UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion for City of Ketchikan Removal of Berth II Rock Pinnacle Project

NMFS Consultation Number: AKRO-2019-00553

Action Agencies: National Marine Fisheries Service, Office of Protected Resources, Permits and Conservation Division (PR1)
U.S. Army Corps of Engineers (USACE)

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Humpback whale (*Megaptera novaeangliae*) Mexico DPS	Threatened	Yes	No	N/A

Consultation Conducted By: National Marine Fisheries Service

Issued By:

for James W. Balsiger, Ph.D.
Administrator, Alaska Region

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TERMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
AKR	Alaska Region NMFS
BA	Biological Assessment
CFR	Code of Federal Regulations
CV	Coefficient of variation
dB	Decibels
DPS	Distinct Population Segment
DQA	Data Quality Act
ECSA	Endangered Species Conservation Act
EFH	Essential Fish Habitat
ESA	Endangered Species Act of 1973
ft	feet
FR	*Federal Register*
GPS	Global Positioning System
hr	hour(s)
Hz	Hertz
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
kHz	kilohertz
km	kilometer(s)
lb	pound(s)
L_E	cumulative sound exposure level
m	meter(s)
min	minute(s)
MMPA	Marine Mammal Protection Act
µPa	microPascals
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
k	peak sound level
PR1	NMFS Office of Protected Resources, Permits and Conservation Division
PRD	Protected Resources Division, Alaska NMFS
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
rms	root mean square
RPM	Reasonable and Prudent Measures
SAR	marine mammal stock assessment reports
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SSV	Sound Source Verification

TL	Transmission Loss
TTS	Temporary Threshold Shift
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service

1. INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1536(a)(2)) requires each Federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a Federal agency's action "may affect" a protected species or critical habitat, that agency is required to consult with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies may fulfill this general requirement informally if they conclude that an action may affect, but is not likely to adversely affect endangered species, threatened species, or designated critical habitat, and NMFS or the USFWS concurs with that conclusion (50 CFR §402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS and/or USFWS provide an opinion stating how the Federal agency's action is likely to affect ESA-listed species and their critical habitat. If incidental take is reasonably certain to occur, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking, specifies those reasonable and prudent measures necessary to minimize such impact, and sets forth terms and conditions to implement those measures.

For the actions described in this document, the action agencies are the U.S. Army Corps of Engineers (USACE), which proposes to authorize construction activities at the City of Ketchikan's Berth II, and the NMFS Office of Protected Resources Permits and Conservation Division (PR1). PR1 proposes to permit Marine Mammal Protection Act (MMPA) Level A take (*i.e.*, take by injury or mortality) of harbor seals (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*), and Dall's porpoise (*Phocoenoides dalli*), and Level B take (*i.e.*, take by harassment) of nine marine mammal species: harbor seal, harbor porpoise, Dall's porpoise, Steller sea lion (*Eumetopias jubatus*), killer whale (*Orcinus orca*), humpback whale (*Megaptera novaeangliae)*, minke whale (*Balaenoptera acutorostrata*), gray whale (*Eschrichtius robustus*), and Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), in conjunction with the action. The City of Ketchikan is the applicant. The consultant team for the City of Ketchikan included Moffatt and Nichol, GeoEngineers, and Alaska Seismic Environmental. Moffatt and Nichol is the permitting agent. GeoEngineers, with input from Alaska Seismic Environmental, prepared the biological assessment (BA), marine mammal monitoring plan (MMMP), and incidental harassment authorization (IHA) request. The consulting agency for this proposed action is NMFS's Alaska Region (AKR). This document represents NMFS's biological opinion (opinion) on the effects of the proposed construction activities on endangered and threatened species and designated critical habitat.

The biological opinion and incidental take statement (ITS) were prepared by NMFS AKR in accordance with section 7(b) of the ESA of 1973, as amended (16 U.S.C. §1531-1544), and implementing regulations at 50 CFR §402.

The biological opinion and ITS are in compliance with the Data Quality Act (44 U.S.C. §3504(d)(1)) and underwent pre-dissemination review.

