic invertebrates. However, surveys in the last few years indicate they may not be using the area as much as in the past (Clarke et al. 2011a). Bearded and ringed seals are common in the area during summer, feeding on benthic invertebrates and fish. walruses are also common when the ice edge is near Hanna Shoal in either spring or fall. In the winter, walruses and bearded seals concentrate along leads and polynya regions, including Hanna Shoal. If oil collects or migrates into these small open-water areas in the ice, most if not all of the seals in the area could be adversely affected by direct contact, ingestion, and contamination of prey.

Walruses are less vulnerable to injury from contact than are furred seals but more likely to be subjected to long-term chronic ingestion of hydrocarbons from eating more sedentary benthic prey than are seals that eat fish.

Hanna Shoal is one of several areas in the Chukchi Sea that forms consistent polynyas in the winter and leads in the pack ice crucial to marine mammals and some seabird species. The closeness of Hanna Shoal to existing lease areas means it has relatively high probabilities for exposure to oil in BOEM's VLOS modeling exercise (BOEM 2015b). The majority of seabird species would be most susceptible to effects of a spill during the open-water season. The effects on marine mammals, especially walruses, bearded seals, and ringed seals would be much greater if the spill occurred in or persisted into the winter than if it was only in the summer, due to the concentration of these animals in polynyas and leads. Young of the year would be especially vulnerable. Benthic invertebrate species favored by walruses and diving seabirds could become contaminated and become a source of chronic exposure for years after a spill. Hanna Shoal is an important resource in the Chukchi Sea. If a VLOS occurred in or persisted into the winter, the effects would be considered high in magnitude and intensity due to effects on walruses and ice seals, long-term in duration (lasting more than five years), and state-wide in geographic extent because it would affect migrating populations of birds and marine mammals. A VLOS would be considered to have major effects on Hanna Shoal according to the criteria established in Section 4.1.3.

4.10.6.12.2 Kasegaluk Lagoon

Kasegaluk Lagoon is an estuary important to rearing fish, including out-migrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers. Salmon, other fish, and abundant invertebrate populations are a major attractant for very large numbers of migratory birds that make use of Kasegaluk Lagoon during May to October. Concentrations of beluga whales use Kasegaluk Lagoon in the spring/summer for molting, where the relatively warm waters and gravelly substrate helps the process. Spotted seals haul out along the shores of Kasegaluk Lagoon in the summer and feed in nearby waters.

The effects of a VLOS on coastal vegetation and wetlands could involve hundreds of miles of shoreline and, if influenced by strong winds and waves, could be blown or washed some distance inland. Although barrier islands could protect lagoon areas to some extent, if oil entered a lagoon in substantial amounts, the barrier islands could inhibit weathering and flushing by waves, thereby leading to a more extended exposure of the lagoon environment to the oil than if it was on an outer coast. Kasegaluk Lagoon has a number of entrances to the open ocean and would thus be susceptible to oil spill penetration. BOEM (2015b) VLOS analyses are prefaced with assumptions about when, where, and how much oil would directly affect given areas. Of great importance to biological resources is the timing of the spill and how it would overlap with migration and other critical life functions. If oil enters Kasegaluk Lagoon and persists for up to 10 years, as is projected in the BOEM model, most of the animals that use the area at any time of the year could be exposed at least one time and perhaps repeatedly over the years, with potentially permanent effects on all of the populations with intensive use of the lagoon, including many species of fish, waterfowl, shorebirds, beluga whales, and spotted seals. Kasegaluk Lagoon is a unique resource in the Chukchi Sea and the effects of a VLOS would be considered high in magnitude and intensity, permanent in duration (lasting more than five years), and state-wide in geographic extent because it would affect migrating populations of birds and marine mammals. This would be considered a major effect on this time/area closure location according to the criteria established in Section 4.1.3.

4.10.6.13 Socioeconomics

4.10.6.13.1 Existing Analysis (BOEM 2015b and BOEM 2012)

Section 4.5.10 of BOEM (2015b) describes potential impacts to socioeconomic resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

A VLOS event of 2.2 MMbbl spilled over the course of 75 days would generate several thousand direct, indirect, and induced jobs, and millions of dollars in personal income associated with oil spill response and cleanup in the short run. The effects would be substantial in the short term. The expectation is that employment of cleanup workers to increase rapidly during Phase 2 and Phase 3, and to peak during Phase 4. Revenue impacts from a VLOS event include additional property tax revenues accruing to the NSB from any additional onshore oil spill response infrastructure, and any potential decline in federal, state, and local government revenues from displacement of other oil and gas production. A VLOS could also have substantial adverse impacts on economic activity that does not currently take place in the area but could exist in the future, such as commercial fishing, recreational fishing, tourism, and increased Arctic marine shipping.

The BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on sociocultural systems in the Alaskan Arctic. This information is incorporated herein by reference, and a summary of the information is provided. The analysis notes that while local villagers would be employed in the cleanup for a catastrophic discharge event, it is likely that thousands of workers would be necessary, placing stress on village facilities. An influx of outsiders is likely to result in some cultural conflict, stressing the local sociocultural systems. As is evident from the EVOS event, such cleanup efforts can be disruptive socially, psychologically, and economically for an extended period of time (BOEM 2012).

4.10.6.13.2 Additional Analysis for Socioeconomics

The socioeconomic effects of historical oil spills provide indicators for estimating the future impact in a very large oil spill scenario. The Chukchi VLOS described in this hypothetical worst-case scenario would be 2.2 MMbbl and 1.8 Bcf of gas. The 1989 EVOS was 240,000 bbl. The socioeconomic effects researched after EVOS can serve as good indicators, but are of a different magnitude than this analysis.

Public Revenue and Expenditures

The BOEM (2015b) analysis describes potential new NSB revenues associated with property taxes assessed for the construction of worker infrastructure, as well as potential lost NSB, NAB, state and federal revenues due to permitting delays or exploration moratoria. Local and state agencies may also increase expenditures associated with the administration of oil spill response and social services related to the influx of new workers.

Employment and Personal Income

The BOEM (2015b) analysis provides an estimate for the number of workers needed for spill clean-up, but does not estimate the number or percent of these workers that would be local from NSB and NAB. MMS (2003) VLOS estimated, “an 180,000 bbl spill could generate approximately 3,000 jobs for 1-2 years, declining to zero by the third year after a spill” and the BOEM 2015b estimate of 10,000 jobs for a 240,000bbl spill. It is likely that a 2.2MMbbl spill in the Chukchi Sea would induce substantial local employment. Without estimating the displacement of Native residents from their jobs or normal subsistence activities or the contribution of the clean-up efforts to local inflation, an increase of only 500 full-time jobs would represent over a 5 percent increase in employment in NSB and NAB and a high intensity direct impact.

A major impact to subsistence would occur after a VLOS (described in Section 4.10.6.15) and could change the components of the non-cash economy. Households could require more cash to supplement the loss of subsistence resources. NSB and NAB residents may be able to access emergency assistance or employment in the short-term, but there could be long-term public health and environmental justice impacts related to a loss of subsistence opportunities. This is discussed further in the Environmental Justice Section 4.10.6.22 and Public Health Section 4.10.6.16 of this EIS.

Demographic Characteristics

The BOEM (2015b) sociocultural analysis, discussed in Section 4.10.6.16 of this EIS, describes that new oil spill clean-up employment opportunities could be generated from a VLOS. However, it is not likely that workers originating from elsewhere would relocate permanently to the region. The BOEM (2015b) sociocultural analysis notes that an outmigration of residents did not take place in the case of the 1989 EVOS and similarly it would not be expected in the case of a VLOS in the Chukchi Sea. However, a study in Northeast NPR-A states that: "workforce changes and demographic changes could occur through consolidation of households to save money, placement of dependents with relatives beyond the village, and outmigration of wage earners in search of employment" when subsistence-harvest patterns are disrupted for multiple years (BLM 2015b; BLM 2012).

Social Organizations and Institutions

The influx of clean-up workers would create a short to long-term demand on institutions and social services in North Slope communities. Regional and local non-profit organizations such as the AEWC and Eskimo Walrus Commission that mediate between industry and subsistence users would be impacted. (BOEM 2011b). Fears about institutional capacity would be well-founded and it is likely that the quality of local community services would be diminished or halted in the short to long-term to respond to agencies, researchers, and litigation. The inability of local leaders to fulfill their roles could lead to community stress and instability (BOEM 2015b).

Private companies and regional corporations may be beneficially impacted in the short-term (Phases 1 to 4) through the sale of goods and services to spill response companies.

4.10.6.13.3 Conclusion

Employment and local revenues associated with VLOS would be high intensity, interim in duration lasting a few years, statewide to national in extent, and unique in context. The impact to the non-monetary economy is discussed in detail in Section 4.10.6.15 (Subsistence), but would be high intensity, long-term in duration halting subsistence harvests for multiple seasons and develop persistent food safety concerns. The extent of the impact would be felt regionally to a unique harvest and sharing practice. Therefore, the summary impact level for socioeconomics would be major.

4.10.6.14 Subsistence

4.10.6.14.1 Existing Analysis (BOEM 2015b and BOEM 2012)

BOEM (2015b) describes potential impacts to subsistence resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

If a VLOS occurred and affected any part of the bowhead whale's migration route, it could taint this culturally important resource. Any actual or perceived disruption of the bowhead whale harvest from oil spills and any actual or perceived impacts anywhere during the bowhead's spring migration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season even though whales still would be available. In fact, even if whales were available for the spring and fall seasons, traditional cultural concerns of tainting could make bowheads less desirable and alter or stop the subsistence harvest in Barrow, Wainwright, Point Lay, and Point Hope, and the beluga whale hunt in Point Lay for at least two seasons. Concerns over the safety of subsistence foods could persist for many years past any actual harvest disruption. This would be a substantial adverse effect. In terms of other species, this same concern also would extend to walruses, seals, polar bears, fish, and birds.

A spill originating within the Chukchi Sea region could produce indirect impacts felt by communities remote from the sale area and far removed from the spill. Essentially, concerns about subsistence harvests and subsistence food consumption would be shared by all Iñupiat and Yup'ik Eskimo communities in the Chukchi (including indigenous people on the Russian Chukchi Sea coast) and Bering seas adjacent to the migratory corridor used by whales and other migrating species. Major impacts are expected from a VLOS when contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together (MMS 2009c).

In addition, the BOEM (2012) analysis provides some information about the impacts of a catastrophic discharge event on subsistence harvest in the Alaskan Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that as the result of a catastrophic discharge event, the economically, socially, and culturally important bowhead whale hunt could be disrupted, as could the beluga harvest and the more general and longer hunt for walruses west of Barrow. Animals could be directly oiled, or oil could contaminate the ice floes or onshore haulouts they use on their northern migration. Such animals could be more difficult to hunt because of the physical conditions. Animals could be spooked and/or wary, either because use of the spill itself or because of the hazing of marine mammals, which is a standard spill-response technique in order to encourage them to leave the area affected by a spill. Oiled animals are likely to be considered tainted by subsistence hunters and would not be harvested, as occurred after the EVOS. This would also apply to terrestrial animals, such as bears that scavenge oiled birds and animals along the shore, or caribou that seasonally spend time along the shore or on barrier islands seeking relief from insects. The loss of subsistence harvest resources, particularly marine mammals, would have substantial effects on Alaska Native culture and society (BOEM 2012).

4.10.6.14.2 Conclusion

Impacts to subsistence harvests and sharing of subsistence resources associated with VLOS would be high intensity, long-term in duration, statewide in extent, and unique in context affecting harvest and sharing practices beyond the region. Therefore, the summary impact level for subsistence would be major.

4.10.6.15 Public Health

4.10.6.15.1 Existing Analysis (BOEM 2015b and BOEM 2012)

Subsistence Harvest Patterns and Sociocultural Systems of BOEM (2015b) describe potential impacts to public health from the potential for contamination of subsistence resources and disruption of sociocultural systems during the five phases of a possible VLOS in the Chukchi Sea. In addition, Section 4.3.2.4.2 of the BOEM (2012) analysis provides some information about the impacts of a catastrophic discharge event on human health in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of that information is provided here.

The effects of a VLOS on sociocultural systems could cause substantial adverse effects via chronic disruption to sociocultural systems for several years with a tendency for additional stress on the sociocultural systems. Longer term disruptions to subsistence resources and practices would impact sharing networks, subsistence task groups, and crew structures, as well as cause disruptions of the central Iñupiat cultural value: subsistence as a way of life (MMS 2007a).

These disruptions could cause breakdowns in family ties, a community's sense of well-being, and damage sharing linkages with other communities and could seriously curtail community activities and traditional practices for harvesting, sharing, and processing subsistence resources—a major impact on sociocultural systems. The effects of disruption to sociocultural systems would last beyond the period of oil-spill cleanup and could lapse into a chronic disruption of social organization, cultural values, and institutional organization with a tendency to displace existing social patterns. The accommodation response of Iñupiat culture in itself to the impacts of a VLOS could represent major impacts to social systems (MMS 2003a, 2006a, 2007a; BLM and MMS 2003).

4.10.6.15.2 Additional Analysis for Public Health

The above section describes in detail some of the effects of a VLOS on sociocultural systems, with subsequent impacts on health by way of disruptions in social organization, cultural values, and institutional organization. In addition to the long-term impacts on sociocultural systems, the short-term strain resulting from a large influx of outside workers following a VLOS would have a number of other health impacts. The presence of migratory workers in isolated areas is associated with the spread of infectious disease, particularly sexually transmitted infections (STIs) (Goldenberg 2008). Rates of Chlamydia, gonorrhea, and other STIs would be expected to increase during Phase 4 of a VLOS, as the population of extra-regional workers surges. Similarly, the population increase in response to a VLOS will strain the already limited capacity of the local health care system, particularly if the response results in temporary settlement of workers in villages outside of Barrow or Deadhorse. Additional strain on the health care system could result from increased burden of disease, starting with potential respiratory illness in the immediate post-spill environment and persisting through changes in chronic disease and social pathology resulting from long-term alterations in subsistence activities and sociocultural systems.

The impact of a VLOS on air quality is described in detail in Section 4.10.6.4. Potentially harmful emissions of several EPA criteria pollutants are likely to occur, likely resulting in severe levels of nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), and VOCs. The impact is likely to be greatest during Phase 1, following the initial explosion and fire, and during Phase 4 due to the use of burning, dispersants and as a result of emissions from aircraft and offshore vessels operating during clean-up. The effect for both phases would be greater if the spill were to occur during winter. Respiratory irritation, asthma, and exacerbations of chronic obstructive lung disease are likely to increase in areas where concentrations of the pollutants are greatest. Pre-existing lung disease and prolonged exposure to respiratory irritants would be the greatest risk for exposed individuals.

The greatest and most persistent impacts to public health following a VLOS are likely to result from stress, anxiety, and changes to subsistence harvest patterns. Impacts on subsistence are described in detail in Section 4.10.6.15 and are likely to result from a combination of factors including diversion of hunters to jobs in the clean-up response; contamination and perception of contamination of food sources; and displacement and/or mortality of marine mammal stocks. The experience of the EVOS demonstrated that changes in consumption patterns may persist in some communities long after species themselves recover. Persistent changes in diet and nutrition are likely to result in increases in the rate of food insecurity and increased prevalence of diabetes and related chronic disease. To the degree to which contamination enters the food system, increases in cancer may occur.

Social pathology, including alcohol use and subsequent alcohol-related problems, is likely to occur following a VLOS as a result of stress, alterations in the social environment, and support networks and the influx of outside workers. These impacts are described in the Environmental Justice Section (4.10.6.22).

4.10.6.15.3 Conclusion

The magnitude of adverse impacts to public health is expected to be medium to high. Many predicted public health effects would be treatable and/or transient, which would be associated with a magnitude of medium. However, some impacts may be irreversible and thus should be classified as high. Duration of impacts would range from temporary to long-term, with some effects only lasting for a brief period associated with the influx of workers during the Phase 4 clean-up period. However, health effects resulting from changes in subsistence patterns would likely persist for many years. The extent would be regional, and the context would be unique, as a VLOS would affect two or more minority or low-income communities in the EIS project area. Therefore, the summary impact on public health of a VLOS in the Chukchi Sea is expected to be moderate to major depending on the size, nature, and location of the spill.

4.10.6.16 Cultural Resources

4.10.6.16.1 Existing Analysis (BOEM 2015b and BOEM 2012)

Section 4.5.15 of BOEM (2015b) describes potential impacts to cultural and archaeological resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

The greatest impacts on archaeological resources from a very large oil spill would be to onshore archaeological sites from oil-spill-cleanup activities. The potential for effects increases with oil-spill size and associated cleanup operations. Primary oil-spill impacts from cleanup activities would be expected on both prehistoric and historic archaeological sites. Following the EVOS, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. Offshore resources are at greatest risk from bottom-disturbing activities, notably anchoring and anchor dragging.

Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost. It is difficult to draw a distinct correlation between the potential for archaeological impacts from a VLOS under the different action alternatives. Because impacts to archaeological resources would not vary under the different action alternatives, additional information about the location of currently unknown resources is not essential to a reasoned choice among lease sale alternatives.

The most effective way to avoid adverse impacts from a VLOS would be to focus on effective surveying of potential exploration sites and the various mitigating measures used to protect archaeological sites while cleaning up oil spills. The latter category should include avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al. 1991; MMS 2007a, 2009c).

In addition, the BOEM (2012) analysis provides some information about the impacts of a catastrophic discharge event on archaeological resources in Alaskan Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could result in extensive impacts on a large number of archaeological and historic resources. Due to the large area affected by a catastrophic event some resources such as coastal historic sites that are sensitive to prolonged contact with oil could be heavily impacted. Cleanup crews would be needed in a greater number of locations. This could allow oil to be in contact with resources for a substantial amount of time before cleanup efforts could be applied, which could result in impacts to these resources. A greater threat to archaeological and historic resources during a catastrophic discharge event would result from the larger number of response crews being employed. A catastrophic discharge event would result in large impacts to numerous archaeological and historic resources from response activities (BOEM 2015b, 2012).

4.10.6.16.2 Additional Analysis for Cultural Resources

Given the limited data related to historic and prehistoric resources in the Chukchi Sea, it is difficult to determine how many historic properties might be located in areas affected by a VLOS event. The presence of oil and the various oil-spill response and cleanup activities could potentially impact both prehistoric and historic archaeological resources, including submerged prehistoric sites and historic shipwrecks, as well as onshore prehistoric and historic resources, including camps, village sites, artifact scatters, historic structures, and World War II and Cold War era facilities.

Offshore Prehistoric and Historic Resources

As discussed in Chapter 3, Section 3.3.4, the presence of offshore prehistoric resources in the EIS project area is difficult to assess. In the event of a VLOS, submerged prehistoric and historic resources adjacent to a blowout could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during relief well drilling, or contaminated by hydrocarbons (BOEM 2015b). Oil settling to the seafloor could contaminate organic materials associated with archaeological sites, resulting in erroneous dates from standard radiometric dating techniques (e.g., 14C-dating), and accelerate the deterioration of wooden shipwrecks and artifacts on the seafloor (BOEM 2015b). However, offshore resources are at greatest risk from bottom-disturbing activities, notably anchoring and anchor dragging. The potential to impact archaeological resources increases as the density of anchoring activities in these areas increases (BOEM 2015b). The anchoring of VLOS response and support vessels near a blowout site and in shallow water could result in damage to both known and undiscovered archaeological sites.

Onshore Prehistoric and Historic Resources

Archaeological resources have been recorded in greater numbers in the Chukchi Sea area, and unknown resources are more likely to be present. The greatest impacts on archaeological resources from a VLOS would be to onshore archaeological sites from oil-spill-cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archaeological sites. Any onshore activity (cleanup or otherwise) that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the DEW Line (a system of radar stations) could be affected by increased cleanup activity in remote areas and increased vandalism. Prehistoric sites, though often not as visible as historic sites, also might be subjected to increased vandalism, as well (MMS 2007a, MMS 2009, BLM 2008a). As Bittner (1993) described in her summary of the 1989 EVOS, “Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself” (MMS 2007a, 2009).

4.10.6.16.3 Conclusion

In conclusion, major direct and indirect impacts to cultural resources are expected to result from a VLOS scenario. Impacts would be of high intensity, temporary to long-term in duration, regional to state-wide in geographic extent, and would affect a finite resource.

4.10.6.17 Land and Water Ownership, Use, and Management

4.10.6.17.1 Existing Analysis (BOEM 2012)

The BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on land use, development patterns, and infrastructure in the Alaskan Arctic. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have both direct and indirect effects on land use, depending on the type, size, location, and duration of the incident. Impacts generally would be more intense in areas with little infrastructure in place to handle accidents and where a greater reliance is placed on coastal activities for subsistence (BOEM 2012).

4.10.6.17.2 Additional Analysis for Land and Water Ownership, Use, and Management

Land and Water Ownership

Because the response efforts to a VLOS would not require any change in existing leasing rights, or the sale or transfer of any federal, state, or Native land or waters, no change in underlying land or water ownership would be anticipated in the Chukchi Sea. This includes federal waters (from 3 to 200 nm) and the federal lands National Petroleum Reserve-Alaska, Alaska Maritime National Wildlife Refuge, and Cape Krusenstern National Monument, state waters (shore to the three-mile limit), state lands and state selected lands, Native village lands and village selections and Native allotments, lands owned by the NSB and NAB, and municipal conveyed and selected lands.

Land and Water Use

A spill of this magnitude in the Chukchi Sea would impact some land uses. Should an oil spill result in oil accumulating along the shoreline and in tidal zones, the presence of oil could affect existing land uses by making it difficult to access land, creating a real or perceived change to the resources and values that support specific land uses, and discouraging pursuit of traditional land use in areas affected by a spill. Examples of these uses include subsistence, other traditional land uses, and recreation.

Industrial land may experience increased usage to support additional vessels, aircraft, vehicles and materials used in responding to a VLOS. This could require the construction or expansion of docks, warehouses, airstrips and/or storage facilities. It is unlikely that new permanent facilities would be constructed for spill response. Response support crews would need to be housed, affecting residential land uses. This could be accommodated through the construction of temporary worker camps, most likely in the vicinity of Prudhoe Bay or in the villages of Wainwright or Barrow. Depending on the location of industrial and commercial lands in the immediate vicinity of spill response activities, some temporary industrial land use may occur in new areas. Remote lands currently designated for natural resource protection might experience increased levels of human activity or disturbance for habitat restoration along shorelines where oil may accumulate. This would have similar effects to those discussed above, regarding access, damage to land and resource values, and interest in using the area. The duration of potential effects on land use would depend on the amount of oil that reaches shoreline and intertidal areas, the nature and duration of response activities, and the success in cleanup and restoration activities.

Land and Water Management

Current management plans within the EIS project area do not include contingencies for a VLOS. It is assumed that in the event of a VLOS, federal and state management plans that include coastal areas may require additional approvals for response and cleanup activities to accommodate heightened levels of human access for habitat restoration and oil cleanup efforts. Federal and state waters would be managed in the short term with an intense focus on response and clean-up of oil. Any management plan policies that are modified for a VLOS event would most likely be temporary, but could lead to plan updates to address any potential change in land and resource values, actions needed to promote recovery of affected resources, or address the potential for response activities in the unlikely event that they are needed.

4.10.6.17.3 Conclusion

Based on Table 4.4-2 and the analysis provided above, there would be no impact on land and water ownership because no change would be expected. The magnitude of impact would be high for land and water use for areas affected by a spill that have seen historical or current use for subsistence, other traditional land uses, and recreation, due to the potential change in resource/use values, and the level of activity associated with spill response and cleanup. The magnitude of impact would be medium for land and water management if management plans must result in new approvals to accommodate response efforts or a spill results in a change in resource or land values. The duration of impact would be -interim because response efforts may extend up to several years, although the impact could be long-term if in the unlikely event construction of a new facility or infrastructure to accommodate spill response activities. The extent of impacts would be regional because the spill would affect large expanses of water and has the potential to come into contact with land along an extensive area of shoreline in and near the EIS project area. The context of impact would generally be common because the areas of land and water affected are extensively available, unless some special, rare, or unique characteristics associated with specific subsistence and recreation areas are affected. In summary, the effects of a VLOS would be major because of the possibility for high intensity and interim impact to land use and land management.

4.10.6.18 Transportation

4.10.6.18.1 Existing Analysis (BOEM 2015b and BOEM 2012)

No specific analysis of the potential effects of a VLOS on transportation was provided in either the BOEM (2015b) or (2012) discussions.

4.10.6.18.2 Additional Analysis for Transportation

The transportation systems among the Chukchi Sea communities would experience increased levels of air, vessel and surface traffic associated with containment, recovery, and cleanup activities for a VLOS that would involve hundreds of workers and vessels, aircraft, and onshore vehicles operating over an extensive area for one to two years. BOEM (2015b) predicted that in the event of a VLOS, offshore vessels such as skimmers, workboats, barges and icebreakers involved with cleanup would be used to remove oil from a spill area that occurs at sea and to drill a new well. As described in BOEM (2015b) "15 to 20 vessels (i.e., the Nanuq, Endeavor Barge, Tor Viking, other barges from Prudhoe Bay, vessels from Cook Inlet and Prince William Sound, and other vessels of opportunity) could be used in offshore areas. Some of these would be capable of oil skimming. The majority of open ocean vessels would be positioned relatively close to the source of the oil spill to capture oil in the thickest slicks, thus enabling the greatest rate of recovery".

Additionally a VLOS may require "roughly 300-400 skimming, booming, and lightering vessels could be used in areas closer to shore. Based on the trajectory of the slick, shallow water vessels would be deployed to areas identified as priority protection sites" over the course of time to confine and remove oil from the ocean surface (BOEM 2015b). Small boats and aircraft could also be involved with beach cleaning activities at oiled beaches (including booming) at marine and freshwater shorelines. Housing for responders and workers could be on offshore vessels or in temporary camps at 5 to 10 staging areas (BOEM 2015b). The amount and type of vessels used during cleanup efforts could vary depending on seasonal and ice conditions:

> *"In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to cover the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. At this point, operations could shift to in-situ burning if sufficient thicknesses are encountered. The lack of daylight during winter months would increase the difficulties of response. As ice formation progresses, the focus of the response would shift to placing tracking devices in the forming ice sheet to follow the oil as it is encapsulated into the ice sheet. Once the ice sheet becomes solid and stable enough, recovery operations could resume by trenching through the ice to recover the oil using heavy equipment. This would most likely occur in areas closer to shore because the ice would be more stable. In late spring and early summer, as the ice sheet rots, larger ice-class vessels could move into the area and begin recovery or in-situ burning operations as the oil is released from the ice sheet. The ice would work as a natural containment boom keeping the oil from spreading rapidly. As the ice sheet decays, oil encapsulated in the ice would begin surfacing in melt pools at which time responders would have additional opportunities to conduct in-situ burn operations. Smaller vessels could eventually re-commence skimming operations in open*

> *leads and among ice flows, most likely in a free skimming mode (without boom) along the ice edge(BOEM 2015b)."*

Aircraft could be used to apply dispersants used to decrease the size of the oil slick on the surface in the event of a VLOS. In addition, BOEM (2015b) noted that "during the response and cleanup process other aircraft may be needed for personnel and equipment transport, including helicopters, small piston-powered aircraft, and large commercial jets." Aircraft (fixed wing) would also likely be engaged in application of dispersants. This would require the use of "dozens of planes and helicopters would fly over the spill area, including impacted coastal areas. Existing airport facilities along the Arctic coast (including airports at Kotzebue, Point Hope, Point Lay, Wainwright, Barrow, and any other suitable airstrips) would be used to support these aircraft. If aircraft are to apply dispersants, they could do so from altitudes of 50 to 100 feet" as described by BOEM (2015b). Small vessels and surface vehicles would also be used during response operations at onshore areas.

As indicated in BOEM (2015b):

> *"Aircraft and vessel operations would support many short-term efforts during the initial spill response as well as throughout the spill containment and treatments to minimize volume, spread, and environmental consequences. These include a wide variety of surveillance missions, placement of transmitter equipped buoys (to track spill edge in real time), media coverage, monitoring wildlife, dispersant application, treatments to shorelines and waters, as well as various activities associated with spill research, monitoring, and evaluation."*

Even after spill response and cleanup has occurred "aircraft and vessel operations would be supporting many longer term efforts for monitoring the recovery of resources, fate of oil and/or dispersants in the Arctic environment, and research and monitoring on the effectiveness of various cleanup and restoration practices" (BOEM 2015b). The effects and impacts of aircraft and vessels disturbance causes during response to a VLOS to seabirds, marine mammals and terrestrial mammals is described in Sections 4.10.6.10 through 4.10.6.12 and the affects to subsistence hunters is described in Section 4.10.6.15.

Local modes of transportation between communities by aircraft, vessels and surface means would be affected by a VLOS in nearshore and coastal areas. In the event of a VLOS, responders and additional response equipment would likely be transported to the airports of the Chukchi Sea communities. The Barrow airport could serve as a center for distributing responders and equipment to the smaller airports. As response efforts continue, the levels of air traffic to the areas affected in the Chukchi Sea would experience an increase in the numbers of flights arriving as additional response crews and supplies are transported to the affected areas. Air transportation within the state could also be indirectly affected as higher demand would occur for air travel to the spill area connecting from the Anchorage and Fairbanks airports. Increased levels of aircraft associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Use of local airports associated with spill response activities (resupply, transport of spill response crews) could strain local transportation infrastructure.

Vessels and equipment associated with response would be present in increased numbers. It is likely that local tug/barge and small vessel traffic between communities would be affected during the spill due to the increased numbers of response and support vessels present in nearshore areas. Increased levels of response and support vessels associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Local nearshore areas normally used for marine transportation between communities would experience and encounter vessels associated with spill response activities. This could strain the local patterns of existing transportation. It is likely that in response to a VLOS there would be impairment of normal operations with deployment of response workers, vessels and equipment affecting the exiting levels of transportation along the coastline of the Chukchi Sea communities.

Surface transportation in the summer months could also be interrupted in the event of a VLOS that reaches the nearshore areas and coastlines. Local modes of surface transportation (e.g., off-road vehicles) used by residents during subsistence activities along the coasts may also become oiled if traveling within these areas.

4.10.6.18.3 Conclusion

The conclusions for impacts to transportation in the Chukchi Sea would be of high intensity (potentially year round), and long-term in duration lasting one to two years or more during response and surveillance monitoring during recovery. The extent would be regional to statewide extent, and important in context. In summary, the impact of a VLOS on transportation would be moderate to major.

4.10.6.19 Recreation and Tourism

4.10.6.19.1 Existing Analysis (BOEM 2012)

The BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on recreation and tourism in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that effects from a catastrophic discharge event would likely include beach and coastal access restrictions, including restrictions on visitation, fishing, or hunting while cleanup is being conducted, and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be interim, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event (BOEM 2012).

4.10.6.19.2 Additional Analysis for Recreation and Tourism

Recreation and tourism occur at generally low levels of use in the Chukchi Sea. The effects of a VLOS for recreation and tourism will be described by setting and activities. It is important to distinguish between recreation and subsistence uses. The vast majority of fishing, hunting, and boating that occurs in the EIS project area are *subsistence*-based, managed completely apart from recreation-based activities, with separate rights and privileges (see Section 4.10.6.15, Subsistence for further discussion). This section discusses only recreation-based activities, a small portion of the human uses in the area.

The setting for recreation and tourism could be impacted by a VLOS, primarily the visitor experience of the recreation setting. If visitors recreating in the Chukchi Sea are expecting a fairly isolated and undeveloped recreation setting, the presence of response vessels, aircraft and support crews could alter the experience of the setting or the sense of place (Williams & Stewart 1998), as expectations of a pristine, isolated setting would not be met. The expectation for an isolated and undeveloped setting could be held by people traversing the area in vessels or commercial tours and recreationists using the coastal areas. Visual impacts are discussed in further detail in Section 4.10.6.21. The setting would also be adversely impacted by the physical presence of oil on the water and shoreline. The impact of the oil on the recreation setting would increase in effect as it spreads and reaches coastal areas. The appearance of water and coastline would be altered, presence or abundance and distribution of wildlife could change, and natural sounds could be supplanted by human-induced noise for spill response.

A VLOS could have a potential impact on the recreation setting including impacts on existence and bequest values (Schuster et al. 2005). Existence value refers to the knowledge that a particular resource exists and an emotional attachment to the resource, even if the place is never visited in person (Cordell et al. 2003, Rolston 1985) and bequest value refers to a desire to bequeath a natural resource to future generations (Cordell et al. 2003, Rolston 1985). A person who does not physically recreate in the Chukchi

Sea could hold existence or bequest values related to the Arctic environment. A VLOS would alter the recreation setting from a natural setting to a setting impacted by oil and response vessels. The experience of the recreation setting would also likely be altered, including the experience of recreationists that hold existence and bequest values related to the Arctic environment.

The main activities that would be affected by a VLOS are offshore and coastal activities. Offshore wildlife viewing may be adversely impacted by the presence of the response efforts if wildlife avoids these vessels or industrial sites. If wildlife populations decrease as a result of the VLOS, that would also impact wildlife viewing through decreased sitings. Nearshore activities are generally engaged in by residents of local communities, and levels of activity are low; but those that exist would have noticeable impacts. Recreation activities could also be displaced; recreationists may avoid the affected areas, choosing instead to recreate someplace else to avoid the VLOS areas as publicity of the spill increases.

4.10.6.19.3 Conclusion

Based on the criteria given in Section 4.1.3, the intensity of the VLOS on recreation and tourism is expected to be high; the VLOS would noticeably alter recreation in the study area. Offshore and coastal settings would be altered by the amount of vessels, aircraft, and support for response. As the oil moves from the offshore setting to the coastal setting, recreation resources would be highly impacted from the oil. Most recreation in the area occurs in or near the water, and activities would be affected by the presence of the response teams, and the oil; particularly wildlife viewing, fishing and yachting. The recreation setting and activities would be altered for interim duration, by the response teams and by the physical oil which could take over a year to clean or disperse, as well as impacts to existence and bequest values, which may last several years. Direct impacts to visitor setting and activities would be regional and could affect up to the entirety of the EIS project area. Indirect impacts to existence and bequest values would be considered state-wide based on the criteria because recreationists beyond the Chukchi Sea could hold existence and bequest values for the area.

The Alaska Maritime National Wildlife Refuge and Cape Krusenstern National Monument are within the EIS project area in the Chukchi Sea. Because these areas are federally designated and management includes public use, there is a perception of high recreation sensitivity in the area. Even though recreation opportunities across the Chukchi Sea are not scarce and not protected by legislation, the potential to impact recreation settings and activities in a national monument and public use of a national wildlife refuge, the context is considered important.

The impacts would be high intensity, interim duration, regional to statewide in extent, and important in context. In summary, the impact of a VLOS on recreation and tourism would be major.

4.10.6.20 Visual Resources

4.10.6.20.1 Existing Analysis (BOEM 2015b and 2012)

No analysis of impacts specific to visual resources is presented in the BOEM (2015b) or BOEM (2012) documents.

4.10.6.20.2 Additional Analysis for Visual Resources

A VLOS occurring in within the Chukchi Sea portion of the EIS project area has the potential to impact scenic quality and visual resources during Phases 2, 3, and 4 of the spill scenario. Potential impacts to scenic quality and visual resources are based on information presented in BOEM's LS 193 Final Second SEIS (BOEM 2015b), Section 4.44.5. (VLOS Scenario), 4.5.1 Appendix A (OSRA Model [Oil Spill Trajectories]), and Section 4.54.3.1 (Water Quality). Direct effects could include views of the incident observed from local on-land or at-sea vantage points, or from images displayed in various forms of image-based media (e.g., television, newspapers, and magazines). Indirect effects may include distress from witnessing the incident first hand, or observing accounts of the incident through the same image-based media described above. The intensity, duration and extent of impacts would depend on the magnitude of the release (i.e., how much oil was released, and for how long) and the timing (seasonality) and location of the event. For example, a spill that occurred in closer proximity to the shoreline would have less time to weather before reaching nearshore and shoreline areas, thereby increasing potential for impacts to these areas. Oil released from a spill occurring during the fall season would have a greater likelihood of being sequestered under forming ice pack, and consequently may be transported across large geographic areas through moving ice. For the purposes of this analysis, potential impacts to scenic quality and visual resources are discussed by Phases 1 to 4 of the spill scenario. It is further assumed that the constituency of viewers would expand beyond the local population, tourist, and/or recreational visitors in the area to include a broader public exposed to the VLOS via national (and international) media coverage.

Phase 1 (Initial Event)

The magnitude of impacts to scenic quality and visual resources is expected to be high during Phase 1 of the VLOS scenario. The explosion and resulting fire may be seen by individuals situated on marine vessels or those engaged in offshore subsistence activities. It is expected that air and marine traffic would be mobilized immediately to the location of the incident, resulting in a perceptible change in movement and activity in local communities (spill response and clean-up discussed further in Phase 4). Phase 1 direct impacts to visual resources would be local and temporary. Indirect effects, such as distress are expected to occur among a broad public as a result of viewing images of the explosion and fire.

Phase 2 (Offshore Spill)/Phase 3 (Onshore Contact)

The magnitude of impacts to scenic quality and visual resources is expected to be high during Phase 2 and Phase 3 of the VLOS scenario. Direct impacts are expected to result from first-hand observation or media-based observation of images of oil on the water surface and in contact with inland areas. Indirect effects could include distress from viewing oil on the water surface. The geographic extent and degree to which an offshore spill would affect on- and offshore locations outside of the EIS project area would depend on how far surface oil traveled (i.e., sequestration in moving ice, spreading through wind and wave action), and the amount that reached the shoreline. Although the duration of impacts under the VLOS scenario are expected to be interim, potential direct and indirect impacts resulting from Phase 2 and 3 scenarios could be longer depending on the persistence of oil, extent of affected area, and the degree to which seasonality influenced clean-up efforts.

Phase 4 (Spill Response and Cleanup)

The magnitude of impacts to scenic quality and visual resources is expected to be high during Phase 4. Direct impacts are expected to result from witnessing first-hand or through media outlets the perceptible change in activity level due to the presence of vessels, aircraft, skimmers, boomers, and actions associated with in-situ burning, animal rescue, introduction of dispersants, bioremediation, beach cleaning, and drilling of the relief well. Indirect effects could include distress from viewing response efforts, again either first hand or through media outlets. The duration of impacts under the VLOS scenario 4 is expected to be interim; long-term response efforts are discussed below (Phase 5).

Phase 5 (Long-Term Recovery)

The magnitude of impacts to scenic quality is expected to depend largely on the intensity, duration, and extent of Phases 2 and 3, and the effectiveness of efforts described in Phase 4. The magnitude of effects is expected to be highest in areas where oil is still visible on the surface of the water or on land, or where efforts to remediate water quality are underway. Indirect effects, such as distress from witnessing (viewing) the spill and subsequent response is expected to attenuate in Phase 5 – although, the degree to which such indirect effects are reduced is again dependent on the visibility of oil and the level of response still underway. Such indirect effects may persist due to knowledge or fear of contamination, regardless of whether evidence of such contamination is visible to viewers. It is assumed that media coverage would not continue at levels experienced in Phases 1 to 4, thereby reducing direct and indirect effects to sensitive viewers located outside of Alaska.

4.10.6.20.3 Conclusion

In conclusion, major direct and indirect impacts to visual resources are expected to result from a VLOS scenario. Impacts would be of high intensity, interim, regional to state-wide in geographic extent, and would affect an important resource.

4.10.6.21 Environmental Justice

4.10.6.21.1 Existing Analysis (BOEM 2015b and 2012)

Section 4.5.14 of the BOEM (2015b) describes potential impacts to environmental justice during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Environmental Justice impacts on Iñupiat Natives could occur because of their reliance on subsistence foods, and oil-spill impacts would affect subsistence resources and harvest practices, sociocultural systems, and human health. Depending on the trajectory of the VLOS, the Iñupiat communities of Barrow, Wainwright, Point Lay, and Point Hope, as well as the subsistence communities on the Russian Arctic Chukchi Sea coast, would all experience adverse impacts to varying degrees.

In the event of a VLOS in the Chukchi Sea, the Environmental Justice-related impacts described above would produce disproportionate, high, adverse effects in the Iñupiat subsistence-oriented communities of Barrow, Wainwright, Point Lay, and Point Hope and in Russian subsistence communities along the Chukchi Sea coastline.

In addition, the BOEM (2012) analysis provides some information about the impacts of a catastrophic discharge event on environmental justice in Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that many of the long-term impacts of a catastrophic discharge event on low-income and minority communities are unknown. Different cultural groups would likely possess varying capacities to cope with catastrophic events, with some low-income and/or minority groups more reliant on subsistence resources and/or less equipped to substitute contaminated or inaccessible subsistence resources with those purchased in the marketplace. Because lower income and/or minority communities may live near and be directly involved with catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects (BOEM 2012).

4.10.6.21.2 Conclusion

The impacts to subsistence foods and human health in the Iñupiat subsistence-oriented communities of Barrow, Wainwright, Point Lay, and Point Hope would be high intensity, long-term in duration, regional in extent, and unique in context. Therefore the summary impact level for environmental justice is major; there would be a disproportionate adverse effect to Alaska Native (minority) populations.

4.10.7 Beaufort Sea – Analysis of Impacts

The foundation for the analysis in Section 4.10.7 of this EIS is taken from the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2012), which contains the first post-DWH event scenario for the Beaufort Sea. Summaries of this information are provided in the applicable resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the Final Programmatic EIS (BOEM 2012) into this EIS by reference.

Summaries of information from the former MMS (now BOEM) FEIS for the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (MMS 2003) are also provided in this EIS where applicable. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information from BOEM's FEIS into this document by reference. The specific sections from MMS (2003) that are referenced in this EIS are noted in the appropriate sections of this document.

Analysis beyond what was presented in BOEM (2012) and MMS (2003) pertinent to this EIS is presented in each resource section. The information taken from BOEM (2012) and MMS (2003) is identified as "Existing Analysis," and the analysis beyond what was presented in those documents is listed as "Additional Analysis."

4.10.7.1 Physical Oceanography

4.10.7.1.1 Existing Analysis (BOEM 2012 and MMS 2003)

BOEM (2012) analysis describes the effects of the movement and weathering of spilled oil on sea ice and currents in the Beaufort Sea planning area. This information is incorporated herein by reference.

Section IV.I.1 of MMS (2003) describes the behavior of spilled oil from a possible VLOS in the Beaufort Sea under various oceanographic conditions. This information is incorporated herein by reference, and a summary of that information is provided here.

4.10.7.1.2 Additional Analysis for Physical Oceanography

The direction and rate of movement of a VLOS originating in the narrow (15 to 40 km [9 to 25 mi]) Beaufort OCS would depend largely upon the wind direction in the spill area. Winds in the narrow area where exploration activities would occur are predominantly from the northeast and would facilitate wind driven transport of oil westward along the Beaufort Sea coast. Under such conditions, Ekman transport would tend to move spilled oil north, away from the shore. In contrast, westerly winds would tend to move oil closer to shore. Barrier islands would provide some protection to the mainland shoreline from a VLOS event originating outside of the barrier islands.

Phase 1 (Initial Event)

Impact producing factors associated with a well control incident, such as explosion, fire, and redistribution of sediment would have minor effects on physical ocean resources within the EIS project area. Uncontrolled combustion of petroleum hydrocarbons in the environment would result in an increase in water temperature in the immediate vicinity of the fire. It is difficult to quantify the increase in water temperature that would result from fire associated a well control incident, but it is likely that the geographic extent of changes in water temperature would be limited to areas immediately adjacent to the fire, and the duration of such thermal effects would be temporary. Redistribution of seafloor sediments would have minor impacts on the seafloor topography in the immediate vicinity of the well control incident. Although effects resulting from redistribution of seafloor sediment would likely be permanent, the intensity of the effects would be low and the geographic extent would be limited to the immediate vicinity (probably within 1 km) of the well control incident. Sinking of the drilling rig to the sea floor would effectively create an artificial reef, which would have permanent, local, low-intensity effects on the physical character of the EIS project area. If the rig were to sink in shallow water it could be considered a navigational hazard. Overall, effects of the initial well control incident on the physical character of the EIS project area would be minor.

Phase 2 (Offshore Oil)

Oil in the water from a VLOS event would affect the physical character of the sea surface in the EIS project area. An oil slick covering hundreds of square kilometers of ocean surface would influence ocean-atmosphere interactions including exchange of gasses across the air-water interface and the generation of wind driven waves in the affected area. The presence of an oil slick at the sea surface would impede normal gas exchange across the air-water interface, but the impacts of such effects would likely be surpassed by the release of large quantities of methane, ethane, propane and other hydrocarbon gasses into the water column. The natural gas mixture released into the water during a VLOS event would have temporary effects on the dissolved gas content of seawater in the affected area. The presence of an oil slick at the sea surface would likely lead to decreases in the magnitude of wind-driven waves in the affected area. Effects on waves resulting from a VLOS would be low intensity, local, and temporary. Such effects would decrease concomitant with clean-up or partitioning of the oil into environmental compartments other than the sea surface. Due to limited water depths on the Beaufort Sea shelf, most fractions of the released oil would float to the surface and effects on the physical character of pelagic and benthic zones are expected to be minor during this phase of the VLOS. However, effects of an oil slick on the viscosity of the sea surface would be high-intensity and regional. The sea surface could be considered an important physical resource within the EIS project area because of its critical role in myriad chemical, physical and biological processes. Due to the viscosity and stickiness of spilled oil, the overall effects of offshore oil on the physical character of the ocean would be major. In addition, an oil slick would effectively decrease the freezing point of the affected seawater, and may have non-negligible impacts on the formation of sea ice in affected areas.

Phase 3 (Onshore Contact)

Exposure to oil would affect the physical character of the shoreline for reasons similar to those described above. Spilled oil would adhere to the shoreline and affect the composition of beach substrates.

Phase 4 (Spill Response and Cleanup)

Spill cleanup operations could have adverse impacts on the physical character of the ocean and shoreline. Minor impacts due to differential shoreline erosion would be possible if the removal of contaminated substrates affects beach stability.

In situ burning of oil result in high-intensity effects on sea surface temperature, but these effects would be temporary and spatially limited to the area of *in situ* burning operations. The use of dispersants would effectively move the impacts associated with spilled oil from the sea surface into the water column. Dispersed oil in the pelagic environment would affect the density and viscosity of the water, but these effects would be low-intensity, and would decrease as the dispersed oil is weathered, diluted, and degraded.

Phase 5 (Long-term Recovery)

Long-term direct effects on the physical character of the ocean would be negligible. Oil is a mixture comprised mostly of volatile and hydrophobic compounds. As a result of these properties, oil has a strong tendency to associate with non-aqueous phase materials. Oil associated with solid phase particles may remain on beaches and in sediments on the sea floor for extended periods of time, but the long-term effects of weathered oil in the environment are expected to be related to the chemical properties and potential toxicity of certain hydrocarbon compounds.

4.10.7.1.3 Conclusion

The overall effects of the VLOS on the physical character of the ocean would initially be high-intensity due to the viscosity and stickiness of oil floating at the sea surface. The duration of these impacts would be limited by the properties of oil that cause it to associate with non-aqueous phase materials. If *in situ* burning is used as a response technique, high-intensity short term impacts would occur to the physical character of the sea surface. The overall effects of the VLOS on the physical character of the Beaufort Sea in the EIS project area would be high-intensity, temporary, and would affect an area of hundreds of square kilometers. Overall impacts to physical oceanography would be classified as moderate due to their high-intensity and temporary duration.

4.10.7.2 Climate and Meteorology

4.10.7.2.1 Existing Analysis (BOEM 2012)

Discussions on GHG emissions in the existing BOEM (2012) analysis can be found in Sections 4.10.7.4 (Air Quality) of this EIS.

4.10.7.2.2 Additional Analysis for Climate and Meteorology

The VLOS scenario in the Beaufort Sea has the potential to impact climate change, especially during Phases 1 and 4 of the oil spill and cleanup scenario. These impacts are considered to be of the same nature and magnitude of those that could occur as a result of a VLOS in the Chukchi Sea (Section 4.10.6.3). The level of the impacts are expected to be of low magnitude, long-term duration, a minimum extent of state-wide, and unique in context. Therefore, the overall impact rating would be considered moderate.

4.10.7.3 Air Quality

4.10.7.3.1 Existing Analysis (BOEM 2012)

BOEM (2012), provides an analysis of the impacts of a catastrophic discharge event on air quality in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that evaporation of oil from a catastrophic discharge event, and emissions from spill response and cleanup activities including in situ burning, if used, have the potential to affect air quality in Arctic Alaska. The greatest impacts on air quality would occur during the initial explosion of gas and oil and during spill response and clean up, particularly if the event occurs during the winter. Impacts could continue for days during the initial event and could continue for months during spill response and clean up. Therefore, while the impacts may be large during these two phases, overall, the emissions from a catastrophic discharge event would be temporary and, over time, air quality in Arctic Alaska would return to pre-oil spill conditions (BOEM 2012).

4.10.7.3.2 Additional Analysis for Air Quality

As described above, a VLOS has the potential to temporarily impact air quality in localized areas in the Beaufort Sea. However, the MMS 2003 information is based on a smaller potential VLOS; the magnitude, extent, and duration of effects on air quality would likely be larger for a larger spill, with higher initial emissions and more cleanup activities required. The potential VLOS-related air quality impacts are expected to be the same (similar levels of effect) in the Beaufort Sea as in the Chukchi Sea. Therefore, based on the more detailed information provided in Section 4.10.6.4, a VLOS has the potential to impact air quality, particularly during Phases 1 and 4 of the oil spill and cleanup scenario.

4.10.7.4 Acoustics

4.10.7.4.1 Existing Analysis (BOEM 2012)

The BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on the acoustic environment in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis concludes that the pressure wave and noise generated from an incident involving a loss of well control would affect marine mammals and could be large enough to harass or disturb them if they were close enough to the site of the event. In addition, accident response and support activities, including support aircraft and vessel activity, have the potential to cause noise impacts. These impacts would occur both at the site of the response activity and along the routes of support vessels and aircraft. The duration and magnitude of the impacts would depend on the volume, location, duration, and weather conditions during the catastrophic discharge event, and the response and cleanup activities (BOEM 2012).

4.10.7.4.2 Additional Analysis for Acoustics

In the event of a VLOS, the acoustic environment could be changed by noise generating sources associated with the initial well control incident and with the subsequent cleanup effort. The impacts of a VLOS in the Beaufort Sea would be considered to be of the same nature and magnitude (minor to moderate) of those that could occur as a result of a VLOS in the Chukchi Sea, discussed in Section 4.10.6.5.

4.10.7.5 Water Quality

4.10.7.5.1 Existing Analysis (BOEM 2012)

The BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on water quality in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event in either coastal or marine waters could present sustained degradation of water quality from hydrocarbon contamination in exceedence of state and federal water and sediment quality criteria, and that these effects could be substantial depending upon the duration and area impacted by the spill. Additional effects on water quality could occur from response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring (BOEM 2012).

4.10.7.5.2 Additional Analysis for Water Quality

The above analysis of effects of a VLOS on water quality in the Beaufort Sea (MMS 2003) is based on a potential VLOS flow rate of 15,000bbl per day over 15 days totaling 225,000bbl, of which 20 percent evaporates, leaving 180,000 bbl spilled on an artificial island and surrounding Beaufort Sea waters. The VLOS scenario analyzed for the Chukchi Sea uses a spill size of 2.2MMbbl, which would have similar effects on water quality in the Beaufort Sea analysis (MMS 2003). If a VLOS event were to originate outside the barrier islands in the Beaufort Sea, the islands could afford some level of protection to nearshore water quality in sensitive areas. If a VLOS event were to originate inside the barrier islands, the geographic extent of the affected area could be constrained to some extent by the effects of the islands on transport of spilled oil. However, sensitive areas inshore of the barrier islands would be likely to experience high-intensity effects on water quality in the event of an oil spill occurring inside of the islands.

A spill of 2.2 MMbbl in the Beaufort Sea would result in elevated concentrations of petroleum hydrocarbons and related compounds in the water. Those concentrations would exceed both state and federal water quality criteria over large areas and for extended periods of time. A VLOS in the Beaufort Sea would have high-intensity effects on water quality. The duration of such effects could be long-term, and the geographic extent of the effects could be either regional or state-wide depending on the specific launch area, meteorological conditions at the time of the spill, and effectiveness of the response effort. Chemical response techniques, such as the use of dispersants, could result in additional degradation of water quality, which may or may not offset the benefits of dispersant use. Although water is generally considered a common resource, a VLOS in the Beaufort Sea could impact water quality in sensitive areas that are protected by legislation. Overall, a VLOS would have major effects on water quality in the Beaufort Sea.

4.10.7.6 Environmental Contaminants and Ecosystem Functions

4.10.7.6.1 Existing Analysis (BOEM 2012)

The BOEM (2012) analysis provides some information about the impacts of a catastrophic discharge event on ecosystem functions in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis states that sensitive benthic habitats could suffer long-term loss of ecological function because of both hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at sublethal concentrations in sediments for decades, and sensitive habitats (i.e., kelp beds, intertidal zones; live-bottom and coral reef) damaged by a spill would likely recover slowly and possibly not recover at all. However, hydrocarbons would be broken down by natural processes, and most benthic habitats are likely to eventually recover. Pelagic habitats would eventually recover their habitat value as hydrocarbons broke down and were diluted. Recovery time would vary with local conditions and the degree of oiling. Overall, impacts on habitats from hydrocarbon spills in open water could range from negligible to moderate, and impacts could be short term to long-term; no permanent degradation of pelagic habitat would be expected (BOEM 2012).

4.10.7.6.2 Additional Analysis for Environmental Contaminants and Ecosystem Functions

Impacts to ecosystem functions potentially resulting from a VLOS in the Beaufort Sea would be very similar to those described for the Chukchi Sea in Section 4.10.6.7 of this EIS, with several exceptions that are described below.

Potential locations for exploratory drilling activities are generally located closer to shore in the Beaufort Sea compared to the Chukchi Sea portion of the EIS project area. Due to the proximity of potential VLOS launch locations to sensitive nearshore habitats, a VLOS in the Beaufort Sea would have greater impacts on habitat functions relative to a similar event in the Chukchi Sea. Spawning and refuge habitats would be affected for most communities in the vicinity of the well control incident as discussed in other sections of this document. Impacts to coastal wetlands, tidal flats, and sheltered beaches would generally be greater than impacts to exposed gravel, cobbled beaches, or offshore areas (Gundlach and Hayes 1978). The effects of a VLOS on habitat functions in the Beaufort Sea would be high-intensity and regional scale. Overall impact of a VLOS on habitat functions in the Beaufort Sea would be major.

Response and clean-up activities could have intense effects on habitat functions in sensitive areas. For example, the use of hot water hydraulic washing to clean oiled shoreline could destabilize physical substrates causing adverse impacts to spawning and refuge habitats for coastal species.

Persistence of oil in sediments may have negative long-term effects on habitat functions within the affected area. Long-term effects on habitat functions would be limited to areas where oil may become trapped in sediments or other substrates, and shielded from weathering and degradation. Long-term effects on habitat functions would be local and medium intensity, but would have the potential to affect unique resources depending upon the location of the discharge and the efficacy of the response effort. Due to the prevalence of barrier islands in the Beaufort Sea portion of the EIS project area that shelter the coastline from wave action and weathering processes, it is probable that long- term adverse effects of a VLOS on habitat functions would persist over greater geographic areas in the Beaufort Sea relative to the Chukchi Sea. In addition, presence of oil would be likely to affect production functions by inhibiting the germination and growth of many species in the Beaufort Sea area. However, robust primary producers such as Arctic Kelp (*Laminaria solidungula*), which dominates the Boulder Patch community in Stefansson Sound, would be likely to recover rapidly subsequent to clean-up. Some studies show that complete recovery of high-arctic boulder communities in the Beaufort Sea may take a decade or more, especially if entire organisms are removed. However, if removal is partial, recovery can be quicker, particularly in low sediment areas (Konar 2013). Thus, overall levels of photosynthesis and primary production would decrease temporarily, but would likely return to pre-VLOS levels within several years after the cessation of clean-up activity.

4.10.7.6.3 Conclusion

Effects of a VLOS on ecosystem functions in the Beaufort Sea would be high intensity, long-term, regional, and could affect unique resources. Overall, the effects of a VLOS on ecosystem functions in the Beaufort Sea would be considered major. However, with few exceptions, the ecosystem functions in the VLOS area would likely recover within several years of the cessation of clean-up activities. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e., resistant to stressors) than are species composition and other structural properties. As suggested by Peterson et al. (2003), a VLOS event would be likely to affect ecosystem structure over timescales of decades; ecosystem functions, from which humans derive value, would be likely to recover more quickly.

4.10.7.7 Lower Trophic Levels

4.10.7.7.1 Existing Analysis (BOEM 2012 and MMS 2003)

The BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on invertebrates and lower trophic levels in the Beaufort Sea. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could affect a large number of benthic and pelagic invertebrates and their habitats. The location of the spill and the season in which the spill occurred would be important determinants of the impact magnitude of the spills. Hydrocarbon releases contacting the Stefansson Sound Boulder Patch community could have direct impacts on organisms inhabiting the area. The magnitude of impacts to the Boulder Patch would depend on the location and severity of the spill (BOEM 2012).

Section IV.1.2.b of MMS (2003) describes potential impacts to lower trophic level organisms during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Large-scale effects on marine plants from oil spills have been observed in the intertidal and subtidal zones of other regions. Some studies show that complete recovery of high-arctic boulder communities in the Beaufort Sea may take a decade or more, especially if entire organisms are removed. However, if removal is partial, recovery can be quicker, particularly in low sediment areas (Konar 2013).

A very large oil spill probably would affect half of the planktonic organisms in about half of the sound, or a total of about one-quarter of the Stefansson Sound plankton. Because of their wide distribution, large numbers, and rapid rate of regeneration (12 hours), there would be only a temporary, local effect on the planktonic community. The recovery of the community would be complete within 1-2 weeks (the estimated flushing time for Stefansson Sound).

Some lower trophic-level organisms on the shorelines would be adversely affected. Use of dispersants on a spill near benthic kelp communities would mix the oil farther down into the water column and could affect the kelp community. However, the use of dispersants is not essential for spill response; their use would require further approval by the Coast Guard.

4.10.7.7.2 Additional Analysis for Lower Trophic Levels

The oil spill discussion in MMS (2003) analyzed the effects of an oil spill of 180,000 bbls, but for the purposes of this EIS, a VLOS of 2.2 MMbbls occurring over a 74-day period is considered for the Beaufort Sea. Although the impacts to lower trophic levels would be similar regardless of the size of the spill, the magnitude, duration, and extent would be substantially greater with a larger spill.

The existing leases in the Beaufort Sea are much closer to shore than those in the Chukchi Sea, with most leases within 56 km (35 mi) of the shore, and in shallower waters. A VLOS could therefore have a greater impact on nearshore habitats, although some impacts could be mitigated by the extensive barrier islands protecting the Beaufort Sea coastline. These islands may protect many of the bays and lagoons in the nearshore habitat from exposure to oiling unless the spill occurs within the barrier islands. Although MMS (2003) determined that up to half of the coastline could be oiled in an 180,000-bbl spill, a larger spill could impact more coastline. No modeling was performed for the Beaufort Sea analysis, but prevailing winds are generally easterly through mid-July, and then shift to westerly in August. Over the course of a 74-day spill, there would likely be a net westerly movement, blowing the oil onshore and affecting any portion of the coastline.

As the lower trophic level organisms in the Beaufort and Chukchi seas are very similar, the extensive analysis performed by BOEM (2012) for the Chukchi Sea (Section 4.10.6 of this EIS) can be largely applied to the Beaufort Sea. The most likely impacts to lower trophic levels include:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Impact to food web through bioaccumulation and biomagnification as a result of the close interactions between megafauna (i.e., whales, seals, walruses) and lower trophic organisms (Dunton et al. 2005; Grebmeier et al. 2006) (see Section 4.10.6.11 for more information regarding the effects of bioaccumulation and biomagnification on marine mammals);
- Longer recovery rates due to species traveling outside the original contamination site or being consumed later, thereby prolonging the recovery, as a result of drift or diapause (a forma of hibernation), respectively. This would delay recovery since these species surviving the initial incident, would store toxins and be consumed at a later date by higher trophic level organisms (MMS 2004; Jiang et al. 2010; Brodersen 1987); and
- Habitat loss due to oiling of ice or benthic substrate and the resultant mortality events or decrease in primary productivity.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Duration and volume of the spill;
- Distribution and geographic coverage of surface oil slicks;
- Persistence and dispersion of oil in the water column (epontic, pelagic, or benthic);
- Chemical composition of the oil;
- Efficacy of chemical dispersants;
- Incorporation of spill into first year ice; and
- Weather patterns, including hours of daylight and UV intensity, presence or absence of ice, and presence or absence of polynyas and reaches.

Depending upon the factors discussed above, a VLOS in the Beaufort Sea could have a summary impact level of major, should the spill persist in the environment or affect unique resources. However, should the spill not last a long time or affect unique resources, the impacts to the lower trophic levels would be of low to medium magnitude, short-term duration, local to regional geographic extent, and common context. In this case, the impact criteria listed above would lead to a summary impact level of moderate due to the shorter duration and regional impacts to common resources.

