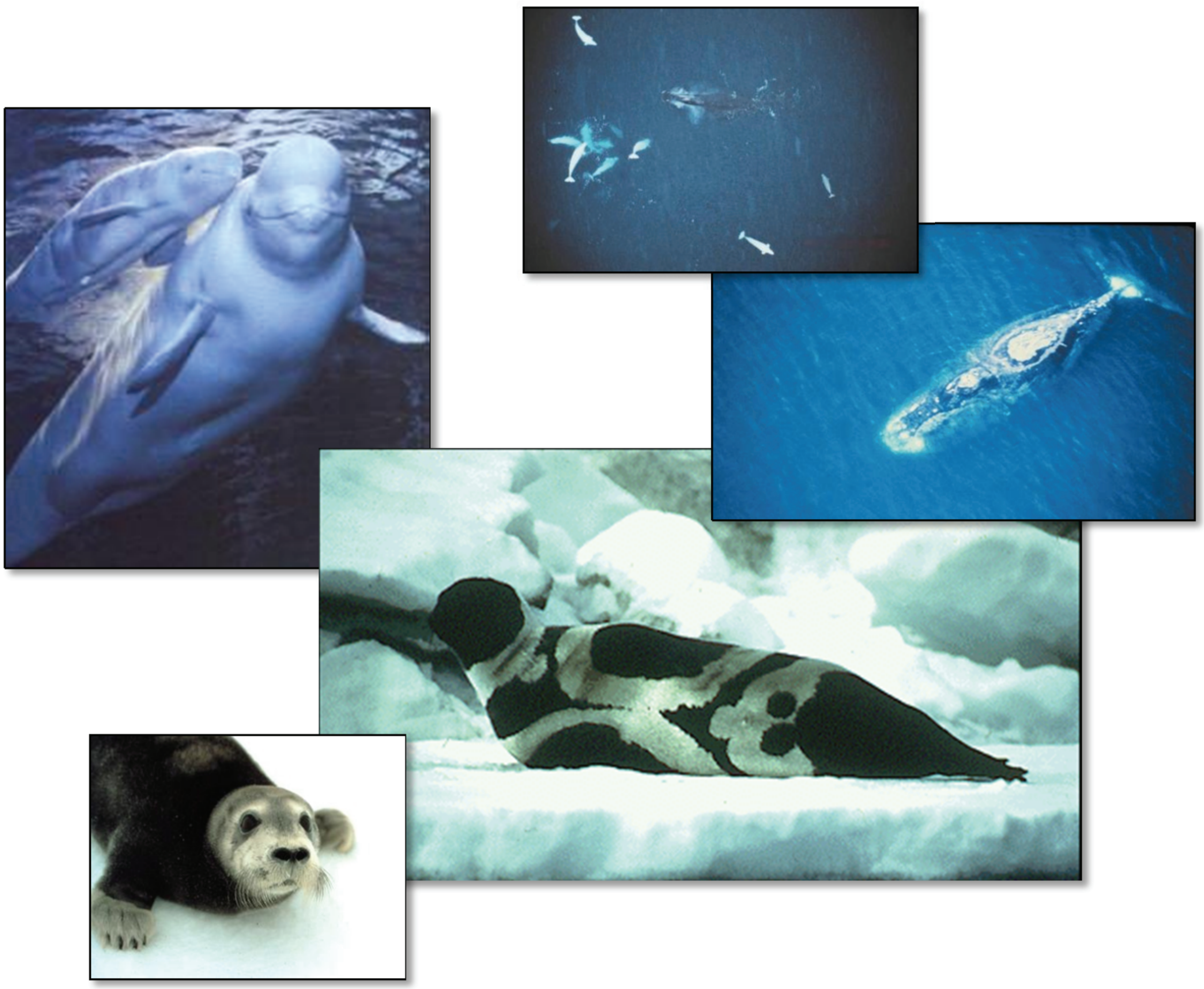
Effects of Oil and Gas Activities in the Arctic Ocean

Draft Environmental Impact Statement

Volume 2: Chapters 4-6



December 2011

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

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LIST OF ACRONYMS AND ABBREVIATIONS

1D	One-dimensional
2D	Two-dimensional
3D	Three-dimensional
4D	Four-dimensional
AAC	Alaska Administrative Code
ACP	Arctic Coastal Plain Physiographic Province
ACMP	Alaska Coastal Management Act of 1977
ACP	Arctic Coastal Plain
ADCCED	Alaska Department of Commerce, Community, and Economic Development
ADCP	Acoustic Doppler Current Profile
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADLWD	Alaska Department of Labor and Workforce Development
ADNR	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission
AF	Arctic Foothills Physiographic Province
AHRS	Alaska Heritage Resource
AMNWR	Alaska Maritime National Wildlife Refuge
AN(SW)T	Ambient-Noise (Surface-Wave) Tomography
ANCSA	Alaska Native Claims Settlement Act
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
ANILCA	Alaska National Interest Lands Conservation Act
ANOs	Alaska Native Organizations
ANWR	Arctic National Wildlife Refuge
AO	Arctic Oscillation
AOOS	Alaskan Ocean Observing system
APD	Application for Permit to Drill
APP	Alaska Pipeline Project
AQRV	air quality related values
ARRT	Alaska Regional Response Team
ASNA	Arctic Slope Native Association

ASRC	Arctic Slope Regional Corporation
BACT	Best Available Control Technology
bbl	barrels
BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BOEMRE	U.S. Bureau of Ocean Energy Management, Regulation and Enforcement
BOWFEST	Bowhead Whale Feeding Ecology Study
BSEE	Bureau of Safety and Environmental Enforcement
BWASP	Bowhead Whale Aerial Survey Program
°C	Degrees-Celcious (spelling?)
CAA	Conflict Avoidance Agreement
CAH	Central Arctic Caribou Herd
cANIMIDA	Continuation of Arctic Nearshore Impact Monitoring in Development Area
CAR	Comment Analysis Report
CatExs	Categorically Excludes
CDS	conical drilling unit
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
CH_4	Methane
CBS	Chukchi/Bering Seas stock
CIDS	Concrete Island Drilling Structure
CLRD	Chronic lower respiratory disease
cm	Centimeter
cm^3	Cubic centimeter
cm/s	Centimeters per second
CO	carbon monoxide
CO_2	Carbon Dioxide
CO_2e	carbon dioxide equivalent
COA	corresponding onshore area
COMIDA	Chukchi Offshore Monitoring in Drilling Area Survey Project
CSPA	Chukchi Sea Planning Area

CPAI	ConocoPhillips Alaska, Inc
CPUE	Catch Per Unit Effort
CSEM	Controlled Source Electromagnetic
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
D	Drilling
DAO	Department Administrative Order
dB	Decibel
dBA	A-weighted sound level
dB re 1 µPa rms	Decibels Relative to 1 micropascal Root Mean Square
DCOM	Division of Coastal and Ocean Management
DCRA	Division of Community and Regional Affairs
DDT	dichlorodiphenyltrichloroethane
deg.	Degrees
DEIS	Draft Environmental Impact Statement
Detritus	Dead
DEW	Distant Early Warning
DLI	Daylight Imaging
DMLW	Division of Mining, Land and Water
DO&G	Department of Oil and Gas
DOC	U.S. Department of Commerce
DPEIS	Draft Programmatic Environmental Impact Statement
DS	Deep Seismic Survey
DTAGS	Deep-towed Acoustics/Geophysics System
DPP	Development and Production Plan
DWG	Supplemental Final EIS
EA	Environmental Assessment
Ecotone	salinity transition zone
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EP	Exploration Plan
EPA	U.S. Environmental Protection Agency

EMS	Emergency Medical Services
EO	Executive Order
EP	Exploration Plan
EPA	U.S. Environmental Protection Agency
ERD	Extended Reach Drilling
ERM	Effects Range Median
ERL	Effects Range Low
ESA	Endangered Species Act
ESP	Environmental Studies Program
EVOS	Exxon Valdez Oil Spill
°F	Degrees-Fahrenheit
FEIS	Final Environmental Impact Statement
FLIR	Forward Looking Infrared
FM	frequency-modulated
FMPs	Fishery management plans
FOSC	Federal On-Scene Coordinator
FONSI	Finding of No Significant Impact
FR	Federal Register
ft	Feet
FY	fiscal year
g	gram
G&G	Geological and Geophysical
GAO	Government Accountability Office
GHG	Greenhouse Gas
GIS	Geographic Information System
Gm	geographic mile
GPS	Global Positioning System
GTP	gas treatment plant
HAP	hazardous air pollutants
Hg	elemental mercury
$HgCl_2$	Mercuric chloride
HIV	Human Immunodeficiency Virus
HRS	High Resolution Seismic

HyMAS	Hydrocarbon Microtremor Analysis
Hz	Hertz
IAP	Integrated Activity Plan
IB	Icebreaking
ICAS	Inupiat Community of the Arctic Slope
IHA	Incidental Harassment Authorization
in	Inch
in^3	Cubic Inch
IMPROVE	Interagency Monitoring of Protected Visual
ISER	Social and Economic Research
ITA	Incidental Take Authorization
IVI	Industrial Vehicle International
IWC	International Whaling Commission
Kg	kilograms
kHz	kilohertz
KIC	Kikiktagruk Inupiat Corporation
km	Kilometer
km_2	square kilometers
kn	Knot
LACS	Low Level Acoustic Combustion Source
Lb	pounds
LBCHU	Ledyard Bay Critical Habitat Unit
LCU	Lower Cretaceous Unconformity
L_{eq}	Equivalent sound level
LET	Local Earthquake Tomography
LME	Large Marine Ecosystem
L_{min}	RMS maximum noise level
L_{min}	RMS minimum noise level
LOA	Letters of Authorization
LFS	Low-Frequency Spectroscopy
LRI	lower respiratory tract infections
m	Meter
mg/kg	milligrams per kilograms

Mg/L	Milligrams per liter
Mg/m^3	Milligrams per cubic meter
mi	Mile
min.	Minutes
MIRIS	Michigan Resource Information System
mm	Millimeter
MMbbls	million barrels
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MMt	million metric tons
MODU	Mobile Offshore Drilling Unit
Mph	Miles per hour
MSFCMA	Magnuson Stevens Fishery Conservation and Management Act
my	million years
myBP	million years before present
µPa	Micro Pascal
NAAQS	National Ambient Air Quality Standards
NAB	Northwest Arctic Borough
NANA	NANA Regional Corporation
NAO	North Atlantic Oscillation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEP-A	National Environmental Policy Act
Ng/L	parts per trillion
NGO	non-governmental organization
NH	ammonia
NM	Nautical Miles
NMFS	National Marine Fisheries Service
NMI	nautical miles
NO	nitrogen oxides
N_2O	Nitrous Oxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent

NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fisheries Management Council
NPR-A	National Petroleum Reserve–Alaska
NRC	National Research Council
NSR	New Source Review
NTL	Notice to Lessees
NTU	Nephelometric Turbidity Units
NVDs	Night Vision Devices
NPFMC	North Pacific Fisheries Management Council
NPS	National Park Service
NRHP	National Register of Historic Places
NSB	North Slope Borough
NSB DHHS	North Slope Borough Department of Health and Social Services
NSR	New Source Review
O_3	ozone
OBC	Ocean-bottom-cable
OBN	ocean bottom node
OCRM	Office of Ocean and Coastal Resource Management
OCS	Outer Continental Shelf
ODPCP	Oil Discharge Prevention and Contingency Plan
OMB	U.S. Office of Management and Budget
OPEC	Organization of Petroleum-Exporting Countries
OSRB	Oil Spill Response Barge
OSRO	Oil Spill Removal Organizations
OSRP	Oil Spill Response Plan
OSRV	Oil Spill Response Vessels
Pa	Pascals
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PCB	Polychlorinated Biphenyl
PCH	Porcupine Caribou Herd
PDO	Pacific Decadal Oscillation
PEA	Programmatic Environmental Assessment

PEIS	Programmatic Environmental Impact Statement
PILT	payment in lieu of tax
PGS	Petroleum Geo-Services
$PM_{2.5}$	Particulate matter 10 microns in diameter
PM_{10}	Particulate matter 10 microns in diameter
P	Pressure
P_1	Sound having pressure
POC	Plan of Cooperation
P_{ref}	Standard Reference Pressure
ppm	parts per million
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
Psi	per square inch
PSO	Protected Species Observer
psu	practical salinity units
PTE	potential-to-emit
PTS	permanent threshold shifts
R/B	biomass ratio
RDD	Resource Development Districts
RFFA	reasonably foreseeable future actions
RMS	root-mean-square
ROD	Record of Decision
RSC	reduced sulfur compounds
RUSALCA	Russian-American Long-term Census of the Arctic
s	Second
SA	Subsistence Advisor
SAR	Search and Rescue
SBI	Shelf Basin Interactions
SBS	Southern Beaufort Sea stock
SCR	Selective catalytic control
SEL	sound exposure level
SEIS	Supplemental Environmental Impact Statement
SEMS	Safety and Environmental Management Systems

SFEIS	Supplemental Final EIS
SO	sulfur dioxide
SOPCs	Stressors of Potential Concern
SQRU	Scenic Quality Rating Unit
SSV	Sound Source Verification
SDC	Steel Drilling Caisson
SLRU	Sensitivity Level Rating Unit
SPLASH	Structure of Populations, Levels of Abundance, and Status of Humpbacks
SQRU	Scenic Quality Rating Unit
STI	Sexually transmitted infection
TA&R	Technology Assessment & Research
TAPS	Trans-Alaska Pipeline System
TB	Tuberculosis
TCH	Teshekpuk Caribou Herd
TCP	Traditional cultural properties
TK	Traditional Knowledge
TPY	tons per year
TTS	temporary threshold shifts
µPa	Micro Pascal
ULSD	ultra-low sulfur diesel
URI	Upper respiratory tract infection
U.S.	United States of America
USACE	U.S. Army Corps of Engineer
USCG	U.S. Coast Guard
USDOI	U.S. Department of the Interior
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
USPS	U.S. Park Service
VLCC	Very Large Crude Carrier
VLOS	Very Large Oil Spill
VOC	volatile organic compounds
WAH	Western Arctic Caribou Herd
WCD	Worst Case Discharge

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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 several 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 a large oil spill within the EIS project area. A large oil spill is not considered part of the proposed action for any alternative because the occurrence of an oil spill is a highly unlikely event. However, if a 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 4.9 of this EIS.

4.1 Analysis Methods and Impact Criteria

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

Direct Impacts – caused by the action and occur at the same time and place (40 Code of Federal Regulations [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 Impacts – defined as effects which are "*caused by an action and are later in time or farther removed in distance but are still reasonably likely. 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 impacts are caused by the project, but do not occur at the same time or place as the direct impacts;

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 4.10.1 and 4.10.2 describe the steps involved in the cumulative impact assessment; and

Reasonably Foreseeable Future Actions – this term is used in concert with the Council on Environmental Quality (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, reasonably foreseeable future actions (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 kilometers (km) (200 miles [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 offshore 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 years (from 2012 to 2017) 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 know, 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 OCS activities over the next five years. 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 OCS activities may affect environmental features. Therefore, consistent with the CEQ regulations, this EIS identifies those areas where information is unavailable to support a thorough evaluation of the environmental consequences of the alternatives. Efforts have been made to obtain all relevant information; however, gaps in some baseline data still exist at this time for several reasons, such as the costs of obtaining the missing data are exorbitant, the data will take several years to obtain, or the means to obtain the data are unknown. Limited resources to collect and analyze baseline information due to limited funding are problematic. Where data gaps still exist, the EIS provides the information listed above, according to CEQ guidelines.

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. 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, or last no more than a single season.

Long-term: Impacts would be frequent or extend up to several years.

Permanent: 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. The portion of the resource affected fills a distinctive ecosystem role within the locality or the region.

Unique: The affected resource is protected by legislation 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.

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”. 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.

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 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 or permanent in duration, a regional or state-wide extent, and affect important or unique resources.

[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.

4.1.4 Resources Not Carried Forward for Analysis

Resources that were chosen for analysis in this EIS have a distinct nexus with offshore oil and gas seismic exploration activities and the authorized take of marine mammals that could occur from 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

The following discussion provides potential assumptions and scenarios about how geophysical survey methods and exploratory drilling programs could be deployed 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) will only occur on active leases, along potential pipeline corridors, and on leases acquired in future lease sales (both federal and state) that can reasonably be explored within the time period of this EIS (i.e. 2012 to 2017). 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 (i.e. 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. Active federal leases include 34 leases from the Sale 186 area (15,217 hectares), 117 leases from Sale 195 (170,464 hectares), and 90 leases from Sale 202 (196,276 hectares) in the Beaufort Sea; and 487 leases (1,116,277 hectares) from the Sale 193 area 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; however, the Point Thomson Project area (to be offered for lease by the State in December 5, 2011 sale) is beyond Bullen Point to the east. There are currently no State of Alaska leases in the Chukchi Sea. As of May 2011, the State has 360,435 acres on 189 leases in the Beaufort Sea. Exploratory activities (drilling and seismic surveys) could occur in any of these active state leases within the five year period beginning in 2012. The State of Alaska plans to conduct area-wide lease sales in the Beaufort Sea annually through 2015, potentially adding new areas where exploratory activities could occur. 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, one seismic or marine survey "program" entails however many survey areas a particular company is planning for that open water season. Each seismic or marine survey "program" would use only one source vessel (or two if the vessels are working in tandem such as with ocean-bottom cable seismic surveys) to conduct the program and would not survey multiple sites concurrently. One exploratory drilling program can entail multiple wells drilled by a single drilling platform (operated by one or multiple companies working together) working under a single approved Exploration Plan in a single season on specific leases. However, only one well would be drilled at a time for a specific program during the season.

Different combinations of seismic activity types could potentially occur under the different action alternatives within the overall limits for the two levels of activity outlined in Chapter 2 (Sections 2.4.2 and 2.4.3). For the purposes of analysis only in this EIS, the different types and numbers of seismic exploration activity that could occur under the action alternatives will be analyzed as identified in Tables 4.2-1 and 4.2-2 below. A conceptual example of temporal and spatial distributions that could occur for exploration activities is depicted for Alternative 2 and Alternative 3, and can be seen in Figures 4.3-1 through 4.3-3 for the Beaufort Sea and Figures 4.4-1 through 4.4-3 for the Chukchi Sea. 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 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 Alternatives 3, 4, and 5 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 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)	

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 will be one 2D/3D seismic survey in state waters of the Beaufort Sea each season. There will 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 will 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 within 90 days per survey, not including downtime.
- 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, 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 ocean-bottom cable (OBC) surveys are also used to acquire 2D and 3D data. Vibroseis surveys occur in nearshore 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 surveys are conducted during open water in nearshore 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 will only be 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 45-90 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

While 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, as part of the assumptions for analysis in this EIS, it is assumed that exploratory drilling will 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 five-year analysis window (2012 to 2017). 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, anchor handling, oil spill response, capping and spill containment, refueling, resupply, and servicing the drilling operations. The ice management vessels will consist of an icebreaker.
- 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 marine bases in the Canadian Beaufort Sea (e.g. Tuktoyaktuk) or the Russian Arctic.
- Timing of operations would commence in approximately early July and end by early November.
- Drilling could occur on multiple drill sites per drilling program per year, allowing for up to four wells to be drilled per season depending upon weather and ice conditions. For purposes of analysis, assume up to three wells could be drilled in the season.

- 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 drillship, SDC, or other MODU (under tow) and associated support vessels will 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.

Open-water exploratory drilling currently does not occur in state waters of the Beaufort Sea. Exploratory drilling on state leases would likely occur from artificial ice islands, where the drilling is done directionally. 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 generally 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

While exploratory drilling located in offshore portions of the Chukchi Sea could occur on any active lease, 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 will likely occur initially in areas 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 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. 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) or the Russian Arctic, 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 mid November.
- 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.
- 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, SAR helicopters would operate out of Barrow.
- At the end of the drilling season, the drillship or jackup rig, and associated support vessels will 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

Two conceptual examples have been provided to help illustrate potential temporal and spatial arrangements of exploration activities under the action alternatives. The two conceptual examples are both within the levels of activity contemplated for Alternatives 2 and 3. Additionally, the examples do not exceed the level of each type of activity described in Tables 4.2-1 and 4.2-2 above.

For Alternative 2, Figures 4.3-1 and 4.3-2 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 3.3-18 – 3.3-24. An associated bar graph (Figure 4.3-3) was included to depict an example of the temporal distribution of the activities in Alternative 2 illustrated in Figures 4.3-1 and 4.3-2, 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 4.4-1, 4.4-2, and 4.4-3. These figures illustrate how for Alternative 3 (as compared to Alternative 2) the total area over which potential impacts from the activities may occur is likely 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 both impacts to more individuals, 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.

4.3 Mitigation Measures

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

Standard Mitigation Measures – These measures, which are required in all four of the action alternatives, are those that NMFS and BOEM have agreed are appropriate to *require* in G&G permits, ancillary activity notices, and MMPA authorizations. Typically, 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 four 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.

At the end of the Physical, Biological and Social Environment sections under Alternative 2 (Sections 4.5.1, 4.5.2, and 4.5.3, respectively), the standard and additional mitigation measures are more comprehensively discussed in the context of the manner and degree in which the measure is expected to lessen impacts to the resource, its likely effectiveness, and the practicability of implementation associated with the measure. Specific resources that could experience reductions in adverse impacts from the implementation of the standard or additional mitigation measure are discussed as applicable under each measure. However, because the suite of standard and additional mitigation measures that are analyzed in this EIS are designed specifically to mitigate impacts to marine mammals and to ensure the availability of marine mammals for subsistence uses, the discussions of standard and additional mitigation measures associated with marine mammals and subsistence can be found after the direct and indirect effects analyses under Alternative 2 (Sections 4.5.2.4 and 4.5.3.2, respectively). 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.

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 ancillary activity notices for activities in the Beaufort and Chukchi seas. 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. Therefore, only these two resources are discussed under Alternative 1.

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.

4.4.1 Social Environment

4.4.1.1 Socioeconomics

Offshore seismic activity and exploration drilling is conducted to locate 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 significant driver in "the next generation of economic activity by extending the duration of the petroleum industry in the state" (ISER 2009). 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 the 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 that this EIS would result in greater predictability in the issuance of MMPA ITAs. New natural gas production from Alaska's OCS was also perceived to enhance the economic viability of the proposed natural gas pipeline from Alaska to the Lower 48. Also voiced during scoping was the concern 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 detail 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.

The analysis of impacts is general in nature because publicly available economic information has not disaggregated the impact of exploration activities from the larger process of development and production nor estimated contributions at a community level. Employment data about the NSB and the NAB provided in Chapter 3 (Section 3.3.1.2) provide the best available detailed information.

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

Table 4.4-1 Impact Levels 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	**Long-term**: Changes in social indicators extend up to several years	**Permanent**: Changes in social indicators persist after actions that caused the impacts cease

Impact Component	Effects Summary		
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 & Expenditures

Under Alternative 1, there would be no new public revenue sources associated with offshore exploration activities. There would be no change of expenditures to the public sector from federal, state, or local governments. If Alternative 1 results in the inability of NMFS and BOEM to issue authorizations and permits, and a lessee cannot 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/lose of any production, royalties, employment, and taxes from any petroleum that might have been produced.

There is potential corresponding loss in State revenue from foregone taxes, and to the NSB from foregone facility improvements to handle produced petroleum. 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, no potential production would occur.

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 pipeline 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.

Employment & Personal Income

Alternative 1 would result in lost opportunities for employment and personal income in areas providing support activities in the NSB, NAB, Nome, and Dutch Harbor. This includes lost employment to NSB and NAB residents as PSOs, subsistence advisors, Com Center staff, and spill response personnel. There could also be lost employment and personal income to oil and gas professionals in Anchorage, other parts of the state, and nation as a result of Alternative 1. An example of the number of unrealized jobs can be found in Tables 4.5-23 and 4.5-24.

Demographic Characteristics

Under Alternative 1, the potential for new local jobs associated with exploration activities would be unrealized. However, the small number of local hire positions and short term nature of the work is not enough to cause any outmigration, therefore there would be no change to coastal communities' populations in the Beaufort and Chukchi seas.

Social Organizations & Institutions

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

4.4.1.1.2 Standard Mitigation Measures

No standard mitigation measures associated with socioeconomics would be implemented under Alternative 1 as no oil and gas exploration activities would occur.

4.4.1.1.3 Conclusion

The general direction of the socioeconomic direct and indirect impacts under Alternative 1 is generally 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 several billion dollars to the current leaseholders. In terms of local employment and sales tax, the potential impact is low in magnitude because total personal income and local employment rates are not increased by more than five percent. The duration of the local socioeconomic impacts are temporary because it is not year-round, however, the activity is scheduled to occur over a fixed number of years. 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. However, these potential negative economic impacts of the activity are 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 communities. Therefore, the summary impact level for socioeconomics is minor.

4.4.1.1.4 Additional Mitigation Measures

There would be no additional mitigation measures employed under Alternative 1 as no oil and gas exploration activities would occur.

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 that, for all action alternatives, existing land use and management is in compliance with current federal and 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 only a single season.
	Long term	Land/water use, ownership, or management changes may reasonably be expected to convert (or revert) to another use frequently, or extend up to several years.
	Permanent	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, and BOEM would not issue G&G permits or authorize ancillary activities in the Beaufort and Chukchi seas. 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 offshore waters. It would cause some change in activity levels or procedures and affect management plans for land and water in the EIS project area.

4.4.1.2.1 Direct and Indirect Effects on Land and Water Ownership

Federal Ownership

Because 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 non-issuance of ITAs by NMFS and 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 and constrain their ability to utilize their leases. This would indirectly affect BOEM mandate to manage development of offshore energy and balance economic development, energy indepdence, and environmental protection by constraining activities on leases awarded and represents a high intensity, long-term 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 for and developing petroleum resources. 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 ownership by constraining activities on leases awarded and represents a high intensity, long-term adverse effect of regional extent. There would be no indirect effect to state ownership by constraining activities on leases. 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 Supreme Court has recognized that "[u]nder OCS Lands Act'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, long-term adverse effect of regional extent on lease awarded to private parties and their exploration rights.

There would be no direct or indirect effects on Alaska Native land ownership 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.

4.4.1.2.2 Standard Mitigation Measures

No standard mitigation measures associated with land ownership would be implemented under Alternative 1.

4.4.1.2.3 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 is high because major changes in the ability to conduct activities on leases on federal and state waters will result from this action. The duration of impact would be long-term because leaseholders will 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 are high intensity, long-term, 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.

4.4.1.2.4 Additional Mitigation Measures

No additional mitigation measures would be implemented under Alternative 1.

4.4.1.2.5 Direct and Indirect Effects on 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

The inability of BOEM and NMFS to issue permits and authorizations 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. For more detail, see Section 4.7.3.2, Subsistence.

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 in or elimination of support activities like 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 when 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 Lands

There would be no direct or indirect effects on protected land use 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 less maintenance demand 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.

4.4.1.2.6 Standard Mitigation Measures

No standard mitigation measures associated with land and water use would be implemented under Alternative 1.

4.4.1.2.7 Conclusion

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 is high because major changes in the ability to conduct activities on leases in federal and state waters will result from this action, also affecting transportation and commercial uses that support these activities. The duration of impact would be long-term because leaseholders will 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 are high intensity, long-term, 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.

4.4.1.2.8 Additional Mitigation Measures

No additional mitigation measures would be implemented under Alternative 1.

4.4.1.2.9 Direct and Indirect Effects on Land and Water Management

Federal Land and Water Management

Because 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 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 their ability to utilize their 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 indepdence, and environmental protection. This represents a high intensity, long-term adverse effect of national extent.

State Land and Water Management

The ADNR has awarded leases in the Beaufort Sea for the purpose of exploring for and developing petroleum resources. 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 offshore 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, long-term adverse effect of statewide extent.

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.

Borough 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 Borough Land Management Regulations is undertaken on a voluntary basis for activities occurring on state and federal waters. The Alaska Coastal Management program was not reauthorized by the State legislature in 2011 and is no longer in effect.

4.4.1.2.10 Standard Mitigation Measures

No standard mitigation measures associated with land and water management would be implemented under Alternative 1.

4.4.1.2.11 Conclusion

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 is high because major changes in the ability to conduct activities on leases on federal and state waters will result from this action and conflict with management objectives. The duration of impact would be long-term because leaseholders will 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 land use could occur in support areas out of the region. 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, long-term, regional, and result in changes of federal and state land and water management by effectively preventing exploration for oil and gas resources.

4.4.1.2.12 Additional Mitigation Measures

No additional mitigation measures would be implemented under Alternative 1.

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 will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-1.

Table 4.5-1 Impact Levels 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**: Physical characteristics of the ocean would be impacted infrequently but not longer than the span of the project season and would be expected to return to pre-activity states at the completion of the activity	**Long-term**: Physical characteristics of the ocean would be impacted through the life of the project and would return to pre-activity states at some time after completion of the project	**Permanent**: Chronic effects; physical characteristics of the ocean would not be anticipated to return to previous state
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 4.5-1) (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 offshore 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).

The overall effect of material discharged from exploration wells on water depth in the proposed action area would depend on the characteristics of the discharged material, 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). Changes in water depth from discharged material would have only minor effects on the physical resource character of the proposed action area. Those effects would be low-intensity, permanent, 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, permanent, localized 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, 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 may lead to formation of 'brash ice' and an overall thickening of ice within the channel (Ettema and Huang 1990). 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, localized 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

As described in Section 3.1.4.2, effects associated with climate change are considered to be those that are 1) a result of implementation of the proposed action; and 2) a result of how climate change could affect the project alternatives and associated activities. As discussed in Section 3.1.4.4, specific climate change impacts in the Arctic have been observed, which include increasing air temperatures, rising sea levels, decreasing thickness and extent of Arctic sea ice, changes in precipitation amounts, changes to ocean salinity, and changes to storm intensity and frequency (ACIA 2005). As mentioned in Section 4.4.1.2, these types of impacts to global climate change are expected to increase if GHG emissions continue at or above current emissions. Since it is not feasible to accurately predict actual impacts to climate change resulting from the project (e.g. degrees of temperature change, inches of sea level rise, decrease in ice thickness), GHG emissions are used as a surrogate to predict an activity's impact on climate change.

4.5.1.2.1 Direct and Indirect Effects

Project-Related Effects to Climate Change

Effects associated with climate change that are a result of Alternative 2 are attributed to GHG emissions that result both directly and indirectly from the exploration activities and associated equipment involved in the alternative.

Direct effects to climate change associated with Alternative 2 are primarily associated with direct GHG emissions that are a product of fuel combustion from equipment used to carry out the level of activity associated with Alternative 2. These GHG emissions are regulated under the GHG Tailoring Rule and are included in the Prevention of Significant Deterioration (PSD) and Title V permitting programs associated with the Clean Air Act (CAA) (EPA 2011a). More specifically, the current GHG Tailoring Rule requires an operating permit for any source emitting at least 100,000 tons per year (tpy) of Carbon Dioxide equivalent (CO_2e). Direct effects are closely tied to the number of exploration activities allowed by the alternative, as well as the type of equipment used for these activities. GHG emissions summed over the total amount of allowable exploratory drilling operations are indicative of the direct impacts associated with the proposed action.

Indirect effects associated with the project alternatives that contribute to climate change are considered to be those that are related to drilling, transport, refining raw oil and gas product, and usage of oil and related products that would likely occur if any of the oil exploration activities allowed under Alternative 2 were successful in locating oil reserves. Drilling activity would involve heavy machinery operating for long periods of time and equipment and supplies being transported to the site, all of which would generate GHG emissions. Transportation of gas and oil would involve GHG emissions from vehicles and vessels that transport crude and refined product. The process of refining crude oil in usable petroleum products would produce GHG emissions. The usage of refined oil products, such as gasoline, would also produce

GHG emissions, especially from the transportation sector, which was projected to account for approximately 36 percent of the State of Alaska's net GHG emissions in 2010 (Table 3.1-3). Manufacturing of plastic products and asphalt from crude oil also emits GHGs. However, the level of indirect effects associated with Alternative 2 depends on the outcome of the exploration activities, which cannot be foreseen and would be considered speculative. Indirect impacts associated with the proposed action could extend outside the region. To make a determination of the level of impact Alternative 2 would contribute to climate change, the magnitude, duration, extent, and context of the potential direct and indirect effects are considered.

The magnitude of impacts to climate change is a function of the amount of tpy of GHG emissions, measured as CO2e in tpy, estimated from the equipment associated with Alternative 2. As the magnitude of GHG emissions increases so does the amount of heat that can be trapped by these gases in the earth's atmosphere. The rate of climate changes (e.g. increase in air temperatures, inches of sea level rise, decrease in ice thickness) is expected to be higher for higher GHG emissions. This is summarized below in Table 4.5-2. When compared with the State of Alaska's projected emissions in 2010, these predicted potential annual emissions are equal to approximately five percent of the total CO2e emissions associated with the fossil fuel industry which were estimated at 2,900,000 tpy (Table 3.1-3), but only 0.3 percent of the State's total project emissions from all sectors. The magnitude of direct emissions associated with Alternative 2 is considered to be low, since a change in the resource condition is perceptible (measurable at five percent of the fossil fuel industry's emissions), but is not expected to noticeably alter the function of the climate system by itself.

Indirect effects cannot be quantified; however, based on EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*, fossil fuel combustion accounts for approximately 79 percent of the country's GHG emissions (EPA 2011b). These data suggest that the combustion of fossil fuels plays a substantial role in GHG emissions and, consequently, could contribute to the aspects of global climate change as described above. Additionally, continued exploration and usage of fossil fuels could alleviate the pressure to explore alternative, non- or low emitting sources of energy, which could lead to a measurable or observable alteration to GHG concentrations and global climate changes. Indirect effects of the proposed action could be expected to be of a low intensity.

Table 4.5-2 Estimated CO_2e Emissions for Alternative 2

Source/Activity	**Emissions (tpy)**
Survey Vessel	4.24E+04
Ice-Management Vessel	7.38E+03
Drill Rig	7.59E+03
Supply/Support Vessel	8.16E+04
Oil Response Vessels	6.75E+03
Total Emissions (tpy)	**145,726**

Note: Refer to Section 4.5.1.3 under Emissions Estimates for complete details and assumptions regarding emissions calculations

Direct emissions of GHGs would occur during actual exploration activities; however GHGs are believed to be capable of remaining in the atmosphere for decades or even centuries after emission. Even after stabilization, GHGs can continue to contribute to anthropogenic warming and associated effects such as sea level rise for centuries (IPCC 2007a). This suggests that after the oil exploration activities have subsided, effects to climate change could continue to be observed for long periods. This same logic also applies to *indirect* effects associated with Alternative 2. Therefore both direct and indirect effects to climate change are considered to be long-term.

Both direct and indirect effects associated with GHG emissions, as described above, have the potential to affect global climate change. GHGs, which trap heat, can lead to world-wide effects such as melting of ice sheets, sea level rise, changes in coastline and inundation of low-lying areas, melting of permafrost, droughts, and floods throughout the planet. Therefore both direct and indirect effects to climate change are considered to be at least regional and perhaps beyond.

While climate change affects the entire globe, certain geographic areas and ecosystems are more susceptible to the effects of climate change than others. Coastal areas vulnerable to damage from rising sea levels, permafrost regions, and ecosystems dependent on sea ice are examples of such areas that are more susceptible to the effects of climate change. Areas like the Arctic, which have several of these vulnerable resources (permafrost, coastline, sea ice) also support unique ecosystems. Additionally, weather and climate patterns play major roles in the components of an ecosystem: precipitation affects water bodies and vegetation type and coverage, temperatures affect vegetation and wildlife species able to thrive in certain environments, etc. Therefore, the context of both direct and indirect effects to climate change is considered to be important.

Effects of Climate Change on the Proposed Action

Effects of climate change on the proposed action are considered indirect. As discussed previously, scientific evidence suggests that GHG emissions contribute to global climate change. Melting of permafrost could affect the ability and timeframe for moving large, heavy equipment over frozen tundra to the EIS project area if the tundra is softer for longer periods. 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 activities requiring ice-free conditions. Although these climate changes have already been observed (Section 3.1.4.4, Changes in Arctic) and are expected to continue, existing climate models are not refined enough to accurately predict the climate changes within the next five years. Additionally, climate changes resulting from GHG emissions can occur years after the emissions are generated. Given the small timeframe of five years (relative to climate change) and the accuracy of existing climate change models, it is not feasible to determine whether the effects of climate change within the next five years would occur to such a degree to noticeably affect the actions proposed in Alternative 2.

4.5.1.2.2 Conclusion

Direct and indirect impacts associated with climate are anticipated to be low in intensity, long-term, regional in extent and affecting important resources. Overall direct and indirect impacts resulting from Alternative 2 are considered to be minor, due to their low contribution to GHG emissions.

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 vibroesis and electromagnetic surveys), and exploratory drilling. Table 2.2 provides a list of typical equipment for these activities such as survey source vessels, diesel-fired power generating equipment needed for drilling and miscellaneous support activities, trucks for various equipment (on ice), and various other vessels used in support of these survey and drilling activities (for example: tugboats, supply boats, icebreakers, crew boats, oil spill response vessels, and aircraft). The majority of air pollutant emissions from these activities are due to fuel combustion for vessel propulsion and power generation.

Of the federal and state regulated air pollutants (see Table 3.1-4), those mainly associated with diesel fuel combustion are: the criteria pollutants (nitrogen oxides [NO_x], carbon monoxide [CO], sulfur dioxide [SO_2], and particulate matter [PM] including PM equal to or less than 10 micrometers in diameter [PM_{10}] and PM equal to or less than 2.5 micrometers in diameter [$PM_{2.5}$]), and volatile organic compounds (VOCs), a precursor to the criteria pollutant ozone (O_3). Lesser emissions of lead (Pb), ammonia (NH_3), and reduced sulfur compounds (RSC) may also be released, dependent on fuel characteristics and applied control technologies. Other project-related air emissions may include VOCs as fugitives from storage tanks, and fugitive dust (as PM) from potential associated onshore activities.

The level of impacts to air quality will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-3.

Table 4.5-3 Impact Levels 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

4.5.1.3.1 Direct and Indirect Effects

Air Permitting

As discussed in Section 3.1.5.2, air pollutant sources located offshore are regulated under Section 55.2 of the OCS Air Regulations as specified in 40 CFR Part 55 (BOEM 2011a, EPA 2011a); sources being located in the OCS require permitting under these regulations. For operations outside the 25 geographic mile (gm) (46.3 km) seaward boundary (outer OCS), the federal 40 CFR Part 71 Operating Permit rules apply (EPA 2011b). For operations within the seaward boundary (inner OCS), EPA applies the COA rules, in this case the Alaska permitting rules in 18 AAC 50 (AAC 2011), which also cover potential onshore facilities.

The magnitude of emissions dictates the type of air permit(s) required for the seismic survey type of activity, or source category. Following federal rules (40 CFR Part 71), and adopted by reference in 18 AAC 50.040, a Title V air operating permit (Part 71 permit) is required for a source with potential-to-emit (PTE) of 100 tons per year (tpy) or more of any of the regulated pollutants. In addition to Title V regulations, the federal New Source Review (NSR) program may also apply (EPA 2011l). For sources located in areas that are in attainment of the NAAQS, such as the EIS project area, the PSD rules apply under this program (40 CFR Part 52). A PSD permit is required for this type of source category having a PTE of 250 tpy or more for any regulated pollutant. In both of these cases, if the regulation applies, the activity would be considered a Major Source under federal rule.

GHG emissions are also a product of fuel combustion and are now regulated under the GHG Tailoring Rule and are included in the PSD and Title V permitting programs (EPA 2011d). Whereas PSD applicability for emissions of NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$, and VOC is based on a PTE of 250 tpy for this type of facility/activity, for GHG (measured as carbon dioxide equivalents [CO_2e]) the PSD threshold is 100,000 tpy, per Step 2 of the Tailoring Rule (for permits issued on or after July 1, 2011).

If the activity does not constitute a Major Source under the federal Title V of PSD rules, an owner or operator of a new source may still be required to obtain a Minor Source permit under 18 AAC 50.502 if emission levels exceed the values given in 18 AAC 50.502(c)(1): NO_x - 40 tpy; SO_2 – 40 tpy; PM_{10} – 15 tpy; Pb – 0.6 tpy, and; CO – 100 tpy if located within 10 km of a CO nonattainment area (which is not applicable for this EIS project area). This type of permitting would not apply if the source was located in the outer OCS.

Under Section 112 of the Clean Air Act, air toxic, or hazardous air pollutant (HAP), emissions are also subject to permitting requirements (EPA 2011e). A source is Major for HAPs if it emits 10 tpy or more of any one HAP, or 25 tpy or more total HAPs. A Major Source of HAPs is subject to standards under 40 CFR Part 63, adopted by reference in 18 AAC 50.040, and must obtain a construction permit for the source. Although HAP emission estimates are required to determine applicability, it is expected that none of the proposed alternatives for the project will be a Major Source of HAPs.

Specific air permitting requirements are not included as part of this EIS. Details regarding permit actions (type(s) and schedule, for example), along with specific source/equipment applicability will be determined in the air permitting phase of the project once an alternative has been selected and more details are known. A general discussion of emissions and potential impacts is provided below. Emissions estimates will be required for the project as the initial step in identifying permitting needs. Depending on the magnitude of the potential emissions from a proposed alternative, it may qualify for one or more permitting requirements, including: implementation of Best Available Control Technology (BACT); air quality impact analysis (dispersion modeling); and evaluation of impacts to air quality related values (AQRV) such as visibility, acid deposition and effects on soils and vegetation. The section below gives an overview of the methodology used in the determination of emissions and impacts, which are the primary factors in assessing the effects on air quality for each alternative.

Emissions Estimates

Equipment and usage are based on information provided for each alternative, including timing and location, in order to develop potential emission and impact scenarios for each alternative. Emissions estimates are based on current EPA draft permits for similar activities, along with the plethora of application materials used to develop these draft permits (EPA 2011o, EPA 2011p, EPA 2011q, and EPA 2011r). Specific equipment has not yet been defined for the project, therefore these estimates are based on typical equipment use types. As the project progresses, air permit applications will be required to show detailed emission inventories, and impact analyses may be needed to demonstrate that the project will be in compliance with NAAQS (see Table 3.1-4). The specific location of activities (inner or outer OCS) will also dictate permitting requirements and which source-specific regulatory requirements are triggered. Therefore, the air permitting process may actually create changes in the effects of air quality on the environment by requiring emissions and/or impact reductions through regulatory compliance drivers.

Based on information in Section 2.3, the proposed alternatives may involve the use of several air pollution sources that would require permitting, including: survey vessels, monitoring vessels, crew change vessels, ice-management vessels, oil spill response equipment, fuel barges, aircraft, and staging areas. There are several options for specific types of these sources, and different sizes and uses will create a wide range of potential emissions. Table 4.5-4 shows typical equipment and emission factors that may apply to the project activities. The emission factors are consistent with those used in current draft permits for similar activities with further details shown in the table and in the references cited above. Although emissions of Pb and NH_3 are required for the permitting process, they are not included in this table because, for these types of combustion sources, these pollutants typically are not expected to be emitted in quantities that are detrimental to air quality, nor are they critical in determining permitting needs at this point. In addition, NH_3 emissions are dependent mostly upon control technologies, which are unknown at this time. An emissions analysis for these pollutants will be required for any air permitting evaluation. Also, comparisons of impacts for these pollutants between alternatives are expected to be similar to the other pollutants described in this EIS.

Many of the emission factors used in the current draft permits incorporate EPA emission factors from AP-42, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*, Fifth Edition (EPA 2011j). The draft permits have also used manufacturer-specified emission factors when data are available; these data are typically more realistic (less conservative) than AP-42 data. For some equipment, the owners/operators have opted for air pollution control devices, and/or lower-emitting engines that meet EPA's Tier 2 or Tier 3 emission standards. The conservative AP-42 resource is used exclusively for this EIS, including those sections for Stationary Internal Combustion Sources (AP-42 Section 3.4 Large Stationary Diesel and All Stationary Dual-fuel Engines [EPA1996a]), External Combustion Sources (AP-42 Section 1.3 Fuel Oil Combustion [EPA 2010], and Solid Waste Disposal (AP-42 Section 2.1 Refuse Combustion [EPA 1996b]).

The use of ultra-low sulfur diesel (ULSD) is expected for all diesel combustion sources. Selective catalytic control (SCR) for NO_x reduction is a requirement (permit condition) in the current draft permits cited above. The use of SCR is limited to certain engines, and it is not required for all hours of operation, due to the difficulties of using this method of control under certain conditions (such as freezing temperatures). Besides this limited assumption of NO_x control for the project emission calculations, no additional emission controls are applied to any of the sources included in this EIS. Lesser emissions from potential tank fugitives are not included in this assessment, as they are expected to have only a minor influence on overall emissions, impacts, and regulatory applicability. However, these emission sources will be included in the future analysis for air permitting. During the permitting phase, other emission resources may be used, including manufacturer's specifications (as available), specific control efficiencies, and/or more detailed factors for specific marine engine sources used in other regulatory documents.

As discussed in Section 2.3.2, vessel transit speeds are highly variable, ranging from 8 to 20 kn (14.8 to 37.0 km/hour) depending on a number of factors including, but not limited to, the vessel itself, sea state, urgency (the need to run at top speed versus normal cruising speed), and ice conditions. The 2D seismic survey vessels generally are smaller than 3D survey vessels; however, the larger 3D survey vessels are also able to conduct 2D surveys. An assumed usage of 1,745 hours (approximately 72 days at 24 hours per day of surveying) is input for each survey emission estimate for vessel propulsion. This value is based on a 2D survey collecting up to 12,875 line-km (8,000 line-mi) at up to177 line-km (110 line-mi) per day during an open water seismic operational season in Arctic waters. For the level of emissions analysis in this EIS, only one average vessel size (as propulsion horsepower [hp]) is assumed, with an average number of power generation engines aboard each survey vessel, each assumed to have the same operating hours. The assumed engine ratings are given in Table 4.5-4, along with estimated fuel consumption rates.

Table 4.5-4 Estimated Air Pollutant Emission Factors by Source Equipment

Source/Activity	Fuel Consumption[1] (MMBtu/hr)	Emission Factor (lb/MMBtu, fuel input)						
		NO_x	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
Survey Vessel[2]								
Propulsion engine: 1000 hp	7.0	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Generators/Engines: 500 hp (total)	3.5	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Ice-ManagementVessel[10]								
Propulsion engines: 28,000 hp (total)	98	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Generators/Engines: 1,500 hp (total)	10.5	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Heaters: 8 MMBtu/hr (total)	8.0	0.143[11]	0.0357[11]	0.0015[4,11]	0.00714[12]	0.00143[13]	160[7,13,14]	0.0474[15]
Incinerator: 175 lb/hr	0.0875 ton/hr	3 lb/ton[16]	10 lb/ton[16]	2.5 lb/ton[16]	7 lb/ton[16]	3 lb/ton[16]	353 lb/ton[7,16,17]	2.16 lb/ton[18]
Drill Rig[19]								
Main engines: 13,500 hp	94.5	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Generators/Engines: 2,500 hp (total)	17.5	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Heaters: 8 MMBtu/hr (total)	8.0	0.143[11]	0.0357[11]	0.0015[4,11]	0.00714[12]	0.00143[13]	160[7,13,14]	0.0474[15]
Incinerator: 275 lb/hr	0.1375 ton/hr	3 lb/ton[16]	10 lb/ton[16]	2.5 lb/ton[16]	7 lb/ton[16]	3 lb/ton[16]	353 lb/ton[7,16,17]	2.16 lb/ton[18]
Supply/Support Vessel[20]								
Propulsion engine (including thruster engines): 8,850 hp	62.0	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Generators/Engines: 1,750 hp (total)	12.3	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]

Source/Activity	Fuel Consumption[1] (MMBtu/hr)	Emission Factor (lb/MMBtu, fuel input)						
		NO_x	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
Heaters: 8 MMBtu/hr (total)	8.0	0.143[11]	0.0357[11]	0.0015[4,11]	0.00714[12]	0.00143[13]	160[7,13,14]	0.0474[15]
Incinerator: 275 lb/hr	0.1375 ton/hr	3 lb/ton[16]	10 lb/ton[16]	2.5 lb/ton[16]	7 lb/ton[16]	3 lb/ton[16]	353 lb/ton[7,16,17]	2.16 lb/ton[18]
OIL SPILL RESPONSE VESSELS[21]								
Propulsion engine (including thruster engines): 8,850 hp	62.0	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Generators/Engines: 1,750 hp (total)	12.3	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Boom Workboat propulsion engines: 610 hp (total)	4.27	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Spill Storage Tanker propulsion engines: 3350 hp (total)	23.5	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Spill Storage Tanker generator: 775 hp	5.43	3.2[3]	0.85[3]	0.0015[3,4]	0.0573[5]	0.0819[3,6]	165[7,8]	0.00428[9]
Spill Storage Tanker boiler: 14.4 MMBtu/hr	14.4	0.143[11]	0.0357[11]	0.0015[4,11]	0.00714[12]	0.00143[13]	160[7,13,14]	0.0474[15]

[1] Assume brake-specific fuel consumption rate of 7,000 Btu/hp-hr for diesel fuel, per AP-42, Table 3.4-1 (EPA 1996a).

[2] Survey Vessel equipment based approximately on information provided in OCS Permit No. R10OCS020000, ConocoPhillips Jackup Rig – Chukchi Sea Exploration Drilling Program, *Table 5 – Marine Research Vessel Emission Units* (EPA 2011h).

[3] AP-42 Table 3.4-1 (EPA 1996a); these are uncontrolled emission factors.

[4] Assume ULSD with sulfur content of 0.0015%, by weight.

[5] AP-42 Table 3.4-2 (EPA 1996a); assume $PM_{2.5} = PM_{10}$.

[6] AP-42 Table 3.4-1, footnote f (EPA 1996a).

[7] CO_2e is assumed to be composed of the following GHG components: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). CO_2e emission factors are equal to the sum of each of these components times their individual Global Warming Potential (GWP) factors. The GWP for these are: CO_2 = 1; CH_4 = 21; and N_2O = 310 (EPA 2009).

[8] AP-42 Table 3.4-1 (EPA 1996a) for CO_2 and CH_4 (use footnote f for CH_4 emissions). Emissions of N_2O are assumed negligible for diesel engines.

[9] AP-42 Tables 3.4-3 and 3.4-4 (EPA 1996a); sum of HAPs as indicated by footnote b.

[10] Ice Management equipment based approximately on information provided in OCS Permit No. R10OCS020000, ConocoPhillips Jackup Rig – Chukchi Sea Exploration Drilling Program, *Table 2 – Icebreakers #1 and #2 Emission Units* (EPA 2011h).

[11] AP-42 Table 1.3-1 (EPA 2010); assume heating rate for No. 2 oil (diesel) at 140 MMBtu/1000 gal (Table 1.3-2, footnote d).

[12] AP-42 Table 1.3-6 (EPA 2010) for PM_{10}; assume heating rate for No. 2 oil (diesel) at 140 MMBtu/1000 gal (Table 1.3-2, footnote d); assume $PM_{2.5} = PM_{10}$.

[13] AP-42 Table 1.3-3 (EPA 2010); assume heating rate for No. 2 oil (diesel) at 140 MMBtu/1000 gal (Table 1.3-2, footnote d).

[14] AP-42 Table 1.3-12 for CO_2, and AP-42 Table 1.3-8 for N_2O (EPA 2010); assume heating rate for No. 2 oil (diesel) at 140 MMBtu/1000 gal (Table 1.3-2, footnote d).

[15] Sum of HAP emissions from AP-42 Tables 1.3-9 and 1.3-10 (EPA 2010); assume heating rate for No. 2 oil (diesel) at 140 MMBtu/1000 gal (Table 1.3-2, footnote d).

[16] AP-42 Table 2.1-12 (EPA 1996b); assume $PM_{2.5}$ and PM_{10} are equivalent to PM.

[17] AP-42 Table 2.1-9 (EPA 1996b) for CO_2. Emissions of N_2O are assumed to be 10% of total NO_x emissions for this source.

[18] AP-42 Table 2.1-8 (EPA 1996b); assume HAPs sum of components with footnotes e and j.

[19] Drill Rig equipment based approximately on information provided in OCS Permit No. R10OCS020000, ConocoPhillips Jackup Rig – Chukchi Sea Exploration Drilling Program, *Table 1 – Jackup Rig Emission Units* (EPA 2011h).

[20] Supply/Support Vessel equipment based approximately on information provided in OCS Permit No. R10OCS020000, ConocoPhillips Jackup Rig – Chukchi Sea Exploration Drilling Program, *Table 4 – Supply Vessels Emission Units, Offshore Supply Vessel* (EPA 2011h). Also included boiler and incinerator to incorporate crew support operations.

[21] Oil Spill Response Vessels equipment based approximately on information provided in OCS Permit No. R10OCS020000, ConocoPhillips Jackup Rig – Chukchi Sea Exploration Drilling Program, *Table 3 – Oil Spill Response Vessels Emission Units* (EPA 2011h).

The surveys may involve up to two survey vessels, which equates to 3,490 hours per survey vessel unit type per survey activity. Although engines are not expected to run at full load this entire time, to be conservative, the survey vessel emissions are estimated at full load with this full time use factor. During actual permitting, limitations on fuel use may be employed as a mechanism for maintaining air quality emissions and impacts within regulatory levels. However, for this assessment, hours of operation and use factors are used to give a projection of operating scenarios.

At least one support vessel would be used for safety considerations, general support, maintenance, and resupply of the main vessel, but it would not be directly involved with the collection of seismic data. It is assumed that this vessel and equipment would have a use factor of one-half time of the survey, equivalent to 873 hours at full load. An additional support vessel may be used to monitor for marine mammals ahead of the survey vessel; this is assumed to have a use factor of one-quarter time of the survey, or 436 hours. To be conservative in the air emission calculations, crew changes, refueling, and resupply for the seismic vessels are assumed on a four week schedule (most frequent, or three times per survey). An estimate of 24 hours per change is assumed, for a total of 72 hours per survey. Combined, these support vessels equate to 1,381 hours per survey. The propulsion engine use portion of this time is expected to be approximately one-half of the total use time, or 691 hours per survey. Although helicopters also may be used for vessel support and crew changes, to be conservative, the three marine vessel transports per survey are included in this analysis to account for maximum emissions, in lieu of fewer vessels plus aircraft, which would likely have lower overall emissions. Heaters and an incinerator unit are also included with the support vessels; heaters are assumed to have equivalent use factors (1,381 equivalent full load hours), and the incinerator is assumed to have a use factor of 10 percent, or approximately 138 hours. Table 4.5-5 shows the expected hours of operation for one unit of activity (i.e. one survey) for each source equipment item.

Oil spill response vessels are required as a precaution, and are included in the emissions estimates, as shown in Tables 4.5-4 and 4.5-5. An estimated use factor of five percent of the total survey time is used for propulsion (equivalent to approximately 87 hours at full load). Engine use on the main vessel is expected to be higher for this standby status (10 percent, or approximately 175 hours).

The options for drilling and surveys during ice season are also included as part of the project. These are assumed to have equivalent full load hours of 720 hours, or approximately one month per event. The main engines (including propulsion for the icebreaker) are assumed to have a half-time use factor, or 360 hours. Heaters are assumed to have full time use (720 hours), and incinerators are assumed to have a 10 percent use factor, or 36 hours.

The equivalent full load hours of use are shown in Table 4.5-5 for each of the survey sources and activities. Estimates of 'per unit activity' emission rates are calculated using the emission factors from Table 4.5-4. Emissions of NO_x are shown with a 70 percent control factor for the propulsion engines, and for the main engines on the drill rig. Typical SCR control efficiencies for these types of engines are upward of 80 percent, and this is expected to be BACT for these sources, if required for permitting. Using a 70 percent control factor allows for some uncontrolled operations, when SCR may not be available or usable.

Table 4.5-5 Estimated Survey Unit Air Pollutant Emission Rates by Source Equipment

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SURVEY VESSEL (2 UNITS PER SURVEY)								
Propulsion engine: 1000 hp	3,490	1.95E+01[1]	1.04E+01	1.83E-02	7.00E-01	1.00E+00	2.02E+03	5.23E-02
Generators/Engines: 500 hp (total)	3,490	1.95E+01	5.19E+00	9.16E-03	3.50E-01	5.00E-01	1.01E+03	2.61E-02
ICE-MANAGEMENT VESSEL (1 UNIT PER SURVEY)								
Propulsion engines: 28,000 hp (total)	360	2.82E+01[1]	1.50E+01	2.65E-02	1.01E+00	1.44E+00	2.92E+03	7.55E-02
Generators/Engines: 1,500 hp (total)	360	6.05E+00	1.61E+00	2.84E-03	1.08E-01	1.55E-01	3.12E+02	8.09E-03
Heaters: 8 MMBtu/hr (total)	720	4.12E-01	1.03E-01	4.32E-03	2.06E-02	4.12E-03	4.60E+02	1.37E-01
Incinerator: 175 lb/hr	36	4.73E-03	1.58E-02	3.94E-03	1.10E-02	4.73E-03	5.56E-01	3.40E-03
DRILL RIG (1 UNIT)								
Main engines: 13,500 hp	360	2.72E+01[1]	1.45E+01	2.55E-02	9.75E-01	1.39E+00	2.81E+03	7.28E-02
Generators/Engines: 2,500 hp (total)	360	1.01E+01	2.68E+00	4.73E-03	1.80E-01	2.58E-01	5.21E+02	1.35E-02
Heaters: 8 MMBtu/hr (total)	720	4.12E-01	1.03E-01	4.32E-03	2.06E-02	4.12E-03	4.60E+02	1.37E-01
Incinerator: 275 lb/hr	36	7.43E-03	2.48E-02	6.19E-03	1.73E-02	7.43E-03	8.74E-01	5.35E-03

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SUPPLY/SUPPORT VESSEL (1 MAIN SUPPORT, 1 MONITOR, CREW AND SUPPLY TRANSPORT PER SURVEY)								
Propulsion engine (including thruster engines): 8,850 hp	691	3.43E+01[1]	1.82E+01	3.21E-02	1.23E+00	1.75E+00	3.54E+03	9.17E-02
Generators/Engines: 1,750 hp (total)	1,381	2.72E+01	7.22E+00	1.27E-02	4.87E-01	6.96E-01	1.40E+03	3.64E-02
Heaters: 8 MMBtu/hr (total)	1,381	7.90E-01	1.97E-01	8.29E-03	3.94E-02	7.90E-03	8.82E+02	2.62E-01
Incinerator: 275 lb/hr	138	2.85E-02	9.49E-02	2.37E-02	6.65E-02	2.85E-02	3.35E+00	2.05E-02
OIL SPILL RESPONSE VESSELS (1 UNIT ON STANDBY)								
Propulsion engine (including thruster engines): 8,850 hp	87.3	4.33E+00[1]	2.30E+00	4.06E-03	1.55E-01	2.22E-01	4.47E+02	1.16E-02
Generators/Engines: 1,750 hp (total)	175	3.43E+00	9.12E-01	1.61E-03	6.15E-02	8.79E-02	1.77E+02	4.59E-03
Boom Workboat propulsion engines: 610 hp (total)	87.3	2.98E-01[1]	1.58E-01	2.79E-04	1.07E-02	1.53E-02	3.08E+01	7.97E-04
Spill Storage Tanker propulsion engines: 3350 hp (total)	87.3	1.64E+00[1]	8.71E-01	1.54E-03	5.87E-02	8.40E-02	1.69E+02	4.39E-03
Spill Storage Tanker generator: 775 hp	87.3	7.58E-01	2.01E-01	3.55E-04	1.36E-02	1.94E-02	3.92E+01	1.01E-03
Spill Storage Tanker boiler: 14.4 MMBtu/hr	87.3	8.98E-02	2.24E-02	9.42E-04	4.49E-03	8.98E-04	1.00E+02	2.98E-02

[1] Assume overall NO_x control of 70% on propulsion engines from the use of SCR.

Permitting

Exhaustive modeling has been completed as part of the current draft permits for OCS exploratory drilling programs. Due to the similarities of those activities to the sources included in the project, estimates of impacts can be assessed based on the draft permit modeling results. In order to meet all NAAQS, including some of the new, stringent short-term limits for NO_x, $PM_{2.5}$, and SO_2, modeling was conducted with several operational restrictions, including exclusion zones, distance limits on rigs and vessels, and total fuel use. These restrictions have been incorporated into the draft permit conditions for these operations. Although the impacts from the alternative's worst-case scenario source for permitting are expected to meet the NAAQS, a detailed assessment, and potentially modeling, will be required in the permitting phase to make a more certain demonstration and to identify potential operational restrictions.

Additional Air Quality Concerns

Air quality impacts due to potential oil spills (from equipment leaks or spills, or from a well) are also a possibility for seismic survey and exploratory drilling activities. Although these emissions are unplanned, they have the potential to impact air quality due to the volatilization of the leak or spill and from clean-up activities, such as in-situ burning of spilled fuel and the use of additional vessels to clean up the oil. As discussed above, the use of oil spill response vessels as a precaution is included in the emissions estimates, as shown in Tables 4.5-4 and 4.5-5, and this activity is likely required to be permitted. However, the emissions from actual spills or clean-up activities are not included in air permits. These emissions and impacts are addressed in Section 4.9, and they are not used as a criterion for comparing effects on air quality between alternatives.

Besides human health, air pollutants can also have an effect on other AQRV's, including visibility and vegetation. As mentioned in Section 3.1.5.2, the nearest Class I area to the EIS project area is approximately 650 km (400 mi) away, therefore an AQRV analysis is not typically required. In addition, due to the location of the majority of sources, AQRV-related effects are expected to be negligible at any location in or nearby the EIS project area.

Although there are several regulated air pollutants, as described above, CO and PM are the pollutants of most concern in Alaska, as discussed in Section 3.1.5.2. Both of these pollutant concerns are related to local, near-use, sources, such as combustion engines for CO, and fugitive dust generating activities (construction and other activities in unpaved areas) for PM. With the use of exclusion zones around survey activities, there are not expected to be any levels of CO above regulatory standards at any location due to the project. There are no regular activities associated with this project that would generate fugitive dust, as most activities are located over water. In the event of temporary onshore activities that may generate dust, if necessary, measures would be required to be taken to address potential mitigation measures. Neither of these localized or onshore occurrences are expected to vary with the proposed alternatives, therefore no evaluation of these pollutants on this localized community level is made.

Emissions from the potential use of aircraft would not be included in air quality permitting, and annual average emission rates from these units would likely be minor. Based on information provided for similar activities in an exploration plan (BOEM 2011b), annual emissions from helicopter use are predicted to be within approximately five percent of total emissions for drilling, including all support vessels and equipment. Due to the unknown use amount, and likely infrequent use, these emissions are not quantified for this EIS. As noted above, the use of marine vessels for crew and supply transport was conservatively estimated and should cover the potential substitution of vessel emissions with aircraft emissions. In addition, the potential short-term effects on air quality from aircraft are also expected to be minor due to the brief operation in any one location, along with dispersion created by the aircraft turbulence. Any short-term impacts would also be expected to be the same for any alternative.

Level of Effects

Air pollutant emissions and impact levels are the two basic measurements for assessing the level of effects of a project on air quality. As discussed above under *Air Permitting*, the magnitude of emissions is the primary qualifier for permit type. As emissions increase in magnitude and reach certain thresholds, additional permitting analyses may be required, along with potential required emission controls to reduce source emission levels to within regulatory standards. Therefore, the magnitude of emissions is also considered to be the primary indicator of the project effects on air quality.

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 the project. Besides the averaging periods for NAAQS standards (all one year or less), duration of impacts is not used as an indicator of project effects on air quality.

The extent of air pollution impacts is dependent on several factors, including source location, duration of the emissions, and meteorological conditions. The distance to a location with any noticeable effect on air quality is normally determined as part of the impact modeling analyses, if required by permitting. Because specific locations and schedules are unknown for the project alternatives, the extent, or distance, of air quality effects is not used as a criterion for comparing alternatives. Increases in levels of air pollutants at different distances are attributed to the type of emissions, which are covered by the magnitude indicator.

As discussed above, there are no Class I air quality designations in or around the EIS project area. Due to the variability of exploration activities, the potential for project-related air quality effects at unique or sensitive locations is expected to be only a short-term occurrence. Therefore, the context of air quality effects is expected to be the same for any of the alternatives and is not used as a comparison tool.

4.5.1.3.2 Conclusion

For Alternative 2, considering the worst-case spatially and temporally ‘centralized’ activities combined as one event for permitting purposes, the scenario of two surveys (equating to one survey with icebreaking plus one site clearance and shallow hazard survey in one relatively similar location) and one exploratory drilling program in the same general location is chosen for evaluation. This would require the units identified in Table 4.5-6, which shows equivalent full load hours for each item, and total emissions summed for the event. It is assumed that the two surveys would also require two ‘units’ of supply/support vessels, therefore these equivalent hour values are doubled as compared to those shown in Table 4.5-5. There should only be need for one unit of oil response vessels, since these are used as standby resources, and one icebreaking unit. In this case, the total emissions for each regulated pollutant are below the major source threshold of 250 tpy (and 100,000 tpy for CO_2e and 25 tpy for HAPs).

On a long-term (annual average) basis, these emissions are lower than those given in the example draft permits (EPA 2011f-i). The sources in the draft permits were modeled to demonstrate compliance with NAAQS. Therefore, it is expected that the project would also meet NAAQS, possibly with some operating restrictions, such as exclusion zones or equipment scheduling or placement requirements in order to meet short-term NAAQS. In general, the predicted impacts for the draft permit projects are below Significant Impact Levels (SILs) for some of the long-term pollutant averages and both of the short-term CO standards but have the potential to exceed the SILs for other pollutant standards (although still meet NAAQS when background concentrations are added to predicted impact). Emissions would likely constitute a Minor Source of air pollution. However, if the project, broken down as this worst-case event, constitutes a Major Source due to emission levels, or if an agency requests impact analyses, it may be shown that the project impacts exceed one or more SILs. This indicates that for this expected level of permitted activity, the project may have a moderate effect on air quality.