4.10.7.8 Fish and Essential Fish Habitat

4.10.7.8.1 Existing Analysis (BOEM 2012 and MMS 2003)

BOEM (2012), provides an analysis of the impacts of a catastrophic discharge event on fish in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have population-level consequences on some fish populations if vital habitat areas were affected or if the spill occurred in spawning areas or juvenile feeding grounds when fish populations are highly concentrated (e.g., the Arctic cisco population concentrated near the Colville River). In such cases, catastrophic spills could cause substantial reductions in population levels for one or more years.

Sections IV.1.2.c and IV.I.2.d of MMS (2003) describe potential impacts to fish and essential fish habitat during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Fish

Fish distribution in the Beaufort Sea varies seasonally as many species move from offshore to nearshore environments. Therefore, a VLOS that reached the shore would have a much greater effect in summer and autumn when these fish species are nearshore feeding and spawning than in winter when many of these species are once again offshore. Based on the Oil-Spill-Risk Analysis model (MMS 2003, Table IV.I-9a), the nearshore areas of highest chance of contact include Land Segments 31-37. If a 180,000-barrel oil spill occurred, these land segments would have a 0.5-8% chance of being contacted in 30 days. According to MMS (2003) Tables IV.I-6a and IV.I-6b, a 180,000-barrel oil spill would contact about 300 kilometers of coastline, which is about seven times that estimated for the 4,600-barrel oil spill associated with Alternative I for Sales 186, 195, and 202. However, the combined probability of one or more spills occurring and contacting the nearshore area is low. If it did occur, some marine and migratory fish might be harmed or killed. The number affected would depend on the size of the area affected, the concentration of petroleum present, the time of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive). If lethal concentrations were encountered, or sublethal concentrations were encountered over a long-enough period, fish mortality would be likely to occur. However, mortality due to petroleum-related spills is seldom observed outside of the laboratory environment. This is because the zone of lethal toxicity is very small and short lived under a spill, and fishes in the immediate area typically avoid that zone. Mortality would be expected only in cases where fishes were somehow trapped in a lethal concentration and could not escape.

If oil were to reach the shore and become buried in intertidal and/or subtidal sediments, it likely would be released back into the water column at a later time. However, the amounts of oil released in that manner are likely to be relatively small over time, and fish density in Beaufort Sea coastal waters also is relatively low most of the year. While a 180,000-barrel oil spill would be expected to affect about 300 kilometers of nearshore waters and coastline, it would be likely to have mostly sublethal effects (for example, changes in growth, feeding, fecundity, and temporary displacement) on marine and migratory fish. Juvenile fish (e.g., Arctic cod), which are common in the nearshore area during summer, or nearshore spawners (e.g., capelin) are among those most likely to be adversely affected. Some fish in the immediate area of a spill may be killed; however, it is not expected to be a measurable effect on marine and migratory fish populations. Recovery of the number of fish harmed or killed would be expected within 10 years.

Oil-spill-cleanup activities, whether on ice or for oil entrained in the ice, are not expected to adversely affect fish populations. It is possible that a containment boom could trap some oil in a shoreline area and temporarily contaminate that area long enough to affect fishes or their food resources. In general however, reducing the amount of oil in the marine environment is expected to have a beneficial effect on fishes, because it reduces the possibility of hydrocarbons contacting them and their food resources. The extent of that benefit would depend on the actual reduction in the amount of oil contacting fish and their food resources, as compared to that of not reducing the amount of contact.

Essential Fish Habitat

BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on EFH in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could cause long-term declines of fish species that rely on shallow coastal, intertidal, and freshwater areas. Spills occurring under ice could result in long-term degradation of EFH because of the cleanup difficulties; severity of effects of hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH (BOEM 2012).

4.10.7.8.2 Additional Analysis for Fish and Essential Fish Habitat

The most likely impacts to fish resulting from a VLOS are:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Reduction of individual fitness and survival due to physiological contaminant effects. These effects can, in turn, affect swimming, feeding, reproductive and migratory behaviors and the physiologic adjustment for anadromous fish as they move between freshwater and saltwater environments; and
- Onshore and offshore habitat loss due to oiling, resulting in displacement and stress. Displacement could result in blocked or impeded access to spawning, rearing, feeding, and migratory habitats important for survival.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Location and time of year of the oil spill;
- Life stage affected (egg, larvae, juvenile, adult) and life history (anadromous, migratory, reproductive behaviors and cycle, longevity);
- Species distribution and abundance;
- Species exposure and sensitivity to oil and gas (toxicology, swimming ability); and
- Habitat dependence (marine vs. freshwater, onshore vs. offshore, location of spawning habitat, depth).

Based on the five oil spill phases described in BOEM (2012), the greatest impacts in the Beaufort Sea could be felt during Phases 2 and 3, particularly in benthic and nearshore regions. The fish typically found in these areas are more susceptible to impacts from a VLOS due to their increased dependence on relatively limited habitat when compared to pelagic fish, or decreased swimming ability resulting in an inability to escape impacted areas. Most impacts to habitat could be short-term in duration, with shoreline and substrate impacts lasting longer. The fish assemblages with an increased susceptibility include:

- Migratory and juvenile fish that use nearshore habitat, shallow lagoons, estuaries, and bays;
- Benthic fish, which are typically poor swimmers; and
- Cryopelagic species such as Arctic cod, should the spill occur in winter or get entrained in seasonal pack ice.

In general, the leases in the Beaufort Sea are much closer to shore than those in the Chukchi Sea, with most less than 56 km (35 mi) from shore, and in shallower waters. A spill could therefore have an even greater impact on nearshore habitats, although it could be mitigated to some degree by the extensive barrier islands protecting the Beaufort Sea coastline. Spills within the barrier islands would likely have a greater impact on nearshore habitats relative to spills seaward of the barrier islands. These islands may protect many of the bays and lagoons in the nearshore habitat to their landward side from exposure to oiling. Although MMS (2003) determined that up to half of the shoreline could be oiled in a 180,000 bbl spill, a larger spill could impact more shoreline. No modeling specific to the Beaufort Sea was performed, but prevailing winds are generally easterly through mid-July, and then shift to westerly from August onward. Over the course of a 74-day spill, there would likely be a net westerly movement, blowing the oil onshore. There is a possibility that any portion of the coast could be affected by a spill, but not the whole coast at one time.

The types of effects to EFH would be very similar to those described in Section 4.10.6.9. The biggest concern for fish resources is not oil in the open ocean, but in nearshore waters and along the coast, where it can interfere with juveniles and spawning habitat. It can also be very disruptive in estuaries, lagoons, and bays, where many fish congregate and are not able to escape as easily as their pelagic counterparts can in the open ocean.

Most fish and EFH within the EIS project area are common or important resources. However, the impacts from a VLOS could be of high intensity, long-term duration, and occur over a broad, regional extent. Therefore, according to the criteria laid out in Table 4.5-16, the overall summary impact level of a VLOS could be major.

4.10.7.9 Marine and Coastal Birds

4.10.7.9.1 Existing Analysis (BOEM 2012 and MMS 2003)

The BOEM (2012) analysis and Section IV.I.2 of MMS (2003) describe potential impacts to marine and coastal birds during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

A catastrophic discharge event is expected to cause spectacled eider mortality, if females with recently fledged young contact stranded oil in coastal habitats, or flocks of adult eiders or females with young feeding in lagoons and OCS waters are contacted by a spill sweeping over thousands of square kilometers. A winter spill released from the ice in spring could contact eiders concentrated in open water of river deltas. Substantial mortality that could result from such a large spill would represent a substantial loss for the relatively small Arctic Coastal Plain spectacled eider population, requiring many generations for recovery. Recovery is not likely to occur while the regional population is in declining status. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the loss of oiled individuals. Although Fish and Wildlife Service survey data do not show a substantial decline in the coastal plain spectacled eider population, the potential exists for a substantial adverse effect from an oil spill on this regional population. Mortality of a few Steller's eiders also would represent a substantial loss to its small regional population.

A 180,000-barrel oil spill in open water assumed for this analysis is expected to result in the loss of thousands of brood-rearing and young waterfowl and shorebirds if they contact stranded oil along a substantial proportion of the affected shoreline. In lagoon habitats, observed high densities of long-tailed ducks suggest that on some occasions, tens of thousands of molting individuals could be contacted by a spill sweeping over thousands of square kilometers, representing a substantial loss from the regional population. Likewise, contact of substantial numbers of post-breeding common eiders in the vicinity of barrier islands or Ross' gulls in the vicinity of Point Barrow, August through September could result in substantial losses. Recovery is not expected to occur while specific populations are in declining status. A winter spill entering the environment after the ice melts in the spring could contact loons and other migrant waterfowl concentrated in open water near river deltas. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the losses of oiled individuals.

4.10.7.9.2 Additional Analysis for Marine and Coastal Birds

Direct and indirect exposure to oil is an impact producing factor that can affect marine and coastal birds. The increase from a 180,000 bbl oil spill to a 2.2 MMbbls spill could cause adverse effects to marine and coastal birds that may be longer in duration and cover a larger area then those explained above in the MMS (2003) analysis. The level of effect is dependent upon the timing of the VLOS, the seasonal effects of currents and subsequent advection of oil, timing, and duration of the oil spill, presence or absence of fast or pack ice, location (within important areas or outside) and general weather patterns (wind and storm events). In accordance with criteria established in Section 4.1.3 of this EIS, if a VLOS occurs in critical habitat areas, the magnitude of impacts to marine and coastal birds could be medium to high, with displacement from the area, impacts to prey resources and habitat quality, and a likelihood of injury or mortality from either direct contact with or ingestion of oil and associated contaminants. The duration of the impacts could be long-term, because critical habitat areas could be abandoned or large portions of the population could be affected. The geographic extent could be state-wide due to migrating, molting and breeding bird populations. See Section 4.10.6.10 for more information about critical habitat areas. If the VLOS would occur outside critical habitat areas the effects could be the same except the duration could be interim rather than long-term. The chance of recovery could be greater due to less birds likely being affected, compared to a higher concentration of birds that could be found in many important habitat areas at certain periods of time.

Population level effects are likely, given the high concentration of migrating, molting and breeding bird populations, a VLOS in the Beaufort Sea during the lifetime of this EIS could result in a major impact to marine and coastal birds. This is due to the potential adverse effects to population levels, habitat, molting and breeding areas, important habitat areas, toxicity to prey and individuals, and mortality of individuals.

4.10.7.10 Marine Mammals

4.10.7.10.1 Existing Analysis (BOEM 2012 and MMS 2003)

BOEM (2012) provides an analysis of the impacts of a catastrophic discharge event on marine mammals in Arctic Alaska. The Programmatic Environmental Impact Statement (PEIS) analyzes a catastrophic discharge event of 1.7 to 3.9 million bbl for the Beaufort Sea. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would impact marine mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects would be substantial, causing a multitude of acute and chronic effects. Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbances from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A catastrophic discharge event has the potential to increase the area and duration of an oil spill, thereby increasing the potential for population-level effects, or at a minimum, an increase in the number of individuals killed. For example, a catastrophic discharge event contaminating ice leads or polynyas in the spring could have devastating effects, trapping bowhead whales where they may encounter fresh crude oil. Beluga whales that also use the spring lead system to migrate would also be susceptible to a spill that concentrates in these leads (BOEM 2012).

Section IV.I.2.e(1) Bowhead Whales and IV.I.2.g Marine Mammals of MMS (2003) describes potential impacts to marine mammals during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Bowhead Whales

It is likely that some bowhead whales would experience temporary, nonlethal effects, including one or more of the following symptoms:

- oiling their skin, causing irritation
- inhaling hydrocarbon vapors
- ingesting oil-contaminated prey
- fouling of their baleen
- losing their food source
- temporary displacement from some feeding areas

Some whales could die as a result of contact with spilled oil, particularly if there is prolonged exposure to freshly spilled oil, such as in a lead. The extent of the effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. If spilled oil moved into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed. Under some circumstances, some whales could die as a result of contact with spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small.

Based on conclusions from studies that have looked at the effects of oil spills on cetaceans, exposure to spilled oil is unlikely to have serious direct effects on baleen whales. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects from oiling of the skin, inhaling hydrocarbon vapors, ingesting contaminated prey, fouling of their baleen, reduced food source, and displacement from feeding areas. Exposure of bowhead whales to spilled oil could result in lethal effects to some individuals.

The effect of a very large oil spill is expected to be fairly long-term (1-2 generations, about 15 years) on pinnipeds and polar bears and short term (about 1 year) on beluga whales.

4.10.7.10.2 Additional Analysis for Marine Mammals

The introduction to Section 4.10.5 describes the approach used to extrapolate the estimated spill volume from a VLOS of 180,000 bbls discussed in MMS (2003) to 2.2 MMbbls considered in this EIS and in the following conclusions. With at least an order of magnitude increase in the volume of oil spilled in the current scenario, it can be assumed that the area impacted by such a spill and the volume persisting over time will greatly exceed that calculated by MMS (2003).

4.10.7.10.2.1 Cetaceans

Conclusions regarding potential effects of a VLOS on cetaceans in the Beaufort Sea will be addressed separately for each potentially affected species. Fin whales, humpback whales, minke whales, killer whales, harbor porpoise, and narwhals were omitted from the above MMS (2003) analysis and the following additional analyses due to their absence from or rarity in the Alaskan Beaufort Sea.

Bowhead Whale

Bowhead whales are vulnerable to oil spills in the Beaufort Sea while feeding during late summer and fall and during the westward migration across the region throughout the fall. If the spill occurs in the winter, or if oil persists in ice over winter, bowheads migrating through the lead system during the spring could be impacted.

If injury and/or mortality were to occur, it would most likely occur during the oil spill phase of a VLOS. Contact through the skin, eyes, or through inhalation and ingestion of fresh oil could result in temporary irritation or long-term endocrine or reproductive effects, depending on the duration of exposure. Multiple injuries or mortalities may result from exposure to aggregations, such as feeding aggregations, of bowhead whales during the summer or fall. The nearshore areas from Harrison Bay to Kaktovik are habitat areas of particular concern, as this is the region of highest concentration of active oil leases and an important late-summer and fall feeding, milling, and migration corridor for bowhead whales (Clarke et al. 2011b). Bowhead mothers and calves congregated in the nearshore waters of Camden Bay in disproportionate numbers in 2008 (Koski and Miller 2009) although this has not been seen in the last few years. The bowhead whale feeding “hot spot” that regularly forms during late summer and fall northeast of Point Barrow to Smith Bay is another area of high concentrations of bowhead whales that could be substantially impacted by a VLOS in the Beaufort Sea. This area is to the west of the majority of the federal leases but in close proximity to state leases in Smith Bay. Westerly winds late in the season may limit the initial movement of oil into this area, but easterly winds could do otherwise. In addition, oil persisting months to years after the initial spill either in sediments or sea ice, could have long-term ramifications on habitat quality and prey resources in these important fall feeding areas. Direct mortality of zooplankton may occur, and accumulation of toxins in the lipids of copepods could, through ingestion, bioaccumulate in bowhead whales. Bowhead whales that feed at or near the seafloor could continue to contact and ingest oil and dispersants that settled on and persist in seafloor sediments (Section 4.10.6.11 of this EIS).

The entire population of Western Arctic bowhead whales passes through the Beaufort Sea at least twice each year while migrating from and to the Bering Sea and eastern Beaufort Sea and Amundson Gulf. The whales are dependent on lead systems during spring migration, which leaves them susceptible to oil entrained in sea ice that melts out the following spring. The fall migration corridor is less well defined, with some whales migrating near shore and others offshore. Those travelling farther offshore and not stopping to feed in the areas noted above may avoid contact with oil and associated clean-up activities. The remainder could encounter at least some portion of a VLOS were one to occur in the Beaufort Sea. Bowhead whales are exceedingly long-lived (150+ years [George et al. 1999]), increasing the chances of continued exposure to oil, contaminants, and clean-up activities that persist for years after an initial spill.

Based on criteria established in Section 4.1.3, the magnitude of the resulting impact from a VLOS in the Beaufort Sea could be high. The duration of effects could range from temporary (such as skin irritations or short-term displacement) to long-term (e.g., endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as off Barrow, or along the migratory corridor, the effects may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of bowhead whales. Bowhead whales are a unique resource, as they are a centerpiece of the Iñupiat subsistence lifestyle and listed as endangered under the ESA. Population level effects are possible if a VLOS event coincided with and impacted a large feeding aggregation of bowhead whales during the open water season, particularly if calves were present. Mothers with young calves are also vulnerable to potential exposure to oil in the lead system during the spring migration. A VLOS could result in major impacts on bowhead whales.

Beluga Whale

Beluga whales from both the eastern Chukchi Sea and Beaufort Sea stocks are most vulnerable to a VLOS in the Beaufort Sea during spring and fall migrations. They are largely absent from the area during summer months. Suydam et al. (2005) found that use of the inshore waters within the Beaufort Sea OCS lease sale area was rare during that time. Most of the fall migration occurs offshore of the oil lease areas in the Beaufort Sea. The Beaufort Sea stock migrates westward in September from the eastern Beaufort

Sea either far offshore of the Alaskan coastal shelf, on the shelf edge, or near the continental slope (Richard et al. 2001). Beluga whales regularly sighted during September-October surveys of the Alaska Beaufort Sea coast are distributed offshore along the shelf-break and slope areas, including in Barrow Canyon (Clarke et al. 2011b, 2011c). Under conditions of prevailing easterly winds, oil from a VLOS could disperse offshore where contact with belugas is possible. If prevailing dispersal is shoreward, most belugas could be outside of and avoid the areas of greatest impact. Oil concentrated in the spring lead system could impact the Beaufort stock as they migrate eastward during the spring through direct contact or ingestion of oil. Belugas could also be affected through secondary contamination of prey.

In accordance with criteria of Section 4.1.3 of this EIS, the magnitude of impacts on individual beluga whales could range from medium to high, depending on the extent of oil dispersal and level of injury or mortality resulting from contact. The duration of impacts could range from temporary skin irritations to long-term endocrine or reproductive failure if ingested, and the extent could be state-wide due to the migratory nature of belugas. Belugas are considered unique because of their importance as a subsistence resource. Lasting population level impacts could depend on the extent of the spill. The entire Beaufort Sea stock migrates through the Beaufort Sea twice annually and, if contact with a spill were unavoidable, a large portion of the stock could be impacted. A VLOS could have a major impact on beluga whales in the Beaufort Sea.

Gray Whale

Gray whales may be vulnerable to direct impacts from a VLOS in the Beaufort Sea if the spill extends sufficiently westward. Most summer feeding aggregations of gray whales are on the Chukchi Sea side of Point Barrow. Gray whales are observed feeding in late-summer and fall on the Beaufort Sea side of Point Barrow, although rarely east of Smith Bay (Clarke et al. 2011b, 2011c). MMS (2003) estimated a 0.5 to 6 percent chance that oil spilled in the Beaufort Sea lease area during the open water season would move sufficiently westward to contact the feeding area used by gray whales. Given that, small numbers of gray whales may encounter a VLOS, although larger aggregations will likely be outside of the impact area. Based on criteria of Section 4.1.3 of this EIS, the magnitude of impact from a VLOS on individual gray whales in the Beaufort Sea could be medium to high, depending on level of injury or mortality. Duration could range from temporary (minor skin irritations) to long-term (loss of habitat), and extend state-wide, given that gray whales migrate well beyond the Beaufort Sea to as far south as Mexico. The species is no longer listed as endangered, so it could be considered an important resource. A population level impact is unlikely, assuming oil from a VLOS in the Beaufort Sea remains within the Beaufort Sea. A VLOS in the Beaufort Sea could have a moderate to major impact on individual gray whales.

4.10.7.10.2.2 Ice Seals

The impact of a VLOS on ice seals in the Beaufort Sea may vary by habitat requirements, prey preferences, and seasonality of occurrence in the area, among other factors. Potential impacts are, therefore, discussed separately for each species. Ribbon seals are omitted from this section due to their rarity in the Beaufort Sea.

Bearded Seal

Bearded seals may occur in the Beaufort Sea year round and are commonly sighted throughout the Beaufort Sea shelf area (Clarke et al. 2011b, 2011c). They could, thus, be vulnerable to impacts from encountering fresh oil in open water and residual oil in sea ice, leads, and polynas, as well as associated VLOS clean-up activities. Direct contact with oil could result in large-scale injury or mortality events, particularly if it occurred in a polyna or lead system in which bearded seals aggregate. Bearded seals are benthic feeders and are restricted to shallow shelf areas for feeding. Damage to these areas and prey resources could cause long-term displacement and possible loss of fitness due to inadequate prey availability. Based on criteria of Section 4.1.3 of this EIS, impacts of a VLOS on bearded seals could be of medium to high intensity and of temporary to permanent duration, depending on extent of habitat loss, injury, or level of mortality. The geographic extent could be regional to state-wide, depending on how far bearded seals could be displaced or need to search for alternative habitat. Bearded seals are a unique resource in the Beaufort Sea due to their importance as a subsistence resource for coastal communities, as well as a recent proposal to list the species as threatened under the ESA. Population level impacts are possible if large portions of important benthic habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals, resulting in large-scale injury or mortality. A VLOS in the Beaufort Sea could have a major impact on bearded seals.

Ringed Seal

Ringed seals occur in the Beaufort Sea year round, where they are closely associated with sea ice. Ringed seals are the most commonly sighted pinniped during fall aerial surveys of the Beaufort Sea shelf and are broadly distributed across the area (Clarke et al. 2011b, 2011c). During the open water season, they spend more time in the water foraging, leaving them vulnerable to impacts of a VLOS during that time of the year. During winter and spring, they associate with shorefast ice where ice entrained oil may persist. The intensity, duration, and extent of impacts of a VLOS on ringed seals are similar to that anticipated for bearded seals (see above). Ringed seals are so are considered a unique resource because they are hunted for subsistence by Alaska Natives from communities along the coasts of the northern Bering, Chukchi, and Beaufort Seas. Population level impacts are possible if large portions of important habitat and prey are unavailable, and if contact with a VLOS occurred in areas of high concentrations of seals resulting in large scale injury or mortality. Based on criteria of Section 4.1.3 of this EIS, a VLOS in the Beaufort Sea could have a major impact on ringed seals.

Spotted Seal

Spotted seals may be vulnerable to impacts of a VLOS in the Beaufort Sea, where they are known to occur in nearshore areas and occasionally haul out. Spotted seals could be susceptible to impacts of floating oil in foraging areas in open water, oil that washes ashore in coastal areas, and the multitude of activities associated with clean-up, from boom deployment to vessels and airplanes. Displacement from important habitat areas is possible, as are direct impacts from contact with oil and dispersants. Based on criteria of Section 4.1.3 of this EIS, impacts of a VLOS on spotted seals could be of medium to high intensity and of temporary to permanent duration, depending on the extent of habitat loss, injury, or level of mortality. The geographic extent could be state-wide given the migratory behavior of spotted seals. Spotted seals are an important species for Alaskan subsistence hunters, so are considered a unique resource. Population level impacts are possible if large portions of important habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. A VLOS in the Beaufort Sea could have a major impact on spotted seals.

4.10.7.10.2.3 Pacific Walrus

Walruses are most susceptible to impacts of a VLOS during the summer months and can be affected at sea, on ice floes, or onshore. Walrus distribution in the Beaufort Sea is generally limited to waters north and east of Point Barrow, in the vicinity of Barrow Canyon, and only occasionally east of Smith Bay (Clarke et al. 2011b). There have been no large onshore aggregations of walruses in the Beaufort Sea as are seen along the Chukchi Sea coast. The likelihood of walruses contacting a VLOS in the Beaufort Sea is similar to that described above for gray whales. Assuming that impacts of a VLOS occurring in the Beaufort Sea remain in the Beaufort Sea, small numbers of walruses could be affected (e.g., of the 32 sightings (281 individuals) of walruses during BWASP surveys, 2006 to 2009, only three were east of Barrow Canyon [Clarke et al. 2011b, 2011c]). The larger aggregations in the Chukchi Sea will likely be outside of the impact area. Walruses that do encounter a VLOS could experience impacts associated with physical contact with the skin and membranes, inhalation of fumes, and impacts on benthic prey. Impacts of oil and dispersants on benthic prey resources (such as contamination or mortality) could have lasting impacts on prey and habitat availability for walruses in the Beaufort Sea. Based on criteria established in Section 4.1.3 of this EIS, impacts of a VLOS on individual walruses could be of medium to high intensity, duration could range from temporary displacement to long-term injury or displacement from important habitat, and the geographic extent could be state-wide due to the migratory behavior of walruses. Walruses are an important subsistence species for several communities along the Bering and Chukchi Sea coasts of Alaska and the coast of Chukotka (Russia), so are considered a unique resource. Population level impacts are unlikely, unless oil disperses into the Chukchi Sea areas where large aggregations haul-out and feed. A VLOS in the Beaufort Sea could have major impacts on walruses.

4.10.7.10.2.4 Polar Bear

A VLOS in the Beaufort Sea could involve either the CBS or the SBS during the open-water season and the SBS stock at other times of the year, including during denning. Polar bears are vulnerable to impacts of a VLOS in the Beaufort Sea across a range of habitats and VLOS-related activities. They could directly contact oil in offshore areas during the summer open water period or the broken ice period during the fall, as it comes ashore on barrier islands and coastal regions, and experience disturbance impacts of clean-up activities originating from onshore localities. Polar bear occurrence onshore increased in recent years, likely in response to retreating ice conditions offshore (Schliebe et al. 2006). Polar bears are common in the fall near or onshore between Cape Halkett and Kaktovik (Clarke et al. 2011b, 2011c), the area that encompasses most of the active leases in the Beaufort Sea. Polar bears from the SBS stock den on both sea ice and in snow drifts on land, with an increasing percentage now denning on land (Fischbach et al. 2007). Primary terrestrial denning areas include barrier islands from Barrow to Kaktovik and coastal areas up to 25 miles inland, including ANWR to Peard Bay (Allen and Angliss 2010). Important habitats could be impacted and suitability for use compromised by direct contamination from oil or chemical dispersants or by access being hindered by floating oil and subsequent clean-up activities (including disturbance caused by increased vessel and aircraft activity).

Based on criteria of Section 4.1.3 of this EIS, impacts of a VLOS on polar bears could be of medium to high intensity, particularly if the fur were sufficiently fouled to result in loss of insulation, if oil were ingested, or if displacement from important habitats affected overall fitness. Duration of impacts could range from temporary displacement to permanent habitat loss, reproductive impairment, or even death. Contamination and toxic impacts from either directly consuming oil or through consuming marine mammal prey in which contaminants accumulated could be long-lasting. The geographic extent of impacts could be state-wide, given the migratory movements of bears and possible need to relocate if local habitats are severely altered. It is also possible that, if the oil discharge were widespread, denning areas on barrier islands could be impacted. Shore-based clean-up activities could lead to disturbance or displacement, including during den excavation in the fall or emergence from dens in the spring. Polar bears are considered unique due to their threatened status and importance as a subsistence resource. Population level impacts are possible and dependent on numbers of polar bears directly injured or killed, extent of habitat loss (including denning areas), and chronic long-term impacts on reproduction and survival. A VLOS could have major impacts on polar bears in the Beaufort Sea.

Kaktovik Time/Area Closure

The coastal area off Kaktovik provides habitat for a number of marine and anadromous fish, shorebirds and waterfowl, and marine mammals. MMS (2003) did not calculate the risk of a VLOS affecting Kaktovik in particular, but it did calculate the risk of oil reaching the coastline of the Arctic National Wildlife Refuge, which includes Kaktovik and lands eastward to Canada. The analysis stated that:

> *The coastline would be vulnerable to offshore spills mainly during the summer open-water period; during the rest of the year, the coastline probably would be buffered from offshore spills by the band of landfast ice. The Oil-Spill-Risk Analysis conditional probabilities for summer (Tables A.2-85 through A.2-90) indicate that the risk to the Refuge would be highest, of course, for any inshore spill in the eastern Alaskan Beaufort Sea. The specific probability that a spill from various offshore locations would contact the Refuge's coastline within 30 days is given in Table A.2-87. The table shows that the probability would be 38 percent or less from all*

hypothetical launch areas except one in Launch Area 18, which corresponds with the nearshore lease tracts in the eastern Alaskan Beaufort Sea. A summer spill in that area is estimated to have a 49 percent probability of contacting the Refuge's coastline within 30 days (Table A.2-87).

Large numbers of bowhead whales move past Kaktovik from late August into October. Females with calves are common and some animals feed on concentrations of zooplankton. Several other marine mammal and bird species can be found near Kaktovik.

The primary reason this area is considered for time/area closure in this EIS is because of its importance to marine mammals and subsistence hunters from Kaktovik. The consequences of a 2.2 MMbbl VLOS impacting the waters in and around Kaktovik should be considered much greater than what was identified in the MMS (2003) 180,000 bbl VLOS analysis. No specific risk calculations were made for most of the biological components of the waters around Kaktovik but, because so many important species are migratory, impacts to them anywhere along the migration route would affect their status in this portion of the Beaufort Sea. Using more generalized analyses, the potential effects are likely to be of highest magnitude and duration on birds and marine mammals (see Sections 4.10.7.10 and 4.10.7.11). The effects on certain bird and marine mammal species, many of which are crucial for subsistence cultures, dominate the conclusion about the effects of a VLOS in this time/area closure. These effects are considered to be of high magnitude and intensity, long-term, and of state-wide geographic scope because they affect migrating birds and marine mammals. A VLOS could have major effects on the Kaktovik time/area closure according to the criteria established in Section 4.1.3.

Barrow Canyon and Adjacent Beaufort Shelf and Shelf Break Time/Area Closure

Barrow Canyon, a deep submarine canyon to the west of Point Barrow separates the shallow Beaufort and Chukchi sea shelves (Pickart and Stossmeiser 2008). The Alaskan Beaufort Sea shelf is approximately 80 km (50 mi) wide and extends approximately 500 km (311 mi) from Point Barrow to the Canadian border (Weingartner 2008). Bottom topography varies little along the shelf except for Barrow Canyon, which has steep walls and reaches depths of 200 to 250 m (656 to 820 ft.). Outside and north of the barrier islands, water depths increase gradually to the shelf break approximately 64 km (40 mi) offshore (Shell 2011a). Neither MMS (2003) nor BOEM (2015b) calculated the risks of a VLOS impacting Barrow Canyon and adjoining areas in particular.

Physical and oceanographic features of Barrow Canyon, coupled with favorable wind conditions promote the formation of an important recurring feeding area for bowhead whales near Point Barrow in late summer and fall. A strong shelf-break front forms along the southeastern edge of Barrow Canyon when shelf-break currents are directed onto the Beaufort shelf or along the edge of the canyon in response to weak winds. The front is absent when winds are moderate to strong from the east. The shelf-break front promotes the concentration and retention of euphausiids and copepods on the western Beaufort shelf and, consequently, a bowhead whale feeding "hotspot" (Okkonen et al. 2011).

Barrow Canyon is also an important habitat for beluga whales. During light to moderate ice years, beluga whale sightings are often highest in Barrow Canyon and offshore shelf break and slope areas (Clarke et al. 2011b, 2011c; Moore et al. 2000). Ringed, spotted, and bearded seals are also common year round, especially when ice is present. Many species of tundra-nesting seabirds, shorebirds, and waterfowl use the Barrow Canyon area, especially the nearshore areas, for feeding and staging during migration. These include ESA-listed Steller's and spectacled eiders and candidate species yellow-billed loon and Kittlitz's murrelet.

The primary reason Barrow Canyon and the adjacent seas are considered a time/area closure location in this EIS is because of their importance to marine mammals and subsistence hunters from Barrow and Wainwright. The risk of a 2.2 MMbbl VLOS impacting Barrow Canyon should be considered much greater than what was identified in the MMS (2003) 180,000 bbl VLOS analysis. No specific risk calculations were made for most of the biological components of the Barrow Canyon system but, because so many important species are migratory, impacts to them anywhere along the migration route would affect their status in Barrow Canyon. The potential effects are likely to be of highest magnitude and duration on birds and marine mammals (see Sections 4.10.7.10 and 4.10.7.11). The effects on certain bird and marine mammal species, many of which are crucial for subsistence cultures, dominate the conclusion about the effects of a VLOS on the Barrow Canyon and adjacent Beaufort Sea shelf and shelf break time/area closure, which is considered a unique resource because of its the combination of oceanographic features that concentrate biological resources and proximity to nearby subsistence cultures. These effects are considered to be of high magnitude and intensity, long-term, and of state-wide geographic scope because of impacts to migrating birds and marine mammals. A VLOS could have major effects on the Barrow Canyon and adjacent Beaufort Sea shelf and shelf break areas according to the criteria established in Section 4.1.3.

A low probability, high impact VLOS could affect marine mammals and marine and coastal birds in time/area closure locations in the Beaufort Sea. Discussion of impacts to marine mammals in the waters off Kaktovik and Barrow Canyon and Adjacent Beaufort Shelf and Shelf Break can be found in Section 4.10.7.11 and impacts to marine and coastal birds can be found in Section 4.10.6.10.

4.10.7.11 Terrestrial Mammals

4.10.7.11.1 Existing Analysis (BOEM 2012 and MMS 2003)

BOEM (2012) provides an analysis of the impacts of a catastrophic discharge event on terrestrial mammals in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would result in sustained degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact terrestrial mammals from direct contact, inhalation, and ingestion. These effects could be severe where persistent, heavy oil makes contact with important habitat and prey base, causing a multitude of acute and chronic effects (BOEM 2012).

Section IV.C.8.a(2)(b) of MMS (2003) describes potential impacts to caribou and other terrestrial mammals during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

The potential effect of a very large oil spill (180,000 barrels) on caribou, muskoxen, grizzly bears, and arctic foxes is likely to be limited to caribou groups occurring during the spring and during the insect-relief periods in coastal waters near shorelines with extensive oil contamination. Although the oil spill is estimated to contact over 480 kilometers of shoreline and muskoxen, grizzly bears, and arctic foxes frequenting coastal areas from Pitt Point east to about the Canning River Delta, the majority of the coastline contamination would occur between Oliktok Point (Land Segment 36) east to about the Staines River delta (Land Segment 42) (Table IV.I-9c, LA12, 30 days). Caribou groups that belong to the Central Arctic, Teshekpuk, and Porcupine herds are the assemblages of caribou likely to encounter oil while in coastal waters or on the beaches.

Heavily oiled caribou might die from absorption and/or inhalation of toxic hydrocarbons. Several hundred caribou of the Central Arctic, Teshekpuk, and Porcupine herds could die from the oil spill. Small numbers of muskoxen, grizzly bears, and arctic foxes may encounter oil and be adversely affected. Potential losses would represent a short-term effect, with populations recovering within about one year.

The effects of a very large oil spill on caribou, muskoxen, grizzly bears, and arctic foxes are expected to be short-term (recovery expected within about one year).

4.10.7.11.2 Additional Analysis for Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-5). Among these species, it is expected that only barren-ground caribou (*Rangifer tarandus granti*) may experience interactions with oil and gas exploration activities during critical periods of their life cycle; therefore, this analysis will focus solely on caribou. Descriptions of distribution, life cycle, and habitat characteristics of other species are not included in this EIS.

The oil spill discussion in MMS (2003) analyzed the effects of an oil spill of 180,000 bbl, and for the purposes of this EIS, a VLOS of 2.2 MMbbl occurring over a 74 day period is considered. Although the impacts to caribou would be similar regardless of the size of the spill, the magnitude, duration, and extent would be substantially greater with a larger spill.

The effects of a VLOS would be of medium intensity, temporary duration, local extent and common context because while there is a perceptible change to the caribou population, it is likely to be temporary, with a local impact, and the caribou population can recover within one to two years even with a loss of several thousand animals (BOEM 2015b). For more information regarding the impact to subsistence or recreational hunting, see Sections 4.10.7.15 and 4.10.7.20, respectively. Utilizing the impact criteria listed in Section 4.1.3, a summary impact level of minor to moderate would result for caribou, depending on the magnitude and duration of the VLOS.

4.10.7.12 Socioeconomics

4.10.7.12.1 Existing Analysis (BOEM 2012)

BOEM (2012) provides an analysis of the impacts of a catastrophic discharge event on sociocultural systems in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided.

The analysis concludes that a catastrophic discharge event of 3.9MMbbl spilled over the course of 300 days could employ local villagers during the cleanup. It is likely that thousands of additional workers would be necessary, placing stress on village facilities. An influx of outsiders is likely to result in some cultural conflict, stressing the local sociocultural systems. As is evident from the EVOS, such cleanup efforts can be disruptive socially, psychologically, and economically for an extended period of time (BOEM 2012).

4.10.7.12.2 Additional Analysis for Socioeconomics

The MMS (2003) estimate of employment associated with oil spill clean-up activities was based on the most relevant historical experience of an oil spill in Alaskan waters, the EVOS of 1989. That spill was 240,000 bbls, while the Beaufort Sea VLOS described in this hypothetical VLOS scenario, would be 2.2 MMbbls. The socioeconomic effects described in MMS (2003) would be more intense due to the larger quantities of oil reaching the shore, the larger magnitude of the spill, and the longer duration of clean-up effort. The BOEM (2015b) analysis described in Section 4.10.6.14 contains estimates that relate to an event in the Chukchi Sea, but are relevant to a scenario in the Beaufort Sea as well.

Public Revenue and Expenditures

The BOEM (2015b) analysis describes potential new NSB revenues associated with property taxes assessed for the construction of worker infrastructure. A Natural Resource Damage Assessment conducted by NOAA would determine compensation for natural resource service values. Local revenues would be generated in the communities staging clean-up response through the sale of goods and services to workers. NSB would receive property taxes if an enclave were developed to house the clean-up equipment and workers.

Under a VLOS, there would be loss of future federal and state revenues due to a potential moratorium on future oil and gas production, or other disruptions. There would be potential lost NSB, NAB, state and federal revenues due to permitting delays, or exploration moratoria. Local and state agencies may also increase expenditures associated with the administration of oil spill response and social services related to the influx of new workers.

Employment and Personal Income

The MMS (2003) and BOEM (2015b) analysis provides an estimate for the number of workers needed for spill clean-up, but the VLOS scenario in the Beaufort Sea would be for a larger spill, thereby increasing the estimate for numbers of workers by an order of magnitude. The number of cleanup workers needed and their origin is unknown, but the VLOS would induce substantial local employment (likely more than 5 percent of the total potential workforce of NSB and NAB).

The purchase of goods and services stemming from the disposable income of clean-up workers would have a positive, though short-term local economic impact. MMS (2003) and BOEM (2015b) describe that after EVOS, numerous local residents quit their jobs to work on the cleanup, often accepting positions with considerably higher wages. This generated a sudden and substantial inflation in the local economy, a short to long-term economic impact. Economic impacts would be smaller for NSB than those that occurred during EVOS due to the likelihood that cleanup activities, including administrative personnel and spill-cleanup workers, would be located in Prudhoe Bay's existing enclave-support facilities (Cohen 1993: BOEM 2015b).

Other major impacts related to the long-term disruption of the non-cash/subsistence economy are described in the Environmental Justice Section 4.10.6.22 and Public Health Section 4.10.6.16. The BOEM (2015b) analysis does not detail the level and extent of disaster funding to temporarily replace subsistence activity, but it mentions the redirection from subsistence activities to cash activities.

Demographic Characteristics

New oil spill clean-up employment opportunities described in MMS (2003) are not likely to cause a permanent demographic shift. The potential for outmigration due to the disruption of the subsistence activities is not analyzed in the BOEM (2015b) analysis.

Social Organizations and Institutions

The influx of clean-up workers would create a long-term demand on institutions and social services in Barrow. Regional and local non-profit organizations that mediate between industry and subsistence users and social organizations would be impacted. BOEM (2015b) describes requests for temporary assistance from various institutions.

Private companies and regional corporations may be positively impacted in the short-term (Phases 1-4) through the sale of goods and services to spill response companies.

4.10.7.12.3 Conclusion

Employment and local revenues associated with VLOS clean-up in the Beaufort Sea would be high intensity, interim in duration, regional to national in extent, and unique and important in context. The impact to the non-monetary economy is discussed in detail in Section 4.10.7.15 (Subsistence), and are summarized as major negative impacts (classified as high intensity, long-term to permanent in duration (lasting more than five years), regional to statewide in extent because it would affect local and Alaskan residents, workers and businesses, and unique in context). Therefore, the summary impact level to socioeconomics would be major.

4.10.7.13 Subsistence

4.10.7.13.1 Existing Analysis (BOEM 2012)

BOEM (2012) provides some information about the impacts of a catastrophic discharge event on subsistence harvest in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that as the result of a catastrophic discharge event, the economically, socially, and culturally important bowhead whale hunt could be disrupted, as could the beluga harvest. Animals could be directly oiled, or oil could contaminate the ice floes or onshore haulouts they use on their northern migration. Such animals could be more difficult to hunt because of the physical conditions. Animals could be spooked and/or wary, either because use of the spill itself or because of the hazing of marine mammals, which is a standard spill-response technique in order to encourage them to leave the area affected by a spill. Oiled animals are likely to be considered tainted by subsistence hunters and would not be harvested, as occurred after the EVOS. This would also apply to terrestrial animals, such as bears that scavenge oiled birds and animals along the shore, or caribou that seasonally spend time along the shore or on barrier islands seeking relief from insects. The loss of subsistence harvest resources, particularly marine mammals, would have substantial effects on Alaska Native culture and society (BOEM 2012).

Conclusion

Impacts to subsistence harvests and sharing of subsistence resources associated with VLOS would be high intensity, long-term in duration, statewide in extent, and unique in context affecting harvest and sharing practices beyond the region. Therefore, the summary impact level for subsistence would be major.

4.10.7.13.2 Additional Analysis for Subsistence Resources

Based on the criteria of Section 4.1.3 of this EIS, the intensity of the VLOS on subsistence resources and subsistence harvest in the Beaufort would be of high intensity and cause a year round change in subsistence use patterns. Subsistence harvests of marine mammals, fish, migratory birds, and caribou that occurs in or along the coastlines and lagoons would be affected by oiling and fouling and by the presence of the response equipment and personnel. Subsistence harvests could be altered long-term to permanent in duration. The perception that food is tainted and/or contaminated could be long-lasting or permanent among the Iñupiat communities of the Beaufort Sea (see Section 4.10.7.16, Public Health of this EIS). As observed after EVOS, the interruption of two to three years of training youth in subsistence harvest practices changed the balance of the subsistence economy for a period persisting well beyond the spill itself.

Impacts to subsistence harvests and sharing of resources would be regional to state-wide and may extend throughout the EIS project area and impact the non-wage regional economy of the communities of the Beaufort and Chukchi seas (Section 4.10.7.14, Socioeconomics of this EIS). Impacts from a VLOS to subsistence harvest of ESA protected bowhead whales and polar bears are considered unique in context. Impacts from a VLOS to subsistence harvest of beluga whales, seals, walruses, fish, birds, and caribou are considered important in context.

The impacts of a VLOS in the Beaufort Sea would be high intensity, long-term to permanent in duration, regional to statewide in extent, and affecting resources that are unique and important in context. In summary, the impact of a VLOS on subsistence harvest would be major.

4.10.7.14 Public Health

4.10.7.14.1 Existing Analysis (BOEM 2012)

BOEM (2012) provides some information about the impacts of a catastrophic discharge event on public health in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that major areas of concern related to a catastrophic discharge event would include impacts on subsistence resources, air quality, and oil spill cleanup (BOEM 2012).

4.10.7.14.2 Additional Analysis for Public Health

The effects on public health associated with a VLOS in the Beaufort Sea are anticipated to be similar to those associated with a VLOS in the Chukchi Sea. The magnitude of adverse impacts to public health is expected to be medium to high. Many predicted public health effects would be treatable and/or transient, which would be associated with a magnitude of medium. However, some impacts may be irreversible and thus should be classified as high. Duration of impacts would range from temporary to long-term, with some effects only lasting for a brief period associated with the influx of workers during the Phase 4 clean-up period. However, health effects resulting from changes in subsistence patterns would likely persist for many years. The extent would be regional, and the context would be unique, as a VLOS would affect two or more minority or low-income communities in the EIS project area. Therefore, the summary impact on public health of a VLOS in the Beaufort Sea is expected to be moderate to major depending on the size, nature, and location of the spill.

4.10.7.15 Cultural Resources

4.10.7.15.1 Existing Analysis (BOEM 2012)

BOEM (2012) provides some information about the impacts of a catastrophic discharge event on archaeological resources in Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could result in extensive impacts on a large number of archaeological and historic resources. Due to the large area affected by a catastrophic event some resources such as coastal historic sites that are sensitive to prolonged contact with oil could be heavily impacted. Cleanup crews would be needed in a greater number of locations. This could allow oil to be in contact with resources for a significant amount of time before cleanup efforts could be applied, which could result in impacts to these resources. A greater threat to archaeological and historic resources during a catastrophic discharge event would result from the larger number of response crews being employed. A catastrophic discharge event would result in large impacts to numerous archaeological and historic resources from response activities (BOEM 2012).

4.10.7.15.2 Additional Analysis for Cultural Resources

This section describes potential impacts to both offshore and onshore prehistoric and historic resources from a VLOS event in the Beaufort Sea.

Given the limited data related to historic and prehistoric resources in the Beaufort Sea area, it is difficult to determine how many historic properties might be located in areas affected by a VLOS event. The presence of oil and the various oil-spill response and cleanup activities could potentially impact both prehistoric and historic archaeological resources, including submerged prehistoric sites and historic shipwrecks, as well as onshore prehistoric and historic resources, including camps, village sites, artifact scatters, historic structures, and World War II and Cold War era facilities.

Offshore Prehistoric and Historic Resources

In the event of a VLOS, submerged prehistoric and historic resources adjacent to a blowout could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during relief well drilling, or contaminated by hydrocarbons (BOEM 2015b). Oil settling to the seafloor could contaminate organic materials associated with archaeological sites, resulting in erroneous dates from standard radiometric dating techniques (e.g., 14C-dating), and accelerate the deterioration of wooden shipwrecks and artifacts on the seafloor (BOEM 2015b). However, offshore resources are at greatest risk from bottom-disturbing activities, notably anchoring and anchor dragging. The potential to impact archaeological resources increases as the density of anchoring activities in these areas increases (BOEM 2015b). The anchoring of VLOS response and support vessels near a blowout site and in shallow water could result in damage to both known and undiscovered archaeological sites.

Onshore Prehistoric and Historic Resources

The greatest impacts on archaeological resources from a VLOS would be to onshore archaeological sites from oil-spill-cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archaeological sites. Any onshore activity (cleanup or otherwise) that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the World War II and Cold War era Navy, Air Force, and Army facilities could be affected by increased cleanup activity in remote areas and increased vandalism. Prehistoric sites, though often not as visible as historic sites, also might be subjected to increased vandalism, as well (MMS 2007a, 2009; BLM, 2008). As Bittner (1993) described in her summary of the 1989 EVOS:

> "*Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself* "(MMS 2007a, 2009).

4.10.7.15.3 Conclusion

In conclusion, major direct and indirect impacts to cultural resources are expected to result from a VLOS scenario. Impacts would be of high intensity, temporary to long-term in duration, regional to state-wide in geographic extent, and would affect a finite resource.

4.10.7.16 Land and Water Ownership, Use, and Management

4.10.7.16.1 Existing Analysis (BOEM 2012)

BOEM (2012) provides an analysis of the impacts of a catastrophic discharge event on land use, development patterns, and infrastructure in the Alaskan Arctic. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have both direct and indirect effects on land use, depending on the type, size, location, and duration of the incident. Impacts generally would be more intense in areas with little infrastructure in place to handle accidents and where a greater reliance is placed on coastal activities for subsistence (BOEM 2012). As indicated in Section 3.3.5.3 State Waters Managment, the Alaska Coastal Management Program was not reauthorized by the state legislature and has not been in effect since 2011.

4.10.7.16.2 Additional Analysis for Land and Water Ownership, Use, and Management

An oil spill that reaches the Beaufort Sea coastline has the potential to affect land use and management. In addition, activities associated with oil spill response and clean-up also have the potential to affect land use and management. The following analysis provides a discussion of these potential affects. Impacts to land and water ownership, use, and management related to a VLOS event in the Beaufort Sea would be similar to those occurring in the Chukchi Sea, the only difference being that existing leases in the Beaufort Sea lie closer to shore, making the likelihood of oil contacting the coastline more likely. Taking this into account, the impacts discussed in Section 4.10.6.18 for the Chukchi Sea are applicable to the Beaufort Sea as well.

Land and Water Ownership

Because the response efforts to a VLOS would not require any change in existing leasing rights, or the sale or transfer of any federal, state, or native land or waters, no change in underlying land or water ownership would be anticipated in the Beaufort Sea.

Land and Water Use

A spill of this magnitude in the Beaufort Sea would impact some land uses. Should an oil spill result in oil accumulating along the shoreline and in tidal zones, the presence of oil could affect existing land uses by making it difficult to access land, creating a real or perceived change the resources and values that support specific land uses, and discouraging pursuit of traditional land use in areas affected by a spill. Examples of these include subsistence, other traditional land uses, and local resident recreation.

Industrial land may experience increased usage to support additional vessels, aircraft, vehicles and materials used in responding to a VLOS. This could require the construction or expansion of docks, warehouses, airstrips and/or storage facilities. It is unlikely that new permanent facilities would be constructed for spill response. Response support crews would need to be housed, affecting residential land uses. This could be accommodated through the construction of temporary worker camps, most likely in the vicinity of Prudhoe Bay or in the villages of Kaktovik, Nuiqsut and Barrow. Depending on the location of industrial and commercial lands in the immediate vicinity of spill response activities, some temporary industrial land use may occur in new areas. Remote lands currently designated for natural resource protection might experience increased levels of human activity or disturbance for habitat restoration along shorelines where oil may accumulate. This would have similar effects to those discussed above, regarding access, damage to land and resource values, and interest in using the area. The duration of potential effects on land use would depend on the amount of oil that reaches shoreline and intertidal areas, the nature and duration of response activities, and the success in cleanup and restoration activities.

For a discussion of the impacts from a VLOS event in the Beaufort Sea, see Section 4.10.7.15 (Subsistence) and Section 4.10.7.20 (Recreation).

Land and Water Management

Current management plans do not include contingencies for a VLOS. It is assumed that in the event of a VLOS, federal and state management plans that include coastal areas may require additional approvals for response and cleanup activities to accommodate heightened levels of human access for habitat restoration and oil cleanup efforts. Federal and state waters would be managed in the short term with an intense focus on response and clean-up of oil. Any management plan policies that are modified for a VLOS event would most likely be temporary, but could lead to plan updates to address any potential change in land and resource values, actions needed to promote recovery of affected resources, or address the potential for response activities in the unlikely event that they are needed.

4.10.7.16.3 Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts of land and water use caused by a VLOS are described as follows. There would be no impact for land and water ownership because no change would be expected. The magnitude of impact would be high for land and water use for areas affected by a spill that have seen historical or current use for subsistence, other traditional land uses, and recreation, due to the potential change in resource/use values, and the level of activity associated with spill response and cleanup. The magnitude of impact would be medium for land and water management if management plans must result in new approvals to accommodate response efforts or a spill results in a change in resource or land values. The duration of impact would be interim because response efforts may extend up to several years, although the impact could be long-term if in the unlikely event construction of a new facility or infrastructure to accommodate spill response activities. The extent of impacts would be regional because the spill would affect large expanses of water and has the potential to come into contact with land along an extensive area of shoreline in and near the project area. The context of impact would generally be common because the areas of land and water affected are extensively available, unless some special, rare, or unique characteristics associated with specific subsistence and recreation areas are affected. In summary, the effects of a VLOS would be major due to the possibility for high intensity and interim impact to land use and land management.

4.10.7.17 Transportation

4.10.7.17.1 Existing Analysis (BOEM 2012)

The BOEM (2012) analysis did not specifically analyze impacts to transportation associated with an oil spill scenario.

4.10.7.17.2 Additional Analysis for Transportation

Setting

The transportation systems among the communities of Kaktovik, Nuiqsut and Barrow and the Prudhoe Bay area would experience increased levels of air, vessel and surface traffic associated with containment, recovery, and cleanup activities for a VLOS that would involve hundreds of workers and vessels, aircraft, and onshore vehicles operating over an extensive area for one to two years. In the event of a VLOS, vessels such as skimmers, workboats, barges and icebreakers involved with cleanup would be used to remove oil from a spill area that occurs at sea and to drill a new well. Aircraft (fixed wing) would also likely be engaged in application of dispersants. Equipment involved with clean up and response would vary based on seasonal conditions as described in Section 4.10.6.19. In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to cover the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. Small boats and aircraft would also be involved with beach cleaning activities at oiled beaches (including booming) at marine and freshwater shorelines.

In addition aircraft could be used to apply dispersants used to decrease the size of the oil slick. Additional aircraft would also be used for transporting response personnel and equipment, including helicopters, small piston-powered aircraft, and large commercial jets affecting these communities. Aircraft could also be used to map the extent of an oil spill and for surveillance. Surface vehicles would also be used during response operations onshore.

Activities

Local modes of transportation between communities by aircraft, vessels and surface means would be affected by a VLOS in nearshore and coastal areas. Impacts to the transportation system along the Beaufort Sea coast would be similar as discussed for the Chukchi Sea (Section 4.10.6.19). In the event of a VLOS response, additional equipment would likely be delivered to the Prudhoe Bay area via surface transportation on the Dalton Highway. Air traffic to Deadhorse/Prudhoe Bay would increase from Anchorage and air traffic between the communities of Kaktovik, Nuiqsut and Barrow would increase in the event of a VLOS. The airport at Deadhorse/Prudhoe Bay could be a logistical center for distributing incoming responders and equipment to the airports at Barrow, Nuiqsut and Kaktovik. During the initial response phase the spill equipment that is already staged at local communities would be rapidly deployed via aircraft and support vessels. As response efforts continue the levels of air traffic to the areas affected of the Beaufort Sea would increase in the numbers of flights arriving as additional response crews and supplies are transported into the affected area. In the event of a VLOS air transportation within Alaska could also be indirectly affected as higher demand would occur for air travel to the spill area connecting from the Anchorage and Fairbanks airports. The increased levels of aircraft associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Use of local airports associated with spill response activities (resupply, transport of spill response crews and equipment) could strain the local and regional air transportation infrastructure.

Vessels and equipment associated with response would be present in increased numbers in the nearshore areas. Prudhoe Bay and spill response facilities at West Dock near Prudhoe Bay would be expected to experience high levels of activity as potential areas where response vessels and equipment would be staged and refuel. It is likely that local tug/barge and small vessel traffic between communities would be affected during the spill due to the increased numbers of response and support vessels present in nearshore areas. Increased levels of response and support vessels associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Local nearshore areas normally used for marine transportation between communities would experience and encounter vessels associated with spill response activities. This could strain the local patterns of existing marine transportation. It is likely that in response to a VLOS there would be impairment of normal operations with deployment of response workers, vessels and equipment affecting the exiting levels of transportation along the coastline of the Beaufort Sea communities. In addition skiffs and small vessels used locally in nearshore waters may be come oiled. Skiffs and small vessels used locally in nearshore waters may be come oiled.

Surface transportation in the summer months could also be interrupted in the event of a VLOS that reaches the nearshore areas and coastlines. Local modes of surface transportation, including four wheelers/off road vehicles, used by residents during subsistence activities along the coasts may also become oiled.

The effects and impacts of aircraft and vessels disturbance caused during response to a VLOS to seabirds, marine mammals and terrestrial mammals is described in Sections 4.10.7.10 through 4.10.7.12 and the affects to subsistence hunters is described in Section 4.10.7.15.

4.10.7.17.3 Conclusion

The conclusions for impacts to transportation in the Beaufort Sea would be of high intensity (potentially year round), and long-term in duration lasting one to two years or more during response and surveillance monitoring during recovery. The extent would be regional to state-wide, and important in context. In summary, the impact of a VLOS on transportation would be moderate to major.

4.10.7.18 Recreation and Tourism

4.10.7.18.1 Existing Analysis (BOEM 2012)

BOEM (2012) provides an analysis of the impacts of a catastrophic discharge event on recreation and tourism in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that effects from a catastrophic discharge event would likely include beach and coastal access restrictions, including restrictions on visitation, fishing, or hunting while cleanup is being conducted, and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be interim, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event (BOEM 2012).

4.10.7.18.2 Additional Analysis for Recreation and Tourism

Impacts to the recreation setting and activities in the Beaufort Sea would be similar as discussed for the Chukchi Sea (Section 4.10.6.20), except impacts to the setting of the Beaufort Sea would be magnified along the coast of the ANWR due to the sensitivity of visitors to that area. Visitors to ANWR are expecting an isolated and undeveloped setting here more than the rest of the Beaufort Sea because the area is managed to maintain wilderness characteristics and there is no oil and gas exploration or drilling activities in the coastal area. The area is perceived as an undeveloped setting for recreation with a high sensitivity to impacts to wilderness characteristics. Even though recreation opportunities across the Beaufort Sea are not scarce and not protected by legislation, the potential to impact recreation settings and activities in a National Wildlife Refuge that is managed to maintain wilderness characteristics, the context is considered unique.

4.10.7.18.3 Conclusion

The conclusions for impacts to recreation and tourism discussed earlier for the Chukchi Sea are also applicable to the Beaufort Sea. The impacts would be high intensity, interim duration, regional to state-wide extent, and unique in context. In summary, the impact of a VLOS on recreation and tourism would be major.

4.10.7.19 Visual Resources

4.10.7.19.1 Existing Analysis (BOEM 2012)

No analysis of impacts specific to visual resources is presented in the BOEM (2012) document.

4.10.7.19.2 Additional Analysis for Visual Resources

Based on the scenario described in the spectacled and Steller's Eider, and the Vegetation and Wetland Habitat sections of the MMS (2003) analysis, a VLOS event is expected to temporarily impact scenic quality and visual resources within the Beaufort Sea. The behavior, and hence visibility, of released oil is expected to change depending on the presence and condition of ice. The magnitude and extent of direct impacts expected to scenic quality and visual resources is also expected to change based on the presence and condition of ice. For example, a spill that occurred on solid ice is not expected to enter the water. In such a scenario, the magnitude of impacts to scenic quality and visual resources is expected to be high; however impacts are expected to be of temporary duration and local extent. In contrast, should a VLOS scenario occur during open water, the intensity of impacts is expected to remain high; however the extent of impacts could be of regional extent due to the lack of containment of oil by ice. Additional direct impacts are expected to result from the perceptible change in the level of marine vessel and air traffic due to response and clean-up efforts. In all cases, indirect effects, including distress among viewers, is expected to occur from witnessing oil slicks on the surface of near- or on-shore areas either in person or through media outlets.

The scenario described above is based on an 180,000 bbl VLOS. The magnitude, extent, and duration of impacts to scenic quality and visual resources are expected to be larger for a larger spill, such as that described for a 2.2 MMbbl VLOS. Should a 2.2 MMbbl VLOS scenario occur in the Beaufort Sea, similar impacts are expected to result from Phases 1 and 5 of the oil spill and cleanup scenario as that described in Section 4.10.6.21. The greatest change would likely be observed in the magnitude, duration, and extent of impacts to shoreline and on-land areas.

<u>4.10.7.19.3 Conclusion</u>

In conclusion, major direct and indirect impacts to visual resources are expected to result from a VLOS scenario. Impacts would be of high intensity, interim, regional to state-wide in geographic extent, and would affect an important resource.

4.10.7.20 Environmental Justice

<u>4.10.7.20.1 Existing Analysis (BOEM 2012)</u>

BOEM (2012) provides some information about the impacts of a catastrophic discharge event on environmental justice in Alaska Arctic communities. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that many of the long-term impacts of a catastrophic discharge event on low-income and minority communities are unknown. Different cultural groups would likely possess varying capacities to cope with catastrophic events, with some low-income and/or minority groups more reliant on subsistence resources and/or less equipped to substitute contaminated or inaccessible subsistence resources with those purchased in the marketplace. Because lower income and/or minority communities may live near and be directly involved with catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects (BOEM 2012).

<u>4.10.7.20.2 Additional Analysis for Environmental Justice</u>

The above text recognizes that Iñupiat Alaska Natives are the predominant residents of the affected area and a VLOS would affect subsistence resources and harvest practices, therefore having disproportionately high adverse effects.

For a description of the character and intensity of impacts to subsistence resources and harvests and human health, the reader should also refer to the Subsistence (Section 4.10.7.15) and Public Health (Section 4.10.7.16) discussions in this EIS.

MMS (2003) states that potential effects to subsistence resources and subsistence harvests could be mitigated to some extent. The BOEM (2012) Environmental Justice analysis is more specific about mitigation techniques and limitations, but concludes that there are “significant and perhaps irrevocable adverse impacts.”

<u>4.10.7.20.3 Conclusion</u>

The impacts to subsistence foods and human health in the Iñupiat subsistence-oriented communities of Kaktovik, Nuiqsut and Barrow would be high intensity, long-term in duration, regional in extent, and unique in context. Therefore the summary impact level for environmental justice is major; there would be a disproportionate adverse effect to Alaska Native (minority) populations.

4.11 Cumulative Effects

An EIS must include an analysis of the potential cumulative effects of a proposed action and its alternatives and consider those cumulative effects when determining environmental impacts. The analysis of cumulative effects in this EIS employs the definition of cumulative impacts found in the CEQ regulations (40 CFR 1508.7 and 1508.25(a)(2)):

> *Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*
>
> *To determine the scope of environmental impact statements, agencies shall consider…cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.*

Cumulative effects are assessed by aggregating the potential direct and indirect effects of the proposed action with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project. The ultimate goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the project alternatives. As suggested by the CEQ handbook *Considering Cumulative Effects Under the National Environmental Policy Act* (1997), the following basic types of cumulative effects are also considered:

- additive – the sum total impact resulting from more than one action;
- countervailing – adverse impacts that are offset by beneficial impacts; and
- synergistic – when the total impact is greater than the sum of the effects taken independently.

Cumulative effects may result from the incremental accumulation of similar effects or the synergistic interaction of different effects. Repeated actions may cause effects to build up over time, or different actions may produce effects that interact to produce cumulative impacts greater than (or less than) the sum of the effects of the individual actions.

As directed by CEQ's NEPA regulations (40 CFR 1502.16), direct and indirect impacts on specific physical, biological, and social resources are discussed in combination with varying levels of effects, ranging from negligible to major. The cumulative effects analysis focuses on impacts to long-term productivity and sustainability of valued ecosystem components.

4.11.1 Methodology for Identifying Cumulative Impacts

The methodology used for cumulative effects analysis in this EIS consists of the following steps:

- *Identify issues, characteristics, and trends within the affected environment that are relevant to assessing cumulative effects of the action alternatives.* Include discussions on lingering effects from past activities, and demonstrate how they have contributed to the baseline condition for each resource. This information is summarized in Chapter 3.
- *Describe the potential direct and indirect effects of oil and gas exploration activities.* This information is presented in detail in Sections 4.4 to 4.9 of this EIS.
- *Define the spatial (geographic) and temporal (time) frame for the analysis.* This timeframe may vary between resources depending on the historical data available and the relevance of past events to the current baseline.

- *Identify past, present, and reasonably foreseeable external actions such as other types of human activities and natural phenomena that could have additive or synergistic effects.* Summarize past and present actions, within the defined temporal and spatial timeframes, and also identify any RFFAs that could have additive, countervailing, or synergistic effects on identified resources.
- *Use specific methodology to screen all of the direct and indirect effects, when combined with the effects of external actions, to capture those synergistic and incremental effects that are potentially cumulative in nature.* Both adverse and beneficial effects of external factors are assessed and then evaluated in combination with the direct and indirect effects for each alternative on the various resources to determine if there are cumulative effects.
- *Evaluate the impact of the potential cumulative effects using the criteria established for direct and indirect effects, and assess the relative contribution of the action alternatives to cumulative effects.*
- *Discuss rationale for determining the impact rating, citing evidence from the peer-reviewed literature, and quantitative information where available.* The term "unknown" can be used where there is not enough information to determine an impact level, and the information cannot be readily obtained in a timely or cost effective manner. However, under CEQ guidelines, the effect of missing information on the decision to be made must be addressed in the EIS.

The advantages of this approach are that it closely follows CEQ guidance, employs an orderly and explicit procedure, and provides the reader with the information necessary to make an informed and independent judgment concerning the validity of the conclusions.

4.11.2 Past, Present, and Reasonably Foreseeable Future Actions

Relevant past and present actions are those that have influenced the current condition of the resource. For the purposes of this EIS, past and present actions include both human-controlled events, such as subsistence harvest and commercial whaling, and natural events, such as climate change. The past and present actions applicable to the cumulative effect analysis have been either presented in Chapter 3, or are discussed below. Additional past actions were identified using agency documentation, NEPA documentation, reports and resource studies, peer-reviewed literature, and best professional judgment. Table 4.11-1 lists a summary of relevant past and present actions.

Past, present, and RFFAs and activities considered for the cumulative effects analysis include: oil and gas exploration, development, and production activities; scientific research; mining exploration, development, and production; military facilities and training exercises; air and marine transportation; major community development projects; subsistence activities; recreation and tourism; and climate change. Commercial whaling in the late 19th century is also a past effect specific to bowhead whales that still influences population levels.

Recent environmental reports, lease sale documents, surveys, research plans, NEPA compliance documents, and other source documents have been evaluated to identify these actions. RFFAs were assessed to determine if they were speculative and would occur within the analytical timeframe of the EIS. Some specific assumptions include:

- Oil and gas exploration activities identified within this time frame cannot be foreseeably expected to result in discovery and production, primarily due to commercial uncertainty and regulatory timeframes.
- Potential oil and gas activities in the Canadian and Russian offshore Arctic were also researched and assessed if deemed applicable, given the potential to influence migratory marine mammal populations. Publically available information on the specific timing and nature of these activities is limited;

- Present oil and gas production activities are expected to continue at current levels, with the potential to contribute to cumulative effects through actions associated with both production and resupply;
- Mining activities occur primarily onshore but may involve air and marine support activities;
- Military activities with the potential to result in synergistic and additive effects include major construction or demolition projects and major training exercises;
- Community development activities with the potential to result in synergistic and additive effects include major construction projects such as the Kaktovik Airport and annual sealift resupply for fuel and commercial goods;
- Subsistence activities are evaluated primarily for their cumulative effect on populations of wildlife, such as fish and marine mammals.

Past, present and future actions for consideration in the cumulative impacts analysis are listed below. For the purposes of this EIS, present actions are those that are ongoing and have activities that contribute to potential cumulative effects. Future actions are those that are reasonably foreseeable within the next five to ten years. General categories of past, present and RFFAs are summarized in Table 4.11-1. For each of the general categories, a second set of detailed tables has been developed listing specific actions/activities that are taken into consideration (Tables 4.11-2 through 4.11-10). Figures 4.5 and 4.6 show general locations of relevant past, present, and future actions for the Beaufort and Chukchi seas.

Table 4.11-1 General Categories of Relevant Past, Present, and Reasonably Foreseeable Future Actions

Category	Area	Type of Action
Oil and Gas Exploration, Development and Production	OCS waters[1] (Beaufort and Chukchi seas) Onshore North Slope (Beaufort Sea) Nearshore waters[2] (Beaufort Sea) Canadian Arctic Russian Chukchi Sea	Seismic surveys Coastal/nearshore ice roads Construction Maintenance Exploratory drilling Production Transportation (pipelines, aircraft, marine, ice roads)
Scientific Research	Nearshore waters (Beaufort and Chukchi seas) OCS waters (Beaufort and Chukchi seas) Onshore North Slope	Oceanographic surveys Biological surveys Geophysical surveys
Mining	Western Brooks Range/foothills (Chukchi Sea) Red Dog/Red Dog Port (Chukchi Sea)	Coal mining Minerals mining
Military	Various coastal sites (Northwest Alaska, Gulf of Alaska, North Slope) OCS waters (Beaufort and Chukchi seas)	DEW Line Sites USCG Icebreaker presence Aircraft overflights Submarine traffic
Transportation (separate from oil and gas, mining)	Marine (Beaufort and Chukchi seas) Onshore North Slope	Marine vessel traffic Roads and vehicular traffic Aircraft traffic Utility pipelines
Community Development Projects	North Slope Borough Northwest Arctic Borough	Village expansions Water and sewage projects Airport construction/improvements
Subsistence Activities	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, and adjacent areas (offshore Beaufort, Chukchi seas, onshore)	Hunting (e.g., caribou, birds) Fishing Trapping Whaling Sealing Traveling
Recreation and Tourism	Arctic National Wildlife Refuge Various locations (Beaufort and Chukchi seas)	Wildlife viewing Sport/commercial hunting and fishing Recreation activities Cruise ships and commercial vessels
Commercial Whaling	Range of bowhead whales	Commercial harvest and mortality
Climate Change	Global	Changes in temperature, ice conditions, ocean circulation patterns, and other atmospheric, cryosperic, and ocean processes
Persistent Contaminants	OCS waters (Beaufort and Chukchi seas) Nearshore waters (Beaufort and Chukchi seas) Shoreline (Beaufort and Chukchi seas)	Accumulation of contaminants from multiple sources that have the potential for impact to wildlife (including benthos), and contamination of subsistence resources with human health implications

Notes:
1 – OCS waters are considered federal waters for the purpose of this analysis
2 – Nearshore waters are considered state waters for the purpose of this analysis

4.11.2.1 Oil and Gas Exploration, Development and Production

4.11.2.1.1 Existing Oil and Gas Production and Pipeline Facilities

Oil and gas development is the main agent of industrial-related change within the EIS project area. There are a number of other past, present, and ongoing oil and gas projects that contributed to past and present cumulative effects (Table 4.11-2). Among the cumulative effects issues associated with these activities are effects on marine mammals, subsistence, borough and state fiscal characteristics, and air and water quality. The majority of exploration activities and all of the production and transportation systems have occurred in the central Beaufort Sea portion of the EIS project area. Although oil from seepages was used as fuel by Iñupiat people prior to western contact, the first modern program of oil and gas exploration on the North Slope was conducted by the U.S. Navy and the United States Geological Survey (USGS) during the 1940s and 1950s. Federal leasing on the North Slope began in 1958 and led to several industry-sponsored exploration programs. The discovery of oil at Prudhoe Bay in 1968, followed by discoveries at Kuparuk, West Sak, and Milne Point in 1969, marked the beginning of commercial oil development in the region (NRC 2003). Completion of the Trans-Alaska Pipeline System (TAPS) in 1977 allowed year-round transport of North Slope oil to the marine terminal in Valdez and efficient export to market. Leasing of state and federal offshore continental shelf (OCS) areas began in 1979, and offshore discoveries were made at Endicott, Sag Delta, Point McIntyre, Niakuk, and Northstar (NRC 2003). The Point McIntyre and Niakuk pools, as well as the more recently discovered Liberty field, are located mostly in the offshore area; the Point McIntyre and Niakuk production facilities are located either onshore or on existing nearshore production facilities (MMS 2008). Several additional developments including Nikaitchuq, Northstar, and Oooguruk operate in nearshore areas of the Beaufort Sea. TAPS throughput peaked in 1988, at nearly 2.1 million barrels per day, but has since declined to about 508,000 barrels per day in 2015 (Alyeska Pipeline 2016). Currently there are 35 fields and satellites producing oil on the North Slope and in nearshore areas of the Beaufort Sea, and additional discoveries are under development.

Table 4.11-2 Specific Past, Present, and Reasonably Foreseeable Future Actions Related to Oil and Gas Development and Production in the EIS Project Area

Category	Geographic Area/Unit	Action/Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Oil/Gas Development Onshore Offshore	1- Beaufort Sea Coastal – Badami Unit	Badami	Production currently 1,500 bopd, pipeline to Endicott, additional exploration ongoing, winter sea ice road access		X	X	X	
	2 - Beaufort Sea Inland-Colville River Unit	Alpine (CD-1, CD-2), Fjiord (CD3), Nanuq (CD4)	Currently producing, pipeline to Kuparuk, overland annual ice road access, aircraft traffic		X	X	X	
		Alpine West (CD-5)	Currently producing, pipeline to Kuparuk, overland annual ice road access, aircraft traffic	X	X	X	X	X
		Oooguruk Unit and Placer Unit (2015)	Planning for new unit is in early stages.					
		Pikka Unit	Planning for new unit is in early stages					X
	3 - Beaufort Sea Inland - Greater Mooses Tooth Unit (GMT) (NPR-A)	GMT 1 (aka Alpine Satellite CD-6), GMT 2	GMT1 Past exploration, future development and construction, including road and pipeline access. GMT2 Project in permitting process.	X	X	X	X	X
	4 - Beaufort Sea Nearshore - Duck Island Unit	Endicott, Eider, Sag Delta, Ivishak	Currently producing offshore production facility, pipeline and vehicle access to Prudhoe Bay via causeway			X	X	
		Liberty	Past exploration, future development and construction, onshore directional drilling of offshore field	X	X	X	X	X
	5 - Beaufort Sea Inland - Kuparuk River Unit	Kuparuk, Meltwater, Tabasco, Tarn, West Sak	Currently producing, pipeline and road access from Prudhoe Bay	X	X	X	X	
	6 - Beaufort Sea Coastal - Milne Point Unit	Milne Point, Kuparuk, Sag River, Schrader Bluff, Ugnu	Currently producing, access by road system from Prudhoe Bay	X	X	X	X	
	7 - Beaufort Sea Offshore – Northstar Unit	Northstar, Kuparuk	Currently producing offshore production facility, buried pipeline to onshore	X	X	X	X	

Table 4.11-2 Specific Past, Present, and Reasonably Foreseeable Future Actions Related to Oil and Gas Development and Production in the EIS Project Area

Category	Geographic Area/Unit	Action/Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
	8 - Beaufort Sea Coastal and Inland -Prudhoe Bay	Prudhoe Bay, Aurora, Borealis, Lisburne, Midnight Sun, N. Prudhoe Bay, Niakuk, Orion, Polaris, Point McIntyre, Raven, West Beach	Currently producing, pipeline and road access, central North Slope processing facilities, start of Trans-Alaska Pipeline	X	X	X	X	
	9 - Beaufort Sea Nearshore Oooguruk Unit	Oooguruk, Kuparuk, Nuiqsut	Currently producing offshore production facility, buried pipeline to onshore	X	X		X	
	10 - Beaufort Sea Nearshore, Coastal -Nikaitchuq Unit	Nikaitchuq, Ivisak, Scharder Bluff	Currently producing from onshore production facility at Oliktok Point, pipeline to Kuparuk; proposed drilling from constructed offshore artificial island at Spy Island, pipeline to shore	X	X		X	
	11 - Beaufort Sea Coastal - Point Thomson Unit	Point Thomson	Exploratory drilling completed, construction of expanded gas cycling, onshore pipeline to Badami, barge, air, and ice road access is nearing completion.	X	X	X	X	X
Pipeline	Alaska – from Prudhoe Bay to Nikiski	Alaska LNG	Dredging and improvements to West Dock for pipeline and processing module delivery; large multi-year sealifts delivering processing modules and pipeline to West Dock; construction of large gas processing plant; Construction of large diameter gas pipeline to Cook Inlet ; Liquefy and export natural gas from Prudhoe Bay to Nikiski. Includes liquefaction plant and storage tanks	X	X			X

Table 4.11-2 (cont'd.) Past, Present, and Reasonably Foreseeable Future Actions Related to Oil and Gas Development and Production in the EIS Project Area

Category	Area	Action/Project	Past	Present	Future
Canadian Beaufort Sea Activities Related to Oil and Gas					
Oil & Gas Production	Mackenzie Delta	Norman Wells Oil Fields since 1942 (Deh Cho Area)	X	X	X
		Ikhil Gas Field (Beaufort Area)	X	X	X
Oil/Gas Development Onshore & offshore	Mackenzie Delta Mainland NWT	Sahtu Area	X		X
Oil/Gas Exploration (shallow hazards, site clearance, 2-D and 3-D seismic surveys, exploratory drilling)	Beaufort Sea	Seismic Activity 1965-1992; 2001-2002	X		
		Southern 1994	X		
		GXT Beaufort 2-D Marine Seismic Program 2010	X	X	X
		Canada Basin Seismic Reflection & Refraction Survey 2010		X	X
		Devon Exploration Drilling Program 2004 (no other drilling or seismic programs known at same time)	X		
		GXT Aerial Magnetic Survey 2008	X		
		BP Pokak 3D Seismic Program 2009	X	X	
		Imperial Oil Ajurak 3D Seismic Program Summer 2008	X		
		Fisheries & Oceans Canada Region-wide marine seismic survey 2006-2009	X		
	Arctic Islands	Canadian Polar Margin Seismic Reflection Survey 2009	X	X	
		Oil & Gas leases (current)	X	X	
	Mackenzie Delta offshore	Oil & Gas leases (current)	X	X	
Russian Chukchi Sea Activities Related to Oil and Gas					
Oil/Gas Exploration (shallow hazards, site clearance, 2D and 3D seismic surveys, exploratory drilling)	Chukchi Sea	Federal Program Subsoil Use 2006-2010 (future bidding sites) [5]	X		X
		Sakhalin Island	X		
	Arctic Seas	85,000 km 2D seismic data by 2010 and 278,000 km seismic data by 2020[5]		X	X

Sources: ExxonMobil Corporation 2009, MMS 2007, NMFS 2007, MMS 2010

4.11.2.1.2 Oil and Gas Exploration Activities

Oil and gas exploration activities have also occurred over the last 60 years throughout the EIS project area, but unless they lead to development of a project, are generally limited in time to a specific seasonal period over the course of one or two years, and are individually limited in geographic extent. As a result, the impacts from exploration activities tend to be limited in duration and occur in the immediate vicinity of exploration activities and transportation support routes. Exploration activities are similar to those discussed in Chapter 2 of this EIS, including seismic exploration (on land, over ice, open water) and exploratory drilling (onshore gravel pads and ice pads, offshore drillships and artificial islands). By far, the majority of onshore and offshore exploration activities have taken place in the Beaufort Sea and have occurred on a regular basis since the late 1960s, although some military programs date back to the 1940s. More limited and intermittent exploration activities have taken place in offshore areas of the Chukchi Sea since the 1980s. However, it should be noted that barge traffic to and from the Prudhoe Bay area passes through the Chukchi Sea in early summer, returning in late fall.

A small refined fuel spill (typically less than 48 bbls) from G&G refueling operations at sea or at docks could occur during exploration activities as well.

Oil and gas exploration has also occurred in the Canadian Arctic, specifically in the eastern Beaufort Sea, off the Mackenzie River Delta, Mackenzie Delta and in the Arctic Islands. Characteristics are similar to exploration activities in Alaska (shallow hazards, site clearance, 2D and 3D seismic surveys, exploratory drilling), except that the majority of support is provided by road access and coastal barges. Oil and gas exploration has also occurred in offshore areas the Russian Arctic and in areas around Sakhalin Island to the south of the Bering Straits. Sakhalin Island is located approximately 3,220 km (2,000 mi) from Kotzebue at a latitude approximately the same as British Columbia.

From the perspective of cumulative effects, multiple exploration activities that may occur over a large geographic area, with some level of activity going on from year to year, raise concerns about disturbance to fish and wildlife and response in behavior and distribution. The potential geographic extent of exploration activities, along with air and marine support, implies that sound producing activities are occurring across much of the range of many marine mammal species. In addition, the availability of fish and wildlife for subsistence harvest based on response to exploration activities and interference with subsistence hunting is also of concern to North Slope Natives.

There are currently no State of Alaska leases in the Chukchi Sea, and no onshore oil and gas production along the Chukchi Sea coast. The State of Alaska has scheduled lease sales that would offer exploration rights in certain regions including the Beaufort Sea nearshore areas. Activities in these areas are considered reasonably foreseeable, however, the exact locations and amount of acreage available for leasing are yet to be determined. In its most recent five-year plan, the State of Alaska does not intend to hold lease sales in the nearshore waters of the Chukchi Sea (ADNR 2015a).

There are a number of onshore and nearshore exploration wells being proposed on State oil and gas leases in the Beaufort Sea region. State lease sales in this region, as well as BLM lease sales for the NPR-A, are proposed for 2016. However, these prospects are primarily onshore or inshore with little potential for affecting the proposed area.

Internationally but within the geographical scope of the proposed area, there are a number of past, present, and reasonably foreseeable future activities related to oil and gas exploration, development, and production located in Canadian and Russian waters. There is little information on specific plans, but the effects of Canadian and Russian activities are expected to be similar to those resulting from activities occurring in the Alaska Arctic OCS.

4.11.2.1.3 Large-Scale Future Oil and Gas Projects in Alaska

Activities related to natural gas development in the EIS project are reasonably foreseeable, assuming a market is found for the gas, and a gas pipeline is constructed to transport the gas (see discussion of the Alaska LNG Project below). Such activities may include the construction and installation of a gas pipeline to shore from existing offshore production facilities in the Beaufort Sea, and expansion of existing offshore and shore-based facilities to accommodate natural gas production.

The following project descriptions are five major oil and gas development projects proposed in the Beaufort Sea that are reasonably foreseeable within the next five years. Although the majority of project activities and facilities would take place on shore, there are marine components that would contribute to potential cumulative effects.

Alaska Liquefied Natural Gas (LNG) Project:

ExxonMobil, ConocoPhillips, British Petroleum, and TransCanada are proposing a project to export natural gas from Prudhoe Bay via an 800-mile pipeline to Nikiski where it will be liquefied. The project is projected to require 10 years to construct (OFC 2013).

At Prudhoe Bay a massive gas treatment plant would cleanse the gas of about 400 million to 500 million cubic feet a day of carbon dioxide. The treatment towers will be 120-feet tall and 28-feet wide, with 1-foot-thick steel walls to contain the high pressures of treatment (OFC 2013). The 42-inch-diameter pipeline would carry 3 billion to 3.5 billion cubic feet of natural gas per day from Prudhoe Bay and Point Thomson fields. It features eight compressor stations to move the gas and keep it chilled. In Southcentral Alaska the route would cross the Susitna River and Cook Inlet to reach the LNG plant on the Kenai Peninsula (OFC 2013). As part of this project spur five points have been proposed as gas-take off points for Alaskan communities.

At the Nikiski port on the Kenai Peninsula, a liquification plant would chill the gas to minus 260 degrees to create liquefied natural gas, or LNG, a compressed form of the gas that can be shipped on insulated tankers to markets worldwide. The plant at Nikiski, featuring three liquefaction trains — or manufacturing lines — LNG storage tanks, and two tanker berths on Cook Inlet that could accommodate a ship every two days on average. When operable the plant could make 15 million to 18 million metric tons a year of LNG, the equivalent of 2 billion to 2.4 billion cubic feet a day of gas. This plant would then be one of the world's largest LNG plants (OFC 2013).

Point Thomson Project

ExxonMobil is planning to produce gas and hydrocarbon liquids (condensate and oil) from the Thomson Sand reservoir and delineate other hydrocarbon resources in the Point Thomson area on the North Slope of Alaska. This project is located to the east of the existing Badami field, and west of ANWR. Produced fluids will be processed on site, with condensate and oil being transported by pipeline to existing common carrier pipelines at Badami that supply the TAPS. The completion of a condensate export pipeline that links Point Thomson to TAPS was completed during the winter of 2014 with approximately 2,200 vertical pipeline supports having been installed (ExxonMobil 2013). Construction is complete, and operations began in2016. The primary activities that would contribute to cumulative effects include marine and air traffic associated with operation.

These project components include three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines, a gravel mine, and an airstrip.

The hydrocarbon reservoir lies mainly offshore. To avoid offshore development and potential adverse impacts on the marine environment, onshore drilling pads close to the shore have been selected to directionally drill into the offshore portions of the reservoir.

Sealift by ocean-going barges direct to the Point Thomson location was selected as the option for moving heavy loads, such as process modules, to the site. Offloading barge loads without installing a solid fill causeway or dock would represent the primary marine component of the project.

A service pier and five offshore mooring dolphins (pilings driven into the sea floor) are necessary for landing and securing the ocean barges, which require several feet of draft and cannot directly access the beach. The bulkhead is located above the Mean High Water (MHW) line on the beach. Mooring dolphins are needed to ensure an accurate alignment of the barges for offloading operations and will be left in place for future use.

For transport of operations materials and supplies, smaller coastal barges will be used. To better accommodate landing and offloading of the smaller coastal barges, a boat launch was constructed above the MHW line on the beach, with an associated gravel ramp constructed to the Central Pad. Air traffic will be associated with operations.

Alpine Unit CD-5 and CD-6 Projects

Permits applications for construction of Alpine CD-5 were submitted several years ago, but were delayed due to regulatory challenges resulting in denial of permits. These challenges were resolved in late 2011, and construction was completedy at CD-5 in 2015 with production beginning in in late 2015. Construction of CD 5 (and the planned CD-6) involved constructing a bridge across the Colville River to access the production pad; road connections to the Prudhoe Bay Kuparuk road system would be limited to seasonal ice roads. Barge support for construction is based out of Prudhoe Bay, with modules and other construction material transported by gravel/ice roads. Air traffic would be associated with construction and operations. The primary areas of nexus with offshore exploratory activity would involve barge sealifts through the Beaufort and Chukchi seas, and offloading activity at West Dock. The Greater Moose's Tooth (GMT1) project within the Alpine Unit is has received permits for this development though a final decision for construction .has not yet been made. The GMT 1 project would be a satellite of Alpine connected by road to CD5 with oil processes through existing Alpine facilities (ConocoPhillips 2013)). Permits were filed in 2015 for the development of GMT2.

Liberty Project

The Liberty Project is located in Foggy Island Bay, neighboring the Endicott Causeway in the Beaufort Sea. Hilcorp Alaska LLC (Hilcorp) submitted the Liberty Development and Production Plan to BOEM in December 2014. BOEM is currently preparing an EIS to assess impacts related to the construction and operation of the proposed artificial drilling and production island. The 9.3 acre island is proposed to include drilling and production (processing) facilities, with a 5.6 mile long pipeline extending to shore, where it would travel 1.5 miles overland to tie into the existing Badami Pipeline. This pipeline would transport a peak of 60,000 – 70,000 barrels per day. The reservoir for the Liberty Prospect is approximately 167 million barrels of recoverable oil.

Long-term access to the proposed island may be provided by a seasonal ice road extending from the Endicott Satellite Drilling Island (SDI); marine traffic would originate from West Dock or Endicott SDI and air traffic may originate from West Dock, Endicott SDI or Deadhorse. The primary nodes for this offshore development would be from the Endicott SDI seasonal ice road, or the temporary construction ice road extending along the proposed pipeline route which extends from the proposed island location directly south to shore.

Continuation of Badami Production

The Badami project is located approximately 20 miles east of Prudhoe Bay on the Beaufort Sea coast. It is connected by pipeline to Endicott, but there are no all-season road connections; Badami has a gravel causeway barge dock. The facility went into production around 2001, but was suspended in 2007 after production results were less than expected. In 2010, production was temporarily restarted. Additional winter exploratory drilling is currently being conducted; depending on results, production could be resumed on a continuing basis within a couple of years. Some improvements to the dock and other facilities may be needed. The primary areas of nexus with offshore exploratory activity would involve barge sealifts through the Beaufort and Chukchi seas, and offloading activity at Badami (Bradner 2011, Petroleum News 2011b).

4.11.2.2 Scientific Research

There are a number of scientific research programs that take place in offshore areas of the Beaufort and Chukchi seas. This section cannot be exhaustive in the listing of all studies funded by BOEM and other federal and industry partners in these waters. The following is a representative sample of the number and types of studies that have been and continue to be pursued in Alaskan Arctic waters. These activities involve vessel, air, and over-ice support which may contribute to cumulative effects through disturbance of marine mammals and impacts to subsistence harvest through marine vessel and aircraft traffic, and disturbance of bottom sediment through sampling. BOEM supports a variety of research programs aimed at understanding the Arctic OCS environment and associated ecosystems. BOEM Alaska OCS regional research in 2013 includes physical oceanography studies, habitat and ecology studies including mapping the distribution of marine mammals, shorebirds, fish, benthic, and epifaunal communities in the northern Chukchi Sea and central and eastern Beaufort Sea, studies designed to understand the rate and effects of climate change, modeling of weather and changing patterns of ice formation and loss, atmospheric effects from increased economic development, and effects of development and climate change on native subsistence and cultures. These studies include the Hanna Shoal Ecosystem Study and the Synthesis of Arctic Research study, both designed to attempt synthesizing past and future information being collected in the Alaskan Arctic. Included are marine mammal research studies such as the Bowhead Feeding Variability in the Western Alaska Beaufort Sea, as well as the COMIDA program to establish an integrated knowledge of the Chukchi Sea ecosystem. These programs conduct studies to understand bowhead whale population and migration structures and include a range of biological, chemical, and physical processes. These include collections to establish baseline data sets for benthic infauna and epifauna, organic carbon and sediment grain size, radioisotopes for down core dating, trace metals in sediments, biota and suspended particles, as well as associated parameters. The program operates annually in the Chukchi Sea. In addition, the BOEM research vessel, the 36-foot Launch 1273, supported research in the Beaufort Sea during the 2013 open water season. In the past, the ANIMIDA and (c)ANIMIDA Projects operated during the summers of 2004, 2005, 2006, and 2007. An explicit goal of the (c)ANIMIDA Project is to examine temporal and spatial changes in chemical and biological characteristics of the oil and gas exploration and development area of the Alaskan Beaufort Sea and to determine if any observed changes are related to the Northstar development and production operations. From 1997 through 2008, BOEM developed and conducted 31 projects directly related to improving equipment and processes for the prompt identification and removal of oil from harsh Arctic environments. Since 2000, the ANIMIDA project has been monitoring and attempting to understand the geographical extent of the Boulder Patch, a geographically isolated hard-bottom kelp community that exists in the Stefansson Sound south and east of the Prudhoe Bay and Liberty developments.

The NMFS National Marine Mammal Laboratory contracted with the NSB to provide services related to the Bowhead Head Whale Feeding Ecology study (BOWFEST) through April 2013. The purpose of BOWFEST is to document patterns and variability in the timing and locations of bowhead whales feeding in the western Beaufort Sea and to estimate temporal and spatial patterns of habitat use by bowhead whales within the EIS project area. Local Iñupiat hunters conduct boat-based surveys of the study area to gather information on bowhead whale behavior and movement. The study is based around Barrow. In addition, the bowhead whale satellite tagging study operates annually in the Beaufort and Chukchi seas. The purpose of the project is to understand migration routes, migration timing, feeding areas, diving behavior, and time spent in areas within the spring and summer ranges of bowhead whales. Fifteen satellite tags were deployed on bowhead whales in Alaska and Canada in 2009. In August, eight bowhead whales were tagged near Barrow, Alaska, and three were tagged in Canada near Atkinson Point on the Tuktoyaktuk Peninsula. One gray whale was also tagged in Canada. Four more bowheads were tagged near Barrow in October 2009. The study has been operating since at least 2006, and between two and fifteen tags have been deployed on bowhead whales during each of those years.

The Russian-American Long-term Census of the Arctic (RUSALCA) is funded by NOAA and the NSF Arctic Observing Network Program (ARC-0855748) to understand and ultimately predict the effects of climate change in the northern Bering and Chukchi seas. To this end, the RUSALCA program collects information related to changes in physical and biogeochemical processes, and alteration of biomass and productivity of organisms and their associated marine food webs. The census involves a series of biophysical moorings in the western Bering Strait, CTD transects conducted across the Herald Shelf Valley, and a series of shipboard projects aimed at understanding biogeochemical processes that influence climate and ecosystem dynamics in the study area. RUSCLA appears to operate annually during the open water season and overlaps with the EIS project, in particular, in the Chukchi Sea near Cape Lisburne and Point Hope, and in the northern Beaufort Sea.

The Alaskan Ocean Observing system (AOOS) has various sensors and monitors deployed throughout the EIS project area to measure and record meteorological conditions and other environmental variables. AOOS also coordinates a seabird monitoring network in the proposed action area.

The Western Arctic Shelf Basin Interactions (SBI) project, sponsored by the NSF and the Office of Naval Research, was a multi-year, interdisciplinary program aimed at investigating the impact of global change on physical, biological and geochemical processes over the Beaufort and Chukchi seas shelf basin region in the Western Arctic Ocean. The goal was to improve understanding of shelf-basin exchange, and to improve predictions of global change impacts in the Arctic. The SBI program includes both field and modeling studies (http://www.eol.ucar.edu/projects/sbi/). The project collected data during the 2002 to 2004 field seasons. In addition, NSF plans to conduct seismic surveys in northwest corner of U.S. EEZ, Chukchi Sea within the foreseeable future.

Finally, Chukchi baseline studies funded by ConocoPhillips Alaska, Inc (CPAI), Statoil, and Shell have included physical oceanography, benthic, zooplankton, fish, acoustics, and ice studies in the Chukchi Sea.

Past, present, and reasonably foreseeable future actions related to scientific research in the EIS project area are summarized in Table 4.11-3.

4.11.2.3 Mining

Mining takes place in onshore areas of the Chukchi Sea portion of the EIS project area. While the majority of mining activities take place onshore, marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to the subsistence harvest. The world’s largest known zinc resources are located in the western Brooks Range. As much as 25 million tons of high-grade zinc is estimated to be present near Red Dog Mine, approximately 40 mi from the southwest corner of the NPR-A (Schoen and Senner 2003). The Red Dog Mine port site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea. In addition, coal mining prospecting proposals for the Brooks Range have been submitted to ADNR, Division of Mining, Land and Water (DMLW) for approval. Past, present and reasonably foreseeable future activities related to mining activities within the EIS project area are summarized in Table 4.11-4.

4.11.2.4 Military

It may be reasonable to expect that military activity will continue to increase in the foreseeable future. Military activities in the EIS project area include the transit of military vessels through area waters, as well as submarine activity, aircraft overflights, and related maneuvers. However, very little public information is available about future military activity in the region. Military vessel, submarine, and aircraft traffic could contribute to cumulative effects through the disturbance of marine mammals and effects to the subsistence harvest, and the potential for marine fuel spills.

Table 4.11-3 Past, Present, and Reasonably Foreseeable Future Actions Related to Scientific Research in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Scientific Research (seismic, multi-beam sonar, transect surveys, oceanographic and biological sampling)	U.S. Beaufort and Chukchi Seas	Bowhead Head Whale Feeding Ecology study (BOWFEST) –. Russian-American Long-term Census of the Arctic (RUSALCA) RUSALCA (http://www.arctic.noaa.gov/ aro/russian-american/) Chukchi Offshore Monitoring in Drilling Area (COMIDA) (*http://www.comidacab.org/*) Joint Chukchi baseline studies by CPAI, Statoil, Shell Bowhead whale satellite tagging study (http://www.wildlife.alaska.gov/index.cfm?adfg=marinemammals.bowhead) Bowhead Whale Aerial Survey Project (BWASP) Various BOEM-funded studies (http://www..boem.gov/Studies/) Western Arctic Shelf Basin Interactions project (Healy and Polar Star icebreakers / NSF). NSF Seismic Surveys Arctic Nearshore Impact	Vessel traffic, includes acoustics, aerial surveys, water and benthic sampling n/a funded by MMS, regional area survey of benthic, seabird, marine mammals includes physical ocean, benthic, zooplankton, fish, benthic, acoustics, and ice studies. n/a surveys of the autumn migration of bowhead whales through the Alaskan Beaufort Sea and transect data on all other marine mammals sighted. n/a	X X X X X X X X	X X X X	X	X	X

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
		Monitoring in Development Area III (ANIMIDA III) http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska/Index.aspx	vessel traffic Vessel traffic, seismic surveys Vessel traffic, including water and benthic sampling	**X** **X**	**X**			
	Canadian Beaufort Sea	National Research Council Escape, Evacuation & Rescue Systems and Ice Loading 2007	Vessel traffic	**n/a**	**n/a**	**X**		
		Oceans & Fisheries Canada (OFC) Arctic Fish Ecology and Assessment Research (AFEAR)	Vessel traffic	**n/a**	**n/a**		**X**	**X**
		OFC Arctic Marine Mammal Ecology and Assessment Research (AMMEA)	Vessel traffic	**n/a**	**n/a**		**X**	**X**
		OFC Arctic Stock Assessment (ex. movement of ringed seals, Beaufort belugas)	Vessel traffic	**n/a**	**n/a**		**X**	**X**
		OFC Arctic Environment and Contaminants Research	Vessel traffic	**n/a**	**n/a**		**X**	**X**

Table 4.11-4 Past, Present, and Reasonably Foreseeable Future Actions Related to Mining in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Mining	12 -Southwest Chukchi Sea Inland - Red Dog Mine	Red Dog Mine	Large inland zinc mine, ore trucked to port facility, aircraft traffic	X	X	X	X	X
	Southwest Chukchi Sea Coastal - Red Dog Port	Minerals Export	vessel traffic bringing in supplies, transshipping processed mineral product	X		X	X	X
	14 -Western Chukchi Sea Coastal – Western Arctic Coal Project	Coal exploration and development	Vessel traffic bringing in supplies	X				X

The DEW Line, was a system of 63 radar stations located across the northern edge of the North American Continent, roughly along the 69th parallel. The radar stations were constructed between 1954 and 1957, and decommissioned during the 1990s. A runway operated by NSB (Kaktovik airport) presently active at the former Barter Island DEW Line site. The Bullen Point site is currently managed by the U.S. Air Force and has a gravel airstrip and a small radar system.

Submarines are valuable platforms for a wide variety of research activities including passive and active acoustic studies. Although the U.S. Navy (and other organizations) are likely to continue to use submarines within the proposed action area, detailed information about future military actions is not publicly available.

Past, present and reasonably foreseeable future activities related to military activities within the EIS project area are summarized in Table 4.11-5.

4.11.2.5 Transportation

In addition to marine and air transportation associated with the previously mentioned activities, there is frequent marine and air traffic associated with coastal communities on the North Slope and in Northwest Alaska. Marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to the subsistence harvest. It is reasonable to assume that trends associated with transportation to facilitate the maintenance and development of coastal communities will continue. In some specific cases, described below, transportation and associated infrastructure in the proposed activity area may increase as a result of increased commercial activity in the area. Past, present and reasonably foreseeable future activities related to transportation activities within the EIS project area are summarized in Table 4.11-6.

Vessel Traffic. Vessel traffic through the Bering Strait has risen steadily over recent years according to USCG estimates, and Russian efforts to promote a Northern Seas Route for shipping may lead to continued increases in vessel traffic adjacent to the western portion of the EIS project area. Efforts to regulate Arctic shipping such as the IMO Polar Code, which contains mandatory environmental mitigation measures have been made. An analysis done by Shell Oil as part of a Revised Outer Continental Shelf Lease Exploration Plan for the Chukchi Sea (Shell 2015) indicated that "*during the period from 2008 to 2012, annual vessel traffic transiting the Bering Strait, which is the entry and exit point to the Western Arctic and the Chukchi Sea, increased from 220 to 480 vessels a year (a more than 100% increase). The growth rate was particularly high for tanker vessels. Tugs and other nearshore cargo vessels made up the second and third largest categories of recorded movements. Smaller vessel traffic specific to subsistence hunting will likely remain relatively constant while vessel traffic specific to supply of native villages will likely increase (AMSA, 2009). The estimated number of miles of vessel traffic in the Chukchi Sea for July through October increased from approximately 2,000 miles in 2006 to more than 11,500 miles in 2010 (Marine Exchange of Alaska, 2011). Vessel tracks from 2009 indicate vessel transits in the vicinity of Barrow and Wainwright are traditionally concentrated along the coast (Marine Exchange of Alaska, 2011)*".

Vessel traffic within the EIS project area can currently be characterized as traffic to support oil and gas industries, barges or cargo vessels used to supply coastal villages, smaller vessels used for hunting and local transportation during the open water period, military vessel traffic, and recreational vessels such as cruise ships and a limited number of ocean-going sailboats. Barges and small cargo vessels are used to transport machinery, fuel, building materials and other commodities to coastal villages and industrial sites during the open water period. For example, villages along the Beaufort and Chukchi sea coasts are serviced by vessels from Crowley Alaska and or Northern Transportation Company. Additional vessel traffic supports the Arctic oil and gas industry, and some activity is the result of emergency-response drills in marine areas. The potential for infrastructure for a deep-draft port has been studied and identified two sites - Nome and Port Clarence - as feasible locations that should be evaluated for development of a deep water port (USACE 2013). As of 2015 Port Clarence site was being evaluated as the potential site for this port though the process for evaluating the need has been paused (DeMarban, 2015).

In addition, research vessels, including NSF and USCG icebreakers, also operate in the EIS project area. USCG anticipates a continued increase in vessel traffic in the Arctic. Changes in the distribution of sea ice, longer open-water periods, and increasing interest in studying and viewing Arctic wildlife and habitats may support an increase in research and recreational vessel traffic in the proposed action area regardless of oil and gas activity.

Table 4.11-5 Past, Present, and Reasonably Foreseeable Future Actions Related to Military in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Military	13 -Eastern Beaufort Sea Coastal -Barter Island [1]	Distant Early Warning[6] (DEW) Line Sites	Radar site still active, aircraft traffic, barge traffic	X	X	X	X	X
	13 -Central Beaufort Sea Coastal - Bullen Point SRRS[1]		Aircraft traffic, barge traffic	X	X	X	X	X
	13 -Central Beaufort Sea Coastal -Flaxman Island SRRS[1]		Demolition complete			X		
	13 -Western Beaufort Sea Coastal -Point Barrow		Demolition complete but radar site still active, aircraft and barge traffic			X		
	13 -Eastern Chukchi Sea Coastal -Wainwright		Potential demolition, aircraft and barge traffic			X	X	
	13 -Central Chukchi Sea 13 -Coastal -Point Lay		Demolition complete			X		
	13 -Central Chukchi Seas Coastal - Cape Lisburne		Radar site still active, aircraft traffic, Barge traffic			X	X	X
	13 -Western Chukchi Sea Coastal -Kotzebue		Potential demolition, aircraft and barge traffic			X		
	submarines	Arctic Submarine Laboratory has conducted various arctic activities since 1940 (http://www.csp.navy.mil/asl/Timeline.htm) locations unknown.	Vessel traffic, sonar impacts, ship strikes	X	X	X	X	X
	US Coast Guard icebreakers	*Healy* and *Polar Star* icebreakers	Vessel traffic, potential ships strikes, icebreaking	X	X	X	X	X
	Overflights	North American Aerospace Defense Command (NORAD) Elmendorf AFB	Aircraft traffic	X	X	X	X	X

Table 4.11-6 Past, Present and Reasonably Foreseeable Future Actions Related to Transportation in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Transportation	Beaufort and Chukchi Seas - Coastal	Community Roads and Vehicular Traffic	Vehicle traffic	X	X	X	X	X
		Scheduled Air Transportation	Aircraft traffic	X	X	X	X	X
		Pipelines	Petroleum product offloading, transport, storage	X	X	X	X	X
	Chukchi Sea - Coastal	Deep-Draft Port	Vessel traffic	X	X			X
	Beaufort and Chukchi Seas - Offshore	Marine Vessel Traffic	Vessel traffic	X		X	X	X
		Aircraft Traffic	Aircraft Traffic	X	X	X	X	X

Aircraft Traffic. Industry uses helicopters and fixed wing aircraft to support routine activities within the EIS project area. In addition, at least four companies operate passenger and air cargo services between North Slope communities and population centers, flying inland and along the coast. These may involve several scheduled flights daily using small propeller-driven aircraft. The majority of air travel and freight hauling between Arctic coastal communities involves small commuter-type aircraft, and government agencies and researchers often charter aircraft for travel and research purposes. These activities are expected to continue, and the level of aircraft traffic within the EIS project area may increase as a result of climate change and/or increased industrial activity and community development.

4.11.2.6 Community Development Projects

Community development projects in Arctic communities involve both major infrastructure projects, such as construction of airports and response centers, as well as smaller projects (e.g., construction of a new washeteria). These projects could result in construction noise in coastal areas, and could generate additional amounts of marine and aircraft traffic to support construction activities. Marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to the subsistence harvest. Keeping in mind that "it is not practical to analyze how the cumulative effects of a proposed action interact with the universe (CEQ 1997)," this section will focus only on past, present, and reasonably foreseeable community development projects that are truly meaningful within the context of the cumulative effects analysis.

Major community development projects that are foreseeable at the present time include the construction of a new airport at the village of Kaktovik, and potentially a new emergency response facility at Wainwright.

Past, present and reasonably foreseeable future activities related to community development project activities within the EIS project area are summarized in Table 4.11-7.

Table 4.11-7 Past, Present, and Reasonably Foreseeable Future Actions Related to Community Development Projects in the EIS Project Area

Category	Area	Action / Project	Past	Present	Future
U.S. Community Development/Capital Projects	Kaktovik	Marine and air, airport construction	**X**	**X**	**X**
	Nuiqsut	Marine and air traffic	**X**	**X**	**X**
	Barrow	Marine and air traffic	**X**	**X**	**X**
	Wainwright	Marine and air traffic, port construction	**X**	**X**	**X**
	Point Lay	Marine and air traffic	**X**	**X**	**X**
	Point Hope	Marine and air traffic	**X**	**X**	**X**
	Kivalina	Marine and air traffic	**X**	**X**	**X**
	Kotzebue	Marine and air traffic, small boat harbor	**X**	**X**	**X**
Canadian Community Development/Capital Projects	Aklavik, Yukon Territory	Marine and air traffic	X	X	X
	Inuvik, Northwest Territory (NWT)	Marine and air traffic	X	X	X

4.11.2.7 Subsistence

Subsistence activities occur in coastal and offshore portions of the EIS project area. Subsistence hunters primarily use boats and snowmachines for access. In addition to the harvest and mortality of marine mammals, boat and snowmachine traffic could lead to the disturbance of marine mammals as well. The types of subsistence uses and activities that were described in Chapter 3 are expected to continue into the future. Current and past hunting, gathering, fishing, trapping subsistence activities would be similar in the types of activities and areas utilized for the communities associated with the EIS project area in the future.

Past, present and reasonably foreseeable future activities related to subsistence activities within the EIS project area are summarized in Table 4.11-8.

4.11.2.8 Recreation and Tourism

Recreation and tourism activities are generally pursued by non-residents of the EIS project area. Marine and coastal vessel and air traffic could contribute to potential cumulative effects through the disturbance of marine mammals or impacts to the subsistence harvest. With the exception of adventure cruise ships that transit the Beaufort and Chukchi sea coasts in small numbers, much of the air sightseeing traffic is concentrated in ANWR. The types of recreation and tourism activities that were described in Chapter 3 are expected to continue into the future. Current and past sport hunting and fishing, or other recreation or tourism-related activities would be similar in the types of activities and areas utilized for the communities associated with the EIS project area in the future.

Past, present and reasonably foreseeable future activities related to recreation and tourism activities within the EIS project area are summarized in Table 4.11-9.

4.11.2.9 Climate Change

Climate change is an ongoing factor in the consideration of cumulative environmental effects on the Arctic region (NOAA 2011). It has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, and the timing and duration of phytoplankton blooms in the Beaufort Sea. Climate conditions in the EIS project area have been undergoing remarkable changes, particularly over the past 20 years (USGS 2011a). Warmer air and water temperatures result in earlier spring snowmelt, decreased ice thickness during the winter, and accelerated rates of coastal erosion and permafrost degradation (USGS 2011a). In addition, due to the changing extent and thickness of sea ice, resulting from changes in the temperature regime, there is more open water during the summer season. The lack of sea ice also leads to the creation of wind driven waves, which in turn contribute to coastal erosion. These changes have been attributed to rising CO_2 levels in the atmosphere and corresponding increases in CO_2 levels in the waters of the world's oceans. These changes have also led to the phenomenon of ocean acidification (IPCC 2014). This phenomenon is often called a sister problem to climate change, because they are both attributed to human activities that have resulted in increased CO_2 levels in the atmosphere. Ocean acidification in high latitude seas is happening at a more advanced rate compared to other areas of the ocean. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to increased levels as a result of climate change (Bates and Mathis 2009). This is due to the loss of sea ice that increases the open water surface area of the Arctic seas. Exposure of cooler surface water lowers the solubility (or saturation) of calcium carbonate within the water, which in turn leads to lower available levels of the minerals needed by shell-producing organisms (Fabry et al. 2009).

Climate change could affect the habitat, behavior, distribution, and populations of marine mammals, fish, and other wildlife within the EIS project area. Climate change could also affect the availability of, or access to, subsistence resources, particularly spring hunts for bowhead whales and other marine mammals. Climate change also affects the length of seasons that ice roads are operable, potentially leading to more reliance on marine access.

Past, present and reasonably foreseeable future activities related to climate change activities within the EIS project area are summarized in Table 4.11-10.

Table 4.11-8 Past, Present, and Reasonably Foreseeable Future Actions Related to Subsistence Activities in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Subsistence Activities (marine mammals)	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue and adjacent areas	Bowhead whale harvest	Vessel traffic in fall hunt, snow machine traffic in spring hunt	**X**	**X**	**X**	**X**	**X**
		Harvest of beluga, walruses, seals	Vessel traffic for open water beluga, walrus, seal hunt; snow machine traffic in winter seal hunt	**X**	**X**	**X**	**X**	**X**
Subsistence Activities	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue and adjacent areas	Hunting, gathering, fishing, trapping, and associated activities	Vessel traffic, snow machine traffic	**X**	**X**	**X**	**X**	**X**

Table 4.11-9 Past, Present, and Reasonably Foreseeable Future Actions Related to Recreation and Tourism in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Recreation/Tourism (wildlife watching, cruise ships)	Eastern Beaufort Sea Coastal and Inland -Arctic National Wildlife Refuge	River trips, wildlife viewing, hiking	Aircraft traffic, powered and non-powered vessel traffic	**X**		**X**	**X**	**X**
	Eastern Beaufort Sea Coastal and Inland - North Slope (Kaktovik)	Wildlife viewing	Aircraft traffic, vessel traffic	**X**		**X**	**X**	**X**
	Beaufort Sea Offshore and Nearshore	Cruise ships, ecotours	Vessel traffic	**X**			**X**	**X**
Recreational/Sport Hunting/Fishing	Chukchi Sea Offshore	Cruise ships, ecotours	Vessel traffic	**X**			**X**	**X**
	Eastern Beaufort Sea Coastal and Inland -Arctic National Wildlife Refuge	Hunting, Fishing	Aircraft traffic	**X**		**X**	**X**	**X**

Table 4.11-10 Past, Present, and Reasonably Foreseeable Future Actions Related to Climate Change in the EIS Project Area

Category	Area	Action / Project	Past	Present	Future
Climate Change	Global	Changes in atmospheric, cryosperic, and ocean processes	**X**	**X**	**X**

4.11.3 Alternative 1 – No Action

Under Alternative 1, NMFS would not issue any ITAs under the MMPA for seismic surveys or exploratory drilling in the Beaufort and Chukchi seas, and BOEM would not issue G&G permits or concur on ancillary activity notices for activities in the Beaufort and Chukchi seas. Consequently, no seismic surveys, ancillary activities, or exploratory drilling would be expected to occur in federal waters of the Beaufort and Chukchi seas under this Alternative. There would be no potential for a VLOS under Alternative 1 in the federal OCS, and, as discussed in Section 4.4.1, there would be no direct or indirect effects to resources as a result of Alternative 1, other than to socioeconomics and land and water use, management, and ownership. There would be no cumulative effects to resources outside of these resources under Alternative 1.

As noted previously in Section 4.4, some smaller amount of seismic survey or exploratory drilling operations could potentially be permitted by the State but without an associated MMPA ITA. In such a case, some small amount of impacts to marine mammals, subsistence uses, and other biological resources could occur. These impacts to biological resources would be expected to be of the exact nature and quality analyzed in Alternatives 2, 3, and 4 but of significantly lower quantity and limited spatial extent, and therefore contributing less to the cumulative effects because activities in State waters are already only a subset of the total activity levels analyzed in the alternatives. Therefore, this situation would be a further subset of the levels already considered in the small likelihood that a company elected to conduct work resulting in marine mammal take without pursuing an MMPA ITA.

Over the past several years, there has been a certain level of oil and gas exploration activity that has been permitted by NMFS and BOEM in the Beaufort and Chukchi seas. This level of activity is greater than what is associated with Alternative 1 (no activity permitted), but less than what is associated with Alternative 2. Therefore the impacts analyzed for Alternative 1 would be less than the status quo for oil and gas exploration activities in the Beaufort and Chukchi seas, and is within the range of activities evaluated in this EIS.

4.11.3.1 Socioeconomics

4.11.3.1.1 Summary of Direct and Indirect Effects

The magnitude of the direct and indirect socioeconomic effects from Alternative 1 would be generally negative, due to potential lost opportunity for offshore oil and gas development. There would be no net change to the non-monetary (subsistence) economy. The potential impact to local employment and sales tax would be low in magnitude because total personal income and local employment rates would not have increased by more than five percent. The duration of the local socioeconomic impacts would be interim because it is not year-round, however, the activity would have occurred over several of years. The likelihood of exploration resulting in production cannot be predicted therefore the magnitude of potential unrealized revenue for state and federal governments is unknown. These potential negative economic impacts of the activity would be statewide and even national in extent. The context of the socioeconomic impacts, the people that would experience the potential for local employment and tax revenue, are unique in that Iñupiat (minority population) communities would primarily be affected.

The summary impact level of direct and indirect effects from the No Action Alternative for Socioeconomics would be moderate.

4.11.3.1.2 Past and Present Actions

As described in Chapter 3, oil and gas exploration, development, production, and transportation are major contributors to the economy of Alaska, the communities within NSB, and to a lesser degree for Northwest Arctic Borough.

Public Revenue and Expenditures

The predominant source of NSB revenue comes from property sold or leased by the oil industry (MMS 2008). The Northwest Arctic Borough generates a large portion of its revenue from payment in lieu of taxes from the Red Dog Mine and the remainder from state and federal government sources (EPA 2009c).

Approximately 90 percent of all state tax revenue is paid by the oil and gas industry, but the proposed action involves exploration activities on federal lands which generate no state revenue (ADCCED 2011a). Federal royalty revenue associated with offshore leases is a small portion of the total U.S. budget, but federal spending in Alaska is first based on per capita (ADCCED 2011a). Onshore oil production has been declining, resulting in declining revenues to borough and state governments.

Employment and Personal Income

The extraction of natural resources from remote rural Alaska produces only modest direct economic benefit in the form of jobs, household income, business purchases, and public revenue for most residents (Goldsmith 2007). North Slope oil field operations provide employment to over 5,000 people who are not residents of NSB (ADCCED 2011c). Direct employment in the oil and gas industry makes up just four percent of the total state employment (Fried 2011). Employment rates in NSB and NAB are much lower than state or national averages and have shown further decline in the period between 2000 and 2009 (U.S. Census 2009). However, indirect benefits of oil and gas development are substantial. The majority of employment in these areas is from state and local government, which receive operating revenues from taxes on oil and gas facilities and production. Over time, oil and gas exploration and production have decreased from historic levels; however, oil and gas and mining continue to contribute to local employment and income.

Demographic Characteristics

The middle range for the State of Alaska and EIS project area borough population growth projections are just under one percent annual increase per year; for the EIS project area regions annual growth is about 0.9 percent per year (ADLWD 2011d). The population for the State of Alaska in 2020 is projected to be 766,231; the North Slope Borough projected population for 2019 is 7,140; the NAB projected population for 2019 is 7,709; and Nome Census Area projected population for 2019 is 9,911 (ADLWD 2011d). North Slope Borough population has grown since it started to be tracked in the 1960 Census from 2,133 to 9,430 today (ADCCED 2011c).

In- and out-migration are more substantial and uncertain components of population change in Alaska than natural births and deaths. In certain years, net out-migration was strong enough to reverse the trend of annual growth.

Social Organizations and Institutions

Cultural values are reflected in governmental and tribal (governmental) bodies in the EIS project area (see Table 3.3-6) to ensure that economic development and social services address the needs of local communities appropriately. Social organizations and institutions will remain important in meeting community needs and preserving community culture, with regard to issues associated with resource development and trends in federal, state, and local revenue.

4.11.3.1.3 Reasonably Foreseeable Future Actions

There are numerous categories of reasonably foreseeable future actions that have an impact on public revenue and expenditures, employment and personal income, and social organizations and institutions. These include: onshore oil and gas exploration, development and production; mining exploration, development and production; military, transportation, community development projects, subsistence activities (as they affect the non-cash economy), and recreation and tourism. These categories of socioeconomic impact would likely not be at a magnitude, like the discovery of oil in Prudhoe Bay (1968) and construction of TAPS or the oil price drop of 1985, to impact state and local revenue, employment, and demographic characteristics.

Public Revenue and Expenditures

If oil and gas production activities continue at current levels, the State of Alaska would continue to collect the majority of state tax revenue from the oil and gas industry, although this is expected to decline without major new discoveries, facility development and production. The vast majority of produced oil in Alaska depends on TAPS for transport to market and any OCS oil contribution would extend its commercial life. This would continue state and local royalty oil revenue that otherwise would end immediately upon a shutdown of TAPS.

Oil and gas revenue represented 90 percent of state tax revenue in 2009 during a period of high oil prices (ADCCED 2011a). For the EIS project area, the enacted FY 2012 State Capital Budget is $75.5 million divided between infrastructure ($67.1 million), education ($8.1 million), and ($0.3 million) public safety and health projects (OMB 2011). $52.5 million of this capital budget for the Arctic area comes from the federal government. Revenue generated for the NSB would follow similar trends, including declines in revenue without major new discoveries and subsequent development. Declines in state and borough revenue would be reflected in declines in capital project funding, levels of government services, and public sector employment.

Employment and Personal Income

Government bodies (boroughs, other municipal governments, and school districts) would remain the largest employer in the NSB and NAB (ADLWD 2005, NSB 2005). Foreseeable oil and gas and mining activity would contribute to maintaining current employment and income levels, but would not result in major increases. Increases in scientific research, military activity, transportation, and recreation and tourism would have a minor to negligible impact to local employment because current levels of these activities create very little direct employment. Expansion and continued development at Red Dog would contribute to the employment and income opportunities in Nome and NAB residents; however, a decline in oil and gas development on the North Slope would contribute to a decline in private and public sector employment and personal income.

Demographic Characteristics

Reasonably foreseeable future actions are likely to be of a scale and dispersed geographic nature to maintain current demographic levels and characteristics based on employment and revenue opportunities. As indicated previously, there is nothing foreseeable that would result in large-scale state or regional in-migration and change in demographic characteristics.

Social Organizations and Institutions

It is assumed social organizations and institutions will function at their current levels in the future, subject to available funding, which could be affected by any declines in federal, state, and borough revenue. Modest population growth would increase the demand on institutions and social services to some degree.

4.11.3.1.4 Contribution of Alternative to Cumulative Effects

The No Action Alternative is expected to contribute a low intensity, interim adverse impact to the region due to the lost opportunity for revenue. Although there would be no impact to the local non-monetary economy, there would be unrealized local employment and there would be no OCS oil contribution to extend the commercial life of TAPS. The cumulative socioeconomic impacts would affect minority population (unique) communities. Therefore the contribution to cumulative effects of socioeconomics would be moderate.

If Alternative 1 results in the inability of a lessee to lawfully explore for oil and gas, the federal government could be required to buy back the leases from the lessees, which could cost tax payers several billions of dollars. A buy back of the leases would result in lost lease rentals to the federal government and delay/loss of any production, royalties, employment, and taxes from any petroleum that might have been produced.

4.11.3.1.5 Conclusion

The direct and indirect effects of Alternative 1 would be adverse and moderate due to the unrealized opportunity for employment and lost generation of public revenue. The contribution to the socioeconomic cumulative effects would be adverse and minor.

4.11.3.2 Land and Water Ownership, Use, Management

4.11.3.2.1 Summary of Direct and Indirect Effects

Land and Water Ownership

Based on Table 4.4-2 and the analysis provided in Section 4.4.1.2, the impacts on land and water ownership under Alternative 1 would be high in magnitude, interim in duration, regional in extent, and important in context. In total, the direct and indirect impacts on land ownership are considered to be major, and result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations.

Land and Water Use

Based on Table 4.4-2 and the analysis provided in Section 4.4.1.2 the impacts on land and water use under Alternative 1 would be high in magnitude, interim in duration, important in context, and regional in extent, although some changes in land use could occur in support areas out of the region, in areas that provide support services such as Nome and Dutch Harbor. In total, the direct and indirect impacts on land use are considered to be major; they result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations. Refer to Sections 4.10.6.15 and 4.10.6.20 for impacts on subsistence and recreation.

Land and Water Management

Based on Table 4.4-2 and the analysis provided in Section 4.4.1.2, the impacts on land and water management under Alternative 1 would be high in magnitude, -interim in duration, important in context, and regional in extent, although some changes in land use could occur in support areas out of the region. In total, the direct and indirect impacts on land and water management are considered to be major; they would result in changes of federal and state land and water management by effectively preventing exploration for oil and gas resources in compliance with federal regulations.

4.11.3.2.2 Past and Present Actions

Ownership patterns in Alaska were primarily influenced by Alaska statehood in 1959, ANCSA in 1971, North Slope oil development facilitated by the Trans-Alaska Pipeline in 1973, and ANILCA in 1980. Land management plans and lease sale documents were developed for public land at the federal and state level, while comprehensive plans, zoning, subdivision and other regulations were developed at the municipal level. In turn, physical land and water use generally reflects these policies and regulations. Specific land uses that have affected the EIS project area in the past include oil and gas leasing, development, production, and transportation; subsistence uses, discussed in Section 4.10.6.15; the development of Red Dog Mine, and land uses associated with local communities. Much of the current industrial, transportation, and commercial land and water uses have resulted directly and indirectly from the oil and gas industry. The level of impact of past and present actions would be moderate due to the wide-spread and interim effects of the onshore oil and gas and mining industries.

4.11.3.2.3 Reasonably Foreseeable Future Actions

Lease sales would be likely to continue on state and federal lands, but would not occur and affect ownership in offshore areas. Oil and gas production at existing facilities is expected to continue through the term of the EIS, and additional oil and gas development projects are foreseeable. These will have a continuing influence on land and water use on the North Slope.