Table 4.5-6 Estimated Air Pollutant Emissions for Worst-Case Event

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SURVEY VESSEL								
Propulsion engine: 1000 hp	6,980	2.35E+01	2.08E+01	3.66E-02	1.40E+00	2.00E+00	4.04E+03	1.05E-01
Generators/Engines: 500 hp (total)	6,980	3.91E+01	1.04E+01	1.83E-02	7.00E-01	1.00E+00	2.02E+03	5.23E-02
ICE-MANAGEMENT VESSEL								
Propulsion engines: 28,000 hp (total)	360	1.69E+01	1.50E+01	2.65E-02	1.01E+00	1.44E+00	2.92E+03	7.55E-02
Generators/Engines: 1,500 hp (total)	360	6.05E+00	1.61E+00	2.84E-03	1.08E-01	1.55E-01	3.12E+02	8.09E-03
Heaters: 8 MMBtu/hr (total)	720	4.12E-01	1.03E-01	4.32E-03	2.06E-02	4.12E-03	4.60E+02	1.37E-01
Incinerator: 175 lb/hr	36	4.73E-03	1.58E-02	3.94E-03	1.10E-02	4.73E-03	5.56E-01	3.40E-03
DRILL RIG								
Main engines: 13,500 hp	360	1.63E+01	1.45E+01	2.55E-02	9.75E-01	1.39E+00	2.81E+03	7.28E-02
Generators/Engines: 2,500 hp (total)	360	1.01E+01	2.68E+00	4.73E-03	1.80E-01	2.58E-01	5.21E+02	1.35E-02
Heaters: 8 MMBtu/hr (total)	720	4.12E-01	1.03E-01	4.32E-03	2.06E-02	4.12E-03	4.60E+02	1.37E-01
Incinerator: 275 lb/hr	36	7.43E-03	2.48E-02	6.19E-03	1.73E-02	7.43E-03	8.74E-01	5.35E-03

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SUPPLY/SUPPORT VESSEL								
Propulsion engine (including thruster engines): 8,850 hp	1,382	4.11E+01	3.64E+01	6.43E-02	2.45E+00	3.51E+00	7.08E+03	1.83E-01
Generators/Engines: 1,750 hp (total)	2,762	5.44E+01	1.44E+01	2.55E-02	9.73E-01	1.39E+00	2.81E+03	7.27E-02
Heaters: 8 MMBtu/hr (total)	2,762	1.58E+00	3.94E-01	1.66E-02	7.89E-02	1.58E-02	1.76E+03	5.24E-01
Incinerator: 275 lb/hr	276	5.70E-02	1.90E-01	4.75E-02	1.33E-01	5.70E-02	6.70E+00	4.10E-02
OIL SPILL RESPONSE VESSELS								
Propulsion engine (including thruster engines): 8,850 hp	87.3	2.60E+00	2.30E+00	4.06E-03	1.55E-01	2.22E-01	4.47E+02	1.16E-02
Generators/Engines: 1,750 hp (total)	174	3.43E+00	9.12E-01	1.61E-03	6.15E-02	8.79E-02	1.77E+02	4.59E-03
Boom Workboat propulsion engines: 610 hp (total)	87.3	1.79E-01	1.58E-01	2.79E-04	1.07E-02	1.53E-02	3.08E+01	7.97E-04
Spill Storage Tanker propulsion engines: 3350 hp (total)	87.3	9.84E-01	8.71E-01	1.54E-03	5.87E-02	8.40E-02	1.69E+02	4.39E-03
Spill Storage Tanker generator: 775 hp	87.3	7.58E-01	2.01E-01	3.55E-04	1.36E-02	1.94E-02	3.92E+01	1.01E-03
Spill Storage Tanker boiler: 14.4 MMBtu/hr	87.3	8.98E-02	2.24E-02	9.42E-04	4.49E-03	8.98E-04	1.00E+02	2.98E-02
TOTAL EMISSIONS (tpy)		218	121	0.30	8.39	11.7	26,162	1.48

[1] Assume overall NO_x control of 70% on propulsion engines from the use of SCR.

Table 4.5-7 Estimated Total Air Pollutant Emissions for Level 1 Exploration Activity

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SURVEY VESSEL								
Propulsion engine: 1000 hp	48.860	1.64E+02	1.45E+02	2.57E-01	9.80E+00	1.40E+01	2.83E+04	7.32E-01
Generators/Engines: 500 hp (total)	48,860	2.74E+02	7.27E+01	1.28E-01	4.90E+00	7.00E+00	1.41E+04	3.66E-01
ICE-MANAGEMENT VESSEL								
Propulsion engines: 28,000 hp (total)	720	3.39E+01	3.00E+01	5.29E-02	2.02E+00	2.89E+00	5.83E+03	1.51E-01
Generators/Engines: 1,500 hp (total)	720	1.21E+01	3.21E+00	5.67E-03	2.17E-01	3.10E-01	6.25E+02	1.62E-02
Heaters: 8 MMBtu/hr (total)	1,440	8.24E-01	2.06E-01	8.64E-03	4.11E-02	8.24E-03	9.19E+02	2.73E-01
Incinerator: 175 lb/hr	72	9.45E-03	3.15E-02	7.88E-03	2.21E-02	9.45E-03	1.11E+00	6.80E-03
DRILL RIG								
Main engines: 13,500 hp	720	3.27E+01	2.89E+01	5.10E-02	1.95E+00	2.79E+00	5.62E+03	1.46E-01
Generators/Engines: 2,500 hp (total)	720	2.02E+01	5.36E+00	9.45E-03	3.61E-01	5.16E-01	1.04E+03	2.70E-02
Heaters: 8 MMBtu/hr (total)	1,440	8.24E-01	2.06E-01	8.64E-03	4.11E-02	8.24E-03	9.19E+02	2.73E-01
Incinerator: 275 lb/hr	72	1.49E-02	4.95E-02	1.24E-02	3.47E-02	1.49E-02	1.75E+00	1.07E-02

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SUPPLY/SUPPORT VESSEL								
Propulsion engine (including thruster engines): 8,850 hp	9,674	2.88E+02	2.55E+02	4.50E-01	1.72E+01	2.46E+01	4.96E+04	1.28E+00
Generators/Engines: 1,750 hp (total)	19,334	3.80E+02	1.01E+02	1.78E-01	6.81E+00	9.74E+00	1.97E+04	5.09E-01
Heaters: 8 MMBtu/hr (total)	19,334	1.11E+01	2.76E+00	1.16E-01	5.52E-01	1.11E-01	1.23E+04	3.67E+00
Incinerator: 275 lb/hr	1,933	3.99E-01	1.33E+00	3.32E-01	9.30E-01	3.99E-01	4.69E+01	2.87E-01
OIL SPILL RESPONSE VESSELS								
Propulsion engine (including thruster engines): 8,850 hp	611	1.82E+01	1.61E+01	2.84E-02	1.08E+00	1.55E+00	3.13E+03	8.10E-02
Generators/Engines: 1,750 hp (total)	1,221	2.40E+01	6.39E+00	1.13E-02	4.30E-01	6.15E-01	1.24E+03	3.22E-02
Boom Workboat propulsion engines: 610 hp (total)	611	1.25E+00	1.11E+00	1.96E-03	7.47E-02	1.07E-01	2.16E+02	5.58E-03
Spill Storage Tanker propulsion engines: 3350 hp (total)	611	6.89E+00	6.10E+00	1.08E-02	4.11E-01	5.88E-01	1.19E+03	3.07E-02
Spill Storage Tanker generator: 775 hp	611	5.31E+00	1.41E+00	2.49E-03	9.50E-02	1.36E-01	2.74E+02	7.10E-03
Spill Storage Tanker boiler: 14.4 MMBtu/hr	611	6.29E-01	1.57E-01	6.60E-03	3.14E-02	6.29E-03	7.02E+02	2.08E-01
TOTAL EMISSIONS (tpy)		1,274	677	1.68	46.99	65.36	145,726	8.11

[1] Assume overall NO_x control of 70% on propulsion engines from the use of SCR.

Estimated emissions from this entire alternative are shown in Table 4.5-7. Overall, because of the schedules and locations of activities, the air quality impacts are still expected to meet the NAAQS, similar to the worst-case event scenario shown above, and the alternative would have only a moderate effect on air quality.

Direct and indirect impacts to air quality resulting from the implementation of Alternative 2 would be medium in magnitude, but temporary, localized, and affect common resources (see Table 4.5-3). Therefore, the summary impact level of Alternative 2 on air quality would be considered minor.

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 presence of high sound levels from anthropogenic activity and consequent exposures of marine wildlife to these conditions could potentially cause effects. This section considers levels of ensonification (intensity), duration and spatial extent of anthropogenic noise produced by Alternative 2 to inform the wildlife 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 is 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. 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 Chukchi Sea and the EIS project areas; the impact category of context is not applicable to acoustics.

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 anthropogencic sources reach or exceed 200 dB re 1 uPa @ 1 m.
Duration	Temporary	Acoustic levels are modified for one season or less.
	Long term	Acoustic levels are modified for multiple years, perhaps due to multi-year exploration in preparation for production.
	Permanent	Acoustic levels are increased for many years such as could occur with installation of a permanent structure such as CGBS production facilities.
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, 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 4.5-9). 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 to 2010, 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 Profier	Spark/Boom/Pulse	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. 2010

Project Operator and Year	Primary Survey Type	Location	Water Depths (m)	Airgun Array	Survey Vessel	Support Vessel	Sidescan/Multibeam	Sub-bottom Profier	Spark/Boom/Pulse	Reference
Statoil 2011	SH,GT, GC	Chukchi	37	X	X	X	X	X		Warner and McCrodan, 2012

Notes:

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

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

OBC = Ocean Bottom Cable 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

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 3.1.6.1. 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 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 currently consider thresholds of 190 and 180 dB re 1 µPa (rms) to be representative of onset of PTS 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. 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 at 120 dB re 1 µPa. 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 4.5-9 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 90th 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. Table 4.5-10 provides a summary of the airgun array measurements that have been performed for the programs listed in Table 4.5-9.

Table 4.5-10 Measured distances for seismic survey sounds to reach threshold levels of 190, 180, 160 and 120 dB re 1 µPa (*rms*) at sites in the Beaufort and Chukchi seas

Airgun array Vol (in^3)	**Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))**							
	190		**180**		**160**		**120**	
	Best fit range (m)	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***
Shell Offshore Inc. 2009, Open Water Shallow Hazards and Site Clearance Surveys, Chukchi Sea								
Honeyguide Prospect site (survey vessel M/V Mt. Mitchell)								
10 (single airgun)	17[1]	23[1]	39[1]	52[1]	210[1]	280	5900	7900
20 (2x10in^3)	28[1]	37[1]	66[1]	86[1]	360	460	11000	14000
40 (4x10in^3)	32[1]	41[1]	78[1]	99[1]	470	600	17000	22000[2]
Burger Prospect site (survey vessel M/V Mt. Mitchell)								
10 (single airgun)	6[3]	8[3]	26[3]	34[3]	440	570	18000	19000
40 (4x10in^3)	32[4]	39[4]	120[4]	150[4]	1500	1800	29000[2]	31000[2]
Shell 2008, 3-D Seismic Surveys and Shallow Hazard Surveys, Alaskan Beaufort and Chukchi seas (Hannay and Warner 2009)								
Chukchi Sea, Kakapo Site (3-D seismic survey; vessel M/V Gilavar)								
3147 *Endfire*	370	450	1100	1400	7900	9100	110000	120000
3147 *Broadside*	540	610	1700	2000	12000	13000	75000[6]	77000[6]
30 (single airgun)	140[7]	160[7]	320[7]	370[7]	1600[7]	1900[7]	40000	47000
Alaskan Beaufort Sea, Como Prospect Site (3-D seismic survey; vessel M/V Gilavar)								
3147 *Endfire*	24[8]	51[8]	210	440	6700	9600	54000	58000
3147 *Broadside*	770	920	2,500	2,900	9,000	9,500	≤ 45000[9]	≤ 45000[9]
30 (single airgun)	10[8]	13[8]	46	59	910	1,100	23000	24000

Airgun array Vol (in^3)	Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))							
	190		**180**		**160**		**120**	
	Best fit range (m)	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***
Camden Bay Site (Shallow Hazards survey; vessel Alpha Helix)								
20 (2x10 in^3)	34[10]	45[10]	91[10]	120[10]	630	830	15000	18000
10 (single airgun)	40[10]	53[10]	90[10]	120[10]	440	590	11000	14000
Camden Bay Site (Shallow Hazards survey; vessel Henry Christofferson)								
20 (2x10 in^3)	7[15]	10[15]	27[15]	37[15]	370	490	15000	16000
10 (single airgun)	4[15]	4[15]	14[15]	18[15]	230	280	14000	16000
Chukchi Sea Site (Shallow Hazards survey; vessel Cape Flattery)								
40 (4 x 10 in^3)	45[11]	50[11]	140[11]	160[11]	1200	1400	23000[12]	24000[12]
20 (2 x 10 in^3)	14[13]	17[13]	50[13]	62[13]	730	830	24000[12]	25000[12]
10 (single airgun)	7[14]	8[14]	28[14]	32[14]	380	440	15000	16000[12]
Statoil USA E&P 2010, Open Water 3-D Seismic Survey, Chukchi Sea								
Approximately 190 km (118 mi) northwest of Wainwright (Survey vessel R/V Geo-Celtic)								
3000 *Endfire*	300	370	1000	1300	8600	10000	59000	61000
3000 *Broadside*	430	520	1400	1600	11000	13000	123000	130000
60 (single airgun)	11	13	57	68	1300	1500	25000	26000
ConocoPhillips 2006, Seismic Exploration Program, Alaskan Chukchi Sea								
Approximately 150 km west of Point Lay, (Survey vessel M/V Western Patriot)								
3390 *Endfire*	-	514	-	1112	-	5086	-	65634
3390 *Broadside*	-	517	-	1628	-	11431	-	75370
3035 *Endfire*	-	499	-	1103	-	5148	-	56887
3035 *Broadside*	-	461	-	1471	-	10307	-	65207
105 (single airgun)	-	62	-	179	-	1449	-	30988
Eni Petroleum Company and PGS Seismic Survey 2008, at the Nikaitchuq oil field, east of the Colville River Delta, Beaufort Sea								
Deep water site (nominal depth of 10 m; survey vessel MV Wiley Gunner)								
880 *Endfire*	67	100	170	260	1100	1600	13000	16000
880 *Broadside*	140[4]	180[4]	340	440	2000	2400	20000	21000
20 (single airgun)	59	87	140	210	750	1100	9800	12000
Deep water site (nominal depth of 10 m; survey vessel MV Shirley V)								
880 *Endfire*	66	180	320	640	1600	2200	11000	14000
880 *Broadside*	120[4]	160[4]	410	550	3200	3800	20000	22000
20 (single airgun)	52[4]	73[4]	110[4]	160[4]	510	720	7500	9400

Airgun array Vol (in^3)	Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))							
	190		180		160		120	
	Best fit range (m)	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***
Shallow water site (nominal depth of 2.5 m; Survey vessel MV Wiley Gunner)								
880 *Endfire*	140	220	220	340	510	800	2800	4400
880 *Broadside*	210[16]	270[16]	340[16]	430	870	1100	5700	7100
20 (single airgun)	27[17]	41[17]	81[17]	120	680	870	2200	2400
Shallow water site (nominal depth of 2.5 m; Survey vessel MV Shirley V)								
880 *Endfire*	190	270	290	420	680	970	3700	5300
880 *Broadside*	140	200	300	430	1200	1600	6900	7900
20 (single airgun)	2[18]	6[18]	29	67	500	640	2200	2300
Shell 2007 Open water seismic exploration in Beaufort and Chukchi Seas								
Chukchi Sea (Vessel Gilavar)								
3147 Endfire		450		1140		7150		58400
3147 Broadside		545		2470		8100		66000
30 (single airgun)	<10[19]	<10[19]	<10[19]	<10[19]	1121	1360	36817	41100
Camden Bay (Vessel Gilavar)								
3147 Endfire		757		2245		13405		74813[20]
3147 Broadside		857		2088		10084		61887
30 (single airgun)	<10[4]	<10[4]	15[4]	24[4]	1261	1439	22911	24600
Beechey Point (Vessel Henry C)								
20 (2x10)		12		51		597		10700
10 (single)		5		20		333		8130
Camden Bay (Vessel Henry C)								
20 (2x10)		1[4]		7[4]		1000		25200
GXT Chukchi Sea, October—November 2006								
MV Discoverer, 100 km offshore of the North coast of Alaska in the Chukchi Sea (west of Point Lay)in water depths of 40-46 m.								
3320 Endfire	620		1460		7280		57,530	
3320 Broadside	480		1770		10970		167000	
Shell 2006, open water seismic exploration in the Beaufort and Chukchi seas, July–September 2006. Chukchi measurements in 52 m water depth, Beaufort in 48 m.								
Seismic vessel M//V Gilavar operating in the Chukchi Sea								
3147 End-fire Bow	460		1270		7990		67620*	
3147 End-fire Stern	360		980		6770		82890*	
3147 Broadside	420*		1400		-		-	

Airgun array Vol (in³)	Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))							
	190		**180**		**160**		**120**	
	Best fit range (m)	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***
1049 End-fire Bow	270*		650		-		-	
1049 End-fire Stern	170*		450		3240		61400*	
1049 Broadside	420		1350*		-		-	
Henry Christoffersen, about 54 km east of Kaktovik off the north coast of Alaska, in the Beaufort								
280 (4x70)	89		250		1750		22220*	
Statoil Shallow Hazards survey from M/V Duke at Amundsen Prospect in the Chukchi Sea, August-September 2011								
40 (4x10)	32	37	110	130	1300	1500	28000[3]	30000[3]
10	13	15	50	59	720	840	27000[3]	29000[3]

[1]Extrapolated from minimum measurement range of 240 m (0.15 mi).

[2]Extrapolated from maximum measurement range of 20000 m (1.2 mi).

[3]Extrapolated from minimum measurement range of 275 m (0.17 mi).

[4]Extrapolated from minimum measurement range of 200 m (0.12 mi).

[5]Extrapolated beyond maximum measured range of 20 km

[6]Extrapolated from maximum measurement range of 34.9 km

[7]Extrapolated from minimum measurement range of 8 km (5 mi).

[8]Distances to the 190 dB re µPa level were extrapolated from data at longer ranges.

[9]The level of the interfering airgun signals on OBH D was approximately 120 dB re µPa. Therefore the 120 dB re 1 µPa threshold range for was constrained to less than 45 km, or 28 mi, from the array.

[10]Extrapolated from minimum measurement range of 190 m (620 ft).

[11]Extrapolated from minimum measurement range of 194 m (640 ft).

[12]Extrapolated from maximum measurement range of 15000 m (9.3 mi).

[13]Extrapolated from minimum measurement range of 208 m (680 ft).

[14]Extrapolated from minimum measurement range of 199 m (653 ft).

[15]Extrapolated from minimum measurement range of 90 m (295 ft).

[16]Extrapolated from minimum measurement range of 375 m.

[17]Extrapolated from minimum measurement range of 85 m.

[18]Extrapolated from minimum measurement range of 14 m.

[19]Extrapolated from minimum measurement range of 980 m (260 ft).

[20]Extrapolated from maximum measurement range of 58.7 km (36.5 mi).

*Empirical distance was based on an extrapolation of the fitted curve beyond the range of the measured data

The results in Table 4.5-10 exhibit variability of the measured levels, even when considering similar sources in the same primary acoustic environment. This can arise due to differences of the sediment type or of the structure of the sound speed profile, both factors that influence sound propagation. For example, severe weather and surface waves can increase mixing in the water column and reduce the effect of a surface sound channel that can support strong sound propagation in calm conditions. Or, the sediment type may be more reflective in one measurement site enhancing the 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 the Table 4.5-10 results for offshore and coastal surveys, and are presented in Table 4.5-11. The averages are based on the 90th percentile 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 impacts from airgun sources for each action alternative.

Table 4.5-11 Average distances to sound level thresholds from measurements listed in Table 4.5-10 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.

		Average distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))			
		190	180	160	120
Chukchi Sea Shelf 37 to 52 m depth					
	10 in^3	15	48	560	19000
	40 in^3	42	135	1300	27000
	~3200 in^3	530	1760	10700	95000
Beaufort Sea Shelf, 15 to 40 m depth					
	10 in^3	21	53	401	12700
	20 in^3	19	55	770	16400
	~3200 in^3	890	2570	11400	60000
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	20 in^3	52	140	832	6530
	880 in^3	220	463	2230	15300

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 significant areas where sound levels exceed NMFS' injury criteria thresholds, but they may ensonify regions that should be considered for effects where sound levels exceed the continuous and/or pulsed noise thresholds for marine mammal disturbance. 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 Chukchi and Beaufort Shelf environments may, depending on the type of vessels employed, 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. For the purpose of this evaluation, the 120 dB re 1 µPa threshold distance is based on the source level measurements of the Shell drillship *Noble Discoverer* made in 2009 in the South China Sea (Shell 2011a). Those measurements indicated drilling source levels from 178.5 to 185.4 dB re 1 µPa@1m (10 Hz to 24 kHz), and are 2.6 to 9.6 dB higher than the source level of the *Mt. Mitchell* on DP. Assuming the *Noble Discoverer's* source level is on average 5 dB above the *Mt. Mitchell's*, the estimated 120 dB re 1 µPa threshold distance could be 10 km (6 mi).

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. The 120 dB re 1 µPa threshold distance is expected to extend less than 1 km (0.6 mi) from the source.

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), and that source level will be used for the present analysis. While the source level is several decibels higher than those of vessels, the 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 will be assumed also for the vibroseis in this analysis.

The measurements referenced in the preceding discussion are summarized in Table 4.5-12, providing the expected distances to the 120 dB disturbance criteria for each non-airgun source. These values are used in the impact assessments that follow for each alternative.

Table 4.5-12 Distances to 120 dB re 1 µPa for non-airgun sources, from discussion above.

Source Type	Distance to 120 dB re 1 µPa
Drillship	10 km (6 mi)
Jack-up rig	1 km (0.6 mi)
Support Vessel in Offshore Operation	1.6 km (1 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 (injury) and disturbance that were discussed above.

Estimates of Total Surface Areas of Ensonification at Threshold Levels

Table 4.5-13 contains estimates of surface areas ensonified above given threshold levels under Alternative 2 based on the ranges provided in Table 4.5-11. 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 exploration 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.

Table 4.5-13 Total Surface Areas Ensonified Above Sound Level Thresholds Under Alternative 2, 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					
	3x ~3200 in^3	2.65	29.2	1,079	85,059
	3x 40 in^3	0.02	0.17	15.2	6,371
	% Chukchi	**0.001%**	**0.01%**	**0.4%**	**35%**
Beaufort Sea Shelf, 15 to 40 m depth					
	3x ~3200 in^3	7.47	62.2	1,225	33,929
	2x 20 in^3	0.002	0.02	3.73	1,690
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	1x 880 in^3	0.15	0.67	15.6	735
	1x 20 in^3	0.01	0.06	2.17	134
	% Beaufort	**0.003%**	**0.02%**	**0.5%**	**14%**
Entire Region					
		7.96	**72.3**	**1,948**	**117,344**
	% EIS area	**0.002%**	**0.02%**	**0.5%**	**25%**

4.5.1.4.6 Conclusion

Alternative 2 presents the lowest activity of the alternatives, but it represents an increase in activity above current levels. The distances to PTS thresholds are given in Table 4.5-10 (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. The specific distances to these thresholds for seismic airgun sources are given in Table 4.5-11 and for all other sources in

Table 4.5-13. 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.

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 EIS project areas 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 industrial discharges of pollutants to the surface waters of the Beaufort and Chukchi seas under the National Pollution Discharge Elimination Systems (NPDES) program. Wastes generated from activities within the EIS project area would be discharged in accordance with the conditions of the NPDES general permit. The Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration expired on June 26, 2011. The EPA will reissue separate NPDES General Permits for exploration in the Beaufort Sea and the Chukchi Sea prior to the 2012 drilling season.

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. 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 offshore 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.

The level of impacts to water quality will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-14.

Table 4.5-14 Impact Levels 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**: Water 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**: Water 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**: Water quality would be reduced and would not be anticipated to return to previous level
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

4.5.1.5.1 Direct and Indirect Effects

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. Likewise, seismic surveys are not expected to affect the salinity of waters within the proposed action area.

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. Likewise, site clearance and shallow hazards surveys are not expected to affect the salinity of waters within the proposed action area.

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 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 Clean Water Act (CWA) Section 402, National Pollutant Discharge Elimination System (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; to consult with the U.S. Fish and Wildlife Service (USFWS) and NMFS to ensure that any action it authorizes is not likely to jeopardize the continued existence of any species listed under the Endangered Species Act or result in the destruction or adverse modification of critical habitat for a listed species; and to conduct its own NEPA analysis for the discharges subject to New Source Performance Standards.

It is currently EPA's practice to utilize general permits for exploration activities in the Arctic, with the intention of issuing individual permits for any proposed development or production in the future. 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 2006).

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 degree Celsius (MMS 2002). 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 seismic surveys would result in localized, temporary increases in turbidity in the immediate vicinity of the survey area as the cables are laid on and retrieved from the seafloor. There is also the potential for the cables to affect turbidity if the cables 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, localized 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(c)) 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 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 would not affect dissolved metal concentrations in the EIS project area.

On-ice Seismic Surveys

On-ice seismic surveys would not affect dissolved metal concentrations in the EIS project area.

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 3.1-7 (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 3.1-9.

A detailed discussion related to the environmental distribution of trace metals from exploratory drilling activities is available in the *Final Ocean Discharge Criteria Evaluation of the Arctic NPDES General Permit for Oil and Gas Exploration (Permit No.: AKG280000). Expired: 26 June 2011* (EPA 2006b), and is incorporated here by reference.

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 3.1-7, 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 drillsite (Trefry and Trocine 2009), concentrations of metals dissolved from resuspended sediments are unlikely to exceed the EPA Water Quality Criteria (EPA 2009b). 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 2006b). Although only water based drilling fluids would be used in the drilling of exploration wells within the proposed action area, 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 addition, petroleum hydrocarbons including the polycyclic aromatic hydrocarbons naphthalene, fluorene, and phenanthrene, as well as their alkylated derivatives, are generally present in mineral oils that may be added to drilling fluids as a lubricant and subsequently discharged subject to NPDES permit conditions (see Table 4.5-15) (EPA 2006b). 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 3.1-9 (Chapter 3).

Table 4.5-15 Concentrations of organic pollutants in three mineral oils used as drilling mud additives (Battelle 1984 in EPA 2006b).

Chemical	Concentration in Oils (mg/kg)		
	Oil A	Oil B	Oil C
Benzene	ND	ND	ND
Ethylbenzene	ND	ND	ND
Naphthalene	50	ND	ND
Fluorene	ND	150	10
Phenanthrene	ND	200	40
Phenol	ND	ND	ND
Alkylated benzenes	30,000	ND	ND
Alkylated naphthalenes	280	690	ND
Alkylated fluorenes	ND	1,740	ND
Alkylated phenanthrenes	ND	140	ND
Alkylated phenols	ND	ND	ND
Alkylated biphenyls	230	5,570	20
Alkylated dibenzothiaphenes	ND	370,000	ND

ND = not detected.

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. This challenge is discussed in the 2006 Ocean Discharge Criteria Evaluation (ODCE) for the NPDES Arctic General Permit for Oil and Gas Exploration which states:

> *An assessment of the potential for organic compounds to exceed water quality criteria was not possible due to a lack of data concerning the concentrations of such materials in drilling muds and the lack of applicable water quality criteria for some of the chemicals detected in the muds.* (EPA 2006b)

The 2006 NPDES permit expired in June 2011, and a new permit and ODCE were not available at the time of writing this EIS.

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. However, because of the lack of applicable water quality criteria for some of the chemicals present in drilling fluids (EPA 2006b), it is problematic to determine whether or not inputs of hydrocarbons from the proposed activity would exceed water quality regulatory limits.

4.5.1.5.2 Conclusion

After mitigation, 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 proposed action area are expected to be negligible.

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 3.1.8.1 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. Ecosystem goods and services are only rarely the product of a single species or component. Therefore, the interactions of various ecosystem components must be considered as important aspects of the affected environment. 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 contaminants of concern 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 contaminants of concern on ecosystem functions. These analyses identify contaminants of concern, 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 to environmental contaminants will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-16.

Table 4.5-16 Impact Levels for Effects on 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**: ecosystem functions 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**: ecosystem functions would be reduced through the life of the project and would return to pre-activity levels at some time after completion of the project	**Permanent**: Chronic effects; ecosystem functions would not be anticipated to return to previous levels
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

Impact Component	Effects Summary		
Context	**Common**: Affects usual or ordinary ecosystem functions; not impacted	**Important**: Affects impacted ecosystem functions within the locality or region	**Unique**: Affects unique ecosystem functions

4.5.1.6.1 Direct and Indirect Effects

Contaminants of Concern

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. 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. Due to their hydrophobic properties and persistence in the environment PAHs would partition into sediments and lipids in the marine environment, and their concentrations would increase at higher trophic levels as a result of persistence in biological systems and efficient transfer of lipids between trophic levels.

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), and 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 proposed action area. 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.

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 4.1.5.6 (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. Chromium, copper, mercury, lead, and zinc would be the metals of greatest concern (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).

Overexposure to chromium could lead to increases in the incidence of cancers in higher trophic level organisms and could interfere with the functioning of certain proteins (Cohen et al. 1993). 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 3.1.8.2, 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.

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 higher trophic level organisms. With regard to such higher trophic level organisms, indirect effects 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).

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 (defined in Section 4.4.1.6) 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 in other sections 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 temporary, 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, temporary 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, temporary, localized, 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 negligible.

4.5.1.7 Standard Mitigation Measures for the Physical Environment

Standard Mitigation Measures are outlined in Section 2.4.9 and described in detail in Appendix A. 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. The following standard mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on resources within the physical environment.

A1. Establishment of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for pinnipeds.

Acoustics – This standard mitigation measure includes establishing and implementing exclusion zones based on the true 190 and 180 dB re 1 µPa threshold distances for seismic activities. This measure will not affect acoustic levels except during periods when seismic survey shut-downs occur as a result of animal presence in or near the exclusion zones. In those cases the seismic sound emission from a particular survey would temporarily cease. Vessel sound levels would continue. After a shut-down the sound levels would gradually increase through ramp-up (as described in standard mitigation measure A2) and then finally return to full level.

A2. Specified ramp-up procedures for airgun arrays.

Acoustics – Any time airgun activities commence, a ramp-up procedure is performed whereby the airgun array is gradually brought to its full operating power power by activating a progressively increasing number of airguns. Sound levels increase gradually during ramp-up, providing an opportunity for nearby animals to leave the vicinity of the source before the full survey acoustic emission levels are reached.

B1. Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

Acoustics – Sound emissions from aircraft will elevate underwater and airborne sound levels in a relatively small acceptance footprint directly below the aircraft. The sound levels will decrease with increase of flight altitude due to the greater separation between the noise source and the ground or water, though the size of the underwater footprint will increase with source altitude. Received sound levels can be reduced by selecting appropriate flight altitudes.

C4. Oil Spill Response Plan.

Water Quality, Ecosystem Functions – The requirement for operators to have an oil spill response plan in place would reduce potential adverse impacts on water quality and ecosystem functions within the EIS project area should a spill take place. Having response protocol outlined will minimize the time the oil spill would be impacting the physical environment.

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 or around August 25.

Acoustics – Seismic sources and vessels related to exploration activities generate sound levels that are potentially harmful or disturbing to bowhead whales located nearby. These activities have therefore the potential to cause bowhead whales to avoid the areas where they occur. The cessation of exploration activities in specific areas of the Beaufort at the start of the fall Bowhead whale hunts will prevent interference with the hunting activities at Nuiqsut and Kaktovik.

D3. Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Acoustics – As mentioned for Standard Mitigation Measure B1, sound emissions from aircraft will elevate underwater and airborne sound levels along the flight path. The sound levels will decrease with increase of flight altitude due to the greater separation between the noise source and the ground or water. Received sound levels can be reduced by selecting appropriate flight altitudes and paths to avoid interference with subsistence activities. It is noted that altering flight paths will reduce the sound impact along the original overflight area but will cause a corresponding increase of sound levels in other areas.

4.5.1.7.1 Standard Mitigation Measures Summary for the Physical Environment

Standard mitigation measures that may possibly be incorporated into future authorizations and that could reduce potential adverse impacts to physical resources are discussed above. Efficacy and practicability of these measures are discussed to the extent possible, given the varying degrees of current availability and usage of these measures. The vast majority of standard mitigation measures discussed above would impact the acoustic environment to some degree. However, having an oil spill response plan in place would reduce the duration of any adverse impacts resultant from a spill on water quality and environmental contaminants.

4.5.1.8 Additional Mitigation Measures for the Physical Environment

Additional Mitigation Measures are outlined in Section 2.4.10 and described in detail in Appendix A. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. The following additional mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on resources within the physical environment.

Additional Mitigation Measure A1. Sound source verification tests for sound sources and vessels at the start of the season.

Acoustics – This mitigation measure does not directly affect the acoustic environment as it does not bring about an increase or decrease of generated sound levels; it will, however, provide more accurate ranges to acoustic threshold criteria specific to the environment and activities than any estimation based on numerical modelling or on measurements of unrelated activities. This information in turn will improve the effective implementation of shutdown radii as per the Standard Mitigation Measure A1.

Additional Mitigation Measure A4. Measures to increase detection probability for real-time mitigation (e.g. to maintain 180 dB shutdown zones), such as passive and active acoustic monitoring.

Acoustics – Passive acoustic monitoring can be employed to complement visual observations (Standard Mitigation Measure A1) through the classification and localization of marine mammal vocalizations detected on either towed or moored acoustic systems. This mitigation measure does not directly affect the acoustic environment.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.

Acoustics – The ranges to acoustic impact thresholds for each activity, either estimated or directly measured at start of season through Additional Mitigation Measure A1, provide the necessary offset to avoid excessive sound exposure within the important habitats noted in this mitigation measure. The cessation of an activity over certain periods of time to avoid impacts in important habitats has the most effective mitigation capacity but may result in intensified activity outside of the restriction period.

Ecosystem Functions – This mitigation measure has the potential to reduce adverse impacts on regulation, production, habitat and information ecosystem functions. Such spatiotemporal restrictions may have the potential to reduce adverse effects on ecosystem functions.

Additional Mitigation Measure B2. NMFS restricting 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).

Acoustics – A survey conducted in the same area as another (of the same level of detail) within a relatively short amount of time adds unnecessarily to the cumulative noise dose for no technical benefit. This measure has the effect of reducing the potential revisiting of already surveyed areas with consequent increase of the ensonification of the region.

Additional Mitigation Measure B3. Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

Acoustics – A 145 km (90 mi) separation between surveys would avoid an overlap of the acoustic footprints from each survey, even at the lower levels of biological effect, and prevent an additive effect of the sound levels. This mitigation measure, however, does potentially broaden the expanse of sound exposure, affecting a larger overall area.

Additional Mitigation Measure C1. Vessel and aircraft avoidance of concentrations of groups of ice seals, walrus, and polar bears.

Acoustics – Vessels and aircraft generate continuous sound levels that have the potential to be disturbing to seals, walrus and polar bears. Avoiding concentrations of groups of these animals limits their exposure to these continuous noise sources and reduces the potential for harassment.

Additional Mitigation Measure C2. Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Acoustics – Vessels generate continuous sound levels that have the potential to be disturbing to marine mammals. Avoiding areas of important habitat will limit exposure of high densities of animals to this noise and reduce the potential for harassment.

Ecosystem Functions – Specification of shipping and transit routes to avoid sensitive habitats would reduce adverse impacts to ecosystem functions.

Additional Mitigation Measure C3. 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 habitat.

Water Quality – The adaptations to some permitted discharge streams associated with oil and gas activities are intended to reduce potential adverse impacts to marine mammals or marine mammal habitat. These reductions or limitations could also have indirect effects on water quality in portions of the EIS project area.

Ecosystem Functions – This additional mitigation measure includes 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 of those discharge streams is expected to reduce the potential for adverse impacts to ecosystem functions.

Additional Mitigation Measure C4. Operators are required to recycle drilling muds.

Physical Oceanography – Additional Mitigation Measure C4 requiring operators to recycle drilling muds based on operational considerations to reduce discharges would also have the potential to reduce impacts to physical ocean resources by decreasing the size of the minor sediment mound.

Water Quality – Additional mitigation measures requiring operators to recycle drilling muds may also reduce the potential for adverse impacts to water quality within the EIS project area.

Ecosystem Functions – Additional mitigation measures requiring operators to recycle drilling muds may also reduce the potential for adverse impacts to ecosystem functions within the EIS project area.

Additional Mitigation Measure D1. No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay.

Acoustics – Vessels generate continuous sound levels that have the potential to be disturbing to beluga whales and may cause the whales to avoid areas near the vessels. Eliminating the presence of exploration vessels during the beluga hunt at Point Lay will avoid the potential that vessel activities will deter belugas from the area and interfere with the success of the hunt.

Additional Mitigation Measure D2. 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.

Acoustics – Vessels generate continuous sound levels that have the potential to be disturbing and may cause whales to avoid areas near the vessels. The potential for disturbance near shore east of Bullen Point to the Canadian border is eliminated by restricting vessel transits such that the distance between the vessel and marine mammals limits their sound exposure to levels below the disturbance threshold.

Additional Mitigation Measure D3. 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.

Acoustics – Seismic sources and vessels related to exploration activities generate sound levels that are potentially harmful or disturbing to bowhead whales located nearby. As such, these activities have the potential to cause bowhead whales to avoid the areas where they occur. The cessation of exploration activities in the Beaufort while bowheads presence is reported prevents interference with the hunting activities at Nuiqsut and Kaktovik.

Additional Mitigation Measure D4. Shutdown of exploration activities in the Beaufort Sea for the Barrow bowhead whale hunts from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.

Acoustics – Seismic sources and vessels related to exploration activities generate sound levels that are potentially harmful or disturbing to bowhead whales located nearby. As such, these activities have the potential to cause bowhead whales to avoid the areas where they occur. The cessation of exploration activities in the Beaufort while bowheads are present during the fall hunt will prevent interference with the hunting activities near Barrow from Pitt Point to a location half way between Barrow an Peard Bay.

Additional Mitigation Measure D5. 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.

Acoustics – Seismic sources and vessels related to exploration activities generate sound levels that are potentially harmful or disturbing to bowhead whales located nearby. As such, these activities have the potential to cause bowhead whales to avoid the area surrounding the areas where they occur. The cessation of exploration activities in the Chukchi while bowheads are present and hunting is active at Barrow and Wainwright will prevent interference with the hunting activities.

Additional Mitigation Measure D6. Shutdown of exploration activities in the Chukchi Sea for the Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

Acoustics – Seismic sources and vessels related to exploration activities generate sound levels that are potentially harmful or disturbing to bowhead whales located nearby. As such, these activities have the potential to cause bowhead whales to avoid the areas where they take place. The cessation of exploration activities in the Chukchi while bowheads are present and the hunt is active at Point Hope and Point Lay will prevent interference with the hunting activities.

Additional Mitigation Measure D7. Transit restrictions into the Chukchi Sea modified to allow offshore travel under certain conditions (e.g. 32 km [20 mi] from the coast) if beluga whale, fall bowhead whale (Barrow and Wainwright), and other marine mammal hunts would not be affected.

Acoustics – Vessels generate continuous sound levels that have the potential to be disturbing and may cause whales to avoid areas near the vessels. The potential for disturbance is eliminated by restricting vessel transits so that the distance between the vessel and the marine mammals limits their sound exposure to levels below the disturbance threshold.

Additional Mitigation Measure D8. 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 until the close of the bowhead whale hunt in Barrow.

Acoustics – Vessels and exploratory drilling operations generate continuous sound levels that have the potential to be disturbing and may cause whales to avoid areas near the activities. The potential for disturbance is eliminated by avoiding these activities at any location outside the barrier islands west of Cross island until the close of the bowhead whale hunt in Barrow.

4.5.1.8.1 Additional Mitigation Measures Summary for the Physical Environment

Additional mitigation measures that may possibly be incorporated into future authorizations and that could reduce potential adverse impacts to physical resources are discussed above. Efficacy and practicability of these measures are discussed to the extent possible, given the varying degrees of current availability and usage of these measures. The vast majority of additional mitigation measures discussed above would impact the acoustic environment to some degree.

4.5.2 Biological Environment

Table 4.5-17 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.

Table 4.5-17 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	**Permanent**: Change in behavior patterns even if actions that caused the impacts were to cease; behavior not expected to return to previous patterns	**Long-term**: 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 protected by legislation 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
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	**Permanent**: Incidences of mortality or injury would continue to occur longer than five years or persist after actions that caused the disturbance ceased	**Long-term**: 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 protected by legislation	**Important**: Affects depleted resources	**Common**: Affects usual or ordinary resources in

Type of Effect	Impact Component	Effects Summary		
		and the portion of the resource affected fills a unique ecosystem role within the locality or region	within the locality or region or resources protected by legislation	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	**Permanent**: Chronic effects; resource would not be anticipated to return to previous levels	**Long-term**: 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 protected by legislation 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 production 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, 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 of marine mammals and other higher trophic level animals, and/or habitat loss/alteration, which in turn would affect lower trophic level organisms 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. The removal of surface ice could also provide increased light, leading to out-of-season phytoplankton blooms, which could attract other benthic organisms. Benthic organisms could be displaced from locations where drilling, sediment sampling, ship anchoring, or platform installation would occur. Because these populations are typically impacted by seasonal displacement due to natural ice scour and because the areas impacted would be minor in relation to the overall available benthic habitat the anticipated effect would be localized, minor and short-term.

Injury and Mortality

Any exploration activities that directly impact the seafloor, such as anchoring of drill ships and support vessels, and creation of artificial drilling islands, could cause direct injury and mortality to lower trophic level organisms. Ice scouring is a naturally occurring event. It is not clear if scouring 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 special habitat areas such as Camden Bay, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, the Western Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit 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.

The discharge of drilling muds and cuttings also pose a direct threat to the benthic community’s habitat; sediment and cuttings can sink to the bottom and cause direct mortality and injury by burying benthic organisms. The Beaufort Sea is shallower and experiences less circulation than the Chukchi Sea, so discharges may pose a greater threat to the benthos in these calmer waters. Mortality and injury could 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. Finally, an additional indirect cause of mortality could be the introduction of invasive species from industry ship traffic, particularly if the invasive species are predatory in nature.

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 is highly localized and disparate and therefore difficult to quantify. Some species are quick to repopulate the scoured area, but it can take a decade for the habitat to fully recover from disturbance. Some species, such as the large clams walrus feed on, have been shown to take 9 years to recolonize an area, and even then, they did not recover completely (Conlan and Kvitek 2005, BOEM 2010).

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.

4.5.2.1.2 Conclusion

Using the criteria identified in Table 4.5-17, 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 medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of 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). 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 oil spill in the Beaufort and Chukchi seas are analyzed in Section 4.9.6.9 and 4.9.7.9.

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 walrus. A final concern was the overall scarcity of scientific data regarding biological resources in the action area. Despite this scarcity of scientific data, a desire for quantifiable impacts was expressed. The concerns identified in the scoping process have been addressed in the analysis below.

Exposure to Noise

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 4.5-18. 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 4.5-18 Physical and Behavioral Effects of Noise 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, haemorrhaging, eye damage)	220
Fish Mortality	230-240

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

Research on acoustic impacts to fish has been limited to relatively few species, and specific data regarding the effects of noise on the species encountered in the arctic environment are lacking. 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). However, despite the recognized need for further study on the effects of oil and gas activities on specific arctic species, enough information exists to perform a full analysis.

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. First, the frequency needs to fall within the fish's audible range, and second, the intensity needs to be sufficiently strong for the fish to detect. In other words, 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). Focused studies have been able to cause measurable physiological harm to fish using 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). 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). Presumably, this is because fish are unlikely to remain in an area where intense sounds sources are present 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). There is no recorded evidence that airguns have killed fish or caused injuries during seismic survey operations (Turnpenny and Nedwell 1994).

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 4.5-18). 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 significantly immediately following the use of airguns for seismic surveys, with a period of up to 5 days required for catch rates to return to normal (Hassel et al. 2004, Popper and Hastings 2009). Fish typically initiate avoidance behavior at levels above 160 to 180 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 4.5-18). 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 4.5-18). 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 highly 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. 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 likely that fish would become habituated to them and the zone of displacement would recede or even be eliminated 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 4.5-18), 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 and can be temporary or permanent. 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, such as the construction of a gravel island.

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, and exploratory drilling and associated gravel island construction.

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 the entire 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 transitory, hours at most, and constrained to a narrow swath of ~30 ft (10 m) to each side of the vessel (NMFS 2010).

In shallow areas with thick sea ice, the impacts from icebreaking could potentially extend to the seafloor if the broken ice was to have direct contact. However, in the unlikely event that it did occur, it would simply mimic the scouring occurring naturally by the seasonal movement of pack ice due to wind and currents, except on an extremely small, localized scale, and in an area already likely to experience this action. Ice-breakers cause rapid pack ice movement at a time of year when the ice may not normally be breaking and moving; these ice movements could affect ice-associated fish species, particularly arctic cod eggs and larvae.

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 indirectly 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 2011). 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.

Exploratory Drilling

Exploratory drilling operations 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 impact fish resources, particularly benthic feeders. 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.

4.5.2.2.1 Direct and Indirect Effects

Freshwater Fish

There would be no direct or indirect effects on the freshwater fish resources resulting from Alternative 2. As none of the activities described in Alternative 2 take place in or near freshwater, neither fish nor fish habitat would be affected. Although some freshwater species occasionally get forced into nearshore brackish waters during spring floods (such as Arctic grayling and northern pike), these events do not overlap spatially or temporally with any of the described activities. In the unlikely event that any freshwater fish were exposed to sound from oil and gas exploratory activities, it would be of low intensity and temporary duration over a very localized extent, and therefore have a negligible effect.

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 eliminate any effects from displacement. Therefore, the effect on juvenile and adult fish would be negligible. 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 minor, as a mechanism for population change exists, but no measurable change would result.

General population trends and life histories are sufficiently understood to support sound scientific judgments, and expected impacts to fish resources are negligible. 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.

The opportunity for habitat loss or alteration resulting from Alternative 2 is very 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 very limited areas, particularly when compared to the total area of benthic habitat available. Therefore, the negative impacts are considered minor.

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 substantially.

Within the broad classification of migratory fish, anadromous species (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 3.2.2.3.3, 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. However, pink and chum salmon, the most commonly encountered salmon species in the Arctic, are not very abundant in the areas impacted by oil and gas activities. Chum salmon are known to migrate as juveniles to the Bering Sea to mature, and pink salmon have been very infrequently encountered in marine arctic surveys (see Section 3.2.2.6).

Therefore, as with marine fish, the potential for impacts to migratory fish are so small when compared to the overall size of the habitat area and population that the effects are considered to be negligible.

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 and saffron cod. Large portions of the EIS project area fall within the boundaries of the described EFH for these species; however this is more a function of vague habitat descriptions based on limited data as opposed to specific knowledge of important habitat elements within the region. Therefore, the amount of habitat actually essential to the survival of these fish that falls within the boundaries of the described EFH is likely considerable 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 very small. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

4.5.2.2.2 Conclusion

Given the potential implementation of standard mitigation measures considered by NMFS in this EIS (discussed in Section 4.5.2.7), the effects on fish and EFH would likely be low in magnitude, temporary to short-term in duration, of local extent, and would affect common resources. The direct and indirect effects resulting from Alternative 2 would therefore be considered negligible 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. Four of these species are listed under the ESA: spectacled eider (threatened); Steller's eider (threatened); Kittlitz's murrelet (candidate species); and yellow-billed loon (candidate species). 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 changes/contamination.

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 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 and candidate species yellow-billed loon and Kittlitz's murrelet. The USFWS issued a Biological Opinion (BiOp) for exploration activities in the Beaufort and Chukchi seas (USFWS 2009c) that includes an Incidental Take Statement and required mitigation measures intended to reduce adverse effects on the two listed eider species. These required mitigation measures would also effectively reduce adverse effects on other marine and coastal birds. Although NMFS would not include stipulations to explicitly protect birds in the IHAs they issue for exploration activities, the following mitigation measures are typically required by BOEM for permitted oil and gas exploration activities on the Beaufort and Chukchi seas to minimize impacts on spectacled eiders and are thus incorporated into the analysis of potential effects under Alternative 2:

- No seismic vessel activity, including resupply vessels and other related traffic, will be permitted within the Ledyard Bay Critical Habitat Area between July 1 and November 15 of each year, unless human health or safety dictates otherwise.
- Survey-support aircraft must avoid overflights across the Ledyard Bay spectacled eider critical habitat area below an altitude of 457 m (1,500 ft) between July 1 and November 15 of each year, unless human health or safety dictates otherwise. Seismic-survey-support aircraft would maintain at least 457 m (1,500 ft) over beaches, lagoons, and nearshore waters as much as possible. Designated aircraft flight routes will be established for situations when aircraft associated with seismic activity cannot maintain >457 m (1,500 ft) above sea level (ASL) over the Ledyard Bay Critical Habitat Area.
- Ramping-up procedures will be used when initiating airgun operations.
- Lessees must adhere to lighting requirements aimed at minimizing the radiation of light outward from all exploration or delineation drilling structures so as to minimize the likelihood that migrating marine and coastal birds will strike these structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures while operating on a lease or if staged within nearshore Federal waters pending lease deployment. Lessees are encouraged to consider a full range of technical, operational, and management approaches that could be applied to their specific facilities and operations to reduce outward light radiation. Lessees must provide MMS with a written statement of measures that will be or have been taken to meet the lighting objective, and must submit this information with an exploration plan when it is submitted for regulatory review and approval.
- Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m bathymetric contour. High-intensity lights will be turned off in inclement weather when the seismic vessel is not actively conducting seismic surveys. However, navigation lights, deck lights, and interior lights could remain on for safety.
- All bird-vessel collisions (with vessels or aircraft) shall be documented and reported within three days to USFWS. Minimum information will include species, date and time, location, weather, and if a vessel is involved in its operational status when the strike occurred. Bird photographs are not required but would be helpful in verifying species. Operators are advised that USFWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

- Operators must maintain a minimum spacing of 24 km (15 mi) between the seismic-source vessels for separate operations.
- Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic-substance spill. If vessels transit through the spring lead system before June 10, they may encounter concentrations of listed eiders. The USFWS therefore requires that wildlife hazing equipment (including Breco buoys or similar equipment) be pre-staged and readily accessible by personnel trained in their use, either on the vessel, at Point Lay or Wainwright, or on an on-site oil-spill response vessel, to ensure rapid deployment in the event of a spill.

ADNR also imposes mitigation measures for the existing and anticipated Beaufort Sea Lease Sales on State of Alaska lands specific to protection of bird resources, including:

- Permanent, staffed facilities must be sited to the extent feasible and prudent outside identified brant, white-fronted goose, snow goose, tundra swan, king eider, common eider, Steller‘s eider, spectacled eider, and yellow-billed loon nesting and brood rearing areas.
- Due to high concentrations of staging and molting brant and other waterbirds within the coastal habitats along the Teshekpuk Lake Special Area and other areas, operations that create high levels of disturbance, including but not limited to dredging, gravel washing, and boat and barge traffic along the coast, will be prohibited from June 20 to September 15 within one-half mile of coastal salt marshes. In addition, Tracts 228 and 231 are subject to the same restrictions between May 15 and July 30 to protect large concentrations of breeding snow geese. The construction and siting of facilities within one mile of these areas may be allowed on a case-by-case basis if the Director, Division of Oil and Gas, and ADF&G determine that no other feasible and prudent location exists.

The NSB also has local ordinances to protect coastal birds that apply to existing state leases:

- From June 1 to August 31, aircraft overflights must avoid identified brant, white-fronted goose, tundra swan, king eider, common eider, and yellow-billed loon nesting and brood rearing habitat, and from August 15 to September 15, the fall staging areas for geese, tundra swans, and shorebirds, by an altitude of 457 m (1,500 ft), or a lateral distance of one mile.

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. There is some concern about exploration activities and their potential disturbance of birds important to subsistence.

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. Vessel traffic may cause localized, 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.

Seismic surveys with airgun arrays result in both horizontal and vertical sound propagation in the water column. There has been little directed research on the potential effects of these sounds on birds due to the difficulty in following individual birds in the wild and the lack of facilities to test seismic equipment on captive 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 ESA-listed 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. The great majority of birds are therefore not present in offshore 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 offshore 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 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 Ledyard Bay Critical Habitat Unit (LBCHU), which is off-limits to seismic surveys and any exploration vessels from June 1 through November 15 (as required by BOEM permits for exploration activities as a result of Section 7 consultations with the USFWS).

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. This could be an issue in the Beaufort Sea because of nearshore lease tracts in state waters which could be explored under Alternative 2 but not in the Chukchi Sea because all exploration activities would be far offshore (beyond 60 mi from the coast). Molting long-tailed ducks near Beaufort Sea barrier islands did not appear to change their movement or feeding patterns due to nearby seismic surveys (Lacroix 2003), but no studies have been conducted to determine potential effects on nesting birds. Because most nesting occurs in June and early July and most open-water exploration 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 of 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 tundra nesting seabirds, including ESA-listed Steller's eider and ESA candidate species, yellow-billed loon, and Kittlitz's murrelet. Because of the importance of this area to spectacled eiders, no exploration activities are authorized in the area between July 1 and November 15, which eliminates the potential for disturbance and other effects in this important habitat. Industry has not reported to BOEM the need to enter the LBCHU for safety or emergency reasons since 2006.

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 ASL) 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. Frequent low-level traffic can result in chronic stress responses that could harm birds, especially during sensitive life stages like molting.

Construction activities associated with oil and gas exploration, such as building support facilities on land, can cause loss of habitat for coastal nesting species and disturb birds nearby. However, if clearing and construction of facilities begins before birds start to nest, they will likely choose nest sites far enough away to be undisturbed by the construction activity. This local disturbance of birds within a kilometer of construction would be short term and will not likely have population-level effects.

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 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 vessels 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 significant 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 caused attraction. Therefore, the effectiveness was not clear and was inconsistent (Day et al. 2003, Day et al. 2005).

Despite the efforts to reduce light radiated from exploration vessels and structures, mitigation measures for lighting cannot be assumed to be totally effective and there is still the potential for some bird collision mortality. The USFWS issued an Incidental Take Statement for spectacled and Steller's eiders (USFWS 2009c) that calculated the number of eiders that would be expected to die in collisions with exploration vessels and exploratory drilling rigs. Without knowing the actual location or timing of future exploratory drilling programs, the USFWS had to make some assumptions about how many birds could be exposed to the risk of collision. The calculations assumed that the entire North Slope population of each species could potentially pass by an exploratory drilling operation in the Chukchi Sea during their westward migration in the fall. For an exploratory drilling program in the Beaufort Sea, the calculations assumed that the portion of the populations that nested east of Barrow could be exposed to the risk of collision. Based on data from known collision rates of common eiders at the Northstar Island production facility (an average of three common eiders per year from 2000-2006), the USFWS estimated that in a 12 year period, 6.2 spectacled eiders and 0.3 Steller's eiders would be killed in the Beaufort Sea and 5.3 spectacled eiders and 0.2 Steller's eiders would be killed in the Chukchi Sea (USFWS 2009c). However, the USFWS assumed that there would be two exploratory drilling rigs operating in each sea during this 12 year period, which is twice the level of exploratory drilling that could be authorized under Alternative 2. Based on these estimates, it is clear that fatal collisions of ESA-listed eiders with exploration facilities are expected to be infrequent events. Recent collision events with the Northstar facility (in 2009 and 2010), however, indicate that collision events are episodic in nature and small flocks (5-6 birds) can be killed at one time. The level of mortality calculated in the USFWS BiOp is anticipated to have a minor level of effect on the populations of listed eiders.

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 localized 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 muds. 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.

Whenever vessels are in the marine environment, there is a possibility of a fuel spill. If prevention mechanisms prove ineffective, response actions are required. To be better prepared to respond to a spill event in the spring lead system, BOEM required lessees to pre-stage response equipment under certain conditions:

- If vessels transit through the spring lead system before June 10, they may encounter concentrations of listed eiders. Wildlife hazing equipment (including Breco buoys or similar equipment) will be pre-staged and readily accessible by personnel trained in their use, either on the transiting vessel, at Point Lay or Wainwright, or on an on-site oil-spill response vessel, to ensure rapid deployment in the event of a spill.

4.5.2.3.2 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 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, localized, 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 ESA-listed species would be considered minor and, for other marine and coastal birds, the effects would be considered negligible according to the impact criteria in Table 4.5-17. Conclusions about impacts to birds in the event of a large oil spill are described in Sections 4.9.6.10 and 4.9.7.10.

4.5.2.4 Marine Mammals

Noise exposure, habitat degradation, and vessel activity, which could possibly lead to 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 potential effects are primarily those associated with noise exposure, habitat degradation, and vessel activity, which could possibly lead to ship strikes. 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 the following resources. 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 4.9 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. The impact criteria for marine mammals are outlined for magnitude or intensity, duration, extent, and context in Table 4.5-19.

Table 4.5-19 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
		Medium	Noticeable change in behavior due to exploration activity; animals move away from EIS project area
		High	Acute or obvious/abrupt change in behavior due to exploration activity; animals depart from the EIS project area
	Duration	**Temporary**	Behavior patterns altered infrequently, but not longer than the span of one year and would be expected to return to pre-activity levels after actions causing impacts were to cease
		Long-term	Behavior patterns altered for several years and would return to pre-activity levels at some time after actions causing impacts were to cease
		Permanent	Change in behavior patterns even if actions that caused the impacts were to cease; behavior not expected to return to previous patterns
	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; resource is not depleted in the locality, protected by legislation, or important for subsistence
		Important	Affects depleted resources within the locality or region or resources protected by legislation
		Unique	Resources protected by legislation and the resource affected fills a unique ecosystem role or is an important subsistence resource within the locality or region
Injury and mortality	Magnitude or Intensity	**Low**	No noticeable incidents of injury or mortality
		Medium	Incident of injury
		High	Incident of mortality or multiple incidences of injury
	Duration	**Temporary**	Incidences would occur for a brief, discrete period lasting less than one year
		Long-term	Incidences of mortality or injury would continue for greater than one year to less than five years
		Permanent	Incidences of mortality or injury would continue to occur longer than five years or persist after actions that caused the disturbance ceased
	Geographic Extent	**Local**	Impacts localized; would not extend to a broad region or sector of the population
		Regional	Impacts would occur beyond a local area
		State-wide	Impacts would occur beyond the EIS project area
	Context	**Common**	Affects usual or ordinary resources in the EIS project area; resource is not depleted in the locality, protected by legislation, or important for subsistence
		Important	Affects depleted resources within the locality or region or resources protected by legislation
		Unique	Resources protected by legislation and the resource affected fills a unique ecosystem role or is an important subsistence resource within the locality or region

Type of effect	Impact Component	Effects Summary	
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**	Resource would be reduced infrequently but not longer than the span of one year and would be expected to return to pre-activity levels
		Long-term	Resource would be reduced for five to seven years and would return to pre-activity levels at some time after that point
		Permanent	Chronic effects; resource would not be anticipated to return to previous levels
	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; resource is not depleted in the locality, protected by legislation, or important for subsistence
		Important	Affects depleted resources within the locality or region or resources protected by legislation
		Unique	Resources protected by legislation and the resource affected fills a unique ecosystem role or is an important subsistence resource within the locality or region

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).

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 effects (Richardson et al. 1995).

Tolerance

Pulsed sounds from airguns are often detectable in the water at distances of several 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 they have shown no overt reactions (Richardson et al. 1995).

Masking

Masking occurs when biologically meaningful sounds (e.g. communication, prey) 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 significant 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, 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). Background noise also can include sounds from human activities. Masking of natural sounds can result when human activities produce high levels of background 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 significantly reduce the masking effects of these noises by improving the effective signal-to-noise ratio. In the cases of high-frequency hearing by the bottlenose dolphin, 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.

Masking of marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data of relevance. Some whales are known to continue calling in the presence of seismic pulses; their calls can be heard between seismic pulses (Richardson et al. 1986, McDonald et al. 1995, Greene et al. 1999, Nieukirk et al. 2004). Additionally, as described above, some marine mammals, such as the small toothed whales communicate within frequency bands that are quite different from those frequencies used by other 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).

Cumulative Effects of Anthropogenic Underwater Sound on Marine Mammals is a project currently underway between BP America, NSB, and the University of California. The project will center on bowhead whales in the Beaufort Sea and will focus on summarizing and synthesizing literature on the effects of anthropogenic sound on marine mammals, developing a method of approach for such effects, and suggesting future research needs. This effort will help better understand masking and the effects of masking on marine mammals (NMFS 2011).

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). 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 does react 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, let alone 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 rate or distribution and habitat use in subsequent days or years. The Western Arctic stock of bowhead whales has, however, been increasing at approximately 3.4 percent per year (George et al. 2004), despite exposure to exploration activities in the Beaufort and Chukchi seas since the late 1960s (MMS 2006).

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 (so 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 criteria that estimate at what received sound levels the Level B Harassment, Level A Harassment, and mortality (for explosives) of marine mammals would occur from different types of sounds. The current NMFS acoustic criterion 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) (70 FR 1871, January 11, 2005).

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 hearing impairment or other injury could potentially occur (Level A take), which are 180 and 190 dB re 1 μPa (rms) for cetaceans and pinnipeds, respectively (NMFS 1995, 2000). The established 180- and 190-dB re 1 μPa (rms) criteria are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before additional 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. These criteria were established before information was available about minimum received levels of sound that would cause auditory injury in marine mammals. Therefore, these thresholds are likely lower than necessary to prevent auditory injury and are intended to be precautionary estimates below which no physical injury will occur (Southall et al. 2007). Many marine mammal species avoid ships and/or seismic operations at distances that likely avoid 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 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.

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 loud sound (Kryter 1985). It is not considered to represent physical injury, as hearing sensitivity recovers relatively quickly after the sound ends. It can, however, indicate the potential for physical injury if the animal is exposed to higher levels of sound, especially on a repetitive, constant basis. 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).

The magnitude of TTS depends on the level and duration of noise exposure and to some degree on frequency (Kryter 1985, Richardson et al. 1995, Southall et al. 2007). Very few data are available regarding the sound levels and durations that are necessary to cause TTS in marine mammals. TTS has only been studied in captive odontocetes and pinnipeds (reviewed in Southall et al. 2007). No data are available for mysticete species. No data are available for any wild marine mammals or for exposure to multiple pulses of sound during seismic surveys (Southall et al. 2007). However, simulation modeling based on extrapolations of TTS in odontocetes by Gedamke et al. (2011) suggests that baleen whales 1 km (0.62 mi) or more from seismic surveys could potentially be susceptible to TTS. For species or groups of marine mammals for which studies have been conducted, those data or information are presented in the specific subsections below.

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 (e.g. Richardson et al. 1995, Gedamke et al. 2008).

Southall et al. (2007) used available marine mammal TTS data and precautionary extrapolation procedures based on terrestrial mammal data to estimate exposures that may be associated with PTS onset. They assumed PTS would be likely if the hearing threshold increased by more than 40 dB and there was an increase of 2.3 dB in TTS with each additional dB of sound exposure. This translates to an injury criterion for pulses that is 15 dB above the Sound Exposure Level (SEL) of exposures causing TTS onset. The PTS threshold would, therefore, be approximately 198 dB re 1 $\mu Pa^2 s$ for a single pulse. Table 4.5-20 outlines the in-water SELs and Sound Pressure Levels (SPLs) thought to cause auditory injury to cetaceans and pinnipeds presented in Southall et al. (2007). These levels are higher than the 180 and 190 dB re 1 µPa (rms) criteria currently used by NMFS.

There are no data on the sound level of pulses that would cause TTS onset in pinnipeds. Southall et al. (2007) therefore assumed that known pinniped-to-cetacean differences in TTS-onset for non-pulsed sounds also apply to pulsed sounds. Harbor seals experience TTS onset at received levels that are 12 dB lower than those required to elicit TTS in beluga whales (Kastak et al. 2005, Finneran 2002). Therefore, TTS onset in pinnipeds exposed to a single underwater pulse was estimated to occur at an SEL of 171 dB re 1 $\mu Pa^2 s$. Adding 15 dB results in a PTS onset of 186 dB re 1 $\mu Pa^2 s$ for pinnipeds exposed to a single pulse (Kastak et al. 1999, 2005).

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.

Table 4.5-20 Proposed injury criteria for cetaceans and pinnipeds exposed to "discrete" noise events (either single pulses, multiple pulses, or non-pulses within a 24-hr period; Southall et al. 2007)

	Single pulses	Multiple pulses	Non pulses
Low-frequency cetaceans			
Sound pressure level	230 dB re 1 µPa (peak) (flat)	230 dB re 1 µPa (peak) (flat)	230 dB re 1 µPa (peak) (flat)
Sound exposure level	198 dB re 1 μPa^2-s (M_{lf})	198 dB re 1 μPa^2-s (M_{lf})	215 dB re 1 μPa^2-s (M_{lf})
Mid-frequency cetaceans			
Sound pressure level	230 dB re 1 µPa (peak) (flat)	230 dB re 1 µPa (peak) (flat)	230 dB re 1 µPa (peak) (flat)
Sound exposure level	198 dB re 1 μPa^2-s (M_{lf})	198 dB re 1 μPa^2-s (M_{lf})	215 dB re 1 μPa^2-s (M_{lf})
High-frequency cetaceans			
Sound pressure level	230 dB re 1 µPa (peak) (flat)	230 dB re 1 µPa (peak) (flat)	230 dB re 1 µPa (peak) (flat)
Sound exposure level	198 dB re 1 μPa^2-s (M_{lf})	198 dB re 1 μPa^2-s (M_{lf})	215 dB re 1 μPa^2-s (M_{lf})
Pinnipeds (in water)			
Sound pressure level	218 dB re 1 µPa (peak) (flat)	218 dB re 1 µPa (peak) (flat)	218 dB re 1 µPa (peak) (flat)
Sound exposure level	186 dB re 1 μPa^2-s (M_{pw})	186 dB re 1 μPa^2-s (M_{pw})	203 dB re 1 μPa^2-s (M_{pw})

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 stress responses over a period of time include accelerated aging, sickness-like symptoms, 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, therefore, deep diving marine mammals may be sensitive to noise as a stressor since they live so closely to their physiological limits (Wright et al. 2008).

In an examination of beaked whales 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). 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." These responses have a relatively short duration and may or may not have significant 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 neuroendocrine 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). Although no information has been collected on the physiological responses of marine mammals to anthropogenic sound exposure, studies of other marine animals and terrestrial animals would lead one to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as "distress" upon exposure to anthropogenic sounds.

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). Disruption in feeding, especially within small populations could have impacts on whales, their reproductive success and even the survival of the species (NRC 2005).

The USA National Research Council (NRC) developed a model; [the population consequences of acoustic disturbance] (NRC 2005); which describes several stages to relate acoustic disturbance effects on marine mammal populations. This model defines potential effects ranging from life functions and behavioral and vital rate level effects. The model is based on an analysis of energy changes during foraging trips by northern and southern elephant seals and the effects this change had on pup survival (Walmsley 2007). Anthropogenic noise, by itself or in combination with other stressors, can reduce fitness of individuals and decrease the viability of some marine mammal populations (Wright et al. 2008).

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).

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.

Stranding and Mortality

Marine mammals close to underwater detonations can be killed or severely injured; the auditory organs are particularly susceptible to injury (Ketten et al. 1993, 1995). However, explosives are no longer used for marine waters for commercial seismic surveys. They have been replaced entirely by airguns or related non-explosive pulse generators. 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. There are increasing indications that gas-bubble disease ("the bends") could be a mechanism for the strandings and mortality of some deep-diving whales exposed to naval mid-frequency sonar. Evidence is still circumstantial and, in the Arctic, there are no data showing strandings or mortalities as a result of exposure to seismic surveys (Cox et al. 2006, Southall et al. 2007).

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 (e.g. 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). Nonetheless, the Gulf of California incident, plus the beaked whale strandings near naval exercises involving use of mid-frequency sonar, suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales until more is known about effects of seismic surveys on those species (Hildebrand 2005). However, no injuries or mortalities of beaked whales are anticipated to occur under Alternative 2 because none occur in the proposed EIS project area.

4.5.2.4.3 Potential Effects of Noise from Other Acoustic Sources

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. 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 marine mammals for hearing and/or vocalizing.

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 significant 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.

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 4.5.2.4.9 through 4.5.2.4.14 for details regarding potential effects on bowhead whales, beluga whales, other cetaceans, pinnipeds, walrus, 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. 2004). 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). Icebreaking is considered by NMFS to be a continuous sound. Haley et al. (2010) 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). 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 4.5.2.4.9 through 4.5.2.4.14 for details regarding potential effects on bowhead whales, beluga whales, other cetaceans, pinnipeds, walrus, 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. 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 (e.g. 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 involve the discharge of drill cuttings and drilling fluids 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 localized and temporary. Discharged drilling fluid should be well diluted within 100 m (330 ft) so that any impacts would be localized 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. Population-level effects would, therefore, be negligible (MMS 2008).

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 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 4.9.6.11 and 4.9.7.11.

4.5.2.4.9 Bowhead Whales

4.5.2.4.9.1 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 several 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 calculated from different directions from the source vessel for 3D seismic surveys in the Beaufort Sea in 2008. Ranges were 10 to 770 m (33 to 2,526 ft) for 190 dB re 1 μPa rms, 46 to 2,500 m (151 to 8,202 ft) for 180 dB re 1 μPa rms, 910 to 9,000 m (2,986 ft to 5.29 mi) for 160 dB re 1 μPa rms, and 23 to 54 km (14 to 34 mi) for 120 dB re 1 μPa rms (refer to Table 4.5-10 in Section 4.5.1.4, Acoustics, for details).