Additional land could be required for mining if new or expanded coal and mineral mining operations occur at Red Dog Mine, the Brooks Range, or the Ambler Mining District. This would affect land and water use in the vicinity of specific projects, but would not likely result in changes on a regional scale.

Small community development projects take place, such as village expansions or infrastructure projects, which may require zoning changes. These land use changes would be incrementally small and geographically dispersed.

4.11.3.2.4 Contribution of Alternative to Cumulative Effects

Under Alternative 1, the direct and indirect effects on land ownership would be minor, and on land use and management would be major due to the inability to explore and develop offshore leases in state and federal waters in compliance with federal regulations. The incremental contribution of these impacts to those caused by other reasonably foreseeable future actions would be to place restrictions on the ability of private oil companies to explore and develop leases in federal and state waters that would not otherwise be present. Therefore, the contribution of Alternative 1 to cumulative effects on land use and management would be major.

4.11.3.2.5 Conclusion

Under Alternative 1, because direct, indirect and cumulative impacts are considered major and cumulative impacts are major, the overall level of impact for land ownership, use and management would be considered major.

4.11.4 Alternative 2 – Authorization for Level 1 Exploration Activity

4.11.4.1 Physical Oceanography

4.11.4.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 2 on physical ocean resources would be medium intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. Changes in water depth from discharged material would have minor effects on the physical resource character of the EIS project area. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of one island per year under Alternative 2, would result in medium-intensity, long-term, local effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial islands are constructed to support exploratory drilling activities. The effects of Alternative 2 on sea ice would be medium-intensity, local, temporary, and would affect a resource that is common in the EIS project area. The overall effects of Alternative 2 on physical ocean resources in the EIS project area would be minor, particularly with the implementation of additional mitigation measures related to reducing or eliminating certain discharge streams.

4.11.4.1.2 Past and Present Actions

Oil and gas development is the main agent of industrial related change in the EIS project area. Past and present actions related to oil and gas development have affected physical ocean resources in the Beaufort and Chukchi seas. Present actions are considered those that will occur during the life of this EIS. Several artificial gravel islands have been constructed to support oil and gas activities, and these artificial gravel islands have effects on water depth and local circulation patterns within the EIS project area. For instance, the Endicott development, located approximately 16 km (10 mi) northeast of Prudhoe Bay in the Beaufort Sea, consists of two man-made gravel islands connected by a 2.5 km (1.6 miles) man-made gravel causeway. The construction and existence of such structures influence water depth and currents in the EIS project area. The effects are medium intensity, permanent, and localized in the waters adjacent to the artificial islands.

Several nearshore developments in the Beaufort Sea, including the Northstar development, are connected to the Trans-Alaska Pipeline System (TAPS) via subsea pipelines, which have low-intensity, permanent, local impacts on the physical character of the ocean.

Barging and docking facilities at Barrow and Prudhoe Bay also influence the physical character of the nearshore ocean within the EIS project area.

4.11.4.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions with the potential to impact physical ocean resources in the proposed EIS project area include dredging and screeding associated with sealift barging to support future oil and gas development in the region (see Section 4.10.2). Dredging, screeding, and construction of docking facilities associated with reasonably foreseeable future development would have minor impacts on the physical character of the ocean within the EIS project area.

Expansion of Red Dog Port could result in effects to nearshore physical ocean resources in the EIS project area. Such effects would likely be medium-intensity, permanent, and local to the areas in the immediate vicinity of the Red Dog Port development.

Climate change has the potential to affect water temperatures, sea levels, stream and river discharge, and ice dynamics throughout the EIS project area. These changes could impact the physical character of the ocean in the EIS project area, and could influence the effects of naturally occurring phenomena (e.g., sea ice and storm conditions) on human safety. Due to the changing extent and thickness of sea ice resulting from changes in the temperature regime, there could be more open water during the summer season. The reduced coverage of sea ice would also lead to the creation of larger wind driven waves, which in turn could contribute to increased coastal erosion (USGS 2011a). However, over the lifespan of this EIS climate-related changes to physical ocean resources in the EIS project area are expected to be negligible (see Section 4.5.1.1).

4.11.4.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause local minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 2, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.4.1.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on physical ocean resources in the EIS project area would be minor.

In the event of a VLOS, the overall effects on the physical character of the ocean in the EIS project area would be high-intensity, temporary (with the exception of potential for long-term contamination of sediments with entrained oil), and would affect an area of hundreds of square kilometers. There would be moderate additive effects on the physical character of the ocean resulting from a VLOS in either the Beaufort or Chukchi Sea.

4.11.4.2 Climate and Meteorology

4.11.4.2.1 Summary of Direct and Indirect Effects

As described in Section 4.5.1.2, direct impacts from Alternative 2 to climate are anticipated to be low magnitude, long-term duration, and could affect unique resources on a global scale. Overall, these impacts are assumed to be minor, due to their low contribution to GHG emissions on a state level. Indirect effects are estimated to have a low to medium magnitude, long-term duration, and could affect unique resources on a global scale. Indirect effects are considered minor to moderate, since the outcome of activities associated with Alternative 2 could lead to a greater continued increase in GHG emissions.

4.11.4.2.2 Past and Present Actions

Since pre-industrial times, global anthropogenic GHG emissions have been continually increasing. GHG emissions have increased by 70 percent from 1970 to 2004. The majority of these GHG emissions (77 percent) are CO_2. The amount of GHGs in the atmosphere is the cumulative result of past and present emissions (and removals) of GHGs from human and natural processes. Over time GHGs are removed from the atmosphere due to natural, chemical processes. The removal rate varies between the different GHGs and can also vary based on conditions such as gas concentration in the atmosphere, changes in vegetation coverage, temperature, or other background chemical conditions (Solomon et al. 2007). Carbon dioxide, methane, and nitrous oxide are considered long-lived GHGs and can remain in the atmosphere from a decade to centuries or more. Due to these properties, cumulative effects to climate change from GHG emissions are both additive and synergistic in nature. The effects are additive because the more GHGs that are emitted, the higher the GHG atmospheric concentrations, and consequently the higher the ability to warm the planet which leads to other climate change impacts (see Section 3.1.2.4 for specific examples). The effects are also synergistic because as the concentration of GHGs in the atmosphere increases, it also affects the ability for GHGs to be removed or absorbed by the atmosphere. Therefore, GHG atmospheric concentrations will continue to increase, and perhaps accelerate, because of the continued increase in emissions and the potential decrease in the removal rate of these gases from the atmosphere (Solomon et al. 2007). However, a January 2012 U.S. Energy Information Administration report indicates that with improved efficiency of energy use and a shift away from the most carbon-intensive fuels, CO_2 emissions related to U.S. energy projects could remain at least five percent below 2005 levels through 2040 (EIA 2012).

According to the IPCC, CO_2 is considered the most important GHG due to its dominant atmospheric concentration. Burning fossil fuels is the largest contributor to CO_2 emissions, accounting for approximately two-thirds of the total since 1750 (Solomon et al. 2007). Scientists have identified specific climate trends that are attributed to these human-caused GHG emissions, including increases in air temperature, decrease in snow and ice extent, sea level rise, and decrease in ice thickness, as described in Section 3.1.2.4 under Changes in the Arctic. The past GHG emissions are expected to lead to warming and climate change in the future, even if GHG emissions were to halt (Solomon et al. 2007).

4.11.4.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would cumulatively contribute to global climate change impacts include the continued use of fossil fuels. Fossil fuel are used in the EIS project area for activities associated with oil and gas exploration and production, community power generation and space heating, transportation, and subsistence activities. The continued exploration and development of oil and gas reserves would continue to provide a supply of fossil fuels. When burned, these fossil fuels would emit GHGs and add to the cumulative concentration of GHGs in the atmosphere.

If atmospheric concentrations of GHGs were to stabilize, future warming and other interrelated climate change impacts would still be expected to occur. Therefore, past, present, and future actions within the next five to ten years could continue to impact climate change for years to come. Future climate will depend on committed warming caused by past anthropogenic emissions, as well as future anthropogenic emissions and natural climate variability (IPCC 2014). The global mean surface temperature change for the period 2016–2035 relative to 1986–2005 will likely be in the range 0.3°C to 0.7°C (IPCC 2014). This assumes that there will be no major volcanic eruptions or changes in natural sources of CH_4 or N_2O, or unexpected changes in total solar irradiance (IPCC 2014). A number of factors including population, energy use, amount of renewable energy use, and natural climatic influences are represented by the range in estimates (IPCC 2014.

4.11.4.2.4 Contribution of Alternative to Cumulative Effects

An analysis was performed to quantify emissions of greenhouse gases associated with Alternative 2. Under this alternative, the estimated annual emissions of CO_2e would be 145,203 metric tons in the Chukchi Sea OCS area, and 158,872 metric tons in the Beaufort Sea OCS area. Emissions of CO_2 and other greenhouse gasses under Alternative 2 could potentially contribute to changes in global climate. However, the amount to which changes in global climate are attributable to any single anthropogenic source is very small, and it is not currently useful to attempt to link specific climate impacts to the particular activities proposed under Alternative 2, as such direct linkage is difficult to isolate and to understand. In this case it is appropriate to evaluate and disclose estimated CO_2e emissions by activity and program type for the Arctic OCS under Alternative 2. These data are provided in Table 4.5-2.

The level of emissions described in Table 4.5-2 would be negligible relative to existing GHG emissions at the regional, State, national, and global levels and would represent a negligible level of effect. It is also acknowledged that some portion of the oil and gas produced from Arctic OCS leases would be consumed as fuel, which would produce GHG emissions that would contribute to climate change. As described in Section 4.5.1.2, potential indirect effects associated with Alternative 2 include this sustained and/or increased fossil fuels use. However, because end use consumption is not part of the Proposed Action and because any attempt to quantify a marginal increase in national oil and gas consumption (much less resulting GHG emissions or ensuing environmental effects) attributable to Arctic OCS oil and gas would be unduly speculative, this EIS does not attempt to quantitatively analyze or model environmental effects from the end use consumption of produced oil and gas.

When viewed cumulatively, all projects involving and promoting the sustained or increased use of fossil fuels such as this project, could result in an observable increase in GHG emissions and global climate changes. These observable, global changes would be long-term and could affect unique resources as discussed in Section 4.5.1.2 under Project-Related Effects to Climate Change.

4.11.4.2.5 Conclusion

The direct and indirect use of fossil fuels associated with offshore exploration and drilling is relatively small.

If a VLOS were to occur, as described in Section 4.10, the associated GHG emissions and radiative forcing from black carbon would also contribute to climate change. However, since these impacts are expected to be temporary and of lower intensity than the direct and indirect effects associated with Alternative 2, they are expected to result in minor additive effects to climate change.

4.11.4.3 Air Quality

4.11.4.3.1 Summary of Direct and Indirect Effects

Under Alternative 2, Level 1 Exploration Activity, potential air pollutant emissions are expected to be moderate. These emissions would be short in duration, extent, and content. The overall effect on air quality is expected to be medium to high. Indirect effects of this alternative may include increased use of other resources, such as additional personnel travel and resource transport which may have an effect on air quality. These indirect effects are unknown, but are expected to be negligible to minor, and would occur at locations outside of the EIS project area.

4.11.4.3.2 Past and Present Actions

Oil and gas exploration, development, and production is the primary source category for air emissions in the EIS project area. Past actions are unlikely to have any effect on current (or future) air quality; emissions of air pollutants are assumed to have ceased, and physical and chemical transport would have dissipated any impacts to air quality. Present actions related to exploration, development, or production have the potential to affect air quality in the area due to the use of combustion equipment. Any present activities in this category are expected to be permitted and have potential emissions that meet air quality standards. Oil and gas production activities generating air emissions are concentrated in the area between Prudhoe Bay and the Colville River to the west. Other actions with lesser effects on air quality in the EIS project area include: scientific research; military; transportation; community development projects; subsistence activities; recreation and tourism; and subsistence whaling. These actions may include the use of combustion sources. The actions that include onshore activities (such as transportation and community development projects) also have the potential to create air pollution from ground-disturbing sources.

Oil and gas exploration, development, and production is the primary source of air emissions in the EIS project area. As shown in Table 4.11-2, there are several present allowable exploration, development, and production activities. Each of these has potential activity in the immediate vicinity of the project EIS area, therefore effects of air quality could overlap with the direct effects from Alternative 2. The effects from these activities are expected to be minor to moderate in magnitude, potentially long-term (for development and production facilities), and local in the areas surrounding the specific activities. Present transportation actions (barges and air traffic) could also overlap in the vicinity of the EIS project area. The effects from transportation activities are expected to be minor in magnitude, short term in duration, and local in the areas surrounding the specific activities.

4.11.4.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions with the potential to impact air quality in the proposed EIS project area include the same categories as present actions; oil and gas exploration, development, and production would be the primary future source category for air emissions in the EIS project area. Any future actions would require permitting to demonstrate compliance with air quality standards. Actions that have lesser potential to affect air quality are similar to those described above for present actions.

4.11.4.3.4 Conclusion

Alternative 2 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution, primarily oil and gas exploration, development, and production actions. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude. Because of the short time duration for activities, cumulative effects would be highly dependent on actual meteorological conditions at the time, and the relative location of Alternative 2 activities to any of the other air pollution generating actions. The largest cumulative effects would occur when sources are directly upwind or downwind of each other. However, due to dispersion, the cumulative effects would be less than additive (lower than the sum of the total maximum effects). There are no accumulative or synergistic effects associated with air quality. Due to the short duration of the Level 1 Exploration Activity, cumulative effects with transportation actions (also mobile and, therefore, short in duration at any one location) are expected to be unlikely, however, if occurring, would also have the potential to be moderate in magnitude.

As identified in Sections 4.10.6.4 and 4.10.7.4, in the event of a VLOS, the overall effects on air quality in the EIS project area would potentially be high in magnitude, but only temporary in duration and primarily located in the vicinity of the cleanup activities. There would be moderate additive effects on air quality resulting from a VLOS within the Arctic OCS.

4.11.4.4 Acoustics

4.11.4.4.1 Summary of Direct and Indirect Effects

Direct injurious effects of noise on marine fauna are discussed in Sections 4.5 to 4.9. NMFS currently applies pulse SPL thresholds of 190 and 180 dB re 1 μPa (rms) as conservative criteria for evaluating onset of auditory system injury for pinnipeds and cetaceans respectively. The largest potential zones of auditory system injury are produced by deep-penetration 2-D and 3-D seismic surveys performed in the 15 to 42 m (50 to 130 ft.) depth range (Section 4.5.1.4). These zones can reach almost 3 km in radius although they are typically 2.0 to 2.5 km (1.2 to 1.5 mi) (Section 4.5.1.4 and Appendix G). Seismic surveys performed in shallow coastal waters and shallow hazards surveys using smaller airgun arrays produce smaller zones of ensonification (Table 4.5-9), where the term *zone of ensonification* here refers generally to the spatial areas exposed to sound levels greater than disturbance or injury effects criteria. Auditory system injury from continuous noise produce by vessels and drilling rigs is not believed to be a risk (Southall et al. 2007). As described in greater detail in Section 4.2.6.3, NMFS recently released updated guidance for assessing auditory impact and recommended new injury thresholds. NMFS conducted a comparison using the new thresholds and some assumptions about the operational parameters of the seismic surveys expected to be conducted in the Arctic and found that, generally speaking, impacts from auditory injury would not likely be beyond those that would have been projected using the old thresholds.

NMFS's current criteria for marine mammal disturbance are pulse SPL of 160 dB re 1 μPa (rms) and continuous (non-pulsed) noise SPL of 120 dB re 1 μPa. Deep penetration 2 and 3-D seismic survey disturbance zones for offshore surveys typically have radii greater than 10 km (6 mi) (Table 4.5-9). Transiting vessels typically have smaller disturbance zone radii under 2 km (1.2 mi) (Section 4.5.1.). Vessels on DP produce higher sound levels and larger disturbance zone radii; a measurement of a Shell vessel on DP in the Chukchi Sea estimated the 120 dB re 1 μPa threshold occurred at 5.6 km (3.5 mi) range (Chorney et al. 2011). Limited measurements of noise from jack-up drill rigs are available but their disturbance zones are expected to be less than 1 km (0.6 mi) due to acoustic isolation of the noise-producing equipment from the water. Anchored drillships may produce relatively large disturbance zones nearly 10 km (6 mi) radius during high-noise activities in the Beaufort and Chukchi seas, although anchor setting by tugs could produce short bursts of higher noise with even larger resulting disturbance zones (Section 4.5.1.4). The overall impact rating for direct and indirect effects to the acoustic environment under Alternative 2 would be moderate.

4.11.4.4.2 Past and Present Actions

Existing vessel and barge traffic supplies goods to communities along the Beaufort and Chukchi coasts, including Canadian communities. Barge traffic also supplies equipment to existing oil and gas operations near Prudhoe Bay and Point Thomson. Oil and gas exploration programs in the Canadian Beaufort Sea require vessel traffic along the Beaufort and Chukchi coasts. These vessel transits produce relatively small acoustic footprints in vicinity of the transiting vessels and barges, similar to those from oil and gas exploration support vessels (see Section 4.5.1.4).

Seismic survey exploration activities have occurred both inside and outside (but nearby) the EIS project area. The seismic surveys performed in the EIS project area since 2006 are listed in Table 4.5-8. The collaborative United States Geological Survey (USGS) – Geological Survey of Canada (GSC) seismic survey program in the Canada Basin has been active for several years and is expected to continue. Oil and gas exploration programs by several companies have occurred in the Canadian Beaufort Sea in recent years and these remain active. Noise generated by these seismic surveys has exposed marine mammals that are protected under the MMPA. Noise from these external surveys has propagated over long distances into the Beaufort EIS project area where it is sometimes detectable above background levels; acoustic recorders deployed in the U.S. Beaufort Sea in 2007 recorded seismic survey noise from surveys performed off the Mackenzie Delta in Canadian waters with per-pulse SEL levels sometimes exceeding 120 dB re 1 μPa^2 sec (Blackwell et al. 2009). These measurements were made 100 to 300 km (60 to 180 miles) from the seismic survey locations. At these large distances the pulse rms levels are expected to be numerically similar to SEL values (though the measurement units are different). Higher seismic survey noise levels could be present in the eastern part of the Beaufort Sea EIS project area when Canadian surveys occur close to the U.S.-Canada border. Seismic survey noise from surveys in the Russian Chukchi Sea has not been identified on autonomous acoustic recorders deployed almost continuously since 2007 in the Alaskan Chukchi Sea (Martin et al. 2010). Several Russian seismic projects have been underway during this time period, but those have occurred far enough west that little survey noise has propagated into the Alaskan Chukchi Sea. This situation is likely to change if the Russian surveys move closer to the U.S.-Russia border.

Military activities in the EIS project area, including vessel, submarine and ice breaker transits may generate underwater noise; however, year-round acoustic monitoring in the Alaskan Chukchi Sea has not identified substantial military noise sources (Martin et al. 2010).

4.11.4.4.3 Reasonably Foreseeable Future Actions

As discussed above, vessel and barge traffic for supply of coastal communities and existing and future oil and gas facilities will continue to generate anthropogenic noise along vessel transit routes. It is reasonable to expect that seismic surveys will continue in the Canada Basin and in the Canadian Beaufort Sea. These surveys could generate substantial nearfield sound levels that could impact nearby marine mammals, and they would also generate noise that propagates over long distances into the EIS project area.

4.11.4.4.4 Contribution of Alternative to Cumulative Effects

Cumulative exposures to noise from anthropogenic activities both inside and outside the EIS project area might lead to indirect and cumulative effects. At present the effects of low-level cumulative exposures on marine fauna are poorly understood. However, a recent report by an expert panel has suggested criteria for auditory system injury based on cumulative SEL from multiple impulsive sounds received over 24 hours (Southall et al. 2007). The approach includes frequency-weighting of the received noise signals according to functions based on the hearing sensitivity of five marine mammal groups. The M-weighting functions are illustrated in Figure 3.1-11. Proposed thresholds for auditory system injury under this approach are 198 dB re 1 $\mu Pa^2 s$ for cetaceans and 186 dB re 1 $\mu Pa^2 s$ cumulative M-weighted SEL. Cumulative M-weighted SEL have been computed for single survey line transects for seismic surveys in the Chukchi Sea (O'Neill et al. 2010). These results appear to indicate that, for single-line seismic surveys in the Chukchi Sea EIS project area, the Southall et al. criteria are more conservative than the current rms criteria for estimating effects on pinnipeds, and less conservative for estimating effects on cetaceans (meaning that injury zones computed using the SEL thresholds are greater for pinnipeds and smaller for cetaceans than the respective zones computed using the current rms thresholds). Alternate survey geometries might produce different results. NMFS is considering the Southall et al. report and its proposed cumulative SEL metric for possible inclusion in future criteria, but the rms thresholds discussed above remain the present criteria for defining marine mammal exclusion zones (based on auditory system injury) near seismic survey and other impulsive sources, and disturbance zones near both impulsive and non-impulse noise sources.

While the assessment of cumulative effects is difficult, cumulative exposures to noise from multiple activities over time, sometimes referred to as aggregate exposure, can be estimated for certain species. Few analyses of this type have been attempted due to the inherent uncertainty of where and when animals have or will be exposed to anthropogenic noise. A recent study by University of California under a grant from BP America estimated cumulative noise exposures (Fleishman et al. 2016). A study test case considers seismic survey noise exposures of bowhead whales in the Beaufort Sea. This study involves, as a first step, using an acoustic model to predict the temporally and spatially varying noise levels produced by seismic survey exploration activities. The second step of the study passes simulated bowhead migration paths through the predicted noise field. The paths are computed by a specialized algorithm that incorporates information about bowheads' migration corridor, timing and behavior, and estimated avoidance reactions to seismic survey noise. A cumulative sound exposure metric is calculated by integrating the time-dependent sound level received by each simulated bowhead as it traverses the seismic survey area. Frequency weighting such as proposed by Southall et al. can be included in this approach. The results of this study were discussed in more detail in Section 4.2.6.6, but generally, given the similarity between the levels of activity contemplated in Alternative 2 and the levels of activity contemplated in Fleishman et al. (2016; acknowledging that Alternative 2 levels are somewhat higher), and the fact that cumulative exposure to multiple sources is not strictly additive, the exposures modeled in Fleishman et al. (2016) generally are not out of line with the exposures above 160 dB estimated in this EIS for Alternative 2.

A final cumulative effect that is worth noting is habituation. Animals that have previously been exposed to anthropogenic noise may be less inclined to avoid similar noise on subsequent exposures. Habituation to anthropogenic noise may cause animals to approach loud noise sources more closely than they otherwise would, and as a result become exposed to higher and perhaps injurious noise levels.

Alternative 2 includes multiple 2D and 3D seismic surveys and shallow hazards surveys. It is reasonable to expect that some of these surveys would be concurrent and individual marine mammals could be exposed at relatively close-range to more than one survey in a relatively short time (perhaps less than 24 hours). While the disturbance zones based on 160 dB re 1 μPa (rms) would be unlikely to overlap, animals could have difficulty navigating between these zones. If a cumulative SEL criterion for auditory system injury similar to that proposed by Southall et al. (2007) were adopted, it is likely that some animals would receive more exposure than would occur if only a single survey were present.

The inclusion of ice-breaking and one on-ice winter seismic survey would not be expected to generate substantial cumulative effects due to their temporal separation from most other anthropogenic activities. These operations would also occur at a time of year when fewer marine mammals are present, thereby reducing exposures.

In response to public comments, NMFS conducted a first-order cumulative and chronic assessment of oil and gas activities in the Arctic. Section 4.5.2.4.9 and Appendix F outline the results and limitations of this study. Broadly, results suggest that even with the lower predicted activity levels in Alternative 2, substantial losses of listening area (up to 98%) and bowhead communication space (up to 24%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October. As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data is lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation.

4.11.4.4.5 Conclusion

Under Alternative 2, the presence of multiple seismic surveys could lead to greater exposures of marine mammals to disturbance noise levels or masking than from a single survey if the surveys are concurrent and/or with limited spatial separation. This is a more noteworthy issue in the Beaufort Sea EIS project area than in the Chukchi Sea; marine mammal migration corridors are narrower in the Beaufort and pass more directly through the primary oil and gas exploration areas.

Impacts on the acoustic environment associated with VLOS response and cleanup would be medium-intensity, temporary, and regional. Due to the intensity, duration, and geographic extent associated with these impacts, the overall effects of spill response and cleanup on the acoustic environment in the EIS project area would contribute a moderate additive effect on acoustics.

In addition, impact producing factors associated with a VLOS could include the drilling of a relief well, which would result in effects on the acoustic environment similar to those described in Section 4.5.1.4 of this EIS.

4.11.4.5 Water Quality

4.11.4.5.1 Summary of Direct and Indirect Effects

Actions associated with Alternative 2 would have a variety of direct and indirect effects on water quality in the EIS project area. Discharges from exploratory drilling operations would increase the temperature and salinity of seawater in the immediate vicinity of the discharge. OBC or OBN surveys, anchor handling activities, and discharges from exploratory drilling activities would affect turbidity and concentrations of total suspended solids in the immediate vicinity of the activities. Effects on water quality resulting from increases in salinity, temperature, turbidity and/or total suspended solids would be low-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1. Offshore exploratory drilling activities and associated shore-based and ice-based activities would influence concentrations of metals and organic contaminants in the water, which could affect water quality in the EIS project area. After mitigation, the effects of Alternative 2 on water quality are expected to be low-intensity, temporary, and local. Although applicable water quality criteria have not been established for some of the compounds present in discharged drilling fluids, the overall effects of Alternative 2 on water quality are expected to be minor.

4.11.4.5.2 Past and Present Actions

Over the past three decades, numerous onshore and offshore oil exploration and development projects have influenced water quality in the EIS project area (Brown et al. 2010). Activities that affect water quality include the construction of gravel islands and causeways, and discharges of materials (NRC 2003b). Due to past development and existing anthropogenic effects, existing water quality in the proposed action area cannot currently be considered “pristine” from a chemical perspective (NRC 2003b, Brown et al. 2010). Certain organic pollutants tend to accumulate and persist in cold climates due to low mobility and slow degradation rates at low temperatures. Organic pollutants and other contaminants, such as heavy metals, have been deposited in the EIS project area as a result of both long-range transport processes and local activities.

NPDES-permitted discharges have included drill cuttings and drilling fluids, cement slurry, deck drainage wastewater, noncontact cooling waters, and sanitary and domestic wastewaters, which have been discharged after treatment according to the conditions and limitations of various NPDES permits. Discharges have generally been small, local, and infrequent, and the effects of discharges and spills on water quality have not accumulated (NRC 2003b). Water quality in the Beaufort and Chukchi seas is presently within the EPA criteria for the protection of marine life, and existing influences on water quality generally do not result in changes to ecosystem diversity or productivity, changes in the stability of biological communities, threats to human health, or loss of aesthetic, recreational, scientific, or economic values.

4.11.4.5.3 Reasonably Foreseeable Future Actions

Impacts to water quality in the EIS project area are expected to continue over the reasonably foreseeable future as a result of both long-range transport processes and local activities. It is reasonable to expect that NPDES and APDES permits including restrictions and monitoring requirements will be issued in the future. Discharges from existing industrial developments are expected to continue. Increases in marine vessel traffic (especially large vessels, such as cruise ships), military activities, and atmospheric deposition of pollutants could impact water quality in the Beaufort and Chukchi seas. Reasonably foreseeable increases in marine vessel traffic in the EIS project area would result in increased potential for introducing invasive species such as those contained in ballast water.

Changes in the acidity and alkalinity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future (USGS 2011a). Concentrations of CO_2 dissolved in seawater are expected to increase as a result of increased concentrations of CO_2 in the atmosphere. Dissolution of CO_2 in seawater results in the formation of carbonic acid, which decreases the pH of the seawater causing ocean acidification. However, over the lifespan of this EIS, climate change and ocean acidification are expected to have negligible effects on water quality in the EIS project area.

4.11.4.5.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 2, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a negligible cumulative impact.

4.11.4.5.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on water quality in the EIS project area would be minor.

In the event of a VLOS, the cumulative effects on water quality in the EIS project area would be high-intensity, long-term, and would affect an area of hundreds of square kilometers. There would be major additive effects on water quality resulting from a VLOS in either the Beaufort or Chukchi Sea.

4.11.4.6 Environmental Contaminants and Ecosystem Functions

4.11.4.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 2 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area, but the geographic extent of such impacts would be extremely limited. Habitat functions, particularly those related to benthic habitats, would be locally impacted as a result of activities and discharges associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 2, while the effects of Alternative 2 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall direct and indirect effects of Alternative 2 on ecosystem functions are expected to be minor.

4.11.4.6.2 Past and Present Actions

A variety of past and present actions have affected the distribution of environmental contaminants in the EIS project area. Oil and gas exploration, development, and production have occurred in the area for several decades. Drilling operations generate waste muds and cuttings, produced water, and associated wastes, which typically contain a variety of organic pollutants and toxic metals (NRC 2003). Until recently, waste materials from the drilling of wells, including muds and cuttings, crude oil, spill materials, and other substances were disposed in open bermed areas called ‘reserve pits’ (NRC 2003). Historical practices within the EIS project area have also involved the disposal of muds and cuttings onto landfast ice in nearshore areas (Brown et al. 2010). Some materials from reserve pits have leached into the surrounding tundra, and the historical practice of applying reserve pit fluids to roads as a dust control measure has contaminated some terrestrial areas (NRC 2003). An agreement reached between industry and environmental groups has resulted in the remediation of most historical reserve pit sites, and injection of the contaminated materials into subsurface formations (NRC 2003). Current practices for the disposal of wastes generated from oil and gas exploration, development, and production activities usually involve injection wells used to dispose of wastes into subsurface formations thereby limiting the impact of present activities on the distribution of environmental contaminants within the EIS project area. Discharges from present developments have generally been small, local, and infrequent such that the effects from such discharges have not accumulated (NRC 2003). In addition to environmental contaminants originating from local sources, some organic pollutants and other contaminants are deposited in the EIS project area as a result of long-range transport processes. Oceanic currents and atmospheric transport processes currently contribute to the overall contaminant loads in the EIS project area and are considered in combination with actions that may lead to cumulative impacts.

Other past and present actions likely to influence ecosystem functions include vessel traffic and aircraft traffic within the EIS project area. Existing barging and docking facilities at Prudhoe Bay have the potential to influence ecosystem functions in the nearshore ocean within the EIS project area.

4.11.4.6.3 Reasonably Foreseeable Future Actions

As discussed in Section 4.4.1, anthropogenic materials are introduced to the Beaufort and Chukchi seas from a variety of sources, including influx from the Bering Sea, river runoff, coastal erosion, and atmospheric deposition, as well as from local and distant industrial activities (Woodgate and Aagaard 2005). Due to their hydrophobicity (non-polar molecular structure), persistence in the environment, and temperature-dependent volatility, certain contaminants originating from temperate environments would continue to contribute to the total contaminant loads of habitats and organisms in the Beaufort and Chukchi seas ecosystems. These impacts are likely to continue at varying rates and are considered in combination with actions that could lead to impacts in the cumulative case.

Future oil and gas development within the EIS project area would also contribute to cumulative impacts. Dredging, screeding, and construction of docking facilities associated with reasonably foreseeable future development would have minor impacts on ecosystem functions within the EIS project area.

Discharges from existing industrial developments are expected to continue. Increases in marine vessel traffic (especially large vessels, such as tug and barge fleets and cruise ships), military activities, and atmospheric deposition of pollutants could impact ecosystem functions in the Beaufort and Chukchi seas. The term “Sealift” refers to the annual supply of materials to the existing oilfields by tug and barge. During the next five years it is reasonably foreseeable that the size and number of Sealifts will increase as activities associated with the Alaska LNG Project and Point Thomson increase. Reasonably foreseeable increases in marine vessel traffic in the EIS project area would result in increased potential for introduction of invasive species such as those contained in ballast water.

Climate conditions in the EIS project area have been undergoing noticeable changes, particularly over the past 20 years (USGS 2011a). Warmer air and water temperatures result in earlier spring snowmelt, decreased ice thickness during the winter, and accelerated rates of coastal erosion and permafrost degradation (USGS 2011a). These changes and others are expected to continue over the reasonably foreseeable future and could aggregate with the effects of industrial activity to impact ecosystem functions. In addition to changes in air and water temperatures, changes in the acidity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future (USGS 2011a). Ocean acidification may have substantial impacts on valued ecosystem components in the Beaufort and Chukchi seas, and must be considered in combination with actions that may lead to cumulative impacts in the proposed action area (USGS 2011a).

4.11.4.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause local minor impacts to ecosystem functions within the EIS project area. Some actions associated with Alternative 2, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. The impacts resulting from such interactions would represent only a small fraction of foreseeable cumulative impact, and the accumulation of impacts would likely be neglibible to minor.

4.11.4.6.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on ecosystem functions in the EIS project area would be minor.

A VLOS would likely have substantial accumulating effects on ecosystem functions as a result of high-intensity, long-term impacts to multiple ecosystem components over large geographic areas. Structural properties of the EIS project area ecosystem could be permanently affected as a result of a VLOS, and effects on ecosystem functions would be classified as major due to their high-intensity, long-term duration, and regional geographic extent, as discussed in Sections 4.10.6.7 and 4.10.7.7. There would be major additive effects on ecosystem functions resulting from a VLOS in either the Beaufort or Chukchi Sea.

4.11.4.7 Lower Trophic Levels

4.11.4.7.1 Summary of Direct and Indirect Effects

As discussed under Direct and Indirect Effects in Section 4.5.2, oil and gas exploration activities under Alternative 2 incorporate the use of a variety of small and large support vessels and icebreakers. Included in these efforts are seismic airgun arrays, and associated gear such as hydrophones and sensor arrays on lines or cables deployed in the water column and ocean bottom. Drilling rigs, helicopters, fixed-wing aircraft, and on-shore support facilities are also associated with exploration activities. All of these can directly and indirectly cause behavioral disturbance, injury and mortality, and/or habitat loss/alteration, which in turn would affect lower trophic level organisms in the EIS project area.

The effects discussed above would likely be low in intensity, temporary to long-term in duration, of local extent and would affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.11.4.7.2 Past and Present Actions

Lower trophic levels in the EIS project area have been exposed to activities that may have impacted them in the past and will continue in the reasonably foreseeable future. The biggest impact on lower trophic levels results from activities that disturb the ocean floor; other impacts result from the discharge of drilling muds and cuttings, or habitat loss. Past and present actions that contribute some of these disturbances include oil and gas development and exploration, and the introduction of persistent contaminants. Offshore exploratory drilling activities in the Arctic have historically used systems such as artificial islands, which directly impact the sea floor and have caused direct injury and mortality to lower trophic level organisms, and also cause habitat loss and disturbance. The discharge of drilling muds and cuttings also pose a threat to the benthic community's habitat; sediment and cuttings sink to the bottom and cause mortality and injury by burying benthic organisms. The Beaufort Sea is shallower and experiences less circulation than the Chukchi Sea, so discharges pose a greater threat to the benthos in these calmer waters. Mortality and injury is also be caused by the introduction of toxins and sediments into the water column due to drilling discharges. These toxins may pose a threat to pelagic and benthic organisms. Habitat loss can also result from oil and gas exploration activities that require ice breaking efforts, forcing organisms to relocate.

The effects from past and present actions on lower trophic levels tend to be local to the modest areas near the activity, and so are geographically dispersed, as are exploration activities, in the EIS project area.

4.11.4.7.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected lower trophic levels in the past are likely to continue in the future. Offshore oil and gas exploration and development is likely to increase in Arctic waters of other countries (i.e.,., Russia and Norway) as the ice pack recedes and allows access to previously ice-covered areas. These activities would add to the risk of ocean floor disturbance that impact lower trophic habitat across large areas potentially reaching into the EIS project area. Ongoing offshore oil and gas exploration is expected to continue the accumulation of persistent contaminants from multiple sources and has the potential to affect lower trophic levels in the reasonably foreseeable future.

The influences of climate change on lower trophic levels are discussed in Section 3.2.1.3. In summary, the decrease of the extent of the Arctic ice pack impacts the epontic community, and subsequently, the pelagic and benthic communities (MMS 2007c). Warming ocean temperatures associated with climate change may increase zooplankton growth rates and generation times in the Beaufort and Chukchi seas.

The effects from oil and gas activity in the reasonably foreseeable future on lower trophic levels tend to be local to the modest areas near the activity, and so are geographically dispersed, as are exploration activities, in the EIS project area. Although the effects of climate change could be long-term, the effects that would occur in the upcoming five years are not expected to considerably impact lower trophic levels.

4.11.4.7.4 Contribution of Alternative to Cumulative Effects

The exploration activities authorized under Alternative 2 would add incrementally to the disturbance of lower trophic levels from increased sea floor disturbance. Discharge of drilling muds and small spills would contribute a small amount to habitat change but such changes would be local and very small. The resource would not be stressed to a point that would cause an irreversible impact. In the absence of a VLOS (see below), the exploration activities authorized under Alternative 2 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

4.11.4.7.5 Conclusion

Alternative 2 would have a negligible contribution to cumulative effects on lower trophic organisms. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

In the event of a VLOS, the impact could be expected to be major should the spill persist in the environment or affect unique resources. However, should the spill not last a long time or not affect unique resources, the impacts could lead to a summary impact level of moderate due to the shorter duration and regional impacts to common resources. In the event of a VLOS, there would be moderate additive effects on lower trophic levels in the EIS project area; there would be major additive effects should the spill persist in the environment or affect unique resources.

4.11.4.8 Fish and Essential Fish Habitat

4.11.4.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 2 on fish resources and EFH would be minor. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 2, there would be no measurable effect on the resource and theimpact would be minor.

Of the noise sources introduced by Alternative 2, most have been shown to have no long-term impact on fish or fish resources. Because marine fish are widely dispersed and are largely unrestricted in their movements, noises associated with these activities are not expected to have a measurable effect on marine fish populations. All fish assemblages could potentially be exposed to noise, although pelagic and cryopelagic species are more likely to be affected, mainly through behavioral disturbance. However, the transient nature of the noise sources associated with seismic surveys, vessel traffic and icebreaking minimize the exposure to fish and fish resources, with standard ramp up procedures allowing further opportunity for mobile fish to escape the area of impact before any detrimental effects are felt. For more stationary noises associated with exploratory drilling, habituation provides a mechanism for fish to reduce effects from displacement. The size of the footprint of the seismic surveys is small relative to the amount of habitat over the entire EIS project area.

The opportunity for habitat loss or alteration resulting from Alternative 2 is small. Direct effects to nearshore and offshore demersal fish and fish habitats from exploratory drilling, gravel island construction, icebreaking, and anchoring would be restricted to limited areas, particularly when compared to the total area of benthic habitat available.

Of the activities described in Alternative 2, only those resulting in potential habitat loss or alteration are relevant to EFH. Effects to fish habitat from exploratory drilling, gravel island construction, and anchoring would be restricted to limited areas, particularly when compared to the total area of benthic habitat available. Icebreaking would impact a small percentage of ice, which is essential for Arctic cod. Salmon species spend much of their adult life at sea and therefore require feeding habitat. Saffron cod spend their entire lives in the marine environment and require spawning, rearing, and feeding habitat. Saffron cod also occur in nearshore and estuarine environments (Wolotira 1985, Cohen et al. 1990). As with the analysis for marine fish, the opportunity for habitat loss or alteration resulting from Alternative 2 is small. Most impacts would be of low intensity and of small geographic extent.

4.11.4.8.2 Past and Present Actions

Past and present actions that have impacted or currently impact fish and EFH within the project EIS area include oil and gas development, transportation, military activity, scientific research, and subsistence activities. Primary issues of concern to fish and EFH include local injury and mortality, impediments to fish passage and nearshore movement, and loss of habitat. Although the range of activities listed above have impacted fish resources, the scope of these impacts are difficult to quantify, but are considered to be limited on a regional scale.

Oil and gas exploration and development activities have been occurring on the Arctic Coastal Plain since the 1960s. Much of the activity has been land-based, with fewer offshore elements. However, support for the North Slope development has relied on marine transportation, and continues to do so. Vessel traffic related to the oil and gas industry includes sealifts of large infrastructure pieces, barge deliveries, limited dredging, development (construction), and exploration activities (including seismic). Project-dependent traffic is infrequent and seasonally-dependent, occurring during the brief summer when the routes to the North Slope are ice-free. Exploration activities similar to those addressed in this EIS have also been ongoing within the EIS project area, but their limited scope is considered to have resulted in limited impacts to fish. Seismic surveys are currently being undertaken in both Canadian and Russian Arctic waters. Impacts from seismic surveys to fish resident in Canadian or Russian waters would be independent of the fish resources within the project EIS area; however, some species of fish, such as Arctic cisco, regularly migrate back and forth between the Canadian Beaufort Sea and U.S. Beaufort Sea. These type of migratory species could experience effects in both nations and therefore are not independent. The potential effects on fish from the oil and gas exploration and development activities listed here are the same as what is described in Section 4.5.2.2.

Arctic communities rely heavily on sea-going barges to transport consumer goods such as fuel and food to their remote locations. Barge traffic is slow-moving, infrequent, and seasonally dependent.

Scientific research is ongoing within the EIS project area, and is driven by several factors. Although widespread and broadly focused, the cumulative impacts of these studies on fish resources are considered small, as the amount and scope of research is so limited.

Subsistence activities have been a vital part of northern life for as long as humans have lived in the region. Although subsistence patterns have changed over the years, and are likely to continue to evolve in the future, it is not anticipated that adverse impacts have occurred, or are occurring, to fish. Harvest of whitefish and salmon occurs across the coastal plain, but in small enough numbers to limit impacts. A detailed management regime has ensured that fish populations are maintained at viable levels, and fish resources are expected to be closely monitored into the future.

4.11.4.8.3 Reasonably Foreseeable Future Actions

Environmental changes associated with Arctic climate change have the greatest potential to impact fish resources within the EIS project area, and throughout the entire Arctic. Warming air and water has resulted in earlier spring snowmelt, decreased ice thickness, and permafrost degradation (USGS 2011a). Studies have also documented a northern expansion of species. Pacific cod, walleye pollock, other groundfish are suspected to be expanding their range, based on the comparison of historical records. As the waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the Arctic.

This northward expansion of commercially viable species has renewed interest in a commercial fishery in the Arctic, which is currently not permitted in U.S. Arctic waters. The 2009 Arctic Fisheries Management Plan outlines the North Pacific Fisheries Management Council's (NPFMC) approach to "prohibit commercial harvest of all fish resources of the Arctic Management Area until sufficient information is available to support the sustainable management of a commercial fishery" (NPFMC 2009). No timeline has been set for such a decision to be made, but any decision would be highly dependent on climatic and financial factors.

The reduction in sea ice is anticipated to impact cryopelagic species such as Arctic cod. As the cryopelagic community is centered around sea ice, reduced sea ice would result in habitat loss. Warming waters and decreases in ice cover also have the potential to alter prey and predator distributions and concentrations, thereby impacting fish.

Ocean acidification is a phenomenon associated with climate change that has recently begun to receive more scientific attention. Fish can be impacted by this phenomenon through several pathways including: reduction in calcifying prey organisms (e.g., pteropods for pink salmon); effects on calcium-carbonate structures in fish such as otoliths and some types of scales; alteration of carbonate based habitats that provide structural habitat; alteration of sound propagation causing increased exposure of fish to sound; effects on the olfactory sense leading to decreased ability of fish larvae to detect adult settling sites; and acidification acting synergistically with other climate change processes in influencing the risk of dispersal of non-native invasive species (BOEM 2012).

With sea ice across the Arctic gradually declining, vessel traffic is expected to increase throughout the region in coming years. However, even an exponential rise in vessel traffic would not be anticipated to have a measurable impact on fish, as the number of vessels would still be low enough to avoid.

Future mining activities are anticipated in the Arctic. Prospecting for zinc and coal in the western Brooks Range is on the horizon, but are unlikely to have any nexus with fish populations impacted by the activities proposed in this EIS. There would be no anticipated interactions with marine species.

Increased interest in the Arctic has resulted in an increase in scientific research, which could substantially increase the scientific understanding of fish resources within the EIS project area. This incremental increase in Arctic research activities will allow for an increasingly refined analysis of impacts on Arctic resources, including fish, but could also have a small impact on fish populations.

4.11.4.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have measurable effects on fish and EFH within the EIS project area, and those effects may be beneficial or detrimental. As discussed in Section 4.11.4.8.3, ocean acidification could have a variety of negative effects on fish and fish habitat. Climate change could also make it easier for non-native invasive species to take hold in the Arctic. Warming waters and decreases in ice cover could later predator and prey distributions and concentrations, thereby impacting fish. On the other hand, as Arctic waters warm, productivity could increase, thereby creating more favorable fish habitat throughout the region. The contribution of the activities associated with this alternative to cumulative effects on fish and EFH would be minor.

4.11.4.8.5 Conclusion

Most direct and indirect impacts resulting from Alternative 2 on fish and EFH would be of such low intensity and of such small geographic extent that the effects would be considered minor. The incremental contribution of activities associated with Alternative 2 to cumulative effects on fish would be minor.

As described in Sections 4.106 and 4.10.7, in the event of a VLOS, there would be a major additive effect on fish and EFH within the EIS project area.

4.11.4.9 Marine and Coastal Birds

4.11.4.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.5.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary, local, affect important or unique resources, and not likely to have population-level effects for any species. In summary, the impact of Alternative 2 on marine and coastal birds would be considered minor.

4.11.4.9.2 Past and Present Actions

Section 3.2.3 provides a brief description of the bird species that occur in the project area, including ESA-listed species, with references to conservation concerns from interactions with human activities and natural factors. The many marine species have been exposed to a wide variety of marine vessel traffic and some species have been attracted to lights and collided with ship structures. Coastal species and nesting marine species may be affected by disturbance and loss of habitat from construction and some species, such as waterfowl, have been susceptible to collisions with power lines and communications structures. There have been no commercial or subsistence fishing operations in the Arctic seas large enough to affect their prey base or to threaten them with accidental entanglements but many species migrate through the Bering Sea, Gulf of Alaska, and other seas where there are large fisheries which may have adverse effects. Fixed-wing and helicopter traffic in nearshore areas has caused disturbance of marine and coastal birds. All species have been exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Waterfowl and a few other species are also subject to subsistence hunting in various parts of their ranges, including the coastal communities adjacent to the Beaufort and Chukchi seas. Changes in sea-ice distribution, ocean acidification, and ocean dynamics due to climate change could have adverse effects on the some species and beneficial effects on others.

4.11.4.9.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected marine and coastal birds in the past are likely to continue in the future. Offshore oil and gas exploration and development is likely to increase in Arctic waters of other countries (i.e., Russia and Norway) as the ice pack recedes and allows access to previously ice-covered areas. These activities would add to the risk of oil spills and other contamination that could affect the same species of marine birds as occur in Arctic Alaska. Large spills from other areas could also be transported into Alaska waters by currents and ice. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope, which would contribute to disturbance and habitat loss for coastal and nesting marine species. Reasonably foreseeable natural gas development projects, such as the Alaska Liquid Natural Gas Project, could affect marine and coastal birds through disturbance associated with marine vessel traffic and habitat loss from on-shore facility construction. Potentially toxic compounds will continue to be produced around the world and many may find their way to the Arctic with potentially adverse effects on all species. Hunting along migration paths and in Arctic breeding areas will likely continue to be the largest source of direct human-induced mortality on waterfowl. Climate change could affect marine and coastal bird habitats through changes in sea-ice distribution, water quality, seasonality and characteristics of tundra vegetation, and ocean acidification. Some habitat changes could be adverse for some species and beneficial for others.

4.11.4.9.4 Contribution of Alternative to Cumulative Effects

The exploration activities authorized under Alternative 2 would add incrementally to the disturbance of birds from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Vessels and on-shore structures could also contribute to the risk of injurious or fatal collisions. Discharge of drilling muds and small spills would contribute a small amount to habitat change but such changes would be local and very small compared to the contribution from climate change. The exploration activities authorized under Alternative 2 would have a minor contribution to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.4.9.5 Conclusion

The direct and indirect effects of Alternative 2 on marine and coastal birds would be considered minor, given the temporary and local nature of potential effects. Alternative 2 would have minor contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

There would be a remote chance of a VLOS occurring during exploratory drilling under Alternative 2 (Sections 4.10.6.10 and 4.10.7.10). The implications for birds would depend on the amount and distribution of the spill and to how quickly and thoroughly it could be cleaned up, especially in relation to areas and times when birds are in dense congregations during migration and post-breeding molt. If a very large spill occurred in the Chukchi Sea and impacted the Ledyard Bay/Kasegaluk Lagoon area, the population of spectacled eiders could be severely impacted because of their concentration in this area during spring migration and post-breeding molt and the high risk of mortality from exposure to oil. Other species could also be severely impacted and many could have population-level effects if the spill coincided with their staging areas during spring or fall migration. Areas in the Beaufort Sea within the barrier islands would be particularly sensitive because they are high use areas for a variety of birds. Contamination of coastal and benthic habitats could persist for many years and have chronic effects on the health and reproductive success of birds. A very large oil spill could also contribute substantially to the cumulative effects of disturbance on birds because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. If a VLOS were to occur, there would be a major additive effect to the cumulative effects on many species of marine and coastal birds.

4.11.4.10 Marine Mammals

4.11.4.10.1 Bowhead Whales

4.11.4.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on bowhead whales are described in detail in Section 4.5.2.4.10 and are summarized here. Potential direct and indirect effects of oil and gas exploration activities on bowhead whales are primarily disturbance and behavioral changes from noise exposure and, possibly, injury or mortality from ship strikes, and habitat degradation. Oil and gas exploration activities authorized under Alternative 2 would likely cause varying degrees of disturbance to feeding, resting, or migrating bowhead whales. Disturbance could lead to displacement from and avoidance of areas of exploration activity to distances up to 20 to 30 km (12.4 to 18.6 mi) (Miller et al. 1999, Richardson et al. 1999), as well as changes in calling behavior (Blackwell et al. 2010b, Blackwell et al. 2013). The EIS project area encompasses a large portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not an option. Duration of disturbance is expected to be short-term; long-term effects of disturbance are not well understood. Surveys utilizing ice breakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, but the period of time over which this activity would overlap with bowhead whales is much shorter. Multiple exploration activities occurring simultaneously or overlapping to varying degrees temporally and/or spatially would increase the footprint of the cumulative activities and also potentially increase impacts to bowhead whales as a result. Although bowhead whales react to approaching vessels at greater distances than they react to most other activities, most observed disturbance reactions to vessels and aircraft appear to be short-term. The extent of disturbance effects will depend on the number of exploration activities and associated support vessels in an area, but, for individual sound sources, impacts are expected to be local.

Incidence of injury and mortality due to ship strikes appears low, but could rise with increasing vessel traffic. Only three ship-strike injuries to bowhead whales were documented from 1976 to 1992 (George et al. 1994).

Potential impacts to bowhead whale habitat from oil and gas exploration activities permitted under Alternative 2 would mostly affect the area immediate adjacent to the site of impact, whether it be discharges, sediment disruption, or icebreaking. Most impacts would also be temporary, although longer-term and regional effects could occur through the process of bioaccumulation through the food chain.

Sub-lethal impacts on bowhead whale health (such as hearing impairment or increased stress) cannot currently be measured. There is no information on TTS or PTS thresholds specific to bowheads, and the likelihood of obtaining the information is low. Hearing and hearing damage can only be readily analyzed in smaller cetaceans, primarily in captivity, or through studying ears of dead whales. Because bowhead whales respond behaviorally to loud noise and generally move away from the sound source, they are less likely to suffer hearing loss from increased noise. However, and Richardson and Thomson (2002) note that bowhead whales are less responsive to seismic airguns when engaged in certain activities, such as feeding.

In terms of the impact criteria identified in Table 4.5-16, most effects of individual exploratory activities authorized under Alternative 2 are of medium intensity and temporary in duration. Potential long-term effects from repeated disturbance over time or over a broad geographic range are unknown. Individually, the various activities may elicit local effects on bowhead whales, yet the area and extent of the population over which effects would be felt would increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Since the EIS project area extends across most of the spring and fall migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales. Bowhead whales are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast, which places them in the context of being a unique resource. Evaluated collectively, and with consideration given to reduced adverse impacts through the imposition of the required standard mitigation measures, the overall effect of activities authorized under Alternative 2 on bowhead whales is likely to be moderate.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order cumulative and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments. Broadly, results suggest that even with the lower predicted activity levels in Alternative 2, substantial losses of listening area (up to 98%) and bowhead communication space (up to 20%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October. As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data is lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation, especially, perhaps for bowhead whales, which are migrating through with calves where communication is important to retain group cohesion.

4.11.4.10.1.2 Past and Present Actions

Commercial whaling was the single greatest historical source of mortality for bowhead whales. An estimated 60 percent of the pre-whaling population was harvested by the late nineteenth century (Braham 1984). Commercial whaling for bowheads ended in the early twentieth century. Subsistence harvests are currently the primary source of mortality for bowhead whales, with an average of about 40 takes per year (Suydam et al. 2011). The subsistence harvest is well-managed and regulated through a quota system by the IWC (Section 3.3.2). In addition to direct injury or mortality from subsistence whaling, non-targeted bowheads in the vicinity of a struck whale may experience acoustic disturbance from motorized skiffs (especially during the fall hunt) and the explosive sounds of a whale bomb detonating when a whale is harpooned.

Individual bowhead whales encounter multiple industrial activities conducted by Russia (Chukchi Sea), the U.S. (Beaufort and Chukchi seas), and Canada (Beaufort Sea) each year during migration and while in feeding areas (Quakenbush et al. 2011c). Offshore oil and gas exploration, development and production activities have occurred in State waters or on the OCS in the Beaufort and Chukchi seas since 1979. Seismic surveys have been conducted in the Beaufort and Chukchi seas since the late 1960s and early 1970s (MMS 2006a). Most of this activity has occurred in the Beaufort Sea (Table 4.11-2). The Western Arctic stock of bowhead whales has been exposed to these activities for several decades. These offshore activities and their known and potential effects on bowhead whales were discussed in Section 4.5.2.4.10, including ice management vessels, seismic sources, exploratory drilling, aircraft (fixed wing and helicopter) for crew transport and monitoring, and other associated vessels. What is currently known of effects–particularly relating to acoustic disturbance—was derived from studies of bowhead whales coincident to these past and presently occurring activities. Although bowhead whales may avoid or be temporarily displaced from an area of oil and gas activity by as much as 20 to 30 km (12.4 to 18.6 mi) (see Section 4.5.2.4.10 for details), there is no evidence of long-term population level effects on the health, status, or population recovery due to these past and present activities (MMS 2006a).

Bowhead whales are exposed to other marine vessel traffic including large ocean-going barges, industrial container ships, icebreakers and other vessels used for scientific and commercial purposes throughout their range, including many vessels used to supply on-shore oil and gas developments on the Prudhoe Bay area. In addition to acoustic disturbance from icebreaking and engine noise from vessel traffic, ship strikes are possible. However, only three ship-strike injuries of bowhead whales were documented from 1976 to 1992. The low number is likely due to relatively few vessels passing through most of the bowhead's range or because bowheads struck by ships do not survive and are, therefore, not accounted for (George et al. 1994).

Bowhead whales are also exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Since bowhead whales feed on lower trophic level organisms (zooplankton), they are considered at lower risk of bioaccumulation of contaminants, such as persistent organic compounds, than higher level consumers. Levels of persistent organic compound concentrations in samples collected from bowhead whales in Alaska are low compared to other marine mammals (O'Hara and Becker 2003).

Bowhead whales may be sensitive to current and ongoing effects of climate change in the Arctic. It is not, however, currently possible to make reliable predictions of the effects of changes in weather, sea-surface temperatures, or sea ice extent on bowheads. Research and models suggest that, at least in the short term, reduced sea ice cover may actually increase prey availability for bowhead whales and result in improved body condition (Moore and Laidre 2006, George et al. 2006, cited in Allen and Angliss 2010). The loss of sea ice is also opening new habitat and the possibility of exchange between Atlantic and Pacific populations that were previously separated by sea ice. Satellite-tagged bowhead whales from Alaska and West Greenland recently entered the Northwest Passage from opposite directions and spent roughly ten days in the same general area. This is the first documented overlap of these two populations (Heide-Jørgensen et al. 2011).

Bowhead whales in the EIS project area, thus far, appear resilient to the level of human-caused mortality and disturbance that has occurred within their range since the end of commercial whaling (MMS 2006b). Since bowhead whales may live 150+ years (George et al. 1999), many individuals in this population may have already been exposed to numerous disturbance events during their lifetimes. The subsistence harvest levels (approximately 0.1 to 0.5 percent of the population per year [Philo et al. 1993b]) appear to be sustainable. With the Western Arctic stock of bowhead whales continuing to increase at an estimated 3.7 percent (Givens et al. 2013), there is no indication that the combined effects of past or present noise and disturbance-causing factors (e.g., oil and gas activities, shipping, subsistence hunting, and research activities), habitat altering activities (e.g., gravel island construction, port construction), or pollutants has had any long-lasting physiological, or other adverse effect(s) on the population (MMS 2006b).

4.11.4.10.1.3 Reasonably Foreseeable Future Actions

The factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that affected bowhead whales in the past and present are likely to continue into the future. Subsistence hunting will likely continue to be the greatest source of mortality for bowhead whales. The oil and gas exploration activities likely to occur during the next five years are the subject of this EIS and their potential impacts on bowhead whales are described in Sections 4.5.2.4.10, 4.6.2.4.1, 4.7.2.4.1 and 4.8.2.4.1. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of neighboring countries, such as Russia and Canada. Increased traffic and industrial activity in the Russian Chukchi Sea and Canadian Beaufort could affect bowhead whales at different stages of migration or during summer feeding in the eastern Beaufort Sea and Amundsen Gulf.

On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Reasonably foreseeable future natural gas development projects (e.g., the Point Thomson production unit and the Alaska Pipeline Project) could affect bowhead whales during the open-water season marine transport of processing facilities and materials for the construction phases and development of nearshore structures.

Potentially toxic compounds may be accidentally discharged coincident to some of the above mentioned industrial activities, as well as continue to be produced around the world and potentially end up in the Arctic food web.

Continued Arctic warming trends and the resulting changes in sea ice conditions could impact bowhead whales in several ways, including prey productivity and shifting migratory patterns based on the presence of sea ice. Whether the short-term beneficial increases in prey productivity will continue in the long-term is unknown. Climate change would affect the entirety of the bowhead whales' range, although the nature and extent of habitat changes may differ by area.

Marine vessel traffic may increase with continued retreat of summer sea ice due to climate change. Increased commercial shipping, fishing, and tourism could occur. Increased vessel traffic in the Beaufort and Chukchi Seas could increase disturbance effects on feeding and migrating bowhead whales and lead to a higher incidence of ship strikes. Expansion of commercial fisheries into Arctic waters may also occur coincident to retreating ice extent and result in additional acoustic disturbance, incidental takes, or entanglement in fishing gear. Coast Guard activities and icebreaker traffic may also increase coincident to growth in shipping and exploration activities during longer ice-free periods. The influence of climate change on marine mammals is further discussed in Section 3.2.4.

4.11.4.10.1.4 Contribution of Alternative to Cumulative Effects

The direct and indirect effects of oil and gas exploration activities authorized under Alternative 2 are detailed in Section 4.5.2.4.10 and summarized above. The primary impacts of these activities derive from increased acoustic disturbance in several areas across the summer and fall range of the Western Arctic stock of bowhead whales. Since the EIS project area extends across most of the migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales and a minor to moderate additive contribution to cumulative acoustic effects. The spatial and temporal extent of disturbance depends on the spatial and temporal distribution of exploration activities relative to bowhead whale distribution and behavior (e.g., feeding, resting, or migrating). The geographic area and percent of the population over which effects would be felt would increase with multiple activities—including activities external to oil and gas exploration authorized under Alternative 2-- occurring simultaneously or consecutively throughout much of the summer-fall range of this population.

Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the likelihood of occurrence is relatively low. The contribution of this source of mortality to overall mortality levels for this stock of bowhead whales would be negligible compared to the annual level of mortality incurred through the subsistence harvest.

Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds and contaminants. Most of these effects would be local and short-term and, relative to the potential ecosystem-wide climate change effects of extensive sea ice loss and ocean acidification on habitat, seemingly minor. However, there is a great deal of uncertainty regarding future impacts of Arctic climate change and adequately assessing potential additive or synergistic effects of combined habitat impacts is not feasible.

The contribution of the direct and indirect impacts resulting from Alternative 2, when combined with the past, present, and reasonably foreseeable future actions would be moderate, with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.11.4.10.1.5 Conclusion

Under Alternative 2, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 2 would have a moderate contribution to cumulative effects on bowhead whales.

There would be a remote chance of a VLOS occurring during exploratory drilling under Alternative 2 (Sections 4.10.6.11 and 4.10.7.11). A very large oil spill would contribute substantially to cumulative effects of disturbance, injury and mortality, and habitat alterations. The duration of effects could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g., endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as off Barrow or Kaktovik, or along the migratory corridor, the effects may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of bowhead whales. Population level effects are possible if a very large oil spill coincided with and impacted large feeding aggregations of bowhead whales during the open water season, particularly if calves were present. If a VLOS were to occur, there would be a major additive effect to the cumulative effects on bowhead whales.

4.11.4.10.2 Beluga Whales

4.11.4.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on beluga whales are described in Section 4.5.2.4.11 and are summarized here. The oil and gas exploration activities proposed in Alternative 2 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

Direct and indirect effects on beluga whales from Alternative 2 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 2 on beluga whales would be considered moderate.

4.11.4.10.2.2 Past and Present Actions

The historical baseline for beluga whales in Arctic Alaska is described in Section 3.2.4.2 and is summarized here. The primary source of human caused mortality in beluga whales has been and continues to be subsistence hunting. The annual subsistence take of Beaufort Sea stock belugas by Alaska

Natives averaged 26 belugas during the five-year period from 2005-2009 (Allen and Angliss 2012b). The average annual subsistence take by Alaska Natives averaged 94 belugas from the eastern Chukchi stock during 2005-2009 (Allen and Angliss 2012b).

Beluga whales are exposed to marine vessel traffic including small skiffs and skin umiaqs operating close to shore, large ocean-going barges, industrial container ships, and icebreakers used for scientific and commercial purposes throughout their range. Fixed-wing and helicopter traffic in nearshore areas may cause temporary disturbance of belugas. Beluga whales are also exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Since beluga whales feed on higher trophic level organisms they are considered at higher risk of bioaccumulation of contaminants, such as persistent organic compounds, than lower level consumers.

The best available abundance estimate for the Beaufort Sea stock is 39,258. The current population trend of the Beaufort Sea stock of beluga whales is unknown (Allen and Angliss 2010).

The most reliable estimate for the eastern Chukchi Sea stock continues to be 3,710 whales derived from 1989-91 surveys. There is currently no evidence that the eastern Chukchi Sea stock of beluga whales is declining (Allen and Angliss 2010).

Neither the Beaufort Sea stock nor the eastern Chukchi Sea stock is listed as depleted under the MMPA or threatened or endangered under the Endangered Species Act.

4.11.4.10.2.3 Reasonably Foreseeable Future Actions

The same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that affected beluga whales in the past and present are likely to continue into the future. Subsistence hunting will likely continue to be the primary source of human-caused mortality for beluga whales. Marine vessel traffic is expected to increase with continued retreat of summer sea ice due to climate change. Increased commercial shipping, fishing, and tourism are likely as a result. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries, such as Russia and Canada. Coast Guard activities and icebreaker traffic may also increase coincident to growth in shipping and exploration activities.

On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect beluga whales during construction phases that involve large sea lifts of processing facilities and material during the open-water season and development of nearshore structures. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic food web.

Continued Arctic warming trends and the resulting changes in sea ice conditions could impact beluga whales throughout the entirety of their range, although the nature and extent of habitat changes may differ by area.

4.11.4.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 2 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible. The exploration activities authorized under Alternative 2 would therefore have minor to moderate additive contributions to the cumulative effects on beluga whales.

4.11.4.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 2 would result in minor to moderate contributions to cumulative effects on beluga whales.

There would be a small chance of a VLOS occurring during exploratory drilling under this alternative (Section 4.10.7.11). A VLOS would contribute substantially to cumulative effects of disturbance, injury and mortality, and habitat alterations. The duration of effects could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g., endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as the Shelf Break of the Beaufort Sea, or along the migratory corridor, the effects may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of beluga whales. Population level effects are possible if a very large oil spill coincided with and impacted large feeding aggregations of beluga whales during the open water season, particularly if calves were present. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 on beluga whales.

4.11.4.10.3 Other Cetaceans

4.11.4.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on cetaceans are described in Section 4.5.2.4.12 and are summarized here. In general, potential direct and indirect effects on other cetaceans resulting from exploration activities in the Beaufort and Chukchi seas authorized under Alternative 2 are similar to those on bowhead whales and beluga whales. The primary direct and indirect effects on other cetaceans would result from noise exposure. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs.

Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

Direct and indirect effects on other cetaceans from Alternative 2 would be of low to medium intensity, of temporary or short-term duration, local to regional in extent, and would affect a unique resource. The summary impact level of Alternative 2 on other cetaceans would be considered minor.

4.11.4.10.3.2 Past and Present Actions

The historical baseline for cetaceans in Arctic Alaska is described in Section 3.2.4.2 and is summarized here. In the past, commercial whaling was the single greatest source of mortality for cetaceans, primarily mysticetes. Humpback, fin, and gray whales were all taken in large numbers up until the cessation of commercial whaling activities in the twentieth century. Commercial whaling for gray whales was banned after 1946, humpbacks were protected worldwide in 1965 and fin whales were commercially taken in the North Pacific until 1976 (Perry et al. 1999, Rice et al. 1984). Since then, subsistence hunting has provided the only whaling pressure to Arctic species. Bowhead whales are the primary target, with only sporadic and occasional takes of gray, humpback and minke whales by Alaskan and Russian Natives. A single humpback whale was taken in Norton Sound in 2006, but that is the only reliable record of a subsistence humpback whale take by Alaska Natives (Allen and Angliss 2010). During the period of 1950 to 1980, 47 gray whales were taken by Alaskan subsistence hunters from 12 villages (Marquette and Braham 1982).

Only two gray whales were taken in the 1990s, both in 1995 (Angliss and Outlaw 2005). The annual subsistence take by Russian Natives was 122 during the five-year period from 1999 to 2003 (Angliss and Outlaw 2005). All subsistence takes are within the limits set by the International Whaling Commission (Angliss and Outlaw 2005). No other cetaceans within the EIS project area are affected by subsistence whaling.

All cetaceans are exposed to marine vessel traffic including small skiffs operating close to shore, large ocean-going barges, industrial container ships, and icebreakers used for scientific and commercial purposes throughout their range. Fixed-wing and helicopter traffic in nearshore areas may cause temporary disturbance. Gray whales and harbor porpoises, being the most abundant and regularly encountered of the non-beluga and -bowhead cetaceans throughout the EIS project area, are likely exposed to the most potential disturbance. Any disturbance is negligible.

Cetaceans are also exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Most mysticetes, such as gray, humpback, and fin whales, feed primarily on amphipods, euphasiids, and other lower trophic level benthic organisms. However, toothed whales, such as harbor porpoise and narwhals, feed on higher trophic level organisms and are therefore considered at higher risk of bioaccumulation of contaminants, such as persistent organic compounds.

Cetaceans may be sensitive to current and ongoing effects of climate change in the Arctic. It is not, however, currently possible to make reliable predictions of the effects of changes in weather, sea-surface temperatures, or sea ice extent on any specific species. Research and models suggest that, at least in the short term, reduced sea ice cover may actually increase prey availability for bowhead whales and result in improved body condition (Moore and Laidre 2006, George et al. 2006, cited in Allen and Angliss 2010). This conclusion could be expected to hold true for other mysticetes, and likely for odontocetes as Arctic warming is thought to be resulting in the northern expansion of fish ranges and abundances. The loss of sea ice is also opening new habitat and the possibility of exchange between Atlantic and Pacific populations that were previously separated by sea ice.

4.11.4.10.3.3 Reasonably Foreseeable Future Actions

The same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that affected cetaceans in the past and present are likely to continue into the future. Subsistence hunting will likely continue to be a source of mortality for gray whales. Marine vessel traffic is expected to increase with continued retreat of summer sea ice due to climate change. Increased commercial shipping, fishing, and tourism are likely, as a result. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries, such as Russia, Canada, and Norway. Marine military activity in the region is also on the rise, as both the U.S. Coast Guard and U.S. Navy have stated their interest in increasing their presence and response capabilities in the Arctic. As a result, Coast Guard activities and icebreaker traffic may also increase coincident to growth in shipping and exploration activities.

On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Reasonably foreseeable natural gas development projects include the Point Thomson production unit and the Alaska Pipeline Project. These projects could affect cetaceans during their construction phases through increased vessel traffic in the form of sea lifts and barge transport during the open-water season and development of nearshore structures.

Continued Arctic warming and the resulting changes in sea ice conditions are likely to continue to impact cetaceans throughout the EIS project area. Whether the short-term beneficial increases in prey productivity will continue into the long-term is unknown. Any impacts are difficult to quantify. There is no indication of long-term adverse effects on the population from extensive seismic surveys and exploration drilling in previous decades.

4.11.4.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 2 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 2 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.4.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 2 would result in minor contributions to cumulative effects on other cetaceans.

There would be a small chance of a VLOS occurring during exploratory drilling under this alternative (Section 4.10.7.11). A VLOS would contribute substantially to cumulative effects of disturbance, injury and mortality, and habitat alterations. Some species would be impacted more than others, depending on species abundance within the area affected by the spill, and the location and magnitude of the VLOS. Gray whales and harbor porpoises would be more likely to be impacted than other species in this group because of their higher relative abundance.

The duration of effects could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g., endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by a spill due to the presence of oil and increased vessel activity would be likely. If the area was an important feeding area, such as the Shelf Break of the Beaufort Sea, or along a migratory corridor, the effects would be of higher magnitude. Population level effects would not be likely given the sporadic and seasonal distribution of most cetaceans throughout the EIS project area. However, the extent could be regional, given the migratory nature of many cetaceans. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 on other cetaceans.

4.11.4.10.4 Ice Seals

4.11.4.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called “ice seals”; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 2 on ice seals are described in Section 4.5.2.4.13 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 2 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are protected under the MMPA, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 2 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 2 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.11.4.10.4.2 Past and Present Actions

Each species of ice seal has a unique set of ecological and seasonal distribution characteristics that help determine their exposure to anthropogenic and natural forces within the EIS project area. These species are all highly dependent on sea ice for critical life functions and their seasonal distributions are heavily influenced by seasonal ice movement in Arctic waters. They are all exposed to marine vessel traffic ranging from small skiffs operated close to shore to large ocean-going barges, industrial container ships, and icebreakers used for scientific and commercial purposes. Vessel traffic associated with oil and gas development projects in the Prudhoe Bay area has made up a large percentage of total marine traffic in the past, with all of the large equipment and materials barges traversing the Beaufort and Chukchi seas in both directions between southern ports and Prudhoe Bay. Fixed-wing and helicopter traffic in nearshore areas has caused disturbance of seals on the ice and on shore-based haulouts. There have been no commercial or subsistence fishing operations in the Arctic seas large enough to affect their prey base, although large fisheries in the Bering Sea may affect the winter prey base of migrating seals. They are all exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Each species is also subject to subsistence hunting in various parts of their ranges, primarily near coastal communities adjacent to the Beaufort and Chukchi seas but also in the Bering Sea during winter.

In 2010, NMFS determined that some of the DPS for ringed seals, spotted seals, and bearded seals should be listed as threatened under the ESA, primarily based on the likelihood of sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification. NMFS determined that ribbon seals did not warrant listing under the ESA in 2008.

4.11.4.10.4.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected ice seals in the past are likely to continue in the future. Marine vessel traffic is expected to increase as the ice pack recedes due to climate change, primarily involving large international commercial ships. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries (i.e., Russia and Canada) as the ice pack recedes and allows access to previously ice-covered areas. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope, with many of them requiring large sea barges to transport equipment and material from southern ports to the Prudhoe Bay area. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect ice seals during their construction phases which involve large sea lifts of processing facilities and material during the open-water season and development of nearshore structures. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic. Subsistence hunting will likely continue to be the largest source of direct human-induced mortality on ice seals. The greatest concern for ice seals in the reasonably foreseeable future is the continued Arctic warming trends and the resulting deterioration of sea ice conditions that are so important to these species. Most of the other factors that could affect ice seals would have more local effects but climate change affects the entire ranges of these species and could adversely affect every life stage. It is not clear how or when this issue will be addressed or when the deterioration of ice seal habitat will be reversed.

4.11.4.10.4.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have negligible to minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.4.10.4.5 Conclusion

The direct and indirect effects of Alternative 2 on pinnipeds would be considered minor. Alternative 2 would have negligible to minor contributions to the cumulative effects on the four species of ice seals.

There would be a small chance of a VLOS occurring during exploratory drilling under Alternative 2 (Section 4.10.7.11). The implications for ice seals would depend on the amount and distribution of the spill, especially in relation to the ice pack, and how quickly and thoroughly it could be cleaned up. However, ice seals have the ability to purge their bodies of hydrocarbons through renal and biliary pathways and are not dependent on their fur to keep them warm so they are not as susceptible to spilled oil as are birds or polar bears. Although they can get lesions on their eyes and some internal organs from contacting crude oil, studies have indicated that many of the physiological effects self-correct if the duration of exposure is not too great (Engelhardt et al. 1977, Engelhardt 1982, Engelhardt 1983, Engelhardt 1985, Smith and Geraci 1975, Geraci and Smith 1976a, Geraci and Smith 1976b, St. Aubin 1990). A VLOS could contribute substantially to the cumulative effects of disturbance on ice seals because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. It could also contribute to injury and mortality of seals, especially young animals and those with poor health, although the numbers of animals involved is unlikely to be very large given their physiological resistance to acute oil toxicity. The contribution to habitat effects could be long-term because of the potential for spilled oil to be captured in the food web and to persist on shore-based haulouts for greater than five years. If a VLOS were to occur, there would be a minor to moderate additive effect to the cumulative effects associated with Alternative 2 on the four species of ice seals considered in this EIS.

4.11.4.10.5 Walruses

4.11.4.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on walruses are described in Section 4.5.2.4.14 and are summarized here. Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walrus' reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walruses are protected under the MMPA, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. For the level and type of exploration activities that would be authorized under Alternative 2, given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects on walruses would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 2 would therefore be considered minor for walruses according to the criteria established in Table 4.5-18.

4.11.4.10.5.2 Past and Present Actions

Walruses are considered to be one population that ranges from Russia to Alaska in the Bering and Chukchi seas. Population trends have fluctuated substantially due to historic periods of heavy commercial and subsistence harvest alternating with conservation efforts. Joint U.S.-Russia surveys have been conducted since the 1970s but inconsistencies between methodologies, survey periods, and extent of area surveyed have yielded estimates of abundance that vary widely and the USFWS does not consider these surveys sufficient to establish the current population abundance or trend, although advances in thermal imaging and satellite telemetry could improve this situation (USFWS 2011c). Although not ruled out completely, the USFWS has replaced aerial surveys with other methods to estimate population size and trend, such as genetic mark-recapture. In February 2011 the USFWS determined that walruses should be listed as either endangered or threatened under the ESA but higher priorities precluded the action and the species was put on the list of candidate species awaiting future action (USFWS 2011c). The listing action was determined to be warranted primarily based on the likelihood of sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification.

Walruses are highly dependent on sea ice for critical life functions and their seasonal distribution is heavily influenced by seasonal ice movement in Arctic waters. They typically remain in close proximity to the pack ice as it recedes north in summer and south in the winter. Relatively few walruses have been exposed to the many exploration and shipping vessels traversing the Arctic seas in the past because these large ships tend to stay away from the ice edge if possible. However, the number of walruses encountered by vessels in the open water has increased in recent years, primarily in the fall when the ice pack recedes beyond the shelf break into water too deep for walruses to forage. The ice pack has been receding further north and sooner than it has in the past due to climate change. This change in the pack ice distribution has forced thousands of walruses to swim to shore-based haul outs along the Chukchi coast where they are more exposed to vessel and aircraft traffic (Clarke et al. 2011a, Fischbach et al. 2009). Use of shore-based haul outs may leave walruses, particularly calves and juveniles, vulnerable to disturbance related stampedes and trampling mortalities (Fischbach et al. 2009) and predation from similarly shore-bound polar bears.

Walruses have been displaced from pack ice and ice floes by icebreakers and other vessels used for scientific and commercial purposes. Low-flying fixed-wing and helicopter traffic over the ice and in nearshore areas has caused disturbance of walruses on the ice and on shore-based haul outs. There have been no commercial or subsistence fishing operations in the Arctic seas large enough to affect their prey base, Like all Arctic-dwelling animals, walruses have been exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Walruses are also subject to subsistence hunting in various parts of their range, primarily near coastal communities adjacent to the Bering and Chukchi seas in Alaska and Russia. The majority of walruses taken by subsistence hunters are taken the in spring by hunters from Gambell and Savoonga. The USFWS estimates that the most recent five-year average subsistence harvest in Alaska and Russia (2003 to 2007) is 4,960 to 5,457 walruses per year, including animals estimated to be struck and lost (Allen and Angliss 2011).

4.11.4.10.5.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected walruses in the past are likely to continue in the future. Marine vessel traffic is expected to increase as the ice pack recedes due to climate change, primarily involving large international commercial ships. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries (i.e., Russia and Canada) as the ice pack recedes and allows access to previously ice-covered areas. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Although very few walruses would likely occur east of Barrow they could be exposed to vessels and barges passing through the Chukchi and Bering seas between southern ports and the Prudhoe Bay area. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect walruses during their construction phases due to their use of large sea lifts for pre-built facilities and materials. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic, with unknown impacts on walruses and their habitat. Subsistence hunting will likely continue to be the largest source of direct human-induced mortality on walruses. The greatest concern for walruses in the reasonably foreseeable future is the continued Arctic warming trends and the resulting deterioration of sea ice conditions that are so important to this species. Most of the other factors that could affect walruses would have more local effects but climate change affects the entire range of this species and could adversely affect every life stage.

4.11.4.10.5.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add to the disturbance of walruses from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walruses, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have negligible to minor contributions to the cumulative effects on walruses.

4.11.4.10.5.5 Conclusion

The direct and indirect effects of Alternative 2 on walruses would be considered minor. Alternative 2 would have negligible to minor contributions to the cumulative effects.

There would be a remote chance of a very large oil spill occurring during exploratory drilling under Alternative 2 (Section 4.10.7.11). The implications for walruses would depend on the amount and distribution of the spill, especially in relation to the ice pack, and how quickly and thoroughly it could be cleaned up. Walruses are not dependent on their fur to keep them warm so they are not as susceptible to rapid lethal effects from spilled oil as are birds or polar bears. Ingestion of oil or oil contaminated prey items can cause tissue changes (Kooyman et al. 1976). It is not clear if walruses are able to metabolize small amounts of oil as has been demonstrated with ringed and bearded seals but they have a similar physiology so tissue damage may be temporary unless they are exposed to chronic contamination (Kooyman et al. 1976). Chronic exposure may result in mortality or long-term sub-lethal effects that reduce fitness. A very large oil spill could contribute substantially to the cumulative effects of disturbance on walruses because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. It could also contribute to injury and mortality of walruses if such disturbance causes stampedes of animals hauled out on land, especially young animals and those with poor health. The contribution to habitat effects could be long-term because of the potential for spilled oil to persist in benthic sediments, to be captured in the food web, and to persist on shore-based haulouts for greater than 5 years. Given the conservation concerns for the walrus population due to changing ice conditions, the additional mortality and disturbance caused by a very large oil spill that impacts the Chukchi Sea could have population-level effects. If a VLOS were to occur, there would be a moderate to major additive effect to the cumulative effects associated with Alternative 2 on walruses.

4.11.4.10.6 Polar Bears

4.11.4.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on polar bears are described in Section 4.5.2.4.15 and are summarized here. Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected under the MMPA and ESA, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 2 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 2 would therefore be considered minor for polar bears.

4.11.4.10.6.2 Past and Present Actions

There are two populations of polar bears in Alaska waters, the Southern Beaufort Sea stock and the Chukchi/Bering seas stock. Abundance levels and trend information on polar bears have been difficult to obtain due to their wide but sparse distribution and the logistical difficulties in conducting research over the shifting ice pack. The current best estimate is that the Southern Beaufort Sea stock has about 1,500 animals and is declining slowly (Allen and Angliss 2010, Hunter et al. 2007). There is currently no reliable population estimate or trend information for the Chukchi/Bering seas stock. In 2008, the USFWS determined that polar bears should be listed as threatened under the ESA throughout their range (73 FR 28212, May 15, 2008). This determination was based on declining sea ice habitat throughout the species range and the anticipated continued decline in the foreseeable future. Critical habitat, which was designated in 2010, included sea-ice habitat, terrestrial denning habitat, and barrier island habitat (75 FR 76086, December 7, 2010); this designation was recently upheld by the courts in 2016.

Polar bears are highly dependent on sea-ice for critical life functions and their seasonal distribution is heavily influenced by the seasonal distribution of the ice seal species, which are their main prey, and by seasonal ice movement in Arctic waters. All polar bears except denning females typically roam across the pack ice as it recedes north in summer and south in the winter, although some bears spend time on barrier islands and the coast in the fall and winter to scavenge on whale carcasses. In the past, the majority of denning females in Alaska chose den sites on the pack ice (Amstrup and Gardner 1994) but more recent data indicate that the majority now choose den sites on land (Fishbach et al. 2007), a trend that appears related to thinning of the ice cap due to climate change (Durner et al. 2006). Another result of climate change is the increasingly delayed formation of sea-ice in the fall, forcing more bears to spend more time on land where they have difficulty catching prey and subsequently increasing the chance of human-bear interactions with increased mortality of bears killed in defense of life (Amstrup 2000b).

Polar bears have been subject to subsistence and sport hunting in many parts of their range but several treaties and inter-government agreements have been implemented to limit hunting mortality. Only subsistence hunting by Alaska Natives is allowed in Alaska. The 2003-2007 average Alaska harvest for the Southern Beaufort Sea stock was 33 bears per year and an additional 21 bears per year were taken from this stock in Canada (Allen and Angliss 2011). Harvest levels from the Chukchi/Bering stock are not as well known. An average of 65 bears per year are known to be harvested in Alaska and Russia but illegal harvests in Russia may account for an additional 150 to 250 bears per year (Allen and Angliss 2010).

Relatively few polar bears have been exposed to the many exploration and shipping vessels traversing the Arctic seas in the past because these large ships tend to stay away from the ice edge if possible. In the Beaufort Sea, polar bear sightings from exploration vessels are uncommon and most of these have been of polar bears on or near barrier islands in the fall (Savarese et al. 2010). In the Chukchi Sea, polar bear sightings from vessels have been relatively rare, with half the bears sighted in the water, and they generally do not react strongly to the presence of vessels (Haley et al. 2010b). Other temporary sources of disturbance in the past include icebreakers and low-flying fixed-wing and helicopter traffic.

Like all Arctic-dwelling animals, polar bears have been exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). As a top predator, polar bears could have high levels of potentially toxic compounds that bioaccumulate in the food chain, such as organochlorines and mercury (Braune et al. 2005, AMAP 2005).

4.11.4.10.6.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected polar bears in the past are likely to continue in the future. The greatest concern for polar bears in the reasonably foreseeable future is the continued Arctic warming trends and the resulting deterioration of sea ice conditions that are necessary for this species and its prey. Most of the other factors that could affect polar bears would have more local effects but climate change affects the entire range of this species and could adversely affect every life stage.

Marine vessel traffic is expected to increase as the ice pack recedes due to climate change, primarily involving large international commercial ships, which contributes to the risks of fuel spills and other contamination. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries (i.e., Russia and Canada) as the ice pack recedes and allows access to previously ice-covered areas. These developments outside of Alaska could affect polar bears through oil spills transported in the ice pack or ocean currents. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope, although the impacts should be mitigated through LOAs issued by the USFWS. Reasonably foreseeable natural gas development projects could affect polar bears through disturbance in denning and barrier island habitats, especially during construction, although these activities would also be mitigated through USFWS LOAs. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic, with unknown impacts on polar bears and their habitat. Hunting will likely continue to be the largest source of direct human-induced mortality on polar bears.

4.11.4.10.6.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of injury or additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have a negligible to minor contribution to the cumulative effects on polar bears.

4.11.4.10.6.5 Conclusion

The direct and indirect effects of Alternative 2 on polar bears would be considered minor. Alternative 2 would have negligible to minor contributions to the cumulative effects.

There would be a remote chance of a VLOS occurring during exploratory drilling under Alternative 2 (Section 4.10.7.11). The implications for polar bears would depend on the amount and distribution of the spill, especially in relation to the ice pack and to denning areas, and how quickly and thoroughly it could be cleaned up. Polar bears are susceptible to oil spill-induced injury and death through lost insulation value of their fur and ingestion of oil by grooming or contaminated prey (Hurst and Oritsland 1982, Neff 1990). Polar bears are curious about new things in their environment and may not avoid oil spill areas or contaminated prey or carcasses (St. Aubin 1990, Derocher and Stirling 1991). Bear monitors/bear guards on clean-up crews may be effective at deterring bears from small spill areas but would likely be ineffective if the spill covers a large area or occurs during periods of darkness. A VLOS could contribute substantially to the cumulative effects of disturbance on polar bears because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. The contribution to habitat effects could be long-term because of the potential for spilled oil to persist on coast lines and barrier islands for greater than five years.

Given the conservation concerns for polar bears due to changing ice conditions, the additional mortality and disturbance caused by a VLOS in either the Beaufort or Chukchi seas could have population-level effects. If such a spill were to occur, there would be a moderate to major additive effect to the cumulative effects associated with Alternative 2 on polar bears.

4.11.4.11 Terrestrial Mammals

4.11.4.11.1 Summary of Direct and Indirect Effects

The oil and gas exploration activities proposed in Alternative 2 could have direct and indirect effects on caribou, and possibly other terrestrial mammals from disturbances created by helicopters and fixed wing aircraft fly overs used for crew changes and other support of exploratory drilling programs in the Beaufort and Chukchi seas. Disturbances to caribou may also result from a general increase in human activities (air or ground) in the EIS project area, due to an overall increase in human population from support crews living in the North Slope area.

Disturbance to caribou may result in movements away from preferred habitats or away from preferred migration routes. Caribou respond to flyovers and nearby landings in a variety of ways depending on the degree of their habituation, weather conditions, sex and age composition of the herd, and the aircraft itself (Calef et al. 1976, Horejsi 1981). The type of aircraft, altitude, airspeed and frequency of flyovers all play a role on the caribou’s reaction. Disturbance of caribou could also cause immediate physical injury or death to animals fleeing the disturbance, or could result in increased expenditures of energy or changes in the physiological condition of the animals, which reduces their rates of survival and reproduction. These reactions can result in long-term changes in behavior, especially the traditional use of calving areas and insect-relief areas (Calef et al. 1976). An increase in human population within the EIS project area and the associated vehicle traffic from support crews or the population in general may result in an increase in the number of vehicle strikes causing injury or mortality to caribou. Increased hunting pressure from increased human populations in the EIS project area may also have short term effects on the caribou populations and an increase in the number of local sport hunters may compete with subsistence users.

4.11.4.11.2 Past and Present Actions

Numerous past and present actions have caused disturbances to the four caribou herds that may be affected by the implementation of Alternative 2. Although most of these probable disturbances may not be occurring within the EIS project area they have occurred in the past and continue to occur at several other locations within the migratory ranges of these North Slope caribou herds. Activities causing disturbance to caribou throughout their range contribute to the overall disturbance levels of these animals.

Past and present actions include North Slope oil and gas exploration, development, and production activities including the construction and operation of the Trans-Alaska Pipeline System, permanent roads and winter ice roads; construction of support facilities; and transportation activities involving surface vehicles, aircraft or marine traffic along the coast or within the barrier islands. The Central Arctic Herd's use of calving and midsummer habitats declined from the mid 1970s through the mid 1980s near oil field infrastructure on Alaska's Arctic Coastal Plain (Dau and Cameron 1986).

Caribou habitat has also experienced direct and indirect effects. Road construction, as well as pipeline construction, has not only destroyed some caribou habitat within the footprint of the road, but has also resulted in a reduction of habitat use within the adjacent areas. Cameron et al. (1992) found that calving caribou were displaced outward after construction of the Milne Point road system, resulting in underutilization of habitats adjacent to roads and overutilization elsewhere, effectively diminishing the capacity of the area to support caribou. Cameron et al. (2005) also reported that in the Kuparuk Development Area, west of Prudhoe Bay, abundance of calving caribou was less than expected within 4 km (2.5 mi) of roads and declined exponentially with road density. There are at least thirty-five Alaska oil fields and satellite oil fields producing oil within the migratory ranges of the North Slope caribou herds, and additional discoveries are under development. The Point Thompson project, located about 60 miles east of Prudhoe Bay is currently being constructed and will include three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines and an airstrip. There are also numerous oil and gas development activities occurring in Canada within the migratory range of the Porcupine Caribou Herd.

Mining is another example of past and present activities with direct and indirect effects on caribou, such as the development and operation of Red Dog Mine within the Northwest Arctic Caribou Herd range, which is the world's largest known zinc resource. As much as 25 million tons of high-grade zinc was estimated to be present near Red Dog Mine. Mining activities relative to caribou include the loss of habitat within the foot print of the mine and its support facilities and vehicle traffic between the mine and the coast.

Scientific research such as the continuation of ongoing and special biological surveys, and geophysical studies using both surface and aircraft transportation throughout the North Slope and Brooks Range can effect caribou. BOEM Alaska OCS region Oceanographic research in 2011 included physical oceanography studies, habitat and ecology studies including mapping the distribution of shorebirds. Many of these activities involve aircraft support with potential for caribou disturbances along the coast.

Military activity in the Arctic is thought to have increased in recent years. The Distant Early Warning Line, also known as the DEW-Line, was a system of 63 radar stations located across the northern edge of the North American Continent, roughly along the 69th parallel. Many of these coastal sites are associated with insect relief areas used by caribou. The radar stations were constructed between 1954 and 1957, and decommissioned during the 1990s. The Bullen Point site is currently managed by the U.S. Air Force and has a gravel airstrip and a small radar system.

Subsistence activities, such as routine travel to subsistence camps using aircraft, snow machines and boats along the coast or within the barrier islands cause some disturbance to caribou utilizing those areas. Sport hunting, as well as other recreational activities utilizing aircraft support also cause some level of disturbances to caribou throughout the seasonal ranges of these four caribou herds.

4.11.4.11.3 Reasonably Foreseeable Future Actions

There are numerous reasonably foreseeable future actions that may result in direct or indirect effects to caribou, through construction and operation of many projects, as well as the related activities of the associated human population expected to increase as a result. Oil and gas development in NPR-A will include the development of exploration and production facilities, road networks and support facilities. The Alaska Liquified Natural Gas Project near Prudhoe Bay will include facilities to treat, transport and deliver gas from the North Slope of Alaska to market, which will include the installation and operation of a large gas treatment plant at Prudhoe Bay and an 800-mile buried pipeline to Nikiski.

Mining exploration, development, and production are expected in increase, which includes operations at the Red Dog Mine and the Red Dog Port within the migratory range of the Western Arctic Caribou Herd. The Red Dog Mine port site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea. In addition, coal mine prospecting proposals for the Brooks Range have been submitted to ADNR, Division of Mining, Land and Water (DMLW) for approval.

Military activity in the Arctic is expected to continue to increase in the foreseeable future. Activities may include training exercises and dismantling of DEW-Line sites (which may include demolition projects).

Routine travel and growth of transportation facilities is expected to continue within the North Slope. Industry uses helicopters and fixed wing aircraft to support routine activities. In addition, at least four companies operate air cargo services between North Slope communities and population centers. The majority of air travel and freight hauling between Arctic coastal communities involves small commuter-type aircraft, and government agencies and researchers often charter aircraft for travel and research purposes. These activities are expected to continue, and the level of aircraft traffic within the EIS project area may increase as a result of increased industrial activity. Activities associated with planned community development projects also have potential for direct and indirect effects on caribou. These include the Kaktovik airport project and ongoing water and sewage projects facilitated by the North Slope and Northwest Arctic boroughs.

Recreation and tourism will continue to increase, such as sport hunting, hiking, floating rivers, etc., particularly in the Arctic National Wildlife Refuge, as a result of elevated media exposure of the Refuge. Finally, subsistence hunting is a major source of mortality to caribou, and will continue in the future.

4.11.4.11.4 Contribution of Alternative to Cumulative Effects

The direct and indirect effects from Alternative 2 on caribou may be additive with some countervailing beneficial impacts, when considered in addition to the cumulative effects from other past, present and future activities identified above. Kutz et al. (2004) and Urban (2006) found that the construction of roads and gravel pads may provide caribou with additional insect-relief habitat, particularly when there is little or no road traffic present. However they also recognized that the construction of roads and pipelines could provide vectors by which invasive species, parasites, and new diseases could be introduced into the Arctic environment resulting in negative effects for caribou. Some studies of caribou responses to disturbances indicate that avoidance is not absolute and caribou may habituate to infrastructure and human activity

(Haskell et al. 2006). Several studies have reported that ungulate populations in North America, including caribou have developed tolerance to aircraft, ground-vehicle traffic, and other human activities (Johnson and Todd 1977). Cronin et al. (2000) maintain that effects from onshore development and production have not resulted in negative population-level effects, and that the Central Arctic Herd has grown throughout the period of oil field development at a rate comparable to other herds in undeveloped areas (Lenart 2007).

Cow and calf groups appear to be the most sensitive to vehicle traffic, especially during the early summer months immediately after calving, and bulls appear to be least sensitive during that season. Minimizing traffic, especially within calving areas during the calving period, would reduce the potential for negative impacts on caribou (BOEM 2015b).

These findings suggest that caribou are able to habituate and adapt to some human activities, including vehicle traffic, aircraft operations and the construction and operation of oil and gas production facilities, but cow and calf groups are sensitive to these disturbances.

4.11.4.11.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on caribou would be minor.

In the event of a VLOS, there would be a minor to moderate additive effect to the cumulative effects associated with Alternative 2 on caribou, depending on the magnitude and duration of the spill.

4.11.4.12 Time/Area Closures

The analysis of the cumulative effects associated with time/area closures can be found in Sections 4.11.4.10 (Marine Mammals), 4.11.4.9 (Marine and Coastal Birds) and 4.11.4.14 (Subsistence).

4.11.4.13 Socioeconomics

4.11.4.13.1 Summary of Direct and Indirect Effects

There would be no new federal or state revenues generated under the implementation of Alternative 2 during the time period covered by this EIS because lease sales in federal and state waters have already been conducted and are the subject of proposed exploration activities. Some local revenues would be generated in communities that would stage crew or support services and that have a sales tax.

There would be a limited number of direct local North Slope employment opportunities associated with the standard mitigation measures for PSOs, Subsistence Advisors, Com Centers, and oil spill responders. There would be direct and indirect employment opportunities for regional and village corporations that procure service contracts related to the above activities or support of crews and staging. In the communities of Barrow, Wainwright, Nome and Unalaska/Dutch Harbor (where crew changes occur or vessels are based), there could be short-term, seasonal demand on institutions and social services.

If a deflection or disturbance of subsistence resources occurs as a result of Alternative 2 (see the Subsistence Section), the activities of non-profit organizations could be impacted in order to coordinate adaptive strategies regarding potential economic and social implications of reduced harvest of subsistence resources. The CAA, Com Centers, and POCs are mechanisms currently used for communication, cooperation, and conflict avoidance between industry and local groups like the AEWC.

The magnitude of the socioeconomic impact would be positive but low because total personal income and local employment rates would not be increased by more than five percent. Revenues to the North Slope Borough would also not exceed five percent of their annual operating budgets. The duration of the socioeconomic impacts is interim because the activity would be scheduled for several years, but not year-round. The positive economic impacts of the activity are statewide and national in extent. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat (minority) communities. The summary impact level for Socioeconomics under Alternative 2 is moderate.

4.11.4.13.2 Past and Present Actions

The ongoing activities of the oil and gas industry are generally contained within the Prudhoe Bay industrial complex, between the Alpine Project to the west and Point Thomson Project to the east. The past and present actions that would contribute to the cumulative effects to socioeconomics under Alternative 2 are the same as those described for Alternative 1 (Section 4.11.3.1.3).

4.11.4.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions for Alternative 2 would be the same as those described for Alternative 1. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 2 would result in future oil and gas production.

4.11.4.13.4 Contribution of Alternative to Cumulative Effects

Alternative 2 would have a minor contribution to cumulative effects on socioeconomic resources because employment rates and state and regional revenues are expected to remain stable. At a local level, the new direct employment, public revenue generation, and impact to social institutions would be experienced by Iñupiat (minority) communities.

4.11.4.13.5 Conclusion

The direct and indirect effects of Alternative 2 would be moderate. The contribution to the cumulative effects of socioeconomics would be minor.

A VLOS in the Beaufort Sea or Chukchi Sea could result in short to long-term employment, potential new NSB revenues (property taxes for the construction of worker infrastructure) as well as potential lost revenue for NSB, state and federal revenues due to permitting delays, and exploration moratoria. Local and state agencies may also increase expenditures associated with the administration of oil spill response and social services related to the influx of new workers. The influx of workers would create a short to long-term demand on institutions and social services in NSB communities. Employment and local revenues associated with clean-up of a VLOS in the either the Beaufort or Chukchi Sea would be high intensity, long-term in duration, statewide to national in extent, and unique in context. The impact to the non-monetary economy is discussed in detail in Subsistence Section 4.10.6.15, but would be high intensity, long-term in duration, regional in extent, and important to unique in context. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 to socioeconomics.

4.11.4.14 Subsistence

4.11.4.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.2-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 2 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales, bearded and ringed seals and polar bears are considered unique in context as these resources are protected by legislation (e.g., MMPA, ESA) or are considered an important subsistence resource (beluga whales). Therefore the summary impact level of Alternative 2 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.5.3.2).

4.11.4.14.2 Past and Present Actions

Numerous past and present actions (Section 4.11.2) have likely caused disturbances to subsistence resources and hunting/harvest activities that may be affected by the implementation of Alternative 2. Although most of these probable disturbances may not be occurring within the EIS project area they have occurred in the past and would likely continue to occur at several other locations within mapped subsistence harvest areas (Figure 3.3-13). Past and present actions that cause disturbance to subsistence activities throughout the ranges of harvested resources contribute to the overall disturbance levels on resources and affect the success of subsistence hunting, harvests and rates of sharing between communities.

Past and present actions include North Slope oil and gas exploration, development, and production activities including the construction and operation of the Trans-Alaska Pipeline System, permanent roads and winter ice roads; construction of support facilities; and transportation activities involving surface vehicles, aircraft or marine traffic along the coast or within the barrier islands. Issues with user access and disturbance associated with these activities have caused real and perceived impacts to subsistence activities and harvest success. The habitat of subsistence resources has previously experienced direct and indirect effects which in turn have affected subsistence harvest. For instance road construction, as well as pipeline construction, has destroyed some caribou habitat within the footprint of the road, and has also resulted in a reduction of habitat use by this subsistence resource and limited harvest areas available within the adjacent areas (Section 4.11.4.11).

Mining is an example of past and present activities with direct and indirect effects on marine mammals and caribou, such as the development and operation of Red Dog Mine. This mine is located within the Northwest Arctic Caribou Herd range and barge traffic occurs through marine mammal harvest areas of Kivalina hunters. Subsistence users from Kivalina have noted a change in the seasonal pattern of harvest of beluga whales since the mine has been operational (Section 4.5.3.2). Mining activities relative to subsistence resources include the loss of habitat within the foot print of the mine and its support facilities and vehicle traffic between the mine and the coast and maritime shipping traffic.

Scientific research such as the continuation of ongoing and special biological surveys, and geophysical studies using both surface and aircraft transportation along the coast lines and throughout the North Slope can affect subsistence hunting and harvest activities. Many of these activities have included vessel, aircraft and over ice-support that potentially disturbs marine mammals and terrestrial resource subsistence hunting and harvest activities along the coast.

Military activity in the Arctic is thought to have increased in recent years. Vessel traffic through open water, aircraft overflights and related maneuvers have likely and will continue to contribute to cumulative effects on subsistence resources and their harvest by hunters.

Past and present subsistence activities, such as routine travel to subsistence camps using aircraft, snow machines and boats along the coast and small boat traffic within the barrier islands causes some disturbance to the subsistence resources and rates of harvest of the resources that are utilizing those areas. It is unlikely that past subsistence bowhead whaling led to adverse effects on a population level. Subsistence harvests are currently the primary source of mortality for bowhead whales, with an average of about 40 takes per year (Suydam et al. 2011). The subsistence harvest is well-managed and regulated through a quota system by the IWC (Section 3.3.2). There is no indication of long-term adverse effects on the population from the level of take through the subsistence harvest (approximately 0.1 to 0.5 percent of the population per year [Philo et al. 1993b]) which appears to be sustainable.

Recreation, tourism and sport hunting, as well as other recreational activities utilizing aircraft support also cause some level of disturbances to subsistence activities such as caribou hunting, fishing, and migratory bird hunting throughout the project area.

Subsistence hunters have noted that climate change has affected the trends and methods of subsistence harvest of marine mammals (Section 3.3.2.6). Changes in ice conditions have influenced the spring bowhead whale hunt in the Beaufort and Chukchi seas communities. Wainwright, Point Hope and Point Lay recently have been conducting fall bowhead whale hunts to provide for their communities and meet allotted quotas. In recent years, ice conditions during these fall periods are considered to be less dangerous than current spring seasons which are now considered too dangerous for crews to hunt (Comstock 2011).

4.11.4.14.3 Reasonably Foreseeable Future Actions

The same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected subsistence harvests in the past and present are likely to continue in the future. Subsistence hunting will likely continue to be the largest source of direct human-induced mortality on marine mammals. Marine vessel traffic is anticipated to increase and vessels would include those used for used for fishing and hunting, cruise ships, icebreakers, Coast Guard vessels, supply ships, tugs, and barges. The retreat of sea ice will make navigation easier during the longer open ice periods and increases in the levels of commercial shipping and tourism are expected to occur (Arctic Council 2009). The reduced sea ice extent will likely open up the Northwest and Northeast Passages for maritime shipping. Offshore oil and gas exploration, mineral exploration and development are also likely to increase in Arctic waters of other countries (i.e., Canada, Russia and Norway) as the ice pack recedes and allows access to previously ice-covered areas. Icebreakers from other nations are expected to become increasingly more present in the Arctic seas contributing the levels of noise introduced into the marine environment which in turn could impact subsistence resources and rates of harvest. The distribution of subsistence resources could change if the disturbance or alters resource distribution and/or migratory patterns.

Onshore oil and gas exploration and production activities are expected to continue on the Alaskan North Slope. Reasonably foreseeable natural gas development projects (e.g., continued development of the Point Thomson production unit and/or a large diameter natural gas pipeline) could affect subsistence resources and harvests during their construction phases which involve sea lifts of processing facilities infrastructure and materials during the open water season and development of nearshore structures. Access to subsistence resources and subsistence-hunting areas could change if the disturbance reduces the availability of subsistence resources for harvest or alters species distribution and or migratory patterns.

Potentially toxic compounds will continue to be produced around the world and many could find their way to the Arctic. There is the potential that some contaminants may accumulate in marine and terrestrial subsistence resources and in turn may have human health implications.

The greatest concern for subsistence resources in the reasonably foreseeable future is the continued trends of Arctic warming and the resulting deterioration of sea ice conditions that are important to subsistence resources and users. Climate change affects the entire range of subsistence resources and eventually could adversely affect harvest rates and success. Climate change could lead to changes in diversity, abundance, and distribution of traditional subsistence resources and harvest patterns and in turn lead to rapid and long-term impacts on the availability of some subsistence resources. Changing ice conditions are noted as a threat to indigenous lifestyles and subsistence practices. As ice conditions deteriorate, travel to hunting areas, and hunting itself become more hazardous due to more hunting in open water. Larger and more expensive vessels and motors may be required (Forbes 2011).

4.10.4.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 2 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. Of greatest concern would be potential effects on fall bowhead whale and other subsistence hunting activities associated with disturbance and behavioral responses. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, local and temporary or short-term in duration, and affecting common to unique resources in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have a negligible to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 2 would be considered additive to cumulative effects on subsistence resources.

4.11.4.14.5 Conclusion

Under Alternative 2, the direct and indirect effects to subsistence resources are considered low in intensity, temporary to interim in duration, local to regional in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 2 would be considered additive to cumulative effects on subsistence resources. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence, depending on the subsistence resources affected.

There would be a low probability of a VLOS occurring during exploratory drilling under Alternative 2. The implications for subsistence resources and harvests would depend on the amount and distribution of the spill, especially in relation to the ice pack, and how quickly and thoroughly it could be cleaned up. A VLOS could contribute substantially to the cumulative effects of disturbance on marine mammals. This would be due to the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. It could also contribute to injury and mortality of fish, marine and coastal birds and terrestrial resources which are important subsistence resources. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 to subsistence resources and harvests.

4.11.4.15 Public Health

4.11.4.15.1 Summary of Direct and Indirect Effects

As described in Section 4.5.3.3, both beneficial and adverse impacts on public health and safety could result from Alternative 2. Possible changes could occur to the numbers of people experiencing chronic disease and injury/trauma, primarily as a result of effects on traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes occurring, and effects are unlikely to be large enough cause a measurable change in health outcomes at a population level. The magnitude or intensity of effects is estimated to be low: above background conditions, but within both the natural variation and adaptive ability of the local population. If health changes do occur they would affect minority or low-income communities, the duration of changes may be long-term, and multiple communities could be affected.

4.11.4.15.2 Past and Present Actions

Over the last 50 to 100 years, as development and industrialization have increased, the population living in the EIS project area has experienced rapid modernization and acculturation, with substantial changes in diet, housing, employment, and traditional culture. These changes have been accompanied by a shift in the burden of disease experienced by the population, as infectious disease and infant mortality have abated and chronic disease and cancer have become leading causes of death. This phenomenon, often known as the epidemiologic transition, is typical in any population as it develops, but is particularly acute in populations experiencing rapid modernization. Indigenous populations worldwide have seen particularly dramatic health changes over the last several decades as modernization has brought with it marked changes in diet, sociocultural systems and economic conditions. Circumpolar regions such as the EIS project area are particularly impacted.

Much of the change associated with this transition is for the better. For example, life expectancy increases, infant mortality decreases and age-specific mortality decreases. Rates of infectious diseases such as tuberculosis and vaccine-preventable illnesses also decline. Health care services, public health programs and municipal health infrastructure such as sanitation and water treatment also improve with development. Most population health indicators show that health in the EIS project area has steadily improved since the 1950s.

However, the epidemiologic transition also comes with some adverse health outcomes. The rates of chronic diseases such as cancer, cardiovascular disease and metabolic disorders rise. Health outcomes related to social conflict and stress also increase. In the EIS project area, as in most other circumpolar and indigenous populations, development has been commensurate with increases in alcohol and substance misuse, suicide, violence and other social dysfunction.

Much of this change in the burden of disease among the Iñupiat is a result of general development, economic growth and cultural change. The extent to which oil and gas development has contributed to it is unknown; however, there are well-documented causal pathways between oil and gas development activities and changes in both health determinants and outcomes, and local testimony supports the association of oil and gas with both positive and adverse health outcomes. Although the exact contribution of oil and gas development is unknown, its role as the primary driver of economic and industrial development in the region does support at least an indirect causal association.

However, the pattern of development and modernization that has taken place in the EIS project area has led to the creation of certain health areas that are of particular importance when considering cumulative effects. These include:

- **Injury and trauma.** The population living in the EIS project area experiences high levels of injury and trauma, with high morbidity and mortality rates across most age groups. This is common in any rural or remote region and is particularly high in populations that engage in subsistence activities. These high rates of injury may be exacerbated by the way in which traditional subsistence activities have adapted to the presence of development – for example, hunters report that they need to travel farther to reach subsistence resources due to both a displacement of animals and to avoidance of industrialized areas.
- **Social pathologies such as alcohol and drug misuse, social dysfunction and violence.** Oil and gas development, with its large in-migrations of outside workers and influxes of money into the local economies, is associated with increased social pathology. In addition, the development of roads and seasonal access to the region increase opportunities to import alcohol.
- **Health disparities.** There already exist patterns of economic and health disparity within the EIS project area, with health outcomes and health determinants unevenly distributed within and across the population. Recent/present development, as well as future development has the potential to exacerbate these disparities both because of the uneven distribution of the "rewards" of development and because of uneven distribution of the risks.

4.11.4.15.3 Reasonably Foreseeable Future Actions

There are a number of activities planned and/or approved in the EIS project area, including oil /gas exploration, development and production; scientific research activities; mining projects; military developments and activities; transportation plans; community development projects; and recreation and tourism activities. These future actions will continue to influence public health and safety. The common components of these future actions that are most likely to drive public health and safety outcomes are:

- A potential growth in population in the communities of the EIS project area;
- In-migration of workers not originally from the EIS project area;
- Economic changes at the level of both individual residents and the Native Corporations;
- Changes in the level or success of subsistence activities;
- Regional industrialization;
- Changes in/improvements to public infrastructure;
- Potential exposure to environmental contaminants;
- Changes in access to or use of the land; and
- Continued acculturation of the Iñupiat people and deterioration of sociocultural traditions.

As the reasonably foreseeable future actions continue the path and progress of development seen in past actions, it can be expected that the changes in public health and safety outcomes will follow the same trends that have been observed in recent years. These include:

- Improvements in general health indicators such as mortality and life expectancy;
- A shift in the burden of illness away from infectious disease and towards higher rates of chronic conditions;
- Changes in diet towards increased use of store-bought foods and associated changes in nutritional outcomes;
- Increasing disparities in health outcomes between the more-wealthy and the less-wealthy; and
- Increased rates of social ills including crime, violence, and alcohol and drug misuse.

Of particular significance for public health and safety is further increases in offshore oil and gas exploration, development and production following the demonstration of economically feasible opportunities. A ramp-up of offshore development has been posited by key informants to lead to potentially substantive changes in public health outcomes via three pathways: a) via displacement of marine mammals and the subsequent reduction of success and safety of subsistence hunting; b) via the potential for contamination and the fear of contamination through oil spills or routine discharge; and c) via substantially increased economic returns to the NSB, village corporations and individuals with resulting positive and negative health effects and disparities as outlined in Section 4.5.3.3.

4.11.4.15.4 Contribution of Alternative to Cumulative Effects

The effects on public health and safety resulting from Alternative 2 are likely to be low; and the direct contribution of the actions specified in Alternative 2 to cumulative effects on public health and safety should best be characterized as negligible. The pathways through which health effects would occur include diet and nutrition, contamination, safety, acculturative stress and economic impacts, as described in Section 4.5.3.3.

However, the health impacts of oil and gas development in the North Slope have been well documented in the past and insomuch as the activity in Alternative 2 would lead to further offshore oil and gas activity, there could be contributions to cumulative impacts in the future. These may also include health effects in other areas not anticipated through the direct and indirect effects of Alternative 2, such as increases in infectious disease and health outcomes related to air quality.

4.11.4.15.5 Conclusion

As described above, the contribution of the actions of Alternative 2 on public health and safety are likely to be negligible; however, the possibility of the exploration activity leading to further development raises the possibility of health consequences subsequent to this further activity.

As described in Sections 4.10.6.16 and 4.10.7.16, the magnitude of impacts from a VLOS would be medium to high, as some public health outcomes would be treatable and/or transient, but some may be irreversible. Some predicted public health effects would last for only a brief period and would be associated with the influx of workers during the Phase 4 clean-up period. However, health effects of a VLOS resulting from changes in subsistence patterns would be likely to persist for many years. The geographic extent of the impact would vary depending on the size and location of the spill, but all EIS project area communities would be affected to some degree.

Alternative 2 therefore would contribute to cumulative impacts on public health and safety via three mechanisms: a) the relatively small contribution of the direct and indirect impacts; b) acting as the gateway for additional future offshore oil and gas development; and c) and an unlikely but potentially large contribution from a VLOS. If a VLOS were to occur, there would be moderate to major additive effects to the cumulative effects associated with Alternative 2 to public health, depending on the size, nature, and location of the spill.

4.11.4.16 Cultural Resources

4.11.4.16.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to cultural resources resulting from the implementation of Alternative 2 would be low-intensity and interim in duration, but in a very local area. Therefore, the summary impact level of direct and indirect effects from Alternative 2 for cultural resources is negligible, not exceeding the significance threshold.

Direct effects to cultural resources include those activities that physically impact the condition or integrity of the resource. Specifically, construction of on-shore pipelines or staging areas could result in direct effects to surface or subsurface prehistoric or historic archaeological sites. Likewise, sea-floor based seismic activities and exploratory drilling could directly affect submerged prehistoric sites or historic vessels on the seafloor.

Indirect effects to offshore resources are unlikely, given that impacts would likely result during the exploratory phase of the project. Previously undiscovered resources, however, could be inadvertently damaged during this phase of the project. On-shore resources are more susceptible to indirect effects and can include inadvertent damage, looting caused by the introduction of increased access and local activity; and visual impacts to historic or traditional cultural properties.

4.11.4.16.2 Past and Present Actions

Past and present actions related to oil and gas exploration, development, production, and transportation are the main activities that have the potential to affect cultural resources in the EIS area. Currently there are 35 fields and satellites producing oil on the North Slope and in nearshore areas of the Beaufort Sea, and additional discoveries are under development. Specifically, these actions include North Slope oil and gas exploration, development, and production activities including the construction and operation of the Trans-Alaska Pipeline System, permanent roads and winter ice roads; construction of support facilities; and transportation activities involving surface vehicles, aircraft or marine traffic along the coast or within the barrier islands.

Mining is another example of past and present activities with direct and indirect effects on cultural resources, such as the development and operation of Red Dog Mine which is the world's largest known zinc resource. As much as 25 million tons of high-grade zinc was estimated to be present near Red Dog Mine. Mining activities relative to cultural resources include ground-disturbing activities within the foot print of the mine and its support facilities and vehicle traffic between the mine and the coast.

Scientific research such as the continuation of ongoing and special biological surveys, and geophysical studies using both surface and aircraft transportation throughout the North Slope and Brooks Range can affect cultural resources with potential for ground disturbances along the coast.

Military activity in the Arctic, such as the development of the Distant Early Warning Line, also known as the DEW-Line, was a system of 63 radar stations located across the northern edge of the North American Continent, roughly along the 69th parallel. The radar stations were constructed between 1954 and 1957, and decommissioned during the 1990s. The Bullen Point site is currently managed by the U.S. Air Force and has a gravel airstrip and a small radar system.

Additionally, subsistence activities, such as routine travel to subsistence camps using aircraft, snow machines and boats along the coast or within the barrier islands cause some ground disturbance.

4.11.4.16.3 Reasonably Foreseeable Future Actions

There are numerous reasonably foreseeable future actions that may result in direct or indirect effects to cultural resources, through construction and operation of many projects, as well as the related activities of the associated human population expected to increase as a result. Oil and gas development will include the development of exploration and production facilities, road networks and support facilities.

The Alaska LNG Project will include facilities to treat, transport and deliver gas from the North Slope of Alaska to markets in North America, which will include the installation and operation of a gas treatment plant at Prudhoe Bay. The Point Thompson project, located about 60 miles east of Prudhoe Bay will include the construction of three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines and an airstrip.

Mining exploration, development, and production are expected in increase, which includes operations at the Red Dog Mine and the Red Dog Port. The Red Dog Mine port site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea. In addition, coal mine prospecting proposals for the Brooks Range have been submitted to ADNR, DMLW for approval.

Military activity in the Arctic are expect to continue to increase in the foreseeable future. Activities may include training exercises and dismantling of DEW-Line sites (which may include demolition projects).

Routine travel and growth of transportation facilities is expected to continue within the North Slope. Activities associated with planned community development projects also have potential for direct and indirect effects on cultural resources. These include the Kaktovik airport project and ongoing water and sewage projects facilitated by the North Slope and Northwest Arctic boroughs.

Recreation and tourism will continue to increase, such as sport hunting, hiking, floating rivers, etc., particularly in the ANWR, as a result of elevated media exposure of the Refuge.

4.11.4.16.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of activities associated with Alternative 2 to cumulative effects on cultural resources would be negligible.

4.11.4.16.5 Conclusion

Direct and indirect effects associated with Alternative 2 are considered to be negligible. The incremental contribution of activities associated with Alternative 2 to cumulative effects on cultural resources would be negligible.

If a VLOS were to occur, there would be negligible additive effects to the cumulative effects associated with Alternative 2 to cultural resources.

4.11.4.17 Land and Water Ownership, Use, Management

4.11.4.17.1 Summary of Direct and Indirect Effects

Land and Water Ownership

Based on Table 4.4-2, and the analysis provided in Section 4.5.3.5, there would be no direct or indirect impacts on land and water ownership under Alternative 2and no contribution to cumulative effects to land and water ownership.

Land and Water Use

Based on Table 4.4-2 and the analysis provided in Section 4.5.3.5, the impacts of land and water use caused by Alternative 2 would be high in magnitude where activity occurs in areas of little to no previous activity (such as Wainwright), and low in magnitude where activity occurs in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). Impacts would be temporary in duration, although the impact could be long-term if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local and the context would be common. In summary, the direct and indirect effects of Alternative 2 on land and water use would be moderate.

Land and Water Management

Based on Table 4.4-2 and the analysis provided in Section 4.5.3.5, the impacts on land and water management caused by Alternative 2 would be low in magnitude, temporary in duration, local in extent, and common in context. In total, the direct and indirect impacts of Alternative 2 on land and water management would be negligible.

4.11.4.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under the cumulative effects analysis for Alternative 1, Section 4.11.3.2.2.

4.11.4.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under the cumulative effects analysis for Alternative 1, Section 4.11.3.2.3.

4.11.4.17.4 Contribution of Alternative to Cumulative Effects

There would be no impact to land and water ownership under Alternative 2. The level of impact on land and water use under Alternative 2 would be moderate, and duration would be interim. With the possibility of some small changes in land use in the foreseeable future, the cumulative impact would remain moderate, as any additional changes in land use and water use would be incrementally small, short-term in duration and geographically dispersed. The level of impact on land management under Alternative 2 would be minor, and effects from past, present, and reasonably foreseeable future actions are negligible. Under Alternative 2, all changes would be incrementally small and geographically dispersed, and thus would have negligible effects creating cumulative impacts on land ownership, use, or management.

4.11.4.17.5 Conclusion

Under Alternative 2, the levels of direct, indirect and cumulative impacts for land and water ownership, use, and management would be none, moderate, and negligible, respectively. Based on this, the overall level of impact is considered minor. The contribution of Alternative 2 to cumulative effects would be considered negligible.

If a VLOS were to occur, there would be major additive effects to the cumulative effects associated with Alternative 2 on land and water ownership, use, and management.

4.11.4.18 Transportation

4.11.4.18.1 Summary of Direct and Indirect Effects

Alternative 2 would increase the levels of air, roadway, and vessel traffic in the EIS project area. However, the increased traffic levels would be of low intensity, interim in duration, local to regional in extent, and affecting resources considered common in context. As a result, the overall direct and indirect effects would be considered minor.

4.11.4.18.2 Past and Present Actions

Past and present actions such as: transportation of freight and local residents to, from, and between communities in the EIS project area; oil and gas exploration, drilling, and development; military development; mining; and tourism have included construction and expansion of local roads, airstrips, docks, seasonal ice roads, and the presence of vessels in the EIS project area. Coastal and marine vessel/barge traffic, fixed-wing and helicopter traffic, low-pressure tundra-travel, off road vehicles (four wheelers), snowmobile traffic, and vehicle traffic on local roadways have been generated as a result of these actions.

4.11.4.18.3 Reasonably Foreseeable Future Actions

It is reasonable to assume that trends associated with transportation to facilitate the maintenance and development of coastal communities, Red Dog Mine, and Prudhoe Bay area oil and gas facilities will continue. In some specific cases, described below, transportation and associated infrastructure in the proposed activity area may increase as a result of increased commercial activity in the area.

Aircraft Traffic: Existing air travel and freight hauling for local residents is likely to continue at approximately the same levels. Air traffic to support mining is expected to continue to be related to exploration because there are no new large mining projects in the EIS project area in the permitting process. Tourism air traffic will not likely change much because there are no reasonably foreseeable events that would draw large numbers of visitors to travel to or from the area using aircraft. Sport hunting and fishing demand for air travel will likely continue at approximately the same levels. Use of aircraft for scientific and search and rescue operations is likely to continue at present levels.

Oil and gas industry use of helicopters and fixed wing aircraft to support routine activities and exploration within the EIS project area is likely to increase as a result of increased interest in North Slope exploration. Air traffic is likely to increase to the Point Thomson Project area and if the Alaska LNG Project were to be constructed. These increases could cause congestion at the Deadhorse Airport during construction seasons.

Vehicle Traffic: None of the RFFAs propose to construct permanent roads to the communities in the EIS project area. Construction of ice roads could allow industry vehicles access to community roads, and likewise allow residents vehicular access to the highway system on a seasonal basis.

Vessel Traffic: Vessel traffic through the Bering Strait has risen steadily over recent years according to USCG estimates, and Russian efforts to promote a Northern Seas Route for shipping are expected to lead to continued increases in vessel traffic adjacent to the western portion of the EIS project area. Additional increases in the use of the Northwestern Passage Route from Canadian waters would also contribute to vessel traffic adjacent to the western portion of the EIS project area.

In addition, research vessels, including NSF and USCG icebreakers, also operate in the EIS project area. USCG anticipates a continued increase in vessel traffic in the Arctic. Cruise ships and private sailboats sometimes transit through the proposed project area. Changes in the distribution of sea ice, longer open-water periods, and increasing interest in studying and viewing Arctic wildlife and habitats may support an increase in research and recreational vessel traffic in the proposed action area regardless of oil and gas activity.