Observed responses of bowhead whales to seismic noise depend on 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, Miller et al. 2005). 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). Data from an aerial monitoring program in the Alaskan Beaufort Sea during 2006 to 2008 also indicate that bowheads feeding during late summer and autumn did not exhibit large-scale distribution changes in relation to seismic operations (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, cause adverse effects (NMFS 2010). They could be suffering increased stress by staying in a location with very loud noise (MMS 2008).

Migrating bowhead whales respond 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). Preliminary analyses of recent 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). Most bowheads would be expected to avoid an active source vessel at received levels of as low as 116 to 135 dB re 1 μPa rms when migrating (MMS 2008). Richardson (1999) suggests that migrating bowheads start to show significant behavioral disturbance from multiple pulses at received levels around 120 dB re 1 μPa.

The effect of seismic airgun pulses on bowhead whale calling behavior has been extensively studied in the Beaufort Sea. During the autumn season in 2007 and 2008, calling rates decreased significantly in the presence (<30 km [<18.6 mi]) of airgun pulses (Blackwell et al. 2010). There was no observed effect when seismic operations were distant (>100 km [>62 mi]). Call detection rates dropped rapidly when cumulative sound exposure levels (CSELs) were greater than 125 dB re 1 $\mu Pa^2 \cdot s$ over 15 minutes. The decrease was likely caused by a combination of less calling by individual whales and by avoidance of the area by some whales in response to the seismic activity. 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. 2010). 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 October) 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 Bowhead Whale Aerial Survey Project (BWASP) and other surveys (Ashjian et al. 2010, Clarke et al. 2011b, 2011c, 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 (see Section 3.2.6.2, Barrow Canyon and Adjacent Beaufort Sea Shelf Special Habitat Area) and the Camden Bay and Kaktovik area (see Section 3.2.6.1, Camden Bay Special Habitat 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 is 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 (MMS 2008). Most observed disturbance reactions appear to be short-term, yet 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 3.4 percent per year (George et al. 2004), despite exposure to exploration activities in the Beaufort and Chukchi seas since the late 1960s (MMS 2006). 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 4.5-19, the disturbance effects of exploratory activity under Alternative 2 would be considered of medium intensity, as, at least, some whales would be displaced, but not likely to leave the EIS project area entirely. The EIS project area encompasses a large portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area to avoid impacts is not a likely option. The duration of exposure, as observed, is expected to be limited and any behavioral responses by bowhead whales to activities is expected to be temporary. The extent of the impact will depend on the number of seismic activities and associated support vessels in an area, but, for individual sound source vessels, impacts are expected to be localized. 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.

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 noise 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 2010). Estimated source levels for an icebreaker range from 177 to 191 dB re 1 μPa (Richardson et al. 1995). 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 2010). BWASP surveys of the Alaskan Beaufort Sea include sightings of bowhead whales through at least mid-October, with concentrations in Camden Bay and between Point Barrow and Cape Halkett (Clarke et al. 2011b, 2011c). 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 will have migrated out of the Beaufort Sea; therefore, impacts to bowhead whales from this type of activity are only anticipated for the first few weeks of the survey.

Anticipated impacts of in-ice activities, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) would be similar to those described for 2D/3D seismic surveys above (see Table 4.5-19 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.

Ocean-Bottom-Cable Survey (July to October)

Ocean-bottom-cable (OBC) seismic surveys are used in nearshore areas where water is too shallow (≤14 m [≤45.9 ft]) for a towed marine streamer seismic survey vessel and too deep to have bottomfast ice in the winter. An OBC 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 surveys require the use of multiple vessels (see Chapter 2, Table 2.4). Noise and disturbance effects of support vessels are discussed separately below.

Reactions to sounds from OBC 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 that 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 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 occur near Camden Bay 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 2009 BWASP surveys ranged from 15 to 44 m (49.2 to 144.4 ft) (Clarke et al. 2011b, 2011c). In addition, the distance from which migrating bowheads appear to deflect from OBC sound sources suggest possible disturbance to whales traveling or feeding farther offshore.

Anticipated impacts of OBC surveys, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) would be similar to those described for 2D/3D seismic surveys above. See Table 4.5-19 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 survey anticipated in the Beaufort Sea, short-term effects should remain localized.

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. 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 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. 1985).

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

Based on the criteria defined in Table 4.5-19, anticipated impacts of these surveys, in terms of magnitude (medium), duration (temporary), 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 3.2-12), 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* (MMS 2008).

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 11 or 12). 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.

Reaction 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. 1985, 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 noise 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 localized 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, elicit less dramatic reactions 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.

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 that 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 in western Camden Bay 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). Both studies noted that the distribution of whales observed in the Camden Bay area 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. Results in Schick and Urban (2000) indicated that 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 that spatial distribution 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).

Bowhead whales, including mothers and calves, commonly occur in Camden Bay as early as July but more typically from late-August through September (Koski and Miller 2009). It appears to be an important feeding area in the U.S. Beaufort Sea (see Section 3.2.6.1, Special Habitat Areas) and part of the fall migration corridor. There is, therefore, a high likelihood that drilling operations would coincide with bowhead whale occurrence in the area, with reactions ranging from apparent tolerance to displacement and avoidance of the drilling operations.

Based on the impact criteria defined in Table 4.5-19, anticipated impacts of exploratory drilling activities, in terms of magnitude (medium), duration (temporary), 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 drill rig.

Associated Vessels and Aircraft

Bowhead whales react to approaching vessels at greater distances than they react to most other activities. 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.

Data are not sufficient to determine sex, age, or reproductive characteristics of bowhead whale response to vessels. Data are also not available to determine whether female bowheads with calves react differently than other segments of the population (MMS 2008).

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 in areas such as Camden Bay, 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 localized area where there are concentrations of whales are unknown. Based on the impact criteria for marine mammals defined in Table 4.5-19, 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 temporary; 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 localized. 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 Tables 4.5-10 and 4.5-11, Section 4.5.1.4, Acoustics) that would affect distances at which noise impacts may occur. Differences also exist regionally within the Chukchi Sea Lease Sale 193 area. 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).

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), 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 3.2-13). 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. The areas with the greatest probability of use were in the northeastern part of the Lease Area, not in the area of the currently leased blocks. Leased blocks contained only 2 percent of the total probability of use by 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. Reactions of bowhead whales migrating through the Chukchi Sea in fall may differ from that observed in the Beaufort Sea (Funk et al. 2010). 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 (see Figures 3.2-14 and 3.2-15).

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 sounds levels known to elicit avoidance responses.

Based on the impact criteria defined in Table 4.5-19, anticipated impacts of these activities, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea.

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

Disturbance effects on bowhead whales from in-ice seismic surveys with icebreaker support in the Chukchi Sea would likely be similar to those described above for the Beaufort Sea.

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 2010). 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, 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 during October. Displacement during migration is possible, although 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 (temporary), 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.

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 are most likely to coincide with 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 3.2-13). 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. However, 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 4.5-19, anticipated impacts of these activities, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) would be similar to those described for the Beaufort Sea.

Exploratory Drilling (July through October)

Known effects of drilling operations on bowhead whales are as described above for the Beaufort Sea and would be expected to 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 a drillship or jackup rig with six to eight support vessels would be used for exploratory drilling, which is anticipated to start in early July and continue through October.

The drillship and support vessels would 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 (temporary), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea.

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). 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 4.5-19, anticipated impacts of these activities, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea.

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 an oil spill, which is considered improbable and for which incidental would not be authorized by NMFS under any alternative, are discussed separately in Section 4.9.

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 the possibility that 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 (MMS 2008).

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.

Assessing whether or not TTS or PTS is occurring is not currently possible. There is no information on these 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. Determining intensity is not possible, unless noise exposure were 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 unique, since bowhead whales are listed as endangered and an integral part of the Iñupiat subsistence lifestyle.

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 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 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, near Point Barrow, or in the vicinity of Harrison and Camden Bays.

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 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 unique, since bowhead whales are listed as endangered and an integral part of the Iñupiat subsistence lifestyle. Refer to Table 4.5-19 for marine mammal impact criteria definitions.

Habitat Alterations

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 4.9. 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 the EPA NPDES General Permit. The impact of drill cuttings and drilling mud discharges would be localized 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 localized 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 (MMS 2008).

Bottom-founded drilling units or gravel islands could impact small areas of benthic habitat that support epibenthic invertebrates that bowhead whales feed on, including through increased turbidity or sediment suspension in marine waters (MMS 2008). Exploration drilling on past and current leases would add incrementally to potential discharges into the Beaufort and Chukchi seas but would remain localized to areas immediately surrounding exploration drilling activity (MMS 2008).

Effects on Zooplankton

In a review of available information on the effects of seismic sound on invertebrates, the Canadian Department of Fisheries and Oceans reported that, under experimental conditions, 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) (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 localized (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 zooplankton pre resources) from oil and gas exploration activities permitted under Alternative 2 would, based on the criteria defined in Table 4.5-19, be of low to medium intensity and mostly localized in the area immediate adjacent to the impacts, 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. The context would be unique, since bowhead whales are listed as endangered and an integral part of the Iñupiat subsistence lifestyle.

4.5.2.4.9.2 Conclusion

Oil and gas exploration activities in the Beaufort and Chukchi seas, as allowed under Alternative 2, would likely cause 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 large portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not likely an option. The duration of disturbance from oil and gas activities is expected to be temporary. 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. 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 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 localized. Because whales respond behaviorally to loud noise, they are less likely to suffer auditory damage from increased noise due to oil and gas exploration activities.

The geographic area and extent of the population over which effects would be felt 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 3.4 percent per year despite past and present exploration activities within their range (George et al. 2004). It is not currently possible to predict which behavioral responses to anthropogenic noise might result in significant population consequences for marine mammals, such as bowheads, in the future (NRC 2005).

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 in the region. Potential impacts of individual activities associated with oil and gas exploration considered under Alternative 2 on bowhead whales would be mostly of medium intensity, temporary duration, and localized. 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.

4.5.2.4.10 Beluga Whales

4.5.2.4.10.1 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), CSEM electromagnetic signals, 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 will be discussed together. Where activities or mechanisms are unique to one sea or the other, they will be 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.

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. 2000, 2002), 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. 2002). 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, so animals may be insensitive to sounds produced by these activities.

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. 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).

Ocean-Bottom-Cable Survey (July to October)

Ocean-bottom-cable (OBC) seismic surveys are used in nearshore areas where water is too shallow (≤14 m [≤45.9 ft]) for a towed marine streamer seismic survey vessel and too deep to have bottomfast ice in the winter. An OBC 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 surveys are similar to those reported for 2D/3D steamer seismic surveys. Anticipated impacts of OBC surveys, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) 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 survey anticipated in the Beaufort Sea, short-term effects should remain localized.

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, primarily masking, 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. 2002, Finneran and Schlundt 2004).

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, localized 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, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) 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.

Exploratory Drilling (July through October)

Reactions of beluga whales to drillship operation noises 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.

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.

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.

The onset of mild TTS in the beluga whale resulted from a received sound level of ~186 dB re 1 μPa^2-s or 186 dB SEL (Finneran et al. 2002). 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 reported in the Section 4.5.1.4 (Acoustics), distances to the 190 dB rms received level from various sizes of airgun arrays are <770 m (2,526 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 one 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.

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 appears 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.

Habitat Loss/Alteration

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 localized 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 localized in relation to affecting whale habitat and prey populations. The effects of such discharges are anticipated to remain localized 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 (MMS 2008).

4.5.2.4.10.2 Conclusion

If seismic operations overlap in time, the zone of seismic exclusion or influence could potentially be quite large, depending on the number and the relative proximity of the surveys. NMFS is concerned these simultaneous seismic activities could result in effects that are biologically significant, if they cause avoidance of feeding, resting, or calving areas by large numbers of females with calves over a period of many weeks. Potential impacts to the population would be related to the numbers and types of individuals that were affected (e.g. juvenile males versus females with calves), and to whether areas avoided or from which whales are potentially displaced provide important energetic needs for belugas particularly during their spring and autumn migrations.

The potential total adverse effects of long-term added noise, disturbance, and related avoidance of feeding and resting habitat in a long-lived species such as the beluga whale are unknown. Available information does not indicate any long-term adverse effects on any of the beluga whale stocks from the high level of seismic surveys and exploration drilling during the 1980s in the Beaufort and Chukchi seas. Sub-lethal impacts on health (such as reduced hearing or increased stress) are not currently measurable. There has been no documented evidence that noise from previous OCS operations impacted migration routes. 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.

Beluga whales in the Arctic are not listed under the ESA but 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. The intensity and duration of the various effects and activities considered are mostly medium and temporary. 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 the Arctic populations. The summary impact level of Alternative 2 on beluga whales would be considered moderate.

4.5.2.4.11 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 4.5.2.4.9 and Section 4.5.2.4.10, 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 porpoise, killer whale, and narwhal. 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 are correlated 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.

4.5.2.4.11.1 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 4.5.2.4.9) and beluga whales (Section 4.5.2.4.10). 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 stampeding or stranding (Nowacek et al. 2007, Richardson et al. 1995, Southall et al. 2007). 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 in3 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 including 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 tend to exhibit localized avoidance, remaining significantly further 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 would be of low intensity, temporary duration, local in extent, and important in context. The summary impact level would therefore be negligible.

Toothed Whales (harbor porpoise, killer whales, narwhals): Toothed whales 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 further 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 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). In contrast, Dall's porpoises seem relatively tolerant of airgun operations (Bain and Williams 2006), 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 within the EIS project area, there is a low likelihood of these encounters occurring. Should they occur, effects would be of low intensity, temporary duration, local in extent, and important in context. The summary impact level would therefore be negligible.

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 presence, effects would be similar to those described for summer seismic survey activities, described above.

Ocean-Bottom-Cable Survey (July to October)

Ocean Bottom Cable Surveys are used to acquire seismic data in water that is too shallow for large marine vessels or too deep to have grounded ice during the winter. The areas within the EIS project area meeting this criteria are primarily the nearshore waters of the Beaufort Sea. Therefore, gray whales are the only species expected to be exposed to any effects from these types of surveys, as all other species are so rarely observed in that region. Past surveys of this type have typically not encountered any baleen whales (73 FR 40529).

Reactions to sounds from OBC surveys would be similar to those reported for 2D/3D steamer seismic surveys. Limited research has been conducted on the effects of OBC surveys on baleen whales, focusing exclusively on bowheads. Gray whale feeding and migration patterns fairly closely mimic those of bowhead whales, therefore, gray whales are expected to be exposed to similar potential effects. 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 surveys are likely to occur, coincides with summer feeding and late-summer/fall migration periods for gray whales in the Beaufort Sea. Anticipated impacts of OBC surveys, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) 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 survey anticipated in the Beaufort Sea, short-term effects would remain localized.

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).

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 mild. 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.

Hearing Impairment, Injury, and Mortality

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 (MMS 2008). 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). 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).

Assessing whether or not TTS or PTS is occurring is not currently possible. There is no information on these thresholds specific to baleen whales 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. Determining intensity is not possible, unless noise exposure were severe enough to result in observed mortality where cause of death could be attributed to sound impulses. 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 important.

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 20 kn (see 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 bowheads or aggregations feeding in more coastal regions of the northeast Chukchi, near Point Barrow, or in the vicinity of Harrison and Camden Bays.

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 would be temporary to permanent 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 negligible.

Habitat Alterations

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 Permit. The impact of drill cuttings and drilling mud discharges would be localized 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 localized 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 (MMS 2008).

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(MMS 2008). Exploration drilling on past and current leases would add incrementally to potential discharges into the Beaufort and Chukchi seas, but would remain localized to areas immediately surrounding exploration drilling activity (MMS 2008).

The results of habitat alterations caused by oil and gas exploratory activities on other cetaceans would be negligible. Effects would be of low intensity, and very local in extent. Although some habitat alteration, such as those from the construction of gravel islands, would be permanent, most would be temporary, and only and affect common benthic resources.

4.5.2.4.11.2 Conclusion

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.

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 temporary. 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 exclusion or influence could potentially be quite large, depending on the number, and the relative proximity of the surveys. NMFS is concerned these simultaneous seismic activities could result in effects that are biologically significant for bowhead whales in particular, if they cause avoidance of feeding, resting, or calving areas by large numbers of females with calves over a period of many weeks. Gray whales have similar migration and life histories to bowhead whales, and could therefore suffer from similar effects. The impact to individuals 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 not the disturbance 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. For the most part, effects will be of low magnitude, temporary in duration, and local in extent. The resources affected are important.

4.5.2.4.12 Pinnipeds

4.5.2.4.12.1 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 4.5.2.4.11) and Pacific walrus (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.

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 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. 2010). 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. 2010). 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. 2010). 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, 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 in late fall-early winter 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.

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 surveys and shallow hazard/site clearance seismic surveys cover smaller geographic areas but more intensely and thus present more localized 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 not active (Savarese et al. 2010, Haley et al. 2010). 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.

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 significant 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.

Any two deep penetration seismic surveys cannot be conducted concurrently from closer than 24 km (15 mi). This restriction, based on the need of the surveys not to interfere with each other to preserve the quality of the data, provides an effective limit on the intensity of disturbance effects on ice seals no matter where the activities take place. 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 minor to negligible intensity and 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 (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 appear to have the 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 their 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. 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 is likely very temporary in nature and not likely to drive animals out of their normal territory.

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 helicopter or to its physical presence flying overhead. The available information describes reactions of hauled out pinnipeds and not of pinnipeds in the water. Typical reactions of hauled out pinnipeds to aircraft that have been observed 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. (2004) 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. (2004) 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 that 49% of ringed seals escaped (i.e. left the ice) as a response to 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 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 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 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

Although mortality of seals due to ship strikes has been reported off the coast of Scotland where numerous seals apparently died after being sucked through large ducted propellers (BBC News 2010), similar mortalities or injuries have not been observed in the Chukchi and Beaufort 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.

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).

There is the potential for seals to be exposed to small accidental 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 season and location of the spill. If a spill were to occur during the ice free, open water season, seals may exposed to oil through direct contact, or perhaps through contaminated food items. It is believed, however, that with their keen sense of olfaction and good sense of vision ringed and bearded seals could detect and avoid most 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 could be particularly 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 and gray seal pups were impeded by a heavy oil coating (Davis and Anderson 1976; Sergeant 1991) leading to the drowning of the gray seal pups. 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 that 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 each year by oil.

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 that 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 quantity of exposure. Based on morphological similarities, the physiological impacts in bearded 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 source of hydrocarbon contamination for marine mammals during extended periods.

Bivalve molluscs however, tend to accumulate hydrocarbons from prolonged or repeated exposure, posing a threat to benthic-feeding seals. Spilled oil has caused major disruptions to benthic communities inducing substantial contamination of tissues, failed spawning, significantly 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 because they are able to metabolize hydrocarbons (Payne 1992).

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. 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 4.9.6.11 and 4.9.7.11.

Habitat Change

There are four 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; and 4) contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities.

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. 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 under Alternative 2, a time period when ice seals are often on top of sea ice but not in subnivean structures. 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. The effects on ice seal habitat are therefore temporary and may be reduce adverse impacts 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.

4.5.2.4.12.2 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 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 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, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique 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 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.

4.5.2.4.13 Pacific Walrus

4.5.2.4.13.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 2 on Pacific walrus. 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 Pacific walrus from exploration activities authorized under Alternative 2 are similar to those discussed for cetaceans (Sections 4.5.2.4.9 to 4.5.2.4.11) and pinnipeds (Section 4.5.2.4.12). 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. Walrus are distributed widely across the Chukchi Sea but are uncommon in the deeper offshore waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact Pacific walrus.

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 Pacific walrus 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 Pacific walrus and polar bears 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 2008b). 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 Pacific walrus 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 Pacific walrus and initiate adaptive mitigation measures.
- Except under emergency situations, vessels must maintain the maximum distance possible from concentrations of Pacific walrus and never get closer than 805 m (0.5 mi) from Pacific walrus.
- Vessel operators must take every precaution to avoid harassment of concentrations of feeding walrus 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 walrus.
- Operators of support aircraft should, at all times, conduct their activities at the maximum distance possible from concentrations of walrus.
- 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 walrus 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 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 walrus 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 walrus 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 walrus is 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 walrus 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 walrus 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 walrus 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 walrus, USFWS LOAs have provisions to protect subsistence hunting of walrus by requiring plans of cooperation and communication channels between industry and subsistence communities. 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 walrus and the results of monitoring programs.

Disturbance

There are several mechanisms for potential disturbance to Pacific walrus 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 on Acoustics) and have a physical presence that could affect Pacific walrus in the water or on sea ice. Many of these vessels have carried PSOs in the past and the data they have collected about walrus 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 Pacific walrus with a total of 10 individual walrus (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 Pacific walrus sightings comprised of 4821 individual walrus (Haley et al. 2010). 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 walrus 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 walrus was 265 m (869 ft) (Haley et al. 2010). Seismic source vessels traveling under non-seismic conditions appear to disturb walrus at greater distances, perhaps in part because of their larger physical presence, with the average closest point of approach to walrus being

822 m (2,700 ft) (Haley et al. 2010). 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 walrus 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. 2010). This data indicates that there is a range of sensitivities among walrus 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 walrus move away from approaching ships before they react more strongly to the disturbance. Disturbance of walrus 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 walrus than non-icebreaking vessels. These activities would take place in late fall to early winter under Alternative 2, a time period when walrus are often closely associated with the pack ice edge or are hauled out on coastal shores. Walrus 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 walrus 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 walrus on the ice and the short time period and limited geographic extent of icebreaking activities authorized under Alternative 2, it is unlikely that many walrus 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 walrus.

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. Walrus 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. Walrus 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 walrus.

During the 2006 to 2008 open-water seasons, 10 walrus 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 walrus (Savarese et al. 2010). In the Chukchi Sea, 32 walrus were detected within this safety radius in 2006 and 53 walrus were seen within this radius in 2007 (Haley et al. 2010). 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 walrus to passing active source vessels was either no reaction or to just watch it go by rather than swimming away (Haley et al. 2010). Walrus 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 walrus that were visible to observers. Given the short time period in which seismic vessels would be operating in any one area, potential disturbance of walrus by seismic surveys would likely be temporary and affect very small numbers of animals.

Aircraft Traffic

The behavioral response of walrus to aircraft traffic varies with distance, type of aircraft, flight pattern, age, sex, and group size. Richardson et al. (1995) reviewed responses of walrus 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. The greatest potential impact of aircraft is when the disturbance causes walrus at a haulout site to stampede into the water, which may result in the crushing of calves. However, flight restrictions imposed by USFWS LOAs greatly reduce the risk of aircraft disturbance to walrus 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 walrus 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 Pacific walrus are not present in the area. Therefore, no impacts to Pacific walrus 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 walrus from a small geographic area. The importance of that displacement would depend on the quality of the benthic habitat for feeding walrus 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 walrus. NMFS and USFWS have adopted a 180 dB re 1 µPa rms safety radius for walrus as a precautionary measure to reduce the risk of seismic sounds on walrus 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 walrus in the water. There have been no suspected or documented cases of walrus 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 walrus is considered negligible. It is also 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 walrus on land-based haulouts. Due to pack ice receding beyond the shelf break in low-ice years, thousands of walrus 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 and crush calves and juvenile animals to death. USFWS LOA mitigation measures for exploration aircraft and vessels are intended to monitor and avoid such haulouts to avoid causing such deadly disturbance.

There is the potential for walrus to be exposed to small accidental 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 walrus is unknown, but is probably similar to those of other pinnipeds. This includes irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). Kidney and liver damage would likely occur from ingestion of petroleum products while feeding (Cornelius and Kaneko 1963, Geraci and Smith 1977, Holden 1978). Because walrus are gregarious, any one animal that is exposed to a spill could spread that contact to other walrus. Walrus 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 MMOs to monitor for walrus and other marine mammals and deter them from entering the spill area if possible. Given the occurrence of walrus 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 walrus 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 4.9.6.11 and 4.9.7.11.

Habitat Change

There are three potential mechanisms for habitat changes that may affect walrus: 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 muds and other waste streams from ships and support facilities.

Benthic prey of walrus may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as ocean bottom cable 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 walrus, these activities would be unlikely to affect the availability of prey to walrus. In addition, ocean bottom cable surveys would only occur in the Beaufort Sea where few walrus 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 walrus 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 muds and other waste streams from drilling rigs and other exploration vessels could affect walrus habitat by contaminating benthic prey and fouling ice floes. 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 marine mammal 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 on walrus would likely be prohibitive and very difficult to interpret given the many other factors that can influence an animals' health.

4.5.2.4.13.2 Conclusion

Walrus 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 walrus 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 walrus 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 accidental 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 calf and juvenile mortality from stampedes. Walrus 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 Pacific walrus 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 walrus according to the criteria established in Section 4.1.3.

4.5.2.4.14 Polar Bears

4.5.2.4.14.1 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. Designated critical habitat for polar bears (75 FR 76086, 7 December 2010) covers almost the entire area under consideration for oil and gas exploration activities in this EIS.

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 Pacific walrus, 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 Pacific walrus 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 walrus 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, USFWS LOAs have provisions to protect subsistence hunting of polar bears by requiring plans of cooperation and communication channels between industry and subsistence communities. 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.

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. 2010). 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. 2010). 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 bear-human 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 likely to deter the rare polar bear from swimming too close to the rig and support vessels while it is in that particular area. 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.

There is the potential for polar bears to be exposed to small accidental 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 negligible. The potential effects of a very large oil spill caused by a well blowout are much more serious and are discussed in Sections 4.9.6.11 and 4.9.7.11.

The main concern for the safety of polar bears during exploration activities is to minimize the risk of bear-human 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 bear-human 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 are forced to 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 obviously in the industry's self-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.

Habitat Change

There are four potential mechanisms for habitat changes that may affect polar bears: disturbance/dispersion of prey species (ice seals) by seismic surveys; disturbance of sea ice habitat from icebreakers; ice-road construction and on-ice survey activities; and contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities.

The analysis of effects on pinnipeds (Section 4.5.2.4.12) 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.

The discharge of drilling muds and other waste streams from drilling rigs and other exploration vessels could affect polar bear 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 marine mammal 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 on polar bears would likely be prohibitive and very difficult to interpret given the many other factors that can influence an animals' health.

4.5.2.4.14.2 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 bear-human 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.

4.5.2.4.15 Standard Mitigation Measures for Marine Mammals

Standard Mitigation Measures are outlined in Section 2.4.6 and described in detail in Appendix A. 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. Many of them are similar or identical to mitigation measures required by the USFWS in the LOAs for polar bears and walrus. 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 walrus, which are species under the jurisdiction of the USFWS. The following standard mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on marine mammals.

A1. Establishment of 180 dB shutdown/power down radius for cetaceans.

***Bowhead Whales* –** This mitigation measure was developed to reduce potential auditory injury or TTS effects and applies to seismic surveys (2D/3D, in-ice, site clearance, and high resolution shallow hazards). The 180 dB radius is established through acoustic modeling or on-site verification tests and is monitored by Protected Species Observers (PSOs) onboard the sound source vessels. When a marine mammal is sighted within or approaching the safety zone, the PSO will notify the appropriate personnel who will then shut down or power down the airgun array. The radius for the zone varies based on the airgun array used, water depth, and other factors related to the water and seafloor properties. For example, measurements of the ≥180 dB rms distances for sound pulses from seismic survey airgun arrays deployed in the Chukchi Sea from 2006 to 2008 ranged from 0.01 km (0.006 mi) (1 airgun) to 2.47 km (1.53 mi) (24 airguns) (Haley et al. 2010b). Table 4.5-11 further illustrates the variability in distances to sound level thresholds for several airgun systems on the Chukchi Sea shelf, Beaufort Sea shelf, and coastal waters of the Beaufort Sea.

The ability of PSOs to effectively monitor this radius 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).

One limitation and concern regarding monitoring of the exclusion radii is that the zone may extend beyond the detection limits of the PSOs, so that whales 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.

Power down and shut down procedures are currently used during exploration activities in the Beaufort and Chukchi seas. Frequency of implementation 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). Proposed injury criteria for low-frequency cetaceans (Table 4.5-20), which includes bowhead whales, is well above the 180 dB exposure threshold upon which this mitigation measure is based. Acoustic impairment or injury is, therefore, unlikely for the whales that briefly enter within the 180 dB exposure radius before the mitigation measure can be implemented.

NMFS is confident that power down and shutdown of airgun arrays protect marine mammals from Level A and B harassment from seismic noise sources (75 FR 49760, August 13, 2010). Shutting down removes the noise source and potential for exposure, and powering down the acoustic source reduces the size of the safety zones. Marine mammals that were in the original zones would then be outside the zones ensonified by a smaller airgun source (75 FR 49760, August 13, 2010).

Beluga Whales – This mitigation measure was developed to reduce potential auditory injury or TTS effects and applies to seismic surveys (2D/3D, in-ice, site clearance, high resolution shallow hazards). Mitigation Measure A1 could impact beluga whales the same as it would bowhead whales (Refer Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure).

Other Cetaceans – This mitigation measure was developed to reduce potential auditory injury or TTS effects and applies to seismic surveys (2D/3D, in-ice, site clearance and high resolution shallow hazards). The 180 dB radius is established through acoustic modeling or on-site verification tests and is monitored by PSOs onboard the sound source vessels. Mitigation Measure A1 could impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This mitigation measure applies to seismic surveys (2D/3D, in-ice, OBC, site clearance, and high resolution shallow hazards). NMFS adopted this safety radius for pinnipeds as a precautionary measure *in lieu* of direct evidence regarding sound source characteristics that would cause TTS in pinnipeds (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 seals a chance to swim away from potentially harmful sound sources or to minimize their risk of accidental exposure to such sounds. Data from PSOs indicates 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/shut down procedures.

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. This radius is smaller than the 180 dB radius used for cetaceans and is therefore easier to monitor with less complications from poor visibility conditions such as fog and waves. The ability of PSOs to effectively monitor this radius depends on their experience, state of alertness, and visibility/sea conditions, all of which vary over time. The typical range for 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. 2010). 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. 2010). Ice seals are the most common marine mammals sighted by PSOs and the detection of seals within the 190 dB safety radius has resulted in numerous power down/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. 2010). 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.

Walrus – NMFS adopted this safety radius for walrus 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 walrus 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 walrus in the water near seismic vessels, primarily in the Chukchi Sea.

Polar Bears – NMFS and USFWS adopted this 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.

Bowhead Whales – This mitigation measure applies to 2D/3D seismic including an in-ice surveys, and site clearance and high resolution shallow hazards surveys. The rationale for this measure is that using the ramp-up (soft-start) procedure when starting airgun operations gives whales near the vessel the opportunity to move away before being exposed to sound levels that might be strong enough to cause

TTS. 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. There have been no documented cases where cetaceans have been observed to move away from a survey vessel during ramp-up. Efficacy is assumed, based on studies of effects of airgun sounds on marine mammals, although the degree to which ramp-up protects marine mammals from exposure to intense noises is unknown (75 FR 49760, August 13, 2010).

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 criteria 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. 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.

Beluga Whales – This mitigation measure applies to 2D/3D seismic surveys, including an in-ice survey, and site clearance and high resolution shallow hazards surveys. The rationale for this measure is that using the ramp-up (soft-start) procedure when starting airgun operations, gives whales near the vessel the opportunity to move away before being exposed to sound levels that might be strong enough to cause TTS. Mitigation Measure A2 should impact beluga whales the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Other Cetaceans – This mitigation measure applies to 2D/3D seismic, in-ice seismic, site clearance and high resolution shallow hazards surveys. The rationale for this measure is that using the ramp-up (soft-start) procedure when starting airgun operations gives whales near the vessel the opportunity to move away before being exposed to sound levels that might be strong enough to cause TTS.

Mitigation Measure A2 could impact other cetaceans the same as it would bowhead whales (see Section 4.5.2.4.9). 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. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This standard mitigation measure applies to seismic surveys. The rationale for this measure is that seals 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 generally takes five to ten minutes to accomplish depending on the size of the array, and is therefore easy to implement. 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 conservative approach to conservation based on its potential for reducing adverse effects on a variety of species and its ease of application.

Walrus – 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 walrus 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 up to 30 minutes to accomplish depending on the size of the array, and is therefore easy to implement. There have been no documented cases where walrus 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 walrus 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 up to ½ hour 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 ice breakers, as well as on support (chase) vessels.

Bowhead Whales – This mitigation measure applies to seismic surveys and icebreaking. Presence of and observations by PSOs 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 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.

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).

PSO effectiveness is limited by an inability to detect distant, but potentially disturbed, whales that may be outside of the 180 dB radius, but within the 160 dB or 120 dB radii. These received levels are the acoustic criterion NMFS currently uses for Level B behavioral harassment for impulse and continuous sounds, respectively (70 FR 1871, January 11, 2005). For example, evidence from a satellite tagged bowhead whale indicated avoidance of a seismic vessel at a distance of approximately 9.2 km (5.7 mi). (Quakenbush et al. 2010b). Other limitations include an inability to visually detect marine mammals during periods of low to poor visibility, including fog and darkness. Extensive ice cover, particularly during icebreaking activities, could hinder detectability of marine mammals in water. There is also concern about inconsistencies in data recorded by PSOs that limit the ability to merge and integrate datasets (Hutchinson and Ferrero 2011). Despite limitations, PSOs are invaluable for the purposes of mitigation and data collection aboard industry vessels.

Beluga Whales – This mitigation measure applies to seismic surveys and icebreaking. Presence of and observations by PSOs 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 trained in species identification and many other operational and data recording procedures. Mitigation Measure A3 should impact beluga whales the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Other Cetaceans – This mitigation measure applies to seismic surveys and support vessels including ice breakers. Presence of and observations by PSOs are crucial for implementing many of the other mitigation measures, such as the shutdown and power down measures, and for estimating potential impacts. PSOs are trained in species identification and many other operational and data recording procedures. Mitigation Measure A3 would impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This standard mitigation measure applies to seismic surveys and all support vessels including ice breakers. 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 Iñupiaq or Yupik hunters that live in Arctic coastal communities and bring a wealth of experience and traditional knowledge to the position.

Walrus – These are the same people and they have the same training and roles as 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 – These are the same people and they have the same training and roles as PSOs 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 150 m (490 ft) from any observed ringed seal lair.

Pinnipeds – 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 150 m (492 ft) radius of ringed seal lairs. At this distance, sound source levels from vibroseis gear are not likely to appreciably affect ringed seals (Burns and Kelly 1982, Kelly et al. 1988). 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. This measure is meant to reduce both disturbance and the potential for injury or mortality of ringed seals. Crew at BP's Northstar Island have searched for and marked ringed seal lairs over the last decade prior to ice road construction activities.

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 150 m (492 ft) radius of ringed seal lairs. This measure helps reduce potential effects on the main prey of polar bears in the Beaufort Sea.

A5. No energy source may be placed over a ringed seal lair.

Pinnipeds – This measure applies only to on-ice surveys. Vibroseis equipment and sensors can only be placed on prepared ice surfaces so this measure is easy to implement in conjunction with the pre-survey scouting for ice seal structures. Implementation of this measure will help reduce the potential for disturbance, as well as injury or mortality.

Polar Bears – This measure applies only to on-ice surveys and also helps reduce potential effects on the main prey of polar bears in the Beaufort Sea.

A6. PSOs required on all drill ships and ice management vessels.

This measure would be the same as discussed under Standard Mitigation Measure A3 for all marine mammals. The PSOs would be required on exploratory drilling and ice management vessels, but would still have similar reductions in adverse impacts to marine mammals as discussed above.

B1. Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

Bowhead Whales – This mitigation measure applies to 2D/3D seismic including in-ice surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities. 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. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions. 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). The altitude restrictions associated with this mitigation measure should, therefore, adequately reduce most adverse impacts from aircraft overflights. 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. NMFS has required this measure as a conservative approach to conservation based on its potential for reducing adverse effects on a variety of species and its ease of application.

Beluga Whales – 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 fly overs. 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. NMFS has required this measure as a conservative approach to reducing potentially adverse effects on a variety of species because of its ease of application.

Other Cetaceans – This mitigation measure applies to 2D/3D seismic, icebreaking, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities. 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. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions. Mitigation Measure B1 could impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing ice seals and other marine mammals in the water or hauled out 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 ice seals but 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. NMFS has required this measure as a conservative approach to conservation based on its potential for reducing adverse effects on a variety of species and its ease of application.

Walrus – This standard mitigation measure applies to all exploration activities and is the same as the USFWS LOA measures. Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing walrus and other marine mammals in the water or on the ice or land. This restriction would be especially important for avoiding walrus concentrations hauled out on land or on ice where panic reactions could cause injuries or mortality of young 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 walrus 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 and is the same as the USFWS LOA measures. 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 to conservation 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.

Bowhead Whales – This mitigation measure applies to 2D/3D seismic including in-ice surveys, site clearance and high resolution shallow hazards surveys and exploratory drilling activities, and all associated support vessels and is the only one designed specifically to mitigate vessel collision. 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 (Laist et al. 2001, Vanderlaan and Taggart 2007), this mitigation measure should prove effective. Recent 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.

Although the primary intent of this mitigation measure is to reduce the risk of collisions with whales, it may also indirectly reduce the risk of disturbance to bowhead whales. Reducing sudden or multiple changes in vessel direction and requiring vessels to slow down under conditions of poor visibility would 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 Whales – This mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling, site clearance and high resolution shallow hazards surveys, and is the only mitigation measure designed specifically to mitigate vessel collision. This mitigation measure is intended to reduce the risk of collisions with marine mammals, and may also indirectly reduce the risk of disturbance to beluga whales by reducing sudden changes in vessel direction and requiring vessels to slow down under conditions of poor visibility. This will also serve to reduce noise levels. There is no evidence by which to determine the effectiveness of this measure to indirectly reduce adverse effects of vessel disturbance. 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 impact belugas whales as it would bowhead whales (see Section 4.5.2.4.9).

Other Cetaceans – This mitigation measure applies to 2D/3D seismic, in-ice seismic, site clearance and high resolution shallow hazards surveys and exploratory drilling activities, and is the only one designed specifically to mitigate vessel collision. 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 Silbur 2003). Mitigation Measure C1 could impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This standard mitigation measure applies to seismic surveys, support vessels including ice breakers, 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 ice seals 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 seals in the dark or obscured conditions. 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.

Walrus – 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 walrus 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 walrus 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.

C2. Lost equipment notification.

Bowhead Whales – This mitigation measure applies to seismic surveys and exploratory drilling. It requires notification by the operators to the responsible agencies if any equipment is lost that may affect bowhead whales or other marine mammals. This measure would not have any direct reduction of adverse effects to bowhead whales because it is very unlikely that any of the agencies would be able to find or otherwise ameliorate any potential adverse effects from such lost equipment. It serves primarily to provide information that may be valuable in the future if any animals are found with injuries related to entanglement in such equipment, which is unlikely to occur.

Beluga Whales – This mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. It requires notification of responsible agencies if any equipment is lost that may affect beluga whales or other marine mammals. This measure would impact beluga whales the same as it would bowhead whales (see Section 4.5.2.4.9).

Other Cetaceans – This mitigation measure applies to seismic surveys and exploratory drilling. It requires notification of responsible agencies if any equipment is lost that may affect any marine mammals, including all cetaceans. Mitigation Measure C2 would impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

***Pinnipeds* –** This standard mitigation measure applies to seismic surveys, and exploratory drilling. It requires notification of responsible agencies if any equipment is lost that may affect ice seals or other marine mammals. This measure would not have any direct reduction of adverse effects to ice seals because it is very unlikely that any of the agencies would be able to find or otherwise ameliorate any potential adverse effects from such lost equipment. It serves primarily to provide information that may be valuable in the future if any animals are found with injuries related to entanglement in such equipment.

***Walrus* –** This standard mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. It requires notification of responsible agencies if any equipment is lost that may affect walrus or other marine mammals. This measure would not have any direct reduction of adverse effects to walrus because it is very unlikely that any of the agencies would be able to find or otherwise ameliorate any potential adverse effects from such lost equipment. It serves primarily to provide information that may be valuable in the future if any animals are found with injuries related to entanglement in such equipment.

***Polar Bears* –** This standard mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. It requires notification of responsible agencies if any equipment is lost that may affect polar bears or other marine mammals. This measure would not have any direct reduction of adverse effects to polar bears because it is very unlikely that any of the agencies would be able to find or otherwise ameliorate any potential adverse effects from such lost equipment. It serves primarily to provide information that may be valuable in the future if any animals are found with injuries related to entanglement in such equipment.

C3. When traveling on ice-roads, the area shall be monitored for marine mammals.

***Pinnipeds* –** This standard mitigation measure applies only to on-ice surveys. The presence of PSOs is intended to provide the means to detect ice seals and their subnivean structures on the ice so they can be avoided. It is important for the implementation of Standard Mitigation Measures A5 and A6 as well.

***Walrus* –** This standard mitigation measure applies only to on-ice surveys, which would only occur in the Beaufort Sea and are thus unlikely to affect walrus. The presence of PSOs would provide the means to detect walrus so they can be avoided. It is important for the implementation of Standard Mitigation Measures A5 and A6 as well.

***Polar Bears* –** This measure applies only to on-ice surveys and drilling from ice islands. The presence of PSOs is intended to provide the means to detect polar bears and ice seals on the ice so they can be avoided. It is important for the implementation of Standard Mitigation Measures A5 and A6 and polar bear safety plans developed in conjunction with USFWS LOAs.

C4. Oil Spill Response Plan.

***Bowhead Whales* –** This mitigation measure applies to exploratory drilling activities. This would have indirect effects on bowhead whales and their habitat by helping to reduce the risk of oil spills. The analysis of oil spill risks is discussed in Section 4.9.

***Beluga Whales* –** This mitigation measure applies to exploratory drilling activities. This would have indirect effects on beluga whales and their habitat by helping to reduce the risk of oil spills. The analyses of possible effects from an oil spill on marine mammals are discussed in Sections 4.9.6.11 and 4.9.7.11.

***Other Cetaceans* –** This mitigation measure applies to exploratory drilling activities. It would have an indirect effect on cetaceans and their habitat by helping to reduce the risk of oil spills, and improving the effectiveness of a response should a spill occur. For a complete discussion and analysis of the effects of an oil spill on marine mammals, see Sections 4.9.6.11 and 4.9.7.11.

Pinnipeds **–** This standard mitigation measure applies to exploratory drilling only. It requires operators to develop and implement plans and procedures to minimize the risk of spills occurring and to expedite clean-up responses. It requires operators to inventory response equipment needed to support a worst-case-discharge response, contractual agreements with oil spill removal organizations who will provide response services, a dispersant-use plan, an in situ-burning plan, and a training and response drills plan. These measures dovetail with other response plans required of industry by BOEM. This measure reduces the risk of impact from oil spills to ice seals through injury or mortality and contamination of habitat.

Walrus **–** This standard mitigation measure applies to exploratory drilling only. It requires operators to develop and implement plans and procedures to minimize the risk of spills occurring and to expedite clean-up responses. It requires operators to inventory response equipment needed to support a worst-case-discharge response, contractual agreements with oil spill removal organizations who will provide response services, a dispersant-use plan, an in situ-burning plan, and a training and response drills plan. These measures dovetail with other response plans required of industry by BOEM. As mentioned above, any accidental spill cleanup procedures would also involve the use of PSOs to monitor for walrus in the area. This would have direct and indirect effects on walrus and their habitat by helping to reduce the risk of oil spills to walrus and their benthic/ice habitat.

Polar Bears **–** This standard mitigation measure applies to exploratory drilling only. It requires operators to develop and implement plans and procedures to minimize the risk of spills occurring and to expedite clean-up responses. It requires operators to inventory response equipment needed to support a worst-case-discharge response, contractual agreements with oil spill removal organizations who will provide response services, a dispersant-use plan, an in situ-burning plan, and a training and response drills plan. These measures dovetail with other response plans required of industry by BOEM. As mentioned above, any accidental spill cleanup procedures would also involve the use of PSOs to monitor for polar bears in the area and deter them if possible. This would have direct and indirect effects on polar bears and their habitat by helping to reduce the risk of oil spills to ice seals and their marine/ice habitat.

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 or around August 25.

Bowhead Whales **–** This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of bowhead whales for subsistence uses. It could indirectly reduce disturbance effects from oil and gas exploration on bowheads by removing or minimizing noise sources from exploration activities in localized areas, as well as diminish simultaneous combined disturbance effects from both whale hunting and exploration activities. The shutdown of exploration activities—and associated vessels—eliminates vessel presence and movements from several areas utilized by bowhead whales during fall for migration and feeding purposes.

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 to avoid conflicts and have also include design measures in programs to move activities from one area to another to avoid conflicts.

D3. Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Bowhead Whales **–** This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals for subsistence uses. Mitigation Measure D3 would provide similar reductions in potential adverse impacts as B1, above.

***Beluga Whales* –** This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals for subsistence uses. Mitigation Measure D3 would provide similar reductions in potential adverse impacts as B1, above.

***Other Cetaceans* –** Standard Mitigation Measure D3 applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals for subsistence uses. Mitigation Measure D3 would provide similar reductions in potential adverse impacts as B1, above.

***Pinnipeds* –** This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals (particularly bowhead whales) for subsistence uses. As this mitigation measure concerns the reduction of potential conflicts with subsistence hunting of bowhead whales, it would not likely be an effective mitigation measures for ice seals.

***Walrus* –** This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals (particularly bowhead whales) for subsistence uses. This mitigation measure is similar to B1, but, as it specifically concerns the reduction of potential conflicts with subsistence hunting of bowhead whales, it is more limited in time and areas of implementation and would not likely be an effective mitigation measures for walrus.

***Polar Bears* –** This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals (particularly bowhead whales) for subsistence uses. This mitigation measure is similar to B1, but, as it specifically concerns the reduction of potential conflicts with subsistence hunting of whales, it is more limited in time and areas of implementation and would not likely be an effective mitigation measures for polar bears.

4.5.2.4.15.1 Standard Mitigation Measures Summary for Marine Mammals

The incorporation of any combination of standard mitigation measures discussed above into future permits and authorizations would work to reduce any adverse impacts resulting from oil and gas exploration activities. Several measures are designed with a particular species in mind, but could result in a reduction of adverse indirect impacts to an additional marine mammal species as well.

4.5.2.4.16 Additional Mitigation Measures for Marine Mammals

Additional mitigation measures are outlined in Section 2.4.7 and described in detail in Appendix A. 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 OCS Lands Act. The following are applicable to mitigating effects of oil and gas exploration activities on marine mammals.

Additional Mitigation Measure A1. Sound source verification tests for sound sources and vessels at the start of the season.

***Bowhead Whales* –** The immediate purpose of this mitigation measure is to accurately predict sound propagation for the specific source in use. This information is most immediately used to designate appropriate exclusion zones for the current open water season based on empirical measurements, as compared to the zones based on modeling and extrapolation from different datasets. However, this information is also used to inform future analyses by increasing the accuracy of the predictions of the distances at which marine mammals are exposed to specific received levels associated with specific responses.

This measure would be intended to improve mitigation of any potential disturbance or hearing effects from noise by using field verified monitoring zones based on actual environmental conditions and acoustic propagation rather than modeled results. Modeled results are often conservative and may result in larger shut down zones. Although larger shut down 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 is not required throughout the season but rather at the beginning of the exploration activity and often gives industry a more useful zone for monitoring that season.

Sound propagation depends on both sound source characteristics and environmental characteristics such as temperature, salinity, bottom type, and bathymetry. Sound source verification measurements have been conducted for several years now 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 every survey. 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.

It is not clear whether there is any practical reduction of adverse effects to bowhead whales as a result of the implementation of this measure, but it has been required by NMFS during the last few years of seismic activity and industry is generally supportive of the measure.

***Beluga Whales* –** Additional Mitigation Measure A1 could impact beluga whales the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

***Other Cetaceans* –** This measure would be intended to improve mitigation of disturbance effects from noise by using field verified monitoring zones based on actual environmental conditions and acoustic propagation rather than modeled values. Modeled values are often conservative and may result in larger shut down zones. Although larger shut down zones would theoretically seem more valuable as they increase 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 whales that spend large periods of time underwater.

This measure is only required at the beginning of the exploration activity season, and can give industry a more useful zone for monitoring during the period. It has been required by NMFS during the last few years of seismic activity, and industry is generally supportive of the measure. Additional Mitigation Measure A1 would impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

***Pinnipeds* –** Additional Mitigation Measures A1 through A5 apply to all types of seismic survey sources (except on-ice surveys) and vessels used, including ice breakers It requires in-field testing of sound levels and establishment of buffer zones by measurement rather than modeling in an effort to improve the accuracy of safety zones for pinnipeds and other marine mammals. This requirement would be more difficult to implement than establishing safety radii based on modeling, especially under some weather and sea conditions, and it is not clear whether measured safety radii would be larger or smaller than modeled safety radii. Given the large number of variables that determine whether a particular animal is disturbed or injured by a sound source, safety radii are intended to be conservative estimates of safe buffer zones rather than exact boundaries. There is also the issue of uncertainty regarding how accurately and completely safety radii can be monitored given variable sea conditions and species that are difficult to detect at a distance, especially small species such as ice seals. Given the uncertainty about detection rates at different distances and conditions and uncertainty about the actual effects of different sound level exposures, it is not clear whether there would be any practical reduction of adverse effects to ice seals if all safety radii were established by measurement as opposed to having some established by modeling based on previous measurements, as required under mitigation measure A1.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure A2. Measures to assess efficacy and improve detection capabilities in low visibility situations (e.g. Forward Looking Infrared [FLIR] imaging devices, 360° thermal imaging devices).

Bowhead Whales – As of 2011, this technology has been tested by industry for additional measures to improve detection capabilities but has not yet proven to be successful. 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). Its effectiveness is weather dependent, with fog and poor sea state hampering visibility (white caps caused false positives). Based on this, such devices are likely not yet useful for implementing mitigation measures. However, 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 – and that would only be useful under conditions with very little wind or if the animal is relatively close the monitoring vessel.

Beluga Whales – Additional Mitigation Measure A2 could impact beluga whales the same as it would bowhead, although the smaller blows of beluga whales would not be detected at as great a distance as those of bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Other Cetaceans – New technology has been under development by industry to improve marine mammal detection capabilities, including Big Eyes (powerful binoculars), FLIR, and thermal imaging devices. Different types of equipment, such as Big Eyes, would likely be easier for PSOs to operate than others, such as FLIR. 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. Additional Mitigation Measure A2 would impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This additional mitigation measure would provide equipment to PSOs to help them detect marine mammals at sea under poor visibility conditions. Different types of equipment, such as Big Eyes, would likely be easier for PSOs to operate than others, such as FLIR. The efficacy of these various pieces of equipment in detecting ice seals and other marine mammals would likely vary substantially under different sets of conditions and with the experience of PSOs in operating them. Field testing under different conditions would be needed to clarify when such devices may be useful for detecting ice seals within safety radii. Effectiveness is weather dependent, with fog and sea state affecting visibility. Refer to Section 4.5.2.4.9 for a more thorough description and analysis of the efficacy and practicability of this mitigation measure.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

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. It is therefore unlikely that this measure would appreciably reduce the potential effects of seismic surveys on polar bears.

Additional Mitigation Measure A3. Limiting activities in situations of low visibility.

Bowhead Whales – This measure does not specify which activities may be limited or under what conditions. However, if a survey effort is delayed because of poor visibility due to light or weather conditions, vessels may have to maintain their position until conditions improve. Therefore, the potential for disturbance to bowhead whales from engine noise would not be eliminated. Limiting activities during periods of poor visibility could reduce the magnitude of disturbance and potential for collisions, but could also extend the survey period to compensate for time lost due to poor conditions, and thus increase the overall extent and duration of vessel presence in an area and the potential for disturbance. 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 is decreasing 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.

Beluga Whales – Additional Mitigation Measure A3 could impact beluga whales the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Other Cetaceans – Currently, low visibility restricts the effectiveness of marine mammal observers on board exploratory vessels. This measure would limit the activities permitted under low visibility conditions, in order to reduce the amount of time that unobserved marine mammals might be within established sound radii. Additional Mitigation Measure A3 would impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This additional mitigation measure does not specify which activities may be limited or under what conditions. It is therefore impossible to determine how it would reduce adverse effects on ice seals other than to generally reduce the potential for unseen interactions and reduce the level of potential disturbance at certain times. However, if a survey effort is delayed because of poor visibility, vessels would either have to maintain their position or travel to another area until conditions improve so the potential for disturbance from vessels would not be eliminated. In addition, the survey would likely be continued at a later time so the overall level of survey activity could remain the same and be stretched out over time, potentially causing a longer timeframe for disturbance to ice seals. Whether such a measure would reduce overall adverse effects on ice seals would depend on the actual avoidance of adverse interaction during poor visibility shutdowns and the potential increase in exposure to disturbance over a longer timeframe for the survey. It is not clear how this uncertainty about effectiveness could be tested. This measure would likely be expensive to implement and would cause logistical complications for survey completion.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure A4. Measures to increase detection probability for real-time mitigation (e.g. to maintain 180 dB shutdown zones), such as passive and active acoustic monitoring.

Bowhead Whales – The efficacy of real-time passive acoustic monitoring (PAM) in the Arctic depends on species, frequency and source level of calls, how often the marine mammals call, 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). 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 significant 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.

PAM systems only work if an animal produces a sound that can be detected by the system. An active acoustic monitoring (AAM) system circumvents this limitation, as it can detect animals that are not producing sounds. To do so, however, requires introducing sound into the environment, which can cause behavioral disturbances. Additional limitations include only being able to detect a whale ≥7 m (23 ft in length) out to a distance of about 1 km (0.62 mi), difficulty detecting whales at depth when their lungs are collapsed and at the surface when there is interference from signal reflections off of surface waves. Use of AAM remains in the realm of research and development (Bingham 2011).

The Sound and Marine Life Joint Industry Programme (JIP) is currently funding ongoing research on the use of real-time acoustic identification of cetaceans and the use of active acoustics technologies for use in mitigation and monitoring marine mammals during offshore exploration activities (JIP 2009). The technology, although not yet proven in Arctic conditions, has the potential for future application, pending continued research and modifications.

Beluga Whales – The efficacy of real-time PAM in the Arctic at this time depends on species, frequency and loudness of calls, how often the marine mammals call, 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. These technologies have the potential to greatly improve the detection of marine mammals, particularly in such a large area where visual sightings are often limited. The 2010 Statoil seismic survey program did detect beluga whales on the towed PAM array by JASCO (NMFS 2011b), but localizing the animals is difficult because the system must have very good received signal-to-noise ratio to localize beluga whales.

PAM systems are only effective for detecting animals that are emitting sounds. An active acoustic monitoring (AAM) system can detect animals that are not producing sounds, but require introducing sound into the environment, which may cause behavioral disturbances. In addition, AAM can only detect a whale ≥7 m (23 ft) in length out to a distance of about 1 km (0.62 mi), has difficulty detecting whales at depth and at the surface when there is interference from signal reflections off of surface waves. The relatively small size of beluga whales (3.5 to 4.5 m [11 to 15 ft]) means they may escape detection by an AMM. Use of AAM remains in the realm of research and development (Bingham 2011).

Other Cetaceans – The efficacy of real-time PAM in the Arctic currently depends on species, frequency and source level of calls, how often the marine mammals call, 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 bowhead whales, which overlap with seismic sounds (NMFS 2010). Fin, gray and humpbacks whales also vocalize in lower frequencies. These technologies have the potential to greatly improve the detection of marine mammals, particularly in such a large area where visual sightings are often limited. However, there are significant technical challenges for using this system from moving vessels with their own noise source within the frequency range low-frequency whales. This is less problematic for higher frequency toothed whales. Several vessels are required to collect acoustic information from different angles to allow the calculation of animal locations and all of this data must be combined and analyzed in real-time to be useful. Additional Mitigation Measure A4 would impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for additional analysis of the efficacy and practicability of using PAM and AAM for detecting marine mammals in Arctic waters

Pinnipeds – This additional mitigation measure would require use of technology such as active and passive acoustic monitoring to improve real-time detection of marine mammals. These technologies have the potential to greatly improve the detection of marine mammals, at least under certain conditions, and could provide more information about potential interactions and actual behavioral responses to disturbance. However, there are significant technical challenges for using passive acoustic monitoring to provide real-time locations of animals in relation to moving vessels which would be useful to monitor appropriate safety radii. Several vessels are required to collect acoustic information from different angles to allow the calculation of animal locations and all of this data must be combined and analyzed in real-time to be useful. In addition, only animals that are vocalizing can be detected with passive arrays. 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. Active acoustic systems may also be useful in locating animals in real-time but they introduce additional sounds into the marine environment that may cause behavioral reactions in the animals they are intended to monitor. These types of systems are subjects of continuing research to determine their efficacy and practical limitations. Refer to Section 4.5.2.4.9 for a more thorough description and analysis of the efficacy and practicability of this mitigation measure.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure A5. Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (e.g. cow/calf groups and feeding or resting aggregations).

Bowhead Whales – Some characteristic mitigation language that has been used in past ITAs for these measures include:

- For seismic activities (including shallow hazards and site clearance and other marine surveys where active acoustic sources would be employed) in the Beaufort Sea after August 25, a 120-dB monitoring zone for bowhead whales would be established and monitored for the next 24 hours if four or more bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program within the area where an ensonified 120-dB zone around the vessel's track is projected. To the extent practicable, such monitoring should focus on areas upstream (eastward) of the bowhead migration. No seismic surveying shall occur within the 120-dB safety zone around the area where these whale cow-calf pairs were observed, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.
- A 160-dB vessel monitoring zone for bowhead and gray whales would be established and monitored in the Chukchi Sea and after August 25 in the Beaufort Sea during all seismic surveys. Whenever an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a non-migratory, significant biological behavior (e.g. feeding, socializing) are observed during an aerial or vessel monitoring program within the 160-dB safety zone around the seismic activity, the seismic operation would not commence or would shut down, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 160-dB safety zone of seismic-surveying operations.

These additional measures were 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. 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 potential biological significance.

However, since requiring the implementation of these measures in the Beaufort Sea beginning in 2006, there have been no shut downs 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) (Table 4.5-11). 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 implemented, then it is likely not reducing impacts to the species. 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 (NMFS 2010c). To date, implementation of this measure has not been required, leaving the efficacy and practicability of the measure as questionable.

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.

Pinnipeds – 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.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.

Bowhead Whales – This measure is targeted at reducing potential disturbance to several marine mammal species and threatened and endangered species, such as spectacled eiders in the Ledyard Bay Critical Habitat Unit. Areas of particular importance to bowhead whales are Camden Bay and Barrow Canyon, where they have been documented as concentrating to feed. This measure could both reduce the number of bowhead whales disturbed by oil and gas activities by eliminating the activities in an area of known high numbers and potentially reduce the severity of impacts by avoiding an area where animals are specifically feeding where disturbance could result in their temporary abandonment of preferred feeding habitat (thus potentially preventing their energy input at that site and necessitating the use of additional reserves to find food at an alternate spot). No oil and gas industry exploration activities would be permitted to occur in the areas specified here during the listed timeframes. Additionally, buffer zones around these time/area closures could potentially 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. In the event that a buffer zone of this size was impracticable, a buffer zone avoiding the ensonification of the important habitat above 180 dB could be used. Avoidance of these important habitat areas may be costly to industry, as bowhead feeding time is at the same time as proposed industry operations because both are using the area during the ice-free months. Moreover, federal lease sales within some of these areas have already occurred, and companies have purchased leases in these areas, such as Camden Bay.

The time/area closures included in this measure are the same as would be required under Alternative 4. Refer to Section 4.7.2.4.1 for details.

Beluga Whales – This measure is targeted at reducing potential disturbance to several marine mammal species and threatened and endangered species, such as spectacled eiders in the Ledyard Bay Critical Habitat Unit. Areas of particular importance to beluga whales are Kasegaluk Lagoon, Barrow Canyon and the Beaufort Sea shelf break. This measure could reduce the number of beluga whales disturbed by oil and gas activities by eliminating the activities in known beluga whales high-use areas. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure. The time/area closures included in this measure are also the same as would be required under Alternative 4. Refer to Section 4.7.2.4.2 for further details.

Other Cetaceans – 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 Native subsistence. As marine mammals are not randomly distributed throughout the EIS project area, targeted closures around important habitat areas would likely have a disproportionate reduction of impact to those animals that use those areas regularly. This measure may be costly to industry, as the feeding time for many marine mammals is at the same time as proposed industry operations (ice-free months). Additional Mitigation Measure B1 proposes the same temporal/spatial limitations analyzed under Alternative 4; for a complete description of this measure, please see Section 4.7.2.4.3.

Pinnipeds – Additional Mitigation Measures applies to all exploration activities that occur during open-water season. The important areas designated in this mitigation measure are primarily meant to protect whale habitat but they are all areas that are important to the ice seals at least part of the year. Each area has a specific set of time periods associated with closures to exploration activities and the presence of vessels. The effects of this mitigation measure for ice seals would be similar to those described for Standard Mitigation Measure D1; it 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. Because ice seals are widely distributed, the total number of animals affected by exploration activities may not change with the implementation of this mitigation measure, although the species most affected in any given area could change with the timing of exploration activity in that area.

Table 4.5-21 Summary of Ice Seal Occurrence in Habitat Areas Under Consideration for Temporal/Spatial Limitations in Additional Mitigation Measure B1

Species/Area	Shelf Break of the Beaufort Sea	Camden Bay	Barrow Canyon	Hanna Shoals	Ledyard Bay Critical Habitat Unit
Ringed seal	Present year-round, concentrations July-September	Present year-round, concentrations February-September	Present year-round, concentrations February-September	Present year-round, concentrations July-September	Present year-round, concentrations February-June
Spotted seal	Not present	Present June-December	Present June-December	Present June-Freeze up	Present June-Freeze up
Ribbon seal	Present in western portion of Beaufort only	Not present	Present June-December	Present June-December	Not present
Bearded seal	Present year-round, concentrations July-September	Present year-round, concentrations July-September	Present year-round, concentrations July-September	Present year-round, concentrations July-September	Present year-round, concentrations March-June

Walrus – Additional Mitigation Measures B1 and B2 apply to all exploration activities that occur during open-water season. The important 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 walrus since they infrequently occur in those areas. However, Hanna Shoal is an important habitat for feeding walrus and any reduction in exploration activity in this area would reduce the potential for disturbance of walrus. Ledyard Bay is also important habitat for walrus when the sea ice is present in spring and early winter. 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 special habitat areas 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 on polar bears.

Additional Mitigation Measure B2. NMFS restricting 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).

Bowhead Whales – 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.

The intent is to reduce duplicative surveys, the effectiveness of which would be contingent upon detailed tracking of existing and proposed surveys and the willingness of industry to share what may be considered proprietary information. Legal restrictions would also likely prohibit implementation of this measure by BOEM.

Beluga Whales – Additional Mitigation Measure B2 would impact beluga whales the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Other Cetaceans – Additional Mitigation Measure B2 could impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for a more thorough description and analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – Additional Mitigation Measure B2 applies to all exploration activities that occur during open water season. This additional mitigation measure would require or encourage industry to share data in order to avoid duplication of efforts in the same area within a certain time period. 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 areas. There is the potential for this measure to reduce repeated disturbance and other effects on ice seals in a particular area and timeframe (unspecified) but the alternatives have a specified level of exploration activity that could be authorized, even with restrictions, so an overall reduction of effort below the Alternative's description is not considered.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12. Additional Mitigation Measures B2 and B3 would impose further spatial restrictions on seismic surveys during open-water season. These measures would theoretically reduce disturbance impacts on walrus by reducing seismic activities but there would likely be few walrus affected to any extent by open-water seismic surveys even without these additional restrictions. The temporal/spatial restrictions on exploration activities in the Chukchi could appreciably reduce the potential effects of exploration on walrus at Hanna Shoal.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure B3. Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

Bowhead Whales – This measure would expand the minimum distance between authorized seismic surveys from 24 km (15 mi) to 145 km (90 mi). Currently, as an operational requirement (and therefore it is considered part of the activity itself), separate 2D and 3D seismic surveys are not allowed to operate within 24 km (15 mi) of one another in order to ensure that there are no issues with data collection. This measure would increase this distance not for operational reasons but rather for consideration of impacts on marine mammals. The farther concurrently operating sources get from one another, the less likely the respective 160 dB radii will overlap, but the greater the overall area of ensonification. For example, a bowhead whale migrating through the Chukchi Sea would be exposed to two different seismic surveys far enough apart such that the 160 dB radii do not overlap, but the overall area of potential disturbance is increased. Furthermore, as each seismic survey is required to have support vessels for monitoring, this increases the overall area of potential disturbance from vessel noise in the region as a whole. The efficacy of this mitigation measure may vary by area of operation, season, and whether whales are feeding or migrating.

Beluga Whales – Additional Mitigation Measure B3 would impact beluga whales the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Other Cetaceans – Additional Mitigation Measure B3 could impact other cetaceans the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for a more thorough description and analysis of the efficacy and practicability of this mitigation measure.

Pinnipeds – This additional mitigation measure would expand the minimum distance between authorized seismic surveys from the current 24 km (15 mi) standard. It is not clear how often this measure would be implemented or how many seismic surveys it would involve. Data from Beaufort Sea and Chukchi Sea seismic surveys indicate that the 160 dB radii range from 8 to 13.4 km (5 to 8.3 mi) (16 to 36 airguns) (Thomas et al. 2010, Haley et al. 2010). Two concurrent seismic survey efforts at the standard mitigation measure distance could therefore have overlapping 160 dB safety radii and leave open the possibility of animals in between the surveys being exposed to two ensonified zones concurrently, perhaps leading to effects on the animals greater than from only one survey. However, observational evidence indicates that ice seals do not react strongly to seismic operations even at fairly close distances so seals occurring between two concurrent seismic surveys are unlikely to be disturbed by both of them even at the standard minimal spacing. Overlap of ensonified areas at the 160 dB level is unlikely if operation distances increase as specified under this mitigation measure.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure C1. Vessel and aircraft avoidance of concentrations of groups of ice seals, walrus, and polar bears.

Pinnipeds – Additional Mitigation Measures C1 through C5 would apply to all exploration activities that occur in the open-water season. C1 does not define how many ice seals (or walrus or polar bears) constitute a "group" or what restrictions would apply to ice seals. It would require all vessels to slow down, steer around if possible, and not approach groups of walrus 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. Ice seals are difficult to see at 0.8 km 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 safety buffer approaching groups of ice seals. In addition, the great 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.

Walrus – Additional Mitigation Measure C1 is intended to provide extra protection for groups of ice seals, Pacific walrus, and polar bears. All of the elements relating to walrus are identical to what would be required under a USFWS LOA so this measure would make no practical difference to walrus.

Polar Bears – Additional Mitigation Measure C1 is intended to provide extra protection for groups of ice seals, Pacific walrus, and polar bears. All of the elements relating to polar bears are identical to what would be required under a USFWS LOA so this measure would make no practical difference to polar bears.

Additional Mitigation Measure C2. Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Bowhead Whales – This measure would require exploration vessels to use unspecified designated shipping lanes 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. Vessels in the Chukchi Sea have been avoiding the Ledyard Bay Critical Habitat Unit (for spectacled eiders), so they are used to transiting around designated areas. Therefore, it is anticipated that this additional mitigation measure would result in reduced disturbance to bowhead whales in areas used for activities such as feeding.

Beluga Whales – Additional Mitigation Measure C2 could impact beluga whales the same as it would bowhead whales. Refer to Section 4.5.2.4.9 for an analysis of the efficacy and practicability of this mitigation measure.