Increased barge traffic would occur if the Alaska LNG project were constructed during the time period covered under this EIS. Coastal barges would support this project by delivering fuel, construction equipment, and materials and sea lift barges would deliver modules for processing and camp facilities. If realized, this would result in additional barge traffic transiting through the EIS project area but potential for congestion would only be expected near Prudhoe Bay docks and only during construction. Offshore oil and gas exploration drilling would also result in some additional tug and barge, support, icebreaker, and other vessel traffic (Petroleum News 2011a) that could contribute to congestion if they used Prudhoe Bay area docks.

4.11.4.18.4 Contribution of Alternative to Cumulative Effects

Alternative 2 would be expected to have minor direct and indirect impacts on transportation infrastructure. Alternative 2 could cause a minor increase in vessel activity in the area, potentially adding to the congestion that would be expected at Prudhoe Bay docks if a large project such as the Alaska LNG Project as being constructed simultaneously. It is likely, however, that dock operators would schedule vessel callings to reduce potential for congestion and operate continuously to speed the servicing of vessels and barges. Barge traffic would cease in the winter and continue at a reduced frequency during the open water season when the proposed projects are in operation.

Likewise, Alternative 2 could result in increased air travel through the EIS project area. This could contribute to congestion at the Deadhorse Airport if major projects were also being constructed. Airlines would probably increase the number of flights during the busiest seasons and the flight volume would be within the overall capacity of the system. Following construction, there would be a modest long-term increase in flights to support operation of newly constructed projects.

Alternative 2 could cause minor interim increases in local road traffic when aircraft or vessels use local community airstrips or docks. RFFAs are unlikely to increase local traffic to levels approaching a use that could interrupt service or cause congestion and the combined total local road traffic would not be expected to result in congestion.

4.11.4.18.5 Conclusion

The direct and indirect effects of Alternative 2 would be minor for transportation infrastructure and systems, with a minor contribution to cumulative impacts if Alternative 2 overlaps with large-scale development projects and the RFFAs go forward. A VLOS would be considered an additive adverse long-term impact to cumulative impacts to transportation. If a VLOS were to occur, there would be a moderate additive cumulative effects associated with Alternative 2 on transportation.

4.11.4.19 Recreation and Tourism

4.11.4.19.1 Summary of Direct and Indirect Effects

As discussed in Section 4.5.3.7, the direct impacts on recreation and tourism would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the direct and indirect impacts associated with Alternative 2 on recreation and tourism would be minor.

4.11.4.19.2 Past and Present Actions

Recreation and tourism occur at generally low levels of use in the EIS project area and are more common onshore (hiking, river float trips) than offshore (small cruise ships, kayaking). It is important to distinguish between recreation and subsistence uses. The vast majority of fishing, hunting, and boating that occurs in the EIS project area are *subsistence*-based, managed completely apart from *recreation*-based activities, with separate rights and privileges (see Section 4.5.3.2, Subsistence for further discussion). Past activities that have affected recreation include the discovery of oil and natural gas, and the resulting development of Deadhorse, industrial support facilities in the vicinity of Barrow, and the construction and operation of the Dalton Highway. The EIS project area became more accessible to recreationists, including minimal accommodations. Another past action that affected recreation and tourism use was the designation of the Arctic National Wildlife Refuge (ANWR). The designation brought attention to the area; it became a destination for recreation and tourism. All of these factors may have increased levels of recreation and tourism in the EIS project area. However, total recreation and tourism use in the EIS project area remains low, and impact would be minor.

4.11.4.19.3 Reasonably Foreseeable Future Actions

Most of the North Slope areas are underused for recreation and have the potential to support increased levels of recreation use in the future. The continuation of development for oil and natural gas drilling is highly likely. As development increases, the increase in noise and visibility, and simply the knowledge of the existence of industrial development is expected to impact the setting for recreation. Despite this, continued development may make the North Slope more accessible, and as a result bring more recreationists and tourists. As infrastructure improves and accommodations are increased in places like Deadhorse and Wainwright, there is a higher possibility that people would go to those places to recreate, or use those areas as a base to access recreation opportunities. Overall impact would be minor; recreation and tourism levels will not increase or decrease substantially in the foreseeable future.

4.11.4.19.4 Contribution of Alternative to Cumulative Effects

Under Alternative 2, the direct and indirect effects to recreation and tourism would be minor. The contribution of the direct and indirect impacts to the past, present, and reasonably foreseeable future actions would be minor; the additional demands on the recreation setting would be low, and the levels of activities are expected to remain low. Recreation and tourism would not be stressed to a point that would cause an irreversible impact. Therefore, the contribution of Alternative 2 to cumulative effects to recreation and tourism would be minor.

4.11.4.19.5 Conclusion

The direct and indirect impacts associated with Alternative 2 on recreation and tourism would be minor. Alternative 2 would have a minor contribution to cumulative effects on recreation and tourism.

In the event of a VLOS, offshore and coastal settings would be altered by the amount of vessels, aircraft, and support for response. The recreation setting in the EIS project that would be most affected would be near the water, and activities would be affected by the presence of the response teams and the oil; particularly wildlife viewing, fishing and yachting. If a VLOS were to occur, there would be major additive effect to the cumulative effects associated with Alternative 2 on recreation and tourism.

4.11.4.20 Visual Resources

4.11.4.20.1 Summary of Direct and Indirect Effects

Alternative 2 would include vessel-based surveys implemented in the Beaufort and Chukchi seas, and a single exploratory drilling program in both the Beaufort and Chukchi seas. Although the actions associated with this alternative could occur across the EIS project area, actions would primarily be seen from population centers located east of Barrow, extending to the Canadian border (including the ANWR). Due to the distances offshore, views of the proposed project in the Chukchi Sea would be restricted to those of industrial workers or commercial marine traffic occurring in offshore locations in the Chukchi and would not be detected by viewer groups located in on-land or near-shore locations (see Section 3.3.8 for a description of viewer groups).

Seismic and hazard survey operations would not require a construction phase. Implementation of seismic and hazard surveys is expected to result in weak visual contrast where actions occur at close proximity (within 3 to 5 miles) to on-land and near-shore locations state waters of the Beaufort Sea. Visual contrast is expected to attenuate beyond 5 miles due to the scale of the vessels relative to the landscape and the transient nature of the proposed action.

The exploratory drilling program would include construction, operation, and decommissioning phases. Construction-related impacts may occur as part of exploratory drilling programs situated in state waters (located within 3 miles) of the Beaufort Sea. Construction-related actions would result in a temporary increase in marine barge, vehicle, and potentially air traffic around local drill site(s). Such actions would contribute color, angular lines, and movement to the landscape; however, because oil and gas activity is underway in this area, change in visual resources and scenic quality as a result of construction of drill site(s) is not expected to create visual contrast or attract attention of the casual observer.

During the operational phase, the moderate to strong visual contrast may result from operation of drill sites, particularly where situated within five miles of viewers. Like vessel traffic, visual contrast of drilling facilities (i.e., ice islands) and lighting would be maximized where viewed from proximate locations and would attenuate with distance from the viewer. Project-related actions in the nearshore Beaufort Sea would be viewed by both viewers from the Alaska Native community of Nuiqsut and viewers located in the industrial centers of Deadhorse and Prudhoe Bay.

Standard mitigation measures implemented as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Although Category D Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in the culturally important activity of bowhead whaling) to vessel-based surveys during certain periods. However it would not change exposure to drill sites, as these structures would remain in place during shutdown periods unless the operator agrees to move off location during such shutdown periods.

In conclusion, implementation of Alternative 2 is expected to result in *interim moderate effects* to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be local; however they would affect an important resource.

4.11.4.20.2 Past and Present Actions

Large scale oil and gas exploration is a major component of the landscape character of the Beaufort Sea, located on the North Slope. Oil and gas-related development has occurred in this area since the 1940s, with major onshore development in Prudhoe Bay and offshore exploration in the Beaufort and Chukchi seas underway by the 1970s. Development and production in the near shore Beaufort Sea began in the early 1980s. The TAPS was completed in 1977, providing a transport mechanism to move oil from the North Slope to Valdez, AK. Industrial development is primarily situated on the Beaufort Sea. Onshore and near-shore (within three miles) activity extends from the Colville River Unit west of Wainwright, east to the Badami Unit, and includes discrete industrial facilities connected by a network of roads, pipelines. Recent discoveries have led to at least six additional offshore operations in the Beaufort Sea; three of which are supported by on on-shore production facilities (MMS 2008). Currently, 35 fields and satellites producing oil are in operation on the North Slope and in near-shore areas of the Beaufort Sea.

Ongoing oil and gas activity is the most defining landscape characteristic separating portions of the Beaufort Sea located between the Point of Borrow and the border of ANWR, from the rest of the EIS project area. Views of the EIS project area from native communities and industrial nodes along the shoreline of this geographic area would experience views of existing on- and offshore oil and gas activity. Developments may be long-term or temporary. Developments appear as compact areas of dense development with distinct vertical lines that contrast color, texture and reflexivity to varying extents with the surrounding landscape. The industrial footprint is currently being expanded by the Point Thompson Project, located 60 miles east of Prudhoe Bay, producing additional light and movement to the landscape. When viewed from the EIS project area, the low-lying, horizontal lines of inland roads and pipelines blend with predominant horizontal lines of the landscape; however, when viewed from the air, the broad network of linear roads and pipelines are apparent. In contrast, because much of the oil and gas activity occurs approximately 75 miles offshore in the Chukchi Sea, these areas are not seen by viewer group's located on-land, and are rarely observed by non-industrial marine travelers.

4.11.4.20.3 Reasonably Foreseeable Future Actions

Several reasonably foreseeable future actions are planned for the EIS project area that may affect visual resources. Actions include:

- natural gas-related development, including a pipeline, and expansion of near shore and shore-based natural gas production facilities; and
- State of Alaska lease sales in the near-shore portions of the Beaufort Sea.

The reasonably foreseeable future actions listed above are expected to affect visual resources during both construction and operation phases. Actions would be seen from population centers located east of Barrow, extending to the Kaktovok, nearshore areas, and from the air. Construction-related impacts are expected to result from heightened activity due to increase in personnel, air and marine traffic, including sealifts, channel dredging, and modifications of an existing structure (i.e., Dock Head, airstrips). All projects would require installation of temporary work camps and access roads to support construction activities. Operations-related impacts are expected to result from the expanded footprint of industrial nodes.

4.11.4.20.4 Contribution of Alternative to Cumulative Effects

.Implementation of Alternative 2 would contribute to cumulative effects by increasing the industrial character of the area through introduction of an exploratory drilling structure and associated support vessels. Impacts are expected to be greatest if exploratory drilling is implemented in near-shore areas of the Beaufort Sea, between Harrison Bay and Kaktovik, where the majority of past, present, and reasonably foreseeable future actions are located. This area coincides with locations of viewers such as native communities or recreational visitors using the ANWR. Transient views of seismic and shallow hazard survey vessels are not expected to contribute to the industrial character of the area, as views of vessels would be episodic. Proposed actions on the Chukchi Sea are, likewise, not expected to contribute to cumulative effects, as actions are separated geographically from reasonably foreseeable future actions.

4.11.4.20.5 Conclusion

Past, present, and reasonably foreseeable future actions could result in strong visual contrast that collectively could contribute to the industrial landscape character of the state waters of the Beaufort Sea. Under Alternative 2, the anticipated contribution to cumulative effects to visual resources is expected to be minor. Impacts would be of low to moderate intensity based on the specific location of drill sites, as visual contrast of these actions is expected to attenuate with distance. Impacts would be interim and local in geographic extent, as impacts would not extend beyond the project area; however occurring in an important context of ANWR.

If a VLOS were to occur, there would be major additive effect to the cumulative effects associated with Alternative 2 on visual resources, as the event would be high intensity, resulting in strong visual contrast in color and texture of effluent against the surrounding landscape. Impacts would be interim, extended in geographic scope as a VLOS could be observed from large distances, and would affect an important resource in the ANWR.

4.11.4.21 Environmental Justice

4.11.4.21.1 Summary of Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

Activities related to implementation of Alternative 2 would have a low intensity impact to the number of marine mammals harvested for subsistence use and access to marine mammals. Impacts would be of a temporary duration and would occur over a regional extent to unique (Iñupiat) minority populations.

Activities associated with Alternative 2 are expected to cause low intensity health outcomes (within normal human variation) due to potential exposure to contamination from subsistence foods. The changes in health would be long-term, persisting after the actions cease, and would be regional in extent. Alternative 2 may have an indirect effect of adding to the perception that subsistence foods are contaminated and alter confidence in their consumption. Subsistence foods and human health are unique resources, protected under the MMPA and Executive Order 12898. Thus, the direct and indirect effects of Alternative 2 to subsistence and public health would be minor.

4.11.4.21.2 Past and Present Actions

Impacts to the abundance and distribution or access to subsistence resources associated with past and present actions are described in Subsistence Section 4.11.4.14.

Impacts to subsistence foods and impacts to health indicators from past and present actions are described in the Public Health Section 4.11.4.15.

4.11.4.21.3 Reasonably Foreseeable Future Actions

Future industrial activities in the Arctic (including oil and gas exploration and production, mining, military activity, shipping) have the potential to impact the environmental justice indicators of subsistence and public health. Climate change can affect temperature, ice conditions and ocean circulation which can adversely impact abundance and distribution of subsistence resources. Therefore, climate change can have an indirect adverse impact on subsistence access and public health.

4.11.4.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 2 to the overall industrial activity in the area includes a potential: increase in contamination of subsistence foods; increased perception of contamination of subsistence foods; overall decrease in access or availability of subsistence resources; and decline in public health indicators. The contribution of Alternative 2 to subsistence cumulative effects would be minor because the impacts to subsistence resources and uses would be low intensity, temporary duration, regional in extent, and unique in context. The contribution of Alternative 2 to public health cumulative effects would be similar to subsistence except the duration would be long-term. Therefore, the contribution to cumulative effects of these environmental justice indicators would be minor.

4.11.4.21.5 Conclusion

The direct and indirect effects of Alternative 2 would be minor. The contribution to the cumulative effects of environmental justice indicators would be minor. Therefore, there would be a minor impact to Alaska Natives (minority population) in the EIS project area.

In the event of a VLOS in the Beaufort or Chukchi Sea, an indirect impact of the proposed action to issue G&G permits and ITAs for an exploratory drilling program, the allocation quota for bowhead whales would be reduced. The intensity of the VLOS on subsistence resources and subsistence harvest would be of high intensity and cause a year round change in subsistence use patterns. Subsistence harvests of marine mammals, fish, migratory birds and caribou would be affected by direct contact with oil and the presence of the response equipment and personnel. Subsistence harvests could be altered long-term to permanent in duration. The impacts of a VLOS in the Beaufort Sea would be high intensity, long-term to permanent in duration, regional to statewide in extent, and affecting resources that are unique and important in context. In summary, the impact of a VLOS on subsistence harvest would be major.

In addition to the long-term impacts on sociocultural systems, a VLOS could cause a large influx of outside workers that could spread infectious disease and strain the health care system in villages used as staging areas, and respiratory irritation or illness related to air quality. The greatest and most persistent impacts to public health would result from the stress, anxiety and changes to subsistence harvest patterns. Adverse public health effects would be medium to high in intensity because some are treatable and/or transient, but some effects may be irreversible. These health effects may be temporary to permanent lasting for a brief period or persisting for many years in two more communities in the EIS project area. In summary, the impact of a VLOS on public health would be moderate to major depending on the nature and location of the spill.

Therefore a VLOS would have disproportionate adverse additive impacts to Alaska Natives (minority population) living in communities near the EIS project area.

4.11.5 Alternative 3 – Authorization for Level 2 Exploration Activity

4.11.5.1 Physical Oceanography

4.11.5.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 3 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. Under Alternative 3, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact could effectively be doubled. Relative to Alternative 2, water depth would be affected over a larger area. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 3, would result in medium-intensity, temporary or long-term (temporary if ice or long-term if gravel), local effects on nearshore currents in the waters adjacent to the artificial islands. Relative to Alternative 2, sea ice would be affected over a larger area due to more extensive icebreaking activity and thermal inputs associated with exploratory drilling activities. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on physical ocean resources in the EIS project area would be minor, particularly with the implementation of additional mitigation measures related to reducing or eliminating certain discharge streams.

4.11.5.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.5.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.5.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause local minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 3, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.5.1.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.5.2 Climate and Meteorology

4.11.5.2.1 Summary of Direct and Indirect Effects

Alternative 3 would directly emit more GHGs than Alternative 2; however direct impacts to climate change are estimated to have the same level of impact (minor) due to their low magnitude and low contribution to GHG emissions on a state level. Due to uncertainties in the outcome of exploration activities, indirect effects associated with Alternative 3 are assumed to be the same as those for Alternative 2: minor to moderate.

4.11.5.2.2 Past and Present Actions

Past and present actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.5.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.5.2.4 Contribution of Alternative to Cumulative Effects

Alternative 3 would directly emit more GHGs than Alternative 2; therefore it would directly contribute more to cumulative climate change impacts than Alternative 2. Alternative 3 would result in approximately 82,308 tpy more CO_2e emissions than Alternative 2 (See Sections 4.5.1.2 and 4.6.1.2). Alone, this difference would not result in a noticeably larger cumulative effect than Alternative 2. However, when accounting for all past, present, and future projects with GHG emissions, even a minor contribution such as 82,308 tpy of CO_2e per project, can cumulatively result in a perceptible impact. Therefore, Alternative 3 could have a larger impact on cumulative impacts to climate change than Alternative 2. Indirect effects from Alternative 3 are expected to have the same contribution to cumulative effects as Alternative 2, resulting in observable, global changes that could be long-term and could affect unique resources.

4.11.5.2.5 Conclusion

Due to the additive and synergistic nature of GHG emissions on climate change impacts, Alternative 3 could contribute to a moderate to major cumulative impact to climate change.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.5.3 Air Quality

4.11.5.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the most conservative case activity under Alternative 3, Level 2 Exploration Activity, are expected to be the same as those predicted for Alternative 2. The emissions would be moderate in magnitude, and minor in duration, extent, and content. The total emissions from the Level 2 Exploration Activity is greater than that for Level 1 Exploration Activity; the overall direct effect on air quality is expected to be medium to high. Indirect effects on air quality would remain at negligible to minor.

4.11.5.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.5.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.5.3.4 Contribution of Alternative to Cumulative Effects

As with Alternative 2, Alternative 3 has the potential to contribute to future cumulative effects on air quality if activities occur during the same time period(s) and vicinity of any of the actions identified above that have the potential to affect air quality. Because of the short time duration for activities, cumulative effects would be highly dependent on actual meteorological conditions at the time, and the relative location of sources. The cumulative effects would be negligible (lower than the sum of the total maximum effects). There are no accumulative or synergistic effects associated with air quality.

4.11.5.3.5 Conclusion

Alternative 3 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.5.4 Acoustics

4.11.5.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 3. The overall impact rating for direct and indirect effects to the acoustic environment under Alternative 3 would be moderate.

4.11.5.4.2 Past and Present Actions

The past actions for Alternative 3 are the same as listed for Alternative 2 (Section 4.11.4.4). The present actions will consist of up to six deep penetration seismic surveys in the Beaufort Sea and up to five seismic surveys in the Chukchi Sea. This alternative also allows for up to five site clearance and high resolution shallow hazards surveys in Beaufort and five of these surveys in the Chukchi. Up to two drilling programs in each of the Beaufort and Chukchi seas and one on-ice seismic survey would be permitted.

4.11.5.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.5.4.4 Contribution of Alternative to Cumulative Effects

The possibility of up to six deep-penetration seismic surveys and five site clearance and high resolution shallow hazards surveys with inclusion of two potential drilling operations in the Beaufort Sea open water season produces substantial total disturbance zone areas. Marine mammals could have difficulty navigating between the disturbance zones surrounding each of the surveys and drill operations if these activities were performed concurrently. The concurrent operation of multiple noise sources could lead to confusion by marine mammals at choosing a path to avoid regions of high noise. If cumulative SEL criteria for auditory system injury were considered, the total effects of exposures to multiple operations could be greater than from individual activities. The large number of deep penetration seismic surveys would be the primary source of higher cumulative exposures.

Cumulative effects in the Chukchi Sea would be fewer than in the Beaufort Sea because the marine mammal migration corridors there are less concentrated. There would consequently be more opportunity for migrating marine mammals to choose paths between the surveys and drilling locations to avoid passing close to individual operations where noise levels are highest.

In response to public comments, NMFS conducted a first-order cumulative and chronic assessment of oil and gas activities in the Arctic. Section 4.5.2.4.9 and Appendix F outline the results and limitations of this study. Broadly, results suggest that for Alternative 3, substantial losses of listening area (up to 98%) and bowhead communication space (up to 24%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October, with notable, but lesser, losses of listening area also occurring around the lease areas in the Chukchi (up to 72% at shallower depths). As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data is lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation.

4.11.5.4.5 Conclusion

Cumulative effects from noise exposures to marine mammals under Alternative 3 are similar but larger than the effects described for Alternative 2 due to the greater number of noise-generating activities that would be permitted. The ability of marine mammals to avoid close approaches to seismic survey sources would be reduced when many sources were concurrently in operation with limited spatial separation.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.5.5 Water Quality

4.11.5.5.1 Summary of Direct and Indirect Effects

Impacts to water quality from Alternative 3 would be the same in nature as those described for Alternative 2 in Section 4.11.4.5. The only difference between the two alternatives is the level of activity. Alternative 3 would allow additional surveys and exploratory drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impacts may effectively be doubled. Relative to Alternative 2, water quality parameters may be affected over larger areas and over longer periods of time. However, the effects of Alternative 3 on water quality would be low intensity, temporary, and local to areas in the immediate vicinity of the activities. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 3 on water quality are expected to be minor.

4.11.5.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.5.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.5.5.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 3, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.5.5.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on water quality in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.5.6 Environmental Contaminants and Ecosystem Functions

4.11.5.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 3 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area. While the geographic extent of such impacts would potentially be greater than that resulting from Alternative 2, the overall geographic extent of impacts to regulation functions would be limited. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 3, while the effects of Alternative 3 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall effects of Alternative 3 on ecosystem functions would be minor.

4.11.5.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.5.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.5.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause local minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 3, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. Relative to Alternative 2, these interactions would potentially be distributed over a greater geographic area. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial over the lifespan of this EIS.

4.11.5.6.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.5.7 Lower Trophic Levels

4.11.5.7.1 Summary of Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.11.4.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to lower trophic levels. The conclusions for Alternative 2 are applicable to Alternative 3; therefore, the overall impact to lower trophic levels would be negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.11.5.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.5.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.5.7.4 Contribution of Alternative to Cumulative Effects

Alternative 3 would have the same types of effects as Alternative 2 but the increased level of exploration activities under Alternative 3 would add incrementally to its contribution to cumulative effects on lower trophic levels. However, the conclusions about Alternative 3 would be similar to Alternative 2 discussed in Section 4.11.4.7. In the absence of a VLOS, the exploration activities authorized under Alternative 3 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

4.11.5.7.5 Conclusion

Alternative 3 could have a negligible contribution to cumulative effects on lower trophic organisms. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.5.8 Fish and Essential Fish Habitat

4.11.5.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 3 on Fish Resources and EFH would be minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in the overall impact level, due to the small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 3.

The direct and indirect effects on marine fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 2. Demersal assemblages, on the other hand, would feel the additional effects from the increase in seismic survey levels and exploratory drilling, both in terms of habitat loss and the effects from noise. Pelagic assemblages would be impacted by the increase in surveys but less so by the increased drilling programs. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain the same given the limited area affected compared to the distribution of fish populations.

The direct and indirect effects on migratory fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 2, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 2, those anadromous species known to inhabit the area where project activities would occur are not very abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same.

The direct and indirect effects on EFH resulting from Alternative 3 would be very similar to those described under Alternative 2, with an increase in effects due to the increase in oil and gas exploration activities. In particular, the increase in exploratory drilling programs would result in increased habitat loss and alteration, potentially to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 3 is small and only incrementally larger than for Alternative 2. Most impacts would be of low intensity and of small geographic.

4.11.5.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.5.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.5.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have measurable effects on fish and EFH within the EIS project area, and those effects may be beneficial or detrimental. As discussed in Section 4.11.4.8.3, ocean acidification could have a variety of negative effects on fish and fish habitat. Climate change could also make it easier for non-native invasive species to take hold in the Arctic. Warming waters and decreases in ice cover could later predator and prey distributions and concentrations, thereby impacting fish. On the other hand, as Arctic waters warm, productivity could increase, thereby creating more favorable fish habitat throughout the region. The contribution of the activities associated with this alternative to cumulative effects on fish and EFH would be minor.

4.11.5.8.5 Conclusion

Direct and indirect impacts resulting from Alternative 3 on fish and EFH would be of such low intensity and of such small geographic extent that the effects would be considered minor. The incremental contribution of activities associated with Alternative 3 to cumulative effects on fish would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.5.9 Marine and Coastal Birds

4.11.5.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary, local, affect important or unique resources, and not likely to have population-level effects for any species. In summary, the impact of Alternative 3 on marine and coastal birds would be considered minor.

4.11.5.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.5.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.5.9.4 Contribution of Alternative to Cumulative Effects

Alternative 3 would have the same types of effects as Alternative 2 but the increased level of exploration activities under Alternative 3 would add incrementally to its contribution to cumulative effects on marine and coastal birds. However, the conclusions about Alternative 3 would be similar to Alternative 2 (4.11.4.9). The exploration activities authorized under Alternative 3 would have minor contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.5.9.5 Conclusion

The direct and indirect effects of Alternative 3 on marine and coastal birds would be considered minor. Alternative 3 would have minor contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds, as discussed under Alternative 2 (Section 4.11.4.9).

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.5.10 Marine Mammals

4.11.5.10.1 Bowhead Whales

4.11.5.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on bowhead whales are described in Section 4.6.2.4.1 and are summarized here. Impacts of individual activities associated with oil and gas exploration in the EIS project area under Alternative 3 are similar to Alternative 2. Despite a substantial increase in level of activity over Alternative 2, the overall impact level would be the same (See Section 4.11.4.10.1).

In terms of the impact criteria identified in Table 4.5-18, most effects of individual exploratory activities authorized under Alternative 3 are of medium intensity and temporary in duration. Potential long-term effects from repeated disturbance over time or over a broad geographic range are unknown. Individually, the various activities may elicit local effects on bowhead whales, yet the area and extent of the population over which effects would be felt would increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Since the EIS project area extends across most of the migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales. Bowhead whales are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast, which places them in the context of being a unique resource. Evaluated collectively, and with consideration given to reduced adverse impacts through the imposition of the required standard mitigation measures, the overall effect of activities authorized under Alternative 3 on bowhead whales is likely to be moderate.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order cumulative and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments. Broadly, results suggest that for Alternative 3, substantial losses of listening area (up to 98%) and bowhead communication space (up to 24%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October, with notable, but lesser, losses of listening area also occurring around the lease areas in the Chukchi (up to 72% at shallower depths). As noted in Section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data is lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation, especially, perhaps for bowhead whales, which are migrating through with calves where communication is important to retain group cohesion

4.11.5.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.5.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.5.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 3, when combined with the past, present, and reasonably foreseeable future actions would be minor to moderate, the same as under Alternative 2 (Section 4.11.4.10.1), with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.11.5.10.1.5 Conclusion

Under Alternative 3, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 3 would have a minor to moderate contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

4.11.5.10.2 Beluga Whales

4.11.5.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on beluga whales are described in Section 4.6.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 3 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The direct and indirect effects on beluga whales from the exploration activities under Alternative 3 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 3 on beluga whales would be considered moderate.

4.11.5.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.5.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.5.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 3 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 3 would therefore have minor to moderate additive contributions to the cumulative effects on beluga whales.

4.11.5.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 3 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.5.10.3 Other Cetaceans

4.11.5.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on cetaceans are described in Section 4.6.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 3 on other cetaceans is minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 3, impacts on the resource would be low in intensity, of short duration, and limited extent. Long-term impacts are unknown, but anticipated to be minor.

The primary direct and indirect effects on other cetaceans would result from noise exposure. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs.

Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

4.11.5.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.5.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.5.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 3 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in impact level.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 3 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.5.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 3 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.3).

4.11.5.10.4 Ice Seals

4.11.5.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called “ice seals”; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 3 on ice seals are described in Section 4.6.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 3 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 3 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 3 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.11.5.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.5.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.5.10.4.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 3 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 3 would therefore have negligible to minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.5.10.4.5 Conclusion

The direct and indirect effects of Alternative 3 on pinnipeds would be considered minor. Alternative 3 would have negligible to minor contributions to the cumulative effects on the four species of ice seals.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.5.10.5 Walruses

4.11.5.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on walruses are described in Section 4.6.2.4.5 and are summarized here. Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walrus' reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 3, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 3 on walruses would therefore be considered moderate.

4.11.5.10.5.2 Past and Present Actions

Past and present actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.5.10.5.3 Reasonably Foreseeable Future Actions

Past and present actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.5.10.5.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 3 would add to the disturbance of walruses from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walruses, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 3 would therefore have negligible to minor contributions to the cumulative effects on walruses.

4.11.5.10.5.5 Conclusion

The direct and indirect effects of Alternative 3 on walruses would be considered moderate. Alternative 3 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with walruses were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.5.10.6 Polar Bears

4.11.5.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on polar bears are described in Section 4.6.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative 3 as for Alternative 2**.** The primary difference for polar bears would be an incremental increase in disturbance from vessel and air traffic and an incremental increase in risk of habitat contamination**.** Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative 3, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 3 on polar bears would therefore be considered minor.

4.11.5.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.5.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.5.10.6.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 3 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 3 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.5.10.6.5 Conclusion

The direct and indirect effects of Alternative 3 on polar bears would be considered minor. Alternative 3 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.5.11 Terrestrial Mammals

<u>4.11.5.11.1 Summary of Direct and Indirect Effects</u>

Alternative 3 is the same as Alternative 2 except with increased levels of activity, with two exploratory drilling programs. The impacts discussed for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to terrestrial mammals. The conclusions for Alternative 2 are applicable to Alternative 3; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to terrestrial mammals from aircraft activity would be minor.

4.11.5.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.5.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.5.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.5.11.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on caribou would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.5.12 Time/Area Closures

The analysis of the cumulative effects associated with the time/area closures can be found in Sections 4.11.5.10 (Marine Mammals), 4.11.5.9 (Marine and Coastal Birds) and 4.11.5.14 (Subsistence).

4.11.5.13 Socioeconomics

4.11.5.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 3 are similar to those described in Alternative 2. Alternative 3 would represent an increased level of oil and gas exploration therefore there would be an increased level of local revenue generated in staging communities; direct and indirect employment opportunities for regional and village corporations that procure service contracts. There could also be negative impacts to institutions and social services in the staging communities. The magnitude of the socioeconomic impact is positive but still low because total personal income, local employment rates, and borough revenues would not increase by more than five percent.

Direct employment opportunities associated with the standard mitigation measures could increase or stay the same as Alternative 2 due to their duplicative nature. Also similar to Alternative 2, the duration of the socioeconomic impacts would be interim (not year-round, but scheduled over several years). The geographic extent of socioeconomic impacts would local, statewide, and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat (minority population) communities. The summary impact level for Socioeconomics under Alternative 3 is moderate, not exceeding the significance threshold.

4.11.5.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.5.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 3 would result in future oil and gas production.

4.11.5.13.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would have a minor contribution to cumulative effects on socioeconomic resources because employment rates and state and regional revenues are expected to remain stable. They differ from Alternative 2 by a higher magnitude of direct employment and generation of local revenue, but with a potential increase in negative impacts on local institutions. At a local level, the new direct employment, public revenue generation, and impact to social institutions would be experienced by Iñupiat (minority) communities.

4.11.5.13.5 Conclusion

The direct and indirect effects of Alternative 3 would be moderate. The contribution to cumulative effects of socioeconomics would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics would be major and are discussed under Alternative 2 (Section 4.11.4.13).

4.11.5.14 Subsistence

4.11.5.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-24, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 3 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales, bearded and ringed seals and polar bears are considered unique in context as these resources are protected by legislation (e.g., MMPA, ESA) or are considered an important subsistence resource (beluga whales). Even with the increase in the number of activities/programs that could potentially occur under Alternative 3, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity, and comparable duration, but occurring in more locations. Therefore the summary impact level of Alternative 3 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.6.3.2).

4.11.5.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.5.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.5.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 3 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, local to regional in extent, temporary in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 3 would occur at a higher level of activity in comparison to those proposed under Alternative 2. The contribution of Alternative 3 would have a negligible to moderate contribution to the cumulative effects on subsistence resources.

4.11.5.14.5 Conclusion

Under Alternative 3, the direct and indirect effects to subsistence resources as a result of the increased levels of activity associated with this alternative are considered low in intensity, temporary to interim in duration, local to regional in extent and affect subsistence resources that range from common to unique in context. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.5.15 Public Health

4.11.5.15.1 Summary of Direct and Indirect Effects

As described in Section 4.6.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 3 are expected to be similar to those expected under Alternative 2.

4.11.5.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.5.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.5.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 3 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.5.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 3 would contribute to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts as well as acting as the gateway for additional future offshore oil and gas development.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.5.16 Cultural Resources

4.11.5.16.1 Summary of Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity, with two exploratory drilling programs. The impacts discussed for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to cultural resources. The conclusions for Alternative 2 are applicable to Alternative 3; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to cultural resources from increased levels of activity would be negligible.

4.11.5.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.5.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.5.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.5.16.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on cultural resources would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with cultural resources were discussed under Alternative 2 (Section 4.11.4.16).

4.11.5.17 Land and Water Ownership, Use, Management

4.11.5.17.1 Summary of Direct and Indirect Effects

The cumulative effects for Alternative 3 would be similar to Alternative 2, discussed in Section 4.5.3.5. There would be no direct or indirect impacts on land and water ownership. The direct and indirect impacts on land and water use would have a high magnitude, be temporary or interim in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, interim in nature, local, and common. In summary, the impacts of Alternative 3 on land and water ownership, use, and management would be none, moderate, and negligible, respectively.

4.11.5.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under the cumulative effects analysis for Alternative 1, Section 4.11.3.2.

4.11.5.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under the cumulative effects analysis for Alternative 1, Section 4.11.3.2.

4.11.5.17.4 Contribution of Alternative to Cumulative Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The cumulative effects discussed in Section 4.11.4.17.4 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to land or water ownership, use, and management. The conclusions for Alternative 2 are applicable to Alternative 3; changes would be negligible, temporary in duration, and geographically dispersed, and thus would have negligible effects creating cumulative impacts on land ownership, use, or management and would be considered minor.

4.11.5.17.5 Conclusion

Under Alternative 3, the levels of direct, indirect and cumulative impacts for land and water ownership, use, and management are negligible, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 3 is considered minor. The contribution of Alternative 3 to cumulative effects would be considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management would be major, as discussed under Alternative 2 (Section 4.11.4.17).

4.11.5.18 Transportation

4.11.5.18.1 Summary of Direct and Indirect Effects

Increased levels of marine vessel traffic in Alternative 3 associated with the seismic survey and exploratory drilling programs would be expected to primarily occur in offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when lightering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence would be low in intensity, interim in duration, limited in geographic extent to a local to regional area, and common in context. The summary impact from increases in vessel traffic would be considered minor.

4.11.5.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.5.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.5.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 3 would be similar but of slightly higher intensity than described for Alternative 2 in Section 4.11.4.18.

4.11.5.18.5 Conclusion

The direct and indirect effects of Alternative 3 would be minor for transportation, with a minor contribution to cumulative impacts if Alternative 3 overlaps with another large-scale development project.

A VLOS in the Beaufort or Chukchi seas would have moderate additive cumulative effects to transportation, similar to Alternative 2 (Section 4.11.4.18).

4.11.5.19 Recreation and Tourism

4.11.5.19.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.3.7, the direct impacts on recreation and tourism would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 3 on recreation and tourism would be minor.

4.11.5.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.5.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.5.19.4 Contribution of Alternative to Cumulative Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The cumulative effects discussed in Section 4.10.4.19 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 3; the contribution of Alternative 3 to cumulative effects to recreation and tourism would be minor.

4.11.5.19.5 Conclusion

Alternative 3 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.5.20 Visual Resources

4.11.5.20.1 Summary of Direct and Indirect Effects

Implementation of Alternative 3 would be similar to that describe in Section 4.11.4.20, however there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in interim moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 3, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, local and occur in an important context.

Standard mitigation measures implemented as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Although Category D Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in the culturally important activity of bowhead whaling) to vessel-based surveys during certain periods. However it would not change exposure to drill sites, as these structures would remain in place during shutdown periods unless the operator agrees to move off location during such shutdown periods.

4.11.5.20.2 Past and Present Actions

Past and present actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.5.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.5.20.4 Contribution of Alternative to Cumulative Effects

Implementation of Alternative 3 would increase the level of permitted activity (i.e., three versus two 2D/3D seismic surveys; two versus one exploratory drilling program). Actions could occur at any location within the EIS project area; however, like Alternative 2, actions associated with implementation of Alternative 3 would result in the greatest impact to visual resources if sited in near-shore areas between Harrison Bay and Kaktovik, where the majority of past, present, and reasonably foreseeable future actions are located. The location would also coincide with locations of viewers, such as residents of native communities or recreational visitors using the ANWR. If actions associated with Alternative 3 are concentrated in areas where the majority of past, present, and reasonably foreseeable future actions are located, Alternative 3 would contribute to the industrialized landscape character of the area. Transient views of seismic and shallow hazard survey vessels are not expected to contribute to the industrial character of the area, as views of vessels would be episodic.

4.11.5.20.5 Conclusion

Past, present, and reasonably foreseeable future actions could result in strong visual contrast that collectively could contribute to the industrial landscape character of the state waters of the Beaufort Sea. Under Alternative 3, anticipated cumulative effects to visual resources are expected to be minor. Impacts would be of high intensity, interim, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.5.21 Environmental Justice

4.11.5.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 3 would be minor, similar to those described in Alternative 2. The level of activity associated with Alternative 3 is greater than Alternative 2, but the effects do not change the summary impact level for these environmental justice indicators.

4.11.5.21.2 Past and Present Actions

Past and present actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).

4.11.5.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.11.5.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 3 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 3 to environmental justice indicator cumulative effects would be minor.

4.11.5.21.5 Conclusion

The direct and indirect effects of Alternative 3 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a minor impact to Alaska Native (minority) communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental justice were discussed under Alternative 2 (Section 4.11.4.21). A VLOS would have disproportionate adverse impacts to Alaska Native (minority) communities in the EIS project area.

4.11.6 Alternative 4 – Authorization for Level 3 Exploration Activity

4.11.6.1 Physical Oceanography

4.11.6.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 4 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. Under Alternative 4, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 3. Alternative 4 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact could effectively be doubled. Relative to Alternative 3, water depth would be affected over a larger area. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 3, would result in medium-intensity, temporary or long-term (temporary if ice or long-term if gravel), local effects on nearshore currents in the waters adjacent to the artificial islands. Relative to Alternative 3, sea ice would be affected over a larger area due to more extensive icebreaking activity and thermal inputs associated with exploratory drilling activities. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 3, the overall effects of Alternative 4 on physical ocean resources in the EIS project area would be minor, particularly with the implementation of additional mitigation measures related to reducing or eliminating certain discharge streams.

4.11.6.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.6.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.6.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause local minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 4, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.6.1.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.6.2 Climate and Meteorology

4.10.5.2.1 Summary of Direct and Indirect Effects

Alternative 4 would directly emit more GHGs than Alternative 3; however direct impacts to climate change are estimated to have the same level of impact (minor) due to their low magnitude and low contribution to GHG emissions on a state level. Due to uncertainties in the outcome of exploration activities, indirect effects associated with Alternative 4 are assumed to be the same as those for Alternative 3, which would be minor to moderate.

4.11.6.2.2 Past and Present Actions

Past and present actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.6.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.6.2.4 Contribution of Alternative to Cumulative Effects

Alternative 4 would directly emit more GHGs than Alternative 3; therefore it would directly contribute more to cumulative climate change impacts than Alternative 3. Alternative 4 would result in approximately 82,308 tpy more CO_2*e* emissions than Alternative 3 (See Sections 4.5.1.2 and 4.6.1.2). Alone, this difference would not result in a noticeably larger cumulative effect than Alternative 3. However, when accounting for all past, present, and future projects with GHG emissions, even a minor contribution such as 82,308 tpy of CO_2*e* per project, can cumulatively result in a perceptible impact. Therefore, Alternative 4 could have a larger impact on cumulative impacts to climate change than Alternative 3. Indirect effects from Alternative 4 are expected to have the same contribution to cumulative effects as Alternative 3, resulting in observable, global changes that could be long-term and could affect unique resources.

4.11.6.2.5 Conclusion

Due to the additive and synergistic nature of GHG emissions on climate change impacts, Alternative 4 could contribute to a moderate to major cumulative impact to climate change.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.6.3 Air Quality

4.11.6.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 4, Level 3 Exploration Activity, are expected to be the same as those predicted for Alternative 3. The emissions would be moderate in magnitude, and minor in duration, extent, and content. The total emissions from the Level 3 Exploration Activity is greater than that for Level 2 Exploration Activity; the overall direct effect on air quality is expected to be medium to high. Indirect effects on air quality would remain at negligible to minor.

4.11.6.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.6.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.6.3.4 Contribution of Alternative to Cumulative Effects

As with Alternative 3, Alternative 4 has the potential to contribute to future cumulative effects on air quality if activities occur during the same time period(s) and vicinity of any of the actions identified above that have the potential to affect air quality. Because of the short time duration for activities, cumulative effects would be highly dependent on actual meteorological conditions at the time, and the relative location of sources. The cumulative effects would be negligible (lower than the sum of the total maximum effects). There are no accumulative or synergistic effects associated with air quality.

4.11.6.3.5 Conclusion

Alternative 4 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining medium to high in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.6.4 Acoustics

4.11.6.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 4. The overall impact rating for direct and indirect effects to the acoustic environment under Alternative 4 would be moderate.

4.11.6.4.2 Past and Present Actions

The past actions for Alternative 4 are the same as listed for Alternative 2 (Section 4.11.4.4). The present actions will consist of up to six deep penetration seismic surveys in the Beaufort Sea and up to five seismic surveys in the Chukchi Sea. This alternative also allows for up to five site clearance and high resolution shallow hazards surveys in Beaufort and five of these surveys in the Chukchi. Up to four drilling programs in each of the Beaufort and Chukchi seas and one on-ice seismic survey would be permitted in the Beaufort Sea only.

4.11.6.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.6.4.4 Contribution of Alternative to Cumulative Effects

This alternative permits the highest level of activity of all alternatives. The possibility of up to six deep-penetration seismic surveys and five site clearance and high resolution shallow hazards surveys with inclusion of two potential drilling operations in the Beaufort Sea open water season produces substantial total disturbance zone areas. Marine mammals could have difficulty navigating between the disturbance zones surrounding each of the surveys and drill operations if these activities were performed concurrently. The concurrent operation of multiple noise sources could lead to confusion by marine mammals at choosing a path to avoid regions of high noise. If cumulative SEL criteria for auditory system injury were considered, the total effects of exposures to multiple operations could be greater than from individual activities. The large number of deep penetration seismic surveys would be the primary source of higher cumulative exposures.

Cumulative effects in the Chukchi Sea would be fewer than in the Beaufort Sea because the surveys will have greater spatial separation and marine mammal migration corridors there are less concentrated. There would consequently be more opportunity for migrating marine mammals to choose paths between the surveys and drilling locations to avoid passing close to individual operations where noise levels are highest.

In response to public comments, NMFS conducted a first-order cumulative and chronic assessment of oil and gas activities in the Arctic. Section 4.5.2.4.9 and Appendix F outline the results and limitations of this study. Broadly, results suggest that with the predicted activity levels in Alternative 4, substantial losses of listening area (up to 98%) and bowhead communication space (up to 28%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October, with notable, but lesser, losses also occurring around the lease areas in the Chukchi (up to 72% at shallower depths). As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data is lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation.

4.11.6.4.5 Conclusion

Cumulative effects from noise exposures to marine mammals under Alternative 4 are similar but slightly larger than the effects described for Alternative 3 due to the greater number of noise-generating activities that would be permitted. The ability of marine mammals to avoid close approaches to seismic survey sources would be reduced when many sources were concurrently in operation with limited spatial separation.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.6.5 Water Quality

4.11.6.5.1 Summary of Direct and Indirect Effects

Impacts to water quality from Alternative 4 would be the same in nature as those described for Alternative 2 in Section 4.11.4.5. The only difference between the two alternatives is the level of activity. Alternative 4 would allow additional surveys and exploratory drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impacts may effectively be doubled. Relative to Alternative 2, water quality parameters may be affected over larger areas and over longer periods of time. However, the effects of Alternative 4 on water quality would be low intensity, temporary, and local to areas in the immediate vicinity of the activities. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 4 on water quality are expected to be minor.

4.11.6.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.6.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.6.5.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 4, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.6.5.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on water quality in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.6.6 Environmental Contaminants and Ecosystem Functions

4.11.6.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 4 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area. While the geographic extent of such impacts would potentially be greater than that resulting from Alternative 3, the overall geographic extent of impacts to regulation functions would be limited. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 4, while the effects of Alternative 4 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall effects of Alternative 4 on ecosystem functions would be minor.

4.11.6.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.6.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.6.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause local minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 4, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. Relative to Alternative 3, these interactions would potentially be distributed over a greater geographic area. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial over the lifespan of this EIS.

4.11.6.6.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.6.7 Lower Trophic Levels

4.11.6.7.1 Summary of Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased levels of activity. The impacts discussed in Section 4.11.4.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to lower trophic levels. The conclusions for Alternative 2 are applicable to Alternative 4; therefore, the overall impact to lower trophic levels would be negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.11.6.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.6.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.6.7.4 Contribution of Alternative to Cumulative Effects

Alternative 4 would have the same types of effects as Alternative 3 but the increased level of exploration drilling activities under Alternative 4 would add incrementally to its contribution to cumulative effects on lower trophic levels. However, the conclusions about Alternative 4 would be similar to Alternative 3 discussed in Section 4.11.5.7. In the absence of a VLOS, the exploration activities authorized under Alternative 4 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

4.11.6.7.5 Conclusion

Alternative 4 could have a negligible contribution to cumulative effects on lower trophic organisms. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.6.8 Fish and Essential Fish Habitat

4.11.6.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 4 on Fish Resources and EFH would be minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in the overall impact level, due to the small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 4.

The direct and indirect effects on marine fish resulting from Alternative 4 would be similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 2. Demersal assemblages, on the other hand, would feel the additional effects from the increase in seismic survey levels and exploratory drilling, both in terms of habitat loss and the effects from noise. Pelagic assemblages would be impacted by the increase in surveys but less so by the increased drilling programs. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain the same given the limited area affected compared to the distribution of fish populations.

The direct and indirect effects on migratory fish resulting from Alternative 4 would be similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 3, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 3, those anadromous species known to inhabit the area where project activities would occur are not very abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same.

The direct and indirect effects on essential fish habitat resulting from Alternative 4 would be very similar to those described under Alternative 2.The increase in exploratory drilling programs would result in increased habitat loss and alteration, potentially to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 4 is small and only incrementally larger than for Alternative 3. Most impacts would be of low intensity and of small geographic extent.

4.11.6.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.6.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.6.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have measurable effects on fish and EFH within the EIS project area, and those effects may be beneficial or detrimental. As discussed in Section 4.11.4.8.3, ocean acidification could have a variety of negative effects on fish and fish habitat. Climate change could also make it easier for non-native invasive species to take hold in the Arctic. Warming waters and decreases in ice cover could later predator and prey distributions and concentrations, thereby impacting fish. On the other hand, as Arctic waters warm, productivity could increase, thereby creating more favorable fish habitat throughout the region. The contribution of the activities associated with this alternative to cumulative effects on fish and EFH would be minor.

4.11.6.8.5 Conclusion

Direct and indirect impacts resulting from Alternative 4 on fish and EFH would be of such low intensity and of such small geographic extent that the effects would be considered minor. The incremental contribution of activities associated with Alternative 4 to cumulative effects on fish would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.6.9 Marine and Coastal Birds

4.11.6.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, local, of medium intensity, affect important or unique resources. In summary, the impact of Alternative 4 on marine and coastal birds would be considered moderate.

4.11.6.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.6.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.6.9.4 Contribution of Alternative to Cumulative Effects

Alternative 4 would have the same types of effects as Alternative 2 but the increased level of exploration activities under Alternative 4 would add incrementally to its contribution to cumulative effects on marine and coastal birds. The exploration activities authorized under Alternative 4 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.6.9.5 Conclusion

The direct and indirect effects of Alternative 4 on marine and coastal birds would be considered moderate. Alternative 4 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds, as discussed under Alternative 2 (Section 4.11.4.9).

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.6.10 Marine Mammals

4.11.6.10.1 Bowhead Whales

4.11.6.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on bowhead whales are described in Section 4.7.2.4.1 and are summarized here. Impacts of individual activities associated with oil and gas exploration in the EIS project area under Alternative 4 are similar to Alternative 3. Despite a substantial increase in level of activity over Alternative 2, the overall impact level would be the same (See Section 4.11.4.10.1).

In terms of the impact criteria identified in Table 4.5-18, most effects of individual exploratory activities authorized under Alternative 4 are of medium intensity and temporary in duration. Potential long-term effects from repeated disturbance over time or over a broad geographic range are unknown. Individually, the various activities may elicit local effects on bowhead whales, yet the area and extent of the population over which effects would be felt would increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Since the EIS project area extends across most of the migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales. Bowhead whales are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik of the Arctic coast, which places them in the context of being a unique resource. Evaluated collectively, and with consideration given to reduced adverse impacts through the imposition of the required standard mitigation measures, the overall effect of activities authorized under Alternative 4 on bowhead whales is likely to be moderate to major.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order cumulative and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments. Broadly, results suggest that for Alternative 4, substantial losses of listening area (up to 98%) and bowhead communication space (up to 28%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October, with notable, but lesser, losses of listening area also occurring around the lease areas in the Chukchi (up to 72% at shallower depths). As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data is lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation, especially, perhaps for bowhead whales, which are migrating through with calves where communication is important to retain group cohesion.

4.11.6.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.6.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.6.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 4, when combined with the past, present, and reasonably foreseeable future actions would be moderate, with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.11.6.10.1.5 Conclusion

Under Alternative 4, the direct and indirect effects to bowhead whales would be moderate to major. Overall, Alternative 4 would have a moderate contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

4.11.6.10.2 Beluga Whales

4.11.6.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on beluga whales are described in Section 4.7.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 4 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The direct and indirect effects on beluga whales from the exploration activities under Alternative 4 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 4 on beluga whales would be considered moderate.

4.11.6.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.6.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.6.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 4 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level.

Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 4 would therefore have minor to moderate additive contributions to the cumulative effects on beluga whales.

4.11.6.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 4 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.6.10.3 Other Cetaceans

4.11.6.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on cetaceans are described in Section 4.7.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 4 on other cetaceans is minor to moderate. Despite a doubling in the level of exploratory drilling activity over Alternative 3, there would be no corresponding increase in impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 4, impacts on the resource would be low in intensity, of short duration, and limited extent. Long-term impacts are unknown, but anticipated to be minor.

The primary direct and indirect effects on other cetaceans would result from noise exposure. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs.

Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

4.11.6.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.6.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.6.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 4 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible. Despite a doubling in the level of exploratory drilling activity over Alternative 3, there would be no corresponding increase in impact level.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 4 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.6.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 4 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.3).

4.11.6.10.4 Ice Seals

4.11.6.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called “ice seals”; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 4 on ice seals are described in Section 4.7.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 4 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 4 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 3 would therefore be considered minor to moderate for all ice seal species according to the criteria established in Section 4.1.3.

4.11.6.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.6.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.6.10.4.4 Contribution of Alternative 4 to Cumulative Effects

The exploration activities authorized under Alternative 4 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 4 would therefore have minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.6.10.4.5 Conclusion

The direct and indirect effects of Alternative 4 on pinnipeds would be considered minor to moderate. Alternative 4 would have minor contributions to the cumulative effects on the four species of ice seals.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.6.10.5 Walruses

4.11.6.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on walruses are described in Section 4.7.2.4.5 and are summarized here. Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walrus' reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 4, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim to long term in duration. The effects of Alternative 4 on walruses would therefore be considered moderate.

4.11.6.10.5.2 Past and Present Actions

Past and present actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.6.10.5.3 Reasonably Foreseeable Future Actions

Past and present actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.6.10.5.4 Contribution of Alternative 4 to Cumulative Effects

The exploration activities authorized under Alternative 4 would add to the disturbance of walruses from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walruses, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 4 would therefore have negligible to minor contributions to the cumulative effects on walruses.

4.11.6.10.5.5 Conclusion

The direct and indirect effects of Alternative 4 on walruses would be considered moderate. Alternative 4 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with walruses were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.6.10.6 Polar Bears

4.11.6.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on polar bears are described in Section 4.7.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative **4** as for Alternative **3.** The primary difference for polar bears would be an incremental increase in disturbance from vessel and air traffic and an incremental increase in risk of habitat contamination**.** Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative 4, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 3 on polar bears would therefore be considered minor.

4.11.6.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.6.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.6.10.6.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 4 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 4 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.6.10.6.5 Conclusion

The direct and indirect effects of Alternative 4 on polar bears would be considered minor. Alternative 4 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.6.11 Terrestrial Mammals

4.11.6.11.1 Summary of Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased level of exploratory drilling activity (a total of four programs in each sea instead of two programs in each sea). The impacts discussed for Alternative 3 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to terrestrial mammals. The conclusions for Alternative 3 are applicable to Alternative 4; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to terrestrial mammals from aircraft activity would be minor.

4.11.6.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.6.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.6.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.6.11.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on caribou would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.6.13 Socioeconomics

4.11.6.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 4 are similar to those described in Alternative 3. Alternative 4 represents an increased level of oil and gas exploration therefore there would be an increased level of local revenue generated in staging communities; direct and indirect employment opportunities for regional and village corporations that procure service contracts. As with other action alternatives, there could be negative impacts to institutions and social services in the staging communities. The magnitude of the socioeconomic impact is positive but still low because total personal income, local employment rates, and borough revenues would also not increased by more than five percent.

Direct employment opportunities associated with the standard mitigation measures could increase or stay the same as Alternative 3 due to their duplicative nature. Also similar to Alternative 3, socioeconomic impacts would be interim in duration. The geographic extent of socioeconomic impacts would be local, statewide, and even national. The context of the socioeconomic impacts would be unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat (minority) communities. The summary impact level for Socioeconomics under Alternative 4 is moderate.

4.11.6.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.6.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 3 would result in future oil and gas production.

4.11.6.13.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would have a minor contribution to cumulative effects on socioeconomic resources because employment rates and state and regional revenues are expected to remain stable. They differ from Alternative 3 by a higher magnitude of direct employment and generation of local revenue, but with a potential increase in negative impacts on local institutions. At a local level, the new direct employment, public revenue generation, and impact to social institutions would be experienced by Iñupiat (minority) communities.

4.11.6.13.5 Conclusion

The direct and indirect effects of Alternative 4 would be moderate. The contribution to cumulative effects of socioeconomics would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics would be major and are discussed under Alternative 2 (Section 4.11.4.13).

4.11.6.14 Subsistence

4.11.6.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 4 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales, bearded and ringed seals and polar bears are considered unique in context as these resources are protected by legislation (e.g., MMPA, ESA) or are considered an important subsistence resource (beluga whales). Even with the increase in the number of activities/programs that could potentially occur under Alternative 4, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity, and comparable duration, but occurring in more locations. Therefore the summary impact level of Alternative 4 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.7.3.2).

4.11.6.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.6.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.6.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 4 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, local to regional in extent, temporary to interim in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 4 would occur at a higher level of activity in comparison to those proposed under Alternative 3. The contribution of Alternative 4 would have a negligible to moderate contribution to the cumulative effects on subsistence resources.

4.11.6.14.5 Conclusion

Under Alternative 4, the direct and indirect effects to subsistence resources as a result of the increased levels of activity associated with this alternative are considered low in intensity, temporary in duration, local to regional in extent and affect subsistence resources that range from common to unique in context. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.6.15 Public Health

4.11.6.15.1 Summary of Direct and Indirect Effects

As described in Section 4.7.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 4 are expected to be similar to those expected under Alternative 2.

4.11.6.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.6.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.6.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 4 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.6.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 4 would contribute to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts as well as acting as the gateway for additional future offshore oil and gas development. The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.6.16 Cultural Resources

4.11.6.16.1 Summary of Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased level of exploratory drilling activity, with two additional programs in each sea per season. The impacts discussed for Alternative 3 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to cultural resources. The conclusions for Alternative 3 are applicable to Alternative 4; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to cultural resources from increased levels of activity would be negligible.

4.11.6.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.6.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.6.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.6.16.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on cultural resources would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with cultural resources were discussed under Alternative 2 (Section 4.11.4.16).

4.11.6.17 Land and Water Ownership, Use, Management

4.11.6.17.1 Summary of Direct and Indirect Effects

The cumulative effects for Alternative 4 would be similar to Alternative 2, discussed in Section 4.5.3.5. There would be no direct or indirect impacts on land and water ownership. The direct and indirect impacts on land and water use would have a high magnitude, be temporary or interim in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, interim in nature, local, and common. In summary, the impacts of Alternative 4 on land and water ownership, use, and management would be none, moderate, and negligible, respectively.

4.11.6.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.11.3.

4.11.6.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.11.3.

4.11.6.17.4 Contribution of Alternative to Cumulative Effects

Alternative 4 is the same as Alternative 2 except with increased levels of activity. The cumulative effects discussed in Section 4.11.4.17 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to land or water ownership, use, and management. .4The conclusions for Alternative 2 are applicable to Alternative 4; changes would be negligible, temporary in duration, and geographically dispersed, and thus would have negligible effects creating cumulative impacts on land ownership, use, or management and would be considered minor.

4.11.5.17.5 Conclusion

Under Alternative 4, the levels of direct, indirect and cumulative impacts for land and water ownership, use, and management are negligible, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 4 is considered minor. The contribution of Alternative 4 to cumulative effects would be considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management were discussed under Alternative 2 (Section 4.11.4.17).

4.11.6.18 Transportation

4.11.6.18.1 Summary of Direct and Indirect Effects

Increased levels of marine vessel traffic in Alternative 4 associated with the seismic survey and exploratory drilling programs would be expected to primarily occur in offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when lightering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence would be low in intensity, interim in duration, limited in geographic extent to a local to regional area, and common in context. The summary impact from increases in vessel traffic would be considered minor.

4.11.6.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.6.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.6.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 4 would be similar but of slightly higher intensity than described for Alternative 2 in Section 4.11.4.18.

4.11.6.18.5 Conclusion

The direct and indirect effects of Alternative 4 would be minor for transportation, with a minor contribution to cumulative impacts if Alternative 4 overlaps with another large-scale development project.

A VLOS in the Beaufort or Chukchi seas would have moderate additive cumulative effects to transportation, similar to Alternative 2 (Section 4.11.4.18).

4.11.6.19 Recreation and Tourism

4.11.6.19.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.3.7, the direct impacts on recreation and tourism would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 4 on recreation and tourism would be minor.

4.11.6.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.6.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.6.19.4 Contribution of Alternative to Cumulative Effects

Alternative 4 is the same as Alternative 3 except with increased levels of exploratory drilling activity. The cumulative effects discussed in Section 4.11.4.19 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 4; the contribution of Alternative 4 to cumulative effects to recreation and tourism would be minor.

4.11.6.19.5 Conclusion

Alternative 4 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.6.20 Visual Resources

4.11.6.20.1 Summary of Direct and Indirect Effects

Implementation of Alternative 4 would be similar to that describe in Section 4.10.4.20, however there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in interim moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 4, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, local and occur in an important context.

Standard mitigation measures implemented as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Although Category D Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in the culturally important activity of bowhead whaling) to vessel-based surveys during certain periods. However it would not change exposure to drill sites, as these structures would remain in place during shutdown periods unless the operator agrees to move off location during such shutdown periods.

4.11.6.20.2 Past and Present Actions

Past and present actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.6.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.6.20.4 Contribution of Alternative to Cumulative Effects

Implementation of Alternative 4 would increase the level of permitted activity (i.e., four versus two exploratory drilling programs per sea each year). Actions could occur at any location within the EIS project area; however, like Alternative 3, actions associated with implementation of Alternative 4 would result in the greatest impact to visual resources if sited in near-shore areas between Harrison Bay and Kaktovik, where the majority of past, present, and reasonably foreseeable future actions are located. The location would also coincide with locations of viewers, such as residents of native communities or recreational visitors using the ANWR. If actions associated with Alternative 4 are concentrated in areas where the majority of past, present, and reasonably foreseeable future actions are located, Alternative 4 would contribute to the industrialized landscape character of the area. Transient views of seismic and shallow hazard survey vessels are not expected to contribute to the industrial character of the area, as views of vessels would be episodic.