Other Cetaceans – This additional mitigation measure would require exploration and support vessels to use designated shipping lanes while in transit to avoid concentrations of marine mammals. Designated routes could result in fewer disturbances to animals in potentially important habitats, such as feeding and calving grounds. However, as seismic activities often cover wide regions, particularly for the 2D non-lease sale areas, designated transit routes may be difficult to establish. Weather and ice conditions are also important determinants of transit routes. Additionally, course alterations could result in increased transit time in some cases. Currently, vessels in the Chukchi Sea have been avoiding the Ledyard Bay Critical Habitat Unit (for spectacled eiders), so they are used to transiting around designated areas. This additional mitigation measure could result in reduced disturbance to bowhead whale feeding areas, and, coincidentally, reduce population disturbance to other cetaceans in those areas. Gray whales are the only species in the group of "other cetaceans" that occurs with regularity in the EIS project area, especially in the Chukchi Sea, and may form feeding aggregations in somewhat predictable locations. They are, therefore, the species in this group most likely to be impacted by designated shipping lanes.

Pinnipeds – This additional mitigation measure would require exploration vessels to use designated shipping lanes (unspecified) while in transit to avoid concentrations of marine mammals. It is not clear if concentrations of ice seals would be considered under this measure. Given the smaller amount of concern for disturbance for ice seals compared to bowhead whales and other species, it seems unlikely that ice seals would experience much reduction in disturbance and other effects unless the mitigation measure was designed for that purpose.

Walrus – This additional mitigation measure requires shipping routes to avoid high densities of marine mammals, including walrus. This measure is also identical to what would be required under a USFWS LOA to protect groups of walrus.

Polar Bears – Additional Mitigation Measure C2 requires shipping routes to avoid high densities of marine mammals. Because polar bears typically do not occur in "concentrations", it is not apparent that this measure would have any practicable effect on polar bears.

Additional Mitigation Measure C3. 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 habitat.

Beluga Whales – This additional mitigation measure could result in potentially reduced impacts on beluga whale food resources and habitats on a localized scale where the discharge activity may occur. The level at which this mitigation measure would reduce impacts on beluga whales is unknown.

Other Cetaceans – Additional Mitigation Measure C3 is designed to reduce or eliminate discharge of potentially harmful substances into the water. This would result in potentially reduced impacts on food sources of cetaceans on a localized scale surrounding discharge activities. Any reduction in the discharge of potentially harmful substances into the food chain could decrease potential adverse impacts; the extent which would be dependent on the volume of discharge. As the introduction of harmful substances resulting from oil and gas exploration activities is not currently known to be a problem for cetaceans, it is unlikely that a measurable impact would occur.

Pinnipeds – This additional mitigation measure would require reduced discharges of various waste streams. No reduction levels are specified but, to the extent that any substances with potentially adverse effects on ice seals or their prey could be kept out of the marine environment, this measure could reduce adverse effects on ice seals by reducing the risk of injury/mortality and habitat changes. The current risk to ice seals would depend on the environmental concentrations and persistence of such substances, exposure levels, and many other factors. An environmental risk assessment in relation to exploration discharges has not been conducted for ice seals so there is no quantifiable measure of the reduced risk afforded by a no-discharge mitigation measure.

Walrus – 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 walrus or their prey could be kept out of the marine environment, this measure could reduce adverse effects on walrus by reducing the risk of injury/mortality and habitat changes.

Polar Bears – Additional Mitigation Measure C3 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. The current risk to polar bears would depend on the environmental concentrations and persistence of such substances, exposure levels, and many other factors. An environmental risk assessment in relation to exploration discharges has not been conducted for polar bears so there is no quantifiable measure of the reduced risk afforded by a no-discharge mitigation measure.

Additional Mitigation Measure C4. Operators are required to recycle drilling muds.

Bowhead Whales – Measures C3 and C4 are designed to reduce or eliminate discharge of potentially harmful substances into the water during exploratory drilling activities. All measures would 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 these additional mitigation measures would reduce impacts to bowhead whales is unknown. Operators could incur additional costs with implementation of this measure.

Beluga Whales – This additional mitigation measure would result in potentially reduced impacts on beluga whale food resources and habitats on a localized scale of where the discharge activity may occur. The level at which this mitigation measure would reduce impacts on beluga whales is unknown.

Other Cetaceans – Additional Mitigation Measure C4 is designed to reduce or eliminate discharge of drilling muds into the water. This would result in potentially reduced impacts on food sources of cetaceans on a localized scale surrounding drill sites. Any reduction in the discharge of drilling muds into the marine environment could decrease potential adverse impacts; the extent which would be dependent on the volume of discharge. As the introduction of harmful substances resulting from oil and gas exploration activities is not currently known to be a problem for cetaceans, it is unlikely that a measurable impact would occur.

Pinnipeds – This additional mitigation measure is very similar to Additional Mitigation Measure C3. To the extent that any substances with potentially adverse effects on ice seals or their prey could be kept out of the marine environment, this measure could reduce adverse effects on ice seals by reducing the risk of injury/mortality and habitat changes.

Walrus – This additional mitigation measure requires recycling of drilling muds and other waste reduction measures and is very similar to Additional C3. To the extent that any substances with potentially adverse effects on walrus or their prey could be kept out of the marine environment, this measure could reduce adverse effects on walrus by reducing the risk of injury/mortality and habitat changes.

***Polar Bears* –** Additional Mitigation Measure C4 requires recycling of drilling muds and other waste reduction measures. This mitigation measure is very similar to Additional Mitigation Measure C3. 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 C5. Use trained seal-lair sniffing dogs for areas with water deeper than 3 m (9.8 ft) depth contour to locate seal structures under snow in the work area and camp site before initiation of activities.

***Pinnipeds* –** This additional mitigation measure and Additional Mitigation Measure C6 apply to on-ice exploration activities only. Additional Mitigation Measure C5 requires use of seal-sniffing dogs to locate ice seal structures under the snow before on-ice seismic work is initiated or camps are established. The measure does not specify buffer distances but the intent is clearly to avoid disturbance of ice-seals. Use of trained dogs greatly 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 definitely reduce the risk of disturbing 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 substantial numbers of seals. 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.

Additional Mitigation Measure C6. Use trained seal-lair sniffing dogs to survey the ice road and establish a route where no seal structures are present.

***Pinnipeds* –** This measure is similar to Additional Mitigation Measure C5 but would apply to ice road construction. Seal-sniffing dogs would be used to detect seal structures under the snow and ice along proposed ice-road routes and the road would presumably be rerouted to safe distances if seals were detected. As with Additional Mitigation Measure C5, this mitigation measure could reduce disturbance impacts for substantial numbers of seals or perhaps only a few, depending on the route, and should be logistically possible to implement, as long as there are trained dogs available.

Additional Mitigation Measure D1. No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay.

***Bowhead Whales* –** This additional mitigation measure is targeted to minimize conflict with the beluga whale hunt at Point Lay and Wainwright. It could 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. Limiting entrance into the Chukchi Sea until after July 15could shorten exploration periods during the open water period in both the Beaufort and Chukchi seas by preventing activity and staging prior to this time.

***Beluga Whales* –** This additional mitigation measure is designed to minimize conflict with the beluga whale subsistence hunt at Point Lay and Wainwright. It could also reduce potential disturbance from vessels on beluga whales that congregate in the nearshore waters of Kotzebue Sound and Kasegaluk Lagoon during June and July prior to migrating into the Beaufort Sea. Delaying passage into or through the Chukchi Sea until after July 15 could incur additional direct or indirect costs to industry by shortening the open water season period of activity and staging of equipment.

Additional Mitigation Measure D2. 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.

Bowhead Whales – The measure is designed to avoid conflict with the subsistence hunt in the nearshore Beaufort Sea shelf region, but it would also reduce the potential for vessel disturbance of whales in nearshore areas. Operators could incur costs and lost survey time associated with altering transit routes farther offshore.

Additional Mitigation Measure D3. 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.

Bowhead Whales – This measure is designed to avoid conflict with the subsistence hunt and give both the hunters and companies' flexibility in when they stop activities in the Cross Island and Barter Island regions. As the hunters commenced whaling activities, they would communicate with industry vessels via the designated communication protocols and the exploration activity would move out of the area. Therefore, there would be less chance that the industry activities would either disturb bowhead whales or otherwise interfere with the bowhead hunt. 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.

Additional Mitigation Measure D4. Shutdown of exploration activities in the Beaufort Sea for the Barrow bowhead whale hunts from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.

Bowhead Whales – Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area.

Additional Mitigation Measure D5. 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.

Bowhead Whales – Potential impacts from this mitigation measure would be the same as described for D3 but would apply to this particular area.

Additional Mitigation Measure D6. Shutdown of exploration activities in the Chukchi Sea for the Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

Bowhead Whales – Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area.

Additional Mitigation Measure D7. Transit restrictions into the Chukchi Sea modified to allow offshore travel under certain conditions (e.g. 32 km [20 mi] from the coast) if beluga whale, fall bowhead whale (Barrow and Wainwright), and other marine mammal hunts would not be affected.

Bowhead Whales – Potential impacts from this mitigation measure would be the same as described for D3 but would apply to this particular area.

Additional Mitigation Measure D8. 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 until the close of the bowhead whale hunt in Barrow.

***Bowhead Whales* –** Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area.

***Beluga Whales* –** Additional Mitigation Measure D8 could impact beluga whales the same as it would bowhead whales (see Section 4.5.2.4.9) by reducing potential vessel and drilling disturbance to migrating and/or feeding beluga whales along the western Beaufort Sea shelf.

4.5.2.4.16.1 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 bowhead whales are discussed above. Efficacy and practicability of these measures are discussed to the extent possible, given the varying degrees of current availability and use. 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, are still being developed and tested and not yet ready for use in 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. Drawing conclusions regarding the effectiveness of these measures to mitigate adverse impacts on bowhead whales from oil and gas exploration activities is, however, limited by not knowing which, if any, of these measures may be required in the future.

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 except for Additional Measures C5 and C6. These measures could improve detection of seal lairs on ice and therefore reduce the risk of injury or mortality from on-ice surveys. The temporal/spatial restrictions on exploration activities in the Hanna Shoal area could reduce adverse impacts to Pacific walrus, 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 Pacific walrus would still likely be low in magnitude, distributed over a wide geographic area, and temporary in duration.

4.5.2.5 Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-5). Among these species, it is expected that only caribou may experience coastal interactions with offshore oil and gas exploration activities during critical periods of their life cycle; therefore, this analysis will focus 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 (MMS 2008, 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 is 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 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 us 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

Although ADF&G monitors the harvest and makes necessary adjustments to seasonal bag limits to prevent long term effects on the caribou population, increased hunting pressure may have short term effects on the population. Increases in the number of local sport hunters may also compete with subsistence users (see Section 4.5.3.2 for more information about subsistence).

Another anticipated effect of oil and gas exploration is an increase in vehicle traffic from support crews. Vehicle strikes could also cause injury to caribou or even mortality.

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 will 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.

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 Special Habitat Areas

The analysis of the direct and indirect effects associated with special habitat areas can be found in Sections 4.5.2.4 (Marine Mammals), 4.5.2.3 (Marine and Coastal Birds) and 4.5.3.2 (Subsistence).

4.5.2.7 Standard Mitigation Measures for the Biological Environment

Standard Mitigation Measures are outlined in Section 2.4.9 and described in detail in Appendix A. 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. The following standard mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on resources within the biological environment. The discussion of standard mitigation measures for marine mammals can be found in Section 4.5.2.4.15.

A1. Establishment of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for pinnipeds.

Fish – The shutdown/power down procedures described in this measure, to be enacted whenever a marine mammal enters the 180/190 dB radius, would impact fish resources in the immediate vicinity of each specific action by reducing their exposure to high sound levels. However, the overall effect on a resource-wide scale is likely nonexistent, since it will not reduce the overall amount of sonic energy being emitted into the ocean. Since the shutdown/power down procedures are not specifically directed at fish, they are effectively random in nature, and therefore no more likely to reduce the overall amount of exposure of the entire fish resources to sonic energy.

A2. Specified ramp-up procedures for airgun arrays.

Fish – The ramp-up procedures required in this mitigation measure are assumed to be effective at mitigating injuries to juvenile and adult fish, due to avoidance behavior triggered by loud noises. No studies have been performed to determine their effectiveness, although fish response to loud noise has been shown through extensively studies. As described above (see *Exposure to Noise*), fish have been shown to initiate avoidance behavior at sound levels above 160 to 180 dB re 1 µPa. Since detrimental physiological effects are not typically experienced until sound levels in excess of this value are reached, ramp-up procedures are anticipated to drive all motile fish away from the area before injury can occur. Ramp-up procedures will not mitigate adverse effects to sedentary fish resources, such as eggs and larvae, which have no means of locomotion, and therefore will not be able to escape the sounds, regardless of the ramp-up action.

B1. Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

Marine and Coastal Birds – Under Standard Mitigation Measure B1, 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. These are essentially the same mitigation measures imposed by the USFWS to reduce the risk of disturbance for birds.

Terrestrial Mammals – This measure states that: aircraft shall not operate below 457 m (1,500 ft) unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or any other emergency situations; aircraft engaged in marine mammal monitoring shall not operate below 457 m (1,500 ft) in areas of active subsistence use; except for airplanes engaged in marine mammal monitoring, aircraft shall use a flight path that keeps the aircraft at least five miles inland until the aircraft is directly (south) of its offshore destination, then at that point it shall fly directly to its destination; and helicopters shall not hover or circle above groups of marine mammals or within 457 m (1,500 ft) of such areas. While this is intended to decrease the impact to marine mammals, it may inadvertently direct the traffic over caribou use areas.

C2. Lost equipment notification.

Lower Trophic Levels – The notification of lost equipment that could pose a danger to marine mammals may indirectly mitigate threats to the benthic habitat in that unsecured equipment could sink and drag across the seafloor, damaging habitat and causing injury and mortality to benthic flora and fauna.

C4. Oil Spill Response Plan.

Lower Trophic Levels – Operators are required to have a plan(s) in place that: a) minimize the likelihood of a spill; b) outline the response protocol in the event of a spill; and c) identify the means of minimizing impacts to marine mammals following a spill. Minimizing the impacts of an oil spill reduce impacts for the entire lower trophic level.

Fish – The requirements of this mitigation measure will reduce impacts to fish resources in the instance of an oil spill. The measure requires the preparation of plans intended to reduce the likelihood of an oil spill and prepare operators to deal with a spill and cleanup should one occur. While the measure is directed towards marine mammals, any actions taken to protect that group will also be advantageous to fish resources.

Marine and Coastal Birds – This measure is intended to reduce/lessen non-acoustic impacts on marine mammals. However, the measure would have indirect effects on birds and their habitat by helping to reduce the risk of oil spills.

Terrestrial Mammals – Operators are required to have a plan(s) in place that: minimizes the likelihood of a spill; outlines the response protocol in the event of a spill; and identifies the means of minimizing impacts to marine mammals following a spill. In the event of an oil spill, this mitigation measure would indirectly reduce the adverse impacts to caribou by having a plan for efficient clean up.

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 or around August 25.

Fish – Any reduction or elimination of seismic activities in a specific area will also reduce or eliminate the effects of those activities on the fish resources in that area accordingly. However, similar to the situation described in Standard Mitigation Measure A2, unless there is an overall reduction in the amount of sonic energy emitted into the ocean, no net reduction in impacts to fish will occur. This measure will only provide a resource-level reduction in impacts if the total sonic energy emitted is reduced.

D3. Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Terrestrial Mammals – Standard Mitigation Measure D3 is the same as Standard Mitigation Measure B1 with the following two exceptions: Measure B1 includes language about helicopters and Measure D3 adds a stipulation regarding flying in lower altitudes due to weather. As with Standard Mitigation Measure B1, the avoidance of marine mammals may inadvertently direct the aircraft to the caribou's use area.

4.5.2.7.1 Standard Mitigation Measures Summary for the Biological Environment

Most of the standard mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on biological resources other than marine mammals. Often if a standard mitigation measure reduces adverse impacts to marine mammals, other resources such as fish or lower trophic levels experience the indirect reduction in impacts from implementation.

4.5.2.8 Additional Mitigation Measures for the Biological Environment

Additional Mitigation Measures are outlined in Section 2.4.10 and described in detail in Appendix A. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. The following additional mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on resources within the biological environment. The discussion of additional mitigation measures for marine mammals can be found in Section 4.5.2.4.16.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.

Lower Trophic Levels – Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, the Western Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit, could help to reduce the effects of exploration in those areas and indirectly reduce effects on the lower trophic organisms that inhabit those areas. However, exploration activities could be redirected to other areas and times so the potential effects on lower trophic levels would just be displaced rather than eliminated.

Fish – The temporal/spatial closures identified in Additional Mitigation Measure B1 would reduce adverse effects to fish and fish resources in these areas by reducing the amount of exploration activity that occurs in certain time periods. However, exploration activities could be redirected to other areas and times so the potential effects on fish and EFH would just be displaced rather than eliminated.

Marine and Coastal Birds – The temporal/spatial closures suggested in this mitigation measure mirror the time/area closures required in Alternative 4. These closures would reduce adverse effects on marine and coastal birds by reducing the amount of exploration activity that occurs in areas with varying importance to marine and coastal birds. The most important area in this regard is Ledyard Bay. The other areas are certainly important to particular species during the time periods considered, such as Barrow Canyon and the adjacent waters are for Ross's gull in the fall, but spatial/temporal restrictions in areas besides Ledyard Bay would not be as effective in reducing adverse effects to birds as they would be for bowhead whales.

Additional Mitigation Measure C3. 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 habitat.

Lower Trophic Levels – Requirements to ensure reduced discharge of the specific discharge streams identified with potential impacts to marine mammals or marine mammal habitat will help to minimize the volume of discharge and therefore the impact on the benthic habitat.

Fish – Discharges with potential impacts to marine mammals or marine mammal habitat are likely to overlap to some degree with discharges with potential impacts to fish or fish habitat, due to the shared environment. Scientific evidence suggests that drilling discharges have minor effects on fish health (Hurley and Ellis 2004). Other discharge streams likewise have little or no measurable effect on fish resources, but removing even a potential hazard would be viewed as reducing possible adverse impacts.

Marine and Coastal Birds – This additional mitigation measure would require reduced discharges of various waste streams. No reduction levels are specified but, to the extent that any substances with potentially adverse effects on marine and coastal birds or their prey could be kept out of the marine environment, this measure could reduce adverse effects on marine and coastal birds by reducing the risk of injury/mortality and habitat changes.

Additional Mitigation Measure C4. Operators are required to recycle drilling muds.

Lower Trophic Levels – Operators are required to recycle drilling muds (e.g. use those muds on multiple wells) based on operational considerations to reduce discharges which will, in turn, reduce the impact on the benthic habitat.

Fish – Although scientific evidence suggests that drilling discharges have minor effects on fish health (Hurley and Ellis 2004), any further reduction in their exposure to potential hazards would be a reduction in overall possible adverse impacts to fish.

Marine and Coastal Birds – This additional mitigation measure is very similar to Additional Mitigation Measure C3. To the extent that any substances with potentially adverse effects on marine and coastal birds or their prey could be kept out of the marine environment, this measure could reduce adverse effects on marine and coastal birds by reducing the risk of injury/mortality and habitat changes.

4.5.2.8.1 Additional Mitigation Measures Conclusion for Biological Resources

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on biological resources other than marine mammals except for Additional

Mitigation Measures C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the reductions in adverse impacts relative to the standard mitigation measures would be limited to small numbers of benthic organisms, fish, and birds and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on these biological resources would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect important or unique resources.

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 will be based on levels of intensity, duration, geographic extent, and context, identified in Table 4.4-1 (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.
>
> **State Revenue**: None. Lease payments were already generated in advance of the proposed activities; there are no facilities proposed that would generate property tax; and no production activity that would generate production revenue or corporate income tax. 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 where crew and support services are stationed. No new property taxes would be generated other than potential rental fees. A general economic contribution related to the purchase of goods and services, aside from taxes and employment, would occur in all communities that serve some staging purpose.

A detailed list of communities that could receive local revenue from the proposed action alternatives can be found in Table 4.5-22. Table 3.3-1 lists costal 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 Barrow, Nome, and Unalaska/Dutch Harbor.

Table 4.5-22 Potential Revenue Sources Under Alternative 2

Alternative 2 (Activity Level 1)	Support/Crew Changes[1]	Owner	New Public Revenue from Services[2]
<u>Up to four</u> 2D/3D seismic surveys in the Beaufort Sea per year including <u>One</u> 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**

Alternative 2 (Activity Level 1)	Support/Crew Changes[1]	Owner	New Public Revenue from Services[2]
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 & 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 – Protected Species Observers (PSOs) required on all seismic source vessels, ice breakers, and support (chase) vessels when required.
- A6 – PSOs required on all drill ships and ice management vessels.

The standard mitigation measures could create a limited number of (direct) new local hire employment opportunities associated with the PSO program, Subsistence Advisor (SA) 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 4.5-23 outlines communities that may see larger numbers of local hire opportunities.

Table 4.5-23 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 4.5-24	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
Subsistence Advisors	Not available	Prudhoe Bay, Barrow, Kaktovik, Nuiqsut, Wainwright
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.

IHAs require biologically-trained, on-site individuals to be onboard vessels approved in advance by NMFS. Table 4.5-24 demonstrates a hypothetical quantity of PSOs hired under Alternative 2. The total workforce in the NSB, NAB and City of Nome is 12,461. 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.

Table 4.5-24 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		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 whether direct full-time employment benefits would materialize locally from the Action Alternatives. Companies like Shell and BPXA have committed to hiring local residents. Historically, few village residents have been employed despite their efforts of training programs and recruitment (MMS 2002). The NSB is actively advocating for the employment of Iñupiat people, but still sees room for improvement by the industry to train unskilled laborers (MMS 2002).

In general, employment and associated personal income increases would be at a relatively low level in exploration; they usually peak during development activities (MMS 2007a). 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. Native Corporations and private entities may capitalize on these opportunities.

Demographic Characteristics

Alternative 2 would not have a direct or indirect contribution 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 & Institutions

The implementation of Alternative 2 would result in relatively small revenues to Municipal Governments, primarily in 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 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 (see Section 4.4.3.2), the activities of non-profit organizations (see Table 3.3-6 in Section 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 is positive, but low, because total personal income and local employment rates are not increased by more than five percent. Revenues to the NSB would also not exceed five percent of their annual operating budgets. Standard mitigation measures could reduce interference between industry and subsistence activities and associated social impacts.

The duration of the socioeconomic impacts is temporary because it is not year-round. However, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are 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 communities. The summary impact level for Socioeconomics under Alternative 2 is minor.

4.5.3.2 Subsistence

4.5.3.2.1 Direct and Indirect Effects

The level of impacts on subsistence resources will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-25.

Table 4.5-25 Impact Levels for Effects on Subsistence

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Shift within seasonal subsistence use patterns	**Medium**: Seasonal change in subsistence use patterns	**High**: Year-round change in subsistence use patterns
Duration	**Temporary**: Changes in use patterns for one year or less	**Long-term**: Changes in use patterns for greater than one year to less than five years	**Permanent**: Changes in use patterns would occur longer than five years or persist after actions that caused the impacts ceased
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 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 or changes in 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; and
- Permitted discharges.

These sources of disturbance have distinct characteristics in their effects on marine mammal and other important subsistence resource species. In the next six 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 4.5-26 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 5. Detailed information regarding the seasonal cycles of subsistence resources and harvest patterns is described in Section 3.3.2.

Table 4.5-26 Description of Subsistence Hunts by Resource

Community	Bowhead whales	Beluga Whales	Seals	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 5)
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. 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, walrus, 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 bear 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, walrus, 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, walrus, 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 bear 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	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 walrus 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, walrus, 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.

Community	Bowhead whales	Beluga Whales	Seals	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 5)
	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.								Nearshore summer and late fall harvests for seals, 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 bear are harvested during the winter.
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.	Walrus 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, walrus, 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, walrus, 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 walrus migrate north past Point Lay, and the community conducts their annual hunt. Walrus 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.

Community	Bowhead whales	Beluga Whales	Seals	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 5)
									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, walrus, 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.
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 walrus 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	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 5)
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 and 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 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 4.5.2.4.9), noise from oil and gas exploration activities has been shown in certain instances to displace bowhead whales from certain habitat areas in the EIS proposed 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 subsistent 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.

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 spear. 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 Iñupiat 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 effects 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. The Arctic Multiple-Sale EIS (MMS 2008) states that in a March 1997 workshop on seismic-survey effects conducted 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."*

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.

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. 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. In addition, shutdown of exploration activities in the Chukchi Sea for Wainwright, Point Lay, and Point Hope bowhead whale hunts would be based on real-time reporting of whale presence and hunting activity rather than a fixed date. 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.

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. Mitigation is intended to reduce negative impacts occurring to subsistence hunting. Limitations of when activity can occur in the Beaufort Sea would continue at least until hunting 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 based on real-time reporting of whale presence and hunting activity rather than a fixed date. 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 correctly 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 4.5.2.4.9) 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 impact of disturbance to subsistence hunters is estimated to be of low intensity and temporary duration, i.e. for the duration of the seismic surveys and exploratory drilling activities offshore. These effects involve a resource that is unique in context, due to listing under the ESA. 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. Bowhead whales 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. The summary impact to subsistence harvest from disturbance of bowhead whales could be moderate.

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 negligible impacts on bowhead subsistence harvests.

Beluga Whales

Section 4.5.2.4.10 (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.

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). As reported by MMS (2008) *"Kivalina hunters have observed that belugas are intelligent and have learned to associate the sound of an outboard engine with danger. They report that Kotzebue hunters hunt with larger and faster boats, and the beluga have learned to go to deeper water when they hear the outboard engine noise from these faster boats. The implication is that belugas retain their experiences with high-speed boats in Kotzebue Sound, making them more wary of hunters in boats with outboard motors, as they migrate northwestward toward Kivalina. Belugas are known to avoid hunters in boats with outboards in Cook Inlet and Kotzebue Sound and can recognize the sound of individual motors used to capture them near Point Lay for satellite-tagging studies."*

In addition, 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. 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 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 duration, occurring for the duration of the activities offshore, 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 in the Arctic are not listed under the ESA, but 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. The summary impact to subsistence harvest from disturbance of belugas could be minor to moderate.

Seals

Bearded, ringed, and spotted seals comprise a large portion of subsistence harvest (predominately in the Chukchi Sea communities) and could be affected by seismic and high resolution shallow hazard surveys, including on-ice seismic surveys and exploratory drilling activities. Section 4.5.2.4.12 (Pinnipeds) 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. Subsistence hunts of seals occur either in nearshore coastal areas or onshore in the spring and winter seasons when seismic survey and exploratory drilling would not be conducted. Most ringed and bearded seals are harvested in the winter or in the spring before the proposed 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 any subsistence use areas. Activities within the lease areas offshore 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 walrus could occur during the summer months if seismic and high resolution shallow hazard surveys and exploratory drilling operations were conducted when walrus are present. Section 4.5.2.4.13 (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 walrus. Should walrus leave or abandon areas where they could be harvested by subsistence hunters, then subsistence harvest patterns would be affected.

Impacts of disturbance to walrus 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 to important in context. The summary impacts of disturbance to subsistence harvest of walrus are negligible.

Polar Bears

Section 4.5.2.4.14 (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 2D/3D 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. 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. As a result there are no anticipated effects of disturbance to subsistence fishing.

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 of the vicinity of these sound sources by fish but would not result in adult fish mortality or other population effects.

Fishing by residents of the Beaufort Sea communities occurs at inland fish camps 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. 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 and the timing of subsistence bird harvests. 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 mammals hunts when seismic and high resolution shallow hazard surveys and exploratory drilling activities would not be occurring. As subsistence harvesting would occur in areas close to shore, no effects of disturbance from noise are anticipated.

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 coast line and would be expected to be unaffected 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 bird harvest and egg gathering harvest. Therefore no impact is anticipated.

Caribou

No effects from 2D/3D 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 2D/3D 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 4.5.2.4.9 (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 in duration. Effects of the impact would be local, affecting a resource that is unique in context. The summary impact 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 4.5.2.4.10 (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 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 though temporary in duration and occur 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 in Mitigation Measure D1. Additional Mitigation Measure B1 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 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 and 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, though mitigation measures are expected to lessen the extent of disturbance, which would be considered low in intensity, temporary in duration, and localized to a very specific area along the helicopter flight path affecting a unique resource. Mitigation measures are expected to minimize or altogether avoid impacts to beluga whales and their subsistence harvest. The summary impact to subsistence harvest from aircraft disturbance of belugas could be minor to moderate.

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 4.5.2.4.12 (Pinnipeds) 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 D1 on 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 3.3.7). 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. Seal hunting occurs primarily in the winter and spring and would not be expected to occur at higher levels during the open water season when seismic and high resolution shallow hazard surveys and exploratory drilling would be active. 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.

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 to important in context. The summary impact is considered negligible.

Pacific Walrus

Walrus could react to aircraft overflights by stampeding into the water when they become disturbed while ashore at haul out sites. During a stampede the calves would be the most vulnerable to trampling mortality. Brueggeman (et al. 1990) observed reactions of walrus 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 walrus hauled out on land or ice were more sensitive to overflights (Brueggeman et al. 1990). The implications to subsistence hunters could be that repeated overflights cause disturbance at haul outs sites and limit 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 4.5.2.4.13 (Pacific Walrus) of this EIS.

Limited numbers of walrus are likely to be present in the central and eastern Beaufort Sea. In the Chukchi Sea walrus would not be expected to haul out in large concentrations during the open water period when seismic and high resolution shallow hazard surveys and exploratory drilling would occur. Instances where walrus occur near these presumed activities would be infrequent.

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 walrus 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 summer.

Aircraft overflights are unlikely to have an adverse effect on walrus availability for subsistence harvest. Impacts that would 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 summary impact is considered negligible.

Polar Bears

The responses of polar bears exposed to aircraft overflights are likely to be that a bear initially moves away 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 4.5.2.4.14 (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 localized 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 measure D1 on 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, though affecting a resource that is unique in context, due to its listing under the ESA. The summary impact is considered minor.

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. 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.

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 of 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. Impacts that did occur to subsistence hunting and egg collecting would be of low intensity and temporary duration. Impacts would be local and affect resources that are common and /or important in context. The summary impact is considered to be minor.

Caribou

Effects to caribou could range from no response or 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 normal 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, the ducks"* – 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.

The impacts to subsistence hunters would be considered of low intensity and temporary in duration. Effects of the impact would be local and affecting a resource that is common in context. Subsistence hunters could perceive increased levels of aircraft traffic as disruptive and intrusive in subsistence areas, resulting in hunters avoiding affected areas.

Aircraft overflights are unlikely to have an 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 summary impact is considered minor.

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 4.5.2.4.1 (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 these 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 sealskins. 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.

Mitigation measures could lessen these impacts as vessels for seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels would not enter the Chukchi Sea until after July 1 when most of the spring bowhead migration is complete. 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) and 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. 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 in duration, local in extent, and affecting a resource that is unique in context. The summary impact could be considered minor to moderate.

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 4.5.2.4.10 (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. However under mitigation measures for vessels transiting through the Bering Straits into the Beaufort and Chukchi seas for seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels, traffic would not occur before July 1 after the majority of the spring beluga hunting is completed in the Chukchi Sea villages. The impact to late migrating beluga whales that do encounter vessels would be of low intensity, temporary duration, local extent, and affecting a resource that is unique in terms of the context. The summary impact could be considered minor to moderate.

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 4.5.2.4.12 (Pinnipeds) 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. The majority of seal subsistence hunting occurs in the spring and winter seasons when vessels associated with seismic and high resolution shallow hazard surveys and exploratory drilling would not be expected to be present in subsistence harvest areas. With spatial and seasonal separations, the impact to subsistence seal harvest would be of low intensity, temporary duration, local extent, and affecting resources that are important in context. The summary impact could be considered negligible to minor.

Pacific Walrus

Information on the impacts of vessel sounds to Pacific Walrus associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.13 (Pacific Walrus) of this EIS. Effects to walrus 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, walrus may also exit the water or approach vessels out of curiosity. Walrus that avoid vessel traffic may affect subsistence harvest by becoming less readily available for subsistence harvest.

Walrus 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 duration, local extent, and affecting a resource that is important in terms of the context. The summary impact could be 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). 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 these proposed activities are being conducted. Under 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 unique in context, due to listing under the ESA. The summary impact could be considered minor.

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 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.

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 short term, occurring only as long as the activity takes place, and affecting only localized 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. 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 summary impact could be 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 duration, local extent, and affecting a resource that is common in context. The summary impact could be 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. 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 nonexistent and visibility is reduced.

Ice management activities would introduce less noise into the marine environment than full on 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. 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 4.5.2.4.9 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 2010). 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 mitigation measures limit the time frame in which these activities occur. 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.

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 by making the whales divert from normal migratory paths and thus become less readily available for harvest. The avoidance by the whales 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. However, many 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 could not occur until after fall whaling is complete. 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, short term in duration, local in extent, and affecting a resource that is unique in context. This would be considered a minor summary impact.

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, short term in duration, local in extent, and affecting a resource that is unique in context. This would be considered a minor summary impact.

Beluga Whales

Beluga whales are reported to be extremely sensitive to icebreaking (Section 4.5.2.4.10). 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 since then” - Inoke 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. There is a low probability that impacts could occur to subsistence users from late season activities. Some operators have recently proposed to conduct seismic surveys requiring icebreaking 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 mitigation measures limit the time frame in which these activities occur. 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. The majority of these types of in-ice surveys requiring icebreaking would occur after the completion of harvests in the Beaufort and Chukchi seas. In the event that icebreaking does cause beluga whales to avoid an area, the impact to subsistence resources is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is important in context. This would be considered a minor summary impact.

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 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.

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 or absent and visibility is reduced making seals more difficult to spot. At this time of year sealing efforts for subsistence are not a concentrated or intensive activity. Icebreakers could potentially collide with seals hauled out on the ice (Section 4.5.2.4.12). The probability of icebreakers colliding with seals and having lethal effects on populations of seal 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, short term in duration, and local in extent, and affecting resources that are common to important in context. This would be considered a negligible summary impact.

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 offshore 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 end, so there would be few seals expected in the area where the proposed activities would be occurring. 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, short term in duration, and local in extent, and affecting resources that are common to important in context. This would be considered a negligible summary impact.

Pacific Walrus

Icebreaking activities could cause walrus to avoid the areas where these activities would be occurring (Section 4.5.2.4.13). Walrus that are hauled out or feeding when icebreaking is occurring could be affected by avoiding the area. In areas where subsistence hunting occurs for walrus, avoidance of the area could lead to reduced availability of this resource to hunters and reduced harvests. Given the dispersed distribution of walrus on the ice and the short time period and limited geographic extent of icebreaking activities authorized under Alternative 2, it is unlikely that many walrus 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 does cause walrus to avoid a subsistence use area and reduces the success of harvest, the impact to subsistence resources is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is important in context. This would be considered a negligible summary impact to subsistence harvest of walrus.

Ice management activities, and associated vessel traffic, would not likely be conducted in offshore waters that are subsistence use areas for this species. Mitigation measures are expected to avoid and minimize impacts on walrus subsistence harvest so that no unmitigable adverse impacts occur. There is a low probability that impacts could occur to subsistence users. In the event that ice management activities cause walrus to avoid a subsistence use area and reduce the success of the harvest, the impact to subsistence is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is important in context. This would be considered a negligible summary impact to subsistence harvest of walrus.

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 4.5.2.4.14). 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, short term 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 offshore 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, short term 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.

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 only minutes, 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 are considered of low intensity, temporary duration, local extent, and affecting resources that are common in context. The summary impact would be considered negligible.

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. Birds could avoid or be attracted to the activity. 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. 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. 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 summary impact 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 4.5.2.4.12 (Pinnipeds) 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 important in context. No unmitigable adverse impacts are expected to occur. The summary impact 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 walrus are not present. Therefore, no impacts to walrus subsistence harvest from on-ice seismic surveys are expected to occur.

Polar bears

Section 4.5.2.4.14 (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. No unmitigable adverse impacts are expected to occur. Therefore, impacts 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 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 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 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 General Permits. The impacts of a major oil spill are discussed in Section 4.9.6.15 and 4.9.7.15. Permitted discharge could 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, marine mammals, and eventually the diets of subsistence users.

These 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, resulting in impacts to human health from consumption of the resources. The likelihood of subsistence resources occurring in the vicinity of the likely areas where drilling and/or any associated discharge or minor spills could occur is low as these activities would occur at a time when subsistence hunts are not occurring in areas that are offshore and removed from known hunting areas. In addition, fuel transfers 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. The impacts to subsistence users would be of low intensity, short term duration, local extent, and affecting resources that are common to unique in context.

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 has the potential to result in major impacts on subsistence resources. For example, if bowhead whales are repeatedly deflected away from their migration path, there could be adverse impacts, including the unavailability of whales for subsistence harvest. In the absence of the proposed mitigation measures, the impacts of disturbance and disruption of subsistence resources and harvest patterns would be considered major. However standard mitigation measures 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 will be 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 significantly alter the existing levels of harvest.

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. 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. 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 in duration (i.e. not expected to endure more than one season). Impacts would be local to regional in extent and would affect resources that range from common to important, and in the case of protected species unique, 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 this 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, temporary in duration (less than one year), local to regional in extent (in view of sharing practices), but affecting a resource that is unique in context. As a result, this summary impact would be considered moderate. A complete failure to harvest any bowhead whales, due to disruptions attributable to Alternative 2, would be an impact of major intensity, but the probability of this is considered very low. 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 moderate, depending on the species. The summary impact to belugas is considered minor to moderate. 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 subsistence resources 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.

Aircraft overflights are unlikely to have an adverse effect on subsistence harvests. Impacts that did occur would be considered low in intensity but temporary in duration. Effects of the impact would be local and affecting resources that are common to unique 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 to moderate. The summary impact to seal and walrus harvest are considered negligible. The summary impacts to polar bears, marine and coastal birds and caribou are considered minor. No impacts of disturbance are anticipated to subsistence harvests of fish,

Impact of Vessel Traffic to Subsistence Resources

The summary impact of vessel traffic on subsistence harvest of bowhead and beluga whales is expected to be minor to moderate. The summary impact to subsistence harvest from vessel traffic on seals and walrus is considered negligible to minor. The summary impact to subsistence harvest of polar bears is considered minor. Negligible summary 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

Summary impacts to bowhead whales, beluga whales, and polar bears from icebreaking and ice-management activities are expected to be minor. Summary impacts to seals, walrus, fish, and bird hunting and egg gathering from icebreaking are expected to be negligible. No impacts to caribou or caribou hunting are expected.

Impact of On-ice Seismic Surveys to Subsistence Resources

No impacts are anticipated subsistence harvests of bowhead whales, beluga whales, Pacific walrus, 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 would be negligible. The summary impacts to polar bears could be minor.

Indirect Impact to Subsistence Resources from Permitted Discharges

The impacts to subsistence users would be of low intensity, short term duration, local extent, and affecting resources that are common to unique in context. Therefore the summary impact to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

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 measures to address non-acoustic impacts, acoustic impacts, and other impacts.

C4. Oil Spill Response Plan.

Operators are required to have a plan(s) in place that: a) minimize the likelihood of a spill; b) outline the response protocol in the event of a spill; and c) identify the means of minimizing impacts to marine mammals following a spill.

This is one of several measures for drilling operations that are intended to reduce/lessen non-acoustic impacts on marine mammals that are common to all communities. This mitigation measure would be applied to Alternatives 2 to 5 and would require operators to have plans in place that:

a) minimize the likelihood of a spill;
b) outline the response protocol in the event of a spill; and
c) identify the means of minimizing impacts to marine mammals following a spill.

The activities affected by this mitigation measure would be exploratory drilling activities. Under this mitigation measure, each operator is required by BOEM to prepare an oil spill response plan for any facilities seaward of the coastline, develop a worst-case-discharge (WCD) scenario and possibly be required to stage spill response equipment near areas of concern to facilitate more rapid deployment to protect critical resources and limit exposure to oil.

The effective implementation of these measures faces important practical limitations and challenges in Arctic conditions. At present, the USCG does not have the capabilities (vessels or year round physical presence) to respond to an oil spill in the Arctic, so the responsibility of first response and response planning falls on the industry performing the activity. While this mitigation measure requires an emergency response plan, WCD scenarios, and response equipment to be available and immediately implemented, inclement weather and safety hazards to personnel may limit the ability of industry and oil spill removal organizations and service companies to rapidly deploy personnel and equipment to protect areas of concern close to shore. The local communities are unlikely to be able to rapidly deploy sufficient sized teams or infrastructure (small vessels) to a WCD scenario in terms of providing additional responses.

Standard Mitigation Measure C4 would put in place procedures for response to a WCD that would attempt to reduce impacts to subsistence resources and harvests in the event of an oil spill. In the event of a WCD, areas may be closed for subsistence harvest, and marine mammals and terrestrial wildlife could be hazed from areas where harvest occurs. In this case, the result would be a loss of opportunity for subsistence harvest or the contamination of resources/foods.

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 or around August 25.

This mitigation measure applies to the communities of Kaktovik and Nuiqsut to ensure no unmitigable adverse impacts occur to the subsistence harvest of bowhead whales for these two communities. 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. 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. Activities that would be affected by this mitigation measure include: 2D/3D Seismic and CSEM Surveys with associated icebreaking; Site Clearance and High Resolution Shallow Hazards Surveys; and Exploratory Drilling Activities. For a detailed description of the specific areas that would be affected by this mitigation measure refer to Section 4.5.2.4.9 (Bowhead Whales) and Appendix A.

This mitigation measure is intended to ensure that no unmitigable adverse impacts to subsistence users of Kaktovik and Nuiqsut occur as a result of the activities permitted by this EIS. As a result of the restrictions incorporated into this mitigation measure, industry activity would not occur until after the fall bowhead hunt is considered 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. 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. This mitigation measure may be reduce impacts to subsistence whalers at Barrow as it would limit the potential for disruption of 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?"*

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.

Mitigation Measure D2 requires the 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. Activities that would be affected are 2D/3D Seismic and CSEM Surveys, including associated icebreaking; Site Clearance and High Resolution Shallow Hazards Surveys; and Exploratory Drilling Activities. For a detailed description of how this mitigation measure would ensure no unmitigable adverse impacts to subsistence resources refer to Section 4.5.2.4.9 (Bowhead Whales) and Appendix A.

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 this mitigation measure 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 will be updated to incorporate new requirements for effective communications and consultation with the communities. The effectiveness of Mitigation Measure D2 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, 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.

Willie Goodwin, representing the Alaska Beluga Whale Committee made comments at the Kotzebue Public Scoping Meeting for this EIS on February 18, 2020: *"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."*

D3. Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

This mitigation measure applies to the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, and Kivalina to ensure no unmitigable adverse impact to subsistence uses occur to the subsistence harvest of bowhead whales for these seven communities. Mitigation Measure D3 sets forth the flight altitudes and paths (offset distances) for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Activities that would be affected are: 2D/3D Seismic and CSEM Surveys, including associated icebreaking; Site Clearance and High Resolution Shallow Hazards Surveys; and Exploratory Drilling Activities. Implementation of this mitigation measure requires that vessels and aircraft avoid concentrations or groups of whales. Operators shall, at all times, conduct their activities at a maximum distance from such concentrations of whales. For a detailed description of the aircraft flight altitudes permitted under this mitigation would ensure no unmitigable adverse impacts to subsistence resources refer to Section 4.5.2.4.9 (Bowhead Whales) and Appendix A.

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.

This mitigation measure is intended to ensure no unmitigable adverse impacts occur to subsistence users from the anticipated increases in levels of aircraft overflights during seismic and high resolution shallow hazard surveys and exploratory drilling operations. However, 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.

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 or 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 4.5-25, 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 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 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.

4.5.3.2.5 Additional Mitigation Measures for Subsistence

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.

This measure is targeted at reducing potential disturbance to feeding habitats of bowhead whales; therefore, would reduce potential adverse effects from disturbance on bowheads and lessen any adverse impacts to subsistence harvests. This measure may be costly to industry, as bowhead feeding time is at the same time as proposed industry operations because both are using the area during the ice-free months.

Camden Bay: minimizing surface vessel and aircraft disturbance of feeding and resting whales.

- Bowhead whales: September 1 to October 15 for primary migration and feeding (Huntington and Quakenbush 2009, Koski and Miller 2009, Quakenbush et al. 2010a)
- Subsistence (bowhead whale hunting): late August to early October (Huntington and Quakenbush 2009)
- Except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations shall avoid travel within Camden Bay during dates determined by real-time reporting of whale presence and hunting activity rather than a fixed date.

Barrow Canyon and the Western Beaufort Sea: minimizing surface vessel and aircraft disturbance of feeding and resting whales.

- Bowhead whales: late August to early October
- Beluga whales: mid-July to late August
- Except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations shall avoid travel within the Barrow Canyon area from September 15 to the close of the fall bowhead whale hunt in Barrow.

This measure is targeted at reducing potential disturbance to feeding habitats of bowhead whales; therefore, would reduce potential adverse effects from disturbance on bowheads. This measure may be costly to industry, as bowhead feeding time is at the same time as proposed industry operations because both are using the area during the ice-free months. This measure could reduce impacts to subsistence hunters as it would limit the levels of vessel traffic and aircraft overflights at times when subsistence activities are occurring and therefore lessen the potential for disruption or displacement of this subsistence resource in critical areas. For example in the Beaufort Sea after the fall bowhead whale hunt, the subsistence activities of the Iñupiat of Nuiqsut and Kaktovik move from the coast to the interior, with subsistence hunters using the foothills south of Deadhorse. Relocating helicopter routes away from seasonal subsistence use areas could reduce impacts to subsistence harvesters and effects on inland subsistence activities in the remote likelihood that bad weather required flights to travel at a lower altitude.

Additional Mitigation Measure C1. Vessels and aircraft avoidance of concentrations of groups of ice seals, walrus, and polar bears.

Additional Mitigation Measures C1 would require operators to avoid groups of certain marine mammals and to restrict vessel transit routes in areas where marine mammals may occur in high densities. While these measures are not directly related to reducing impacts on subsistence activities, by avoiding groups of marine mammals or areas where they occur in high densities, impacts to those species would be reduced, thereby reducing potential impacts on subsistence hunts of those species. Activities that would be affected include: 2D/3D Seismic, In-Ice Sesimic, and CSEM Surveys, including associated icebreaking; Site Clearance and High Resolution Shallow Hazards Surveys; and Exploratory Drilling Activities.

Additional Mitigation Measure C2. Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Additional Mitigation Measure C2 would require exploration vessels to use unspecified designated shipping lanes while in transit to avoid concentrations of marine mammals. A designated route would result in less disturbance to animals in those important habitats. However, as seismic activities often cover wide regions, particularly for the 2D non-lease sale areas, a designated route may be difficult to establish. As long as routes are the same year to year, vessels should have no problem in avoiding these areas, although it may result in increased transit time for some. Vessels in the Chukchi Sea have been avoiding the Ledyard Bay Critical Habitat Unit (for spectacled eiders), so they are used to transiting around designated areas. Therefore, it is anticipated that this additional mitigation measure would result in reduced disturbance to bowhead whales feeding areas and in turn reduce impacts for subsistence users.

Additional Mitigation Measure C3. Requirements to ensure reduced discharge of the specific discharge streams identified with potential impacts to marine mammals or marine mammal habitat.

Additional Mitigation Measure C3 would set forth requirements to ensure reduced discharge of the specific discharge streams identified with potential impacts to marine mammals or marine mammal habitat during exploratory drilling activities. This would include mitigating the discharge of drill cuttings, drilling fluids, sanitary wastes, bilge water, ballast water, and domestic water (i.e. grey water).

Additional Mitigation Measure C4. Operators are required to recycle drilling muds.

Additional Mitigation Measure C4 would require operators to recycle drilling muds (e.g. use those muds on multiple wells) based on operational considerations to reduce discharges. The activity affected by this measure would be exploratory drilling.

Additional Mitigation Measures C3 and C4 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. Mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources. As shown in scoping comments and other testimony, contamination of subsistence foods is a major concern of the Iñupiat people. There is concern that drilling muds could be carried beyond a localized area by currents, and there is concern that water pollution could cause toxins to bioaccumulate in subsistence resources:

"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. We don't have enough information in that area" - Rosemary Ahtuangaruak of the Iñupiat Community of the Arctic Slope on March 11, 2010 at Nuiqsut Scoping Meeting for this EIS.

Additional Mitigation Measure C5. Use trained seal-lair sniffing dogs for areas with water deeper than 3 m (9.8 ft) depth contour to locate seal structures under snow in the work area and camp site before initiation of activities.

This mitigation measure is intended to reduce/lessen non-acoustic impacts on marine mammals and could be applied to all of the communities by requiring use of trained seal-lair sniffing dogs for areas with water deeper than 3 m (9.8 ft) depth contour to locate seal structures under snow in the work area and camp site before initiation of activities. The activity affected by this measure would be on-ice seismic surveys. This mitigation measure would reduce the likelihood of disturbance of seals in areas of subsistence harvest during on-ice seismic surveys.

Additional Mitigation Measures D1 through D8 are intended to ensure no unmitigable adverse impact to subsistence uses. A description of which communities would be affected by these measures follows. Please refer to Section 4.5.1.3.1 (Bowhead Whales) and Section 4.5.2.4.10 (Beluga Whales) and Appendix A for the full description of each measure and the impacts to these resources. For Additional Mitigation Measures D1 through D7, the activities that would be affected include: 2D/3D seismic surveys; site clearance and high resolution shallow hazards surveys; and exploratory drilling activities. Only exploratory drilling activities would be affected by Additional Mitigation Measure D8.

Additional Mitigation Measure D1. No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay.

This additional mitigation measure is targeted to minimize conflict with the 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.

Additional Mitigation Measure D2. 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.

This additional mitigation measure is designed to avoid conflict with the subsistence hunt in the nearshore region, but would also reduce the potential for vessel disturbance to marine mammal subsistence resources hunted near Nuiqsut and Kaktovik.

Additional Mitigation Measure D3. 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 is designed to avoid conflict with the subsistence hunt and give both the hunters and companies flexibility in when they stop activities in the Barter Island and Cross Island regions (Kaktovik and Nuiqsut hunts). As the hunters commence whaling activities, the exploration activity would move out of the area. Therefore, there would be less disturbance to bowhead whales from exploration activities, but whaling activities also result in disturbance to the animals.

Additional Mitigation Measure D4. Shutdown of exploration activities in the Beaufort Sea for the Barrow bowhead whale hunts from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.

Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area and affect hunters in Kaktovik, Nuiqsut and Barrow.

Additional Mitigation Measure D5. 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.

Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area.

Additional Mitigation Measure D6. Shutdown of exploration activities in the Chukchi Sea for the Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area.

Additional Mitigation Measure D7. Transit restrictions into the Chukchi Sea modified to allow offshore travel under certain conditions (e.g. 32 km [20 mi] from the coast) if beluga whale, fall bowhead whale (Barrow and Wainwright), and other marine mammal hunts would not be affected.

Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area.

Additional Mitigation Measure D8. 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 until the close of the bowhead whale hunt in Barrow.

Potential impacts from this mitigation measure would be the same as described for Additional Mitigation Measure D3 but would apply to this particular area.

Collectively, Additional Mitigation Measures D1 through D8 could be required for issuance of every ITA and are intended to ensure no unmitigable adverse impacts occur to subsistence uses of marine mammals within the various communities to which they could be applied. The efficacy of previous similar mitigation measures is described by subsistence hunters who have reported the following observations:

> *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.

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, local to regional in geographic area, temporary in duration and range from common to unique in context. The effects of Alternative 2 to subsistence resources with additional mitigation measures applied would therefore be considered to range from no impact to minor depending on the specific subsistence resource affected and the source of disturbance.

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 4.5-27.

Table 4.5-27 Impact Levels for Effects on Public Health and Safety

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Affects one health indicator in a single community	**Medium**: Affects multiple communities or multiple health indicators in a single community	**High**: Affects multiple health indicators in multiple communities throughout the region
Duration	**Temporary**: Changes in health indicators last for less than one year	**Long-term**: Changes in health indicators extend up to several years	**Permanent**: Changes in health indicators persist after actions that caused the impacts 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 4.5-2 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. 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.

Summary

Activity levels pursuant to Alternative 2 are not expected to have a significant 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.

Although the activities resulting from Alternative 2 are not anticipated to result in meaningful changes in the success of harvests, a community that is dependent on single species would be more susceptible to food insecurity should dispersion of that species result in an unsuccessful hunt.

The potential for diet and nutrition to be affected via increased income to hunters is discussed below under *Economic Impacts*. The potential for diet and nutrition to be affected via perceived safety of subsistence foods is discussed below 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 polycyclic aromatic hydrocarbons (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, walrus and polar bear. The range of contaminants examined has included polychlorinated biphenyls (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 accidental 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 4.9), 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 will 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 significant change in acculturative stress in Barrow and will 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 will 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 significant 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 will 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 significantly 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 will minimize this risk, and the overall risk can be classified as minor.

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 and their families 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 increase 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 will 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 will 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 4.5-28 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	Permanent: changes in health indicators persist after actions that caused the impacts 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 permanent, and multiple communities could be affected.

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. Because cultural resources inventories have not been completed for the entire project area, it is not possible to identify all potential impacts to cultural resources in this environmental analysis. 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 (i.e. 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 of May 2011, the State has 360,435 acres on 189 leases in the Beaufort Sea. Exploratory activities (drilling and seismic surveys) could occur in any of these active state leases within the five year period beginning in 2012. The State of Alaska plans to conduct area-wide lease sales in the Beaufort Sea annually through 2015, potentially adding new areas where exploratory activities could occur. Industry activities on State of Alaska Beaufort Sea leases in the recent past have largely been concentrated offshore between Harrison Bay and Bullen Point.

Exploratory activities will 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 ocean-bottom cable (OBC) or ocean bottom node (OBN) seismic surveys. OBC and OBN surveys are used primarily to acquire seismic data in transition zones where water is too shallow for a towed marine streamer seismic survey vessel and too deep to have grounded ice in the winter. An OBC operation begins by laying cables off the back of a layout boat, using cable 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 cable in intervals of 12 to 50 m (39 to 164 ft). Multiple cables are laid on the seafloor parallel to each other, with a cable spacing of between hundreds of meters to several kilometers, depending on the geophysical objective of the seismic survey. When the cable is in place, a vessel towing the source array passes over the cables 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.

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 (i.e. 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 will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-29.

Table 4.5-29 Impact Levels 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**: Disturbances in cultural resources last less than one year	**Long-term**: Disturbances in cultural resources extend up to several years	**Permanent**: Disturbances in cultural resources persist after actions that caused the impacts 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
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. There could also be various forms of indirect 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 indirect 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. 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.

4.5.3.4.2 Conclusion

Compliance with existing federal, state, and local archaeological regulations and policies and the application of BOEM's Drilling Stipulation 6 (regarding the discovery of archaeological resources) and 30 CFR 551.6 (a)(5) regarding G&G Explorations of the Outer Continental Shelf and the provision to avoid disturbing archaeological resources, will reduce or eliminate most impacts to archaeological resources. Therefore, no impacts or only minor impacts to archaeological resources are anticipated. To ensure compliance, prior to exploratory drilling of a well, companies are required to conduct shallow hazards surveys to detect archaeological resources, as well as to measure water depth, seafloor morphology, potential shallow faults or gas zones, and depth and distribution of ice gouges in the seabed. These shallow hazards surveys are also used to evaluate the near-surface geology, to locate shallow hazards, obtain engineering data for drilling or placement of structures (platforms and pipelines), and detect certain types of benthic communities. These surveys may be collected over portions of individual lease blocks or several contiguous lease blocks depending on the exploration targets of the company. These surveys would typically need to be completed at least one season 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 long-term in duration, but in a very localized 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 will be 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

Because 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, no direct or indirect change in underlying land or water ownership is anticipated. This includes federal waters (from 3 to 200 nm), the Arctic National Wildlife Refuge (ANWR), the National Petroleum Reserve-Alaska (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

Because 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, no direct or indirect change in underlying land or water ownership is anticipated. 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 is not influenced by the implementation of this project alternative.

Private Ownership

Because the project does not involve any ANCSA corporation lands or Alaska Native allotments, 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 will 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 is not influenced by the implementation of this project alternative.

Borough and other Municipal Lands

Because the project does not involve or facilitate the sale or transfer of borough or municipal lands, 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 will result. This includes lands owned by the NSB and the NAB. No change in ownership is anticipated for any other municipal lands. Municipal land selections have already been established, and their conveyance is not influenced by the implementation of this project.

4.5.3.5.2 Conclusion

Based on Table 4.4-2, and the analysis provided above, the impacts on land and water ownership under Alternative 2 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no changes in ownership or development rights will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership are considered to be negligible;

they would be low intensity, temporary, localized, and result in no change of ownership or development rights.

4.5.3.5.3 Direct and Indirect Effects of Land and Water Use

Recreation

Recreation occurs at generally low levels of use in the EIS project area. Key recreational activities include wildlife viewing and sightseeing from the air. Because seismic exploration is already occurring in the EIS project area, 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 4.7.3.7.

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 A. 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 4.7.3.2.

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 impact is 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 any new permanent residents needing 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 in the EIS project area.

Protected Natural Lands

An increase in seismic exploration activity under Alternative 2 would have no expected direct or indirect impacts on critical habitat, wilderness areas, or other land used for ecological reasons; the land use is removed from areas of offshore seismic activity and exploratory drilling. The primary potential for land use conflict would be associated with marine vessel and air traffic associated with crew changes and other support activities. Any 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.

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, increase 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 will 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. See Socioeconomic Section 4.5.3.1 for further discussion on employment opportunities under this alternative.

4.5.3.5.4 Conclusion

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 permanent 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 long term structures in smaller communities.

4.5.3.5.5 Direct and Indirect Effects of Land and Water Management

Federal Lands 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. Currently, the U.S. Fish and Wildlife Service is updating the Comprehensive Conservation Plan for the Arctic National Wildlife Refuge, with a final revised plan expected to be released during the summer of 2012 (USFWS 2011b), and the Bureau of Land Management is updating the Integrated Activity Plan/Environmental Impact Analysis for the National Petroleum Reserve-Alaska, with the first draft scheduled for early 2012 (BLM 2011). Because seismic surveys, exploratory drilling and leasing activities have been ongoing in the Beaufort and Chukchi seas for over 30 years, 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. However, both documents are in draft form, and there is a chance that the information generated in this EIS could result in additional mitigation measures affecting the management of exploratory drilling activities in the Records of Decision of those documents. 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 Lands and Waters 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 is anticipated as a result of this alternative. This includes state waters (shore to the 3 nautical mile limit), Area Plans, and lands subject to oil and gas lease sales.

Borough and other Municipal Lands

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 3.3.6 Coastal Management, the Alaska Coastal Management Program was not reauthorized by the State legislature and is no longer in effect. The NSB and NAB may recommend mitigation measures and permit/authorization conditions in response to new land based projects proposed within its jurisdiction.

4.5.3.5.6 Conclusion

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 temporary 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 localized 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 are low intensity, would be 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 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 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**: Changes in transportation volume last less than one year	**Long-term**: Changes in transportation volume extend up to several years	**Permanent**: Changes in transportation volume persist after actions that caused the impacts 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 3.3.7. 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 five-year analysis window (2012 to 2017). 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 support (SAR), 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 littering 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 (i.e. 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.* - 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.* - 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 3.3.7. 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 2D/3D 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 2D/3D 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' five-year analysis window (2012 to 2017). Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions of increased vessel traffic related to exploratory drilling in the Beaufort Sea are as follows:

- For each exploratory drilling program, a drillship or conical drilling unit (CDS) 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 or CDS 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 or CDS (under tow) and associated support vessels will exit the area by traveling west into and through the Chukchi Sea. As an alternative, the CDS, if used, could be towed to the Canadian Beaufort for the winter.

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 levels of air traffic in the regional air transportation system. However, the increase in the levels of air traffic to regional transportation would be of low intensity, and the duration would be temporary (length of survey or exploratory drilling activities each year). 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, temporary effect on a resource that is common in context. Increased vehicle traffic on local roadways would also be characterized as temporary, 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 as a result of implementation of Alternative 2 would be a direct impact to the existing levels of vessel traffic in the Beaufort and Chukchi seas. Considering the required and additional mitigation measures, direct impacts from increased vessel traffic in these seas would be temporary and occur regionally. The intensity of increased marine vessel traffic is considered low, as it would be temporary in duration, local in extent, and common in context. Industry vessel traffic associated with Alternative 2 would occur in areas that are largely offshore, within a specific region and are considered 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, temporary duration, 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 will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-31.

Table 4.5-31 Impact Levels 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 year	**Long-term**: Changes in recreation setting or activities extend up to several years	**Permanent**: 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

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. If a visitor was expecting a fairly isolated and undeveloped recreation setting, the presence of industrial vessels or drilling rigs could alter the experience of the setting or the sense of place (Williams & Stewart 1998), as expectations of the setting would not be met. The expectation for an isolated and undeveloped setting could be held by people traversing the project area in personal pleasure boats or yachts. Visual impacts are discussed in further detail in Section 4.4.3.8.

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 activities are generally engaged in by residents of local communities, and levels of activity are low; little impact is expected on levels or types of recreation use. Recreation activities could also be displaced; recreationists may avoid seismic survey and exploratory drilling programs, choosing instead to recreate someplace else to avoid project activities.

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 temporary 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 temporary; 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, temporary 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 will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-32.

Table 4.5-32 Impact Levels for Effects on Visual Resources

Impact Component	Effects Summary		
Magnitude or Intensity	**High**: Acute or obvious disturbance in visual resources	**Medium**: Noticeable disturbances in visual resources	**Low**: Disturbances in visual resources may not be measurable or noticeable
Duration	**Permanent**: Disturbances in visual resources persist after actions that caused the impacts cease	**Long-term**: Disturbances in visual resources extend up to several years	**Temporary**: Disturbances in visual resources last less than one year
Geographic Extent	**State-wide**: Affects visual resources beyond a regional scale	**Regional**: Affects visual resources on a regional scale	**Local**: Affects cultural visual only locally
Context	**Unique**: Affects unique visual resources or resources protected by legislation	**Important**: Affects visual resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary visual resources; not 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.

Indicators used to measure potential impacts to visual resources that may result from the proposed project included:

- Impacts to visual resources, measured by the estimated level of visual contrast created by the project; and
- Expected temporary change in the distribution of scenic resources, as measured by temporary change in scenic quality class.

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. Because 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.

At each Scenic Quality Rating Unit (SQRU), existing landforms, vegetation, and structures were 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.

Temporary change in Scenic Quality Class was measured by estimating the Scenic Quality Score for each action alternative and comparing that value to the baseline Scenic Quality Score established in Section 3.3.9 (Table 3.3-46).

An overall impact determination was made based on the anticipated contrast, change in Scenic Quality Rating, 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 deviations in the landscape character are not expected to result in a reduction of Scenic Quality Class; where project design is consistent with existing planning goals, temporary, and/or where sensitive 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 deviations in the landscape character are expected to result in a reduction of Scenic Quality Class; where project design is not consistent with existing planning goals, temporary or long-term, and where sensitive 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 deviations in the landscape character are expected to result in a reduction of Scenic Quality Class; where project design is not consistent with existing planning goals, long-term, and where sensitive 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 short term and will not extend beyond the life of the EIS (5 years).

- The assessment of short-term 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), short-term construction-related impacts do not pertain to these actions and are not considered in this analysis.
- The assessment of short-term impacts that may result from decommissioning of the proposed project was limited to structures associated with exploratory drilling. Because open water / on-ice seismic surveys and hazard surveys are not reliant on any facility or related infrastructure (i.e. artificial islands, jackup rigs), it is assumed that potential impacts related to decommissioning of the project do not pertain to these actions and are not considered in this analysis.
- For the purposes of this analysis and for comparison of alternatives, indirect effects are not considered in this analysis. 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 ice-islands if obtained from on-land quarries. It is further assumed that no new quarries would be constructed to support this action.
- Because changes to landform, vegetation, water, color, adjacent scenery, and scarcity are not expected to be altered as a result of any action alternative, the discussion of potential changes to the ranking of scenic quality for key factors used to determine Scenic Quality Class is limited to "Cultural Modification."
- 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 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 Sea and would not be detected by any sensitive viewer groups located in on-land or near-shore locations (see Section 3.3.9.7 for a description of viewer groups). The degree of project-related visual contrast and subsequent degree of cultural modification 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 describe as a large-scale panoramic. Viewer sensitivity to the potential impacts to views will depend on existing land use and perceived cultural value. Landscape analysis factors for each of the viewshed areas are summarized in Table 4.5-33.

Table 4.5-33 Description of Analysis Factors by Scenic Quality Rating Unit

	Scenic Quality Rating Unit			
	West Beaufort Sea	**East Beaufort Sea**	**North Chukchi Sea**	**South Chukchi Sea**
Distance from Project	Up to approximately 50 miles	Up to approximately 50 miles	>50 miles	>50 miles
Predominant Angle of Observation	Variable within a 180º arc	Variable within a 180º arc	Variable within a 180º arc	Variable within a 180º arc
Dominant Land Use	On land and near shore Industrial	Near shore Industrial; On-land ANWR	Predominantly Undeveloped, but including the NPRA[1] on shore	Predominantly Undeveloped
Duration of View	Prolonged, but short-term	Prolonged, but short-term	Prolonged, but short-term	Prolonged, but short-term

Notes:
1) NPRA = National Petroleum Reserve Alaska

Because predominant viewer distance of sensitive viewers in the North and South Chukchi SQRUs 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 these SQRUs (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 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 localized and therefore is not considered further in this analysis.

The operation of survey and support vessels would not entail construction or decommissioning phases, as vessels are deployed for surveys and CSEM and 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 localized 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 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 construction, operation, and decommissioning phases. Construction-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, CDS, or a jackup rig, and consequently no construction-related impacts to visual resources are expected.

Construction-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. Construction-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 moderate to strong 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 would be viewed by both highly sensitive viewers from the Alaska Native community of Nuiqsut and viewers located in the industrial centers of Deadhorse and Prudhoe Bay characterized as having low visual sensitivity.

Project-related actions are not expected to change the Scenic Quality Class of any SQRU analyzed. Project actions and effects to visual resources expected to result from implementation of Alternative 2 are summarized in Table 4.5-34, below. An explanation of factors used to determine scenic quality scores is provided in Section 3.3.9.9.

Table 4.5-34 Potential Temporary Changes to Scenic Quality Rating under Alternative 2

	Key Factor	Scenic Quality Rating (Summer/Winter)			
		East Beaufort Sea Unit	West Beaufort Sea Unit	North Chukchi Sea Unit	South Chukchi Sea Unit
Existing Conditions	Cultural Modification	0/0	-4/-3	0/0	0/0
	Total Score	24/15	20/12	25/16	25/16
	Scenic Quality Class[1]	A/B	A/B	A/B	A/B
Alternative 2	Cultural Modification	-2/-2	-4/-3	0/0	0/0
	Total Score	22/13	20/12	25/16	25/16
	Scenic Quality Class[1]	A/B	A/B	A/B	A/B

Notes:

1) Class A = Score of 19+
2) Class B = Score of 12-18
3) Class C = Score of 11 or less

4.5.3.8.3 Conclusion

In conclusion, implementation of Alternative 2 is expected to result in *short-term 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 localized; however they would occur in an important ecosystem.

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 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 activity levels associated with Alternative 2 are expected to have a negligible to minor impact to the numbers of marine mammals harvested for subsistence use in the EIS project area. As described in the Public Health Section 4.5.3.3, increased contamination levels in subsistence food sources are likely to be negligible. Alternative 2 may have an indirect effect of adding to the perception that subsistence foods are contaminated and alter confidence in their consumption.

4.5.3.9.2 Conclusion

Activities related to implementation of Alternative 2 would have a low intensity impact on subsistence resources and human health, a temporary duration, and a regional extent. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Thus, Alternative 2 is expected to have a minor impact to subsistence resources. Alternative 2 with Standard Mitigation Measures would also create some local employment and economic support activities, and would reduce adverse effects. There would be minor disproportionate adverse and beneficial impacts to Alaska Native communities under Alternative 2.

4.5.3.10 Standard Mitigation Measures for the Social Environment

Standard Mitigation Measures are outlined in Section 2.4.9 and described in detail in Appendix A. 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. The following standard mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on resources within the social environment. The discussion of standard mitigation measures for subsistence resources can be found in Section 4.5.3.2.3.

A3. PSOs required on all seismic source vessels and ice breakers, as well as on support (chase) vessels.

Socioeconomics – This mitigation measure contributes beneficially to local employment through the training and hire of local PSOs. To the extent that PSOs avoid or minimize disturbance of marine mammals, and therefore avoid or minimize interference with subsistence activities, the measure also indirectly reduces the potential for social impacts on communities and the need for social organizations and institutions to respond to social and subsistence harvest impacts.

A6. PSOs required on all drill ships and ice management vessels.

Socioeconomics – This mitigation measure has similar beneficial effects to those resulting from Standard Mitigation Measure A3.

B1. Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

Transportation – Standard Mitigation Measure B1 specifies the flight altitudes for all support aircraft (except for takeoff landing and emergency situations), and is intended to reduce the impacts of aircraft overflights to marine mammals.

Visual Resources – Standard Mitigation Measure B1 may have an indirect reduction in adverse impacts to visual resources as it would lessen the visual impact and presence of aircraft to sensitive viewers either on land or in boats.

C2. Lost equipment notification.

Cultural Resources – This mitigation measure applies to seismic surveys and exploratory drilling and requires notification by the operators to the responsible agencies if any equipment is lost. This measure would not have any direct reduction of adverse effects cultural resources because it is very unlikely that any of the agencies would be able to find or otherwise ameliorate any potential adverse effects from such lost equipment. Applications of this mitigation measure may aid in the protection of cultural resources – of which the bowhead whale is considered to be by the Iñupiat. Lost equipment notification can provide information that may be valuable in the future if any whales are found with injuries related to entanglement in such equipment, which is unlikely to occur.

C3. When traveling on ice-roads, the area shall be monitored for marine mammals.

Public Health – This mitigation measure is primarily intended to avoid disturbance of denning polar bears, and to a lesser degree denning ice seals. It would have an indirect effect of reducing adverse effects to the subsistence harvest to the degree that they occurred in the vicinity of areas with ice roads. This would also provide indirect reductions in adverse impacts to public health through the continuation of subsistence hunting in traditional areas.

C4. Oil Spill Response Plan.

Public Health –This mitigation measure will improve response to any spill and thus will minimize the likelihood of health impacts secondary to contamination. In addition, a well-articulated plan with a good communications strategy should help lessen local residents' perceptions of contamination and health risks associated with subsequent avoidance of subsistence foods.

Cultural Resources –This mitigation measure will improve response to any spill and thus will minimize the likelihood of impacts to cultural resources becoming contaminated. In addition, a well-articulated plan with a good communications strategy should help lessen local residents' perceptions of contamination of cultural resources.

Recreation and Tourism –By minimizing the likelihood of a spill, adverse impacts to the recreation setting would be reduced. If a spill were to occur, this mitigation measure would indirectly reduce the adverse impacts to recreation by having a plan for efficient clean up. Minimizing the impacts to marine mammals would reduce adverse impacts to wildlife viewing.

Visual Resources –By minimizing the likelihood of a spill, adverse impacts to the visual resources would be reduced. If a spill were to occur, this mitigation measure would indirectly reduce the adverse impacts to visual resources by having a plan for efficient clean up in place.

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 or around August 25.

Public Health – Standard Mitigation Measure D1 is intended to avoid potential disturbance of Bowhead whale and the fall subsistence hunts in the Beaufort Sea. It is similar in intent to Conflict Avoidance Agreements negotiated with the Alaska Eskimo Whaling Commission. In concert with other mitigation measures, such as Standard Mitigation Measure D2 below, this measure would be successful in avoiding or reducing disturbance of whales and subsistence hunting activities. This would indirectly provide reductions in adverse impacts to public health.

Visual Resources – Standard mitigation measures implemented as part of the proposed action would alter the level of anticipated impacts to visual resources or scenic quality, particularly when Category D Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in the culturally important activity of subsistence bowhead whaling) to vessel-based surveys during certain periods. However the mitigation measures 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.

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.

Socioeconomics and Environmental Justice – This mitigation measure contributes beneficially to local employment through the financial support of Communications Center staff. To the extent the Communications Centers avoid or minimize interference with subsistence activities, it also reduces the potential for social impacts.

Public Health – Standard Mitigation Measure D2 is intended to foster communication between offshore oil industry activities and subsistence hunters in order to avoid or reduce potential disturbance of marine mammals and the subsistence hunts in the Beaufort and Chukchi seas. In concert with other mitigation measures, such as Standard Mitigation Measure D1 above, this measure would be successful in avoiding or reducing disturbance of marine mammals and subsistence hunting activities. This would indirectly provide reductions in adverse impacts to public health.

D3. Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Transportation – Standard Mitigation Measure D3 sets forth the required flight altitudes and paths for all support aircraft in areas where subsistence occurs (except during take-off, landing, and emergency situations) and includes measures that stipulate the avoidance of concentrations of whales, and the altitude levels of aircraft engaged in marine mammal monitoring. The criteria also designate flight paths and operational procedures for inclement weather. The mitigation measure lessens the direct impact of disturbance caused by the anticipated increases in levels of aircraft overflights during seismic survey and exploratory drilling operations.

Visual Resources – Standard Mitigation Measure D3 would have similar impacts to visual resources as discussed under Standard Mitigation Measure B1.

4.5.3.10.1 Standard Mitigation Measures Summary for the Social Environment

The reduction of potential impacts from the standard mitigation measures apply to marine mammal species and habitat, which could indirectly affect resources in the social environment. Many of the additional mitigation measures discussed above would avoid or reduce interference with subsistence activities and the need for organization/institutional response to adverse social impacts, while some would beneficially impact the local economy.

Standard mitigation measures affecting environmental justice include those associated with socioeconomic, subsistence, and public health effects. Mitigation measures that create local employment opportunities through PSOs and Communication Centers would reduce adverse effects on environmental justice; other that restrict the location and timing of exploration activities could have offsetting effects on employment and economic support activities. This is discussed further in Section 4.5.3.10 (above). With standard mitigation and conflict avoidance measures in place, adverse impacts to subsistence resources and hunts from oil and gas exploration activity, noise, and disturbance would not be expected to occur.

4.5.3.11 Additional Mitigation Measures for the Social Environment

Additional Mitigation Measures are outlined in Section 2.4.10 and described in detail in Appendix A. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. The following additional mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on resources within the social environment. The discussion of additional mitigation measures for subsistence resources can be found in Section 4.5.3.2.5.

Additional Mitigation Measure A1. Sound source verification tests for sound sources and vessels at the start of the season.

Socioeconomics – This mitigation measure is used to establish and monitor more accurate safety zones. To the extent that it contributes to avoiding or minimizing disturbance of marine mammals, and therefore avoids or minimizes interference with subsistence activities, it also indirectly reduces the potential for social impacts on communities and the need for social organizations and institutions to respond to social and subsistence harvest impacts.

Additional Mitigation Measure A2. Measures to assess efficacy and improve detection capabilities in low visibility situations (e.g. Forward Looking Infrared [FLIR] imaging devices, 360° thermal imaging devices).

Socioeconomics – Additional Mitigation Measure A2 would have similar indirect benefits to socioeconomics as discussed under Additional Mitigation Measure A1.

Additional Mitigation Measure A3. Limiting activities in situations of low visibility.

Socioeconomics – Additional Mitigation Measure A3 would have similar indirect benefits to socioeconomics as discussed under Additional Mitigation Measure A1.

Additional Mitigation Measure A4. Measures to increase detection probability for real-time mitigation (e.g. to maintain 180 dB shutdown zones), such as passive and active acoustic monitoring.

Socioeconomics – Additional Mitigation Measure A4 would have similar indirect benefits to socioeconomics as discussed under Additional Mitigation Measure A1.

Additional Mitigation Measure A5. Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (e.g. cow/calf groups and feeding or resting aggregations).

Socioeconomics – Additional Mitigation Measure A5 would have similar indirect benefits to socioeconomics as discussed under Additional Mitigation Measure A1.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.

Socioeconomics – Many of these important habitats support fish and wildlife utilized for subsistence, and during certain times of year may be used for subsistence activities. To the extent that this mitigation measure contributes to avoiding or minimizing disturbance of marine mammals, and avoids or minimizes interference with subsistence activities, it also directly and indirectly reduces the potential for social impacts on communities and the need for social organizations and institutions to respond to social and subsistence harvest impacts.

Temporal/spatial limitations on exploratory activities may adversely affect the timing and level of employment and economic support activities. Should a reduction in employment and support activities result from this mitigation measure, the effects would be adverse.

Additional Mitigation Measure B2. NMFS restricting 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).

Socioeconomics – Additional Mitigation Measure B2 seeks to reduce the need for surveys that may be duplicative. It would have similar impacts to Additional Mitigation Measure B1, as it could indirectly avoid/reduce interference with subsistence activities and the need for organization/institutional response to impacts. However, it would also reduce employment and support activities, resulting in adverse effects to local communities.

Visual Resources – There is the potential for this measure to reduce repeated disturbance 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. The intent of this additional mitigation measure is to reduce duplicative surveys. The effectiveness of this additional mitigation measure would be contingent upon detailed tracking of existing and proposed surveys and the willingness of industry to share what may be considered proprietary information. This mitigation measure may be a secondary benefit to visual resources as it would reduce the visual impact and presence of vessels to sensitive viewers.

Additional Mitigation Measure B3. Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

Socioeconomics – Additional Mitigation Measure B3 would have similar indirect benefits to socioeconomics as discussed under Additional Mitigation Measure A1.

Visual Resources – Additional Mitigation Measure B3 would have similar impacts to visual resources as discussed under Additional Mitigation Measure B2. This mitigation measure may be a secondary benefit to visual resources as it would also reduce the visual impact and presence of vessels to sensitive viewers.

Additional Mitigation Measure C1. Vessel and aircraft avoidance of concentrations of groups of ice seals, walrus, and polar bears.

Transportation – Additional Mitigation Measure C1 states that vessels and aircraft avoid concentrations of groups of ice seals, walrus, and polar bears and sets distances, a safety radius, and no disturbance zones around some marine mammals (including walrus and polar bears).

Additional Mitigation Measure C2. Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Public Health – Beyond the health benefits related to preserved ability and access to subsistence stocks, specified shipping and transit routes, particularly with regard to icebreaking, will help minimize conflict between hunters and ships and concerns about ice safety and subsequent injury or trauma.

Transportation – Additional Mitigation Measure C2 states that specified shipping or transit routes should be used to avoid important habitat in areas where marine mammals may occur in high densities. Activities that could be affected by this additional mitigation could include: 2D and 3D seismic and CSEM surveys, including icebreaking; site clearance and high resolution shallow hazards surveys; and exploratory drilling activities. This mitigation measure would be applied in anticipation of the projected increase expected from vessel traffic and to prevent marine mammal strikes and collisions with vessels.

At present, mitigation for vessel traffic in the Beaufort and Chukchi seas is guided by the oil and gas industry, and communities through a Plan of Cooperation (POC) (as required by NMFS 50 CFR 216.104(a)(12)). Separate Conflict Avoidance Agreements (CAA) have been executed between the AEWC and each private company. The agreements require support vessels and aircraft to operate in accordance with appropriate measures and procedures that are related to the timing and areas of the industries' planned activities. For the activities proposed for seismic surveys and drilling exploration, the communication centers would be located in strategic areas for support of industry activities. They would be expected to adhere to the mitigation measures as outlined in this section. The communication centers function to provide communication between operator's vessels and whaling crews, support PSOs on industry vessels and have the ability to provide emergency assistance to subsistence hunters.

Some residents of the affected communities noted that even though mitigation measures may be applied to a permit, or as a stipulation to a program, the implementation of the measure can be problematic. For example, a Nuiqsut resident commented:

> *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, 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 for this EIS, March 11, 2010.

Recreation and Tourism – An additional mitigation measure in Alternative 2 requires that 2D/3D Seismic, In-Ice Sesimic and CSEM Surveys, Site Clearance and High Resolution Shallow Hazards Surveys; and Exploratory Drilling Activities use specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities. This would indirectly reduce the adverse impacts to recreation and wildlife viewing by ensuring that high densities of marine mammals may be undisturbed by survey activity.

Visual Resources – Additional Mitigation Measure C2 states that specified shipping or transit routes should be used to avoid important habitat in areas where marine mammals may occur in high densities. Activities that could be affected by this additional mitigation could include: 2D and 3D seismic and CSEM surveys, including icebreaking; site clearance and high resolution shallow hazards surveys; and exploratory drilling activities. This mitigation measure would be applied in anticipation of the projected increase expected from vessel traffic and to prevent marine mammal strikes and collisions with vessels.

A secondary benefit of this additional mitigation measure would be limiting the visual impact to sensitive viewers.

Additional Mitigation Measure C3. 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 habitat.

Public Health – Additional Mitigation Measure C3 would include mitigating the discharge of drill cuttings, drilling fluids, sanitary wastes, bilge water, ballast water, and domestic water (i.e. grey water) during exploratory drilling activities. This additional mitigation measure would avoid or reduce the discharge of contaminants into the marine environment which has been a long-standing concern of North Slope residents. Indirectly, reduction in discharge of contaminants would reduce the potential of contaminants entering into the food chain and ingestion through subsistence harvests of marine resources.

Environmental Justice – Additional mitigation measures to reduce discharge of wastes that potentially impact marine mammals would likely reduce the potential for introduction of new contaminants to subsistence foods. These mitigation measures would reduce adverse impacts to subsistence foods and would not contribute to impacts on human health.

Additional Mitigation Measure C4. Operators are required to recycle drilling muds.

Public Health – This mitigation measure would avoid or reduce the discharge of contaminants into the marine environment. This has been a long-standing concern of North Slope residents. Indirectly, reduction in discharge of contaminants would reduce the potential of getting contaminants into the food chain and ingestion through subsistence harvests of marine resources.

Environmental Justice – Additional Mitigation Measure C4 would have a similar impact to environmental justice as discussed under Additional Mitigation Measure C3.

Additional Mitigation Measure D1. No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay.

Public Health – Baseline data suggest that Point Lay is disproportionately dependent on beluga as a food source. Limiting impacts to the beluga stocks until after the hunt is completed in Point Lay will minimize any potential exacerbation of food insecurity in the community.

Additional Mitigation Measure D3. 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.

Public Health – Baseline data suggest that Kaktovik is highly dependent on bowhead as a food source. Limiting impacts to the bowhead stocks until after the hunt is completed in Kaktovik will minimize any potential exacerbation of food insecurity in the community.

4.5.3.11.1 Additional Mitigation Measures Summary for the Social Environment

The reduction of potential impacts from the additional mitigation measures apply to marine mammal species and habitat, which could indirectly and beneficially affect resources in the social environment. Many of the additional mitigation measures discussed above would avoid or reduce interference with subsistence activities and the need for organization/institutional response to adverse social impacts. These additional mitigation measures could reduce potential conflicts with subsistence use and increase consistency with NSB and NAB comprehensive plans and Land Management Regulations. Additional mitigation measures that reduce discharge of potential contaminants and reduce perception that subsistence foods are contaminated and alter confidence in their consumption are beneficial to environmental justice.

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, permanent, 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, permanent/temporary (permanent if gravel, temporary if ice), localized 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 not affect tides or water levels within the EIS project area.

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. 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 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to physical ocean resources are discussed under Alternative 2 (Section 4.5.1.1).

4.6.1.1.3 Conclusion

The overall effects of the proposed actions on physical ocean resources 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 3 on physical ocean resources in the proposed action area would be minor.

4.6.1.1.4 Additional Mitigation Measures

Additional mitigation measures that could reduce adverse impacts to physical ocean resources are discussed under Alternative 2 (Section 4.5.1.1).

4.6.1.2 Climate

4.6.1.2.1 Direct and Indirect Effects

Although the number of exploration activities proposed in Alternative 3 is greater than the number proposed in Alternative 2, the nature of both direct and indirect effects to climate changes associated with Alternative 3 would be the same as those discussed for Alternative 2 (see Section 4.4.1.2).

The estimated total yearly emissions of CO2e resulting from Alternative 3 are approximately 91,166 tpy higher than those associated with Alternative 2, a 67 percent increase (Table 4.6-1). When compared against the State of Alaska's projected emissions in 2010, these yearly emissions are equal to approximately eight percent of the total CO2e emissions associated with the fossil fuel industry which were estimated at 2,900,000 tpy, and approximately 0.4 percent of the State of Alaska's total projected GHG emissions for 2010 (Table 3.1-3). The magnitude of direct emissions associated with Alternative 2 is considered to be low, since a change in the resource condition is perceptible (measurable at eight percent) but is not expected to noticeably alter the function of the climate system by itself. As mentioned in Section 4.5.1.2, quantification of indirect impacts would be speculative. Therefore the magnitude of indirect impacts resulting from Alternative 3 is assumed to be the same as for Alternative 2: low to medium.

Table 4.6-1 Estimated CO_2e Emissions for Event for Alternative 3

Source/Activity	**Emissions (tpy)**
Survey Vessel	6.66E+04
Ice-Management Vessel	7.38E+03
Drill Rig	1.52E+04
Supply/Support Vessel	1.28E+05
Oil Response Vessels	1.06E+04
Total Emissions (tpy)	**228,034**

Note: Refer to Section 4.1.4 for complete details and assumptions regarding emissions calculations

The duration for both direct and indirect effects is expected to be the same as Alternative 2. Therefore, both direct and indirect effects to climate change associated with Alternative 3 are considered to be long-term. Because the nature of impacts associated with Alternative 3 is the same as Alternative 2, the extent of both direct and indirect impacts is considered to be State-wide and beyond, and the context of impacts is also assumed to be unique.

Effects of Climate Change on the Proposed Action

Alternative 3 involves more exploration activities than Alternative 2, but the nature of the activities is the same. Therefore effects of climate change on Alternative 3 are considered to be same as for Alternative 2 (Refer to Section 4.5.1.2 Climate).

4.6.1.2.2 Standard Mitigation Measures

There are no standard mitigation measures identified that would reduce adverse impacts to climate change.

4.6.1.2.3 Conclusion

Although the projected direct GHG emissions associated with Alternative 3 are higher than those projected for Alternative 2, direct impacts are still assumed to be 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. Overall, the summary impact rating for climate under Alternative 3 would be minor.

4.6.1.2.4 Additional Mitigation Measures

No additional mitigation measures have been identified to address impacts associated with climate change.

4.6.1.3 Air Quality

4.6.1.3.1 Direct and Indirect Effects

Details for the method of air quality assessment are provided in Section 4.5.1.3 above. Permitting requirements are expected to remain the same under this alternative, with a worst-case scenario event matching that shown in Table 4.5-6. This level of permitted activity is expected to have a moderate effect on air quality.

The overall emissions from Alternative 3 are based on the Level 2 Exploration Activity, as shown in Table 4.4-2. This alternative equates to 22 seismic surveys including two in-ice surveys, and four drilling activities. The supply and support activities are expected to match the survey amounts (22 units), and the oil spill response activities are expected to be needed on a 2-to-1 basis, or 11 units. Estimated emissions from this entire alternative are shown in Table 4.6-2. The magnitude of emissions for Level 2 Exploration Activity is greater than that for Level 1 Exploration Activity. However, the increase in detrimental effects on air quality (that is, air quality impacts) due to this increase is expected to be minimal. The overall effect on air quality for this alternative is still expected to be moderate, as based on the worst-case activity.

4.6.1.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to air quality are discussed under Alternative 2 (Section 4.5.1.3).

4.6.1.3.3 Conclusion

Direct and indirect impacts to air quality resulting from the implementation of Alternative 3 would be moderate in magnitude, but temporary, localized, and would affect common resources. Therefore, the summary impact level of Alternative 3 on air quality would be considered minor.

4.6.1.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to air quality are discussed under Alternative 2 (Section 4.5.1.3).

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 noise-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. A detailed discussion of the acoustic properties of the noise sources is given in Section 4.5.1.4; that discussion is relevant also to Alternative 3 operations.

Table 4.6-2 Estimated Total Air Pollutant Emissions for Level 2 Exploration Activity

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SURVEY VESSEL								
Propulsion engine: 1000 hp	76,780	2.58E+02	2.28E+02	4.03E-01	1.54E+01	2.20E+01	4.44E+04	1.15E+00
Generators/Engines: 500 hp (total)	76,780	4.30E+02	1.14E+02	2.02E-01	7.70E+00	1.10E+01	2.22E+04	5.75E-01
ICE-MANAGEMENT VESSEL								
Propulsion engines: 28,000 hp (total)	720	3.39E+01	3.00E+01	5.29E-02	2.02E+00	2.89E+00	5.83E+03	1.51E-01
Generators/Engines: 1,500 hp (total)	720	1.21E+01	3.21E+00	5.67E-03	2.17E-01	3.10E-01	6.25E+02	1.62E-02
Heaters: 8 MMBtu/hr (total)	1,440	8.24E-01	2.06E-01	8.64E-03	4.11E-02	8.24E-03	9.19E+02	2.73E-01
Incinerator: 175 lb/hr	72	9.45E-03	3.15E-02	7.88E-03	2.21E-02	9.45E-03	1.11E+00	6.80E-03
DRILL RIG								
Main engines: 13,500 hp	1440	6.53E+01	5.78E+01	1.02E-01	3.90E+00	5.57E+00	1.12E+04	2.91E-01
Generators/Engines: 2,500 hp (total)	1440	4.03E+01	1.07E+01	1.89E-02	7.22E-01	1.03E+00	2.08E+03	5.39E-02
Heaters: 8 MMBtu/hr (total)	2880	1.65E+00	4.11E-01	1.73E-02	8.23E-02	1.65E-02	1.84E+03	5.46E-01
Incinerator: 275 lb/hr	144	2.97E-02	9.90E-02	2.48E-02	6.93E-02	2.97E-02	3.49E+00	2.14E-02

Source/Activity	Hours per Year	Emission Rate (tons per year)						
		NO_x[1]	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	CO_2e	HAPs
SUPPLY/SUPPORT VESSEL								
Propulsion engine (including thruster engines): 8,850 hp	15,202	4.52E+02	4.01E+02	7.07E-01	2.70E+01	3.86E+01	7.79E+04	2.02E+00
Generators/Engines: 1,750 hp (total)	30,382	5.98E+02	1.59E+02	2.80E-01	1.07E+01	1.53E+01	3.09E+04	8.00E-01
Heaters: 8 MMBtu/hr (total)	30,382	1.74E+01	4.34E+00	1.82E-01	8.68E-01	1.74E-01	1.94E+04	5.76E+00
Incinerator: 275 lb/hr	3038	6.27E-01	2.09E+00	5.22E-01	1.46E+00	6.27E-01	7.37E+01	4.51E-01
OIL SPILL RESPONSE VESSELS								
Propulsion engine (including thruster engines): 8,850 hp	960	2.86E+01	2.53E+01	4.46E-02	1.70E+00	2.44E+00	4.92E+03	1.27E-01
Generators/Engines: 1,750 hp (total)	1920	3.78E+01	1.00E+01	1.77E-02	6.76E-01	9.67E-01	1.95E+03	5.05E-02
Boom Workboat propulsion engines: 610 hp (total)	960	1.97E+00	1.74E+00	3.07E-03	1.17E-01	1.68E-01	3.39E+02	8.77E-03
Spill Storage Tanker propulsion engines: 3350 hp (total)	960	1.08E+01	9.59E+00	1.69E-02	6.46E-01	9.24E-01	1.86E+03	4.83E-02
Spill Storage Tanker generator: 775 hp	960	8.34E+00	2.21E+00	3.91E-03	1.49E-01	2.13E-01	4.31E+02	1.12E-02
Spill Storage Tanker boiler: 14.4 MMBtu/hr	960	9.88E-01	2.47E-01	1.04E-02	4.93E-02	9.88E-03	1.10E+03	3.28E-01
TOTAL EMISSIONS (tpy)		1,999	1,060	2.63	73.6	102	228,034	12.7

[1] Assume overall NO_x control of 70% on propulsion engines from the use of SCR.

4.6.1.4.1 Direct and Indirect Effects

Estimates of Total Surface Areas of Ensonification at Threshold Levels

Table 4.6-3 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.

Table 4.6-3 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
	% Chukchi	**0.002%**	**0.02%**	**0.7%**	**58%**
Beaufort Sea Shelf, 15 to 40 m depth					
	4x ~3200 in^3	7.47	62.2	1,225	33,929
	3x 20 in^3	0.003	0.03	5.59	2,535
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	**0.004%**	**0.03%**	**0.7%**	**19%**
Entire Region					
		12.4	**113**	**3,105**	**191,321**
	% EIS area	**0.003%**	**0.03%**	**0.7%**	**39%**

4.6.1.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to acoustics are discussed under Alternative 2 (Section 4.5.1.4). These include establishing and implementing marine mammal exclusion zones, and performing ramp-up prior to performing full seismic survey operations. The implementation of exclusion zones would lead to reduction or cease of seismic survey noise when shut-downs occur. Seismic sound levels would resume with a gradual increase during ramp-up to full level after completion of ramp-up.

4.6.1.4.3 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 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.

4.6.1.4.4 Additional Mitigation

Additional mitigation measures identified that could reduce adverse impacts to acoustics are discussed under Alternative 2 (Section 4.5.1.4).

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. 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 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 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 4.9 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 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to water quality are discussed under Alternative 2 (Section 4.5.1.5).

4.6.1.5.3 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 negligible.

4.6.1.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to water quality are discussed under Alternative 2 (Section 4.5.1.5).

4.6.1.5.5 Additional Mitigation Measures Conclusion

Although the overall effects on water quality are expected to be negligible, the additional mitigation measures would further reduce the potential for adverse impacts.

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.

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 (defined in Section 4.4.1.6) 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 temporary, 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, temporary, 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) could 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. 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 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to environmental contaminants and ecosystem functions are discussed under Alternative 2 (Section 4.5.1.6).

4.6.1.6.3 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 3 would be medium-intensity, temporary, localized, 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. Because Alternative 3 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 3 on ecosystem functions would be considered minor.

4.6.1.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to environmental contaminants and ecosystem functions are discussed under Alternative 2 (Section 4.5.1.6).

4.6.1.6.5 Additional Mitigation Measures Conclusion

Although the overall effects on ecosystem functions from environmental contaminants are expected to be minor, the additional mitigation measures would further reduce the potential for adverse impacts.

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 discussed in Section 4.5.3.7 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. The conclusions for Alternative 2 are applicable to Alternative 3; therefore, the overall impact to lower trophic levels would be moderate.

4.6.2.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to lower trophic levels are discussed under Alternative 2 (Section 4.5.2.1).

4.6.2.1.3 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 medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate.

4.6.2.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to lower trophic levels are discussed under Alternative 2 (Section 4.5.2.1).

4.6.2.1.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on lower trophic level organisms except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the reductions in adverse impacts relative to the standard mitigation measures would be limited to small numbers of benthic organisms and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on lower trophic level organisms would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect common resources. If exploration activities introduced invasive species, the level of impacts could be of medium intensity, long-term or permanent duration, and of regional geographic extent and would be considered 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, please see Section 4.5.2.2, Fish and Essential Fish Habitat.

Freshwater Fish

The direct and indirect effects resulting from Alternative 3 would be identical to those described under Alternative 2. As none of the activities described in Alternative 3 take place in or near freshwater, neither fish nor fish habitat would be affected. There would be no direct or indirect effects on freshwater fish resources.

For a complete discussion of the effects on freshwater fish resources, please 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 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 impacts to marine fish would be considered minor.

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. The impacts to migratory fish would be considered negligible.

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 very small and only incrementally larger than for Alternative 2. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

For a complete discussion of the effects on Essential Fish Habitat, please see Section 4.5.2.2.

4.6.2.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to fish and EFH are discussed under Alternative 2 (Section 4.5.2.2). The higher activity levels described in Alternative 3 would provide greater potential for mitigation, but the amount of mitigation would be scaled proportionally, therefore resulting in a proportional amount of adverse impacts being mitigated, as a percentage of total activity.

4.6.2.2.3 Conclusion

The overall impact of Alternative 3 on Fish Resources and EFH is negligible. 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, there would be no measurable effect on the resource.

4.6.2.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to fish and EFH are discussed under Alternative 2 (Section 4.5.2.2).

4.6.2.2.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on fish and EFH except for Additional 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 benthic organisms and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on fish and EFH would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect common resources. The effects of Alternative 3 with additional mitigation measures would therefore be considered negligible for fish and EFH.

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 take place in the same areas and timeframes and also involve the same standard mitigation measures. 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). 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 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 3 as under Alternative 2 so this special habitat 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 involved 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 4.9.

4.6.2.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). These include aircraft flight paths and altitude restrictions to reduce the chance of disturbing marine and coastal birds, and development of an oil response plan and procedures for exploratory drilling to minimize the risk of spills occurring and to expedite clean-up responses.

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, they 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 or short-term, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 4 on marine and coastal birds would therefore be considered negligible to minor according to the impact criteria in Table 4.2-1.

4.6.2.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3).

4.6.2.3.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on birds except for Additional 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. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on birds would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect important or unique resources. The effects of Alternative 3 with additional mitigation measures would therefore be considered negligible to minor for birds.

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 icebreaking 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 4.5.2.4.9. 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 4.5.2.4.9.

There would be a moderate 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 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, based on determinations for Alternative 2, be of medium intensity. Some whales may be displaced but would not leave the EIS project area entirely. The duration is expected to be temporary. 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 localized impacts. 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 and protection and importance to North Slope communities as a subsistence resource. The latter statement holds true for all impact determinations in this section.

Anticipated impacts of an additional OBC survey in the Beaufort Sea, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique), may be similar to those described for one OBC 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 surveys. This could result in the geographic extent of impact broadening from localized 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 short-term or temporary. 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.

Anticipated impacts of two exploratory drilling programs under Alternative 3 would be similar to that for Alternative 2 in terms of magnitude (medium), duration (temporary), extent (local), and context (unique). 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 temporary (long term effects are unknown). The extent of impact would depend on the number of support vessels in an area. Impacts are expected to be localized 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 4.5.2.4.9 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 4.5.2.4.9. 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.

Please refer to Section 4.5.2.4.9 for a complete discussion of potential injury or mortality effects on bowhead whales.

Habitat Alterations

The potential effects on bowhead whale habitat in the EIS project area under Alternative 3 would likely be the same as under Alternative 2. Additional exploratory drilling could, however, increase the number of localized sites experiencing possible habitat effects of drilling activities.

Please refer to Section 4.5.2.4.9 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 4.5.2.4.9).

4.6.2.4.1.3 Conclusion

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, there would be no corresponding increase in the overall impact level. 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. The intensity and duration of the various effects and activities considered are mostly medium and temporary. Potential long-term effects from repeated disturbance are, however, unknown. Although the various individual activities may affect bowhead whales on a local level, the area and extent of the population over which 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.

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 4.5.2.4.9).

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 4.5.2.4.9 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 4.5.2.4.10. 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 minimum distance between two seismic surveys conducted concurrently is 24 km (15 mi). Even with the additional seismic surveys authorized under Alternative 3, this restriction would effectively limit the intensity of effects on beluga whales regardless of where the activities take place. As discussed under Alternative 2, these effects are considered to be temporary and low in magnitude although they may affect beluga whales over a broad geographic area.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.10.

Behavioral Disturbance

The same number of 2D (icebreaker) 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 moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect beluga whales over a large area, especially with regard to 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 beluga whales. 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 belugas 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 whales. However, there is no requirement for any separation between a 2D seismic survey and an exploratory drilling program. If these two types of activities occurred close together they could disturb the same group of whales at the same time. The effect of the disturbances could be synergistic – with the net impact being greater than the sum of the individual impacts.

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 unique, since beluga whales are an integral part of the Iñupiat subsistence lifestyle. 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 due to the belugas cultural significance. 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 3 would likely be the same as under Alternative 2. Additional exploratory drilling could, however, increase the number of localized sites experiencing possible habitat effects of drilling activities. Please refer to Section 4.5.2.4.10 for a complete discussion of the potential effects on beluga whale habitat.

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 4.5.2.4.10).

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 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. The intensity and duration of the various effects and activities considered are mostly medium and temporary. 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. However, based on the time of year that beluga whales are typically present in the U.S. Beaufort and Chukchi seas, oil and gas exploration activities that occur in the summer and early fall seasons have the highest probability of impacting beluga whales. Therefore, it is less likely that beluga whales will be impacted by on-ice vibroseis surveys or the latter portions of in-ice seismic surveys with icebreaking.

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 4.5.2.4.10).

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 4.5.2.4.11.

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 intensity, based on determinations for Alternative 2. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in the overall impact level. 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 temporary. 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 localized impacts. Multiple activities in one area or in several areas across migratory corridors could lead to more widespread, regional impact.

Please refer to Section 4.5.2.4.11 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 4.5.2.4.11. 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 4.5.2.4.11 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 the same as under Alternative 2. Additional exploratory drilling could, however, increase the number of localized sites experiencing possible habitat effects of drilling activities.

Please refer to Section 4.5.2.4.11 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 4.5.2.4.11).

4.6.2.4.3.3 Conclusion

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 the minor 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.

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 4.5.2.4.11).

4.6.2.4.4 Pinnipeds

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 4.5.2.4.12. 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 4.5.2.4.12.

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 temporary and low in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of ice seals. 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 ice seals 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 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.

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 accidental 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 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 significant 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 accidental 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 4.9.6.11 and 4.9.7.11. Please refer to Section 4.5.2.4.12 for a complete discussion of potential injury or mortality effects on pinnipeds.

Habitat Change

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.

4.6.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.12).

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 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, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique 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 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.

4.6.2.4.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.12).

4.6.2.4.5 Walrus

4.6.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 3 on Pacific walrus. 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 Pacific walrus 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 Pacific walrus 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. Walrus are distributed widely across the Chukchi Sea but are uncommon in the deeper offshore waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact Pacific walrus. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.13.

Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 3 include several mechanisms for potential disturbance to walrus 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 walrus 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 walrus 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 walrus.

There would be a moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect walrus 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 walrus. 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 walrus 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 walrus.

Alternative 3 could authorize up to two exploratory drilling programs in both Arctic seas. The level of disturbance to walrus 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 walrus could become habituated to it. Given the mild reaction of walrus 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 walrus, although more walrus could be temporarily affected than would occur with only one drilling program. Any disturbance and displacement of walrus 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 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 walrus 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 4.5.2.4.13 exposure to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities could have substantial health effects on walrus 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 accidental spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills and the occurrence of walrus primarily on or near the pack ice rather than swimming in open water where most exploration activities take place, the risk of walrus 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 4.9.6.11 and 4.9.7.11.

Please refer to Section 4.5.2.4.13 for a complete discussion of potential injury or mortality effects on walrus.

Habitat Change

Benthic prey of walrus may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as ocean bottom cable 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 walrus, these activities would be unlikely to affect the availability of prey to walrus.

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 accidental spills and discharges occurring would be proportionally greater. The potential effects on the quality of walrus habitat are unknown. Please refer to Section 4.5.2.4.13 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 Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13).

4.6.2.4.5.3 Conclusion

Walrus 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 walrus 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 walrus 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 accidental 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 calf and juvenile mortality from stampedes.

Walrus 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 walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 3 would therefore be considered minor for Pacific walrus 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 Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13).

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 4.5.2.4.14. 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 4.5.2.4.14.

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 bear-human 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, 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 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 but the minimum distance requirement (24 km [15 mi]) would still apply and therefore effectively minimize the concern for increased disturbance to any polar bear.

Alternative 3 could authorize up to two 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 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 accidental 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 MMOs to deter 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 bear-human 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 4.9.6.11 and 4.9.7.11.

Habitat Change

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 muds and other wastes. There have been no comprehensive studies conducted on how discharges could interact with polar bear prey species. Given this lack of ecological information on the effects of discharges on polar bear habitat and prey species, it is not possible to say whether two drilling programs constitute a substantially larger risk to habitat quality for polar bears than one drilling program. 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 factors that can influence an animals' health.

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 4.5.2.4.14).

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 bear-human 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 low in magnitude, distributed over a wide geographic area, and temporary 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 4.5.2.4.14).

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 Special Habitat Areas

The analysis of the direct and indirect effects associated with special habitat areas can be found in Sections 4.6.2.4 (Marine Mammals), 4.6.2.3 (Marine and Coastal Birds) and 4.6.3.2 (Subsistence).

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 & 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).

Employment & 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.

Table 4.6-4 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 4.6-4 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 are 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 are 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 & Institutions

The implementation of Alternative 3 would result in marginal 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 marginal increases in short-term, seasonal demand on institutions and social services in Barrow, Wainwright, Nome and Unalaska/Dutch Harbor.

4.6.3.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to socioeconomics are discussed under Alternative 2 (Section 4.5.3.1).

4.6.3.1.3 Conclusion

The magnitude of the socioeconomic impact under Alternative 2 is positive and greater than a Level 1 activity. However, the magnitude of increase of total personal income and local employment rates are still not increased by more than five percent. The duration of the socioeconomic impacts is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are 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 communities. The summary impact level for socioeconomic resources under Alternative 3 is minor.

4.6.3.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to socioeconomics are discussed under Alternative 2 (Section 4.5.3.1).

4.6.3.1.5 Additional Mitigation Measures Conclusion

The Additional Mitigation Measures A1 to A7 and B1 to B3 are as noted for Alternative 2. They are intended to reduce negative impacts on marine mammals associated with Level 2 activity. With the incorporation of these measures, the anticipated negative impact to subsistence activity is minor (see Section 4.4.3.2). The relationship to Socioeconomics is a further reduced impact to Governmental and Non-Profit Institutions that may have needed to direct expenditures associated with the coordination of adaptive strategies. Therefore, additional mitigation measures reduce negative impacts to socioeconomics.

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 4.5-26 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 5. 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.

Assumptions regarding the level of activity used in the analysis of impacts to subsistence for Alternative 3 are described in Table 4.5-26. 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. 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 4.5.2.4.9 and Section 4.2.4.6.1 (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 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 could be of low intensity and temporary duration (i.e. for the duration of the activities). 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 summary impact to subsistence harvest from disturbance of bowhead whales could be considered moderate.

Beluga Whales

Sections 4.5.2.4.10 and 4.2.4.6.2 (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 duration, occurring for the duration of the activities offshore. These impacts are considered regional in geographic extent and affecting a resource that is unique 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.

Seals

Sections 4.5.2.4.12 and 4.6.2.4.4 (Pinnipeds) 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 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.

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 described under Alternative 2.

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 3 could be major in the absence of mitigation measures. However 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 the standard and additional mitigation measures, these activities are not expected to disturb or disrupt subsistence activities at a level that would make resources unavailable for harvest or significantly alter the existing levels of harvests. The summary impact of Alternative 3 is considered moderate to subsistence harvests of bowhead and beluga whales. Summary impacts to seals, walrus, 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 4.5.2.4.9 and 4.6.2.4.1 (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 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 3 are low in intensity, temporary 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 4.5.2.4.10 and 4.6.2.4.4 (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 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 3 would result in increased helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations. It is likely that there would be a 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.

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, Walrus, 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. 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. The impacts are considered moderate for bowhead whales, beluga whales, and caribou. Impacts to seals, walrus, 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 4.5.2.4.9 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 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 4.5.2.4.10 and 4.6.2.4.4 (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, if additional mitigation measure

D1 is applied there can be no transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay. 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 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 the levels of subsistence hunting and sharing of the resource that would be affected.

Seals

Sections 4.5.2.4.12 and 4.6.2.4.4 (Pinnipeds) 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.

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.

Under the increased level of activity with Alternative 3, the summary impacts of vessel traffic on subsistence harvest of bowhead whales, and beluga whales are expected to be moderate. The summary impact from vessel traffic to subsistence harvest of seals, walrus and polar bear 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 4.5.2.4.9 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, short term 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 Sections 4.5.2.4.10 and 4.6.2.4.4 (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 offshore 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, short term 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

Sections 4.5.2.4.12 and 4.6.2.4.4 (Pinnipeds) 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 offshore 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, short term 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.

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 same as under Alternative 2.

Summary impacts to subsistence harvest of bowhead whales and beluga whales due to icebreaking and ice-management activities are expected to be moderate. Summary impacts to subsistence harvest of seals and polar bears are considered to be minor. Summary Impacts to walrus, fish, and bird hunting and egg gathering from icebreaking are expected to be negligible and the same as under Alternative 2. No impacts to 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, Pacific walrus, 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 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 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.

Summary

Using the impact criteria identified in Table 4.5-25, 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 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 be considered to 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 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to public health are discussed under Alternative 2 (Section 4.5.3.3).

4.6.3.3.3 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, the duration of changes may be permanent, and multiple communities could be affected.

4.6.3.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to public health are discussed under Alternative 2 (Section 4.5.3.3).

4.6.3.4 Cultural Resources

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 minor.

4.6.3.4.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to cultural resources are discussed under Alternative 2 (Section 4.5.3.4).

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 4.5.3.2.

4.6.3.4.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to cultural resources are discussed under Alternative 2 (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. However, the amount of on-ice seismic surveys and icebreaking remained the same. Taking into consideration these increases, direct and indirect effects to the recreation, residential, mining, and protected land uses are 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 increases 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 are 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 are 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 3.3.6 Coastal Management, the Alaska Coastal Management Program was not reauthorized by the State legislature and is no longer in effect.

4.6.3.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to land and water ownership, use, and management are discussed under Alternative 2 (Section 4.5.3.5).

4.6.3.5.3 Conclusion

Based on Table 4.4-2, and the analyses provided in Section 4.5.3.5, the impacts on land and water ownership under Alternative 3 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no ownership changes will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership/development rights are considered to be negligible; they would be low intensity, temporary, localized, and do not result in changes of ownership.

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5, 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 temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent 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 impact and long term structures 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 temporary 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 localized 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 temporary in nature, local, and common.

4.6.3.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to land and water ownership, use, and management are discussed under Alternative 2 (Section 4.5.3.5).

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), though of an elevated intensity. 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 short term in duration (length of survey or exploratory drilling activities each year). The extent of increased aircraft presence may be on a local and 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, temporary in duration, and local in extent and affect a common resource. The impact level could be considered minor to moderate.

4.6.3.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to transportation are discussed under Alternative 2 (Section 4.5.3.6).

4.6.3.6.3 Conclusion

Increased levels of marine vessel traffic in Alternative 3 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 littering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence and the potential for vessel strikes to marine mammals would be low in intensity, temporary in duration, limited in geographic extent to a local area, and common to potentially unique context (in respect to protected marine mammal resources). The summary impact from increases in vessel traffic would be considered minor.

4.6.3.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to transportation are discussed under Alternative 2 (Section 4.5.3.6).

4.6.3.7 Recreation and Tourism

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.

4.6.3.7.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to recreation and tourism are discussed under Alternative 2 (Section 4.5.3.7). Adverse impacts to recreation and tourism would be reduced by having a plan in place to minimize the likelihood of a spill, outline the response protocol in the event of a spill, and identify the means of minimizing impacts to marine mammals following a spill.

4.6.3.7.2 Conclusion

The direct impacts to recreation and tourism would be low intensity, temporary 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.

4.6.3.7.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to recreation and tourism are discussed under Alternative 2 (Section 4.5.3.7).

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 describe in Section 4.10.4.19, 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 short-term 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, localized and occur in an important context.

4.6.3.8.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to visual resources are discussed under Alternative 2 (Section 4.5.3.8).

4.6.3.8.3 Conclusion

Implementation of Alternative 3 is expected to result in *short-term 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 localized; however they would occur in an important ecosystem.

4.6.3.8.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to visual resources are discussed under Alternative 2 (Section 4.5.3.8).

4.6.3.8.5 Additional Mitigation Measures

Additional mitigation measures recommended as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Category D of the Additional Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in subsistence hunting) to vessel-based surveys and construction-related transport of drilling equipment 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.

Taken together these mitigation measures would reduce exposure to visual impacts from survey vessels during a key period of subsistence activity, but would not change the Scenic Quality Class identified for Alternative 2.

4.6.3.9 Environmental Justice

4.6.3.9.1 Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

The activity levels associated with Alternative 3 are expected to result in similar levels of disruption of 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). Alternative 3 activity levels are expected to cause a negligible increase in contamination levels of subsistence food sources (described in the Public Health Section 4.5.3.3), which could have the indirect effect of adding a similar perception as Alternative 2 that subsistence foods are contaminated and alter confidence in their consumption.

4.6.3.9.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to environmental justice are discussed under Alternative 2 (Section 4.5.3.9). With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts from oil and gas exploration activity, noise, and disturbance would not be expected to occur. This is discussed further in Subsistence Section 4.6.3.2.

4.6.3.9.3 Conclusion

Activities related to implementation of Alternative 3 would have a low intensity impact on subsistence resources and human health, a temporary duration, and a regional extent. Subsistence foods and human health are unique resources and they are protected under the MMPA and EO 12898. Thus, Alternative 3 is expected to have a minor impact to subsistence resources and human health. There would also be minor disproportionate impacts to Alaska Native communities under Alternative 3.

4.6.3.9.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to environmental justice are discussed under Alternative 2 (Section 4.5.3.9). Additional mitigation measures to reduce discharge of wastes that potentially impact marine mammals would likely reduce the potential for introduction of new contaminants to subsistence foods. These mitigation measures would reduce adverse impacts to subsistence foods and would not contribute to impacts on human health.

4.7 Direct and Indirect Effects for Alternative 4 – Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures

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

The effects of Alternative 4 on water depth and general circulation would be the same as those described for Alternative 3.

Currents, Upwellings, and Eddies

The effects of Alternative 4 on currents, upwellings, and eddies would be the same as those described for Alternative 3.

Tides and Water Levels

The time/area closures described under Alternative 4 would not affect tides or water levels within the EIS project area.

Stream and River Discharge

The time/area closures described under Alternative 4 would not affect stream and river discharge within the EIS project area.

Sea Ice

The effects of Alternative 4 on sea ice would be substantially the same as those described for Alternative 3. The time area closures included as additional mitigation measures in Alternative 4 would not substantially change the effects of the alternative on sea ice resources in the proposed action area.

4.7.1.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to physical ocean resources are discussed under Alternative 2 (Section 4.5.1.1).

4.7.1.1.3 Conclusion

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. The overall effects of the proposed activity described in Alternative 4 on physical ocean resources in the EIS project area would be minor.

4.7.1.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to physical ocean resources are discussed under Alternative 2 (Section 4.5.1.1).

4.7.1.2 Climate

4.7.1.2.1 Direct and Indirect Effects

Project-Related Effects to Climate Change

Alternative 4 involves the same exploration activities as proposed in Alternative 3, 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 4 are the same as those for Alternative 3, therefore the magnitude, duration, extent, context, and impact level for Alternative 4 is expected to be the same as for Alternative 3.

Effects of Climate Change on the Proposed Action

As mentioned in Section 4.5.1.2 Climate under Effects of Climate Change on the Proposed Action, global climate change is attributed to changes in sea ice extent and thickness, ocean salinity, and ocean temperatures which could also affect wildlife that depends on these resources. Since Alternative 4 includes time/area closures for protection of wildlife and subsistence hunting, the possibility exists that climate change could affect this aspect of Alternative 4. All other potential effects discussed in Section 4.5.1.2 Climate under Effects of Climate Change on the Proposed Action would also apply to Alternative 4.

4.7.1.2.2 Standard Mitigation Measures

There are no standard mitigation measures expected to alter the projected impacts associated with climate change.

4.7.1.2.3 Conclusion

Direct impacts from Alternative 4 are expected to be 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 Alternatives 2 and 3: minor to moderate.

4.7.1.2.4 Additional Mitigation Measures

No additional mitigation measures have been identified to address impacts associated with climate change.

4.7.1.3 Air Quality

4.7.1.3.1 Direct and Indirect Effects

Permitting requirements are expected to remain the same under this alternative, with a worst-case scenario event matching that shown in Table 4.5-6. Assuming that the same level of activity would occur and work around time/area closures, this level of permitted activity is expected to have a moderate effect on air quality.

The overall emissions from Alternative 4 are based on the Level 2 Exploration Activity, therefore the equipment numbers and usage are expected to match those for Alternative 3 (see Table 4.6-2). The effects on air quality are the same as those for Alternative 3.

4.7.1.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to air quality are discussed under Alternative 2 (Section 4.5.1.3).

4.7.1.3.3 Conclusion

Direct and indirect impacts to air quality resulting from the implementation of Alternative 4 would be moderate in magnitude, but temporary, localized, and would affect common resources. Therefore, the summary impact level of Alternative 4 on air quality would be considered minor.

4.7.1.3.4 Additional Mitigation Measures

No additional mitigation measures are identified for air quality.

4.7.1.4 Acoustics

Under Alternative 4, the number and types of exploration programs envisioned is identical to Alternative 3. A detailed discussion of the acoustic properties of the noise sources is given in Section 4.5.1.4.

Alternative 4 differs from Alternative 3 only in that it implements time/area closures for avoidance of higher marine mammal densities during migration or periods of feeding or subsistence use.

4.7.1.4.1 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 4 are identical to those provided in Alternative 3 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.

4.7.1.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to acoustics are discussed under Alternative 2 (Section 4.5.1.4).

4.7.1.4.3 Conclusion

While Alternative 4 presents the same level of activity as Alternative 3, lower levels of exploration activities may actually occur under Alternative 4 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 4 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. This issue is discussed in Section 4.5.1.4.

Alternative 4 could represent a smaller increase in activity over current levels than Alternatives 2 and 3. 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 4 is still considered to be regional, as in Alternatives 2 and 3. Therefore, the overall impact rating for direct and indirect effects to the acoustic environment under Alternative 4 would be moderate.

4.7.1.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to acoustics are discussed under Alternative 2 (Section 4.5.1.4).

4.7.1.5 Water Quality

Impacts to water quality from Alternative 4 are expected to be very similar to those described above for Alternative 3. The only difference between Alternative 3 and Alternative 4 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 3 are noted below.

4.7.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to impacts for Alternatives 2 and 3, 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 and 3, 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 and 3, 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 and 3. Time/area closures established under Alternative 4 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. Overall, the effects of Alternative 4 on water quality resulting from changes in temperature and salinity would be low intensity, temporary, and local. The overall effects of Alternative 4 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 and 3, effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 4, 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 and 3, 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, 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 4 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 4 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 4 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 and 3, 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 and 3, 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 and 3, 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 and 3. Time/area closures established under Alternative 4 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 4 on water quality resulting from changes in metal concentrations are expected to be low intensity, temporary, and local. The overall effects of Alternative 4 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 and 3, 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 4 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 and 3, 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 4 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 and 3, 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 4. 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 (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 and 3. Time/area closures established under Alternative 4 as mitigation measures would reduce adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 4 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 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.

4.7.1.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to water quality are discussed under Alternative 2 (Section 4.5.1.5).

4.7.1.5.3 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.

4.7.1.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to water quality are discussed under Alternative 2 (Section 4.5.1.5).

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.

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.

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 4 on the four categories of ecosystem functions (defined in Section 4.4.1.6) are assessed below.

Regulation Functions

Additional mitigation measures related to time area closures under Alternative 4 would potentially result in decreased impacts to regulation functions relative to Alternative 3. 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 4 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 4 would potentially result in decreased impacts to habitat functions relative to Alternative 3. 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 4 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 4 would potentially result in decreased impacts to production functions relative to Alternative 3. 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 4 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 4.

Information Functions

Additional mitigation measures related to time area closures under Alternative 4 would potentially result in decreased impacts to information functions relative to Alternative 3. 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 4 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.

4.7.1.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to environmental contaminants and ecosystem functions are discussed under Alternative 2 (Section 4.5.1.6).

4.7.1.6.3 Conclusions

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 4 would be medium-intensity, temporary, 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. Overall effects of Alternative 4 on ecosystem functions would be minor.

4.7.1.6.4 Additional Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to environmental contaminants and ecosystem functions are discussed under Alternative 2 (Section 4.5.1.6).

4.7.2 Biological Environment

4.7.2.1 Lower Trophic Levels

4.7.2.1.1 Direct and Indirect Effects

Activity levels in Alternative 4 are the same as in Alternative 3, and there are additional mitigation measures for seasonal closures for certain areas. These mitigated closures do not affect lower trophic levels in the EIS project area, so the impacts discussed in Sections 4.5.2 and 4.6.2 for Alternatives 2 and 3 are the same for Alternative 4, making the overall impact to lower trophic levels be minor.

4.7.2.1.2 Standard Mitigation Measures

Standard mitigation measures that could reduce adverse impacts to lower trophic levels are discussed under Alternative 2 (Section 4.5.2.1).

4.7.2.1.3 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 4 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 medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate

4.7.2.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to lower trophic levels are discussed under Alternative 2 (Section 4.5.2.1).

4.7.2.1.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on lower trophic level organisms except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the benefits relative to the standard mitigation measures would be limited to small numbers of benthic organisms and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on lower trophic level organisms would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect common resources. If exploration activities introduced invasive species, the level of impacts could be of medium intensity, long-term or permanent duration, and of regional geographic extent and would be considered moderate. The effects of Alternative 3 with additional mitigation measures would therefore be considered negligible to moderate for lower trophic level organisms.

4.7.2.2 Fish and Essential Fish Habitat

4.7.2.2.1 Direct and Indirect Effects

Alternative 4 assumes the same level of oil and gas exploration activity as Alternative 3, described as Level 2. 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 is the same for Alternative 4 as for Alternative 3.

Alternative 4 differs from Alternative 3 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, 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 Native Alaskan 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, and the amount of altered or damaged habitat would also be reduced.

An analysis of each time/area closure area is included here, as well as the anticipated mitigating impact each closure would 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.

4.7.2.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to fish and EFH are discussed under Alternative 2 (Section 4.5.2.2).

4.7.2.2.3 Time/Area Closures

Camden Bay

The Camden Bay closure area extends from the coast of the North Slope to the edge of the continental shelf. It covers shallow nearshore habitats, coastal estuaries, and the deeper waters near the shelf, although none of the closure area has been identified as particularly productive fish habitat in any studies. The continental shelf exhibits higher fish densities than other parts of the Beaufort Sea but mostly in the northwest corner, north of Barrow. For this reason, it is unlikely that this Time/Area Closure would result in any measurable reduction of impacts on fish resources.

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 and also providing a small decrease in habitat loss and alteration. 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 amount of high quality habitat lost or altered and reducing 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.

Hanna Shoal

The Hanna Shoal is known to be a highly productive and important biological area, with high concentrations of sea birds, walrus and whales (Nelson et al. 1993). Although the fish resources in the area are not well understood, studies are currently being undertaken to better catalogue and describe the importance of the area. From the number of other species known to use the area, it can be assumed that it is important fish habitat, likely showing a high density of fish resources, particularly compared to the rest of the Chukchi Sea. This closure area contains very few lease sales, with a limited number located in the far southwestern corner. Therefore, drilling would be essentially eliminated from the list of activities potentially impacting the resources. 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 by decreasing the amount of high quality habitat lost or altered and reducing 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.

Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit

The Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit 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.

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 3.2.2.6). 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.

4.7.2.2.4 Conclusion

The effect of the Time/Area Closures outlined in Alternative 4 on Fish Resources and EFH would be a reduction in the overall impact. Although the overall impact is considered to be negligible based on Alternative 3 alone, any further reduction in impacts resulting from the Time/Area Closures would be beneficial. The already low impact levels would be decreased by each of the individual closures, and any combination would reduce the impacts further. Implementing all of the Time/Area Closures would substantially decrease all effects on fish resources by protecting the most important fish habitats where the highest fish densities are found. Due to the substantial decrease to the already very small scale of any potential effects relative to overall population levels and available habitat, there would be no measurable effect on the resource.

4.7.2.2.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to fish and EFH are discussed under Alternative 2 (Section 4.5.2.2).

4.7.2.2.6 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on fish and EFH except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the benefits relative to the standard mitigation measures would be limited to small numbers of benthic organisms and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on fish and EFH would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect common resources. The effects of Alternative 4 with additional mitigation measures would therefore be considered negligible for fish and EFH.

4.7.2.3 Marine and Coastal Birds

4.7.2.3.1 Direct and Indirect Effects

Alternative 4 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 4 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 4.

The difference between alternatives concerning birds is a matter of degree. Alternative 4 includes a larger number of some authorized exploration activities than Alternative 2. Alternative 4 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 3, 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: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoals, and Kasegaluk Lagoon/Ledyard Bay. The difference between Additional B1 and Alternative 4 is that specific time periods have been specified under Alternative 4 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 Ledyard Bay Critical Habitat Unit/Kasegaluk Lagoon, would be subject to the same closure period as any of the other alternatives, July 1 through November 15, because this restriction is one of the mitigation measures imposed by the USFWS to protect ESA-listed species under their jurisdiction (see Section 4.5.2.3). The other areas are certainly important to particular species during the time periods considered, such as Barrow Canyon and the adjacent waters are for Ross's gull in the fall, but spatial/temporal restrictions in areas besides Ledyard Bay would not be as effective in reducing adverse effects to birds as they would be for bowhead whales.

The direct and indirect effects of oil and gas exploration activities on marine and coastal birds would be very similar under Alternative 4 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 4 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 4, 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 4 as under Alternative 2 so this special habitat 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 4.9.

4.7.2.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3).

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 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 temporary or short-term, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 4 on marine and coastal birds would therefore be considered negligible to minor according to the impact criteria in Table 4.5-17.

4.7.2.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3).

4.7.2.3.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on birds except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the benefits relative to the standard mitigation measures would be limited to small numbers of birds and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on birds would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect important or unique resources. The effects of Alternative 4 with additional mitigation measures would therefore be considered negligible to minor for birds.

4.7.2.4 Marine Mammals

4.7.2.4.1 Bowhead Whales

4.7.2.4.1.1 Direct and Indirect Effects

Alternative 4 includes the same level of oil and gas exploration activity as Alternative 3. The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 4 are also identical to those for Alternatives 2 and 3 except that the time/area closures discussed as additional measures in Alternatives 2 and 3 are required in this alternative. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 4 as for Alternative 3. These are briefly summarized below.

Alternative 4 differs from Alternative 3 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: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, and Kasegaluk Lagoon/Ledyard Bay. No oil and gas industry exploration activities would be permitted to occur in the areas specified here during the listed timeframes. Additionally, buffer zones around these time/area closures could potentially 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. In the event that a buffer zone of this size was impracticable, a buffer zone avoiding the ensonification of the important habitat above 180 dB could be used. 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 Alaska Native marine mammal subsistence hunting activities.

An analysis of each Time/Area Closure area, along with the anticipated mitigating impact each closure could have on bowhead whales, 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 4 are identical to those under Alternative 3, the types and mechanisms for disturbance to bowhead whales would be the same. The level of disturbance and potential direct and indirect effects on bowhead whales would therefore be the same for Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4, the components of which were considered to be of medium intensity, temporary duration, local to regional extent and unique context.

Please refer to Section 4.5.2.4.9 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 4 are identical to those under Alternative 3, the mechanisms for injury and mortality to bowhead whales would be the same. The level of potential direct and indirect physical effects on bowhead whales would therefore be the same for Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4, the components of which were primarily considered to be of medium intensity, generally temporary in duration (except in instances of mortality or serious injury), local in extent and of unique context.

Please refer to Section 4.5.2.4.9 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 4 are identical to those under Alternative 3, the mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on bowhead whale habitat would therefore be the same for Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4.

Please refer to Section 4.5.2.4.9 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 4.5.2.4.9).

4.7.2.4.1.3 Time/Area Closures Required Under Alternative 4

Table 4.7-1 Bowhead Whale Presence in Closure Areas Required Under Alternative 4

Closure Area	Shelf Break of the Beaufort Sea	Camden Bay	Barrow Canyon	Hanna Shoal	Kasegaluk Lagoon	Ledyard Bay Critical Habitat Unit
Closure Time Period	Mid-July to Late September	Approximately 1 September to 15 October	Approximately 15 September to Early October	Approximately 15 September to Early October	Mid-June to Mid-July	1 July to 15 November
Occurrence	Late-August to October	August to October	Late-August to October	September and October (migratory corridor)	Do Not Occur (migrate offshore)	Do Not Occur (migrate offshore)

Camden Bay

Camden Bay is considered a special habitat area for analysis purposes in this EIS (Figure 3.2-25). The area appears to be an important feeding area for bowhead whales, primarily during the fall (Huntington and Quakenbush 2009, Koski and Miller 2009, Quakenbush et al. 2010a). A disproportionately higher number of mothers and calves occur in Camden Bay from early September into October (Koski and Miller 2009). Time/Area closures that would be instituted under Alternative 4 were designed to eliminate adverse impacts on bowhead whales (September 1 to October 15) and subsistence hunting during the fall bowhead whale hunts from Kaktovik and Nuiqsut (Cross Island) (late August to early October). 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. Reducing impacts on concentrations of bowhead whales, particularly mothers and calves, could be energetically beneficial to individual whales and important on a population level, assuming the closure mitigates potential impacts on calves. Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects from medium to low 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 special habitat areas.

Barrow Canyon/Western Beaufort Sea

Barrow Canyon/Western Beaufort Sea is considered a special habitat area for analysis purposes in this EIS (Figure 3.2-25). 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 4 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. 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 from medium to low 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 special habitat areas.

Shelf Break of the Beaufort Sea

The shelf break of the Beaufort Sea is considered an important feeding habitat for belugas whales, prompting potential closure of the area from mid-July to late-September under Alternative 4 (Figure 3.2-25). Closure of this area could affect the fall migratory corridor for bowheads traveling across the Beaufort Sea during September. The fall migratory corridor is broad and, while most travel across inshore waters, some bowheads travel offshore (Quakenbush et al. 2010a) and may benefit from the closure during part of the migratory period. Active leases in the Beaufort Sea are generally on the shelf, inshore of the shelf break, removing drilling from the list of activities potentially impacting bowhead whales and mitigated through this closure. Seismic activities and associated vessel traffic would be affected by the closure, reducing potential adverse impacts on bowhead whales, especially those associated with noise disturbance, such as displacement or impacts on calling behavior. The time and location of reduced adverse impacts would be limited to the area defined by the shelf break. Noise effects of activities occurring outside of this closure area may 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 special habitat areas. Refer to Section 4.5.2.4 for a discussion on behavioral effects of oil and gas exploration activities on bowhead whales, including distances from sound sources from which responses have been observed.

Hanna Shoal

Hanna Shoal is considered a special habitat area for analysis purposes in this EIS (Figure 3.2-26). It is currently an important feeding area for Pacific walrus (USGS 2011) and was historically important as a feeding area for gray whales (Moore et al. 2000, Nelson et al. 1994). Closures of Hanna Shoal proposed under Alternative 5 are to mitigate potential impacts on walrus (July to August) and gray whales (late August to early October), as well as to avoid conflicts with subsistence hunters during the fall bowhead whale hunt (September 15 to close of the hunt). Barrow, and on occasion, Wainwright conduct fall subsistence hunts for bowhead whales in the northeast Chukchi Sea where they could be impacted by vessels transiting between the coast and Hanna Shoal. Harvested whales are generally taken well inshore of Hanna Shoal (Ashjian et al. 2010). Hanna Shoal is not a feeding area for bowhead whales, but it is within the Chukchi Sea fall migratory corridor of bowhead whales (see Figure 3.2-26). 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 bowhead whales migrating across the area. Reduced adverse impacts would be limited to the area defined by the Hanna Shoal 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 special habitat areas.

Refer to Section 4.5.2.4 for a discussion on behavioral effects of oil and gas exploration activities on bowhead whales, including distances from sound sources from which responses have been observed.

Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit

Kasegaluk Lagoon and the Ledyard Bay Critical Habitat Unit are considered special habitat areas for analysis purposes in this EIS. Kasegaluk Lagoon and Ledyard Bay provide important habitat for beluga whales, spotted seals, and spectacled eiders, but these areas are not used by bowhead whales. Bowhead whales migrating through the lead system along the Chukchi Sea coast in spring generally pass offshore of this area (see Figure 3.2-26) and would be out of the area and in the eastern Beaufort Sea by mid-June and July when the closures would go into effect (Quakenbush et al. 2010a). Bowhead whales migrating through the Chukchi Sea in fall also appear to remain to the west of the Ledyard Bay Critical Habitat Unit (see Figure 3.2-26). These closure areas do not contain any lease areas, eliminating drilling from the list of activities potentially impacting resources and mitigated through these closures. Seismic surveys and associated vessel and aircraft traffic would, except in emergency situations, divert around the closure area, which could increase traffic elsewhere, potentially closer to areas through which some bowhead whales could be migrating. Closure of these areas would afford little, if any, additional mitigation effects or reduction of adverse impacts of oil and gas activities on bowhead whales. Effects of activities in the Chukchi Sea during the fall migration would be as described for Alternatives 2 and 3.

4.7.2.4.1.4 Conclusion

Effects of disturbance on bowhead whales from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 4 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 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 localized areas than would result in the absence of closures. However, bowhead whale 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. Effects of concurrent closures also need to be considered. Time/area closures in the Beaufort Sea (Camden Bay, 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 4 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 3 (Section 4.6.2.4) and would be considered moderate.

4.7.2.4.1.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.9). All time/area closures included in Additional Mitigation Measure B1 would be required under Alternative 4.

4.7.2.4.1.6 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 4.5.2.4.9 for details.

4.7.2.4.2 Beluga Whales

4.7.2.4.2.1 Direct and Indirect Effects

Alternative 4 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 3, including the same 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: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, and Kasegaluk Lagoon/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 difference between Additional Mitigation Measure B1 and Alternative 4 is that all of the time/area closures would be implemented. The analyses for direct and indirect effects, standard mitigation measures, and additional mitigation measures are the same for Alternative 4 as for Alternative 3. These are briefly summarized below. An analysis of relevant time/area closure areas, along with their potential mitigating impacts on beluga whales, follows this summary information.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3. Therefore, the types and mechanisms for disturbance to beluga whales would be the same for Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4.2, as would the resulting level of disturbance and potential direct and indirect effects on beluga whales. Potential effects were considered to be of low to medium intensity, temporary duration, local in extent and of unique context. Refer to Sections 4.5.2.4.10 and 4.6.2.4.2 for complete discussions of disturbance effects, by activity type, on beluga whales.

Hearing Impairment, Injury, and Mortality

As discussed under Alternatives 2 and 3 (Sections 4.5.2.4.10 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. 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 unique, since beluga whales are an integral part of the Iñupiat subsistence lifestyle. 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 due to the belugas cultural significance. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale.

Habitat Loss/Alteration

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3, so the mechanisms for habitat alteration or loss are likely to be the same. The level of potential direct and indirect effects on beluga whale habitat would therefore be the same for Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4.2.

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 4.5.2.4.10).

4.7.2.4.2.3 Time/Area Closures Required Under Alternative 4

The proposed time/area closures most relevant to beluga whales are Barrow Canyon and the Western Beaufort Sea, Beaufort Sea Shelf Break, and Kasegaluk Lagoon/Ledyard Bay. These are discussed below.

Table 4.7-2 Beluga Whale Presence in Closure Areas Required Under Alternative 4

Closure Area	Shelf Break of the Beaufort Sea	Camden Bay	Barrow Canyon	Hanna Shoal	Kasegaluk Lagoon	Ledyard Bay Critical Habitat Unit
Closure Time Period	Mid-July to Late September	Approximately 1 September to 15 October	Approximately Mid-July through August and 15 September to Early October	Approximately July to Early October	Mid-June to Mid-July	1 July to 15 November
Occurrence	July to September	Uncommon	Primarily July and August	Unknown	June and July	Spring (during migration)

Barrow Canyon/Western Beaufort Sea

Barrow Canyon/Western Beaufort Sea is considered a special habitat area by NMFS for the purposes of analysis in this EIS. Time/Area closures for this area proposed under Alternative 4 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 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 and avoidance). 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 an important feeding habitat for belugas whales, prompting proposed closure of the area from mid-July to late-September under Alternative 4. 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/Ledyard Bay Critical Habitat Unit

Kasegaluk Lagoon and the Ledyard Bay Critical Habitat Unit are considered special habitat areas for analysis purposes in this EIS (Figure 3.2-26). Kasegaluk Lagoon and Ledyard Bay provide important habitat for beluga whales, spotted seals, and spectacled eiders. 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). These closure areas do not contain any lease areas, so drilling activities would not be affected by these closures. Seismic surveys and associated vessel and aircraft traffic would, except in emergency situations, be required to divert around the closure areas. This could decrease disturbance effects of vessel activity within these important habitats and closure areas, while shifting vessel activity further offshore.