4.11.6.20.5 Conclusion

Past, present, and reasonably foreseeable future actions could result in strong visual contrast that collectively could contribute to the industrial landscape character of the state waters of the Beaufort Sea. Under Alternative 4, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, interim, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.6.21 Environmental Justice

4.11.6.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 4 would be minor, similar to those described in Alternative 2. The level of activity associated with Alternative 4 is greater than Alternative 2, but the effects do not change the summary impact level for these environmental justice indicators.

4.11.6.21.2 Past and Present Actions

Past and present actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).

4.11.6.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.11.6.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 4 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 4 to environmental justice indicator cumulative effects would be minor.

4.11.6.21.5 Conclusion

The direct and indirect effects of Alternative 4 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a minor impact to Alaska Native (minority) communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20). A VLOS would have disproportionate adverse impacts to Alaska Native (minority) communities in the EIS project area.

4.11.7 Alternative 5 – Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures

4.11.7.1 Physical Oceanography

4.11.7.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 5 on physical ocean resources would be substantially the same as those described for Alternative 4. The required time/area closures in Alternative 5 would not substantially change the effects of the alternative on physical ocean resources in the EIS project area. The effects of Alternative 5 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The direct and indirect effects of Alternative 5 on physical ocean resources in the proposed action area would be minor.

4.11.7.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.7.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.7.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 5 would cause local minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 5, such as the construction of man-made gravel islands, would interact with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, resulting in a minor contribution to cumulative impacts.

4.11.7.1.5 Conclusion

The direct and indirect effects of Alternative 5 on physical ocean resources in the EIS project area would be minor. The incremental contribution of activities associated with Alternative 5 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.7.2 Climate and Meteorology

4.11.7.2.1 Summary of Direct and Indirect Effects

Alternative 5 involves the same exploration activities as proposed in Alternative 4, except with the inclusion of time/area closures. Assuming that the same level of activity would occur and work around time/area closures, the estimated amount of GHG emissions associated with Alternative 5 are the same as those for Alternative 4. Therefore the impact levels are expected to be the same as Alternative 4, which are minor direct impacts and minor to moderate indirect impacts.

4.11.7.2.2 Past and Present Actions

Past and present actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.7.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.7.2.4 Contribution of Alternative to Cumulative Effects

Alternative 5 would emit approximately the same amount of GHGs as Alternative 4; therefore its direct impacts would contribute more to cumulative climate change impacts than Alternative 2. As with Alternatives 2 and 3, the indirect effects from Alternative 5 would contribute more to cumulative impacts than the direct effects. The magnitude of indirect effects cannot be quantified and is considered to be the same as for Alternatives 2 and 3. Indirect effects from Alternative 5 are expected to result in changes that could be long-term and could affect unique resources.

4.11.7.2.5 Conclusion

Alternative 5 could contribute to a moderate to major cumulative impact to climate change, to the same as Alternative 4.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.7.3 Air Quality

4.11.7.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 5, Level 3 Exploration Activity, are expected to be the same as those for Alternative 4. The overall direct effect on air quality is expected to be moderate, and indirect effects would be moderate.

4.11.7.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.7.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.7.3.4 Contribution of Alternative to Cumulative Effects

The potential cumulative effects on air quality for Alternative 5 are the same as those for Alternative 4. These are expected to be moderate, with worst-case effect being less than additive.

4.11.7.3.5 Conclusion

Alternative 5 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.7.4 Acoustics

4.11.7.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 5.

4.11.7.4.2 Past and Present Actions

Past and present actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.7.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4. The inclusion of time/area closures may cause greater seismic survey activity levels during non-closure times unless scheduling of individual activities can be performed as part of the closure decisions.

4.11.7.4.4 Contribution of Alternative to Cumulative Effects

The contributions to cumulative effects for Alternative 5 should be substantially less than from Alternative 4 if the closures were scheduled to avoid peak marine mammal migration times. This approach should work relatively well to avoid bowhead migrations that are low in the Beaufort Sea EIS project area prior to mid-September. The number of individual exposures, and hence the total exposures will be reduced. However, the shorter available working season is likely to lead to increased activity during the open periods. Animals that are present during those open periods may have higher activity levels to contend with than if closures were not implemented. Those animals may therefore be exposed to higher sound levels and possibly injurious levels. While the total number of disturbance exposures should decrease, there could be higher chance of injurious exposures for marine mammals present during non-closed periods due to reduced ability to avoid close approaches with seismic survey sources.

4.11.7.4.5 Conclusion

Use of closures as proposed in Alternative 5 should be effective for reducing total exposures to sound levels that could disturb marine mammals. Implementing closures may however lead to compressed periods of higher activity during the reduced open periods. Animals present during those open periods could be exposed to high noise levels that could lead to injuries. Scheduling of individual activities might be considered as part of the closure scheduling to mitigate this possible outcome.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.7.5 Water Quality

4.11.7.5.1 Summary of Direct and Indirect Effects

Impacts to water quality from Alternative 5 are expected to be very similar to those described above for Alternative 4. The only difference between Alternative 4 and Alternative 5 is the addition of required time/area closures. The level of activity would be the same for Alternatives 4 and 5, but the times and locations of the activity could be different. Time/area closures established under Alternative 5 as additional mitigation measures could reduce the likelihood of adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality are expected to be low intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1. The overall effects of Alternative 5 on water quality are expected to be minor.

4.11.7.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.7.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.7.5.4 Contribution of Alternative to Cumulative Effects

Additional time/area closures would reduce the potential for incremental degradation of water quality in sensitive areas. Actions associated with Alternative 5 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 5, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.7.5.5 Conclusion

The incremental contribution of activities associated with Alternative 5 to cumulative effects on water quality in the EIS project area would be minor. The additional time/area closures required under Alternative 5 would reduce the potential for cumulative adverse water quality impacts to occur in sensitive areas.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.7.6 Environmental Contaminants and Ecosystem Functions

4.11.7.6.1 Summary of Direct and Indirect Effects

Additional mitigation measures related to time/area closures under Alternative 5 would potentially result in decreased impacts to environmental contaminants and ecosystem functions relative to Alternative 4. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times and therefore have the potential to reduce adverse impacts to all categories of ecosystem functions.

Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected over a limited geographic extent within the EIS project area. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. However, time/area closures associated with Alternative 5 would limit the potential for adverse impacts to certain important habitats. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 5, while the effects of Alternative 4 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 5 would be medium-intensity, temporary, and local. Overall effects of Alternative 5 on environmental contaminants and ecosystem functions would be minor.

4.11.7.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.7.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.7.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 5 would cause local minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 5, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial. Time/area closures associated with Alternative 5 would limit the potential for aggregation of adverse impacts to occur in sensitive areas.

4.11.7.6.5 Conclusion

The incremental contribution of activities associated with Alternative 5 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor. The additional time/area closures required under Alternative 5 would reduce the potential for cumulative adverse impacts to all categories of environmental contaminants and ecosystem functions in sensitive areas.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.7.7 Lower Trophic Levels

4.11.7.7.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4, with the addition of time/area closures for certain areas. These mitigated closures would not measurably affect lower trophic levels in the EIS project area, so the impacts discussed for Alternative 4 are the same for Alternative 5, therefore, the overall impact to lower trophic levels would be negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.11.7.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.7.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.7.7.4 Contribution of Alternative to Cumulative Effects

Alternative 5 would have the same types of effects as Alternative 2 with the addition of certain time/area closures. Therefore, the conclusions about Alternative 5 would be similar to Alternative 2 discussed in Section 4.11.4.7. In the absence of a VLOS, the exploration activities authorized under Alternative 4 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

4.11.6.7.5 Conclusion

Alternative 5 could have a negligible contribution to cumulative effects on lower trophic organisms. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.7.8 Fish and Essential Fish Habitat

4.11.7.8.1 Summary of Direct and Indirect Effects

The effect of the time/area closures outlined in Alternative 5 on fish resources and EFH are difficult to determine with any certainty but are not anticipated to reduce in the overall impact. These closures would not change the total noise emitted or habitat lost/altered, though they could lessen the effects of exploration activities on fish resources by reducing the total number of fish exposed to potentially deleterious sound levels. These closures would generally be less effective at reducing adverse effects on fish and fish resources than they would be at protecting marine mammals or subsistence hunting. The temporal offset of activity within these areas is unlikely to result in any discernable reduction in overall impact levels. Therefore, the exploration activities authorized under Alternative 5 would result in minor impacts to fish and fish resources.

4.11.7.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.7.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.7.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have measurable effects on fish and EFH within the EIS project area, and those effects may be beneficial or detrimental. As discussed in Section 4.11.4.8.3, ocean acidification could have a variety of negative effects on fish and fish habitat. Climate change could also make it easier for non-native invasive species to take hold in the Arctic. Warming waters and decreases in ice cover could alter predator and prey distributions and concentrations, thereby impacting fish. On the other hand, as Arctic waters warm, productivity could increase, thereby creating more favorable fish habitat throughout the region. The contribution of the activities associated with this alternative to cumulative effects on fish and EFH would be minor.

4.11.7.8.5 Conclusion

Direct and indirect effects associated with Alternative 5 on fish and EFH would be minor. The overall contribution of Alternative 5 to cumulative effects on fish and EFH would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.7.9 Marine and Coastal Birds

4.11.7.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.7.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, local, of medium intensity, affect important or unique resources. In summary, the impact of Alternative 5 on marine and coastal birds would be considered moderate.

4.11.7.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.7.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.7.9.4 Contribution of Alternative to Cumulative Effects

Alternative 5 would have the same types and level of exploration activities as Alternative 4 with the addition of certain time/area closures. The most important of these closure areas for birds, Ledyard Bay, would be the same as exists under Alternative 4 due to USFWS requirements to protect spectacled eiders. The other closure areas would be important to certain species, such as Barrow Canyon for Ross's gull in the fall, but these closures would generally be less effective at reducing adverse effects on birds as they would be to protect marine mammals or subsistence hunting. The effects of Alternative 5 would therefore be essentially the same as for Alternative 4. The exploration activities authorized under Alternative 5 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.7.9.5 Conclusion

Direct and indirect effects associated with Alternative 5 on marine and coastal birds would be moderate. The overall contribution of Alternative 5 to cumulative effects on marine and coastal birds would be moderate.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.7.10 Marine Mammals

4.11.7.10.1 Bowhead Whales

4.11.7.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on bowhead whales are described in Section 4.8.2.4.1. Impacts of activities associated with oil and gas exploration in the EIS project area under Alternative 5 are similar to Alternative 4 (See Section 4.11.6.10.1).

Effects of disturbance on bowhead whales would be reduced in the closure areas during time periods specified in Alternative 5. Overall exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas. Time/Area closures that mitigate adverse impacts on concentrations of bowhead whales, mothers and calves, and important life history functions, such as feeding, could reduce impacts to a lower intensity, shorter duration and more local areas than would result in the absence of closures. However, bowhead whale habitat use in the EIS project area is dynamic and includes large portions of the Beaufort and Chukchi seas not included in the Time/Area closures. Although the Time/Area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on bowhead whales of oil and gas exploration activities allowed under this alternative would be considered moderate.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order cumulative and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments. Broadly, results suggest that for Alternative 5, substantial losses of listening area (up to 98%) and bowhead communication space (up to 28%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October, with notable, but lesser, losses of listening area also occurring around the lease areas in the Chukchi (up to 72% at shallower depths). As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data are lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation, especially, perhaps for bowhead whales, which are migrating through with calves where communication is important to retain group cohesion. However, the implementation of these time/area closures could create some level of reduced effect on acoustic habitat in an area/time where interspecies communication and interpretation of acoustic cues may be of increased importance (i.e., for feeding), although, when compared to the overall level of effects outside these areas, the level of effects on bowhead whale habitat from Alternative 5 could be slightly less, but not substantially different than those discussed for Alternative 4

4.11.7.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.7.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.1.

4.11.7.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 5, when combined with the past, present, and reasonably foreseeable future actions would be similar to Alternative 4 (Section 4.11.6.10.1), with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales. The time/area closures required under this alternative would mitigate potential adverse impacts during the specified times and within the specified locations. However, bowhead whales are not restricted to these specified areas and may be exposed to impacts by exploration activities operating outside of these closure areas. Because the closures would alleviate, but not eliminate, impacts, the contribution of activities authorized under Alternative 5 to cumulative effects on bowhead whales would be minor.

4.11.7.10.1.5 Conclusion

Under Alternative 5, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 5 would have a minor contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

<u>4.11.7.10.2 Beluga Whales</u>

4.11.7.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on beluga whales are described in Section 4.8.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 5 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The time/area closures would reduce the effects of disturbance on beluga whales in the closed areas during the time periods specified. The closures of Kasegaluk Lagoon, Ledyard Bay, and the Shelf Break of the Beaufort Sea would be especially beneficial to beluga whales. Exploration activities could, however, occur during different time periods within these areas. In addition, industry may relocate exploration activities to other, possibly adjacent, areas until the closure areas are available. Overall, exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas. Time/area closures that mitigate adverse impacts on concentrations of beluga whales could reduce impacts to a lower intensity, shorter duration and more local areas than would result in the absence of closures. However, beluga whale habitat use in the EIS project area is dynamic and widespread. Considering the migration corridors, it includes large portions of the Beaufort and Chukchi seas not included in the time/area closures that could coincide with oil and gas exploration activities throughout the region. Although the time/area closures specified in Alternative 5 could reduce or avoid adverse impacts in particular times and locations, the overall impact of Alternative 5 on beluga whales would be considered minor to moderate.

4.11.7.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.7.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.7.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 5 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 5 would therefore have moderate additive contributions to the cumulative effects on beluga whales.

4.11.7.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 5 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.7.10.3 Other Cetaceans

4.11.7.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on cetaceans are described in Section 4.8.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 4 on other cetaceans is minor to moderate. Although the time/area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 5, impacts on the resource would be low in intensity, of short duration, and limited extent. Long-term impacts are unknown, but anticipated to be minor.

Effects on other cetaceans from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 5. Exploration activities could, however, occur during different time periods within these areas, leading to a short-term reduction of effects. In addition, industry may relocate exploration activities to other, possibly adjacent, areas until the closure areas are available. Overall exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas. Time/Area closures that mitigate adverse impacts on concentrations of cetaceans within the closures, mothers and calves, and important life history functions, such as feeding, could reduce impacts to a lower intensity, shorter duration and more local areas than would result in the absence of closures. However, cetacean habitat use in the EIS project area is dynamic and, when migration corridors are considered, includes large portions of the Beaufort and Chukchi seas not included in the time/area closures that could coincide with oil and gas exploration activities throughout the region. These measures are most likely to impact gray whales and less likely to impact the remaining cetaceans in the resource group, due to species distribution.

4.11.7.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.7.10.3.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.7.10.3.3 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 5 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Although the time/area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 5 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.7.10.3.4 Conclusion

As stated above, most exploration activities authorized under Alternative 5 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.3).

4.11.7.10.4 Ice Seals

4.11.7.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called "ice seals"; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 5 on ice seals are described in Section 4.8.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 5 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 5 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 4 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.11.7.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.7.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.7.10.4.4 Contribution of Alternative 5 to Cumulative Effects

The exploration activities authorized under Alternative 5 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under

Alternative 5 would therefore have negligible to minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.7.10.4.5 Conclusion

The direct and indirect effects of Alternative 5 on pinnipeds would be considered minor. Alternative 5 would have negligible to minor contributions to the cumulative effects on the four species of ice seals.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.7.10.5 Walruses

4.11.7.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on walruses are described in Section 4.8.2.4.5 and are summarized here. The types and levels of effects on walruses are essentially the same under Alternative 5 as for Alternative 4 (Section 4.7.2.4.5). The primary difference for walruses would be a change in the timing of vessel traffic and impacts on benthic habitat in the Hanna Shoal area, which would be subject to a closure period in the fall. The closure period would reduce the potential for disturbance of walruses by vessels in that time period but would not change overall exploration efforts so the potential for disturbance in the Chukchi Sea would be similar to Alternative 4. Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. The gradual introduction of alternative technologies for seismic surveys would make very little difference to walruses because they are unlikely to be affected in any biologically meaningful way by seismic noise. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walrus' reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of mortality from stampedes. Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 5, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim to long term in duration. The effects of Alternative 5 on walruses would therefore be considered moderate.

4.11.7.10.5.2 Past and Present Actions

Past and present actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.7.10.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.7.10.5.4 Contribution of Alternative 5 to Cumulative Effects

The exploration activities authorized under Alternative 5 would add to the disturbance of walruses from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walruses, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 5 would therefore have minor to negligible contributions to the cumulative effects on walruses.

4.11.7.10.5.5 Conclusion

The direct and indirect effects of Alternative 5 on walruses would be considered moderate. Alternative 5 would have negligible to minor contributions to the cumulative effects on walruses.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with walruses were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.7.10.6 Polar Bears

4.11.7.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on polar bears are described in Section 4.8.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative 5 as for Alternative 4 (Section 4.7.2.4.6). The time/area closure periods specified in Alternative 5 involve open-water environments where bears are rare so the potential for disturbance and other effects in the Arctic seas would be essentially the same as under Alternative 4. Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative 5, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 5 on polar bears would therefore be considered minor.

4.11.7.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.7.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.7.10.6.4 Contribution of Alternative 5 to Cumulative Effects

The exploration activities authorized under Alternative 5 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 5 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.7.10.6.5 Conclusion

The direct and indirect effects of Alternative 5 on polar bears would be considered minor. Alternative 5 would have negligible to minor contributions to the cumulative effects on polar bears.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.7.11 Terrestrial Mammals

4.11.7.11.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4, with the added requirement for time/area closures for certain areas. These required closures under Alternative 5 do not affect terrestrial mammals in the EIS project area, so the impacts discussed for Alternative 4 are the same for Alternative 5; the summary level direct and indirect impact to terrestrial mammals would be minor.

4.11.7.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.7.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.7.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.7.11.5 Conclusion

Direct and indirect impacts resulting from Alternative 5 on caribou would be minor. The incremental contribution of activities associated with Alternative 5 to cumulative effects on caribou would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.7.13 Socioeconomics

4.11.7.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 5 are moderate, similar to those described for Alternative 2. To the extent that time/area closures in all closure areas provide additional benefits to marine mammals and reduce net impacts on subsistence activities, there would be less impacts to the non-cash economy than under Alternative 2. Time/area closures may result in productivity costs to lease holders and reduced personal income for local hires in PSO and Com Center positions due to reductions in the duration of these positions.

4.11.7.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.7.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.7.13.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would have a minor contribution to cumulative effects on socioeconomic resources because employment rates and state and regional revenues are expected to remain stable. They differ from Alternative 2 by a lower magnitude of lost productivity for lease holders and loss in magnitude in the new local personal income sources. The mitigation measures associated with Alternative 5 would have lower magnitude impacts to subsistence harvest at a local level, the new direct employment, public revenue generation, and impact to social institutions would be experienced by Iñupiat (minority) communities.

4.11.7.13.5 Conclusion

The direct and indirect effects of Alternative 5 would be moderate. The contribution to cumulative effects of socioeconomics would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics would be major and are discussed under Alternative 2 (Section 4.11.4.13).

4.11.7.14 Subsistence

4.11.7.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 5 would be of low intensity, temporary to interim in duration, local in extent, and the context would be common to unique. Protected resources (bowhead whales, bearded and ringed seals and polar bears are considered unique in context as these resources are protected by legislation (e.g., MMPA, ESA) or are considered an important subsistence resource (beluga whales). The impacts of implementing Alternative 5 could be considered beneficial to subsistence harvests and users as the time and area closures would be applied in all circumstances instead of being considered as additional mitigation measures. Direct and indirect impacts to subsistence harvest and subsistence resources are likely to be similar or less than those of Alternative 2 as discussed in Section 4.5.3.2 and Section 4.11.4.14. The summary impact to subsistence is therefore considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance (Section 4.5.3.2 and Section 4.8.3.2).

4.11.7.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.7.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.7.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 5 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, local to regional in extent, temporary to interim in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 5 would occur at a higher level of activity in comparison to those proposed under Alternative 2 but the time and area closures that would be applied under this alternative in all circumstances are considered beneficial to subsistence harvests and users. The exploration activities authorized under Alternative 5 would have a negligible to minor contribution to the cumulative effects on subsistence resources. Implementation of Alternative 5 would be considered additive to cumulative effects on subsistence resources.

4.11.7.14.5 Conclusion

Under Alternative 5, the direct and indirect effects to subsistence resources are considered low in intensity, temporary to interim in duration, local in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 5 while beneficial in implementing time and area closures would be additive to cumulative effects on subsistence resources. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to minor on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.7.15 Public Health

4.11.7.15.1 Summary of Direct and Indirect Effects

As described in Section 4.8.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 5 are expected to be similar to those expected under Alternative 2. To the extent the time/area closures described for Alternative 5 improve the likelihood of maintaining a strong subsistence harvest, there would also be resulting benefits to public health. Similarly, insofar as time and area closures minimize dispersion of marine mammals and allow hunters to complete their hunts with less travel time, the potential impact to safety should be reduced. However, these benefits do not affect the overall impact criteria rating, as the anticipated results to public health are considered negligible.

4.11.7.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.7.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.7.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 5 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.7.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 5 would contribute to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts as well as acting as the gateway for additional future offshore oil and gas development.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.7.16 Cultural Resources

4.11.7.16.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4, with the added requirement for seasonal closures for certain areas. These required closures under Alternative 5 do not affect cultural resources in the EIS project area, so the impacts discussed for Alternative 4 are the same for Alternative 5; the overall impact to cultural resources would be negligible

4.11.7.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.7.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.7.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.7.16.5 Conclusion

The incremental contribution of activities associated with Alternative 5 to cumulative effects on cultural resources would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with cultural resources were discussed under Alternative 2 (Section 4.11.4.16).

4.11.7.17 Land and Water Ownership, Use, Management

4.11.7.17.1 Summary of Direct and Indirect Effects

The cumulative effects for Alternative 5 would be similar to Alternative 2, discussed in Section 4.5.3.5. There would be no direct or indirect impacts on land and water ownership. The direct and indirect impacts on land and water use would have a high magnitude, be temporary or interim in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, interim in nature, local, and common. In summary, the impacts of Alternative 5 on land and water ownership, use, and management would be none, moderate, and minor, respectively.

4.11.7.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.11.3.

4.11.7.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.11.3.

4.11.7.17.4 Contribution of Alternative to Cumulative Effects

Alternative 5 is the same as Alternative 2 except with increased levels of activity and some specific time/area closures for exploration activities in federal marine waters. The cumulative effects discussed in Section 4.11.4.17.4 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to land or water ownership, use, and management. The conclusions for Alternative 2 are applicable to Alternative 5; changes would be negligible, temporary in duration, and geographically dispersed, and thus would have negligible effects creating cumulative impacts on land ownership, use or management and would be considered minor.

4.11.7.17.5 Conclusion

Under Alternative 5, the levels of direct, indirect and cumulative impact on land and water ownership, use, and management are none, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 5 is considered minor. The contribution of Alternative 5 to cumulative effects would be considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management were discussed under Alternative 2 (Section 4.11.4.17).

4.11.7.18 Transportation

4.11.7.18.1 Summary of Direct and Indirect Effects

Impacts to transportation from Alternative 5 are expected to be very similar to those described above for Alternative 4. The only difference between Alternative 4 and Alternative 5 is the addition of required time/area closures. The level of activity would be the same for Alternatives 4 and 5, but the times and locations of the activity could be different. Any direct impact to regional marine transportation would be low in intensity, interim in duration, and limited in geographic extent to a local to regional area and common in context and considered minor.

4.11.7.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.7.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.7.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 4 would be similar as those described for Alternative 3 in Section 4.11.5.18.

4.11.7.18.5 Conclusion

The direct and indirect effects of Alternative 5 would be minor for transportation, with a minor contribution to cumulative impacts if Alternative 5 overlaps with another large-scale development project.

A VLOS in the Beaufort or Chukchi seas would have moderate additive cumulative effects to transportation, similar to Alternative 2 (Section 4.11.4.18).

4.11.7.19 Recreation and Tourism

4.11.7.19.1 Summary of Direct and Indirect Effects

The direct impacts would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 5 on recreation and tourism would be minor.

4.11.7.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.7.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.7.19.4 Contribution of Alternative to Cumulative Effects

To the extent that the required time/area closures contemplated in Alternative 5 provide benefit to marine mammals, they would be beneficial to tourism based on wildlife viewing, and similar to the benefits of other standard and additional mitigation measures. The potential cumulative effects discussed in Sections 4.11.4.19 and 4.11.5.19 for Alternatives 2 and 3 are the same for Alternative 5; the overall impact to recreation and tourism would be minor.

4.11.7.19.5 Conclusion

Alternative 5 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.7.20 Visual Resources

4.11.7.20.1 Summary of Direct and Indirect Effects

Direct and indirect effects of past and present actions are identical to those described in Section 4.11.6.20, Alternative 4.

4.11.7.20.2 Past and Present Actions

Past and present actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.7.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.7.20.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 5 to cumulative effects would be identical to that described for Alternative 4.

4.11.7.20.5 Conclusion

Past, present, and reasonably foreseeable future actions could result in strong visual contrast that collectively could contribute to the industrial landscape character of the state waters of the Beaufort Sea. Under Alternative 5, anticipated cumulative effects to visual resources are expected to be minor. Impacts would be of high intensity, interim, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.7.21 Environmental Justice

4.11.7.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 5 would be minor, similar to those described for Alternative 2. To the extent that time/area closures in all closure areas provide additional benefits to marine mammals and reduce net impacts on subsistence activities, the impacts to subsistence and public health would be lessened, however, these benefits to do not affect the summary impact level of minor.

4.11.7.21.2 Past and Present Actions

The past and present actions that would contribute to the cumulative effects of environmental justice under Alternative 5 are the same as those described for Alternative 1 in Section 4.11.3.21.

4.11.7.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions for Alternative 5 would be the same as those described for Alternative 2 in Section 4.11.4.21. Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.11.7.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 5 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 5 to environmental justice indicator cumulative effects would be minor.

4.11.7.21.5 Conclusion

The direct and indirect effects of Alternative 5 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a minor impact to Alaska Native communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental justice were discussed under Alternative 2 (Section 4.11.4.21). A VLOS would have disproportionate adverse impacts to Alaska Natives (minority population) living in the communities near the EIS project area.

4.11.8 Alternative 6 – Authorization for Level 3 Exploration Activity with Use of Alternative Technologies

4.11.8.1 Physical Oceanography

4.11.8.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 6 on physical ocean resources would be substantially the same as those described for Alternative 4. The additional mitigation measures included in Alternative 6 would not substantially change the effects of the alternative on physical ocean resources in the EIS project area. The effects of Alternative 6 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The effects Alternative 6 on physical ocean resources in the EIS project area would be minor.

4.11.8.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.8.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.8.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 6 would cause local minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 6, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.8.1.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.8.2 Climate and Meteorology

4.11.8.2.1 Summary of Direct and Indirect Effects

Alternative 6 involves the same exploration activities as proposed in Alternatives 4 and 5, with the potential inclusion of alternative technologies. The estimated amount of GHG emissions associated with Alternative 6 is the same as those for Alternatives 4 and 5. Therefore the impact levels are expected to be the same as Alternatives 4 and 5, which are minor direct impacts and minor to moderate indirect impacts.

4.11.8.2.2 Past and Present Actions

Past and present actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.8.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.8.2.4 Contribution of Alternative to Cumulative Effects

Alternative 6 would emit approximately the same amount of GHGs as Alternatives 4 and 5; therefore its direct impacts would contribute more to cumulative climate change impacts than Alternative 2. As with Alternatives 2 through 5, the indirect effects would contribute more to cumulative impacts than the direct effects. The magnitude of indirect effects cannot be quantified and is considered to be the same as for Alternatives 2 through 5. Therefore indirect effects from Alternative 6 are expected to result in changes that could be long-term and could affect unique resources.

4.11.8.2.5 Conclusion

Alternative 6 could contribute to a moderate to major cumulative impact to climate change, the same as with Alternatives 2 through 5.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.8.3 Air Quality

4.118.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 6, Level 3 Exploration Activity, are expected to be the same as those for Alternatives 4 and 5. The overall direct effect on air quality is expected to be moderate, and indirect effects would be negligible to minor.

4.11.8.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.8.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.8.3.4 Contribution of Alternative to Cumulative Effects

The potential cumulative effects on air quality for Alternative 6 are the same as those for Alternative 4, with a moderate contribution to cumulative effects from Alternative 6.

4.11.8.3.5 Conclusion

Alternative 6 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.8.4 Acoustics

4.11.8.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 6. Alternative 6 suggests replacement of some impulsive airgun sources with alternate sources to reduce the emitted impulsive levels. Several alternative source types are described in Section 2.3.5.

4.11.8.4.2 Past and Present Actions

Past and present actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.8.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.8.4.4 Contribution of Alternative to Cumulative Effects

The contribution to cumulative effects from use of alternate technologies is difficult to assess. Simple reductions in pulse rms levels will reduce the number of auditory system injury takes and disturbance takes under the present NMFS criteria for these effects. Some of the proposed sources, such as marine vibrators, operate by extending the time period over which acoustic energy is transmitted into the water. These extended-duration sources operate at lower rms pressure levels but may produce similar SEL. These sources would not show as much improvement when evaluated against SEL-based criteria such as those proposed by Southall et al. (2007). Another important issue associated with extending the transmission time of impulsive sounds is that the source signals become less impulsive and could be reclassified as continuous noise. In that case they could be evaluated against the continuous noise disturbance threshold of 120 dB re 1 μPa instead of the impulsive threshold 160 dB re 1 μPa (rms). The above points illustrate outstanding issues with regard to developing relevant criteria upon which to base acoustic effects assessments. If this alternative is successful then further reductions of seismic survey sound levels might be achieved as improvements to the alternate technologies are made. These improvements could lead to reduced exposures and effects.

4.11.8.4.5 Conclusion

The use of alternate sources under Alternative 6 has potential to substantially reduce the size of effects zones for seismic surveys. There are potential drawbacks for modified sources that increase the duration of source signals, including the smaller reduction of SEL and the possibility the signals may be reclassified as continuous noise – thereby becoming subject to evaluation against a much lower disturbance threshold criterion. Still, these issues can be overcome if accounted for in the development of the alternate source systems.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.8.5 Water Quality

4.11.8.5.1 Summary of Direct and Indirect Effects

Impacts to water quality resulting from Alternative 6 are expected to be very similar to those described for Alternative 4 in Section 4.11.6.5. Alternative 6 includes mitigation measures that focus on the use of alternative technologies to replace or augment traditional airgun-based seismic exploration techniques. See Chapter 2 for descriptions of the mitigation measures included under Alternative 6. These mitigation measures are not expected to affect the level of water quality impacts. The effects of Alternative 6 on water quality are expected to be low intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of Alternative 6 on water quality are expected to be minor.

4.11.8.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.8.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.8.5.4 Contribution of Alternative to Cumulative Effects

Use of alternative technologies would not influence the contribution of exploration activities to cumulative effects on water quality. Actions associated with Alternative 5 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 6, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.8.5.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on water quality in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.8.6 Environmental Contaminants and Ecosystem Functions

4.11.8.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to environmental contaminants and ecosystem functions resulting from the implementation of Alternative 6 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 6, while the effects of Alternative 6 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall effects of Alternative 6 on ecosystem functions would be minor.

4.11.8.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.8.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.8.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 6 would cause local minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 6, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial. The use of alternative technologies associated with Alternative 6 could potentially decrease the accumulation of adverse impacts to habitat, production, and information functions within the EIS project area.

4.11.8.6.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor. Use of alternative technologies could potentially decrease the accumulation of adverse impacts to certain habitat functions within the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.8.7 Lower Trophic Levels

4.11.8.7.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, with the addition of required measures that focus on alternative technologies for seismic exploration. This requirement would not affect lower trophic levels in the EIS project area, so the impacts discussed previously for Alternative 4 are the same for Alternative 6; the overall impact to lower trophic levels would be negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic; which could be of low to medium intensity, long-term duration, of local or regional geographic extent, and affect common or important resources; which could cause a summary impact of minor to moderate.

4.11.8.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.8.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.8.7.4 Contribution of Alternative to Cumulative Effects

Alternative 6 would have the same types of effects as Alternative 2 with the addition of certain time/area closures. Therefore, the conclusions about Alternative 6 would be similar to Alternative 2 discussed in Section 4.10.4.7. The exploration activities authorized under Alternative 6 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

4.11.8.7.5 Conclusion

Alternative 6 could have a negligible contribution to cumulative effects on lower trophic organisms. In the event of the introduction of an invasive species due to increased vessel traffic, the contribution of this alternative to cumulative effects on lower trophic levels would be minor to moderate.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.8.8 Fish and Essential Fish Habitat

4.11.8.8.1 Summary of Direct and Indirect Effects

The effect of the alternative technologies outlined in Alternative 6 on fish resources and EFH are difficult to determine with any certainty but are not anticipated to reduce in the overall impact. The number of airgun arrays that could be replaced by any of these technologies is fairly limited, thereby resulting in minimal impact reductions. Therefore, there would be no measurable effect on the resource, and overall impact would be considered to be minor.

4.11.8.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.8.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.8.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have measurable effects on fish and EFH within the EIS project area, and those effects may be beneficial or detrimental. As discussed in Section 4.11.4.8.3, ocean acidification could have a variety of negative effects on fish and fish habitat. Climate change could also make it easier for non-native invasive species to take hold in the Arctic. Warming waters and decreases in ice cover could later predator and prey distributions and concentrations, thereby impacting fish. On the other hand, as Arctic waters warm, productivity could increase, thereby creating more favorable fish habitat throughout the region. The contribution of the activities associated with this alternative to cumulative effects on fish and EFH would be minor.

4.11.8.8.5 Conclusion

Direct and indirect effects associated with Alternative 6 on fish and EFH would be minor. The overall contribution of Alternative 6 to cumulative effects on fish and EFH would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.8.9 Marine and Coastal Birds

4.11.8.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.9.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, local, of medium intensity, affect important or unique resources. In summary, the impact of Alternative 6 on marine and coastal birds would be considered moderate.

4.11.8.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.8.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.8.9.4 Contribution of Alternative to Cumulative Effects

Alternative 6 would have the same types and level of exploration activities as Alternative 4 with the gradual introduction of alternative seismic technologies. However, the potential reduction in sound levels during seismic surveys would not make much difference to birds so the effects are essentially the same as described for Alternative 4. In the absence of a very large oil spill (see below), the exploration activities authorized under Alternative 6 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.8.9.5 Conclusion

Direct and indirect effects associated with Alternative 6 on marine and coastal birds would be moderate. The overall contribution of Alternative 6 to cumulative effects on marine and coastal birds would be moderate.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.8.10 Marine Mammals

4.11.8.10.1 Bowhead Whales

4.11.8.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on bowhead whales are described in Section 4.9.2.4.1. Impacts of activities associated with oil and gas exploration in the EIS project area under Alternative 5 are similar to Alternative 4 (See Section 4.11.6.10.1).

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on bowhead whales are difficult to determine, but could reduce adverse impacts associated with the use of airgun arrays. The overall reduction would likely be minimal. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment. Airgun noise would not be eliminated, however, since these alternative technologies would not completely replace the existing technology, and what may be replaced is limited. In addition, surveys conducted with alternative technologies would still use marine vessels to tow or deploy equipment which could disturb bowhead whales. Effects of existing technology on bowhead whales would be mostly of medium intensity and temporary duration and range from local to regional in extent. Alternative technologies could reduce the extent to local areas on a small scale; it is not currently possible to assess potential behavioral reactions and determine if intensity level would change, as a result. Bowhead whales are considered a unique resource, since they are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik of the Arctic coast. Despite possible local mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 6 on bowhead whales is considered to be moderate to major.

Section 4.5.2.4.9 and Appendix F outline the results and limitations of a first-order cumulative and chronic assessment of oil and gas activities in the Arctic conducted by NMFS in response to public comments. Broadly, results suggest that for Alternative 6, substantial losses of listening area (up to 98%) and bowhead communication space (up to 28%), to a lesser degree, will occur in the Beaufort Sea area from July-mid-October, with notable, but lesser, losses of listening area also occurring around the lease areas in the Chukchi (up to 72% at shallower depths). As noted in section 4.5.2.4.9, there is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals. And, while data are lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals, it is clear that chronic noise effects that impair an animals ability to detect critical acoustic cues over a relatively large area for 3.5 months must be carefully considered in a broader cumulative effect evaluation, especially, perhaps for bowhead whales, which are migrating through with calves where communication is important to retain group cohesion.

4.11.8.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.8.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.8.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 6, when combined with the past, present, and reasonably foreseeable future actions would, in many respects, be similar to Alternative 4 (Section 4.11.6.10.1). Since most potential impacts are due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales, the use of alternative technologies has the potential to reduce, but not eliminate, such effects. These technologies would gradually be introduced, would not completely replace airguns, and many are still in development with uncertain efficacy; therefore, a thorough assessment of their effectiveness is not currently possible. Therefore, the contribution of activities authorized under Alternative 6 to cumulative effects on bowhead whales would be considered moderate.

4.11.8.10.1.5 Conclusion

Under Alternative 6, the direct and indirect effects to bowhead whales would be moderate. Alternative 6 would have a minor to moderate contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

4.11.8.10.2 Beluga Whales

4.11.8.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on beluga whales are described in Section 4.9.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 6 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be local and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The use of alternative technologies under Alternative 6 may reduce adverse impacts to beluga whales associated with the use of airgun arrays. Alternative technologies could reduce the extent of impacts to local areas on a small scale. It is difficult to quantify the amount of impact reduction likely to occur due to the uncertainty in assessing potential behavioral reactions. Therefore there is no evidence to support a change in the expected impact intensity level. Despite possible local impact reductions from using alternative technologies instead of airgun arrays, the overall impact of Alternative 6 on beluga whales is considered moderate.

The direct and indirect effects on beluga whales from the exploration activities under Alternative 5 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 6 on beluga whales would be considered moderate.

4.11.8.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.8.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.8.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 6 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 6 would therefore have moderate additive contributions to the cumulative effects on beluga whales.

4.11.8.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 6 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.8.10.3 Other Cetaceans

4.11.8.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on cetaceans are described in Section 4.9.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 6 on other cetaceans is minor to moderate. Although the introduction of alternative technologies specified in Alternative 6 could incrementally mitigate adverse impacts into the future, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 6, impacts on the resource would be low in intensity, of short duration, and limited extent. Long-term impacts are unknown, but anticipated to be minor.

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on the cetaceans are difficult to determine, but could reduce adverse impacts associated with the use of airgun arrays. The overall reduction would likely be minimal. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment. New alternative technologies may extend the transmission time of impulsive sounds and source signals could become less impulsive and could be reclassified as continuous noise that would be unlikely to affect fish. Airgun noise would not be eliminated, however, since these alternative technologies would not completely replace the existing technology and what may be replaced is limited. In addition, surveys conducted with alternative technologies would still use marine vessels to tow or deploy survey equipment.

4.11.8.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.8.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.8.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 6 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Although the introduction of the Alternative Technologies specified in Alternative 6 could incrementally mitigate adverse impacts into the future, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Most of this disturbance would occur during the open-water season and would be local and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be local and temporary. The contribution to habitat change would be negligible. The exploration activities authorized under Alternative 6 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.8.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 6 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.8.10.4 Ice Seals

4.11.8.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called “ice seals”; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 6 on ice seals are described in Section 4.9.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 6 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 6 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 6 would therefore be considered minor to moderate for all ice seal species according to the criteria established in Section 4.1.3.

4.11.8.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.8.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.8.10.4.4 Contribution of Alternative 6 to Cumulative Effects

The exploration activities authorized under Alternative 6 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.8.10.4.4.5 Conclusion

Direct and indirect effects associated with Alternative 6 on pinnipeds would be minor to moderate. The overall contribution of Alternative 6 to cumulative effects on pinnipeds would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.8.10.5 Walruses

4.11.8.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on walruses are described in Section 4.9.2.4.5 and are summarized here. The types and levels of effects on walruses are essentially the same under Alternative 6 as for Alternative 4 (Section 4.7.2.4.5). Walruses have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walruses do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. The gradual introduction of alternative technologies for seismic surveys would make very little difference to walruses because they are unlikely to be affected in any biologically meaningful way by seismic noise. Mitigation measures required for walruses by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of spills that may affect walruses or their prey. None of the data collected to date on walrus' reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walruses are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 6, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walruses would likely be medium in magnitude, distributed over a wide geographic area, and interim to long term in duration. The effects of Alternative 6 on walruses would therefore be considered moderate.

4.11.8.10.5.2 Past and Present Actions

Past and present actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.8.10.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting walruses within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.8.10.5.4 Contribution of Alternative 6 to Cumulative Effects

The exploration activities authorized under Alternative 6 would add to the disturbance of walruses from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walruses, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have negligible to minor contributions to the cumulative effects on walruses.

4.11.8.10.5.5 Conclusion

Direct and indirect effects associated with Alternative 6 on walruses would be moderate. The overall contribution of Alternative 6 to cumulative effects on walruses would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with walruses were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.8.10.6 Polar Bears

4.11.8.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on polar bears are described in Section 4.9.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative 6 as for Alternative 4 (Section 4.7.2.4.6). Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of human-bear encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative 6, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 6 on polar bears would therefore be considered minor.

4.11.8.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.8.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.8.10.6.4 Contribution of Alternative 6 to Cumulative Effects

The exploration activities authorized under Alternative 6 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be local and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.8.10.6.5 Conclusion

Direct and indirect effects associated with Alternative 6 on polar bears would be minor. The overall contribution of Alternative 6 to cumulative effects on polar bears would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.8.11 Terrestrial Mammals

4.11.8.11.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures that focus on alternative technologies for seismic exploration. These mitigation measures do not affect terrestrial mammals in the EIS project area, so the impacts discussed for Alternatives 2 and 3 are the same for Alternative 6 and the overall impact to terrestrial mammals would be minor.

4.11.8.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.8.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.8.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.8.11.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on caribou would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.8.13 Socioeconomics

4.11.8.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 6 are the similar to those described for Alternative 2. Alternative technologies may result in additional costs to lease holders due to increased time to complete surveys. The extent that alternative technologies reduce net impacts to subsistence activities is unknown. The summary impact level for Socioeconomics under Alternative 6 is moderate, not exceeding the significance threshold.

4.11.8.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.8.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 6 would result in future oil and gas production.

4.11.8.13.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 6 would have an incremental minor contribution to cumulative effects on socioeconomic resources because employment rates and state and regional revenues are expected to remain stable. They differ from Alternative 2 by the potential for some lost productivity for lease holders due to alternative technologies and mitigation measures and reduced net impacts to subsistence resources. At a local level, the new direct employment, public revenue generation, and impact to social institutions would be experienced by Iñupiat (minority) communities.

4.11.8.13.5 Conclusion

The direct and indirect effects of Alternative 6 would be moderate. The contribution to cumulative effects of socioeconomics would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics would be major and are discussed under Alternative 2 (Section 4.11.4.13).

4.11.8.14 Subsistence

4.11.8.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-28, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 6 would be of low intensity, temporary to interim in duration, local in extent, and the context would be common to unique. Protected resources (bowhead whales, bearded and ringed seals and polar bears are considered unique in context as these resources are protected by legislation (e.g., MMPA, ESA) or are considered an important subsistence resource (beluga whales). The impacts of implementing Alternative 6 could be considered beneficial to subsistence harvests and users as the implementation of new technologies could reduce the levels of noise introduced to the marine environment and then reduce the levels of noise disturbance to marine mammal subsistence resources. New alternative technologies may extend the transmission time of impulsive sounds and source signals could become less impulsive and could be reclassified as continuous noise that would be unlikely to affect subsistence resources. Direct and indirect impacts to subsistence harvest and subsistence resources are likely to be similar or less than those of Alternative 4 as discussed in Section 4.7.3.2 and Section 4.11.6.14. The summary impact to subsistence is therefore considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.5.3.2 and Section 4.9.3.2).

4.11.8.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.8.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.8.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 6 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be low in intensity, temporary in duration and local in extent and affect subsistence resources that are common to unique in context. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, local to regional in extent, temporary in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have a minor to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 6 would be considered beneficial to cumulative effects on subsistence resources.

The exploration activities authorized under Alternative 6 would occur at the same level as Alternative 4 but are considered beneficial to subsistence harvests and users as implementing new technologies that reduce the levels of noise into the marine environment could reduce the potential for disturbance to marine mammal subsistence resources. The exploration activities authorized under Alternative 6 would have a minor to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 6 would be considered beneficial to cumulative effects on subsistence resources.

4.11.8.14.5 Conclusion

Under Alternative 6, the direct and indirect effects to subsistence resources are considered low in intensity, temporary to interim in duration, local in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 6 would be a beneficial contribution to cumulative effects on subsistence resources as it would implement new technologies that would reduce the potential for disturbance to marine mammal subsistence resources. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.8.15 Public Health

4.11.8.15.1 Summary of Direct and Indirect Effects

As described in Section 4.9.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 6 are expected to be similar to those expected under Alternative 2. Alternative 6 includes requirements for the use of alternative technologies. However, as discussed in Section 4.9.3.3, the effectiveness of these alternative technologies in reducing adverse impacts to subsistence uses is at present unknown, and thus the benefits of the additional measures are theoretical. Therefore, these additional mitigations would not affect the overall impact criteria rating for public health for Alternative 6. If, however, the alternative technologies are demonstrated to be effective and feasible to implement, there is the possibility that additional benefit to public health may accrue.

4.18.8.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.8.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.8.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 6 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.8.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 6 would contribute to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts as well as acting as the gateway for additional future offshore oil and gas development.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.8.16 Cultural Resources

4.11.8.16.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures that focus on alternative technologies for seismic exploration. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed for Alternatives 2 and 3 are the same for Alternative 6 and the overall impact to cultural resources would be negligible.

4.11.8.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.8.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.8.17 Land and Water Ownership, Use, and Management

4.11.8.17.1 Summary of Direct and Indirect Effects

The cumulative effects for Alternative 6 would be similar to Alternative 2, discussed in Section 4.5.3.5. There would be no direct or indirect impacts on land and water ownership. The direct and indirect impacts on land and water use would have a high magnitude, be temporary or interim in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, interim in nature, local, and common. In summary, the impacts of Alternative 6 on land and water ownership, use, and management would be none, moderate, and negligible, respectively.

4.11.8.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.11.3.

4.11.8.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.11.3.

4.11.8.17.4 Contribution of Alternative to Cumulative Effects

Alternative 6 is the same as Alternative 2 except with use of alternative technologies. The cumulative effects discussed in Section 4.11.6.17.4 for Alternative 2 are applicable for this alternative. The conclusions for Alternative 2 are applicable to Alternative 6; changes would be negligible, temporary in duration, and geographically dispersed, and thus would have negligible effects creating cumulative impacts of land ownership, use or management and would be considered minor.

4.11.8.17.5 Conclusion

Under Alternative 6, the levels of direct, indirect and cumulative impact for land and water ownership, use, and management are negligible, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 6 is considered minor. The contribution of Alternative 6 to cumulative effects would be considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management were discussed under Alternative 2 (Section 4.11.4.17).

4.11.8.18 Transportation

4.11.8.18.1 Summary of Direct and Indirect Effects

Direct and indirect impacts on regional transportation systems and existing infrastructure would be expected to be the same as those discussed under Alternative 4 as discussed in Section 4.7.3.2. Alternative technologies are likely to use the same types of transportation equipment and infrastructure at the same levels as that currently used for seismic surveys, on-ice surveys and exploratory drilling as Alternatives 2, 3, 4, and 5.

4.11.8.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.8.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.8.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 6 would be similar as those described for Alternative 4 in Section 4.11.6.18.

4.11.8.18.5 Conclusion

The direct and indirect effects of Alternative 6 would be minor for transportation, with a minor contribution to cumulative impacts if Alternative 6 overlaps with another large-scale development project.

A VLOS in the Beaufort or Chukchi seas would have moderate additive cumulative effects to transportation, similar to Alternative 2 (Section 4.11.4.18).

4.11.8.19 Recreation and Tourism

4.11.8.19.1 Summary of Direct and Indirect Effects

The direct impacts would be low intensity, interim duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 6 on recreation and tourism would be minor.

4.11.8.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.8.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.8.19.4 Contribution of Alternative to Cumulative Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures for that focus on alternative technologies for seismic exploration. These mitigation measures do not affect recreation or tourism in the EIS project area, so the cumulative effects discussed in Sections 4.11.4.19 and 4.11.5.19 for Alternatives 2 and 3 are the same for Alternative 6; the overall impact to recreation and tourism would be minor.

4.11.8.19.5 Conclusion

Alternative 6 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.8.20 Visual Resources

4.11.8.20.1 Summary of Direct and Indirect Effects

Direct and indirect effects of past and present actions are identical to those described in Section 4.11.6.20, Alternative 4.

4.11.8.20.2 Past and Present Actions

Past and present actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.8.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.8.20.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 6 to cumulative effects would be identical to that described in Section 4.11.6.20, Alternative 4.

4.11.8.20.5 Conclusion

Past, present, and reasonably foreseeable future actions could result in strong visual contrast that collectively could contribute to the industrial landscape character of the state waters of the Beaufort Sea. Under Alternative 6, anticipated cumulative effects to visual resources are expected to be minor. Impacts would be of high intensity, interim, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.8.21 Environmental Justice

4.11.8.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 6 would be minor, similar to those described for Alternative 2. Alternative technologies may reduce the likelihood of disturbance to marine mammals which in turn could reduce detrimental impacts to subsistence users. However, the effectiveness of these alternative technologies in reducing adverse impacts to subsistence users is unknown and therefore the benefits of these technologies to lessen impacts to subsistence and public health are theoretical and do affect the overall impact criteria rating.

4.11.8.21.2 Past and Present Actions

Past and present actions affecting environmental justice within the EIS project area are discussed under Alternative 2, Section 4.11.4.21.

4.11.8.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental justice within the EIS project area are discussed under Alternative 2, Section 4.11.4.21.

4.11.8.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 6 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 6 to environmental justice indicator cumulative effects would be minor.

4.11.8.21.5 Conclusion

The direct and indirect effects of Alternative 6 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a minor impact to Alaska Native communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental justice were discussed under Alternative 2 (Section 4.11.4.21). A VLOS would have disproportionate adverse impacts to Alaska Natives (minority population) living in the communities near the EIS project area.

4.12 Relationship between Short-term Uses of the Environment and the Maintenance and Enhancement of Long-term Productivity

This section addresses this subject from a broad perspective, incorporating the information and conclusions from detailed analysis provided in previous sections of the EIS (Sections 4.4-4.10). No construction activities are associated with the Proposed Action; therefore, short-term uses of the environment would primarily relate to seismic surveys and exploratory drilling operations. Short- and long-term commitments of labor and capital and the use of non-renewable materials for power and maintenance would be employed to achieve the short-term goal of discovering oil and gas resources and the long-term goal of developing oil and gas resources in the Beaufort and Chukchi seas.

Bowhead whales may be temporarily affected by noise from seismic surveys, exploratory drilling, vessel and aircraft traffic, and small oil spills on a short-term basis. Minor to moderate impacts are expected to occur to bowhead and beluga whales under the action alternatives. Polar bears could experience minor impacts through disturbance from vessel and aircraft traffic, ice breaking and an on-ice seismic survey in the Beaufort Sea. Steller’s eiders and spectacled eiders may be negatively impacted by frequent vessel and aircraft disturbance and collisions with vessels and aircrafts, especially during molting. The impact to Steller’s eiders and spectacled eiders are considered moderate.

Short- and long-term effects on Iñupiat subsistence-harvest activities could be considered disproportionately adverse if seismic survey and exploratory drilling operations are not sufficiently mitigated. No unmitigable adverse impacts are expected to occur to subsistence resources and harvest. Short-term effects of seismic survey and exploratory drilling operations to social systems, cultural values, and institutional organization are not expected to have long-term adverse consequences. Archaeological resources finds discovered as a result of the seismic surveys could enhance long-term knowledge. Such finds could help fill gaps in knowledge of the history and early inhabitants of the area; but any destruction of archaeological sites or unauthorized removal of artifacts would represent long-term losses.

With respect to the short-term uses of the environment and the maintenance and enhancement of long-term productivity, the following could be expected to occur to the economy: federal revenues on offshore lease areas could increase; local and state employment could increase; and personal income could be generated.

In conclusion, the environmental effects of the proposed action alternatives would be temporary in nature and would have no adverse long-term impacts on the long-term productivity of the Beaufort and Chukchi seas, if properly mitigated as proposed. No losses of marine habitats are expected to occur from seismic survey activities. However, the quality of marine habitat surrounding seismic survey activities could be adversely affected in the short-term as airguns are fired to ensonify the area. Other noises originating from exploratory drilling operations (e.g., drilling, vessel traffic, the operation of ship-board equipment, and aircraft traffic) would also cause a temporary degradation of the marine environment, especially for marine mammals, marine birds, and fish unless mitigated as proposed. The benefits offered to the Nation by the long-term productivity of the Proposed Action are expected to offset the short-term use of the environment, if properly mitigated as proposed.

4.13 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitments of resources associated with implementing the alternatives of the Proposed Action. Irreversible and irretrievable commitment of resources refers to impacts or losses to resources that cannot be reversed or recovered. Resources include renewable and nonrenewable natural and mineral resources, including fish and wildlife habitat.

A commitment of resources is irreversible when a proposed action impacts limit the future options for a resource or cannot be reversed, except perhaps in the extreme long-term. It applies primarily to the effects of use of nonrenewable resources, which are those resources that cannot be replenished by natural means, such as oil, natural gas, iron ore, and cultural resources. An irretrievable commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations or is lost for a period of time. It applies to the loss of productivity, harvest, or use of natural resources.

Any irreversible and irretrievable commitments of resources would be limited to the implementation of seismic survey activities and exploratory drilling operations.

Irreversible and irretrievable nonrenewable resources committed for use by seismic survey vessels, support vessels, and support aircraft, include any seismic survey or exploratory drilling equipment that could not be recovered or recycled, diesel fuel, gasoline, aviation fuel, lubricating oil, and drilling mud. The Proposed Action would also require a commitment of human and financial resources (time and labor). Water is the only renewable natural resource used to implement the alternatives. Water would be used on the seismic survey vessels, drilling rigs, and support vessels for cooking, drinking, and processing human wastes.

Any irretrievable or irreversible commitment of resources important to the long-term survival and recovery of threatened or endangered species would violate the Endangered Species Act and the Marine Mammal Protection Act, unless such commitment was made to help protect and aid in its conservation and recovery. Under certain circumstances bowhead whales, polar bears, Steller's eider, and spectacled eiders could be subjected to temporary non-lethal effects of disturbance due to noise from seismic survey activities, vessel and aircraft traffic and from small petroleum spills. It is unlikely that such effects could lead to permanent (irreversible) losses of these resources, particularly for the bowhead whale population, as their population is increasing.

5.0 IMPLEMENTATION, MONITORING AND REPORTING, AND ADAPTIVE MANAGEMENT

The purpose of Chapter 5 is to describe certain procedures that are used to ensure NEPA and MMPA compliance for the issuance of G&G permits and concurrence on ancillary activities by BOEM and MMPA ITAs by NMFS for Arctic oil and gas exploration activities. Specifically, this chapter describes and analyzes several issues:

(1) How the EIS will be used to support NMFS' and BOEM's NEPA compliance;

(2) How the MMPA has been implemented by NMFS in recent years for Arctic oil and gas activities and how it could be implemented in the future;

(3) The purposes, goals, and objectives of monitoring and reporting under the MMPA;

(4) Additional tools for mitigating impacts on the availability of marine mammals for subsistence uses; and

(5) Recommendations for adaptive management.

5.1 EIS Implementation and NEPA Compliance

5.1.1 Need for NEPA Compliance

NEPA was passed by Congress in 1969 and signed into law on January 1, 1970. Its primary focus is to ensure the incorporation of environmental planning into all major federal actions so that "environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations" (Sec. 102 [42 USC 4332] (b)). NEPA mandates that federal agencies prepare a detailed statement of the effects of "major Federal actions significantly affecting the quality of the human environment."

The CEQ is responsible for the development and oversight of regulations and procedures implementing NEPA. The CEQ regulations provide guidance for federal agencies regarding NEPA's requirements (40 CFR Part 1500). Federal agencies are required to produce their own regulations and guidance regarding NEPA implementation. U.S. Department of the Interior's (USDOI) NEPA procedures regulations are codified at 43 CFR Parts 46.10 to 46.450 and can be found at http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title43/43cfr46_main_02.tpl or http://www.doi.gov/oepc/nepafr.html. The BOEM NEPA procedures can be found in the USDOI Department Manual at http://elips.doi.gov/app_dm/index.cfm?fuseaction=home. The NOAA NEPA NAO 216-6 provides guidance on environmental review procedures for implementing NEPA. NAO 216-6 can be found at http://www.corporateservices.noaa.gov/ames/administrative_orders/ chapter_216/216-6.html.

NMFS and BOEM staff, permit applicants, stakeholders, and the general public should understand how NMFS and BOEM will meet their obligations under NEPA. This EIS addresses Arctic oil and gas exploration activities (i.e. seismic surveys, site clearance and shallow hazards surveys, and exploratory drilling) that may occur. This EIS will inform BOEM decisions on specific G&G permit applications and ancillary activity surveys (i.e., not including drilling). This EIS will inform NMFS decisions on specific MMPA ITA requests related to G&G surveys, ancillary activity surveys, and exploratory drilling programs. BOEM will complete site-specific NEPA evaluation of proposed exploration drilling, incorporating the analyses in this EIS by reference, as appropriate.

5.1.2 NMFS NEPA Compliance

The Effects of Oil and Gas Activities in the Arctic Ocean Final EIS covers oil and gas industry exploration activities that may impact the human environment in general, but it is not specific to the request for or issuance of any particular ITA. Thus, each project-specific authorization application will require its own NEPA compliance review. The form of this additional NEPA review will depend on the nature and scope of the proposed activity and may take the form of a Memorandum to the File, an EA, a supplemental EIS, or a new EIS.

In the future, NMFS anticipates receipt of applications to take marine mammals incidental to oil and gas industry exploration activities in both state and federal waters (i.e. G&G and ancillary surveys and exploratory drilling) pursuant to Sections 101(a)(5)(A) and (D) of the MMPA. There is no formal schedule for submission of ITA applications; however, Section 101(a)(5)(D) places a 120-day limit on the processing of an Incidental Harassment Authorization request. Therefore, requests can be submitted throughout the calendar year, meaning that the schedule is initiated and driven by the applicants. Each time an application is received, the request will be reviewed by NMFS to determine whether the proposed activity and its anticipated effects fall within the scope of the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS.

The Effects of Oil and Gas Activities in the Arctic Ocean Final EIS identifies the Preferred Alternative, which is Alternative 2, and includes an analysis of potential environmental consequences and mitigation measures. The ROD associated with the EIS will identify any conditions of approval that are relevant to Arctic oil and gas industry exploration authorization requests and will provide a listing of activities addressed by the Preferred Alternative. Proposed oil and gas exploration activities that are identified and analyzed within the Preferred Alternative will be reviewed to determine whether the proposed action and its anticipated effects fall within the scope of the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS (see description of NMFS' NEPA compliance process below). Proposed oil and gas activities that are not identified and analyzed within the Preferred Alternative will undergo their own NEPA review, to be determined at the time the application is submitted.

New requests for the take of marine mammals incidental to seismic surveys, site clearance and shallow hazards surveys, and exploratory drilling activities will be reviewed by NMFS Permits and Conservation Division, Office of Protected Resources. NMFS will:

- Conduct an internal review of the proposed ITA application to determine if the activities proposed by the applicant and the anticipated effects fall within the scope of the Preferred Alternative identified in the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS.
- If NMFS determines the activities proposed by the applicant and the anticipated effects fall within the scope of the Preferred Alternative in the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS, NMFS could develop a Memorandum to the File. The Memorandum would include a description of the proposed action, the anticipated effects, and include a discussion of the agency's rationale as to whether the proposed action and its anticipated effects are covered by the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS. NMFS may, as appropriate, include any conditions of approval that apply as documented in the ROD.

If NMFS determines through the above process that the proposed activities were not analyzed within the Preferred Alternative, an additional NEPA compliance review (such as an Environmental Assessment) would be conducted. The NOAA NEPA Handbook and NAO 216-6 provide guidance for agency officials on this step of NEPA review, including the process for tiering analyses from a general or broad-scope EIS to a project-specific review, and incorporating by reference.

The EIS will also assist NMFS in carrying out other statutory responsibilities (e.g., assessing environmental impacts on listed species under the ESA [Section 7 consultation] and effects of the proposed action on EFH under the MSFCMA) and serve to support future decisions relating to the agency's role in authorizing the take of marine mammals incidental to deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling activities, as NMFS is required to ensure compliance with all applicable statutes when issuing an MMPA ITA.