4.7.2.4.2.4 Conclusion

The overall impact to beluga whales is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but 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. The intensity and duration of the various effects and activities considered are mostly medium and temporary. 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.

The time/area closures required under Alternative 4 would essentially eliminate disturbance of belugas by exploration vessels in those areas but would not apply to other types of vessels and activities such as whaling. The specified closures are primarily intended to reduce impacts on bowhead and beluga whales and avoid interference with subsistence hunts, not to reduce overall exploration activity. The overall effects on belugas would therefore be similar to what would occur under Alternative 3 but it may occur in somewhat different times and places. In addition, industry may be able to move their exploration activities to other areas until the closure areas are available, so overall exploration effort may not be reduced and, given the wide distribution of belugas in the Beaufort and Chukchi seas, overall effects on belugas would just be displaced to other areas.

4.7.2.4.2.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.10).

4.7.2.4.3 Other Cetaceans

Alternative 4 assumes the same level of oil and gas exploration activity as Alternative 3, described as Level 2. 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 4 as for Alternative 3.

Alternative 4 differs from Alternative 3 in the creation and application of Time/Area Closures. 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 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 the same as those discussed in Additional Mitigation Measure B1: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the

Western Beaufort Sea, Hanna Shoal, and Kasegaluk Lagoon/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 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.

An analysis of each Time/Area Closure area, along with the anticipated mitigating impact each closure could have on cetaceans, follows the summary information on direct and indirect effects and standard and additional mitigation.

4.7.2.4.3.1 Direct and Indirect Effects

As Alternative 4 has the same level of activity as Alternative 3, 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.

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 4.5.2.4.11). Because the activity levels in both alternatives are identical, the effects of the Standard Mitigating Measures will also be the same.

4.7.2.4.3.3 Time/Area Closures

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 Native subsistence. As marine mammals are not randomly distributed throughout the EIS project area, targeted closures around important habitat areas would likely have a disproportionate beneficial impact to those animals that use those areas regularly. This measure may be costly to industry, as the feeding time for many marine mammals is at the same time as proposed industry operations (ice-free months).

Table 4.7-3 Other Cetaceans Presence in Closure Areas Required Under Alternative 4

Species	Shelf Break of the Beaufort Sea	Camden Bay	Barrow Canyon	Hanna Shoals	Ledyard Bay Critical Habitat Unit
Baleen whales (mysticetes)					
Gray whale	Present July-September, possibly overwintering	Present July-September, possibly overwintering	Present July-September, possibly overwintering	Present July-September	Not present
Humpback whale	Rare – August to October	Very Rare – August to October	Rare – August to October	Rare – August to October	Not present
Fin whale	Rare – August to October	Not present	Not present	Rare – August to October	Not present
Minke whale	Rare – August to October	Unknown – very rare, if present	Unknown – very rare, if present	Rare – August to October	Not present

Species	Shelf Break of the Beaufort Sea	Camden Bay	Barrow Canyon	Hanna Shoals	Ledyard Bay Critical Habitat Unit
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

Camden Bay

Camden Bay, considered a special habitat area for analysis purposes in this EIS. The Camden Bay closure area extends from the coast of the North Slope to the edge of the continental shelf. It covers shallow nearshore habitats, coastal estuaries, and the deeper waters near the shelf. Time/Area closures that would be instituted under Alternative 4 were designed to eliminate adverse impacts on bowhead whales (September 1 to October 15) and subsistence hunting during the fall bowhead whale hunts from Kaktovik and Nuiqsut (Cross Island) (late August to early October). Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects for other cetaceans during the closure period. Reduced adverse impacts would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact cetaceans within the closure zone because of the long distances that sound can travel underwater. However, the implementation of a buffer zones around the closure area would reduce and potentially eliminate this effect.

Barrow Canyon/Western Beaufort Sea

The Barrow Canyon/Western Beaufort Sea, considered a special habitat area for analysis purposes in this EIS. Physical and oceanographic features of Barrow Canyon promote a feeding “hotspot” here during late summer and fall. It is an important feeding area for numerous cetaceans, as bowhead, gray and beluga whales are all known to congregate in the area to exploit dense prey concentrations, typically during similar periods (Ashjian et al. 2010, Moore et al. 2010, Okkonen et al. 2011, Clarke et al. 2011b, 2011c; Moore et al. 2000). Time/Area closures for this area proposed under Alternative 4 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 to all three species, particularly those associated with noise disturbance (e.g. displacement and avoidance) on animals feeding, resting, or migrating through this area. 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 could result in a decreased intensity of effects from medium to low during the closure period. Reduced adverse impacts on cetaceans would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact cetaceans within the closure zone because of the long distances that sound can travel underwater. However, the implementation of a buffer zones around the closure area would reduce and potentially eliminate this effect.

Shelf Break of the Beaufort Sea

The shelf break of the Beaufort Sea is considered an important feeding habitat for belugas whales, prompting potential closure of the area from mid-July to late-September under Alternative 4. Closure of this area could affect the fall migratory corridor for gray whales traveling across the Beaufort Sea during the fall. The fall migratory corridor is broad and is similar to that followed by bowhead whales, although few gray whales have typically been found in the eastern Beaufort Sea, instead remaining closer to the Chukchi Sea (Rugh and Fraker 1981). Active leases in the Beaufort Sea are generally on the shelf, inshore of the shelf break, removing drilling from the list of activities potentially impacting bowhead whales and mitigated through this closure. Seismic activities and associated vessel traffic would be affected by the closure, reducing potential adverse impacts on all cetaceans, especially those associated with noise disturbance, such as displacement or impacts on calling behavior. The time and location of reduced adverse impacts would be limited to the area defined by the shelf break. Noise effects of activities occurring outside of this closure area could continue to impact cetaceans within the closure zone because of the long distances that sound can travel underwater. However, the implementation of a buffer zones around the closure area would reduce and potentially eliminate this effect.

Hanna Shoal

Hanna Shoal, considered a special habitat area for analysis purposes in this EIS. It is currently an important feeding area for Pacific walrus (USGS 2011) and is historically important as a feeding area for gray whales (Moore et al. 2000, Nelson et al. 1994). Closures of Hanna Shoal proposed under Alternative 5 are to mitigate potential impacts on walrus (July to August) and gray whales (late August to early October), as well as to avoid conflicts with subsistence hunters during the fall bowhead whale hunt (September 15 to close of the hunt). Barrow, and on occasion, Wainwright conduct fall subsistence hunts for bowhead whales in the northeast Chukchi Sea where they could be impacted by vessels transiting between the coast and Hanna Shoal. Closure of the area to all oil and gas exploration activities during September and October would reduce adverse effects of these activities, especially those associated with noise disturbance, such as displacement, particularly on gray whales. Any other cetaceans in the area would also benefit, although few individuals would benefit due to the low occurrence of other cetaceans in the area. Reduced adverse impacts would be limited mainly to the area defined by the Hanna Shoal closure area. Noise effects of activities occurring outside of this closure area could continue to impact cetaceans within the closure zone because of the long distances that sound can travel underwater. However, the implementation of a buffer zones around the closure area would reduce and potentially eliminate this effect.

Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit

Kasegaluk Lagoon and the Ledyard Bay Critical Habitat Unit are considered special habitat areas for this EIS. Kasegaluk Lagoon and Ledyard Bay provide important habitat for beluga whales, spotted seals, and spectacled eiders, but are not typically used by baleen whales and rarely used by toothed whales, other than belugas. These closure areas do not contain any lease areas, eliminating drilling from the list of activities potentially impacting resources and mitigated through these closures. Seismic surveys and associated vessel and aircraft traffic would, except in emergency situations, divert around the closure area, which could increase traffic elsewhere, potentially closer to areas through which some baleen whales could be migrating. Closure of these areas would afford little, if any, additional mitigation effects or reduction of adverse impacts of oil and gas activities on baleen whales, and offer marginal benefits to toothed whales. Effects of activities in the Chukchi Sea during the fall migration would be as described for Alternatives 2 and 3.

4.7.2.4.3.4 Conclusion

Effects of disturbance on other cetaceans from open-water exploration activities could be reduced in the closure areas during time periods specified in Alternative 4 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 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 localized 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. Effects of concurrent closures also need to be considered. Time/area closures in the Beaufort Sea (Camden Bay, 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.

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. 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 4 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 3 (see Section 4.6.2.4) and would be considered minor.

4.7.2.4.3.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.11). 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 4.5.2.4.11.

4.7.2.4.4 Pinnipeds

4.7.2.4.4.1 Direct and Indirect Effects

Alternative 4 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 4 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

Alternative 4 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 3, 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: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoals, and Kasegaluk Lagoon/Ledyard Bay. Descriptions of these areas are given in Sections 4.7.2.4.1 and 4.7.2.4.3 above. 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 specific time periods for each closure area correspond to periods of high biological productivity or important life functions for some species. Although the time/area closures are primarily designed to protect bowhead and beluga whales, Hanna Shoals has been noted as an important feeding habitat for bearded seals and Kasegaluk Lagoon/Ledyard Bay is 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. Further discussion of the time/area closures follows the summary information on direct and indirect effects and standard mitigation measures.

Disturbance

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3, so the types and mechanisms for disturbance to pinnipeds would be the same. The level of disturbance and potential direct and indirect effects on pinnipeds would therefore be the same for

Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4.4, the components of which were considered to be of low intensity, temporary duration, and local to regional in extent and unique context. See Section 4.5.2.4 for a complete discussion of disturbance effects, by activity type, on pinnipeds.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3, 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 4 as is discussed for Alternative 3 in Section 4.6.2.4.4. See Section 4.5.2.4.12 for a complete discussion of potential injury or mortality effects on pinnipeds.

Habitat Change

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3, 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 4 as is discussed for Alternative 3 in Section 4.6.2.4.4. See Section 4.5.2.4.12 for a discussion of potential effects oil and gas exploration activities on pinniped habitat.

4.7.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.12). These include a 190 dB shutdown/power down radius for pinnipeds, ramp-up procedures for airgun arrays, PSOs required, a 150 m buffer around ringed seal lairs, no energy source on top of ringed seal lairs, minimum flight altitudes for all support aircraft, changing vessel speed and/or direction to avoid collisions with ice seals, ice road marine mammal monitoring, development of an oil response plan, and measures intended to reduce conflicts with subsistence hunters. 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.

4.7.2.4.4.3 Time/Area Closures

Table 4.7-4 shows the special time/area closures specified under Alternative 4 and the presence of ice seal species in those areas. Alternative 4 specifies that, except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations shall avoid travel within the closure areas during the given time period. The time periods marked as approximate indicate that restrictions would be tied to real-time sighting information of bowheads and/or beluga whales and/or subsistence hunting activities.

Table 4.7-4 Ice Seal Presence in Time/Area Closures Required Under Alternative 4

Closure Area	Shelf Break of the Beaufort Sea	Camden Bay	Barrow Canyon	Hanna Shoals	Ledyard Bay Critical Habitat Unit
Closure Time Period	Mid-July to late September	Approximately September 1 to October 15	Approximately September 15 to Early October	Approximately September 15 to Early October	July 1 and November 15
Species Present	Ringed seal * Ribbon seal Bearded seal*	Ringed seal* Spotted seal Bearded seal*	Ringed seal Spotted seal Ribbon seal Bearded seal*	Ringed seal* Ribbon seal Bearded seal*	Ringed seal Spotted seal Ribbon seal Bearded seal

* Indicates concentrations for at least part of the period

To the extent that exploration activities would have occurred in the specified areas and time periods with the restrictions imposed under Alternative 4, the effects of disturbance on ice seals from open-water exploration activities would be reduced in these areas. However, exploration activities could be scheduled for different time periods within these areas so the reduction in effects would be short-term. In addition, industry may move their exploration activities to other areas until the closure areas are available so overall exploration effort may not be reduced and, given the wide distribution of ice seals in the Beaufort and Chukchi seas, overall effects on ice seals would just be displaced to other areas. In any case, the effects of disturbance on ice seals due to open-water exploration vessels and activities is considered to be negligible at the population level (see Section 4.5.2.4.X). A reduction in disturbance effects in the time/area closures specified under Alternative 4 would not change that conclusion.

4.7.2.4.4.4 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. Ringed seals and bearded seals would likely experience the greatest reduction in disturbance due to the time/area closures. They 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 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, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique 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 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.

4.7.2.4.4.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.12).

4.7.2.4.5 Walrus

4.7.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on Pacific walrus. This species is dependent on pack ice and coastal shores for haul outs. Alternative 4 includes all of the same types of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on Pacific walrus under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

Alternative 4 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 3, including the same suite of standard mitigation measures, yet with the addition of mandatory time/area closures. The closure areas are the same as those discussed in Additional mitigation measure B1: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, and Kasegaluk Lagoon/Ledyard Bay. Descriptions of these areas are given in Sections 4.7.2.4.1 and 4.7.2.4.3 above. 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. Although the time/area closures are primarily designed to protect bowhead and beluga whales, Hanna Shoals has been noted as an area of high biological productivity and an important feeding habitat for migrating whales, walrus (July to August), ice seals, and hunting polar bears. Hanna Shoal is relatively shallow, so sea ice often gets grounded and contributes to the consistent formation of leads and polynyas. The other areas also support Pacific walrus to various extents so time/area closures would reduce potentially adverse effects on walrus in those areas. However, if overall exploration effort remains the same but is just displaced to other areas and times, the total effects on walrus would likely be similar to what would occur under Alternative 3 but they may occur in somewhat different times and places. Further discussion of the time/area closures follows the summary information on direct and indirect effects and standard mitigation measures.

Disturbance

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3, so the types and mechanisms for disturbance to walrus would be the same. The level of disturbance and potential direct and indirect effects on walrus would therefore be the same for Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4.5. A more thorough discussion of disturbance effects, by activity type, on walrus can be found in Section 4.5.2.4.13.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3, so the types and mechanisms for injury and mortality to walrus would be the same. The level of potential direct and indirect physical effects on walrus would therefore be the same for Alternative 4 as is discussed for Alternative 3 in Section 4.6.2.4.5. A more thorough discussion of potential injury or mortality effects on walrus can be found in Section 4.5.2.4.13.

Habitat Change

The exploration activities that would be authorized under Alternative 4 are identical to those under Alternative 3, 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 4 as is discussed for Alternative 3 in Section 4.6.2.4.5. A more thorough discussion of potential impacts on walrus habitat can be found in Section 4.5.2.4.13.

4.7.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13). These include a 180 dB re 1 µPa rms shutdown/power down radius for Pacific walrus, ramp-up procedures for airgun arrays, PSOs required, minimum flight altitudes for all support aircraft, changing vessel speed and/or direction to avoid collisions with walrus, ice road marine mammal monitoring, development of an oil response plan, and measures intended to reduce conflicts with subsistence hunters. They would all function to the same level in regard to minimizing disturbance to walrus as discussed under Alternative 2. The key mitigation measures in this respect concern in-ice activities and the presence of PSOs.

4.7.2.4.5.3 Time/Area Closures

The reduction of exploration activity at the designated sites in the Beaufort Sea would have little mitigative value for walrus since they infrequently occur in those areas. However, Hanna Shoal is an important habitat for feeding walrus and a time/area closure to protect walrus during July and August would reduce the potential for disturbance of walrus. Ledyard Bay is also important habitat for walrus when the sea ice is present in spring and early winter. 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. Alternative 4 specifies that, except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations shall avoid travel within the closure areas during specified time periods tied to real-time sighting information of bowheads and/or beluga whales and/or subsistence hunting activities.

To the extent that exploration activities would have occurred in the specified areas and time periods with the restrictions imposed under Alternative 4, the effects of disturbance on walrus and their prey species from exploration activities would be reduced in these areas. However, exploration activities could be scheduled for different time periods within these areas so the reduction in effects would be short-term. In addition, industry may move their exploration activities to other areas until the closure areas are available so overall exploration effort may not be reduced and, given the wide distribution of walrus in the Chukchi Sea, overall effects on walrus could just be displaced to other areas. In any case, the effects of disturbance on walrus due to open-water exploration vessels and activities are considered to be minor at the population level. A reduction in disturbance effects in time/area closures specified under Alternative 4 would not change that conclusion.

4.7.2.4.5.4 Conclusion

Walrus 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 walrus 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 walrus 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 accidental 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 calf and juvenile mortality from stampedes.

Walrus 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 walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 4 would therefore be considered minor for Pacific walrus according to the criteria established in Table 4.5-17.

4.7.2.4.5.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13). They would all function to the same level in regard to minimizing the risk to walrus 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.

4.7.2.4.6 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 Alternative 2 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 Alternative 2 in Section 4.5.2.4.

Alternative 4 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 3, 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: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, and Kasegaluk Lagoon/Ledyard Bay. Descriptions of these areas are given in Sections 4.7.2.4.1 and 4.7.2.4.3 above. 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. Although the time/area closures are primarily designed to protect bowhead and beluga whales and to avoid conflicts with subsistence hunts during the open-water season, these areas may also be important for ice seals, a primary food source for polar bears. Because Hanna Shoal is relatively shallow, sea ice often gets grounded and contributes to the consistent formation of leads and polynyas which are important habitat for migrating whales, walrus, ice seals, and hunting polar bears. 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 4 are identical to those under Alternative 3, 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 4 as is discussed for Alternative 3 in Section 4.6.2.4.6. 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 4.5.2.4.14.

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 4.5.2.4.14). These include a 190 dB re 1 μPa rms shutdown/power down radius for polar bears, ramp-up procedures for airgun arrays, PSOs required, specified flight altitudes for all support aircraft, changing vessel speed and/or direction to avoid collisions with polar bears, ice road marine mammal monitoring, development of an oil spill response plan, and measures intended to reduce conflicts with subsistence hunters. 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 to monitor for polar bears and help reduce the risk of bear-human encounters.

4.7.2.4.6.3 Time/Area Closures

Alternative 4 specifies that, except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations shall avoid travel within the closure areas during specified time periods tied to real-time sighting information of bowheads and/or beluga whales and/or subsistence hunting activities. To the extent that exploration activities would have occurred in the specified areas and time periods with the restrictions imposed under Alternative 4, the effects of disturbance on polar bears and their prey species from exploration activities would be reduced in these areas. Exploration activities could theoretically be scheduled for different time periods within these areas so the reduction in effects would be short-term. However, some of the closure periods, such as those in Ledyard Bay, could be so extensive that overall exploration activity could be reduced. If that was not the case, industry may move their exploration activities to other areas until the closure areas are available so overall exploration effort may not be reduced and, given the wide distribution of polar bears and their prey species in the Beaufort and Chukchi seas, overall effects on polar bears and their prey would just be displaced to other areas. In any case, the effects of level 2 exploration activities on polar bears and their prey due to open-water exploration vessels and activities is considered to be minor at the population level. A reduction in disturbance effects in time/area closures specified under Alternative 4 would not change that conclusion.

4.7.2.4.6.4 Conclusion

The specified time/area closures under Alternative 4 are primarily intended to reduce impacts on bowhead and beluga whales and avoid interference with subsistence hunts, not to reduce overall exploration activity. The overall effects on polar bears would therefore be similar to what would occur under Alternative 3 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 bear-human 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 4 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary 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.

4.7.2.4.6.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.14). 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 4 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 to monitor for polar bears and help reduce the risk of bear-human encounters.

4.7.2.5 Terrestrial Mammals

Activity levels in Alternative 4 are the same as in Alternative 3, with the added requirement for seasonal closures for certain areas. These required closures under Alternative 4 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 4; the overall impact to terrestrial mammals would be minor.

4.7.2.6 Special Habitat Areas

The analysis of the direct and indirect effects associated with special habitat areas can be found in Sections 4.7.2.4 (Marine Mammals), 4.7.2.3 (Marine and Coastal Birds) and 4.7.3.2 (Subsistence).

4.7.3 Social Environment

4.7.3.1 Socioeconomics

4.7.3.1.1 Direct and Indirect Effects

Time/area closures may cause a reduction in or shift the timing of some support service activities described under Alternative 3. 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.

4.7.3.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to socioeconomics are discussed under Alternative 2 (Section 4.5.3.1). The application of the standard mitigation, that establishes Com Centers in subsistence communities and the hires of PSOs, have a beneficial effect on employment and personal income for all coastal communities. Time/area closures may reduce some of the employment or personal income activities associated with Com Centers and PSO hire by limiting the duration of these positions.

4.7.3.1.3 Conclusion

The socioeconomic impact under Alternative 4 is similar to Alternative 3 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 is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are 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 communities. The summary impact level for Socioeconomics under Alternative 4 is minor, not exceeding the significance threshold.

4.7.3.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to socioeconomics are discussed under Alternative 2 (Section 4.5.3.1).

4.7.3.1.5 Additional Mitigation Measures Conclusion

The additional mitigation measures that reduce negative impacts on marine mammals have a net effect of reducing subsistence activity to a minor summary impact level (see Section 4.4.3.2). When impacts to subsistence activity are reduced, the impact to the non-cash economy is reduced and the impact to local institutions is reduced. Therefore, additional mitigation measures reduce negative impacts to Socioeconomics.

4.7.3.2 Subsistence

4.7.3.2.1 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 4 differs from Alternative 3 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: Camden Bay, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, and Kasegaluk Lagoon/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.

4.7.3.2.2 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 4. However, under Alternative 4, 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, and 5. 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 Camden Bay, Barrow Canyon, the Western Beaufort Sea, and the Shelf Break in the Beaufort Sea would e 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, walrus, and polar bear.

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 Pt. 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 4 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, walrus, bearded, ringed and spotted seals, and polar bear, 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 walrus.

4.7.3.2.3 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 4 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.

4.7.3.2.4 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 4.

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 4.5.3.3. The effect of the time/area closures on subsistence resources is described in Section 4.7.3.2, which concludes that the closures will have a beneficial effect on subsistence harvests in Kaktovik and Barrow of bowhead whales, seals, walrus, and polar bear. Section 4.7.3.2 also 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 will 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 already negligible.

4.7.3.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to public health are discussed under Alternative 2 (Section 4.5.3.3). .

4.7.3.3.3 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, the duration of changes may be permanent, and multiple communities could be affected.

4.7.3.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to public health are discussed under Alternative 2 (Section 4.5.3.3).

4.7.3.4 Cultural Resources

Activity levels in Alternative 4 are the same as in Alternative 3. 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 4. The overall impact to cultural resources would be minor.

4.7.3.4.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to cultural resources are discussed under Alternative 2 (Section 4.5.3.4).

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 4.5.3.4.

4.7.3.4.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to cultural resources are discussed under Alternative 2 (Section 4.5.3.4).

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 resulting from Alternative 4 are similar to those resulting from Alternative 3. 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 4.7.3.2, Subsistence for further discussion.

The direct and indirect impacts to land and water use resulting from Alternative 4 are similar to those resulting from Alternative 3 for recreational, residential, and mining land uses. Refer to Section 4.5.3.5 for a discussion on these topics.

Alternative 4 includes the same activity level as Alternative 3 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 4 for industrial, transportation, and commercial land uses are similar to those discussed under Alternative 3 in Section 4.6.3.5, 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 4 are similar to those caused by Alternative 3. Refer to Section 4.6.3.5 for a discussion on these topics.

4.7.3.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to land and water ownership, use, and management are discussed under Alternative 2 (Section 4.5.3.5).

4.7.3.5.3 Conclusion

Based on Table 4.4-2 and the analyses provided in Section 4.5.3.5, the impacts on land and water ownership under Alternative 4 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no ownership changes will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership are considered to be negligible; they would be low intensity, temporary, localized, and do not result in changes of ownership.

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 4 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 temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent 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 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 4 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 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 4 on land and water management would be moderate because they would be low intensity, long term in nature, local, and common.

4.7.3.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to land and water ownership, use, and management are discussed under Alternative 2 (Section 4.5.3.5).

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) though of elevated intensity.

Under Alternative 4, the required time/area closures associated with Camden Bay, Barrow Canyon, Hannah Shoal, Kasegaluk Lagoon, and the Ledyard Bay Critical Habitat Unit 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 4, 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 temporary in duration. Any direct impact would be limited in geography to a local area and common in context. The probability of occurrence would be low, and any direct impact that did occur would be considered negligible to minor.

The direct impact from 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 short term in duration (length of survey or exploratory drilling activities each year). The extent of increased aircraft presence may be on a local and 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 to a common to potentially unique context (in respect to protected marine mammal resources), and, as a result, the impact level could be considered minor.

4.7.3.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to transportation are discussed under Alternative 2 (Section 4.5.3.6).

4.7.3.6.3 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 4. Any direct impact to regional marine transportation would be low in intensity, temporary in duration, and limited in geographic extent to a local area and common in context. The probability of occurrence would be low, and any summary impact that did occur would be considered negligible to minor.

4.7.3.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to transportation are discussed under Alternative 2 (Section 4.5.3.6).

4.7.3.7 Recreation and Tourism

To the extent that the required time/area closures contemplated in Alternative 4 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 4; the overall impact to recreation and tourism would be minor.

4.7.3.7.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to recreation and tourism are discussed under Alternative 2 (Section 4.5.3.7). Adverse impacts to recreation and tourism would be reduced by having a plan in place to minimize the likelihood of a spill, outline the response protocol in the event of a spill, and identify the means of minimizing impacts to marine mammals following a spill.

4.7.3.7.2 Conclusion

The direct impacts would be low intensity, temporary 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.

4.7.3.7.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to recreation and tourism are discussed under Alternative 2 (Section 4.5.3.7).

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 is expected to result in short-term moderate effects to scenic quality and visual resources identical to those described in Alternative 3. Potential impacts could be of low to medium intensity, depending on the geographic separation of programs. In either case, actions would be temporary, localized and occur in an important context.

4.7.3.8.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to visual resources are discussed under Alternative 2 (Section 4.5.3.8). 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 subsistence hunting) 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.

4.7.3.8.3 Conclusion

Implementation of Alternative 4 is expected to result in *short-term 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 localized; however they would occur in an important ecosystem.

4.7.3.8.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to visual resources are discussed under Alternative 2 (Section 4.5.3.8). Additional mitigation measures recommended as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Category D of the Additional Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in subsistence hunting) to vessel-based surveys and construction-related transport of drilling equipment 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.

Taken together these mitigation measures would reduce exposure to visual impacts from survey vessels during a key period of subsistence activity, but would not change the Scenic Quality Class identified for Alternative 2.

4.7.3.9 Environmental Justice

With the incorporation of time/area closures, the impacts to subsistence activities could be further minimized but would remain as minor impacts to subsistence foods and human health (see Subsistence Section 4.7.3.2). Contamination of subsistence foods would be the same as discussed under Alternative 3.

4.7.3.9.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to environmental justice are discussed under Alternative 2 (Section 4.5.3.9). With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts from oil and gas exploration activity, noise, and disturbance would not be expected to occur. This is discussed further in Subsistence Section 4.6.3.2.

4.7.3.9.2 Conclusion

Activities related to implementation of Alternative 4 would have a low intensity impact on subsistence resources and human health, a temporary duration, and a regional extent. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Thus, Alternative 4 is expected to have a minor impact to subsistence resources and minor disproportionate impacts to Alaska Native communities.

4.7.3.9.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to recreation and tourism are discussed under Alternative 2 (Section 4.5.3.9). Additional mitigation measures to reduce discharge of wastes that potentially impact marine mammals would likely reduce the potential for introduction of new contaminants to subsistence foods. These mitigation measures would reduce adverse impacts to subsistence foods and would not contribute to impacts on human health.

4.8 Direct and Indirect Effects for Alternative 5 – Authorization for Level 2 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 5, the number of exploration programs envisioned is identical to Alternatives 3 and 4 (see Sections 4.6.1.4 and 4.7.1.4), 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 5 contemplates Level 2 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.

4.8.1 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 3 and remain minor.

Currents, Upwellings, and Eddies

The effects of Alternative 5 on currents, upwellings, and eddies would be the same as those described for Alternative 3.

Tides and Water Levels

The activities described under Alternative 5 would not affect tides or water levels within the EIS project area.

Stream and River Discharge

The activities 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 the same as those described for Alternative 3. The additional mitigation measures included 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 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to physical ocean resources are discussed under Alternative 2 (Section 4.5.1.1).

4.8.1.1.3 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 5 on physical ocean resources in the proposed action area would be minor.

4.8.1.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to physical ocean resources are discussed under Alternative 2 (Section 4.5.1.1).

4.8.1.2 Climate

4.8.1.2.1 Direct and Indirect Effects

Project-Related Effects to Climate Change

Alternative 5 involves the same exploration activities as proposed in Alternatives 3 and 4, with the potential inclusion of alternative technologies. The estimated amount of GHG emissions associated with Alternative 5 are the same as those for Alternative 3, therefore the magnitude, duration, extent, context, and impact level for Alternative 5 is expected to be the same as for Alternative 3.

Effects of Climate Change on the Proposed Action

Alternative 5 involves the same type of exploration activities as Alternatives 2 through 4. Therefore effects of climate change on the proposed action is considered to be the same as for Alternatives 2 through 4 (Refer to Section 4.5.1.2 Climate under Effects of Climate Change on the Proposed Action).

4.8.1.2.2 Standard Mitigation Measures

The standard mitigation measures associated with Alternative 5 are not expected to alter the projected impacts associated with climate change.

4.8.1.2.3 Conclusion

Direct impacts from Alternative 5 are expected to be 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 5 are assumed to be the same as those for Alternatives 2 through 4: minor to moderate.

4.8.1.2.4 Additional Mitigation Measures

No additional mitigation measures have been identified to address impacts associated with climate change.

4.8.1.3 Air Quality

4.8.1.3.1 Direct and Indirect Effects

Permitting requirements are expected to remain the same under this alternative, with a worst-case scenario event matching that shown in Table 4.5-6. This level of permitted activity is expected to have a moderate effect on air quality.

The overall emissions from Alternative 5 are based on the Level 2 Exploration Activity; therefore the equipment numbers and usage are expected to match those for Alternative 3 (see Table 4.6-2). The effects on air quality are the same as those for Alternative 3.

4.8.1.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to air quality are discussed under Alternative 2 (Section 4.5.1.3).

4.8.1.3.3 Conclusion

Direct and indirect impacts to air quality resulting from the implementation of Alternative 5 would be moderate in magnitude, but temporary, localized, and would affect common resources. Therefore, the summary impact level of Alternative 5 on air quality would be considered minor.

4.8.1.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to air quality are discussed under Alternative 2 (Section 4.5.1.3).

4.8.1.4 Acoustics

Under Alternative 5, the number of exploration programs envisioned is the same as for Alternatives 3 and 4 (see Sections 4.6.1.4 and 4.7.1.4), 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 4.5-9. 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 4.8-1.

Table 4.8-1 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 4.8-2 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 (standard Alternative 3; see Table 4.6-3) 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 4.8-2 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)	39%	39%	39%		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%

4.8.1.4.1 Direct and Indirect Effects

Table 4.8-1 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.

4.8.1.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to acoustics are discussed under Alternative 2 (Section 4.5.1.4).

4.8.1.4.3 Conclusion

Alternative 5 proposes the same level of exploration activities as Alternative 3 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 3000 in^3 airgun array by less than 10dB. However, the estimates in Table 4.8-2 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.

4.8.1.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to acoustics are discussed under Alternative 2 (Section 4.5.1.4).

4.8.1.5 Water Quality

Impacts to water quality resulting from the activities proposed under Alternative 5 are expected to be very similar to those described above for Alternatives 3 and 4. Alternative 5 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 5.

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.

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.

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 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, 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.

4.8.1.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to water quality are discussed under Alternative 2 (Section 4.5.1.5).

4.8.1.5.3 Conclusion

Alternative 5 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 5 on water quality in the proposed action area would be minor.

4.8.1.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to water quality are discussed under Alternative 2 (Section 4.5.1.5).

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.

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.

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 4.4.1.6) are assessed below.

Regulation Functions

The effects of the activities proposed under Alternative 5 on regulation functions would be the same as those described under Alternative 3.

Habitat Functions

Alternative technologies associated with Alternative 5 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 5 on production functions would be the same as those described under Alternative 3.

Information Functions

The effects of the activities proposed under Alternative 5 on information functions would be the same as those described under Alternative 3.

4.8.1.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to environmental contaminants and ecosystem functions are discussed under Alternative 2 (Section 4.5.1.6).

4.8.1.6.3 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 5 would be medium-intensity, temporary, 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. Overall effects of Alternative 5 on ecosystem functions would be minor.

4.8.1.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to environmental contaminants and ecosystem functions are discussed under Alternative 2 (Section 4.5.1.6).

4.8.2 Biological Environment

4.8.2.1 Lower Trophic Levels

4.8.2.1.1 Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 3, but this alternative includes the option of using alternative technologies for seismic exploration. This requirement does not affect lower trophic levels in the EIS project area, so the impacts discussed previously for Alternatives 2, 3, and 4 are the same for Alternative 5; the overall impact to lower trophic levels would be minor.

4.8.2.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to lower trophic levels are discussed under Alternative 2 (Section 4.5.2.1).

4.8.2.1.3 Conclusion

The direct and indirect effects associated with Alternative 5 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 medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate

4.8.2.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to lower trophic levels are discussed under Alternative 2 (Section 4.5.2.1).

4.8.2.1.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on lower trophic level organisms except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the benefits relative to the standard mitigation measures would be limited to small numbers of benthic organisms and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on lower trophic level organisms would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect common resources. If exploration activities introduced invasive species, the level of impacts could be of medium intensity, long-term or permanent duration, and of regional geographic extent and would be considered moderate. The effects of Alternative 5 with additional mitigation measures would therefore be considered negligible to moderate for lower trophic level organisms.

4.8.2.2 Fish and Essential Fish Habitat

4.8.2.2.1 Direct and Indirect Effects

Alternative 5 applies the same levels of activity as Alternative 3, described as Level 2. 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 5 differs from Alternative 3 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 3. 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 from Alternative 3, see Section 4.5.2.2.

4.8.2.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to fish and EFH are discussed under Alternative 2 (Section 4.5.2.2). Because the activity levels in both Alternatives are identical, the effects of the Standard Mitigating Measures will also be the same.

4.8.2.2.3 Alternative Technologies

Hydraulic Marine Vibrators

The replacement of each airgun with a hydraulic 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 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.

Electric Marine Vibrators

The replacement of each airgun with an electric 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 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 unlikely to reduce any adverse impacts to fish resources. In fact, 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.

Low Frequency Passive Seismic Methods for Exploration

Low Frequency Passive Seismic Methods for Exploration are already in use but not yet proven in all environments. Of all the technologies, this one shows the most promise for mitigating adverse effects on fish, due to its passive acoustic nature. No sound would be emitted into the marine environment, resulting in the elimination of all seismic noise impacts.

4.8.2.2.4 Conclusion

The effect of the alternative technologies outlined in Alternative 5 on fish resources and EFH are difficult to determine with any certainty but are anticipated to result in a reduction in the overall impact. Although the overall impact is considered to be negligible based on Alternative 3 alone, any replacement of airgun arrays with alternative technologies would be reduce potentially adverse effects on fish. 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, and overall impact is considered to be negligible.

4.8.2.2.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to fish and EFH are discussed under Alternative 2 (Section 4.5.2.2). Because the activity levels in both Alternatives are identical, the effects of the additional mitigation measures will also be the same.

4.8.2.2.6 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on fish and EFH except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the benefits relative to the standard mitigation measures would be limited to small numbers of benthic organisms and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on fish and EFH would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect common resources. The effects of Alternative 5 with additional mitigation measures would therefore be considered negligible for 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 marine and coastal birds under Alternative 5 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 2009). 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 5.

The number of different exploration activities authorized under Alternative 5 would be the same as under Alternatives 3 and 4. However, implementation of Alternative 5 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 5 as those described under Alternatives 3 and 4. 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 5, 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 5 as under Alternative 2 so this special habitat 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 due to an exploration well blowout could have much more serious effects on birds and is discussed in Section 4.9.

4.8.2.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). These include aircraft flight paths and altitude restrictions to reduce the chance of disturbing marine and coastal birds, and development of an oil response plan and procedures for exploratory drilling to minimize the risk of spills occurring and to expedite clean-up responses. They would all function to the same level in regard to minimizing the risk to marine and coastal birds as discussed under Alternative 2.

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 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 temporary or short-term, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 5 on marine and coastal birds would therefore be considered negligible to minor according to the impact criteria in Table 4.5-17

4.8.2.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). They would all function to the same level in regard to minimizing the risk to marine and coastal bird habitats as discussed under Alternative 2.

4.8.2.3.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on birds except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the benefits relative to the standard mitigation measures would be limited to small numbers of birds and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on birds would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect important or unique resources. The effects of Alternative 5 with additional mitigation measures would therefore be considered negligible to minor for birds.

4.8.2.4 Marine Mammals

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 3. 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 considered for Alternative 3. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 3. These are briefly summarized below.

Alternative 5 differs from Alternative 3 in the application of alternative technologies. Alternative 5 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 and development 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 3. Many of these technologies are in the early stages of development and are difficult to assess. 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 5 are identical to those under Alternative 3, the types and mechanisms for disturbance to bowhead whales would be the same. The level of disturbance and potential direct and indirect effects on bowhead whales would therefore be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4, the components of which were considered to be of medium intensity, temporary 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

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 3, the mechanisms for hearing impairment, injury, and mortality to bowhead whales would be the same. The level of potential direct and indirect physical effects on bowhead whales would therefore be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4, the components of which were primarily considered to be of medium intensity, generally temporary in duration (except in instances of mortality or serious injury), local in extent and of unique context.

Please refer to Section 4.5.2.4 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 3, the mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on bowhead whale habitat would therefore be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4.

Please refer to Section 4.5.2.4 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 4.5.2.4.9).

4.8.2.4.1.3 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 4.8.1.4, 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 3000 in^3 airgun arrays, could, theoretically, substantially reduce acoustic threshold radii and areas of ensonification (Tables 4.8-1 and 4.8-2).

Hydraulic 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.

Electric Marine Vibrators

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.

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.

Low Frequency Passive Seismic Methods for Exploration

Low frequency passive seismic methods for exploration are already in use but not yet proven in all environments, nor have they been tested in the Arctic. Since low frequency passive seismic methods do not emit sound into the marine environment, this technology could mitigate adverse effects of noise on bowhead whales in the areas in which it is employed. Passive seismic surveys cannot, however, replace active seismic acquisition, so broad scale replacement of airguns is impossible in the future.

4.8.2.4.1.4 Conclusion

Mitigating capabilities and effects of alternative technologies introduced under Alternative 5 on bowhead whales are difficult to determine but could reduce adverse impacts associated with the use of airgun arrays (see Section 4.5.2.4 for details on effects of airgun noise on bowhead whales). 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 as described in Section 4.5.2.4. Effects of existing technology on bowhead whales, as described in Alternatives 2 and 3, would be mostly of medium intensity and temporary duration and range from localized to regional in 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. Bowhead whales are considered a unique resource, since they are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 5 on bowhead whales is considered to be moderate.

4.8.2.4.1.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.9).

4.8.2.4.2 Beluga Whales

Alternative 5 includes the same types of exploration activities described in Alternative 2, and the same number of exploration activities as Alternative 3. Alternative 5 differs, however, from Alternatives 2 and 3 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. 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 are identical to those under Alternative 3. Therefore, the types and mechanisms for disturbance to beluga whales would be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4.2, as would the resulting level of disturbance and potential direct and indirect effects on beluga whales. Potential effects were considered to be of low to medium intensity, temporary duration, local in extent and of unique context. Refer to Sections 4.5.2.4.10 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 5 is identical to Alternative 3, so the primary mechanisms of potential injury or mortality due to oil and gas exploration activities (auditory injury and collisions with vessels) are anticipated to be the same. The potential direct and indirect physical effects on beluga whales would therefore be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4.

Habitat Loss/Alteration

The exploration activities that would be authorized under Alternative 5 are the same as under Alternative 3, so the mechanisms for habitat alteration or loss are likely to be the same. The potential direct and indirect effects on beluga whale habitat would therefore be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4.

4.8.2.4.2.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.10).

4.8.2.4.2.2 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.8.2.4.1) 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.

Hydraulic 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.

Electric Marine Vibrators

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.

4.8.2.4.2.3 Conclusion

The use of alternative technologies would reduce noise impacts to beluga whales 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. 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 4.5.2.4.10.

The overall impact to beluga whales is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but 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. The intensity and duration of the various effects and activities considered are mostly medium and temporary. 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.

4.8.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.10).

4.8.2.4.3 Other Cetaceans

Alternative 5 applies the same levels of activity as Alternative 3, described as Level 2. 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 5 differs from Alternative 3 in the application of Alternative Technologies.

Alternative 5 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 3. Many of these technologies are in the early stages of development and are difficult to assess.

An analysis of each alternative technology follows the summary information on direct and indirect effects and standard mitigation measures.

4.8.2.4.3.1 Direct and Indirect Effects

As Alternative 5 has the same level of activity as Alternative 3, 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 4.6.2.4.3.

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 4.5.2.4.11). Because the activity levels in both alternatives are identical, the effects of the standard mitigation measures will also be the same.

4.8.2.4.3.3 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.8.2.4.1) 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.

Hydraulic 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

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.

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 4.8.2.4.1 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.

4.8.2.4.3.4 Conclusion

Mitigating capabilities and effects of alternative technologies introduced under Alternative 5 on Other Cetaceans are difficult to determine, but could reduce adverse impacts 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). The overall reduction 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. 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. Effects of existing technology on cetaceans, as described in Alternatives 2 and 3, would be mostly of medium intensity and temporary duration and range from localized to regional in 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. Most of the species within the Other Cetacean group are either common within the EIS project area, or else 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 5 on Other Cetaceans is considered to be 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 4.5.2.4.11).

4.8.2.4.4 Pinnipeds

4.8.2.4.4.1 Direct and Indirect Effects

Alternative 5 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 5 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 5 would be the same as under Alternatives 3 and 4. However, under Alternative 5, NMFS could potentially require the 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. 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 4.8.2.4.1 and 4.8.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on pinnipeds is incorporated into the following subsections.

Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 5 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 5 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 5 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 5 would be the same as for Alternative 3. 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 5 are identical to those under Alternative 3, 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 5 as is discussed for Alternative 3 in Section 4.6.2.4.4. Refer to Section 4.5.2.4.12 for a discussion of potential injury or mortality effects of oil and gas exploration activities on pinnipeds.

Habitat Change

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 3, so the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on pinnipeds habitat would therefore be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4.4. Refer to Section 4.5.2.4.12 for a discussion of potential effects oil and gas exploration activities on pinniped habitat.

4.8.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.12).

4.8.2.4.4.3 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. 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, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. 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 low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. 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.

4.8.2.4.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.12).

4.8.2.4.5 Pacific Walrus

4.8.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 5 on Pacific walrus. This species is dependent on pack ice and coastal shores for haul outs. Alternative 5 includes all of the same types of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on Pacific walrus 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 3 and 4. However, under Alternative 5, NMFS could potentially require the 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. 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 4.8.2.4.1 and 4.8.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on walrus is incorporated into the following subsections.

Disturbance

The exploration activities that would be authorized under Alternative 5 include several mechanisms for potential disturbance to walrus 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 walrus 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 walrus would not be present. Only one such in-ice survey could be authorized for each Arctic sea under any of the action alternatives. The physical presence of the icebreakers likely has as much or more to do with the disturbance of walrus 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 walrus 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 5 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on walrus.

The number of open water activities authorized under Alternative 5 would be the same as under Alternative 3 and likely to elicit similar disturbance effects. These activities could affect walrus 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 walrus. Any surveys conducted with alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which could disturb walrus in the water. The effects on walrus 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 5 are identical to those under Alternative 3, the types and mechanisms for injury and mortality to walrus would be the same. The level of potential direct and indirect physical effects on walrus would therefore be the same for Alternative 5 as is discussed for Alternative 3 in Section 4.6.2.4.5. A more thorough discussion of potential injury or mortality effects on walrus can be found in Section 4.5.2.4.13.

Habitat Change

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 3, 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 3 in Section 4.6.2.4.5. A more thorough discussion of potential impacts on walrus habitat can be found in Section 4.5.2.4.13.

4.8.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13). All mitigation measures required under the USFWS LOA will be applicable here.

4.8.2.4.5.3 Conclusion

Walrus 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 walrus 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 walrus 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 accidental 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 calf and juvenile mortality from stampedes.

Walrus 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 5, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 5 would therefore be considered minor for Pacific walrus according to the criteria established in Table 4.5-17.

4.8.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13).

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.

The number of different exploration activities authorized under Alternative 5 would be the same as under Alternatives 3 and 4. However, under Alternative 5, NMFS could potentially require the 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. 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 4.8.2.4.1 and 4.8.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on polar bears is incorporated into the following subsections, where relevant.

Disturbance

The exploration activities that would be authorized under Alternative 5 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 bear-human 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 5 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 5 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 5 is identical to those under Alternative 3, 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 5 as is discussed for Alternative 3 in Section 4.6.2.4.6. A more thorough discussion of disturbance effects of oil and gas exploration activities on polar bears can be found in Section 4.5.2.4.14.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 3, 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 5 as is discussed for Alternative 3 in Section 4.6.2.4.5. A more thorough discussion of potential injury or mortality effects of oil and gas exploration activities on polar bears can be found in Section 4.5.2.4.14.

Habitat Change

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 3, 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 5 as is discussed for Alternative 3 in Section 4.6.2.4.6. A more thorough discussion of potential impacts on polar bear habitat can be found in Section 4.5.2.4.14.

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 4.5.2.4.14).

4.8.2.4.6.3 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. 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 bear-human 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 5 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary 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.

4.8.2.4.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.14).

4.8.2.5 Terrestrial Mammals

Activity levels in Alternative 5 are the same as in Alternative 3, 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 5; the overall impact to terrestrial mammals would be minor.

4.8.2.6 Special Habitat Areas

The analysis of the direct and indirect effects associated with special habitat areas can be found in Sections 4.8.2.4 (Marine Mammals), 4.8.2.3 (Marine and Coastal Birds) and 4.8.3.2 (Subsistence).

4.8.3 Social Environment

4.8.3.1 Socioeconomics

4.8.3.1.1 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 3 (Level 2 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 4.8.3.2.

4.8.3.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to socioeconomics are discussed under Alternative 2 (Section 4.5.3.1). The application of the standard mitigation, that establishes Com Centers in subsistence communities and the hires of PSOs, have a beneficial effect on employment and personal income for all coastal communities. It is not anticipated that the use of alternative technologies would change employment or personal income activities associated with Com Centers and PSO hire.

4.8.3.1.3 Conclusion

The socioeconomic impacts under Alternative 5 are similar to Alternative 3 except there could be additional costs incurred by lease holders associated with lost productivity. The duration of the socioeconomic impacts is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are 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 communities. The summary impact level for Socioeconomics under Alternative 5 is minor.

4.8.3.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to socioeconomics are discussed under Alternative 2 (Section 4.5.3.1). The additional mitigation measures that reduce negative impacts on marine mammals have a net effect of reducing subsistence activity to a minor summary impact level (see Section 4.4.3.2). When impacts to subsistence activity are reduced, the impact to the non-cash economy is reduced and the impact to local institutions is reduced.

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 the same as those discussed under Alternative 3 (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 5 are also identical to those for Alternative 3. Alternative 5 differs from Alternative 3 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 2012 – 2017 timeframe. 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.

Low-frequency acoustic source (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 deep-towed acoustics/geophysics system (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 5 proposes the same level of exploration activities as Alternative 3 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 4.8.1.4 and Section 4.8.2.4), 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 localized to regional in extent. The context would range from common to unique. Bowhead whales, beluga whales and polar bears would be considered unique in context. Despite possible localized 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.

4.8.3.2.2 Standard Mitigation Measures

The effects of the standard mitigation measures to subsistence users and subsistence harvest would be expected to be the same as those discussed under Alternative 2 in Section 4.4.3.2.

4.8.3.2.3 Conclusion

The summary impacts to subsistence harvest and subsistence resources from alternative technologies under Alternative 5 are likely to be similar to Alternative 2 as discussed in Section 4.5.3.2.

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.

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 will 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 4.8.3.2, 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 5. 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.

4.8.3.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to public health are discussed under Alternative 2 (Section 4.5.3.3).

4.8.3.3.3 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, the duration of changes may be permanent, and multiple communities could be affected.

4.8.3.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to public health are discussed under Alternative 2 (Section 4.5.3.3).

4.8.3.4 Cultural Resources

Activity levels in Alternative 5 are the same as in Alternative 3, 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 5. The overall impact to cultural resources would be minor.

4.8.3.4.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to cultural resources are discussed under Alternative 2 (Section 4.5.3.4).

4.8.3.4.2 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 4.5.3.2.

4.8.3.4.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to cultural resources are discussed under Alternative 2 (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 caused by Alternative 5 are similar to those caused by Alternative 3. 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.

Alternative 5 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.

Land and Water Use

The direct and indirect impacts to land and water use resulting from Alternative 5 are similar to those resulting from Alternative 3 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 5 are similar those resulting from Alternative 3 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 5 are similar to those resulting from Alternative 3 for federal, state and borough and lands and waters. Refer to Section 4.6.3.5 for a discussion on these topics.

4.8.3.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to land and water ownership, use, and management are discussed under Alternative 2 (Section 4.5.3.5).

4.8.3.5.3 Conclusion

Based on Table 4.4-2, and the analyses provided above and in Section 4.5.3.5, the impacts on land and water ownership under Alternative 5 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no ownership changes will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership are considered to be negligible; they would be low intensity, temporary, localized, and do not result in changes of ownership.

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 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 temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent 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 5 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 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 temporary 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 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 5 on land and water management would be minor because they would be low intensity, would be short term in nature, local, and common.

4.8.3.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to land and water ownership, use, and management are discussed under Alternative 2 (Section 4.5.3.5).

4.8.3.6 Transportation

4.8.3.6.1 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 3 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, and 4.

4.8.3.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to transportation are discussed under Alternative 2 (Section 4.5.3.6).

4.8.3.6.3 Conclusion

The impacts of using alternative technologies would occur slowly – if possible – under the 2012 to 2017 timeframe. It is assumed that these new alternative technologies would require the same levels of aircraft and surface and vessel support as under Alternative 3, and, therefore, the impacts would be expected to be similar.

4.8.3.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to transportation are discussed under Alternative 2 (Section 4.5.3.6).

4.8.3.7 Recreation and Tourism

Activity levels in Alternative 5 are the same as in Alternative 3, 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

Alternatives 2 and 3 are the same for Alternative 5; the overall impact to recreation and tourism would be minor.

4.8.3.7.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to recreation and tourism are discussed under Alternative 2 (Section 4.5.3.7). Adverse impacts to recreation and tourism would be reduced by having a plan in place to minimize the likelihood of a spill, outline the response protocol in the event of a spill, and identify the means of minimizing impacts to marine mammals following a spill.

4.8.3.7.2 Conclusion

The direct impacts would be low intensity, temporary 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.

4.8.3.7.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to recreation and tourism are discussed under Alternative 2 (Section 4.5.3.7).

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 short-term moderate effects to scenic quality and visual resources identical to those described in Alternative 3. Potential impacts could be of low to medium intensity, depending on the geographic separation of programs. In either case, actions would be temporary, localized and occur in an important context.

4.8.3.8.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to visual resources are discussed under Alternative 2 (Section 4.5.3.8). 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 subsistence hunting) 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.

4.8.3.8.3 Conclusion

Implementation of Alternative 5 is expected to result in *short-term 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 localized; however they would occur in an important ecosystem.

4.8.3.8.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to visual resources are discussed under Alternative 2 (Section 4.5.3.8). Additional mitigation measures recommended as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Category D of the Additional Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in subsistence hunting) to vessel-based surveys and construction-related transport of drilling equipment 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.

Taken together these mitigation measures would reduce exposure to visual impacts from survey vessels during a key period of subsistence activity, but would not change the Scenic Quality Class identified for Alternative 2.

4.8.3.9 Environmental Justice

With the incorporation of alternative technologies, the impacts to subsistence foods and human health could be further minimized (see Subsistence Section 4.8.3.2). Contamination of subsistence foods would be the same as discussed under Alternative 3.

4.8.3.9.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to environmental justice are discussed under Alternative 2 (Section 4.5.3.9). With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts from oil and gas exploration activity, noise, and disturbance would not be expected to occur. This is discussed further in Subsistence Section 4.6.3.2.

4.8.3.9.2 Conclusion

Activities related to implementation of Alternative 5 would have a lower intensity impact on subsistence resources and human health due to the incorporation of alternative technologies than Alternatives 3 and 4, but not eliminate all impacts. Level 2 activities are of a temporary duration and a regional extent. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Thus, Alternative 5 is expected to have a minor impact to subsistence resources and minor disproportionate impacts to Alaska Native communities.

4.8.3.9.3 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to environmental justice are discussed under Alternative 2 (Section 4.5.3.9). Additional mitigation measures to reduce discharge of wastes that potentially impact marine mammals would likely reduce the potential for introduction of new contaminants to subsistence foods. These mitigation measures would reduce adverse impacts to subsistence foods and would not contribute to impacts on human health.

4.9 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 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 such a catastrophic event 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 Draft Revised Supplemental EIS (BOEM 2011b) and the Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017 Draft Programmatic EIS (BOEM 2011e). Much of the information summarized in Sections 4.9.1

through 4.9.5 has been taken verbatim from these two documents to provide an accurate representation of their original analysis.

4.9.1 Background and Rationale

The discussion provided in Section 4.9.1 is taken from the BOEM (2011b) 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.

On March 18, 2011, the U.S. Coast Guard (USCG) issued a final action memorandum that identified 4.9 million barrels (MMbbls) (and an unknown quantity of natural gas) as the total estimated amount spilled by the Deepwater Horizon (DWH) in 2010. Of that, most was recovered, burned, skimmed, chemically or naturally dispersed, or evaporated/dissolved. About 1.3 of the 4.9 MMbbls was categorized as residual oil (USCG 2011).

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, 2010). This report recommended that MMS, since 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.

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. On January 11, 2011, the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (Commission) issued its final report. This report described the causes of the DWH event and recommended reforms intended to make offshore energy production safer. The Commission also reviewed and made recommendations concerning oil spill prevention and response.

U.S. Coast Guard. BOEM and the USCG are conducting a joint investigation to identify the causes of the DWH event and any procedural or policy changes that could prevent such tragedies in the future. On April 22, 2011, the Deepwater Horizon Joint Investigation Team released a preliminary report covering issues under Coast Guard jurisdiction. The investigation continues into the Deepwater Horizon's blowout preventer issue and other issues under the jurisdiction of BOEM. BOEMRE and the USCG conducted a joint investigation of areas under the jurisdiction of the Coast Guard and BOEMRE to investigate the causes of the Deepwater Horizon explosion, loss of life, and resulting oil spill, and to make recommendations for safe operations of future oil and gas activities on the U.S. Outer Continental Shelf (OCS). The JIT held seven sessions of public hearings, received testimony from more than 80 witnesses and experts, and reviewed a large number of documents and exhibits pertaining to all aspects of the investigation.

Volume I, released April 22, 2011, includes findings on five aspects of the disaster under Coast Guard jurisdiction – including the explosions on the Mobile Offshore Drilling Unit (MODU) Deepwater Horizon; the resulting fire; evacuations; the flooding and sinking of the Deepwater Horizon; and the safety systems of the MODU and its owner, Transocean.

Volume II, released September 14, 2011, includes findings on the causes, both direct and contributing, of the Macondo blowout and the resulting explosion and fire aboard the Deepwater Horizon.

Rule Changes Following the *Deepwater Horizon* Event

The aftermath of the DWH event provided new information about drilling on the OCS; in particular, it provided new information about (1) systemic safety issues, (2) deficiencies of blowout containment technologies and strategies, and (3) shortcomings in oil spill response strategies and resources relative to spills in deepwater. BOEM has addressed these issues by strengthening its regulations of OCS activities. Notable initiatives are discussed below. For additional discussion on advancements in safety and their meaning for OCS activities going forward, the reader is referred to an October 1, 2010 memorandum from the Director of BOEM to the Secretary, which supported lifting the suspension of certain offshore permitting and drilling activities on portions of the OCS (available at http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&PageID=64703).

New rules and rulemaking procedures, along with new and revised Notices to Lessees, are listed below. Further discussion of more notable developments is then provided.

- The Drilling Safety Rule, Interim Final Rule to Enhance Safety Measures for Energy Development on the Outer Continental Shelf (Drilling Safety Rule). This rule strengthens requirements for safety equipment, well control systems, and blowout prevention practices in offshore oil and gas regulations.
- The Workplace Safety Rule on Safety and Environmental Management Systems (SEMS Rule). This rule requires operators to develop and implement a comprehensive SEMS for identifying, addressing, and managing operational safety hazards and impacts; for promoting both human safety and environmental protection; and for improving workplace safety by reducing risk of human error.
- NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," effective June 18, 2010 (Plans NTL).
- NTL-2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," effective November 9, 2010 (Certification NTL).

The Drilling Safety Rule. On October 14, 2010, BOEM issued an interim final rule entitled "Increased Safety Measures for Energy Development on the Outer Continental Shelf" (75 FR 63346). The interim rulemaking revises selected sections of 30 CFR 250 Subparts D, E, F, O, and Q. The Drilling Safety Rule includes new standards and requirements related to the design of wells and testing of the integrity of wellbores, the use of drilling fluids, and the functionality and testing of well control equipment including blowout preventers. To these ends, the rule is expected to promulgate OCS-wide provisions that will:

- Establish new casing installation requirements
- Establish new cementing requirements
- Require independent third party verification of blind-shear ram capability
- Require independent third party verification of subsea BOP stack compatibility
- Require new casing and cementing integrity tests
- Establish new requirements for subsea secondary BOP intervention
- Require function testing for subsea secondary BOP intervention

- Require documentation for BOP inspections and maintenance
- Require a Registered Professional Engineer to certify casing and cementing requirements
- Establish new requirements for specific well control training to include deepwater operations

Safety and Environmental Management Systems Rule. A new subpart to 30 CFR Part 250: Subpart S – Safety and Environmental Management Systems (SEMS) is designed to reduce the hazards associated with drilling operations and further reduce the likelihood of a blowout scenario such as described for this VLOS analysis. The SEMS Rule requires all OCS operators to develop and implement a comprehensive management program for identifying, addressing, and managing operational safety hazards and impacts, with the goal of promoting both human safety and environmental protection. The interim final rule was published in the *Federal Register* on October 14, 2010 (75 FR 63345), requiring full implementation of a SEMS program by November 15, 2011. The 13 elements of the industry standard (American Petroleum Institute, Recommended Practice 75) that 30 CFR 250 Subpart S now makes mandatory are as follows:

- defining the general provisions for implementation, planning and management review, and approval of the SEMS program;
- identifying safety and environmental information needed for any facility such as design data, facility process such as flow diagrams, and mechanical components such as piping and instrument diagrams;
- requiring a facility-level risk assessment;
- addressing any facility or operational changes including management changes, shift changes;
- contractor changes;
- evaluating operations and written procedures;
- specifying safe work practices, manuals, standards, and rules of conduct;
- training, safe work practices, and technical training, including contractors;
- defining preventative maintenance programs and quality control requirements;
- requiring a pre-startup review of all systems;
- responding to and controlling emergencies, evacuation planning, and oil-spill contingency plans in place and validated by drills;
- investigating incidents, procedures, corrective action, and follow-up;
- requiring audits every 4 years, to an initial 2-year reevaluation and then subsequent 3-year;
- audit intervals; and
- specifying records and documentation that describe all elements of the SEMS program.

NTL (Notice to Lessees) 2010-N06. Though not a rulemaking, a recent NTL issued by BOEM warrants discussion here. Effective November 8, 2010, NTL No. 2010-NO6 requires that blowout intervention information be submitted with future Exploration or Development and Production Plans. The blowout scenarios required by 30 CFR 250.213(g) and 250.243(h) provide a potential blowout of the proposed well expected to have the highest volume of hydrocarbons, and must include supporting information for any assertion that well bridging will constrain or terminate the flow or that surface intervention will stop the blowout. The availability of a rig to drill a relief well and rig package constraints must also be addressed. These scenarios must also specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well, including the possibility of drilling a relief well from a neighboring platform or an onshore location.

NTL (Notice to Lessees) 2010-N10. Also released on November 8, 2010 was NTL 2010-N10. This NTL explains that applications for well permits must include a statement that all authorized activities will be conducted in compliance with all applicable regulations, to include the new measures discussed above. For operations using subsea BOPs or surface BOPs on floating facilities, BOEM will evaluate whether each operator has submitted adequate information demonstrating that it has access to and can deploy subsea containment resources that can adequately and promptly respond to a blowout or other loss of well control. BOEM will also evaluate whether each operator has adequately described the types and quantities of surface and subsea containment equipment that the operator can access in the event of a spill or threat of a spill.

The operating regulations for BOEM and BSEE are at: http://www.gpo.gov/fdsys/pkg/FR-2011-10-18/pdf/2011-22675.pdf

Joint Industry Task Forces. In response to the DWH event, several entities within the oil and gas industry cooperatively formed Joint Industry Task Forces. The stated purpose of each Task Force is “to review and evaluate current capacities, and to develop and implement a strategy to address future needs and requirements in equipment, practices or industry standards” applicable to the studied activity. Where possible, information developed by these Tasks Forces will be augmented with input from regulatory agencies, oil spill response and well control specialists, investigation panels, and other public sector and non-governmental organizations. To date, Task Forces on “Oil Spill Preparedness and Response” and “Subsea Well Control and Containment” have submitted draft recommendations. Joint Industry Task Force recommendations will not have the force of regulation, but may provide the basis for enhanced industry standards or future rulemaking processes.”

4.9.2 Very Large Oil Spill (VLOS) Scenario

Determining the appropriate volume to analyze for a VLOS can be difficult. In the BOEM Lease Sale 193 FSEIS document (2011), BOEM provided the rationale for using a spill volume of 2.2 MMbbls for the assessment of the potential environmental effects of a VLOS in the Chukchi Sea over a period of 74 days. In the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011e), BOEM provided the rationale for using a spill volume of 1.4 to 2.2 MMbbls over a period of 40 to 75 days for the Chukchi Sea and 1.7 to 3.9 Mbbl over a period of 60 to 300 days for the Beaufort Sea as the basis for considering impacts from a Catastrophic Discharge Event. These analyses from BOEM are incorporated into Sections 4.9.3 and 4.9.4 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 reasonably well known 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.

4.9.3 General Assumptions

The discussion provided in Section 4.9.3 is taken from the BOEMRE FSEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEMRE 2011), which is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011e). 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 BOEMRE FSEIS into this EIS by reference.

Very Large Spill Scenario vs. Worst Case Discharge

To facilitate analysis of the potential environmental impacts of a VLOS in the Chukchi and Beaufort 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 Exploration Plan (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 expected 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 [i.e. regardless of the location of an exploration project in the Chukchi Sea, BOEM assumes that the discharge period would be the same]. 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 EP or DPP 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.

It is recognized that the frequency for a VLOS on the OCS from a well control incident is very low. From 1971-2010 there has been one very large oil spill during exploratory and development/production operations on 41,781 wells, or 2.39×10^{-5} per well.

The low ‘geological’ chance that the exploration well will 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.

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 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, Figure 4 shows that 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) (Table 2). 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.

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 (i.e. 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 significant 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 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.

4.9.4 VLOS Scenario for the Chukchi Sea

The discussion provided in Section 4.9.4 is taken from the BOEM FSEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEM 2011), which is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011e). 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 (2011, 2011e) into this EIS by reference.

4.9.4.1 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.

4.9.4.2 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.

4.9.4.3 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 3 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 15 shows that the oil discharge declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 psi (Table 3). The decline in the flow rate flattens somewhat after Day 40. As shown in Table 3, 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.

4.9.4.4 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.

4.9.4.5 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 B of BOEM (2011)].

4.9.4.6 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 2003c). Persistence can be defined and measured in different ways (Davis et al. 2004), but the National Research Council (NRC) generally defines persistence as how long oil remains in the environment (National Research Council 2003c). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (National Research Council 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 (Sale 193 FEIS, Appendix A.1, Figure A.1 and A.2). 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 5. On average, light-weight crude oils are characterized as outlined below in Table 5.

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 (2011) 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.]

4.9.4.7 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 (Table 2) is also 930 cf/bbl. As shown in Table 2, 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.

4.9.4.8 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 (MMS 2007). 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).

4.9.4.9 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).

4.9.4.10 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. As estimated from the OSRA model . . . the length of oiled shoreline increases over time as the spill continues (Table 6). Dependent upon winds and currents throughout the VLOS event, already impacted areas could have oil refloated and oil other areas increasing the estimates above.

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.

4.9.4.11 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.

4.9.4.12 Recovery and Cleanup

The hypothetical VLOS scenario outlined thus far for the Chukchi Sea 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. A more detailed description of the available methods to respond to an oil spill is provided in the Arctic Multi-Sale Draft EIS, in Section 4.3.3.5.5 (USDOI, MMS, 2008a). It is noted that severe weather and/or the presence of ice could interfere with or temporarily preclude each of these methods. For a comprehensive summary report of the 31 Arctic oil spill response research projects that BOEM has funded, the reader is referred to a report called *Arctic Oil Spill Response Research and Development Program: A Decade of Achievement* which can be accessed at:

www.boemre.gov/tarprojectcategories/PDFs/MMSArcticResearch.pdf

In the event of a VLOS, two governmental organizations would assume prominent roles in coordinating response efforts: the Federal On-Scene Coordinator (FOSC) and the Alaska Regional Response Team (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 significantly 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 in consultation with the ARRT. The decision regarding how and when dispersants would be applied would also reside with the FOSC and the ARRT. 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 ARRT. 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 (Inter-agency 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.

4.9.4.13 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," or 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.

4.9.4.13.1 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 re-distribute 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.

4.9.4.13.2 Offshore Spill (Phase 2)

Phase 2 of the scenario encompasses the continuing release of an oil spill in federal and state offshore 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, and/or food sources.
- **Loss of Access**. The presence of oil could prevent or disrupt access to and use of affected areas.

4.9.4.13.3 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.

4.9.4.13.4 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.

4.9.4.13.5 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.

4.9.4.14 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 Table 3). 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 Gulf of Mexico, Inc. 2012 Revised Exploration Plan (EP) for leases in the Chukchi Sea (Shell 2011b). Between the Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan (C-Plan) submitted with the EP application and this proposal contained measures including:

- Shell would use state-of-the-art automatic kick-detection equipment, including pit-volume totalizers, a flow detector, and various gas detectors placed about the rig, to provide early warning of a potential well-control event.
- The blowout preventer Shell would install on the high-pressure wellhead housing on the 20-in conductor casing on each exploration well includes redundant mechanical barriers to provide multiple means of closing in the well to prevent oil flow to the surface.
- Shell would install multiple barriers, including manual and automated valves, on the drilling rig to prevent flows from coming up the drill string.
- Shell has developed and would implement a Well Control Contingency Plan (WCCP) in the extremely unlikely event of a well-control event to minimize the risk of oil coming in contact with the water. As part of the WCCP, Shell would prepare a Relief Well Drilling Plan for each location in advance of spudding the well to ensure that a relief well can be started quickly to kill the well.
- Shell would station and maintain its OSRVs in the immediate vicinity of its drilling operations to ensure timely response to any spill event.
- In addition to the OSR fleet, capping stack equipment will be available for use in the unlikely event of a blowout. The capping stack system will be carried as equipment on an ice management vessel and the containment barge will be located in the Beaufort Sea where it can respond as required.
- Capping Stack equipment will be stored aboard one of the ice management vessels and will be available for immediate deployment in the unlikely event of a blowout. Capping Stack equipment consist of subsea devices assembled to provide direct surface intervention capability with the following priorities:
    - Attaching a device or series of devices to the well to affect a seal capable of withstanding the maximum anticipated wellhead pressure (MAWP) and closing the assembly to completely seal the well against further flows (commonly called “capping and killing”)
    - Attaching a device or series of devices to the well and diverting flow to surface vessel(s) equipped for separation and disposal of hydrocarbons (commonly called “capping and diverting”)

Potential intervention and response methods are qualitatively discussed 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, including the seasonal presence of sea ice.

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 (Table 6).

4.9.5 VLOS Scenario for the Beaufort Sea

The 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011e) 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 Draft Programatic EIS (2011e) into this EIS by reference.

Arctic Risk Profile. An ongoing concern in the Arctic is the environmental effects of a 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 2011).

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 4.9.7 of this EIS is taken from the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011e), 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 2011e) 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.

4.9.6 Chukchi Sea – Analysis of Impacts

The foundation of the analysis provided in Section 4.9.6 of this EIS is taken from the BOEM (2011b) 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 (2011b) that are referenced in this EIS are noted in the sections below. BOEM (2011b) is available online at: http://www.alaska.boemre.gov/ref/EIS%20EA/2011_041_FSEIS/ 2011_041x.htm. Additional information pertinent to this project is presented in each resource section as well. The information taken from BOEM (2011b) is identified as "Existing Analysis," and the analysis beyond what was presented in that document is listed as "Additional Analysis."

The scenario in BOEMRE (2011) is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011e). NMFS has incorporated the information presented in the BOEM Draft Programmatic EIS into this EIS by reference. The specific sections from BOEM (2011e) that are referenced in this EIS are noted in the sections below.

4.9.6.1 Physical Oceanography

4.9.6.1.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

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 estimated values to describe wind, ice, currents, and numerous other physical parameters. A summary of the OSRA model structure, input, and output are provided in Section IV.E.1 of BOEM (2011b), and are incorporated here by reference.

Section 4.2.3.2 of the BOEM (2011e) 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.

4.9.6.1.2 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. Sinking of the drilling rig to the sea floor would effectively create an artificial reef (BOEM 2011b), 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 3.1.7 (Water Quality) and Section 3.1.8 (Ecosystem 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.

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 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.

4.9.6.2 Geology

The geology of the continental shelf and OCS within the EIS project area is discussed in Section 3.1.3 of this EIS. For the purpose of this EIS, geological processes would not be altered by a VLOS; therefore geology as a resource is not carried forward for analysis in Chapter 4. In addition, naturally occurring phenomena like ice gouging and strudel scouring would not likely be affected by a VLOS, nor would these phenomena be expected to significantly affect response to a VLOS.

4.9.6.3 Climate and Meteorology

4.9.6.3.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Discussions on GHG emissions from BOEM (2011b, 2011e) can be found in Section 4.9.6.4 (Air Quality) of this EIS.

4.9.6.3.2 Additional Analysis for Climate and Meteorology

A VLOS in the 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. CO_2 is a GHG, and its emissions have been linked to climate change. Black carbon, 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 2011b). Section 4.9.6.4 (Air Quality) of this EIS has more information on black carbon and radiative forcing.

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 2011b).

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 2011b).

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 black carbon 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 4.4.1.2 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.

4.9.6.4 Air Quality

4.9.6.4.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Section IV.E.3 of BOEM (2011b) describes potential impacts to air quality 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 in the Chukchi Sea 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, Section 4.4.4.3.2 of the BOEM (2011e) 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 2011e).

4.9.6.4.2 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 3.1.5.2, 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 expected to be minimal.

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 could be minimal.

4.9.6.5 Acoustics

4.9.6.5.1 Existing Analysis (BOEM 2011e)

Section 4.4.5.4.2 of the BOEM (2011e) 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 2011e).

4.9.6.5.2 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 4.5-12). 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.

4.9.6.6 Water Quality

4.9.6.6.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Section IV.E.2 of BOEM (2011b) 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 blowout 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 significant. 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, Section 4.4.3.3.2 of the BOEM (2011e) 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 significant 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 2011e).

4.9.6.6.2 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.

4.9.6.7 Environmental Contaminants and Ecosystem Functions

4.9.6.7.1 Existing Analysis (BOEM 2011e)

Section 4.4.6.2.4 of the BOEM (2011e) 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 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 accidental 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 2011e).

4.9.6.7.2 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, and were defined in Chapter 3, Section 3.1.8.

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 localized 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 2011). 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. 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 4.9.7.15 and 4.9.7.17, 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.

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.

4.9.6.8 Lower Trophic Levels

4.9.6.8.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Section IV.E.4 of BOEM (2011b) describes potential impacts to lower trophic levels resources during the five phases of a possible VLOS in the Chukchi Sea. In addition, Section 4.4.7.5.3 of the BOEM (2011e) 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, walrus) 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. 2006). 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 (atlantic cod, bowhead whales, etc.) at a later date (USDOI, MMS, 2004). Toxicity studies carried out with benthic crabs and shrimp indicate they may not immediately die from toxins (living 24-96 hrs, 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.

4.9.6.8.2 Additional Analysis for Lower Trophic Levels

As outlined in the discussion in BOEM (2011b), 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 (2011b) (Section IV.E.) 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, walrus) and lower trophic organisms (Dunton et al. 2005, Grebmeier et al. 2006) (see Section 4.9.6.11 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 form 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 decrease in primary productivity or mortality events.

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, 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 special habitat areas mentioned above. In this case, the impact criteria listed in Table 4.5-17 would lead to a summary impact level of moderate due to the shorter duration and regional impacts to common resources.

4.9.6.9 Fish and Essential Fish Habitat

4.9.6.9.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Fish

Section IV.E.5 of BOEM (2011b) 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 significantly affected (defined here as greater than three generations to return) at a population level.

In addition, Section 4.4.7.3.3 of the BOEM (2011e) 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. However, no permanent impacts on fish populations are expected (BOEM 2011e).

Essential Fish Habitat

Section IV.E.6 of BOEM (2011) describes potential impacts to EFH during the five phases of a possible VLOS in the Chukchi Sea. Likewise, Section IV.E.15 of BOEM (2011b) 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 significantly impacted by a VLOS.

Likewise, Section 4.4.6.4.3 of the BOEM (2011e) 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 accidental hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH (BOEM 2011e).

4.9.6.9.2 Additional Analysis for Fish and Essential Fish Habitat

As outlined in the discussion in BOEM (2011b), a 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 (2011b) (Section IV.E.1.) 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. Therefore, all fish resources within the Chukchi Sea are vulnerable to impacts, potentially 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, 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, 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 important resources that are widespread and abundant. 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 4.5-17, the summary impact level could be moderate.

4.9.6.10 Marine and Coastal Birds

4.9.6.10.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Section IV.E.9 of BOEM (2011b) describes potential impacts to marine and coastal bird resources during the five phases of a possible VLOS in the Chukchi Sea. In addition, Section 4.4.7.2.3 of the BOEM (2011e) 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 listed eiders, loons, seabirds, and waterfowl. 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. The situation with brant is similar to a wide variety of waterfowl and shorebirds that use similar areas of the Chukchi Sea.

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 significant 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.

As a group, the Launch Areas (specifically LAs 8-13) affected by the deferral corridors contemplated in Alternatives III and IV tend to exhibit higher percentages of spill trajectories contacting sensitive nearshore and coastal habitats along the Chukchi Sea. These alternatives may offer protection to nearshore resources, spring lead systems and spring polynyas by decreasing the percentage of trajectories that would contact these resource areas. In this sense, the most protection to nearshore and coastal birds is afforded by the broadest coastal deferral, Alternative III. Deferrals may also afford more time for spill response and cleanup prior to a spill contacting nearshore resources. These benefits would not be expected to accrue to pelagic species of birds.

4.9.6.10.2 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 special habitat areas or outside), and general weather patterns (wind and storm events). If a VLOS occurs in special 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 to permanent 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 special habitat areas, the effects could be the same except the duration could be temporary to long-term rather than long-term to permanent. 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 special 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, special 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 (2011b) 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 and Kittlitz's Murrelet. 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 walrus are present all year but especially when sea ice is present. Spotted seals and walrus also use the coastline for haulouts.

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 special habitat 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 accidental 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, permanent 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 special habitat area according to the criteria established in Table 4.5-17.

Kasegaluk Lagoon Special Habitat Area

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.

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 (2011) 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. This would be considered a major effect on this special habitat area according to the criteria established in Table 4.5-17.

4.9.6.11 Marine Mammals

4.9.6.11.1 Existing Analysis (BOEM 2011b and 2011e)

Section 4.4.7.1.3 of the BOEM (2011e) 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 significant, 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 2011e).

Sections IV.E.7, IV.E.8, IV.E.10, and IV.E.11 of BOEM (2011b) describe 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 alter migratory 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 the health of cetaceans. Human activities brought about by implementation of Oil Spill Response Plans, i.e. cleanup and remediation, 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

Depending on the timing of the spill, bowhead whales could experience contact with fresh oil during summer and/or 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. 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 mortality. Surface feeding bowheads could 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, 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 localized 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, could 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 could occur.

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 could occur. Once offshore, belugas could inhale 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 belugas could redistribute from the 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 could occur, but mortality or population level effects are considered to be unlikely because of the low density of animals in the areas.

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. Temporary and/or permanent injury and non-lethal effects could occur, but mortality or population level effects are considered unlikely because of the low density of animals in the areas. 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 Chukchi and Beaufort Seas originate from the Western North Pacific stock.

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 these intense clean-up 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 abandonment of these primary summer feeding areas that provide the majority of the annual nutritional and energy requirement of these whales and potentially take years to recover. 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 adverse 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 marine mammal prey abundance and distribution could be reduced, or contaminated, leading to modified distribution of killer whales and/or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects could occur, but mortality or population level effects are considered to be unlikely because of the low density of animals in the areas.

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. Temporary and/or permanent 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. 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.

Pinnipeds

Section IV.E.10 of BOEM (2011b) 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 habitat use, densities, 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, Kugrua Bay, 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 the open ocean, their presence is not known to be associated with the ice front. 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 their very low presence in marine mammal surveys, BOEM concludes that they occur only in very low numbers spread across the Chukchi Sea and are virtually absent from the Beaufort Sea. 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, very rarely, if ever, coming ashore. 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 Chukchi and Beaufort 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 Walrus

Section IV.E.11 of BOEM (2011b) describes potential impacts to walrus 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 Pt. Lay. Walrus 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 walrus would include the Herald and Hanna Shoal polynyas and the Wainwright and Pt. Lay areas. Significant impacts to the walrus population would be most likely to occur if large scale contamination of prey and habitat persisted for years.

The Pacific walrus population is currently estimated at a minimum of 129,000. If a VLOS were to occur and to contact large portions of habitat inhabited by walrus, calves of the year would most likely be at risk.

Polar Bears

Section IV.E.8 of BOEM (2011b) 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.

In the event of a VLOS in this scenario, most of the contact between oil and polar bear habitat would occur on the U.S. side of the Chukchi Sea. The majority of the CBS stock is believed to den and come ashore on the Russian side of the Chukchi Sea, particularly at Wrangel Island. The majority of the SBS stock of polar bears come ashore and den further eastward in the Beaufort Sea. However there is a large area of overlap between the CBS stock and the SBS stock 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 and if it resulted in the loss of large numbers of polar bears, particularly adult breeding age females, this would have a significant impact on the SBS and/or CBS stocks 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.

4.9.6.11.2 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 (2011b) 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 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 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 permanent 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 permanent, 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 (2011b) Section IV.E.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 permanent (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, therefore, 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 permanent 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 (2011) states in Section IV.E.7., that recovery from a major reduction in numbers of harbor porpoise in the offshore 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.

Pinnipeds

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 2011). 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, Chukchi and Beaufort 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 2011). 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 Walrus

Pacific walrus 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, walrus 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 walrus 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 walrus in the Chukchi Sea. Based on criteria described in Section 4.1.3 of this EIS, impacts of a VLOS on Pacific walrus could be of medium to high intensity, with intensity greatest if the VLOS and subsequent clean-up activities coincide with dense aggregations of walrus, 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 walrus and potential for decreased fitness and a need to seek alternate forage locations of benthic habitat and prey are severely altered. Walrus 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 Pacific walrus.

Polar Bear

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. Polar bears are listed as threatened and critical habitat was recently designated in December 2010 along the Chukchi Sea coastline and barrier islands. Oil from a VLOS in the Chukchi Sea could foul these areas and impact critical habitat. A VLOS in the Chukchi Sea could involve either the Southern Beaufort Sea stock (SBS) or Chukchi/Bering Seas stock (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 critical 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.

Hanna Shoal Special Habitat Area

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. 2011). Bearded and ringed seals are common in the area during summer, feeding on benthic invertebrates and fish. Pacific walrus are also common when the ice edge is near Hanna Shoal in either spring or fall. In the winter, walrus 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. Walrus 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 2011b). 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 Pacific walrus, 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 walrus 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 Pacific walrus 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.

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 (2011b) 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 special habitat area according to the criteria established in Section 4.1.3.

4.9.6.12 Terrestrial Mammals

4.9.6.12.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Section IV.E.12 of BOEM (2011b) 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 significantly 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 (2011e) 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 2011e).

4.9.6.12.2 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 barrenground 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 localized 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 2011b). For more information regarding the impact to subsistence or recreational hunting see Sections 4.9.6.15 and 4.9.6.20 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.

4.9.6.13 Special Habitat Areas

A low probability, high impact VLOS could affect marine mammals and marine and coastal birds in special habitat areas in the Chukchi Sea. Discussion of impacts to marine mammals in Hanna Shoal and Kasegaluk Lagoon can be found in Section 4.9.6.11 and impacts to marine and coastal birds in Ledyard Bay Critical Habitat Area and Kasegaluk Lagoon can be found in Section 4.9.6.10.

4.9.6.14 Socioeconomics

4.9.6.14.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Section IV.E.14 of BOEM (2011b) 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 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 significant 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 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 significant 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.

Section 4.4.13.3.2 of the BOEM (2011e) 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 many 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 event, such cleanup efforts can be disruptive socially, psychologically, and economically for an extended period of time (BOEM 2011e).

4.9.6.14.2 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 & Expenditures

The BOEM (2011b) 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 & Personal Income

The BOEM (2011) 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. It is possible that a spill in the Chukchi Sea could induce some local employment.

A major impact to subsistence would occur after a VLOS (described in Section 4.9.6.15) and could change the components of the non-cash economy. Households could require 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 opportunity. This is discussed further in the Environmental Justice Section 4.9.6.22 and Public Health Section 4.9.6.16 of this EIS.

Demographic Characteristics

The BOEM (2011b) sociocultural analysis, discussed in Section 4.9.6.16 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 (2011b) sociocultural analysis indicates that an outmigration of residents did not take place in the case of the EVOS so 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 2008:280 in BOEM 2011b).

Social Organizations & 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) described "fears" about the:

> *…lack of local resources to mobilize for advocacy and activism with regional, state, and federal agencies; the lack of personal and professional time…capacity to interact with regional, state, and federal agencies…responding repeatedly to questions and information requests posed by researchers and regional, state, and federal outreach staff; and having to employ and work with lawyers to draft litigation in attempts to stop proposed development" (MMS 2007a:279, in 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.

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.

Conclusion

Employment and local revenues associated with VLOS 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 Section 4.9.7.15 (Subsistence), but would be high intensity, long-term in duration, regional in extent, and unique in context. Therefore, the summary impact level for socioeconomics would be major.

4.9.6.15 Subsistence

4.9.6.15.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Section IV.E.15 of BOEM (2011b) 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 significant adverse effect. In terms of other species, this same concern also would extend to walrus, 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 (USDOI, MMS, 2009).

In addition, Section 4.4.13.3.2 of the BOEM (2011e) 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 walrus 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 significant effects on Alaska native culture and society (BOEM 2011e).

4.9.6.15.2 Additional Analysis for Subsistence

Following a VLOS, the International Whaling Commission could reduce the allocated quota of bowhead whales to subsistence hunters. NMFS has previously reviewed the potential impacts of reduction of the quota by the International Whaling Commission as a No Action Alternative in the Final Environmental Impact Statement for Issuing Annual Quotas to the Alaska Eskimo Whaling Commission for a Subsistence Hunt on Bowhead Whales for the Years 2008 through 2012 (NMFS 2008). In that EIS (see Alternative 1 of NMFS 2008) NMFS concluded:

> *With no subsistence whaling, the direct effects of this alternative would include the loss of tens of thousands of pounds of highly valued food, attenuation of the social cohesion occasioned by the shared work among whaling crews and other cooperators in the year round work of preparation for whaling, disruption in the bonds established through food sharing, and diminished the opportunity for young people to continue to learn the knowledge, practice, and beliefs associated with this central cultural institution (Worl, 1979). Indirectly, Alternative 1 would likely result in redirection of subsistence harvest effort to other subsistence resources, but it is unlikely that the volume of food produced in whaling could be recreated. It is likely that local residents would increase their use of imported foods, but given the high costs of imported foods, especially for frozen and fresh foods, it is likely that the increase would be in imported foods of lower nutritional value.*

In their analysis of the potential impacts of reduction of the bowhead subsistence quota by the International Whaling Commission, NMFS (2008) noted that:

> *Any alternative that would provide fewer whales would be expected to have some level of adverse impact to socio-economic and cultural needs of these villages [AEWC communities]. It is not likely the nutritional or cultural void created would or could be filled with substitute foods. Imported foods cannot readily take the place of whale and other marine mammals which are central to the cultural identity and diets of Eskimos* (Michie 1979).

Similar impacts could be experienced in the event that the bowhead whale quota is limited as a result of a VLOS.

Based on the criteria of Section 4.1.3 of this EIS, the intensity of the VLOS on subsistence resources and subsistence harvest would be high 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 for a long-term to permanent duration. The perception that food is tainted and/or contaminated could be permanent among Iñupiat and Yup'ik Eskimo communities of the Chukchi Sea (see Section 4.9.6.16, Public Health). 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 in extent and may range throughout the EIS project area and impact the non-wage regional economy of the communities of the Chukchi and Beaufort seas (Section 4.9.6.14, Socioeconomics). Impacts from a VLOS to subsistence harvest of ESA protected bowhead whales and polar bears affect resources considered unique in context. Impacts from a VLOS to subsistence harvest of beluga whales, seals, walrus, fish, birds and caribou affect resources considered important in context.

The impacts of a VLOS in the Chukchi 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.

4.9.6.16 Public Health

4.9.6.16.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Sections IV.E.15 Subsistence Harvest Patterns and IV.E.16 Sociocultural Systems of BOEM (2011b) 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 (2011e) 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 significant 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 (USDOI, 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 (USDOI, MMS, 2003a, 2006a, 2007a; USDOI, BLM and MMS, 2003). Similar to Subsistence Harvest-Patterns, the potential for significant impacts could be reduced by implementing larger a larger deferral area under Alternative IV or, to a greater extent, Alternative III.

4.9.6.16.2 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 4.9.6.4. 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 volatile organic compounds (VOC). 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 will 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 4.9.6.15 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 (4.9.6.22).

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 permanent, 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.

4.9.6.17 Cultural Resources

4.9.6.17.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

Sections IV.E.16 and IV.E.17 of BOEM (2011b) 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 and the implementation of deferral corridors under various lease sale 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; USDOI, MMS 2007a, 2009).

In addition, Section 4.4.15.3.2 of the BOEM (2011e) 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 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 2011e).

4.9.6.17.2 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 2011b). 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 2011b). 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 2011b). 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 Distant Early Warning (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 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).

4.9.6.18 Land and Water Ownership, Use, and Management

4.9.6.18.1 Existing Analysis (BOEM 2011e)

Section 4.4.10.3.2 of the BOEM (2011e) 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 2011e).

4.9.6.18.2 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. The presence of oil accumulation along the shoreline and in tidal zones 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.

Conclusion

The magnitude of impact would be low 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 long term because response efforts may extend up to several years, although the impact could be permanent 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 long term impact to land use and land management.

4.9.6.19 Transportation

4.9.6.19.1 Existing Analysis (BOEM 2011b and BOEM 2011e)

No specific analysis of the potential effects of a VLOS on transportation was provided in either the BOEM (2011b) or (2011e) discussions.

4.9.6.19.2 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 (2011b) 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. Aircraft (fixed wing) would also likely be engaged in application of dispersants.

A VLOS may require up to 1,600 diesel-powered oil-skimming vessels, and other marine equipment such as ice breakers, over the course of time to confine and remove oil from the ocean surface (BOEM 2011b). 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*.

Small boats and aircraft could also be involved with beach cleaning activities at oiled beaches (including booming) at marine and freshwater shorelines.

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 (2011b) 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 used during spill response in the Chukchi Sea would likely be deployed from existing airport facilities including the airports of Barrow, Wainwright, Point Lay, Point Hope, Kivalina and Kotzebue, and other suitable airstrips (BOEM 2011b). Small vessels and surface vehicles would also be used during response operations at onshore areas.

As indicated in BOEM (2011b):

> *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 2011b). 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 4.9.6.10 through 4.9.6.12 and the affects to subsistence hunters is described in Section 4.9.6.15.

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.

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.

4.9.6.20 Recreation and Tourism

4.9.6.20.1 Existing Analysis (BOEM 2011e)

Section 4.4.12.3.2 of the BOEM (2011e) 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 temporary, 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 2011e).

4.9.6.20.2 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 4.9.6.15, 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 personal pleasure boats or yachts, and recreationists using the coastal areas. Visual impacts are discussed in further detail in Section 4.9.6.21. 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.

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 long-term 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, long term duration, regional to statewide in extent, and important in context. In summary, the impact of a VLOS on recreation and tourism would be major.

4.9.6.21 Visual Resources

4.9.6.21.1 Existing Analysis (BOEM 2011b and 2011e)

No analysis of impacts specific to visual resources is presented in the BOEM (2011b) or BOEM (2011e) documents.

4.9.6.21.2 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 Section IV.D.2. (VLOS Scenario), Section IV.E.1 (OSRA Model [Oil Spill Trajectories]), and Section IV.E.2 (Water Quality) of the LS 193 FSEIS (BOEM 2011b). 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 psychological/social 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 will depend on the 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 sensitive viewers would expand beyond the local population, tourist, and/or recreators in the area to include a broader public exposed to the VLOS via national (and international) media coverage. For this reason, this analysis assumes high visual sensitivity among all potential affected viewer groups.

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 impact to visual resources would be localized and temporary; resulting in short-term direct impacts to scenic quality and visual resources. Indirect effects, such as psychological/social 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 onland areas. Indirect effects could include psychological/social 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 short-term, potential direct and indirect impacts resulting from Phase 2 and 3 scenarios could be long-term 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 psychological/social 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 short-term; 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 psychological/social 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.

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, short- to long-term in duration, regional to state-wide in geographic extent, and would affect an important resource.

4.9.6.22 Environmental Justice

4.9.6.22.1 Existing Analysis (BOEM 2011b and 2011e)

Section IV.E.18 of BOEM (2011b) 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 Inupiat 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 Inupiat 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 Inupiat subsistence-oriented communities of Barrow, Wainwright, Point Lay, and Point Hope and in Russian subsistence communities along the Chukchi Sea coastline.

In addition, Section 4.4.14.3.2 of the BOEM (2011e) 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 2011e).

4.9.6.22.2 Additional Analysis for Environmental Justice

As stated in BOEM (2011b), "any significant [major] adverse impacts to subsistence resources and harvests or sociocultural systems from a VLOS would represent significant environmental justice impacts, i.e. disproportionate, high, adverse environmental and health effects on low-income, minority populations in the region."

Impacts to Subsistence Foods and Human Health

As described in Subsistence Section 4.9.6.15, a VLOS would result in a major disturbance of subsistence resources and contamination or the perception of contamination of subsistence foods.

As described in Public Health Section 4.9.6.16, a major disruption of subsistence activities would result in major negative effect on the social determinants of health.

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 minority populations.

4.9.7 Beaufort Sea – Analysis of Impacts

The foundation for the analysis in Section 4.9.7 of this EIS is taken from the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011e), 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 2011e) 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 (2011e) and MMS (2003) pertinent to this EIS is presented in each resource section. The information taken from BOEM (2011e) and MMS (2003) is identified as "Existing Analysis," and the analysis beyond what was presented in those documents is listed as "Additional Analysis."

4.9.7.1 Physical Oceanography

4.9.7.1.1 Existing Analysis (BOEM 2011e and MMS 2003)

Section 4.2.3.2 of the BOEM (2011e) 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.

4.9.7.1.2 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.

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.

4.9.7.2 Geology

The geology of the continental shelf and OCS within the proposed action area is discussed in Section 3.1.3 of this EIS. For the purpose of this EIS, geological processes would not be altered by a VLOS; therefore geology as a resource is not carried forward for analysis in Chapter 4. In addition, naturally occurring phenomena like ice gouging and strudel scouring would not likely be affected by a VLOS, nor would these phenomena be expected to affect response to a VLOS.

4.9.7.3 Climate and Meteorology

4.9.7.3.1 Existing Analysis (BOEM 2011e)

Discussions on GHG emissions in the existing BOEM (2011e) analysis can be found in Sections 4.9.7.4 (Air Quality) of this EIS.

4.9.7.3.2 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 4.9.6.3). 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.

4.9.7.4 Air Quality

4.9.7.4.1 Existing Analysis (BOEM 2011e)

Section 4.4.4.3.2 of the BOEM (2011e), 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 2011e).

4.9.7.4.2 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 4.9.6.4, a VLOS has the potential to impact air quality, particularly during Phases 1 and 4 of the oil spill and cleanup scenario.

4.9.7.5 Acoustics

4.9.7.5.1 Existing Analysis (BOEM 2011e)

Section 4.4.5.4.2 of the BOEM (2011e) 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 2011e).

4.9.7.5.2 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 4.9.6.5.

4.9.7.6 Water Quality

4.9.7.6.1 Existing Analysis (BOEM 2011e)

Section 4.4.3.3.2 of the BOEM (2011e) 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 significant 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 2011e).

4.9.7.6.2 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.

4.9.7.7 Environmental Contaminants and Ecosystem Functions

4.9.7.7.1 Existing Analysis (BOEM 2011e)

Section 4.4.6.2.4 of the BOEM (2011e) 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 accidental 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 2011e).

4.9.7.7.2 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 4.9.6.7 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. 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.

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.

4.9.7.8 Lower Trophic Levels

4.9.7.8.1 Existing Analysis (BOEM 2011e and MMS 2003)

Section 4.4.7.5.3 of the BOEM (2011e) 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 2011e).

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. Because of the predominance of shorefast ice in the affected area, there is no resident marine flora in waters less than 6 feet deep; therefore, there would be no effects. The oil spill also is not expected to have any measurable effect on subtidal marine plants (such as those of the Boulder Patch kelp habitat), because they live below the zone where toxic concentrations of oil can reach them.

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.

4.9.7.8.2 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. 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 Chukchi and Beaufort seas are very similar, the extensive analysis performed by BOEM (2011) for the Chukchi Sea (Section 4.9.6 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, walrus) and lower trophic organisms (Dunton et al. 2005, Grebmeier et al. 2006) (see Section 4.9.6.11 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 decrease in primary productivity or mortality events.

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, 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.

4.9.7.9 Fish and Essential Fish Habitat

4.9.7.9.1 Existing Analysis (BOEM 2011e and MMS 2003)

Section 4.4.7.3.3 of the BOEM (2011e), 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. However, no permanent impacts on fish populations are expected (BOEM 2011e).

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 (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 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 very low (less than 0.5%). 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. Because this would be very unlikely outside of the laboratory environment, little to no mortality due to lethal concentrations would be expected.

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 (for example, arctic cod), which are common in the nearshore area during summer, or nearshore spawners (for example, 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

Section 4.4.6.4.3 of the BOEM (2011e) 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 accidental hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH (BOEM 2011e).

4.9.7.9.2 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 (2011), 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, 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. 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 EFH described by NMFS in the Beaufort Sea is very similar to that in the Chukchi Sea, except that there is no opilio crab EFH in the Beaufort Sea. Therefore, it is likely that the types of effects to EFH would be very similar to those described in Section 4.9.6.9. 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 important resources that are widespread and abundant. 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 Section 4.1.3, the overall summary impact level of a VLOS could be moderate.

4.9.7.10 Marine and Coastal Birds

4.9.7.10.1 Existing Analysis (BOEM 2011e and MMS 2003)

Section 4.4.7.2.3 of the BOEM (2011e) 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 offshore 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 significant 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 significant decline in the coastal plain spectacled eider population, the potential exists for a significant adverse effect from an oil spill on this regional population. Mortality of a few Steller's eiders also would represent a significant 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 broodrearing 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 significant loss from the regional population. Likewise, contact of substantial numbers of postbreeding common eiders in the vicinity of barrier islands or Ross' gulls in the vicinity of Point Barrow, August through September could result in significant 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.

4.9.7.10.2 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 2.2MMbbls 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 special habitat 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 to permanent, 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 4.9.6.14 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 temporary to long-term rather than long-term to permanent. 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 special 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, special habitat areas, toxicity to prey and individuals, and mortality of individuals.

4.9.7.11 Marine Mammals

4.9.7.11.1 Existing Analysis (BOEM 2011e and MMS 2003)

Section 4.4.7.1.3 of BOEM (2011e) provides an analysis of the impacts of a catastrophic discharge event on marine mammals in Arctic Alaska. The 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 significant, 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 2011e).

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 oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. 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.

Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

The effects from activities associated with Beaufort Sea oil and gas exploration and development are estimated to include the loss from [a large] oil spill (0.11 percent chance) of small numbers of pinnipeds (perhaps 300 ringed seals but probably fewer than 10-20 spotted and 30-50 bearded seals and small numbers [fewer than 100] walrus), polar bears (6-10 bears), and beluga and gray whales (fewer than 10), with populations recovering (recovery meaning the replacement of individuals killed as a consequence of exploration and development) within about 1 year.

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.

4.9.7.11.2 Additional Analysis for Marine Mammals

The introduction to Section 4.9.5 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).

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 Camden Bay 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 congregate in the nearshore waters of Camden Bay in disproportionate numbers (Koski and Miller 2009), increasing the risk of exposure of a particularly sensitive portion of the population to a VLOS were it to originate from one of the many leases in that area. 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 (see BOEM 2011 Section IV.E.7 in Section 4.9.6.11 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 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 Camden Bay, 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 permanent 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.

Pinnipeds

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.

Pacific Walrus

Pacific walrus 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 walrus in the Beaufort Sea as are seen along the Chukchi Sea coast. The likelihood of walrus 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 walrus could be affected (e.g. of the 32 sightings (281 individuals) of walrus 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. Walrus 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 walrus in the Beaufort Sea. Based on criteria established in Section 4.1.3 of this EIS, impacts of a VLOS on individual Pacific walrus 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 walrus. Walrus 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 individual Pacific walrus.

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). Critical habitat was recently designated along the Beaufort Sea coastline that includes sea ice critical habitat, barrier islands critical habitat, and onshore denning critical habitat. Critical 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 critical 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.

Camden Bay Special Habitat Area

Camden Bay and its coastal regions provide 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 Camden Bay in particular, but it did calculate the risk of oil reaching the coastline of the Arctic National Wildlife Refuge, which includes Camden Bay 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 through Camden Bay from late August into October. Females with calves are common and some animals feed on concentrations of zooplankton. Ringed, spotted, and bearded seals are also common in the bay. Polar bears are common in the greater Camden Bay area. Many species of tundra-nesting seabirds, shorebirds, and waterfowl use Camden Bay, 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.

The primary reason Camden Bay is considered as a special habitat area in this EIS is because of its importance to marine mammals and subsistence hunters from Kaktovik and Nuiqsut. The consequences of a 2.2 MMbbl VLOS impacting Camden Bay 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 Camden Bay system but, because so many important species are migratory, impacts to them anywhere along the migration route would affect their status in Camden Bay. Using more generalized analyses, the potential effects are likely to be of highest magnitude and duration on birds and marine mammals (see Sections 4.9.7.10 and 4.9.7.11). 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 Camden Bay special habitat area, which is considered a unique resource. 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 Camden Bay special habitat area according to the criteria established in Section 4.1.3.

Barrow Canyon and Adjacent Beaufort Shelf and Shelf Break Special Habitat Area

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 (2011) 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 special habitat area 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 4.9.7.10 and 4.9.7.11). 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 special habitat area, 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 special habitat area according to the criteria established in Section 4.1.3.

4.9.7.12 Terrestrial Mammals

4.9.7.12.1 Existing Analysis (BOEM 2011e and MMS 2003)

Section 4.4.7.1.3 of BOEM (2011e) 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 2011e).

Section 4.1.2.h of MMS (2003) describes 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.

The potential effect of a very large pipeline 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 Lake Herd, 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 Lake, 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).

4.9.7.12.2 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 barrenground 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 localized impact, and the caribou population can recover within one to two years even with a loss of several thousand animals (BOEM 2011). For more information regarding the impact to subsistence or recreational hunting, see Sections 4.9.7.15 and 4.9.7.20, 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.

4.9.7.13 Special Habitat Areas

A low probability, high impact VLOS could affect marine mammals and marine and coastal birds in special habitat areas in the Beaufort Sea. Discussion of impacts to marine mammals in Camden Bay and Barrow Canyon and Adjacent Beaufort Shelf and Shelf Break can be found in Section 4.9.7.11 and impacts to marine and coastal birds can be found in Section 4.9.6.10.

4.9.7.14 Socioeconomics

4.9.7.14.1 Existing Analysis (BOEM 2011e)

Section 4.4.13.3.2 of BOEM (2011e) 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 could employ local villagers during the cleanup, it is likely that many 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 2011e).

4.9.7.14.2 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 (2011) analysis described in Section 4.9.6.14 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 & Expenditures

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. 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.

Employment & Personal Income

The MMS (2003) 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 is unknown but the VLOS could induce some local employment.

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 (2011) 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 1993:261 in BOEM 2011).

Other major impacts related to the long-term disruption of the non-cash/subsistence economy are described in the Environmental Justice Section 4.9.6.22 and Public Health Section 4.9.6.16. The BOEM (2011) 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 (2011) analysis.

Social Organizations & 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. BOMRE (2011) describes requests for temporary assistance from various institutions.

Private companies and regional corporations may be positively impacted in the short-term through the sale of goods and services to spill response companies.

Conclusion

Employment and local revenues associated with VLOS clean-up in the Beaufort Sea would be high intensity, long-term 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 4.9.7.15 (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 and important in context). Therefore, the summary impact level to socioeconomics would be major according to the direct and indirect impacts criteria established in Section 4.1.3.

4.9.7.15 Subsistence

4.9.7.15.1 Existing Analysis (BOEM 2011e)

Section 4.4.13.3.2 of BOEM (2011e) 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 significant effects on Alaska native culture and society (BOEM 2011e).

4.9.7.15.2 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 4.9.7.16, 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 4.9.7.14, 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, walrus, 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.

4.9.7.16 Public Health

4.9.7.16.1 Existing Analysis (BOEM 2011e)

Section 4.3.2.4.2 of BOEM (2011e) 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 2011e).

4.9.7.16.2 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. However, if the response to a VLOS in the Beaufort Sea could be staged out of Prudhoe Bay, this may mitigate many of the health impacts associated with the sudden influx of a large clean-up workforce. The overall effects could range from moderate to major depending on the size, nature and location of the spill.

4.9.7.17 Cultural Resources

4.9.7.17.1 Existing Analysis (BOEM 2011e)

Section 4.4.15.3.2 of BOEM (2011e) 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 2011e).

4.9.7.17.2 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 2011). 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 2011). 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 2011). 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).

4.9.7.18 Land and Water Ownership, Use, and Management

4.9.7.18.1 Existing Analysis (BOEM 2011e)

Section 4.4.10.3.2 of BOEM (2011e) 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 2011e). The Alaska Coastal Management Program was not reauthorized by the Alaska Legislature and is not in effect at this time.

4.9.7.18.2 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 4.9.6.18 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 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 4.9.7.15 (Subsistence) and Section 4.9.7.20 (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.

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. The magnitude of impact would be low 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 long term because response efforts may extend up to several years, although the impact could be permanent 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 long term impact to land use and land management.

4.9.7.19 Transportation

4.9.7.19.1 Existing Analysis (BOEM 2011e)

The BOEM (2011e) analysis did not specifically analyze impacts to transportation associated with an oil spill scenario.

4.9.7.19.2 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 4.9.6.19. 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 4.9.6.19). 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 4.9.7.10 through 4.9.7.12 and the affects to subsistence hunters is described in Section 4.9.7.15.

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.

4.9.7.20 Recreation and Tourism

4.9.7.20.1 Existing Analysis (BOEM 2011e)

Section 4.4.12.3.2 of BOEM (2011e) 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 temporary, 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 2011e).

4.9.7.20.2 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 4.9.6.20), except impacts to the setting of the Beaufort Sea would be magnified along the coast of the Arctic National Wildlife Refuge (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.

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, long term duration, regional to state-wide extent, and unique in context. In summary, the impact of a VLOS on recreation and tourism would be major.

4.9.7.21 Visual Resources

4.9.7.21.1 Existing Analysis (BOEM 2011e)

No analysis of impacts specific to visual resources is presented in the BOEM (2011e) document.

4.9.7.21.2 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 short 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 psychological/social 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. As in the analysis of the Chukchi VLOS scenario, both local and off-site viewers in the Beaufort Sea are expected to be sensitive to potential affects to scenic quality and visual resources.

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 4.9.6.21. The greatest change would likely be observed in the magnitude, duration, and extent of impacts to shoreline and on-land areas.

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, short- to long-term in duration, regional to state-wide in geographic extent, and would affect an important resource.

4.9.7.22 Environmental Justice

4.9.7.22.1 Existing Analysis (BOEM 2011e)

Section 4.4.14.3.2 of BOEM (2011e) 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 2011e).

4.9.7.22.2 Additional Analysis for Environmental Justice

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 4.9.7.15) and Public Health (Section 4.9.7.16) discussions in this EIS.

MMS (2003) states that potential effects to subsistence resources and subsistence harvests could be mitigated to some extent. The BOEM (2011e) Environmental Justice analysis is more specific about mitigation techniques and limitations, but concludes that there are “significant and perhaps irrevocable adverse impacts.”

Conclusion

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 minority populations.

4.10 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.

4.10.1 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 4.8 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. The "reasonably foreseeable future" has been established as the next five years (through 2017) for the purposes of this EIS.
- *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 reasonably foreseeable future actions (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.

4.10.2 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 4.10-1 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 (2012 through 2017). 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 five-year timeframe of this EIS. General categories of past, present and RFFAs are summarized in Table 4.10-1. For each of the general categories, a second set of detailed tables has been developed listing specific actions/activities that will be taken into consideration (Tables 4.10-2 through 4.10-10). Figures 4.1 and 4.2 show general locations of relevant past, present, and future actions for the Beaufort and Chukchi seas.

Table 4.10-1 General Categories of Relevant Past, Present, and Reasonably Foreseeable Future Actions

Category	Area	Type of Action
Oil and Gas Exploration, Development and Production	Offshore 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) Offshore 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, North Slope) Offshore 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

Category	Area	Type of Action
Subsistence Activities	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, and adjacent areas (offshore Beafort, 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 coean processes
Persistent Contaminants	Offshore 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

1 – Offshore waters are consideral federal waters for the purpose of this analysis

2 – Nearshore waters are consideral state waters for the purpose of this analysis

4.10.2.1 Oil and Gas Exploration, Development and Production

4.10.2.1.1 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 4.10-2). 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 630,000 barrels per day in 2011 (Alyeska 2011). 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 4.10-2 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)	Permit application under review, construction could begin within 5 years, potential sealift activity and overland ice road access	X	X	X		X
	3 - Beaufort Sea Inland - Greater Mooses Tooth Unit (GMT) (NPR-A)	GMT 1 (aka Alpine Satellite CD-6)	Past exploration, future development and construction, including road and pipeline access		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	
	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	

Table 4.10-2 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
	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, future potential expanded gas cycling, onshore pipeline to Badami, barge, air, and ice road access	X	X	X	X	X
	Beaufort Sea nearshore, Coastal, and Inland – Prudhoe Bay	Alaska Producers Pipeline Project	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	X	X			X

Table 4.10-2 (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

4.10.2.1.2 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, and 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 probably 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.

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 and Chukchi seas 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. The NSB plans to drill exploration and development wells in their East Barrow, South Barrow, and Walakpa gas fields during 2011-2012 (Petroleum News 2011a).

There are a number of onshore and nearshore exploration wells being proposed on State oil and gas leases in the Beaufort Sea region, primarily onshore, for the 2011-12 winter drilling season. These include:

- Pioneer Natural Resources – Pioneer proposes to drill two wells at the eastern edge of the Collvile River Delta, one onshore and one in nearshore waters.
- Repsol E&P USA – Repsol's exploration program has five well locations on the North Slope, four in the Colville River delta and one roughly 8 miles southeast of the Colville River. The drilling program will construct 30 miles of ice roads with 6 ice pads onshore and 30 miles of ice roads with one ice pad offshore.
- Brooks Range Petroleum Corporation– Brooks Range proposes to drill up to three wells onshore in its Mustang Unit, 15 miles east of Nuiqsut on state lands.
- Ultrastar Exploration LLC – Ultrastar proposes to drill one exploratory well onshore in the Prudhoe Bay Unit near Point Storkersen, two miles northwest of Point McIntyre.
- ConocoPhillipsAlaska – ConocoPhillipsAlaska proposes to drill an appraisal well onshore in the Kuparuk River Unit.
- Great Bear Petroleum LLC – Great Bear proposes to conduct exploratory drilling inland on leases along the Dalton Highway and TransAlaskaPipeline.
- North Slope Borough – the NSB intends to drill exploration and development wells onshore in the East Barrow, South Barrow, Walakpa gas fields.

In addition, 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 to from activities occurring in the Alaska Arctic OCS.

4.10.2.1.3 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 Pipeline 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 Pipeline Project

TransCanada Alaska Company, LLC and Foothills Pipe Lines, Ltd., working cooperatively with ExxonMobil, are collectively pursuing a project to treat, transport, and deliver gas from the North Slope of Alaska to markets in North America. The Alaska Pipeline Project (APP) will include the installation and operation of a gas treatment plant (GTP) at Prudhoe Bay on the Alaskan North Slope near the Beaufort Sea coast. The GTP site will be located on state land within the North Slope Borough and entirely within the Prudhoe Bay Unit. Commencement of construction is targeted for 2014 with GTP site preparation. First gas in-service date is projected for 2020. This construction schedule is preliminary and subject to change. While this project would take place primarily onshore, some dredging of dock approach areas and improvements to existing dock facilities would likely be required. Construction of the project would require large marine sealift barge traffic and other marine traffic during the course of a multi-year construction season.

Three marine sealifts to bring in large facility modules and other construction supplies, including pipe, are scheduled to occur for the GTP construction during the open water seasons of 2017, 2018, and 2019. Large sealifts supporting construction of major North Slope oil and gas facilities typically entail substantial numbers of vessels that will be traveling from Dutch Harbor through the Bering Strait, then along the Alaska Chukchi Sea coast and around Point Barrow to Prudhoe Bay. Initial channel dredging for the GTP site preparation is anticipated to require approximately 45 days of near-shore open water at Prudhoe Bay and will be performed during the summer of 2016 prior to Sealift Number 1. Prior to all sealifts (or at first open-water at Prudhoe Bay) in 2017, 2018, and 2019, maintenance screeding (leveling)/dredging will be performed as required to return the channel to specification width and depth.

Most of the modules and materials needed for GTP will be transported to the North Slope by cargo transports using ocean tugs and barges. Upon arriving in Prudhoe Bay, APP will use existing two existing Dock Heads at the West Dock Causeway to off-load the modules and materials to land. APP will modify one of the Dock Heads (Dock Head 2) for the GTP module sealift off-loads, while no modifications beyond normal maintenance activities are planned for the other. Modifications at Dock Head 2 will allow for the simultaneous mooring of multiple barges.

APP will use existing airports and airfields, collectively termed airstrips, to transport personnel and freight to and from the EIS project area. APP does not anticipate the need to upgrade any existing commercial airports for the project, but may need to make minor upgrades to some existing (non-commercial) airfields.

Point Thomson Project

ExxonMobil is proposing 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 eeast 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 Trans Alaska Pipeline System (TAPS). The primary activities that would contribute to cumulative effects include marine and air traffic associated with construction and operation, and an increased level of construction activity on the shoreline over a three-year period.

These project components include three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines, 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.

Offloading sealift modules without installing a solid fill causeway or dock would represent the primary marine component of the project.

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. Module transportation to the project site is scheduled for the summer of 2013 and would take place over three open water seasons (2013 through 2015). It is anticipated that the large ocean barges will be in place at the Point Thomson site for approximately 14 days, providing adequate time to dock and offload cargo. Once offloaded, the barges will leave the site. The method of barge access will be utilized for up to three construction seasons (2013 through 2015), with barges passing through the Chukchi Sea to and from offloading.

A bulkhead 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 (referred to as the high bulkhead) will be 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. To better accommodate landing and offloading of the smaller coastal barges, an adjacent lower bulkhead (low bulkhead) will also be constructed above the MHW line on the beach, with an associated gravel ramp constructed to the Central Pad. Air traffic would be associated with construction and 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 may be resolved, with approval for construction possible in the next two years. Construction of CD 5 and 6 would involve constructing a bridge across the Collville 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 would be 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 Chukchi and Beaufort seas, and offloading activity at West Dock.

Liberty Project

The Liberty Project is located on the eastern end of the Prudhoe Bay area in nearshore waters. It was initially conceived as an offshore production island, but has been redesigned as directional drilling from a location at the Endicott Satelite drilling island. Exploratory drilling was suspended in 2010. Development within the next five years is possible. Road access would be provided through the existing Prudhoe Bay road system; barge support for construction would be based out of Prudhoe Bay, with modules and other construction material transported by gravel roads. Air traffic would use the existing Prudhoe Bay air facilities. The primary areas of nexus with offshore exploratory activity would involve barge sealifts through the Chukchi and Beaufort seas, and offloading activity at West Dock.

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 Chukchi and Beaufort seas, and offloading activity at Badami (Bradner 2011, Petroleum News 2011b).

4.10.2.2 Scientific Research

There are a number of scientific research programs that take place in offshore areas of the Beaufort and Chukchi seas. 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 region Oceanographic research in 2011 includes physical oceanography studies, habitat and ecology studies including mapping the distribution of shorebirds fish and epifaunal communities in the central Beaufort Sea, the Hanna Shoal Ecosystem Study, and marine mammal research studies such as the Bowhead Feeding Variability in the Western Alaska Beaufort Sea, as well as the Chukchi Offshore Monitoring in Drilling Area (COMIDA) program to establish an integrated knowledge of the Chukchi Sea ecosystem. The program conducts studies to understand a wide variety of biological, chemical, and physical processes, and 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 a wide variety of associated parameters. The program operates annually in the Chukchi Sea. In addition, the BOEM research vessel, the 36-foot Launch 1273, will be underway supporting research in the Beaufort Sea during the 2011 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.

The NMFS National Marine Mammal Laboratory has 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 National Science Foundation 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 Chukchi and Beaufort Sea 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 include 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 4.10-3.

4.10.2.3 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 4.10-4.

4.10.2.4 Military

Military activity in the Arctic is thought to have increased in recent years, and it may be reasonable to expect that military activity will continue to increase in the foreseeable future. Military activities in the proposed action 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 harves, and the potential for marine fuel spills.

Table 4.10-3 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) –.	Vessel traffic, includes acoustics, aerial surveys, water and benthic sampling	X		X	X	X
		Russian-American Long-term Census of the Arctic (RUSALCA) RUSALCA (http://www.arctic.noaa.gov/aro/russian-american/)	n/a	X	X			
		Chukchi Offshore Monitoring in Drilling Area (COMIDA) (*www.**mms**.gov/alaska/ess/ongoing_studies/FE_0803.pdf*)	funded by MMS, regional area survey of benthic, seabird, marine mammals	X	X			
		Joint Chukchi baseline studies by CPAI, Statoil, Shell	includes physical ocean, benthic, zooplankton, fish, benthic, acoustics, and ice studies.	X				
		Bowhead whale satellite tagging study (http://www.wildlife.alaska.gov/index.cfm?adfg=marinemammals.bowhead)	n/a	X				
		Bowhead Whale Aerial Survey Project (BWASP)	surveys of the autumn migration of bowhead whales through the Alaskan Beaufort Sea and transect data on all other marine mammals sighted.	X				
		Various MMS-funded studies (http://www..mms.gov/alaska/)	n/a	X	X			
		Western Arctic Shelf Basin						

Table 4.10-3 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
		Interactions project (Heath and Polar Star icebreakers / NSF).	vessel traffic	X	X			
		NSF Seismic Surveys	Vessel traffic, seismic surveys	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 4.10-4 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 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. 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 4.10-5.

4.10.2.5 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 4.10-6.

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. An analysis done by Shell Oil as part of a Revised Outer Continental Shelf Lease Exploration Plan for the Chukchi Sea (Shell 2011a) indicated that barge traffic passing through the Chukchi Sea during the month of July through October has increased from roughly 2000 miles of non-seismic vessel traffic in 2006 to roughly 11,500 miles of non-seismic vessel traffic in 2010. In comparison, the same analysis estimated that vessel miles associated with seismic surveys in 2006 were roughly 70,000 miles, compared to roughly 30,000 miles in 2010.

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.

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 4.10-5 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 Sea* 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 4.10-6 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
	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.

4.10.2.6 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 4.10-7.

Table 4.10-7 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[2]	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

4.10.2.7 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 4.10-8.

4.10.2.8 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 4.10-9.

4.10.2.9 Climate Change

Climate conditions in the EIS project area have been undergoing remarkable changes, particularly over the past 20 years (USGS 2011). 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 2011). 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. 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 4.10-10.

Table 4.10-8 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, walrus, 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 4.10-9 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 4.10-10 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

4.10.3 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 ancillary activity notices for activities in the Beaufort and Chukchi seas. There would be no potential for a VLOS under Alternative 1. 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. Therefore, there would be no cumulative effects to resources outside of socioeconomics and land and water use, management, and ownership under Alternative 1.

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.

4.10.3.1 Socioeconomics

4.10.3.1.1 Summary of Direct and Indirect Effects

The magnitude of the direct and indirect socioeconomic effects from Alternative 1 is 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 is 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 temporary because it is not year-round, however, the activity would have occurred over a fixed number 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 communities would primarily be affected.

The summary impact level of direct and indirect effects from the No Action Alternative for Socioeconomics is Minor, not exceeding the significance threshold.

4.10.3.1.2 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 & 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 & 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 Northwest Arctic Borough 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 2011c). 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 Northwest Arctic Borough projected population for 2019 is 7,709; and Nome Census Area projected population for 2019 is 9,911 (ADLWD 2011c). 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 & 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.

4.10.3.1.3 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 to be not 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 & 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 & Personal Income

Government bodies (boroughs, other municipal governments, and school districts) would remain the largest employer in the NSB and Northwest Arctic Borough (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 will contribute to the employment and income opportunities in Nome and Northwest Arctic Borough 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 & 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.

4.10.3.1.4 Contribution of Alternative to Cumulative Effects

The No Action Alternative is expected to contribute a low intensity, temporary adverse impact to the region due to the lost opportunity for revenue. Although there would be no impact to the local non-monetary economy, new local employment would also not be realized and there would be no OCS oil contribution to extend the commercial life of TAPS. Therefore the contribution to cumulative effects of socioeconomics would be negligible to minor.

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/lose of any production, royalties, employment, and taxes from any petroleum that might have been produced.

4.10.3.1.5 Conclusion

The direct and indirect effects of Alternative 1 would be adverse and negligible to minor due to the lost opportunity for employment and generation of public revenue. The contribution to the socioeconomic cumulative effects would be adverse and negligible to minor.

4.10.3.2 Land and Water Ownership, Use, Management

4.10.3.2.1 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, long term 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, long term 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 4.10.3.14 and 4.10.3.19 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, long term 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.

4.10.3.2.2 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 TransAlaska 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 4.10.3.14; 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 long term effects of the onshore oil and gas and mining industries.

4.10.3.2.3 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, and thus would not have combined effects creating cumulative impacts on land ownership, use, or management.

4.10.3.2.4 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.

4.10.3.2.5 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.

4.10.4 Alternative 2 – Authorization for Level 1 Exploration Activity

4.10.4.1 Physical Oceanography

4.10.4.1.1 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, permanent, localized 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.

4.10.4.1.2 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 five-year 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 (see Table 4.10-2), 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.

4.10.4.1.3 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 localized 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 2011). However, over the five-year 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).

4.10.4.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause localized 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.

4.10.4.1.5 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.

4.10.4.2 Climate & Meteorology

4.10.4.2.1 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.

4.10.4.2.2 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 3.1.4.4 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).

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 3.1.4.4 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).

4.10.4.2.3 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, however, it is not likely that there will be any oil or gas production in the Beaufort or Chukchi seas during the life of this document. 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 years could continue to impact climate change for years to come. Estimates by the IPCC indicate that air temperatures could increase by approximately 1.1 to 6.4 deg. Celsius (3.0 to 11.5 deg. Fahrenheit) and sea levels could rise by approximately 0.2 to 0.6 m (0.7 to 2.0 ft) within the next century. 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 2000).

4.10.4.2.4 Contribution of Alternative to Cumulative Effects

In general, individual GHG emissions by themselves do not have a large impact on climate change. However, once added with all other GHG emissions in the past and present, they combine to create a perceptible change to climate including specific changes to the Arctic climate that are discussed in Section 3.1.4.4. Due to the extended amount of time that GHGs remain in the atmosphere, any amount of

GHG emissions can be reasonably expected to contribute to future climate change impacts. Activities that promote fossil fuel use or make them more accessible, such as oil and gas exploration activities, could result in sustained and even increased use of fossil fuels and GHG emissions in the future. As described in Section 4.5.1.2, potential indirect effects associated with Alternative 2 include this sustained and/or increased fossil fuels use. These indirect effects are expected to have a larger contribution to climate change cumulative impacts than the direct effects since they could add to the largest contributor to atmospheric GHG concentrations, CO_2 emissions from fossil fuel combustion, for years to come. There are many sources of fossils fuels throughout the world, so the contribution of this project by itself may not lead to an observable increase in GHG emissions on a global scale. However when viewed cumulatively, all projects involving and promoting the sustained or increased use of fossil fuels such as this project, would 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.

4.10.4.2.5 Conclusion

The direct and indirect use of fossil fuels associated with offshore exploration and drilling is relatively small. Due to the additive and synergistic nature of GHG emissions on climate change impacts, if offshore exploration activities were to make the use of fossil fuels more accessible, Alternative 2 could contribute to a moderate to major cumulative impact to climate change. However, it cannot be foreseen that exploration activities being analyzed in this EIS would result in the production of oil and gas within the timeframe being analyzed.

If a VLOS were to occur, as described in Section 4.9, 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.

4.10.4.3 Air Quality

4.10.4.3.1 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 moderate. 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.

4.10.4.3.2 Past and Present Actions

Of the action categories presented in Table 4.10-1, 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 4.10-2, 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 localized 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 localized in the areas surrounding the specific activities.

4.10.4.3.3 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.

4.10.4.3.4 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 4.9.6.4 and 4.9.7.4, 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 in either the Beaufort or Chukchi Sea.

4.10.4.4 Acoustics

4.10.4.4.1 Summary of Direct and Indirect Effects

Direct injurious effects of noise on marine fauna are discussed in Sections 4.5 to 4 to 4.8. 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 Table 4.5-10). Seismic surveys performed in shallow coastal waters and shallow hazards surveys using smaller airgun arrays produce smaller zones of ensonification (Table 4.5-10), 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).

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 4.5-10). 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.

4.10.4.4.2 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 4.5-9. 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 significant military noise sources (Martin et al. 2010).

4.10.4.4.3 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 will also generate noise that propagates over long distances into the EIS project area.

4.10.4.4.4 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 3.1-8. 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 (e.g. 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-inpulse 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 is underway to evaluate methods for estimating cumulative noise exposures (Fleishman and Streever 2011; Racca et al. 2011). 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, now in progress, 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.

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 substantially 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 significant 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.

4.10.4.4.5 Conclusion

Under Alternative 2, the presence of multiple seismic surveys could lead to greater exposures of marine mammals to disturbance noise levels 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. Exposures to potentially injurious cumulative sound levels might also occur with higher likelihood in the Beaufort as marine mammals could be exposed to noise from more than one seismic survey within relatively short time periods. The potential for this type of cumulative effect is not presently accounted for by current NMFS criteria for auditory system injury that are based on per-pulse rms sound levels.

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.

4.10.4.5 Water Quality

4.10.4.5.1 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. Ocean-bottom cable 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.

4.10.4.5.2 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; see Table 4.10-2). 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 used drilling fluids, cement slurry, drainage waters, 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.

4.10.4.5.3 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 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 2011). 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 five-year lifespan of this EIS, climate change and ocean acidification are expected to have negligible effects on water quality in the EIS project area.

4.10.4.5.4 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.

4.10.4.5.5 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.

4.10.4.6 Environmental Contaminants and Ecosystem Functions

4.10.4.6.1 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.

4.10.4.6.2 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 (see Table 4.10-2). 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.

4.10.4.6.3 Reasonably Foreseeable Future Actions

As discussed in Section 4.4.1.4, 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 (see Table 4.10-2). 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 Pipeline 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 2011). 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 2011). 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 2011). 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 2011).

4.10.4.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause localized 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 is unlikely to be substantial over the five year timeframe of this EIS.

4.10.4.6.5 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 4.9.6.7 and 4.9.7.7. There would be major additive effects on ecosystem functions resulting from a VLOS in either the Beaufort or Chukchi Sea.

4.10.4.7 Lower Trophic Levels

4.10.4.7.1 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 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 minor. 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 medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources; thereby causing a summary impact of moderate.

4.10.4.7.2 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 localized to the modest areas near the activity, and so are geographically dispersed, as are exploration activities, in the EIS project area. For this reason, overall effects of past and present actions are minor.

4.10.4.7.3 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. The continuation of 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 reasonable foreseeable future on lower trophic levels tend to be localized 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 will be long-term, the effects that would occur in the upcoming five years are not expected to considerably impact lower trophic levels. Therefore the overall impact from reasonably foreseeable future actions is minor.

4.10.4.7.4 Contribution of Alternative to Cumulative Effects

Under Alternative 2, the direct and indirect effects to lower trophic levels would be minor. 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 accidental spills would contribute a small amount to habitat change but such changes would be localized and very small. The resource would not be stressed to a point that would cause an irreversible impact. In the absence of a very large oil spill (see below), the exploration activities authorized under Alternative 2 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.10.4.7.5 Conclusion

Alternative 2 would have a minor contribution to cumulative effects on lower trophic organisms.

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.

4.10.4.8 Fish and Essential Fish Habitat

4.10.4.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 2 on fish resources and EFH is negligible. 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.

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 eliminate any effects from displacement. Therefore, the effect on juvenile and adult fish would be negligible. 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 minor, as a mechanism for population change exists, but no measurable change would result.

The opportunity for habitat loss or alteration resulting from Alternative 2 is very 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 very limited areas, particularly when compared to the total area of benthic habitat available. Therefore, the adverse impacts are considered minor.

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. Saffron cod also occurs 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 very small. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

4.10.4.8.2 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 localized 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 negligible 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). Traffic is 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 negligible impacts to fish. Seismic surveys are currently being undertaken in both Canadian and Russian Arctic waters, but are not considered to have any bearing on the fish resources with the EIS project area. 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 4.4.2.2.

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, resulting in no negligible impacts to fish.

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 negligible, 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 will likely continue to evolve in the future, it is not anticipated that any 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.

4.10.4.8.3 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 2011). 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 NPFMC's 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 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 2011d).

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 any 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 significantly 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 will have a negligible impact on fish populations.

4.10.4.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effects on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable direct or indirect effects on fish and EFH resulting from the implementation of Alternative 2 would represent a negligible contribution to cumulative effects.

4.10.4.8.5 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 negligible.

As described in Sections 4.96 and 4.9.7, in the event of a VLOS, there would be a moderate additive effect on fish and EFH within the EIS project area.

4.10.4.9 Marine and Coastal Birds

4.10.4.9.1 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 or short-term, localized, 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 negligible to minor.

4.10.4.9.2 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 and candidate species, with references to conservation concerns from interactions with human activities and natural factors. The many marine species have been all 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.

4.10.4.9.3 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 (the Point Thomson production unit and the Alaska Pipeline 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 will 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.

4.10.4.9.4 Contribution of Alternative 2 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 accidental spills would contribute a small amount to habitat change but such changes would be localized and very small compared to the contribution from climate change. The exploration activities authorized under Alternative 2 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.10.4.9.5 Conclusion

The direct and indirect effects of Alternative 2 on marine and coastal birds would be considered negligible to minor, given the temporary and localized nature of potential effects. Alternative 2 would have negligible 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 4.9.6.10 and 4.9.7.10). The implications for birds would depend on the amount and distribution of the accidental 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.

4.10.4.10 Marine Mammals

4.10.4.10.1 Bowhead Whales

4.10.4.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on bowhead whales are described in detail in Section 4.5.2.4.9 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. 2010). 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. 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 localized.

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.

In terms of the impact criteria identified in Table 4.5-17, 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 localized 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 2 on bowhead whales is likely to be moderate.

4.10.4.10.1.2 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.

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 Chukchi and Beaufort seas since the late 1960s and early 1970s (MMS 2006a). Most of this activity has occurred in the Beaufort Sea (Table 4.10-2). 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 4.5.2.4.9, 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 appear to 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 4.5.2.4.9 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 2006a). 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. 1993]) appear to be sustainable. With the Western Arctic stock of bowhead whales continuing to increase at an estimated 3.4 percent per year (George et al. 2004), 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 alterating 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 2006a).

4.10.4.10.1.3 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 4.5.2.4.9, 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.

4.10.4.10.1.4 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 4.5.2.4.9 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 localized 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 minor to moderate, with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.10.4.10.1.5 Conclusion

Under Alternative 2, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 2 would have a minor to 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 4.9.6.11 and 4.9.7.11). 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 Camden Bay, 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.

4.10.4.10.2 Beluga Whales

4.10.4.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on beluga whales are described in Section 4.5.2.4.10 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 localized 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.

4.10.4.10.2.2 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 mean estimated subsistence take from the Beaufort Sea beluga stock (Canadian and U.S. combined) was 139 during 2002 to 2006. The average annual subsistence take by Alaska Natives averaged 59 belugas from the eastern Chukchi stock during 2002 to 2006 (Allen and Angliss 2010).

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.

4.10.4.10.2.3 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.

4.10.4.10.2.4 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 localized 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 localized 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.

4.10.4.10.2.5 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 4.9.7.11). 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.

4.10.4.10.3 Other Cetaceans

4.10.4.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on cetaceans are described in Section 4.5.2.4.11 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), CSEM electromagnetic signals, 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 localized 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.

4.10.4.10.3.2 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.

4.10.4.10.3.3 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.

4.10.4.10.3.4 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 localized 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 localized 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.

4.10.4.10.3.5 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 4.9.7.11). 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.

4.10.4.10.4 Pinnipeds

4.10.4.10.4.1 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 4.5.2.4.12 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.

4.10.4.10.4.2 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.

4.10.4.10.4.3 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 localized 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.

4.10.4.10.4.4 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 localized. 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 localized 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.

4.10.4.10.4.5 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 4.9.7.11). The implications for ice seals would depend on the amount and distribution of the accidental 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.

4.10.4.10.5 Walrus

4.10.4.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on walrus are described in Section 4.5.2.4.13 and are summarized here. Walrus 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 walrus 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 walrus 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 accidental 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 calf and juvenile mortality from stampedes. Walrus 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 Pacific walrus 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 walrus according to the criteria established in Table 4.5-17.

4.10.4.10.5.2 Past and Present Actions

Pacific walrus 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). In February 2011 the USFWS determined that Pacific walrus 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.

Pacific walrus 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 walrus 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 walrus 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 walrus 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 walrus 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 walrus, particularly calves and juveniles, vulnerable to disturbance related stampedes and trampling mortalities (Fischbach et al. 2009) and predation from similarly shore-bound polar bears.

Walrus 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 walrus 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 but large bottom trawl fisheries in the Bering Sea may affect the winter prey base of walrus. Like all Arctic-dwelling animals, walrus 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). Walrus 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 USFWS estimates that the most recent five-year average subsistence harvest in Alaska and Russia (2003 to 2007) is 4,960 to 5,457 walrus per year, including animals estimated to be struck and lost (Allen and Angliss 2011).

4.10.4.10.5.3 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 walrus 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 walrus 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 walrus 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 walrus and their habitat. Subsistence hunting will likely continue to be the largest source of direct human-induced mortality on walrus. The greatest concern for walrus 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 walrus would have more localized effects but climate change affects the entire range of this 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 sea ice habitat will be reversed.

4.10.4.10.5.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add to the disturbance of walrus 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 walrus, 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 localized 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 Pacific walrus.

4.10.4.10.5.5 Conclusion

The direct and indirect effects of Alternative 2 on Pacific walrus 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 4.9.7.11). The implications for walrus would depend on the amount and distribution of the accidental spill, especially in relation to the ice pack, and how quickly and thoroughly it could be cleaned up. Walrus 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 walrus 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 walrus 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 walrus 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 Pacific walrus.

4.10.4.10.6 Polar Bears

4.10.4.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on polar bears are described in Section 4.5.2.4.14 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 bear-human 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.

4.10.4.10.6.2 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 was designated in 2010, including sea-ice habitat, terrestrial denning habitat, and barrier island habitat (75 FR 76086, December 7, 2010).

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 or property (Amstrup 2000).

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. 2010). 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).

4.10.4.10.6.3 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 so important to this species and its prey. Most of the other factors that could affect polar bears would have more localized effects but climate change affects the entire range of this 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 sea ice habitat will be reversed.

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 accidental 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 (the Point Thomson production unit and the Alaska Pipeline Project) 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.

4.10.4.10.6.4 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 localized 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.

4.10.4.10.6.5 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 4.9.7.11). The implications for polar bears would depend on the amount and distribution of the accidental 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). Marine mammal observers on clean-up crews may be effective at diverting curious 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.

4.10.4.11 Terrestrial Mammals

4.10.4.11.1 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.

4.10.4.11.2 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 1970's through the mid 1980's 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. Currently there are 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. 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.

4.10.4.11.3 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 Pipeline Project near Prudhoe Bay 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 with construction targeted for 2014. 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 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 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. 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.

4.10.4.11.4 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 2011).

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.

4.10.4.11.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on caribou would be negligible.

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.

4.10.4.12 Special Habitat Areas

The analysis of the cumulative effects associated with special habitat areas can be found in Sections 4.10.4.10 (Marine Mammals), 4.10.4.9 (Marine and Coastal Birds) and 4.10.4.14 (Subsistence).

4.10.4.13 Socioeconomics

4.10.4.13.1 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 Conflict Avoidance Agreement (CAA), Com Centers, and Plans of Cooperation (POC) are mechanisms currently used for communication, cooperation, and conflict avoidance between industry and local groups like the AEWC.

The magnitude of the socioeconomic impact is positive but low because total personal income and local employment rates are not 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 temporary because it is not year-round. However, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are statewide and even 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 communities. The summary impact level for Socioeconomics under Alternative 2 is minor, not exceeding the significance threshold.

4.10.4.13.2 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.

4.10.4.13.3 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.

4.10.4.13.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 2 to socioeconomic cumulative effects would be minor to negligible at a statewide and national level because the magnitude is low, the duration is temporary and the context is common. However, at a local level, the new direct employment, public revenue generation, and impact to social institutions would be greater and the Iñupiat community is a unique context, therefore the contribution would be minor.

4.10.4.13.5 Conclusion

The direct and indirect effects of Alternative 2 would be minor. The contribution to the cumulative effects of socioeconomics would be negligible to 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 4.9.6.15, 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.

4.10.4.14 Subsistence

4.10.4.14.1 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 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 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).

4.10.4.14.2 Past and Present Actions

Numerous past and present actions (Section 4.10.2) 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 4.10.4.11).