Alternative 6 of this EIS analyzes the use of alternative technologies that could potentially augment or replace the use of airguns in traditional seismic surveys at some point in the future. Because the majority of these technologies have not yet been built and/or tested, it is difficult to fully analyze the level of impacts from these devices in this EIS. Additionally, the amount of reduction in impacts is dependent upon how many traditional seismic surveys (i.e. use of airgun arrays) can potentially be replaced or augmented by these alternative technologies, which is unknown at this time. This EIS examines a projected use of alternative technologies, but the actual amount that might be used during the timeframe of this EIS is not fully known at this time. Therefore, NMFS has determined that additional NEPA analyses would likely be required if applications are received requesting to use these technologies during seismic surveys. As described above, NMFS would review the application request to determine how much of the request is already described and analyzed by the Preferred Alternative and ROD. Because of the lack of details on these technologies, it is unlikely that a Memorandum to the File would be sufficient. Therefore, NMFS would likely tier from this EIS and prepare a supplemental NEPA document, incorporating key sections of this EIS by reference as appropriate and where relevant.

5.1.3 BOEM NEPA Compliance

BOEM produces NEPA documents for each of the major stages of energy development planning. From the overarching 5-Year Leasing Program EIS, through each of the NEPA documents for the energy lease sales, exploration, development and production plans. The form of additional NEPA review will depend on the nature and scope of the proposed activity and may take the form of a Categorical Exclusion Review, an EA, a supplemental EIS, or a new EIS. BOEM prepares Categorical Exclusion Reviews (CER) to verify that neither an EA nor an EIS is needed prior to making a decision on the activity being considered for approval. BOEM prepares EAs for proposals to determine if significant impacts may occur that would require preparation of an EIS. EAs are prepared for each exploration plan in the Arctic.

BOEM will conduct site-specific NEPA reviews for G&G permit applications. Proposed activities will be reviewed by BOEM to determine whether the activities are covered by the assessment of impacts contained in the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS, and may incorporate information and analyses in this EIS by reference (see 40 CFR Part 1506.2).

While this EIS is not being used by BOEM to analyze the approval of exploration drilling plans or by BSEE for approval of applications for permits to drill, BOEM may incorporate information and analyses in this EIS by reference (see 40 CFR Part 1506.2), as appropriate.

This EIS will also assist BOEM in carrying out other statutory responsibilities related to the issuance of G&G permits and concurrence on ancillary activity notices, as discussed in Section 1.1 of this document. Several Federal statutes and their implementing regulations establish specific consultation and coordination processes with Federal, State, and local agencies (i.e., Coastal Zone Management Act (CZMA), National Historic Preservation Act (NHPA), ESA, the Magnuson-Stevens Fishery Conservation and Management Act, and the MMPA). In addition, the OCS leasing process and all activities and operations on the OCS must comply with other Federal, State, and local government laws and regulations.

5.2 MMPA Implementation and Compliance History and Process

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. §1361 *et seq.*) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of proposed authorization is provided to the public for review.

ITAs may be issued as either (1) regulations and associated LOAs or (2) IHAs. NMFS' implementing regulations state that an IHA can only be issued if the proposed action will not result in a potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. Where the proposed activity has the potential to result in serious injury and/or mortality (that cannot be negated through mitigation measures), only regulations and associated LOAs may be used to authorize take. However, regulations and LOAs may also be issued when there is no potential for serious injury and/or mortality if the applicant requests it, which applicants sometimes do for multi-year activities because it offers some administrative streamlining benefits. IHAs cannot be valid for more than 12 consecutive months, whereas LOAs can be valid for up to five consecutive years. The Secretary of Commerce is required to authorize the take of small numbers of marine mammals incidental to a specified activity if the taking would have no more than a "negligible impact" on marine mammal species or stocks and not have an "unmitigable adverse impact" on the availability of such species or stocks for taking for subsistence uses.

Since 2006, NMFS has issued IHAs to various oil and gas industry or seismic operators for the take of marine mammals incidental to conducting seismic and site clearance and shallow hazards survey programs both on-ice and in open-water in the U.S. Beaufort and Chukchi seas. Between 2006 and 2015, NMFS issued 22 IHAs for open-water seismic and site clearance and shallow hazards survey programs and four IHAs for on-ice seismic surveys. NMFS also issued one IHA for the take of marine mammals incidental to an exploratory drilling program in the Beaufort Sea in 2007; however, the program was enjoined by a federal court. In 2012, NMFS issued two IHAs for exploratory drilling programs in the U.S. Arctic Ocean. However, only limited operations were conducted, with no drilling into hydrocarbon bearing zones. In 2015, NMFS issued one IHA to Shell for an exploratory drilling program in the Chukchi Sea. Starting in 2000, NMFS also issued several sets of five-year regulations and subsequent LOAs to BP for the take of marine mammals incidental to the construction and operation of its Northstar development and production facility in the Beaufort Sea. However, this type of production drilling activity is not covered by this EIS.

NMFS has explored the possibility of issuing regulations and associated LOAs to companies for oil and gas exploration activities in the Arctic. Doing so would provide some administrative streamlining. However, to date, regulations and LOAs have not been requested in the Arctic for oil and gas exploration activities. Because NMFS has determined in the past that the activities would not result in serious injury or mortality (or such impacts were negated through mitigation measures), NMFS has not required that applicants request regulations instead of IHAs. While past practice has been to issue IHAs for exploration activities instead of regulations and associated LOAs, NMFS could issue regulations and LOAs in the future. Therefore, through this EIS, NMFS is considering issuing either type of ITA (i.e. IHAs or LOAs) for oil and gas exploration activities in the Arctic.

5.3 Monitoring and Reporting

5.3.1 Purposes, Goals, and Objectives of MMPA Monitoring and Reporting Plans

The MMPA mandates that an authorization issued for the incidental take of marine mammals include requirements pertaining to the monitoring and reporting of the taking. The MMPA implementing regulations (50 CFR Part 216.104(a)(13)) further define the information that an applicant must provide when requesting an ITA, including the means of accomplishing monitoring and reporting that will result in increased knowledge of the species and the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities. The regulations further suggest that monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s), including migration and other habitat uses, such as feeding.

NMFS has developed more detailed guidance for applicants and analysts that further specifies the type of monitoring that can be used to comply with the broad goals outlined in the MMPA and its implementing regulations. Monitoring measures developed to comply with, and prescribed in, MMPA authorizations should be designed to accomplish or contribute to one or more of the following top-level goals:

(a) An increase in our understanding of the likely occurrence of marine mammal species in the vicinity of the action, i.e., presence, abundance, distribution, and/or density of species.

(b) An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammal species to any of the potential stressor(s) associated with the action (e.g., sound or visual stimuli), through better understanding of one or more of the following:

   1. the action itself and its environment (e.g., sound source characterization, propagation, and ambient noise levels);
   2. the affected species (e.g., life history or dive patterns);
   3. the likely co-occurrence of marine mammal species with the action (in whole or part) associated with specific adverse effects; and/or
   4. the likely biological or behavioral context of exposure to the stressor for the marine mammal (e.g., age class of exposed animals or known pupping, calving or feeding areas).

(c) An increase in our understanding of how individual marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, i.e., at what distance or received level).

(d) An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: 1) the long-term fitness and survival of an individual; or 2) the population, species, or stock (e.g., through effects on annual rates of recruitment or survival).

(e) An increase in our understanding of how the activity affects marine mammal habitat, such as through effects on prey sources or acoustic habitat (e.g., through characterization of longer-term contributions of multiple sound sources to rising ambient noise levels and assessment of the potential chronic effects on marine mammals).

(f) An increase in understanding of the impacts of the activity on marine mammals in combination with the impacts of other anthropogenic activities or natural factors occurring in the region.

(g) An increase in our understanding of the effectiveness of mitigation and monitoring measures.

(h) An increase in the probability of detecting marine mammals (through improved technology or methodology), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals.

Proposed Monitoring Plans are evaluated in the context of NMFS' implementing regulations and the above guidance, with consideration of the likelihood of effectively answering the questions that they have been designed to answer (e.g., what is the density of beluga whales in a given area; how do bowhead whales respond to drilling sounds at 160, 140, and 120 dB; how effective are forward looking infrared devices at detecting seals on the ice at night), given the proven success of the proposed methods in the past, as well as the proposed amount of effort. Efforts should be made to target questions that have been identified as priorities (i.e. to fill data gaps). Additionally, as described in Section 5.3.2 below, in the specific case of any activity that may affect the availability of marine mammals for subsistence uses and for which an IHA or LOA has been requested, MMPA implementing regulations require that monitoring plans or other research proposals undergo an independent peer review.

5.3.2 Independent Peer Review of Monitoring Plans

Prior to issuing an ITA for an activity that may affect the availability of a species or stock for taking for subsistence purposes, the applicant's monitoring plan must be independently peer reviewed. The MMPA requires that in considering an application for an IHA, monitoring plans be independently peer reviewed "where the proposed activity may affect the availability of a species or stock for taking for subsistence uses" (16 U.S.C. 1371(a)(5)(D)(ii)(III)). Regarding this requirement, NMFS' implementing regulations state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan" (50 CFR § 216.108(d)). NMFS also requires independent peer review of monitoring plans as part of any petition for regulations and associated LOA(s) (50 CFR § 216.105(b)(3)).

As discussed in Section 5.3.1, an applicant's monitoring program should be designed to accomplish one or more of the following: document the effects of the activity on marine mammals; document or estimate the actual level of take as a result of the activity; increase the knowledge of the affected species; or increase knowledge of the anticipated impacts on marine mammal populations. Section 5.3.1 also discusses specific goals that should be accomplished by an applicant's monitoring program.

From 1994 until 2013, NMFS annually hosted a two-to-three day Open Water Meetings. The purpose of these meetings was to bring together ITA applicants, subsistence hunters, agency scientists, and outside scientists with relevant expertise to review the design of industry monitoring plans for the upcoming open water season. Review of study results from the previous year's open water season was also undertaken. The inclusion of subsistence hunters in the review process ensured that both study designs and data interpretation were consistent with real-world observations of marine mammal behaviors and reactions to anthropogenic impacts. ITA applicants adjusted their study designs and/or data interpretation techniques based on discussions in these meetings. In the early years, these meetings satisfied the requirement for an independent peer review via the workshop option described in the regulations.

Prior to 2006, the meetings were small with approximately 15 to 30 participants. The meetings from 2006 to 2013 drew approximately 150 to 250 participants each day of the two- to three-day meetings, thus making it difficult to achieve the focused and detailed reviews of the applicants' monitoring plans and reports provided in earlier meetings. Additional discussion about the Open Water Meeting is provided in Section 5.4.2.

In order to ensure the focused independent peer review of the monitoring plans prescribed by the regulations, in 2010, NMFS divided the annual meeting into two separate parts, one larger and more open stakeholder input meeting (discussed in Section 5.4.2), and one smaller meeting where a pre-selected group of scientists and affected subsistence hunters (who are available to answer questions and provide input) specifically gathers to review the proposed monitoring plans. From 2010 through 2016, after soliciting nominations from the industry ITA applicants, the Marine Mammal Commission, and the affected subsistence organizations, NMFS convened panels of approximately three to seven scientists to provide an independent scientific review of proposed monitoring plans.

During these reviews, NMFS charged the panel members with determining whether or not the monitoring plans, as put forth by the applicants, would accomplish the goals described earlier in this chapter. The panel members were asked to review the proposed monitoring plans, determine whether they were designed to accomplish their intended purpose - to document the effects of the activity on marine mammals, document or estimate the actual level of take as a result of the activity, increase the knowledge of the affected species, or increase knowledge of the anticipated impacts on marine mammal populations - and then make recommendations for how these goals could be better achieved. Panel members were provided the ITA applications and monitoring plans ahead of time in order to prepare for the discussions. Time was also set aside for the panel members to ask questions of the applicants in order to gain a better understanding of their proposal and what changes they may be able to implement. After the meetings, the panel members provided a final report to NMFS with their recommendations.

NMFS reviewed the final peer review panel reports in the context of the applicants' activities and the requirements of the MMPA and selected recommendations that were appropriate for potential inclusion in the applicant's final monitoring plans. NMFS worked with the applicants regarding the feasibility of including these measures and protocols and then included the selected measures as requirements in the issued ITAs.

This process has evolved, and will continue to do so, to address strengths and weaknesses identified by reviewers. Utilizing a smaller group chosen from nominated scientists, with affected subsistence hunters available to share information and respond to questions, allows for a true scientific and independent review of the monitoring plans. The peer review panel report (which was not provided prior to 2010) provides NMFS with concrete recommendations that can be shared with the applicants and allows NMFS and the applicants to identify ways to improve the plans for current and future actions. Panel members suggested that the time allotted for interaction with the applicants in 2010 and 2011 was too short, so NMFS added additional time for interaction at later peer review panel meetings. Also, at the request of the applicants, beginning in 2012, questions were provided to them in advance so that they could be prepared to discuss specific issues identified by the panel members. Generally, both scientist reviewers and applicants have indicated that this more focused method for peer review of the monitoring plans is more effective than the larger meeting format used in 2006 through 2009. However, it is an iterative process, and NMFS intends to continue modifying the methods as necessary to most effectively solicit input.

5.3.3 Potential Improvements for Monitoring and Reporting Plans

As described above, applicants for MMPA authorizations are required to include proposed monitoring plans. In the past, through the Open Water Meetings, public comments on NEPA and MMPA documents, POC meetings, etc., a broad range of recommendations have been made regarding monitoring plans for oil and gas exploration activities. Since 2010, more focused input has been provided via the peer review format described above. However, in the former example (e.g., Open Water Meeting, public comments) input has often been unfocused and too broad to be effectively incorporated into MMPA authorizations, and in the latter example (i.e. independent peer review) much of the input is related to modifications to what a given company has already specifically proposed. What is missing is focused prioritization of needs and guidance to applicants in advance of the development of their initial applications.

In 2010 and 2011, the independent peer reviewers included in their report (in addition to specific comments on the applications that they are reviewing) additional recommendations (related to both the goals of monitoring, in addition to methodology) that could potentially be more broadly applied to multiple applicants, both in the present and the future. This sort of comprehensive consideration of multiple monitoring activities across multiple years could facilitate the most effective combined monitoring efforts in the Arctic.

Through continuing discussions at meetings with the peer reviewers, other scientists, Alaska Native hunters, oil companies, regulators, and others, as well as through the development of our Environmental Impact Statement on the Effects of Oil and Gas Activities in the Arctic Ocean, NMFS identified the targeted need to develop a forward-looking MMPA Monitoring Strategy to comprehensively address the monitoring specifically required by Section 101(a)(5) of the MMPA when incidental take authorizations are issued for oil and gas activities in the Arctic, and to help better understand the aggregate impacts of energy development activities. To support this need, in November 2014, NMFS convened a workshop in Anchorage specifically to explore and discuss this goal. The primary goal of the workshop was to identify and begin prioritizing specific key questions that future monitoring can be designed to answer that will fill critical information gaps to best inform future MMPA and ESA analyses and decisions involving marine mammals and their habitats. In addition to and in support of this primary objective, the participants in the workshop reviewed previous monitoring results, discussed effectiveness of existing and emerging monitoring methods, and touched on ways of synergizing across private, Alaska Native hunter, and government efforts to maximize effectiveness of data collection, analysis, and dissemination to support the conservation and protection of marine mammals.

Following are examples of some of the issues that have been identified, via the 2014 Monitoring Workshop and other venues, as a priority for monitoring and reporting pursuant to MMPA ITAs for oil and gas exploration:

- Identification of presence, abundance, and distribution of multiple species in the winter months, especially belugas in the Chukchi, pinnipeds in both seas, and new species that are seen progressively farther north;
- Better understanding of important areas for marine mammals in the Arctic, and the habitat features that drive use in preferred areas (e.g., prey use);
- Bowhead movement patterns following initial deflection from industry activities during fall migration and bowhead responses to drill cuttings and discharge;
- Development of a real-time monitoring approach that can adequately detect marine mammals during darkness or inclement weather;
- Results of impacts to marine mammals from oil and gas activities since 2006;
- Increased understanding of the chronic and cumulative effects of aggregate sound exposure, as well as other stressors.
- Behavioral responses of bowheads, and other species, to acoustic exposure at specific levels (160 dB, 120 dB), responses of pinnipeds to in-air sounds;
- Behavioral responses of bowhead cow-calf pairs to acoustic exposure at specific levels;
- Measurement of sound produced by icebreakers and the resulting impacts to marine mammals, as well as the effect on habitat of breaking ice; and
- Industry information and data regarding their activities (e.g., specifically when and where a seismic or shallow hazards/site clearance survey was taking place and the times airguns or other devises were operating) and specific monitoring data not being publically available.

In the interest of more comprehensive prioritization and planning of monitoring that could be required and implemented as part of MMPA ITAs, NMFS is considering the following:

- Developing and maintaining (on the NMFS website) a list of monitoring priorities and data gaps for Arctic oil and gas development projects;
- Soliciting input for this list from peer review panels, public comment periods, or, potentially, a longer term panel convened specifically to develop these priorities;
- Including, in the above-mentioned list, specific recommendations for discrete monitoring projects (with suggested methodologies) that could be adopted by new applicants; and
- Considering and describing, in the list, how to best build on existing monitoring results and best integrate data collection, analysis, and reporting with simultaneous monitoring efforts.

Building upon the existing public input tools, NMFS could develop an iterative and systematic annual means of identifying and prioritizing the monitoring goals for Arctic oil and gas exploration activities. These priorities could be available to potential applicants on the NMFS website along with specific methodology recommendations summarized from previous peer review recommendations. This would provide direction and guidance for applicants and allow for the most effective use of resources to answer the most pressing questions related to the effects of oil and gas exploration on marine mammals. NMFS intends to continue to explore this way forward through future peer review meetings and other venues.

5.3.4 BOEM Environmental Studies Program

The OCSLA, as amended, established policy for the management of the OCS energy and mineral resources and for the protection of marine and coastal environments. Section 20 of the OCSLA authorizes an Environmental Studies Program (ESP). The ESP aims to establish the information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS and the potentially affected coastal areas, to predict impacts on the marine biota which may result from chronic, low level pollution or large spills associated with OCS production, from drilling fluids and cuttings discharges, pipeline emplacement, or onshore facilities, and to monitor human, marine, and coastal environments to provide time series and data trend information for identification of significant changes in the quality and productivity of these environments, and to identify the causes of these changes. Nationally, the applied research conducted through the ESP informs management decisions relating to OCS activities from the earliest stage of OCS planning through the final removal of the OCS structure at the end of its productive life.

The *Alaska Annual Studies Plan* complements and reinforces the goals of the ESP. The ESP is guided by several broad themes, which include:

- Monitoring Marine Environments
- Conducting Oil-Spill Fate and Effects Research
- Minimizing Seismic and Acoustic Impacts
- Understanding Social and Economic Impacts
- Maintaining Efficient and Effective Information Management

To be prepared to make decisions arising from activities associated with current oil and gas leases and potential future leasing and changing offshore technologies, the Alaska OCS Region continually proposes new studies and pursues information needs in conjunction with ESP goals. Due to the great differences that exist between Alaska environments and other OCS areas, the Alaska ESP remains especially flexible in planning and implementing needed studies. At each step of the offshore leasing and development process, a variety of potential issues or resource-use conflicts may be encountered. Two questions are fundamental:

- What is the expected change in the human, marine, and coastal environment due to offshore activity?
- Can undesirable change be minimized by mitigation measures?

Environmental studies are the primary means to provide information on these questions for use by decision-makers. Currently, the Alaska ESP is primarily focused on upcoming developments, exploration activities and existing leases, and potential future lease sales in the Beaufort Sea and Chukchi Sea Planning Areas. Current offshore oil and gas-related issues addressed by ongoing and proposed studies in the Beaufort Sea and the Chukchi Sea include, but are not limited to:

- What refinements are there to our knowledge of major oceanographic and meteorological processes and how they influence the human, marine, and coastal environment?
- What role will currents play in distribution of anthropogenic pollutants near development prospects?
- What long-term changes in heavy metal and hydrocarbon levels may occur near Beaufort Sea development prospects, such as Liberty, or regionally along the Beaufort Sea coast?
- How do we improve our model predictions regarding the fate of potential oil spills?
- If oil is spilled in broken ice, what will its fate be?
- What effects might pipeline construction have on nearby marine communities or organisms?
- What changes might occur in sensitive benthic communities such as the Stefansson Sound "Boulder Patch" and other Beaufort Sea kelp communities or fish habitats?
- What are the current spatial and temporal use patterns of these planning areas by species that are potentially sensitive, such as bowhead whales, polar bears, ice seals, walrus, other marine mammals, seabirds and other birds, or fish?
- What is the extent of endangered whale feeding in future proposed or potential lease sale areas?
- What changes might occur in habitat use, distribution, abundance, movement or health of potentially sensitive key species such as bowhead whales, polar bears, ice seals, walrus, other marine mammals, seabirds and other birds, or fish?
- What interactions between human activities and the physical environment have affected potentially sensitive species?
- What changes might occur in socioeconomics and subsistence lifestyles of coastal Alaska communities?
- What are current patterns of subsistence harvest, distribution, and consumption and what changes might occur in key social indicators as a result of offshore exploration and development?
- How can we continue to integrate local and/or traditional knowledge into studies related to the Alaska ESP?

Further information on Alaska Region's ESP and Studies Plan can be found at the BOEM website http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx.

5.4 Tools for Mitigating Impacts on Subsistence

As discussed in Section 2.3.4 of this EIS, over the years, several processes and programs have evolved to facilitate interaction between the industry and the local communities to ensure that the Arctic subsistence culture can continue to thrive in conjunction with oil and gas exploration and development. Some of these processes are federally mandated while others have been voluntary between the industry and local communities. This section of the EIS discusses three of these tools in more detail: (1) POCs, which are required by NMFS' implementing regulations (50 CFR § 216.104(a)(12)); (2) Open Water Season CAAs, which are voluntary and not required by any statute or regulation; and (3) the annual Open Water Meeting. For each of these three tools, this section includes an examination and analysis of:

- what each one is and the purpose it has served;
- the process for developing and/or implementing the tool;

- the strengths and weaknesses of the tool; and
- how the tool can be modified or improved in order to aid NMFS in ensuring that the take of marine mammals incidental to oil and gas exploration activities has no unmitigable adverse impacts on the availability of marine mammals for subsistence uses.

5.4.1 Plan of Cooperation and Conflict Avoidance Agreement

In 1985, the Alaska Eskimo Whaling Commission (AEWC) and a number of Arctic offshore oil and gas operators began working together to identify and mitigate sources of industrial interference with bowhead whale subsistence hunting. Recognizing the need to facilitate the co-existence of marine mammal subsistence uses and Arctic offshore industrial activities, in 1986, Congress amended the MMPA to require that the issuance of ITAs rest on a Secretarial finding of “no unmitigable adverse impact to the availability” of marine mammal subsistence resources. The AEWC and offshore operators undertook an annual initiative to develop mitigation measures, which came to be known as the Open Water Season Conflict Avoidance Agreement (CAA) Process.

Regulations promulgated pursuant to the 1986 MMPA amendments require an activity that will take place near a traditional Arctic hunting ground or may affect the availability of marine mammals for subsistence uses, an applicant for MMPA authorization must either submit a POC or information that identifies the measures that have been taken to minimize adverse impacts on subsistence uses. The regulations provide that a POC must include the following:

- a statement that the applicant has notified the affected subsistence community and provided them a draft POC;
- a schedule for meeting with the communities to discuss proposed activities and resolve potential conflicts regarding any aspects of the operation or POC;
- a description of measures the applicant has taken or will take to ensure that proposed activities will not interfere with subsistence hunting; and
- what plans the applicant has to continue to meet with the communities, prior to and during the activity, to resolve conflicts and notify the community of any changes in the activity.

Input from the impacted bowhead whale subsistence communities indicates that they have historically found that the CAA process, through its highly interactive aspects, has effectively resulted in the development and implementation of measures that will ensure no unmitigable adverse impact. Based on this, for many years, NMFS generally found, after conducting an independent analysis, that if a company and the AEWC signed a CAA (which typically contained the components of a POC), then it was possible for a company to conduct their activity without having an unmitigable adverse impact on the bowhead whale subsistence hunt. However, in more recent years, some companies have become reluctant to sign a CAA with the AEWC. Additionally, some stakeholders have raised the issue that a CAA developed by the AEWC does not represent the interests of subsistence hunters of species other than bowhead whales. Last, NMFS and BOEM have no authority to require private agreements between third parties, and neither NMFS nor BOEM can enforce the provisions of CAAs because the federal government is not a party to the agreements. These concerns highlight NMFS’ responsibility to conduct a rigorous and comprehensive independent analysis of the likely subsistence impacts and to specifically review the contents of each company’s POC. However, the AEWC has raised concerns about the POCs, asserting that while the CAA process traditionally provided content for the regulatory POC process, the POC process as currently implemented by some companies takes place in a one-way fashion, i.e., the company develops a POC without meaningful input from the subsistence communities.

To date, individual companies conducting activities in a given year, as well as the impacted subsistence communities, are involved in meetings related to both the negotiation of CAAs (regardless of whether they are ultimately signed by either party) and the development of POCs. Participating in both of these processes necessitates a lot of work on the part of all parties. With input from both subsistence communities and the applicants for MMPA authorization, NMFS plans to explore methods of clarifying the requirements of the MMPA (as they relate to the POC and ensuring no unmitigable adverse impact) that would incorporate the effective pieces of the CAA negotiations, while continuing to ensure compliance with the MMPA as it relates to the subsistence hunt of all affected species.

Also, similar to the suggestions described above regarding making information available to applicants about monitoring priorities, NMFS could maintain a website containing information and recommendations regarding best practices for working and communicating with Alaska Native subsistence communities to ensure that there are no unmitigable adverse impacts. Information on the website could include:

- Contacts for native villages and co-management organizations
- A list of standard recommended mitigations that have been developed to mitigate subsistence impacts (those established in this Final EIS).
- A recommendation to coordinate with communities through the established CAA process to help ensure no unmitigable adverse impact *for bowhead whales* (not requiring that a CAA be signed, but recommending utilization of existing process);
- Information/maps indicating typical times and locations of marine mammal subsistence hunts.

It is worth noting that both the POC and CAA processes are all about good communication between the appropriate parties, which is absolutely necessary to minimize conflicts between subsistence and industry activities. In support of this, some companies have employed subsistence advisors who serve as the designated seasonal (or longer) contact between a given company and the affected communities and can organize and coordinate timely communication and action to help ensure that the industry activities don’t have an unmitigable adverse impact on subsistence uses.

5.4.2 Open Water Meeting

NMFS held Open Water Meetings from 1994 through 2013. As mentioned in Section 5.3.2, during the 1980s and early 1990s, the monitoring plan peer review and Open Water Meeting were the same meeting. However, as attendance at the Open Water Meeting began to grow exponentially beginning in 2006, it became apparent that the peer review needed to be split out into a separate meeting in order to ensure its efficacy. The Open Water Meeting evolved into a separate open access stakeholder meeting that was important to help ensure NMFS’ understanding, from the affected parties, of the effects of industry activity on the subsistence uses of marine mammals.

From 2006 to 2013, the Open Water Meeting included members of industry, Federal, state, and local government officials and scientists, Alaska Native marine mammal commissions, affected Alaska Native hunters and community members, environmental non-governmental organizations, and other interested members of the public. Typically, each year, the industry would present the results of their marine mammal monitoring programs from the previous year and the suite of activities proposed for the upcoming season along with the associated monitoring plans. Native subsistence group representatives (e.g., whaling captains, AEWC members) presented information related to impacts that industry activities may have had (either in the past year or historically) on their ability to effectively hunt a given species. There were also presentations regarding ongoing western and traditional science programs conducted in the region. Many of these science programs are designed to gain knowledge about the physical and chemical properties of the ecosystem and distribution and abundance trend patterns of marine mammals and other species in the area.

Unlike the monitoring plan peer review, the Open Water Meeting is not specifically required by statute or regulation. However, because of the importance of stakeholder input and interaction in NMFS’ determination of whether the take of marine mammals resulting from a specific activity will likely have an unmitigable adverse impact on subsistence uses, NMFS continued to organize this annual meeting. However, as the meeting continued to grow, it became increasingly difficult for NMFS to accomplish the primary remaining objective of the meeting, which was to solicit input from subsistence users on the impact of industry activities on their hunting, and, after the 2013 meeting, NMFS made a decision to no longer hold the Open Water Meeting.

Therefore, instead of holding the annual Open Water Meeting, NMFS staff will be working with subsistence communities, as well as industry, to determine the best ways to engage, which will likely include attending CAA meetings, Plan of Cooperation processes, Alaska Native Organization meetings and/or other meeting venues where key parties can meet for focused subsistence impact discussions. We believe that this approach will not only be more successful in meeting our objectives but will be a much more effective use of agency resources.

5.5 Adaptive Management

A simple definition of adaptive management is "a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs" (Holling, 1978). The process basically involves the following steps: predict, mitigate, implement, monitor, and adapt.

Adaptive Management is a discretionary learning-based management approach to structured decision-making that may be used in conjunction with the NEPA process. Adaptive management considers appropriate adjustments to federal actions (i.e. decisions related to the issuance of permits and authorizations under multiple statutes) and the associated required mitigation, monitoring, and reporting as the outcomes of previous proposed actions and required mitigation and monitoring, as well as new science, are better understood. NMFS and BOEM historically incorporated, and will continue to incorporate in the future, adaptive management principles in the issuance of permits and authorizations and any needed adjustments of mitigation and monitoring. The following are some of the specific sources of information upon which adaptive management decisions could be based during the life of this EIS:

(1) Results of monitoring required pursuant to MMPA ITAs or other Federal statutes for Arctic oil and gas development activities;

(2) Stakeholder input received during NMFS attendance at CAA, POC, or ANO meetings, or other meetings specifically targeted to better understand impacts on subsistence uses.;

(3) Scientific input from the independent peer review;

(4) Public input during comment periods on MMPA authorizations;

(5) Results from BOEM's Environmental Studies Program;

(6) Results from general marine mammal and sound research;

(7) Results from the efforts of the NOAA Working Groups on Underwater Sound Mapping and Cetacean Mapping in the Arctic and elsewhere;

(8) Results of the BP Cumulative Impact modeling of multiple sound sources in the Beaufort Sea;

(9) Any information which reveals that marine mammals may have been taken in a manner, extent, or number not authorized; and

(10) Traditional ecological knowledge.

The intent of adaptive management is to ensure: (1) the minimization of adverse impacts to marine mammals, subsistence uses of marine mammals, endangered species, and other protected resources, within the context of the associated regulations and statutes; (2) the maximization of value of the information gathered via required monitoring; and (3) industry compliance with environmental protection statutes and regulations. By explicitly laying out this adaptive management framework that identifies the types of information that will be considered and the types of changes that may be considered in order to effect the intent listed above (e.g., those in the Additional Mitigation section or those discussed above in the Monitoring and Reporting Improvement section), it allows for mitigation and monitoring modifications and improvements under the auspices of this EIS, without automatically necessitating a revised NEPA analysis. NMFS will continuously consider adaptive management as the agency executes the ITA program.

Specifically, as described previously, NMFS convenes an independent peer review panel annually to review and recommend changes to submitted Monitoring Plans based on their expertise and the types of information listed above. These recommendations are reflected, as deemed appropriate by NMFS, in changes to the monitoring required in ITAs. Further, NMFS considers the types of information listed above and the recommendations received from the public in the development and final requirements of every individual ITA issued, and mitigation and monitoring measures evolve and change over time based on public input, new information, and the project-specific findings. For example, some of the mitigation measures evaluated in this EIS include spatial or temporal limitations; however, marine mammal distribution may change over time. The adaptive management process is intended to allow for the appropriate modification of time/area closures and other measures in response to new science and developments in technology to implement mitigation measures.

In the past few years, NMFS, BOEM, and USFWS reviewed operational and marine mammal observer reports at weekly environmental/regulatory compliance review meetings related to Arctic OCS activities during the open water season. The purpose of the meetings was to verify environmental/regulatory compliance by the operators during the activity and to determine whether federal decisions on monitoring, mitigation, and reporting were achieving the intended results. If the intended results were not being achieved, the agencies could modify the requirements for ongoing operations, as needed.

BSEE has the responsibility to verify that required environmental monitoring, mitigation, and reporting protocols (i.e. for protected species) are implemented during seismic surveying and drilling activities on the OCS. BSEE has the authority to enforce compliance with environmental requirements on all drilling operations. BOEM continues as the regulatory authority for G&G activities.

BOEM and BSEE will also conduct post-activity reviews. The reviews will be used to:

- document environmental compliance;
- determine whether reporting requirements provide sufficient information on operations and their effects;
- evaluate monitoring and mitigation effectiveness;
- improve site-specific monitoring and mitigation requirements, if needed; and
- support the incorporation of compliance, mitigation, and monitoring efforts into future programmatic and site-specific environmental analyses.

6.0 CONSULTATION AND COORDINATION

6.1 Development of the EIS

The NOI to prepare an EIS published in the *Federal Register* on February 8, 2010 (75 FR 6175). NMFS initiated the scoping period, during which issues and concerns are identified, on February 8, 2010. This provided an opportunity for the oil industry, government organizations, tribal and local governments, environmental groups, the general public, and all other interested parties to comment on areas of interest or special concern regarding this EIS. The NOI also requested stakeholders to identify and provide information that should be considered by NMFS in preparation of the EIS. Scoping comments were received through April 9, 2010, as specified in the NOI and were used to identify issues of concern and develop the alternatives for this EIS. The scoping report summarizing the scoping comments and issues of concern is posted on the NMFS website at and is contained in Appendix C of this FEIS:

http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm.

On December 30, 2011, NMFS published a NOA for the *Effects of Oil and Gas Activities in the Arctic Ocean Draft Environmental Impact Statement* in the *Federal Register* (76 FR 82275). The public was afforded 60 days to provide comments on the DEIS. On January 30, 2013, NMFS published an NOI to prepare a Supplemental DEIS (78 FR 6303). On March 29, 2013, NMFS published an NOA for the *Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft Environmental Impact Statement* in the *Federal Register* (78 FR 19212). The public was afforded 90 days to provide comments on the SDEIS. The comment letters received during the DEIS and SDEIS public comment periods, as well as the transcripts of the public meetings, can be found at the above mentioned website.

NMFS is the lead agency for this EIS and is responsible for the development of the EIS in collaboration with the cooperating agencies. BOEM and the NSB participated as cooperating agencies. The EPA and USFWS participated as consulting agencies. NMFS also worked with the AEWC on the development of this EIS per our co-management agreement. NMFS shared preliminary drafts of the FEIS with the State of Alaska for their review.

Executive Order 13175 (*Consultation and Coordination with Indian Tribal Governments*), states that the U.S. Government will "*work with Indian tribes on a government-to-government basis to address issues concerning Indian Tribal self-government, trust resources, and Indian Tribal treaty and other rights.*" For government-to-government consultation during the scoping process for this EIS and the public comment period for the DEIS, Tribal governments in each community, with the exception of Anchorage, were notified of the EIS process and invited to participate. The Tribal Organizations that received invitations to participate are listed below. Native Village of Point Hope declined to participate at the scoping stage because they received less than one month of prior notification.

- Native Village of Nuiqsut
- Iñupiat Community of the Arctic Slope
- Native Village of Point Hope
- Native Village of Point Lay
- Native Village of Barrow
- Native Village of Wainwright
- Native Village of Kotzebue

All of the above mentioned groups were also notified at the DEIS and SDEIS public comment stage, and the Native Village of Kivalina was also contacted at that time.

6.2 Consultation

Section 7(a)(2) of the ESA requires each federal agency to ensure that any action that it authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. To satisfy its ESA obligations, NMFS will engage in the consultation and coordination processes with other regulatory agencies at the MMPA stage, and BOEM and BSEE will fulfill this requirement at the time of activity review.

6.3 Agencies and Organizations Contacted

The following lists the federal, state, tribal and local government agencies; academic institutions; members of the oil and gas industry; special interest groups; and other organizations who were notified of the availability of the FEIS.

Federal – Executive Branch	
Department of Commerce	National Marine Fisheries Service; National Marine Mammal Laboratory National Marine Fisheries Service, Alaska Region Office of the Assistant Secretary for Oceans and Atmosphere
Department of Defense	U.S. Army Corps of Engineers; Regulatory Branch, Alaska District
Department of Homeland Security	U.S. Coast Guard
Department of the Interior	National Park Service; Regional Director, Subsistence Division U.S. Fish and Wildlife Service; Alaska Regional Office U.S. Geological Survey; Biological Resources Division
Federal – Legislative Branch	
U.S. House of Representatives	Congressman Don Young
U.S. Senate	Senator Mark Begich Senator Lisa Murkowski
Federal – Administrative Agencies and Other Agencies	
	Arctic Research Commission Marine Mammal Commission Environmental Protection Agency; Office of Federal Activities, Region 10, NPDES Permit Unit, Alaska Operations Office, Anchorage

State of Alaska	
Alaska Oil and Gas Conservation Commission	Department of Transportation and Public Facilities
Department of Environmental Conservation	Office of the Governor
Department of Fish and Game	State of Alaska Washington, DC Representative
Department of Natural Resources	
Tribal and Local Governments – Alaska Native Organizations	
Alaska Beluga Whale Commission	NANA Regional Corporation Inc., Kotzebue
Alaska Eskimo Walrus Commission, Barrow	Native Village of Barrow
Alaska Eskimo Walrus Commission, Nome	Native Village of Kaktovik
Alaska Eskimo Whaling Commission	Native Village of Kivalina
Alaska Federation of Natives	Native Village of Kotzebue IRA
Alaska Inter-Tribal Council	Native Village of Nuiqsut
Alaska Nanuuq Commission	Native Village of Point Hope
Alaska Native Science Commission	Native Village of Point Lay
Arctic Slope Native Association	Native Village of Wainwright
Arctic Slope Regional Corporation	North Slope Borough Mayor’s Office
Barrow Whaling Captains Association	North Slope Borough, Department of Wildlife Management
City of Barrow, Mayor	Northwest Arctic Borough
City of Kaktovik, Mayor	Nunamiut Corporation, Anaktuvuk Pass
City of Kotzebue, Planning Division	Olgoonik Corporation, Wainwright
City of Nome, City Manager	Point Hope Whaling Captains Association
City of Nuiqsut, Mayor	Tigara Corporation, Point Hope
City of Point Hope, Mayor	Tikigaq Corporation, Point Hope
City of Wainwright, Mayor	Village Coordinator, Anaktuvuk Pass
Cully Corporation, Point Lay	Village Coordinator, Atqasuk
Ice Seal Committee	Village Coordinator, Kaktovik
Iñupiat Community of the Arctic Slope	Village Coordinator, Nuiqsut
Kaktovik Iñupiat Corporation	Village Coordinator, Point Hope
Kaktovik Whaling Captains Association	Village Coordinator, Wainwright
Kikiktagruk Iñupiat Corporation, Kotzebue	
Kuukpik Village Corporation, Nuiqsut	

Libraries	
Chukchi Consortium Library, Kotzebue	Kegoyah Kozpa Public Library, Nome
Government Publications, Juneau	Tikigaq Library, Point Hope
Kali Community School/Community Library	Trapper School Community Library, Nuiqsut
Kaveolook School Library, Kaktovik	Tuzzy Consortium Library, Barrow
	Z.J. Loussac Library, Anchorage
Petroleum Industry	
Alaska Clean Seas	Hilcorp Alaska LLC
American Petroleum Institute	Liberty Petroleum Corporation
BP Exploration (Alaska) Inc.	Marathon Oil Company
Chevron U.S.A. Inc.	Shell Offshore Inc.
ConocoPhillips Alaska Inc	Statoil
Eni Petroleum Exploration Co Inc	TGS
ExxonMobil Oil Corporation	Western Geophysical Company
ExxonMobil Production Company	
Associations, Companies, Special Interest Groups, and Others	
Alaska Coalition	Greenpeace
Alaska Conservation Foundation	Indigenous Peoples Council for Marine Mammals
Alaska Marine Conservation Council	Iñupiat Heritage Center
Alaska Native Knowledge Network, Fairbanks	LGL, Alaska Research Associates
Alaska Natural Heritage Program	National Audubon Society
Alaska Newspapers, Inc.	National Ocean Industries Association
Alaska Oil and Gas Association	National Parks and Conservation Association
Alaska Public Interest Research Group	National Wildlife Federation
Alaska Public Radio Network, Anchorage	Natural Resources Defense Council
Alaska Wilderness League	Northern Alaska Environmental Center
Arctic Marine Resource Commission	Ocean Conservancy
Arctic Sounder	PEW Environmental Group
Audubon Alaska	Resource Development Council for Alaska, Inc.
Center for Biological Diversity	Sierra Club
Center for Regulatory Effectiveness	Trustees for Alaska
Defenders of Wildlife	Wilderness Society
EarthJustice, Juneau	World Wildlife Fund

6.4 List of Preparers

Representatives from NMFS, BOEM, BSEE, EPA, USFWS, NSB, and the State of Alaska reviewed preliminary drafts of the FEIS. Initial versions of chapters were drafted by contractors.

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NSB	Department of Wildlife Management
USFWS	Louise Smith; Fish and Wildlife Biologist, Fairbanks Fish and Wildlife Conservation Office, Fairbanks, Alaska Hilary Cooley; Polar Bear Program Lead, Marine Mammals Management, Anchorage, Alaska Craig Perham, Polar Bear Wildlife Biologist, Marine Mammals Management, Anchorage, Alaska
State of Alaska	Sara Longan; Director, Office of Project Management and Permitting, Alaska Department of Natural Resources Gary Mendivil; Environmental Program Specialist, Office of the Commissioner, Alaska Department of Environmental Conservation
URS and Subcontractors	
URS[1] **(now AECOM)**	Jon Isaacs; Principal in Charge Erin Dunable; Project Manager and Biological Environment Maria Shepherd; Deputy Project Manager and Biological Environment Lisa Baraff; Biological Environment Kaley Volper; Biological Environment Eric Carlson; Physical Environment Thomas Damiana; Physical Environment Erin Gleason; Physical Environment Hannah Kroon; Physical Environment Steven Rusak, Ph.D.; Physical Environment Neal Smith; Physical Environment

[1]*URS Corporation joined AECOM on October 17, 2014. We are combining our operations and leadership to offer a wider range of services, with more technical experts, to our customers. Together AECOM and URS offer 100,000 employees, including nearly 350 in Alaska. Although the existing NMFS contract is with URS Group, Inc., we will be using AECOM branding for our deliverables, in support of this acquisition.*

	Elizabeth Appleby; Social Environment Tara Bellion; Comment Analysis, Administrative Record, and Social Environment Jessica Evans, Comment Analysis and Social Environment Louise Kling; Social Environment Ivy Schultz; Geographic Information Systems Thomas Schultz; Geographic Information Systems Linda Harriss; Word Processor Kelsey Tranel, Word Processor
Subcontractors	David Hannay; Jasco Applied Sciences, Acoustics Melanie Austin; Jasco Applied Sciences, Acoustics Murray Lee; Habitat, Health Impact Assessment Marla Orenstein; Habitat, Health Impact Assessment

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8.0 GLOSSARY

Acute—Sudden, short term, severe, critical, crucial, intense, but usually of short duration.

Anadromous fish—Fish that migrate up river from the sea to breed in fresh water.

Annelid—Worm with a cylindrical body segmented both internally and externally.

Annular preventer—A component of the pressure control system in the Blowout Preventer that forms a seal in the annular space around any object in the wellbore or upon itself, enabling well control operations to commence.

Anthropogenic—Coming from human sources, relating to the effect of humankind on nature.

Aphotic zone—Zone where the levels of light entering through the surface are not sufficient for photosynthesis or for animal response.

Archaeological resource—Any material remains of human life or activities that are at least fifty years of age and that are of archaeological interest.

Aromatic—Class of organic compounds containing benzene rings or benzenoid structures.

Attainment area—An area that is shown by monitored data or by air-quality modeling calculations to be in compliance with primary and secondary ambient air quality standards established by the USEPA.

Barrel (bbl)—A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Benthic—Literally, living on the bottom. Refers to material, especially sediment, at the bottom of an aquatic ecosystem, or it can be used to describe the organisms that live on, or in, the bottom of a water body or the sea.

Benthos—A region that includes the bottom of the sea and the littoral zone; also refers to the benthic invertebrate community, which is a group of animals that lives on or in the bottom sediments.

Biological Opinion—The FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species, in response to formal consultation under Section 7 or the endangered Species Act.

Block—A geographical area portrayed on official BOEMRE protraction diagrams or leasing maps that contains approximately 2,331 ha (9 mi2).

Blowout—An uncontrolled flow of fluids below the mudline from appurtenances on a wellhead or from a wellbore.

Blowout preventer (BOP)—One of several valves installed at the wellhead to prevent the escape of pressure either in the annular space between the casing and drill pipe or in open hole (i.e., hole with no drill pipe) during drilling completion operations. Blowout preventers on jackup or platform rigs are located at the water's surface; on floating offshore rigs, BOPs are located on the seafloor.

Brackish—Slightly salty water.

Cetacean—Large aquatic carnivorous mammal with fin-like forelimbs, no hind limbs includes whales, dolphins, porpoises, and narwhals. Also of or relating to these animals.

Chemosynthetic—Organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthesis).

Critical habitat—Specific areas within the geographical area occupied by the species at the time of listing (under the ESA), if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and specific areas outside the geographical area occupied by the species if the agency (USFWS or NMFS) determines that the area itself is essential for conservation.

Coastal waters—Waters within the geographical areas defined by each state's Coastal Zone Management Program.

Coastal wetlands—Forested and nonforested habitats, mangroves, and marsh islands exposed to tidal activity. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for birds and other animals.

Coastal zone—The coastal waters (including the lands therein and thereunder) and the adjacent shore lands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the U.S. territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shore lands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the federal government, its officers, or agents. (The state land and water area officially designated by the state as "coastal zone" in its state coastal zone program as approved by the U.S. Department of Commerce under the Coastal Zone Management Act.)

Condensate—Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensates generally have an API gravity of 50o-120o.

Continental margin—The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf—The gently seaward-sloping surface that extends between the shoreline and the top of the continental slope at about 150 meters (345 feet) depth. The average gradient of the shelf is between 1:500 and 1:1000 and, although it varies greatly, the average width is approximately 70 kilometers (44 miles). This can also be a judicial term; for example, the outer limit of the legal continental shelf is determined by reference to be a distance of 200 nautical miles (370 kilometers, 230 miles) or to the outer edge of the geological continental margin, wherever the margin extends beyond 200 nautical miles (370 kilometers; 230 miles).

Contingency Plan—A plan for possible offshore emergencies prepared and submitted by the oil or gas operator as part of the plan of development and production, and which may be required for part of the plan of exploration.

Continental slope—That part of the continental margin that lies between the continental shelf and the bottom of the ocean. Sunlight does not penetrate this area, and mostly it is home to scavengers. It is characterized by a relatively steep slope of 3 to 6 degrees.

Critical habitat—a designated area that is essential to the conservation of an endangered or threatened species that may require special management considerations or protection.

Crude oil—Petroleum in its natural state as it emerges from a well, or after it passes through a gas-oil separator but before refining or distillation. An oily, flammable, bituminous liquid that is essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

Crustacean—Includes a diversity of marine, freshwater, and terrestrial animals. All crustaceans have a head and five pairs of appendages, two of which are antennae. Many microscopic crustaceans, like krill and brine shrimp, are marine plankton, an important food source for other animals in the sea. Shrimp, lobsters, crabs, crayfish, and barnacles are crustaceans.

Deferral—Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from the proposed sale.

Delineation well—A well that is drilled for the purpose of determining the size and/or volume of an oil or gas reservoir.

***Deepwater Horizon* (DWH) event**—All actions stemming from the April 20, 2010, explosion and subsequent sinking of the Transocean drillship *Deepwater Horizon*, up to and including the Macondo well kill declaration on September 19, 2010.

Depleted species—Defined by the MMPA as any case in which: (a) the Secretary of Commerce, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals, determines that a species or population stock is below its optimum sustainable population; (b) a State determines that such species or stock is below its optimum sustainable population; or (c) a species or population stock is listed as a threatened species or endangered species under the ESA.

Demersal—Living near, deposited on, or sinking to the bottom of the sea.

Development—Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Document (DOCD)—A document that must be prepared by the operator and submitted to BOEMRE for approval before any development or production activities are conducted on a lease in the Western Gulf.

Diapause—A state of rest, halted development, or arrested development or growth, accompanied by greatly decreased metabolism, often correlated with the seasons, usually applied only to insects.

Dilution—The reduction in the concentration of dissolved or suspended substrates by mixing with water.

Direct employment—Consists of those workers involved the primary industries of oil and gas exploration, development, and production operations (Standard Industrial Classification Code 13—Oil and Gas Extraction).

Discharge—Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersant—A suite of chemicals and solvents used to break up an oil slick into small droplets, which increases the surface area of the oil and hastens the processes of weathering and microbial degradation.

Dispersion—A suspension of finely divided particles in a medium.

Distinct Population Segment (DPS)—A vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. Distinct population segments may be listed as threatened or endangered under the ESA.

Drilling mud—A mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up the annulus between the pipe and the walls of the borehole to a surface pit or tank. The mud lubricates and cools the drill bit, lubricates the drill pipe as it turns in the wellbore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to downhole pressures; also called drilling fluid.

Drillship—A self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water.

Effluent—A waste product that is discharged to the environment, usually used to mean treated wastewater discharged from a wastewater treatment plant, sewer, or industrial outfall.

Effluent limitations—Any restriction established by a state or the EPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged from point sources into U.S. waters, including schedules of compliance.

Endangered species—Defined under the ESA as "any species which is in danger of extinction throughout all or a significant portion of its range."

Environmental Assessment—A concise public document required by the National Environmental Policy Act of 1969 (NEPA). In the document, a federal agency proposing (or reviewing) and action provides evidence and analysis for determining whether it must prepare an EIS or whether it finds there is no significant impact (i.e., Finding of No Significant Impact [FONSI]).

Environmental effect—A measurable alteration or change in environmental conditions.

Environmental Impact Statement (EIS)—A statement required by NEPA or similar state law in relation to any major action significantly affecting the environment; a NEPA document.

Epifaunal—Animals living on the surface of hard substrate.

Essential Fish Habitat (EFH)—Defined under the Magnuson-Stevens Fishery Conservation and Management Act as waters and substrate that are necessary to the fish species for spawning, breeding, feeding, or growth to maturity.

Estuary—Coastal semienclosed body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Eutrophication—The process whereby an aquatic environment becomes rich in dissolved nutrients, causing excessive growth and decomposition of oxygen-depleting plant life and resulting in injury or death to other organisms.

Exclusive Economic Zone (EEZ)—The maritime region extending 200 nm from the baseline of the territorial sea, in which the U.S. has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration—The process of searching for minerals. Exploration activities include: (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the presence of such minerals; and (2) any drilling, except development drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made, and the drilling, after such a discovery, of any additional well that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

Exploration Plan (EP)—A plan that must be prepared by the operator and submitted to BOEMRE for approval before any exploration or delineation drilling is conducted on a lease.

Exploration well—A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present; exploratory well.

Fault—A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Field—An accumulation, pool, or group of pools of hydrocarbons in the subsurface. A hydrocarbon field consists of a reservoir in a shape that will trap hydrocarbons and that is covered by an impermeable, sealing rock.

Fixed or bottom founded—Permanently or temporarily attached to the seafloor.

Flyway—An established air route of migratory birds.

Formation—A bed or deposit sufficiently homogeneous to be distinctive as a unit. Each different formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

Fugitive emissions—Emission into the atmosphere that could not reasonably pass through a stack, chimney, vent or other functionally equivalent opening.

Gathering lines—A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical—Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geologic hazard—A feature or condition that, if unmitigated, may seriously jeopardize offshore oil and gas exploration and development activities. Mitigation may necessitate special engineering procedures or relocation of a well.

Geophysical—Of or relating to the physics of the earth, especially the measurement and interpretation of geophysical properties of the rocks in an area.

Geophysical data—Facts, statistics, or samples that have not been analyzed or processed, pertaining to gravity, magnetic, seismic, or other surveys/systems.

Geophysical survey—A method of exploration in which geophysical properties and relationships are measured remotely by one or more geophysical methods.

Habitat—A specific type of environment that is occupied by an organism, a population, or a community.

Halophytic—A plant that can tolerate or thrive in alkaline soil rich in sodium or calcium salts; tolerant of saline (salty) conditions.

Harassment—Under the 1994 amendments to the MMPA, harassment is statutorily defined as any act of pursuit, torment, or annoyance which: has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (Level B Harassment).

Haulout area—Specific locations where pinnipeds come ashore and concentrate in numbers to rest, breed, and/or bear young.

Holocene Epoch—A geologic time segment of the Quaternary Period, dating from the end of the Pleistocene Epoch, approximately 8,000 years ago until the present.

Hydrocarbons—Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hypothermia—Condition in which body temperature drops below the level required for normal metabolism and/or bodily function to take place.

Hypoxia—Depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

Incidental take—Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a federal agency or applicant (see Taking).

Indigenous—Originating where it is found. Refers to species or peoples found locally and from the local area.

Indirect effects—Effects caused by activities that are stimulated by an action but not directly related to it.

Industry infrastructure—The facilities associated with oil and gas development (e.g., refineries, gas processing plants).

Indirect employment—Secondary or supporting oil- and gas-related industries, such as the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants.

Intertidal—The zone between the high and low water marks.

Invertebrate—An animal without a backbone or spinal column, such as an insect.

Isobath—Line connecting points of equal water depth on a nautical chart; a seabed contour.

Jackup rig—A barge-like, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Lagoon—A water body often separated from ocean water exchange, with enclosure as a defining characteristic.

Lease—Authorization that is issued under and that authorizes exploration for, and development and production of, minerals. Lease means an agreement that is issued under Section 8 or maintained under Section 6 of the OCSLA and that authorizes exploration for, and development and production of, minerals. The term also means the area covered by that authorization, whichever the context requires.

Lease sale—The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lease term—The initial period for oil and gas leases, usually a period of 5, 8, or 10 years depending on water depth or potentially adverse conditions.

Lessee—A party who has entered into a lease with the U.S. to explore for, develop, and produce the leased minerals.

Lightering—Smaller boats supplying larger boats with supplies and/or carrying fuel; lightering operations include transfers within the vessel, to lightering barges, or if necessary, into the sea.

Lithic—Of or pertaining to stone.

Macondo Oil Spill—The name given to the oil spill that resulted from the explosion and sinking of the *Deepwater Horizon* rig from the period between April 24, 2010, when search and recovery vessels on site reported oil at the sea surface until uncontrolled flow from the Macondo well was capped.

Marshes—Persistent, emergent, nonforested wetlands characterized by predominantly cordgrasses, rushes, and cattails.

Migratory bird—Any mutation or hybrid of a listed species, as well as any part, egg, or nest of such bird. Protected under the MBTA.

Minerals—As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Mollusk—An invertebrate having a soft unsegmented body, usually enclosed in a shell. Also a group of freshwater and saltwater animals, including oysters, clams, mussels, snails, conches, scallops, squid, and octopus.

Mysticete—A whale that has baleen (plates of keratinized tissue that hang from the upper jaw) instead of teeth (suborder Mysticeti). Examples include the humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), and minke whale (*Balaenoptera acutorostrata*).

Nautical mile—A distance measurement equivalent to 1.15 statutory miles, or 1.8 kilometers.

Nearshore waters—Offshore open waters that extend from the shoreline out to the limit of the territorial seas (twelve nautical miles).

Nonattainment area—An area that is shown by monitoring data or by air-quality modeling calculations to exceed primary or secondary ambient air quality standards established by the EPA.

Odontocete—Toothed marine mammals (suborder Odontoceti). Examples include the sperm whale (*Physeter macrocephalus*), beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), and bottlenose dolphin (*Tursiops truncatus*).

Offloading—Unloading liquid cargo, crude oil, or refined petroleum products.

Offshore—In beach terminology, the comparatively flat zone of variable width, extending from the shore to the edge of the continental shelf. It is continually submerged. Also the breaker zone directly seaward of the low tide line.

Oil spill contingency plan—A plan submitted by the lease or unit operator along with or prior to a submission of a plan of exploration or a development/production plan that details provisions for fully defined specific actions to be taken following discovery and notification of an oil spill occurrence.

Operational discharge—Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator—An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Organic matter—Material derived from living plants or animals.

Outer Continental Shelf (OCS)—All submerged lands that comprise the continental margin adjacent to the U.S. and seaward of state offshore lands.

Pelagic—Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Perturbation—A secondary influence on a system that causes it to deviate.

Plankton—Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Pathology—The scientific study of the nature of disease and its causes, processes, development, and consequences.

Phocid—True or earless seals (family Phocidae). Examples include the bearded seal (*Erignathus barbatus*) and ringed seal (*Phoca hispida*).

Phytoplankton—Microscopic floating aquatic plants that produce their own nutrients through photosynthesis.

Pinniped—Aquatic carnivorous mammals having a streamlined body specialized for swimming with limbs modified as flippers, for example, seals.

Platform—A steel or concrete structure from which offshore development wells are drilled.

Plankton—Very small, free-floating organisms of the ocean or other aquatic systems, including phytoplankton and zooplankton, which get their nutrients from organisms.

Play—A prospective subsurface area for hydrocarbon accumulation that is characterized by a particular structural style or depositional relationship.

Plume—A narrow thermal feature, which can be either hot or cold, that rises or sinks because of its anomalous temperature compared to the surrounding fluid.

Polychaete—A class of mainly marine annelids, characterized by parapodia bearing numerous hairs; for example, bristle worm.

Polychlorinated Biphenyls (PCBs)—A group of toxic, carcinogenic organic compounds previously used for industrial purposes.

Polycyclic Aromatic Hydrocarbon (PAH)—Chemical compounds that consist of fused aromatic rings; many are known or suspected carcinogens.

Potential impact (effect)—The range of alterations or changes to environmental conditions that could be caused by an action.

Primary production—Organic material produced by photosynthetic or chemosynthetic organisms.

Produced water—Total water discharged from the oil and gas extraction process; production water or production brine.

Production—Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Promulgated—Formally made public; published accounts.

Prospect—An untested geologic feature having the potential for trapping and accumulating hydrocarbons.

Province—A spatial entity with common geologic attributes. A province may include a single dominant structural element such as a basin or a fold belt, or a number of contiguous related elements.

Refining—Fractional distillation of petroleum, usually followed by other processing (for example, cracking).

Relief—The difference in elevation between the high and low points of a surface.

Reserves—Proved oil or gas resources.

Reservoir—A subsurface, porous, permeable rock boy in which hydrocarbons have accumulated.

Rig—A structure used for drilling an oil or gas well.

Right-of-way—A legal right of passage, an easement; the specific area or route for which permission has been granted to place a pipeline, (and) ancillary facilities, and for normal maintenance thereafter.

Rookery—The nesting or breeding grounds of gregarious (i.e., social) birds or mammals; also a colony of such birds or mammals.

Royalty—A share of the minerals produced from a lease paid in either money or “in-kind” to the landowner by the lessee.

Sale area—The geographic area of the OCS being offered for lease for the exploration, development, and production of mineral resources.

Scoping—The process prior to EIS preparation to determine the range and significance of issues to be addressed in the EIS for each proposed major federal action.

Seagrass beds—More or less continuous mats of submerged, rooted marine flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.

Seismic—Pertaining to, characteristic of, or produced by water, earthquakes or earth vibration; having to do with elastic waves in the earth; also geophysical when applied to surveys.

Sediment—Material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Seeps (hydrocarbon)—Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Sensitive area—An area containing species, populations, communities, or assemblages of living resources, that is susceptible to damage from normal OCS-related activities. Damage includes interference with established ecological relationships.

Stranding—Defined under the MMPA as "an event in the wild in which (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance."

Stipulations—Specific measures imposed upon a lessee that apply to a lease. Stipulations are attached as a provision of a lease; they may apply to some or all tracts in a sale. For example, a stipulation might limit drilling to a certain time period of the year or certain areas.

Subarea—A discrete analysis area.

Subsistence uses—The customary and traditional uses by rural residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handcraft articles out of nonedible byproducts of fish and wildlife resources take for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade.

Substrate—Any stratum lying underneath another.

Supply vessel—A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Take—In the MMPA, meaning "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." In the Endangered Species Act, the definition includes to harass, harm, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. A notable component of this definition is "harm," which means an act that actually kills or injures protected wildlife. Such acts may include significant habitat modification or degradation that actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering.

Tertiary—A geologic period dating from 63 million to 2 million years ago.

Threatened species—Defined under the ESA as “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.”

Total suspended solids—The total amount of suspended solids in water.

Turbidity—Reduced water clarity due to the presence of suspended matter.

Trawling—The operation of towing a net (trawl) to catch fish and/or shellfish. Trawls are towed either with bottom contact or in midwater. The towing speed varies, according to such factors as the type of trawl and trawling and the target species.

Trophic—Trophic levels refer to the hierarchy of organisms form photosynthetic plants to carnivores, such as man; feeding trophic levels refer to the hierarchy of organisms from photosynthetic plants to carnivores in which organisms at one level are fed upon by those at the next higher level (e.g., phytoplankton eaten by zooplankton eaten by fish).

Turbidity—Reduced water clarity resulting from the presence of suspended matter.

Upwelling—Divergence of water currents or the movement of surface water away from land, leading to upward movement of cold nutrient-rich water from the ocean depths; often associated with great production of fish and fisheries.

Volatile organic compound (VOC)—Any reactive organic compound that is emitted to the atmosphere as a vapor. The definition does not include methane.

Weathering (of oil)—The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.