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 mammals 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. Past and present scientific research activities are described in Table 4.10-3. 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. 1993]) 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 have recently been conducting fall bowhead whale hunts to provide for their communities and meet allotted quotas when ice conditions have been considered less dangerous than in recent spring seasons when it has been considered too dangerous for crews to hunt (Comstock 2011).

4.10.4.14.3 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 (Table 4.10-1) 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 (the Point Thomson production unit and 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, localized 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.

4.10.4.14.5 Conclusion

Under Alternative 2, the direct and indirect effects to subsistence resources 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. 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 accidental 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.

4.10.4.15 Public Health

4.10.4.15.1 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 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 permanent, and multiple communities could be affected.

4.10.4.15.2 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 significant 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 significant 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 significantly and 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 experience 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.

4.10.4.15.3 Reasonably Foreseeable Future Actions

As described in Tables 4.10-1 through 4.10-7 and 4.10-9, there are a significant 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.

4.10.4.15.4 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 will lead to further offshore oil and gas activity, there could be significant 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.

4.10.4.15.5 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 4.9.6.16 and 4.9.7.16, 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 contributes 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.

4.10.4.16 Cultural Resources

4.10.4.16.1 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 long-term in duration, but in a very localized area. Therefore, the summary impact level of direct and indirect effect from Alternative 2 for cultural resources is minor, 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.

4.10.4.16.2 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 effect 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.

4.10.4.16.3 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 Pipeline Project near Prudhoe Bay 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 with construction targeted for 2014. 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, Division of Mining, Land and Water (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 Arctic National Wildlife Refuge, as a result of elevated media exposure of the Refuge.

4.10.4.16.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of activities associated with Alternative 2 to cumulative effects on cultural resources would be negligible.

4.10.4.16.5 Conclusion

Direct and indirect effects associated with Alternative 2 are considered to be minor. 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 minor to moderate additive effects to the cumulative effects associated with Alternative 2 to cultural resources.

4.10.4.17 Land and Water Ownership, Use, Management

4.10.4.17.1 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, the impacts on land and water ownership under Alternative 2 would be low in magnitude, temporary in duration, local in extent, and common in context. In total, the direct and indirect impacts on land ownership are considered to be negligible; they would result in no change of ownership or development rights.

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 permanent 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 minor.

4.10.4.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.4.1.2.

4.10.4.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.4.1.2.

4.10.4.17.4 Contribution of Alternative to Cumulative Effects

The level of impact for land and water ownership under Alternative 2 would be negligible, and past, present, and reasonably foreseeable future actions are not expected to result in any changes in ownership. The level of impact on land and water use under Alternative 2 would be moderate, and duration would be short-term and seasonal in nature. 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 not have combined effects creating cumulative impacts on land ownership, use, or management.

4.10.4.17.5 Conclusion

Under Alternative 2, the levels of direct, indirect and cumulative impacts for land and water ownership, use, and management would be negligible, moderate, and minor, 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.

4.10.4.18 Transportation

4.10.4.18.1 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, temporary, local in extent, and affecting resources considered common in context. As a result, the overall direct and indirect effects would be considered minor.

4.10.4.18.2 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.

4.10.4.18.3 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 a 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 would also increase if the Point Thomson Project or the Alaska Pipeline Project were 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.

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.

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 action 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 Point Thomson Project or the Alaska Pipeline Project were constructed during the time period covered under this EIS. Coastal barges would support these projects 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.

4.10.4.18.4 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 large projects such as Point Thomson or the Alaska Pipeline Project were 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 temporary 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.

4.10.4.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 2 overlaps with large-scale development projects but those impacts would be of low intensity, temporary in duration affecting local areas of common resources, and are considered unlikely to have long-term impacts on regional transportation infrastructure.

A VLOS would be considered an additive adverse long term impact to cumulative impacts of transportation. Following a VLOS cumulative impacts to transportation in the Beaufort and Chukchi seas could 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. If a VLOS were to occur, there would be moderate additive effect to the cumulative effects associated with Alternative 2 on transportation.

4.10.4.19 Recreation and Tourism

4.10.4.19.1 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, temporary 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.

4.10.4.19.2 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.

4.10.4.19.3 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.

4.10.4.19.4 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.

4.10.4.19.5 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.

4.10.4.20 Visual Resources

4.10.4.20.1 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 any sensitive viewer groups located in on-land or near-shore locations (see Section 3.3.9.7 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 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.

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 highly sensitive viewers from the Alaska Native community of Nuiqsut and viewers located in the industrial centers of Deadhorse and Prudhoe Bay characterized as having low visual sensitivity.

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 *short-term 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 localized; however they would occur in an important ecosystem.

4.10.4.20.2 Past and Present Actions

Large scale oil and gas exploration is a major component of the landscape character of the West Beaufort Sea analysis unit, located on the North Slope. Oil and gas-related development has occurred in this area since the 1940's, 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.

Cultural modification is the most defining landscape characteristic separating the West Beaufort Sea analysis unit from other analysis units. This unit is characterized by ongoing oil and gas activity. Views of the EIS project area from native communities and industrial nodes along the shoreline of this unit would experience views of existing on- and offshore oil and gas activity. Viewers situated along the shoreline of the adjacent East Beaufort analysis unit may also experience views of on- and offshore oils and gas development. 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. When viewed from the EIS project area, the low-lying, horizontal lines of onland 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.

4.10.4.20.3 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.
- State of Alaska lease sales in the near-shore portions of the Beaufort and Chukchi seas.
- Construction and operation of the Alaska Pipeline Project, including a gas treatment plant (GTP) at Prudhoe Bay.
- Construction and operation of the Point Thompson Project located 60 miles east of Prudhoe Bay.

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 – including associated light and movement -- particularly due to the operation of the Point Thomson Project in a geographically distinct area located 60 miles to the east. Reasonably foreseeable future actions are expected to have a major effect on visual resources as the cumulative actions would be high intensity, long-term, local in geographic extent, and affecting an important resource.

4.10.4.20.4 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 sensitive viewers, including native communities or recreators 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.

4.10.4.20.5 Conclusion

Under Alternative 2, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, regional in geographic extent and occurring in an important context.

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, long-term or permanent, extended in scope, and would affect an important resource.

4.10.4.21 Environmental Justice

4.10.4.21.1 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 communities.

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 would be minor. Thus, the direct and indirect effects of Alternative 2 to public health would be minor.

4.10.4.21.2 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 4.10.4.14.

Impacts to subsistence foods and impacts to health indicators from past and present actions are described in the Public Health Section 4.10.4.15.

4.10.4.21.3 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.

4.10.4.21.4 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.

4.10.4.21.5 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 disproportionate impact to Alaska Natives 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 living in communities near the EIS project area.

4.10.5 Alternative 3 – Authorization for Level 2 Exploration Activity

4.10.5.1 Physical Oceanography

4.10.5.1.1 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, permanent/temporary (permanent if gravel, temporary if ice), localized 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.

4.10.5.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.1.

4.10.5.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.1.

4.10.5.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause localized 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.

4.10.5.1.5 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 4.10.4.1).

4.10.5.2 Climate & Meteorology

4.10.5.2.1 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.

4.10.5.2.2 Past and Present Actions

Past and present actions affecting climate change are discussed under Alternative 2, Section 4.10.4.2.

4.10.5.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change are discussed under Alternative 2, Section 4.10.4.2.

4.10.5.2.4 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.

4.10.5.2.5 Conclusion

Due to the additive and synergistic nature of GHG emissions on climate change impacts, and the fact that this project and alternative could promote or make more accessible the use of fossil fuels, 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 4.10.4.2).

4.10.5.3 Air Quality

4.10.5.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-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, however the overall direct effect on air quality is expected to be moderate. Indirect effects on air quality would remain at negligible to minor.

4.10.5.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.3.

4.10.5.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.3.

4.10.5.3.4 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.

4.10.5.3.5 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 in the Beaufort or Chukchi seas associated with air quality were discussed under Alternative 2 (Section 4.10.4.3).

4.10.5.4 Acoustics

4.10.5.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.10.4 (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.

4.10.5.4.2 Past and Present Actions

The past actions for Alternative 3 are the same as listed for Alternative 2 (Section 4.10.4.4). 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.

4.10.5.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.10.4.4.

4.10.5.4.4 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. Likewise marine mammals might have more difficulty avoiding the potential injury zones when greater numbers of seismic surveys were operating. 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 substantially 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.

4.10.5.4.5 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. These animals would therefore be exposed to higher sound levels and higher cumulative sound levels than if fewer concurrent operations were present.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.10.4.4).

4.10.5.5 Water Quality

4.10.5.5.1 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 4.10.4.5. 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 localized 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.

4.10.5.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.5.

4.10.5.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.5.

4.10.5.5.4 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.

4.10.5.5.5 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 4.10.4.5).

4.10.5.6 Environmental Contaminants and Ecosystem Functions

4.10.5.6.1 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.

4.10.5.6.2 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 4.10.4.6.

4.10.5.6.3 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 4.10.4.6.

4.10.5.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause localized 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 five-year lifespan of this EIS.

4.10.5.6.5 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 4.10.4.6).

4.10.5.7 Lower Trophic Levels

4.10.5.7.1 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 4.10.4.7 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 minor.

4.10.5.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.10.4.7.

4.10.5.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.10.4.7.

4.10.5.7.4 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 4.10.4.7 and the overall impact would be moderate. In the absence of a very large oil spill, the exploration activities authorized under Alternative 3 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.10.5.7.5 Conclusion

Alternative 3 could have a moderate contribution to cumulative effects on lower trophic organisms.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.10.4.7).

4.10.5.8 Fish and Essential Fish Habitat

4.10.5.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 3 on Fish Resources and EFH is negligible. 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, there would be no measurable effect on the resource.

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 impacts to marine fish would be considered minor.

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 impacts to migratory fish would be considered negligible.

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 very small and only incrementally larger than for Alternative 2. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

4.10.5.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.10.4.8.

4.10.5.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.10.4.8.

4.10.5.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effect on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable effect on fish and EFH resulting from the implementation of Alternative 3 would not add to any cumulative effects.

4.10.5.8.5 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 negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.10.4.8).

4.10.5.9 Marine and Coastal Birds

4.10.5.9.1 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 or short-term, localized, 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 negligible to minor.

4.10.5.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.10.4.9.

4.10.5.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.10.4.9.

4.10.5.9.4 Contribution of Alternative 3 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 (4.10.4.9). The exploration activities authorized under Alternative 3 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.10.5.9.5 Conclusion

The direct and indirect effects of Alternative 3 on marine and coastal birds would be considered negligible to minor. Alternative 3 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds, as discussed under Alternative 2 (Section 4.20.4.9).

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 4.10.4.9).

4.10.5.10 Marine Mammals

4.10.5.10.1 Bowhead Whales

4.10.5.10.1.1 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 4.10.4.10.1).

In terms of the impact criteria identified in Table 4.5-17, 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 localized 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.

4.10.5.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.1.

4.10.5.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.1.

4.10.5.10.1.4 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 4.10.4.10.1), with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.10.5.10.1.5 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 4.10.4.10.1).

4.10.5.10.2 Beluga Whales

4.10.5.10.2.1 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 localized 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.

4.10.5.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.10.4.10.2.

4.10.5.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.10.4.10.2.

4.10.5.10.2.4 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 localized 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 localized 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.

4.10.5.10.2.5 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 4.10.4.10.2).

4.10.5.10.3 Other Cetaceans

4.10.5.10.3.1 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), CSEM electromagnetic signals, 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 localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

4.10.5.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.3.

4.10.5.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.3.

4.10.5.10.3.4 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 localized 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 localized 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.

4.10.5.10.3.5 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 4.10.4.10.3).

4.10.5.10.4 Pinnipeds

4.10.5.10.4.1 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.

4.10.5.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.4.

4.10.5.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.4.

4.10.5.10.4.4 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 localized 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.

4.10.5.10.4.5 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 4.10.4.10.4).

4.10.5.10.5 Walrus

4.10.5.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on walrus are described in Section 4.6.2.4.5 and are summarized here. Walrus 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 walrus 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 walrus 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 accidental 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 calf and juvenile mortality from stampedes. Walrus 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 walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 3 on Pacific walrus would therefore be considered minor.

4.10.5.10.5.2 Past and Present Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.5.

4.10.5.10.5.3 Reasonably Foreseeable Future Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.5.

4.10.5.10.5.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 3 would add to the disturbance of walrus 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 walrus, 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 localized 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 Pacific walrus.

4.10.5.10.5.5 Conclusion

The direct and indirect effects of Alternative 3 on Pacific walrus 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 Pacific walrus were discussed under Alternative 2 (Section 4.10.4.10.5).

4.10.5.10.6 Polar Bears

4.10.5.10.6.1 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 bear-human 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.

4.10.5.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.6.

4.10.5.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.6.

4.10.5.10.6.4 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 localized 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.

4.10.5.10.6.5 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 4.10.4.10.6).

4.10.5.11 Terrestrial Mammals

4.10.5.11.1 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 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.

4.10.5.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.

4.10.5.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.

4.10.5.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.10.5.11.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on caribou would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.10.4.11).

4.10.5.12 Special Habitat Areas

The analysis of the cumulative effects associated with special habitat areas can be found in Sections 4.10.5.10 (Marine Mammals), 4.10.5.9 (Marine and Coastal Birds) and 4.10.5.14 (Subsistence).

4.10.5.13 Socioeconomics

4.10.5.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 3 are similar to those described in Alternative 2. Alternative 3 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; and countervailing 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 due as Alternative 2 to their duplicative nature. Also similar to Alternative 2, the duration of the socioeconomic impacts is temporary (not year-round) and scheduled to occur over a fixed number of years. The geographic extent of socioeconomic impacts is 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 communities. The summary impact level for Socioeconomics under Alternative 3 is minor, not exceeding the significance threshold.

4.10.5.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.10.4.13.

4.10.5.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.10.4.13. 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.

4.10.5.13.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause minor (positive) direct and indirect impacts to socioeconomics. 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. The summary contribution of these impacts to the cumulative effectives of socioeconomics is negligible to minor at a statewide and national level and minor at the local level.

4.10.5.13.5 Conclusion

The direct and indirect effects of Alternative 3 would be minor. The contribution to cumulative effects of socioeconomics would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics were discussed under Alternative 2 (Section 4.10.4.13).

4.10.5.14 Subsistence

4.10.5.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-25, 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 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). 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).

4.10.5.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.14.

4.10.5.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.14.

4.10.5.14.4 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, localized 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.

4.10.5.14.5 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 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 4.10.4.14).

4.10.5.15 Public Health

4.10.5.15.1 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.

4.10.5.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.10.3.15.

4.10.5.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.10.3.15.

4.10.5.15.4 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 4.10.4.15.

4.10.5.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.10.4.15, Alternative 3 contributes to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts.

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 4.10.4.15).

4.10.5.16 Cultural Resources

4.10.5.16.1 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 minor.

4.10.5.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.16.

4.10.5.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.16.

4.10.5.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.10.5.16.5 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 4.10.4.16).

4.10.5.17 Land and Water Ownership, Use, Management

4.10.5.17.1 Summary of Direct and Indirect Effects

As discussed in Section 4.10.4.17, the direct and indirect impacts on land and water ownership would be low magnitude, temporary duration, local extent, and common in context. The direct and indirect impacts on land and water use would have a high magnitude, be temporary in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, temporary in nature, local, and common. In summary, the impacts of Alternative 3 on land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.10.5.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.10.4.17.

4.10.5.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.10.4.17.

4.10.5.17.4 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 4.10.4.17 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. The conclusions for Alternative 2 are applicable to Alternative 3; all changes would be incrementally small, short-term in duration, and geographically dispersed, and thus would not have combined effects creating cumulative impacts on land ownership, use, or management and would be considered minor.

4.10.5.17.5 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 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 4.10.4.17).

4.10.5.18 Transportation

4.10.5.18.1 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 littering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence would be low in intensity, temporary in duration, limited in geographic extent to a local area, and common to potentially unique context (in respect to protected marine mammal resources). The summary impact from increases in vessel traffic would be considered minor.

<u>4.10.5.18.2 Past and Present Actions</u>

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.10.4.18.

<u>4.10.5.18.3 Reasonably Foreseeable Future Actions</u>

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.10.4.18.

<u>4.10.5.18.4 Contribution of Alternative to Cumulative Effects</u>

The contribution of impacts from Alternative 3 would be similar but of slightly higher intensity than described for Alternative 2 in Section 4.10.4.18.

<u>4.10.5.18.5 Conclusion</u>

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 3 overlaps with another large-scale development project but those impacts would be of low intensity, temporary in duration affecting local areas of common resources, and are considered unlikely to have long-term impacts on regional transportation infrastructure.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with transportation were discussed under Alternative 2 (Section 4.10.4.18).

4.10.5.19 Recreation and Tourism

<u>4.10.5.19.1 Summary of Direct and Indirect Effects</u>

As discussed in Section 4.6.3.7, the direct impacts on recreation and tourism would be low intensity, temporary 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.

<u>4.10.5.19.2 Past and Present Actions</u>

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.10.4.19.

<u>4.10.5.19.3 Reasonably Foreseeable Future Actions</u>

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.10.4.19.

<u>4.10.5.19.4 Contribution of Alternative to Cumulative Effects</u>

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.

<u>4.10.5.19.5 Conclusion</u>

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 4.10.4.19).

4.10.5.20 Visual Resources

4.10.5.20.1 Summary of Direct and Indirect Effects

Implementation of Alternative 3 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 short-term 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, localized 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.

4.10.5.20.2 Past and Present Actions

Past and present actions associated with visual resources are presented under Alternative 2 (Section 4.10.4.20).

4.10.5.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with visual resources are presented under Alternative 2 (Section 4.10.4.20).

4.10.5.20.4 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 sensitive viewers, such as residents of native communities or recreators 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.

4.10.5.20.5 Conclusion

Under Alternative 3, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, 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 4.10.4.20).

4.10.5.21 Environmental Justice

4.10.5.21.1 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.

4.10.5.21.2 Past and Present Actions

Past and present actions associated with environmental justice are presented under Alternative 2 (Section 4.10.4.21).

4.10.5.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with environmental justice are presented under Alternative 2 (Section 4.10.4.21).Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.10.5.21.4 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.

4.10.5.21.5 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 disproportionate 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 visual resources were discussed under Alternative 2 (Section 4.10.4.20). A VLOS would have disproportionate adverse impacts to Alaska Native communities in the EIS project area.

4.10.6 Alternative 4 – Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures

4.10.6.1 Physical Oceanography

4.10.6.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 4 on physical ocean resources would be substantially the same as those described for Alternative 3. The time area closures included as additional mitigation measures in Alternative 4 would not substantially change the effects of the alternative on physical ocean resources in the EIS project area. 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. The direct and indirect effects of Alternative 4 on physical ocean resources in the proposed action area would be minor.

4.10.6.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.1.

4.10.6.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.1.

4.10.6.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause localized 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 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.

4.10.6.1.5 Conclusion

The direct and indirect effects of Alternative 4 on physical ocean resources in the EIS project area would be minor. 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 4.10.4.1).

4.10.6.2 Climate & Meteorology

4.10.6.2.1 Summary of Direct and Indirect Effects

Alternative 4 involves the same exploration activities as proposed in Alternative 3, 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 4 are the same as those for Alternative 3. Therefore the impact levels are expected to be the same as Alternative 3, which are minor direct impacts and minor to moderate indirect impacts.

4.10.6.2.2 Past and Present Actions

Past and present actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.10.4.2.

4.10.6.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.10.4.2.

4.10.6.2.4 Contribution of Alternative to Cumulative Effects

Alternative 4 would emit approximately the same amount of GHGs as Alternative 3; 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 4 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 4 are expected to result in changes that could be long-term and could affect unique resources.

4.10.6.2.5 Conclusion

Alternative 4 could contribute to a moderate to major cumulative impact to climate change, similar to Alternatives 2 and 3.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with climate change were discussed under Alternative 2 (Section 4.10.4.2).

4.10.6.3 Air Quality

4.10.6.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 4, Level 2 Exploration Activity, are expected to be the same as those for Alternative 3. The overall direct effect on air quality is expected to be moderate, and indirect effects would be negligible to minor.

4.10.6.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.3.

4.10.6.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.3.

4.10.6.3.4 Contribution of Alternative to Cumulative Effects

The potential cumulative effects on air quality for Alternative 4 are the same as those for Alternative 3. These are expected to be moderate, with worst-case effect being less than additive.

4.10.6.3.5 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 moderate in magnitude.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with air quality were discussed under Alternative 2 (Section 4.10.4.3).

4.10.6.4 Acoustics

4.10.6.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.10.4 (Alternative 2) is relevant also for Alternative 4.

4.10.6.4.2 Past and Present Actions

Past and present actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.10.4.4.

4.10.6.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.10.4.4. 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.

4.10.6.4.4 Contribution of Alternative to Cumulative Effects

The contributions to cumulative effects for Alternative 4 should be substantially less than from Alternative 3 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.

4.10.6.4.5 Conclusion

Use of closures as proposed in Alternative 4 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 in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.10.4.4).

4.10.6.5 Water Quality

4.10.6.5.1 Summary of Direct and Indirect Effects

Impacts to water quality from Alternative 4 are expected to be very similar to those described above for Alternative 3. The only difference between Alternative 3 and Alternative 4 is the addition of required time/area closures. The level of activity would be the same for Alternatives 3 and 4, but the times and locations of the activity could be different. Time/area closures established under Alternative 4 as additional mitigation measures could reduce the likelihood of adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 4 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 4 on water quality are expected to be minor.

4.10.6.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.5.

4.10.6.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.5.

4.10.6.5.4 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 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.

4.10.6.5.5 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 additional time/area closures required under Alternative 4 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 4.10.4.5).

4.10.6.6 Environmental Contaminants and Ecosystem Functions

4.10.6.6.1 Summary of Direct and Indirect Effects

Additional mitigation measures related to time area closures under Alternative 4 would potentially result in decreased impacts to environmental contaminants and ecosystem functions relative to Alternative 3. The time area closures proposed under Alternative 4 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 4 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 4, 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. Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 4 would be medium-intensity, temporary, and local. Overall effects of Alternative 4 on environmental contaminants and ecosystem functions would be minor.

4.10.6.6.2 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 4.10.4.6.

4.10.6.6.3 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 4.10.4.6.

4.10.6.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause localized 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. 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 5 year lifespan of this EIS. Time/area closures associated with Alternative 4 would limit the potential for aggregation of adverse impacts to occur in sensitive areas.

4.10.6.6.5 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 additional time/area closures required under Alternative 4 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 4.10.4.6).

4.10.6.7 Lower Trophic Levels

4.10.6.7.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 4 are the same as in Alternative 3, and there are additional mitigation measures for seasonal closures for certain areas. These mitigated closures do not affect lower trophic levels in the EIS project area, so the impacts discussed in for Alternatives 2 and 3 are the same for Alternative 4, therefore, the overall impact to lower trophic levels would be minor.

4.10.6.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.10.4.7.

4.10.6.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.10.4.7.

4.10.6.7.4 Contribution of Alternative to Cumulative Effects

Alternative 4 would have the same types of effects as Alternative 2 with the addition of certain time/area closures. Therefore, the conclusions about Alternative 4 would be similar to Alternative 2 discussed in Section 4.10.4.7 and the overall impact would be moderate. In the absence of a very large oil spill, the exploration activities authorized under Alternative 4 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.10.6.7.5 Conclusion

Alternative 4 could have a moderate contribution to cumulative effects on lower trophic organisms.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.10.4.7).

4.10.6.8 Fish and Essential Fish Habitat

4.10.6.8.1 Summary of Direct and Indirect Effects

The effect of the time/area closures outlined in Alternative 4 on Fish Resources and EFH would be a reduction in the overall impact. Although the overall impact is considered to be negligible based on Alternative 3 alone, any further reduction in impacts resulting from the time/area closures would be beneficial. The already low impact levels would be decreased by each of the individual closures, and any combination would reduce the impacts further. Implementing all of the time/area closures would substantially decrease all effects on fish resources by protecting the most important fish habitats where the highest fish densities are found. Due to the substantial decrease to the already very small scale of any potential effects relative to overall population levels and available habitat, there would be no measurable effect on the resource.

4.10.6.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.10.4.8.

4.10.6.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.10.4.8.

4.10.6.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effect on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable effect on fish and EFH resulting from the implementation of Alternative 4 would not add to any cumulative effects.

4.10.6.8.5 Conclusion

Direct and indirect effects associated with Alternative 4 on fish and EFH would be negligible. The overall contribution of Alternative 4 to cumulative effects on fish and EFH would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.10.4.8).

4.10.6.9 Marine and Coastal Birds

4.10.6.9.1 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, localized, and not likely to have population-level effects for any species. In summary, the impact of Alternative 4 on marine and coastal birds would be considered negligible.

4.10.6.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.10.4.9.

4.10.6.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.10.4.9.

4.10.6.9.4 Contribution of Alternative 4 to Cumulative Effects

Alternative 4 would have the same types and level of exploration activities as Alternative 3 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 3 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 4 would therefore be essentially the same as for Alternative 3. The exploration activities authorized under Alternative 4 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.10.6.9.5 Conclusion

Direct and indirect effects associated with Alternative 4 on marine and coastal birds would be negligible. The overall contribution of Alternative 4 to cumulative effects on marine and coastal birds would be negligible.

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 4.10.4.9).

4.10.6.10 Marine Mammals

4.10.6.10.1 Bowhead Whales

4.10.6.10.1.1 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. Impacts of activities associated with oil and gas exploration in the EIS project area under Alternative 4 are similar to Alternative 3 (See Section 4.10.5.10.1).

Effects of disturbance on bowhead whales would be reduced in the closure areas during time periods specified in Alternative 4. 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 localized 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 4 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.

4.10.6.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.1.

4.10.6.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.1.

4.10.6.10.1.4 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 similar to Alternative 3 (Section 4.10.5.10.1), 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 4 to cumulative effects on bowhead whales would be minor.

4.10.6.10.1.5 Conclusion

Under Alternative 4, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 4 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 4.10.4.10.1).

4.10.6.10.2 Beluga Whales

4.10.6.10.2.1 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 localized 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 localized 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 4 could reduce or avoid adverse impacts in particular times and locations, the overall impact of Alternative 4 on beluga whales would be considered moderate.

4.10.6.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.10.4.10.2.

4.10.6.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.10.4.10.2.

4.10.6.10.2.4 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 localized 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 localized 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 moderate additive contributions to the cumulative effects on beluga whales.

4.10.6.10.2.5 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 4.10.4.10.2).

4.10.6.10.3 Other Cetaceans

4.10.6.10.3.1 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. Although the time/area closures specified in Alternative 4 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 3. 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.

Effects on other cetaceans from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 4. 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 localized 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.

4.10.6.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.3.

4.10.6.10.3.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.3.

4.10.6.10.3.3 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. Although the time/area closures specified in Alternative 4 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 3. Most of this disturbance would occur during the open-water season and would be localized 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 localized 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 4 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.10.6.10.3.4 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 4.10.4.10.3).

4.10.6.10.4 Pinnipeds

4.10.6.10.4.1 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 4 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.10.6.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.4.

4.10.6.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.4.

4.10.6.10.4.4 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 localized 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 the four species of ice seals considered.

4.10.6.10.4.5 Conclusion

The direct and indirect effects of Alternative 4 on pinnipeds would be considered minor. Alternative 4 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 4.10.4.10.4).

4.10.6.10.5 Walrus

4.10.6.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on walrus are described in Section 4.7.2.4.5 and are summarized here. The types and levels of effects on walrus are essentially the same under Alternative 4 as for Alternative 3 (Section 4.6.2.4.5). The primary difference for walrus 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 walrus 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 3. Walrus 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 walrus 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 walrus because they are unlikely to be affected in any biologically meaningful way by seismic noise. Mitigation measures required for walrus 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 accidental 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 calf and juvenile mortality from stampedes. Walrus 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 walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 4 on Pacific walrus would therefore be considered minor.

4.10.6.10.5.2 Past and Present Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.5.

4.10.6.10.5.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.5.

4.10.6.10.5.3 Contribution of Alternative 4 to Cumulative Effects

The exploration activities authorized under Alternative 4 would add to the disturbance of walrus 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 walrus, 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 localized 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 to negligible contributions to the cumulative effects on Pacific walrus.

4.10.6.10.5.4 Conclusion

The direct and indirect effects of Alternative 4 on Pacific walrus would be considered minor. Alternative 4 would have negligible to minor contributions to the cumulative effects on Pacific walrus.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with Pacific walrus were discussed under Alternative 2 (Section 4.10.4.10.5).

4.10.6.10.6 Polar Bears

4.10.6.10.6.1 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 (Section 4.6.2.4.6). The time/area closure periods specified in Alternative 4 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 3. 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 bear-human 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 4 on polar bears would therefore be considered minor.

4.10.6.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.6.

4.10.6.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.6.

4.10.6.10.6.4 Contribution of Alternative 4 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 localized 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.

4.10.6.10.6.5 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 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 4.10.4.10.6).

4.10.6.11 Terrestrial Mammals

4.10.6.11.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 4 are the same as in Alternative 3, with the added requirement for time/area closures for certain areas. These required closures under Alternative 4 do not affect terrestrial mammals in the EIS project area, so the impacts discussed for Alternatives 2 and 3 are the same for Alternative 4; the summary level direct and indirect impact to terrestrial mammals would be minor.

4.10.6.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.

4.10.6.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.

4.10.6.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.10.6.11.5 Conclusion

Direct and indirect impacts resulting from Alternative 4 on caribou would be minor. The incremental contribution of activities associated with Alternative 4 to cumulative effects on caribou would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.10.4.11).

4.10.6.12 Special Habitat Areas

The analysis of the cumulative effects associated with special habitat areas can be found in Sections 4.10.6.10 (Marine Mammals), 4.10.6.9 (Marine and Coastal Birds) and 4.10.6.14 (Subsistence).

4.10.6.13 Socioeconomics

4.10.6.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 4 are 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, there would be some potential socioeconomic benefits to the non-cash economy. 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.

4.10.6.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.10.4.13.

4.10.6.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.10.4.13.

4.10.6.13.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 4 to socioeconomic cumulative effects would be minor and positive. They differ from Alternative 2 by a low magnitude of lost productivity for lease holders and loss in magnitude in the new personal income sources. The mitigation measures associated with Alternative 4 would have a net benefit to subsistence resources and activities and therefore would have a countervailing positive impact to the non-cash economy. The summary contribution of these impacts to the cumulative effectives of socioeconomics is negligible to minor at a statewide and national level and minor at the local level.

4.10.6.13.5 Conclusion

The direct and indirect effects of Alternative 4 would be positive and minor. 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 were discussed under Alternative 2 (Section 4.10.4.13).

4.10.6.14 Subsistence

4.10.6.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-25, 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 in duration, local 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). The impacts of implementing Alternative 4 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 4.10.4.14. 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 4.7.3.2).

4.10.6.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.14.

4.10.6.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.14.

4.10.6.14.4 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, localized 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 4 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 4 would have a negligible to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 4 would be considered additive to cumulative effects on subsistence resources.

4.10.6.14.5 Conclusion

Under Alternative 4, the direct and indirect effects to subsistence resources are considered low in intensity, temporary in duration, local in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 4 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 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 4.10.4.14).

4.10.6.15 Public Health

4.10.6.15.1 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. To the extent the time/area closures described for Alternative 4 improve the likelihood of maintaining a strong subsistence harvest, there will 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 already negligible.

4.10.6.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.10.3.15.

4.10.6.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.10.3.15.

4.10.6.15.4 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 4.10.4.15.

4.10.6.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.10.4.15, Alternative 4 contributes to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts.

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 4.10.4.15).

4.10.6.16 Cultural Resources

4.10.6.16.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 4 are the same as in Alternative 3, with the added requirement for seasonal closures for certain areas. These required closures under Alternative 4 do not affect cultural resources in the EIS project area, so the impacts discussed for Alternatives 2 and 3 are the same for Alternative 4; the overall impact to cultural resources would be minor.

4.10.6.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.16.

4.10.6.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.16.

4.10.6.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.10.6.16.5 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 4.10.4.16).

4.10.6.17 Land and Water Ownership, Use, Management

4.10.6.17.1 Summary of Direct and Indirect Effects

As discussed in Section 4.7.3.5, the direct and indirect impacts on land and water ownership would be low magnitude, temporary duration, local extent, and common in context. The direct and indirect impacts on land and water use would have a high magnitude, be temporary in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, temporary in nature, local, and common. In summary, the impacts of Alternative 4 on land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.10.6.17.2 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 2, Section 4.10.4.17.

4.10.6.17.3 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 2, Section 4.10.4.17.

4.10.6.17.4 Contribution of Alternative to Cumulative Effects

Alternative 4 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 4.10.4.17 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. The conclusions for Alternative 2 are applicable to Alternative 4; the contribution of Alternative 4 to cumulative effects to land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.10.6.17.5 Conclusion

Under Alternative 4, the levels of direct, indirect and cumulative impact on 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 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 4.10.4.17).

4.10.6.18 Transportation

4.10.6.18.1 Summary of Direct and Indirect Effects

Impacts to transportation from Alternative 4 are expected to be very similar to those described above for Alternative 3. The only difference between Alternative 3 and Alternative 4 is the addition of required time/area closures. The level of activity would be the same for Alternatives 3 and 4, but the times and locations of the activity could be different. Any direct impact to regional marine transportation would be low in intensity, temporary in duration, and limited in geographic extent to a local area and common in context and considered minor.

4.10.6.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.10.4.18.

4.10.6.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.10.4.18.

4.10.6.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 4 would be similar as those described for Alternative 3 in Section 4.10.5.18.

4.10.6.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 4 overlaps with another large-scale development project but those impacts would be of low intensity, temporary in duration affecting local areas of common resources and are considered unlikely to have long-term impacts on regional transportation infrastructure.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with transportation were discussed under Alternative 2 (Section 4.10.4.18).

4.10.6.19 Recreation and Tourism

4.10.6.19.1 Summary of Direct and Indirect Effects

The direct impacts would be low intensity, temporary 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.

4.10.6.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.10.4.19.

4.10.6.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.10.4.19.

4.10.6.19.4 Contribution of Alternative to Cumulative Effects

To the extent that the required time/area closures contemplated in Alternative 4 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 4.10.4.19 and 4.10.5.19 for Alternatives 2 and 3 are the same for Alternative 4; the overall impact to recreation and tourism would be minor.

4.10.6.19.5 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 4.10.4.19).

4.10.6.20 Visual Resources

4.10.6.20.1 Summary of Direct and Indirect Effects

Direct and indirect effects of past and present actions are identical to those described in Section 4.10.5.20, Alternative 3.

4.10.6.20.2 Past and Present Actions

Past and present actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.20.

4.10.6.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.20.

4.10.6.20.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 4 to cumulative effects would be identical to that described for Alternative 3.

4.10.6.20.5 Conclusion

Under Alternative 4, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, 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 4.10.4.20).

4.10.6.21 Environmental Justice

4.10.6.21.1 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 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.

4.10.6.21.2 Past and Present Actions

The past and present actions that would contribute to the cumulative effects of environmental justice under Alternative 2 are the same as those described for Alternative 1 in Section 4.10.3.21.

4.10.6.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions for Alternative 2 would be the same as those described for Alternative 1 in Section 4.10.3.21. Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.10.6.21.4 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 3 to environmental justice indicator cumulative effects would be minor.

4.10.6.21.5 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 disproportionate 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 4.10.4.21). A VLOS would have disproportionate adverse impacts to Alaska Natives living in the communities near the EIS project area.

4.10.7 Alternative 5 – Authorization for Level 2 Exploration Activity with Use of Alternative Technologies

4.10.7.1 Physical Oceanography

4.10.7.1.1 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 3. The additional mitigation measures included 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 effects Alternative 5 on physical ocean resources in the EIS project area would be minor.

4.10.7.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.1.

4.10.7.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.1.

4.10.7.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 5 would cause localized 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 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.

4.10.7.1.5 Conclusion

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 4.10.4.1).

4.10.7.2 Climate & Meteorology

4.10.7.2.1 Summary of Direct and Indirect Effects

Alternative 5 involves the same exploration activities as proposed in Alternatives 3 and 4, with the potential inclusion of alternative technologies. The estimated amount of GHG emissions associated with Alternative 5 is the same as those for Alternatives 3 and 4. Therefore the impact levels are expected to be the same as Alternatives 3 and 4, which are minor direct impacts and minor to moderate indirect impacts.

4.10.7.2.2 Past and Present Actions

Past and present actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.10.4.2.

4.10.7.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.10.4.2.

4.10.7.2.4 Contribution of Alternative to Cumulative Effects

Alternative 5 would emit approximately the same amount of GHGs as Alternatives 3 and 4; therefore its direct impacts would contribute more to cumulative climate change impacts than Alternative 2. As with Alternatives 2 through 4, 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 4. Therefore indirect effects from Alternative 5 are expected to result in changes that could be long-term and could affect unique resources.

4.10.7.2.5 Conclusion

Alternative 5 could contribute to a moderate to major cumulative impact to climate change, the same as with Alternatives 2 through 4.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with climate change were discussed under Alternative 2 (Section 4.10.4.2).

4.10.7.3 Air Quality

4.10.7.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 5, Level 2 Exploration Activity, are expected to be the same as those for Alternatives 3 and 4. The overall direct effect on air quality is expected to be moderate, and indirect effects would be negligible to minor.

4.10.7.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.3.

4.10.7.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.3.

4.10.7.3.4 Contribution of Alternative to Cumulative Effects

The potential cumulative effects on air quality for Alternative 5 are the same as those for Alternative 3, with a moderate contribution to cumulative effects from Alternative 5.

4.10.7.3.5 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 in the Beaufort or Chukchi seas associated with air quality were discussed under Alternative 2 (Section 4.10.4.3).

4.10.7.4 Acoustics

4.10.7.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.10.4 (Alternative 2) is relevant also for Alternative 5. Alternative 5 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. Table 4.8-1 suggested approximate injury/exclusion zone radius reduction factors that would result from several reductions in source level.

4.10.7.4.2 Past and Present Actions

Past and present actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.10.4.4.

4.10.7.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.10.4.4.

4.10.7.4.4 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.

4.10.7.4.5 Conclusion

The use of alternate sources under Alternative 5 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 4.10.4.4).

4.10.7.5 Water Quality

4.10.7.5.1 Summary of Direct and Indirect Effects

Impacts to water quality resulting from Alternative 5 are expected to be very similar to those described for Alternative 3 in Section 4.10.5.5. Alternative 5 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 5. These mitigation measures are not expected to affect the level of water quality impacts. 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 of this EIS. The overall effects of Alternative 5 on water quality are expected to be minor.

4.10.7.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.5.

4.10.7.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.10.4.5.

4.10.7.5.4 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 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.

4.10.7.5.5 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 additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.10.4.5).

4.10.7.6 Environmental Contaminants and Ecosystem Functions

4.10.7.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to environmental contaminants and ecosystem functions resulting from the implementation of Alternative 5 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 5, while the effects of Alternative 5 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 5 on ecosystem functions would be minor.

4.10.7.6.2 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 4.10.4.6.

4.10.7.6.3 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 4.10.4.6.

4.10.7.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 5 would cause localized 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 over the 5 year lifespan of this EIS. The use of alternative technologies associated with Alternative 5 could potentially decrease the accumulation of adverse impacts to habitat, production, and information functions within the EIS project area.

4.10.7.6.5 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. 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 4.10.4.6).

4.10.7.7 Lower Trophic Levels

4.10.7.7.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 3, with the addition of required measures that focus on alternative technologies for seismic exploration. This requirement does not affect lower trophic levels in the EIS project area, so the impacts discussed previously for Alternatives 2, 3, and 4 are the same for Alternative 5; the overall impact to lower trophic levels would be minor.

4.10.7.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.10.4.7.

4.10.7.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.10.4.7.

4.10.7.7.4 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 4.10.4.7 and the overall impact would be moderate. In the absence of a very large oil spill, the exploration activities authorized under Alternative 5 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.10.7.7.5 Conclusion

Alternative 5 could have a moderate contribution to cumulative effects on lower trophic organisms.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.10.4.7).

4.10.7.8 Fish and Essential Fish Habitat

4.10.7.8.1 Summary of Direct and Indirect Effects

The effect of the alternative technologies outlined in Alternative 5 on fish resources and EFH are difficult to determine with any certainty but are anticipated to result in a reduction in the overall impact. Although the overall impact is considered to be negligible based on Alternative 3 alone, replacement of airgun arrays with alternative technologies could potentially reduce adverse effects on fish. 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, and overall impact is considered to be negligible.

4.10.7.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.10.4.8.

4.10.7.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.10.4.8.

4.10.7.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effect on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable effect on fish and EFH resulting from the implementation of Alternative 5 would not add to any cumulative effects.

4.10.7.8.5 Conclusion

Direct and indirect effects associated with Alternative 5 on fish and EFH would be negligible. The overall contribution of Alternative 5 to cumulative effects on fish and EFH would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.10.4.8).

4.10.7.9 Marine and Coastal Birds

4.10.7.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.8.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. In summary, the impact of Alternative 5 on marine and coastal birds would be considered negligible.

4.10.7.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.10.4.9.

4.10.7.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.10.4.9.

4.10.7.9.4 Contribution of Alternative 5 to Cumulative Effects

Alternative 5 would have the same types and level of exploration activities as Alternative 3 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 3. In the absence of a very large oil spill (see below), the exploration activities authorized under Alternative 5 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.10.7.9.5 Conclusion

Direct and indirect effects associated with Alternative 5 on marine and coastal birds would be negligible. The overall contribution of Alternative 5 to cumulative effects on marine and coastal birds would be negligible.

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 4.10.4.9).

4.10.7.10 Marine Mammals

4.10.7.10.1 Bowhead Whales

4.10.7.10.1.1 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 4 are similar to Alternative 3 (See Section 4.10.5.10.1).

Mitigating capabilities and effects of alternative technologies introduced under Alternative 5 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 localized to regional in 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. Bowhead whales are considered a unique resource, since they are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 5 on bowhead whales is considered to be moderate.

4.10.7.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.1.

4.10.7.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.1.

4.10.7.10.1.4 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, in many respects, be similar to Alternative 3 (Section 4.10.5.10.1). 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, so a thorough assessment of their effectiveness is not currently possible. Therefore, the contribution of activities authorized under Alternative 5 to cumulative effects on bowhead whales would be considered minor to moderate.

4.10.7.10.1.5 Conclusion

Under Alternative 5, the direct and indirect effects to bowhead whales would be moderate. Alternative 5 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 4.10.4.10.1).

4.10.7.10.2 Beluga Whales

4.10.7.10.2.1 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 localized 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 5 may reduce adverse impacts to beluga whales associated with the use of airgun arrays. Alternative technologies could reduce the extent of impacts to localized 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 localized impact reductions from using alternative technologies instead of airgun arrays, the overall impact of Alternative 5 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 5 on beluga whales would be considered moderate.

4.10.7.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.10.4.10.2.

4.10.7.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.10.4.10.2.

4.10.7.10.2.4 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 localized 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 localized 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.

4.10.7.10.2.5 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 4.10.4.10.2).

4.10.7.10.3 Other Cetaceans

4.10.7.10.3.1 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 5 on other cetaceans is minor. Although the introduction of alternative technologies specified in Alternative 5 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 3. 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.

Mitigating capabilities and effects of alternative technologies introduced under Alternative 5 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.

4.10.7.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.3.

4.10.7.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.3.

4.10.7.10.3.4 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 introduction of the Alternative Technologies specified in Alternative 5 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 3. Most of this disturbance would occur during the open-water season and would be localized 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 localized and temporary. The contribution to habitat change would be negligible. The exploration activities authorized under Alternative 5 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.10.7.10.3.5 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 4.10.4.10.2).

4.10.7.10.4 Pinnipeds

4.10.7.10.4.1 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 5 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.10.7.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.4.

4.10.7.10.4.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.4.

4.10.7.10.4.3 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 localized 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.

4.10.7.10.4.4 Conclusion

Direct and indirect effects associated with Alternative 5 on pinnipeds would be minor. The overall contribution of Alternative 5 to cumulative effects on pinnipeds would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.10.4.10.4).

4.10.7.10.5 Walrus

4.10.7.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on walrus are described in Section 4.8.2.4.5 and are summarized here. The types and levels of effects on Pacific walrus are essentially the same under Alternative 5 as for Alternative 3 (Section 4.6.2.4.5). Walrus 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 walrus 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 walrus because they are unlikely to be affected in any biologically meaningful way by seismic noise. Mitigation measures required for walrus 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 accidental 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 calf and juvenile mortality from stampedes. Walrus 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 walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 5 on Pacific walrus would therefore be considered minor.

4.10.7.10.5.2 Past and Present Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.5.

4.10.7.10.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.5.

4.10.7.10.5.4 Contribution of Alternative 5 to Cumulative Effects

The exploration activities authorized under Alternative 5 would add to the disturbance of walrus 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 walrus, 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 localized 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 Pacific walrus.

4.10.7.10.5.5 Conclusion

Direct and indirect effects associated with Alternative 5 on Pacific walrus would be minor. The overall contribution of Alternative 5 to cumulative effects on Pacific walrus would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with Pacific walrus were discussed under Alternative 2 (Section 4.10.4.10.5).

4.10.7.10.6 Polar Bears

4.10.7.10.6.1 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 3 (Section 4.6.2.4.6). 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 bear-human 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 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.

4.10.7.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.6.

4.10.7.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.10.4.10.6.

4.10.7.10.6.4 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 localized 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.

4.10.7.10.6.5 Conclusion

Direct and indirect effects associated with Alternative 5 on polar bears would be minor. The overall contribution of Alternative 5 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 4.10.4.10.6).

4.10.7.11 Terrestrial Mammals

4.10.7.11.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 3, 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 5 and the overall impact to terrestrial mammals would be minor.

4.10.7.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.

4.10.7.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.

4.10.7.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.10.7.11.5 Conclusion

The incremental contribution of activities associated with Alternative 5 to cumulative effects on caribou would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.10.4.11).

4.10.7.12 Special Habitat Areas

The analysis of the cumulative effects under Alternative 5 associated with special habitat areas can be found in Sections 4.10.7.10 (Marine Mammals), 4.10.7.9 (Marine and Coastal Birds) and 4.10.7.14 (Subsistence).

4.10.7.13 Socioeconomics

4.10.7.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 5 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. To the extent that alternative technologies benefit to marine mammals and reduce net impacts to subsistence activities, there would be some potential socioeconomic benefits to the non-cash economy. The summary impact level for Socioeconomics under Alternative 3 is minor, not exceeding the significance threshold.

4.10.7.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.10.4.13.

4.10.7.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.10.4.13. 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 5 would result in future oil and gas production.

4.10.7.13.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 4 to socioeconomic cumulative effects would be minor and positive. They differ from Alternative 2 by the potential for some lost productivity for lease holders due to alternative technologies and mitigation measures and countervailing positive impacts to subsistence resources and activities and therefore would have a countervailing positive impact to the non-cash economy. The summary contribution of these impacts to the cumulative effectives of socioeconomics is negligible to minor at a statewide and national level and minor at the local level.

4.10.7.13.5 Conclusion

The direct and indirect effects of Alternative 5 would be positive and minor. 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 were discussed under Alternative 2 (Section 4.10.4.13).

4.10.7.14 Subsistence

4.10.7.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-25, 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 in duration, local 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). The impacts of implementing Alternative 5 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 2 as discussed in Section 4.5.3.2 and Section 4.10.4.14. 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 4.8.3.2).

4.10.7.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.14.

4.10.7.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.14.

4.10.7.14.4 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 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, localized 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 5 would therefore have a negligible to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 5 would be considered beneficial to cumulative effects on subsistence resources.

The exploration activities authorized under Alternative 5 would occur at a higher level of activity in comparison to those proposed under Alternative 2 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 5 would have a negligible to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 4 would be considered beneficial to cumulative effects on subsistence resources.

4.10.7.14.5 Conclusion

Under Alternative 5, the direct and indirect effects to subsistence resources are considered low in intensity, temporary in duration, local in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 5 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 4.10.4.14).

4.10.7.15 Public Health

4.10.7.15.1 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. Alternative 5 includes requirements for the use of alternative technologies. However, as discussed in Section 4.8.3.3, 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 do not affect the overall impact criteria rating for public health for Alternative 5. 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.

4.10.7.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.10.3.15.

4.10.7.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.10.3.15.

4.10.7.15.4 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 4.10.4.15.

4.10.7.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.10.4.15, Alternative 5 contributes to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts.

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 4.10.4.15).

4.10.7.16 Cultural Resources

4.10.7.16.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 3, 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 5 and the overall impact to cultural resources would be minor.

4.10.7.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.16.

4.10.7.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.16.

4.10.7.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.10.7.16.5 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 4.10.4.16).

4.10.7.17 Land and Water Ownership, Use, and Management

4.10.7.17.1 Summary of Direct and Indirect Effects

As discussed in Section 4.8.3.5, the direct and indirect impacts on land and water ownership would be low magnitude, temporary duration, local extent, and common in context. The direct and indirect impacts on land and water use would have a high magnitude, be temporary in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, temporary in nature, local, and common. In summary, the impacts of Alternative 5 on land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.10.7.17.2 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 2, Section 4.10.4.17.

4.10.7.17.3 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 2, Section 4.10.4.17.

4.10.7.17.4 Contribution of Alternative to Cumulative Effects

Alternative 5 is the same as Alternative 2 except with increased levels of activity and use of alternative technologies. The cumulative effects discussed in Section 4.10.4.17 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. The conclusions for Alternative 2 are applicable to Alternative 5; the contribution of Alternative 5 to cumulative effects to land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.10.7.17.5 Conclusion

Under Alternative 5, 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 5 is 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 4.10.4.17).

4.10.7.18 Transportation

4.10.7.18.1 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 3 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, and 4.

4.10.7.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.10.4.18.

4.10.7.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.10.4.18.

4.10.7.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 5 would be similar as those described for Alternative 3 in Section 4.10.5.18.

4.10.7.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 5 overlaps with another large-scale development project but those impacts would be of low intensity, temporary in duration affecting local areas of common resources and are considered unlikely to have long-term impacts on regional transportation infrastructure.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with transportation were discussed under Alternative 2 (Section 4.10.4.18).

4.10.7.19 Recreation and Tourism

4.10.7.19.1 Summary of Direct and Indirect Effects

The direct impacts would be low intensity, temporary 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.

4.10.7.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.10.4.19.

4.10.7.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.10.4.19.

4.10.7.19.4 Contribution of Alternative to Cumulative Effects

Activity levels in Alternative 5 are the same as in Alternative 3, 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 4.10.4.19 and 4.10.5.19 for Alternatives 2 and 3 are the same for Alternative 5; the overall impact to recreation and tourism would be minor.

4.10.7.19.5 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 4.10.4.19).

4.10.7.20 Visual Resources

4.10.7.20.1 Summary of Direct and Indirect Effects

Direct and indirect effects of past and present actions are identical to those described in Section 4.10.5.20, Alternative 3.

4.10.7.20.2 Past and Present Actions

Past and present actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.20.

4.10.7.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.10.4.20.

4.10.7.20.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 5 to cumulative effects would be identical to that described in Section 4.10.5.20, Alternative 3.

4.10.7.20.5 Conclusion

Under Alternative 5, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, 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 4.10.4.20).

4.10.7.21 Environmental Justice

4.10.7.21.1 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. 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.

4.10.7.21.2 Past and Present Actions

Past and present actions affecting environmental justice within the EIS project area are discussed under Alternative 2, Section 4.10.4.21.

4.10.7.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental justice within the EIS project area are discussed under Alternative 2, Section 4.10.4.21.

4.10.7.21.4 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 3 to environmental justice indicator cumulative effects would be minor.

4.10.7.21.5 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 disproportionate 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 4.10.4.21). A VLOS would have disproportionate adverse impacts to Alaska Natives living in the communities near the EIS project area.

4.11 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 minor.

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.

4.12 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.

No resources would be irreversibly and irretrievably committed (i.e. affected) by construction activities because none of the action alternatives have construction activities associated with them. 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.

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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 authorizing 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) 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 within the five year period of 2012 to 2017. This EIS will inform BOEM decisions on specific G&G permit applications and ancillary activity surveys. 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.

5.1.2 NMFS NEPA Compliance

The Effects of Oil and Gas Activities in the Arctic Ocean Final EIS will cover 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 will identify the Preferred Alternative, including 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:

- Review 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. NMFS staff will conduct an internal review to determine whether or not the application falls within the scope of the Preferred Alternative.
- 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 will 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 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 (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).

Alternative 5 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 between 2012 and 2017 (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 anticipates receipt of applications to conduct exploration seismic surveys pursuant to the OCS Lands Act. Pursuant to 30 CFR Part 551.4, a G&G permit must be obtained from BOEM to conduct G&G exploration for oil, gas, and sulphur resources when operations occur on unleased lands or on lands leased to a third party. Ancillary activities are regulated under 30 CFR Part 550, which states that a notice must be submitted before conducting G&G data collection pursuant to a lease issued or maintained under the OCS Lands Act (30 CFR Part 550.208). BOEM will conduct site-specific NEPA reviews for G&G permit applications and proposed ancillary surveys. 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. The form of additional NEPA review will depend on the nature and scope of the proposed activity and may take the form of a Determination on NEPA Adequacy, a Categorical Exclusion Review, and Environmental Assessment, a supplemental EIS, or a new EIS that tier from this EIS and incorporate information and analyses in this EIS by reference. While this EIS is not being used by BOEM to analyze the approval of exploration drilling plans or by the Bureau of Safety and Environmental Enforcement (BSEE) for approval of applications for permits to drill, BOEM plans to incorporate by reference the content of this EIS into future site-specific NEPA and other environmental analyses for exploratory drilling. BOEM performs a site-specific NEPA compliance review for exploratory drilling activities for each Exploration Plan to issue permits for on-lease exploration operations.

This EIS will also assist BOEM in carrying out other statutory responsibilities. BOEM will coordinate closely with BSEE, NMFS, and the USFWS to verify compliance with the ESA, MSFCMA, NHPA, and, MMPA requirements. BOEM has the authority to modify permit conditions or lease operations, if necessary, to ensure OCS activities meet the requirements of the ESA or MMPA or other authorization.

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 regulations and associated 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 2011, NMFS issued 14 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. Although for production drilling (i.e. not an activity type covered by this EIS), starting in 2000, NMFS 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.

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, it does not mean that NMFS could not so 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 and published 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, e.g., 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 the effectiveness of mitigation and monitoring measures.

(f) A better understanding and record of the manner in which the authorized entity complies with the incidental take authorization and incidental take statement.

(g) 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 infra-red devices at detecting seals on the ice at night, etc.), 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 has been requested, Section 101(a)(5)(D) of the MMPA and its implementing regulations require that monitoring plans or other research proposals undergo an independent peer review.

5.3.2 Monitoring Plan Peer Reviews

Prior to issuing an ITA for an activity that would occur in Arctic waters (i.e. north of 60º North latitude), and 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 Part 216.108(d)). Although the MMPA only includes this requirement for IHAs, NMFS also requires independent peer review of monitoring plans as part of any request for 5-year regulations(50 CFR Part 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 discussed specific goals that should be accomplished by an applicant's monitoring program.

NMFS has hosted a one-to-two day Open Water Meeting each year since 1994. The purpose of these meetings is 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 is also undertaken. The inclusion of subsistence hunters in the review process ensures that both study designs and data interpretation are consistent with real-world observations of marine mammal behaviors and reactions to anthropogenic impacts. ITA applicants adjust 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 2011 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. In both 2010 and 2011, after soliciting nominations from the industry ITA applicants, the Marine Mammal Commission, and the affected subsistence organizations, NMFS convened panels of approximately five 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 report in the context of the applicants' activities and the requirements of the MMPA and selected those that were appropriate for potential inclusion in the applicant's final monitoring plans. NMFS worked with the applicants regarding the practicability of including these measures and protocols, and then included the selected measures as requirements in the issued ITAs.

This process is still developing, and some strengths and weaknesses have been identified. Utilizing a smaller group chosen from nominated scientists and affected subsistence hunters allows for a true scientific, and more 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. However, panel members have suggested that the time allotted for interaction with the applicants in 2010 and 2011 was too short. Therefore, NMFS will strive to provide additional time for interaction where feasible. Also, at the request of the applicants, questions will be provided to them in advance so that they will be prepared to discuss specific issues identified by the panel members. Generally, both scientist reviewers and applicants have expressed that this more focused method for peer review of the monitoring reports 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 and ensure implementation of the best monitoring plans.

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 multitude of recommendations have been made regarding monitoring plans for oil and gas exploration activities. In the last two years, more focused input has been provided via the new peer review format described above. However, in the former example (i.e. Open Water Meeting, public comments, etc.) 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 their development of their initial applications.

In the last two years, the independent peer reviewers have 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 is what is really needed to get the most out of the combined monitoring in the Arctic.

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 Open Water Meetings, 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.

Following are examples of some of the issues that have been identified 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;
- 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;

- Bowhead movement patterns following initial deflection from industry activities during fall migration;
- Behavioral responses of bowheads, and other species, to acoustic exposure at specific levels (160 dB, 120 dB);
- 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; 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.

Using the existing public input tools (potentially with oversight by a select group), NMFS could potentially 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 explore this way forward through public input on this EIS and at the 2012 Open Water Meeting and beyond.

5.3.4 BOEM Environmental Studies Program

The OCS Lands Act, 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 OCS Lands Act 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 Part 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 activities have 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, with each year's CAA Process resulting in an agreement, the CAA, signed by the participants.

Regulations promulgated pursuant to the 1986 MMPA amendments, require that for 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 assumed, with some associated 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 subsistence hunt. However, in more recent years, some companies have become reluctant to sign a CAA with the AEWC, suggesting that the agreement requires more from the industry than is necessary to ensure no unmitigable adverse impact to the hunt. 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 agreements between third parties, and neither NMFS nor BOEM would be able to 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.

5.4.2 Open Water Meeting

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, the need to split these processes into two separate meetings became apparent. The Open Water Meeting now refers to the open access stakeholder meeting (not the monitoring plan review) that is important to ensure NMFS' understanding, from the affected parties, of the effects of industry activity on the subsistence uses of marine mammals.

Since 2006, the Open Water Meeting has attracted members of industry, Federal, state, and local government officials and scientists, Native Alaskan marine mammal commissions, affected Native Alaskan hunters and community members, environmental non-governmental organizations, and other interested members of the public. Typically, each year, the industry presents 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, etc.) present 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 have also been presentations of 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 has continued to organize this annual meeting. The Open Water Meeting allows the public to provide input on industry proposals while the Federal agencies ultimately responsible for authorizing the activity itself and the incidental take of marine mammals can listen to those comments and participate in the interaction.

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 in the next five years (i.e. 2012 to 2017):

(1) Results of monitoring required pursuant to MMPA ITAs or other Federal statutes for Arctic oil and gas development activities;

(2) Stakeholder input during the annual Open Water Meetings;

(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. NMFS will continuously consider adaptive management as the agency executes the ITA program and may seek to revise regulations in the future if they no longer are found to reflect the needs of management towards ensuring that takes are no more than negligible and subsistence needs are being properly addressed.

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.

NMFS and BOEM intend to continue the review meetings, during OCS activities, with USFWS and BSEE. 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.

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6.0 CONSULTATION AND COORDINATION

6.1 Development of the EIS

The Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register* on February 8, 2010 (75 FR 6175). The scoping period, during which issues and concerns are identified, was initiated 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:

http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm.

NMFS is the lead agency for this EIS and is responsible for the development of the EIS in collaboration with the cooperating agencies. BOEM, NSB, and EPA are participating as cooperating agencies.

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, 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 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

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 are lists of 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 EIS.

Federal – Executive Branch	
Department of Commerce	National Marine Fisheries Service; Bowhead Whale Project, Alaska Regional Office, Anchorage National Oceanic and Atmospheric Administration; Policy and Strategic Planning, Information Services Division Office of the Assistant Secretary for Oceans and Atmosphere
Department of Defense	U.S. Army Corps of Engineers; Regulatory Branch, Alaska District U.S. Navy; NEPA Natural Resources
Department of Homeland Security	U.S. Coast Guard
Department of the Interior	Bureau of Indian Affairs; West Central Alaska Field Office Bureau of Land Management; State Director, Northern Field Office, Fairbanks National Park Service; Regional Director, Subsistence Division Office of Environmental Policy and Compliance Special Assistant to the Secretary for Alaskan Affairs U.S. Fish and Wildlife Service; Regional Office, Migratory Bird Management, Subsistence and Fisheries, Anchorage Ecological Services 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 Community and Regional Affairs Department of Environmental Conservation • Anchorage District Office • Northern Alaska District Office Department of Fish and Game • Region II, H&R • Subsistence Division Department of Natural Resources • Citizen's Advisory Commission on Federal Areas	Department of Natural Resources (continued) • Division of Geological and Geophysical Surveys • Division of Oil and Gas • Division of Water, Fairbanks • Office of Project Management and Permitting Department of Transportation and Public Facilities • Joint Pipeline Office • State Pipeline Coordinator Office of the Governor • Governor Sean Parnell State of Alaska Washington, DC Representative
Tribal and Local Governments – Alaska Native Organizations	
Alaska Beluga Whale Commission Alaska Eskimo Walrus Commission, Barrow Alaska Eskimo Walrus Commission, Nome Alaska Eskimo Whaling Commission Alaska Federation of Natives Alaska Inter-Tribal Council Alaska Nanuuq Commission Alaska Native Science Commission Arctic Slope Native Association Arctic Slope Regional Corporation Barrow Whaling Captains Association City of Barrow, Mayor City of Kaktovik, Mayor City of Kotzebue, Planning Division City of Nome, City Manager City of Nuiqsut, Mayor City of Point Hope, Mayor City of Wainwright, Mayor Cully Corporation, Point Lay Ice Seal Committee Iñupiat Community of the Arctic Slope	Kaktovik Iñupiat Corporation Kaktovik Whaling Captains Association Kikiktagruk Iñupiat Corporation, Kotzebue Kuukpik Village Corporation, Nuiqsut NANA Regional Corporation Inc., Kotzebue Native Village of Barrow Native Village of Kaktovik Native Village of Kivalina Native Village of Kotzebue IRA Native Village of Nuiqsut Native Village of Point Hope Native Village of Point Lay Native Village of Wainwright North Slope Borough Mayor's Office North Slope Borough, Department of Wildlife Management Northwest Arctic Borough Nunamiut Corporation, Anaktuvuk Pass Olgoonik Corporation, Wainwright

Tribal and Local Governments – Alaska Native Organizations (continued)	
Point Hope Whaling Captains Association Tigara Corporation, Point Hope Tikigaq Corporation, Point Hope Village Coordinator, Anaktuvuk Pass	Village Coordinator, Atqasuk Village Coordinator, Kaktovik Village Coordinator, Nuiqsut Village Coordinator, Point Hope Village Coordinator, Wainwright
Libraries	
Alaska Pacific University Alaska Resources Library and Information Service (ARLIS) Chukchi Consortium Library, Kotzebue Fairbanks North Star Borough Noel Wien Library Government Publications, Juneau Juneau Public Library Kali Community School/Community Library	Kaveolook School Library, Kaktovik Kegoyah Kozpa Public Library, Nome Tikigaq Library, Point Hope Trapper School Community Library, Nuiqsut Tuzzy Consortium Library, Barrow University of Alaska, Anchorage Consortium Library University of Alaska, Fairbanks Elmer E. Rasmuson Library • Geophysical Institute • Government Documents • Institute of Arctic Biology Z.J. Loussac Library, Anchorage
Petroleum Industry	
AEC Oil and Gas (USA) Inc. Alaska Clean Seas Alaska Support Industry Alliance Amerada Hess Corporation American Petroleum Institute Amoco Production Co. Anadarko Petroleum Corporation Armstrong Oil and Gas Inc. Atofina Petrochemicals, Inc. Aurora Gas LLC BP Exploration (Alaska) Inc. Burlington Resources Chevron U.S.A. Inc. ConocoPhillips Alaska Inc	Devon Energy Production Company Encana Oil and Gas, Inc. Eni Petroleum Exploration Co Inc ExxonMobil Oil Corporation ExxonMobil Production Company Forest Oil Corporation Hess Corporation Liberty Petroleum Corporation Marathon Oil Company Murphy Exploration (Alaska), Inc. Murphy Exploration and Production Company Pennzoil Petrobras-USA Petro-Canada (Alaska) Inc.

Petroleum Industry (continued)	
Phillips Alaska, Inc.	Statoil
Phillips Petroleum Company	Texaco Inc.
Pioneer Natural Resources USA Inc	Total E&P USA Inc
Shell Frontier Oil & Gas, Inc.	Union Oil Company of California
Shell Offshore Inc.	Western Geophysical Company
Associations, Companies, Special Interest Groups, and Others	
Alaska Coalition	Greenpeace
Alaska Conservation Foundation	Indigenous Peoples Council for Marine Mammals
Alaska Journal of Commerce	Iñupiat Heritage Center
Alaska Marine Conservation Council	LGL, Alaska Research Associates
Alaska Native Knowledge Network, Fairbanks	Marine Advisory Program
Alaska Natural Heritage Program	Munger Oil Information Services
Alaska Newspapers, Inc.	National Audubon Society
Alaska Oil and Gas Association	National Ocean Industries Association
Alaska Public Interest Research Group	National Parks and Conservation Association
Alaska Public Radio Network, Anchorage	National Wildlife Federation
Alaska Wilderness League	Natural Resources Defense Council
Applied Sociocultural Research	Northern Alaska Environmental Center
Arctic Connections	Ocean Conservancy
Arctic Marine Resource Commission	PEW Environmental Group
Arctic Sounder	Prince William Sound RCAC
Audubon Alaska	Resource Development Council for Alaska, Inc.
Center for Biological Diversity	Sierra Club
Center for Regulatory Effectiveness	Trustees for Alaska
Defenders of Wildlife	University of Alaska, Anchorage Institute of Social and Economic Research
EarthJustice, Juneau	Wilderness Society
Exxon Valdez Oil Spill Trustee Council	World Wildlife Fund

6.4 List of Preparers

Representatives from NMFS, BOEM, BSEE, EPA, and NSB reviewed draft documents prepared by contractors.

NOAA NMFS	Shane Guan; Fishery Biologist, Office of Protected Resources, Permits and Conservation Division, Silver Spring, MD Jolie Harrison; Supervisory Fishery Biologist, Office of Protected Resources, Permits and Conservation Division, Silver Spring, MD Mark Hodor; Deputy Section Chief, Fisheries and Protected Resources Section, Silver Spring, MD Candace Nachman; Fishery Biologist and EIS Project Manager, Office of Protected Resources, Permits and Conservation Division, Silver Spring, MD Jennifer Nist; Attorney-Advisor, Fisheries and Protected Resources Section, Silver Spring, MD P. Michael Payne; Division Chief, Office of Protected Resources Permits and Conservation Division, Silver Spring, MD Brad Smith; Supervisory Administrator, Protected Resources Division, Alaska Regional Office, Anchorage, Alaska
BOEM	Susan Banet; Chief, Resource Analysis Section, Alaska Region, Anchorage, AK Megan Butterworth; Biological Oceanographer, Headquarters, Herndon, VA Deborah Cranswick; Chief Environmental Analysis Section I, Alaska Region, Anchorage, AK Jana Lage; Geophysicist, Alaska Region, Anchorage, AK Jill Lewandowski; Protected Species Biologist, Headquarters, Herndon, VA Jeffery Loman; Senior Advisor, Alaska Region, Anchorage, AK Mark Schroeder; Wildlife Biologist, Alaska Region, Anchorage, AK Kimberly Skrupky; Marine Biologist, Headquarters, Herndon, VA Pete Sloan; Geologist, Alaska Region, Anchorage, AK Sharon Warren; Regional Supervisor, Office of Environment, Alaska Region, Anchorage, AK
BSEE	Jeffrey Walker; Regional Supervisor Field Operations, Alaska Region, Anchorage, AK Kyle Monkelien; Petroleum Engineer, Alaska Region, Anchorage, AK
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