1.1 Background

This opinion considers the effects of a proposed action by the City of Ketchikan to conduct underwater confined blasting of a rock pinnacle and dredging to remove the blasted material in the Tongass Narrows, southeastern Alaska. Removal of the underwater pinnacle will expand the area of safe navigation depths for cruise ships that presently visit Berths I and II. Removing the pinnacle will provide a more reliable ingress and egress for ships over a much wider range of wind and tide level conditions. The action would occur from September 2019 through April 2020, and has the potential to affect waters in the Tongass Narrows out to Revillagigedo Channel, approximately 3 miles to the south.

The action may affect the threatened Mexico Distinct Population Segment (DPS) of humpback whale. Critical habitat has not been designated for this DPS or species. No designated critical habitat for any species under NMFS's jurisdiction exists in the action area.

This opinion is based on information provided in the December 2018 BA (GeoEngineers 2018a); December 2018 IHA request (GeoEngineers 2018c); December 2018 MMMP (GeoEngineers 2018b), updated project proposals; email and telephone conversations among NMFS Alaska Region, the City of Ketchikan consultant team, and NMFS Permits and Conservation Division (PR1) staff; and other sources of information. A complete record of this consultation is on file at NMFS's Juneau, Alaska office.

1.2 Consultation History

Our communication with PR1, the USACE, and GeoEngineers regarding this consultation is summarized as follows:

- **December 7, 2018**: GeoEngineers submitted an initial IHA application on behalf of the City of Ketchikan to NMFS PR1 for the non-lethal taking of marine mammals incidental to blasting activities near Berth II (described below in Action Area), owned by the City of Ketchikan, during fall 2019 – winter 2020.
- **March 20, 2019**: PR1 submitted a request to initiate formal Section 7 consultation to the NMFS Alaska Region.
- **April 5, 2019**: NMFS Alaska Region deemed the initiation package complete and initiated consultation with PR1.
- **April 8, 2019**: USACE submitted a request to initiate formal Section 7 consultation to the NMFS Alaska Region.
- **April 8, 2019:** NMFS Alaska Region received a letter from the USACE delegating the role of lead action agency to PR1 for this consultation.
- **March 27, 2019:** PR1 published the proposed IHA in the *Federal Register* (84 FR 11508) with a comment period extending through April 26, 2019.
- **May 15, 2019:** PR1 sent AKR the final draft IHA (RIN 0648-XD283) and notification of changes to the proposed IHA in response to comments from the Marine Mammal Commission. No changes were made that affect Mexico DPS humpback whales.
- **May 21, 2019:** NMFS Alaska Region sent a notice of Section 7 consultation request for information to the Alaska Department of Fish and Game. No comments were received.

- **June 15, 2019:** All parties agreed to the proposed mitigation measures.

2. DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

"Action," defined at 50 CFR 402.02, means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration. NMFS Alaska Region has not identified any interrelated or interdependent actions associated with this action.

This opinion considers the effects of underwater confined blasting and removal of a rock pinnacle by the City of Ketchikan in Tongass Narrows on listed species in the action area. The purpose and need for removing the rock pinnacle is to expand the area of safe navigation depths for cruise ships that presently visit Berths I and II. Removing the pinnacle will provide a more reliable ingress and egress for ships over a much wider range of wind and tide level conditions.

The action is planned to occur from September 2019 through April 2020, and the action has the potential to affect waters in the Tongass Narrows and nearby Revillagigedo Channel, approximately 3 miles to the south (Figure 1). The action is scheduled to occur from September 16, 2019, through April 30, 2020, and the blasting portion of the activities will occur between November 15, 2019, and March 15, 2020. This work window will avoid periods of known salmon and eulachon spawning, minimizing impacts on these species and on marine mammals that may be attracted to these prey sources. Blasting is only planned for 50 days, so it will not occur each day during that period. Blasting will occur once per day, with the blast lasting approximately one second a day, and only during daylight hours.

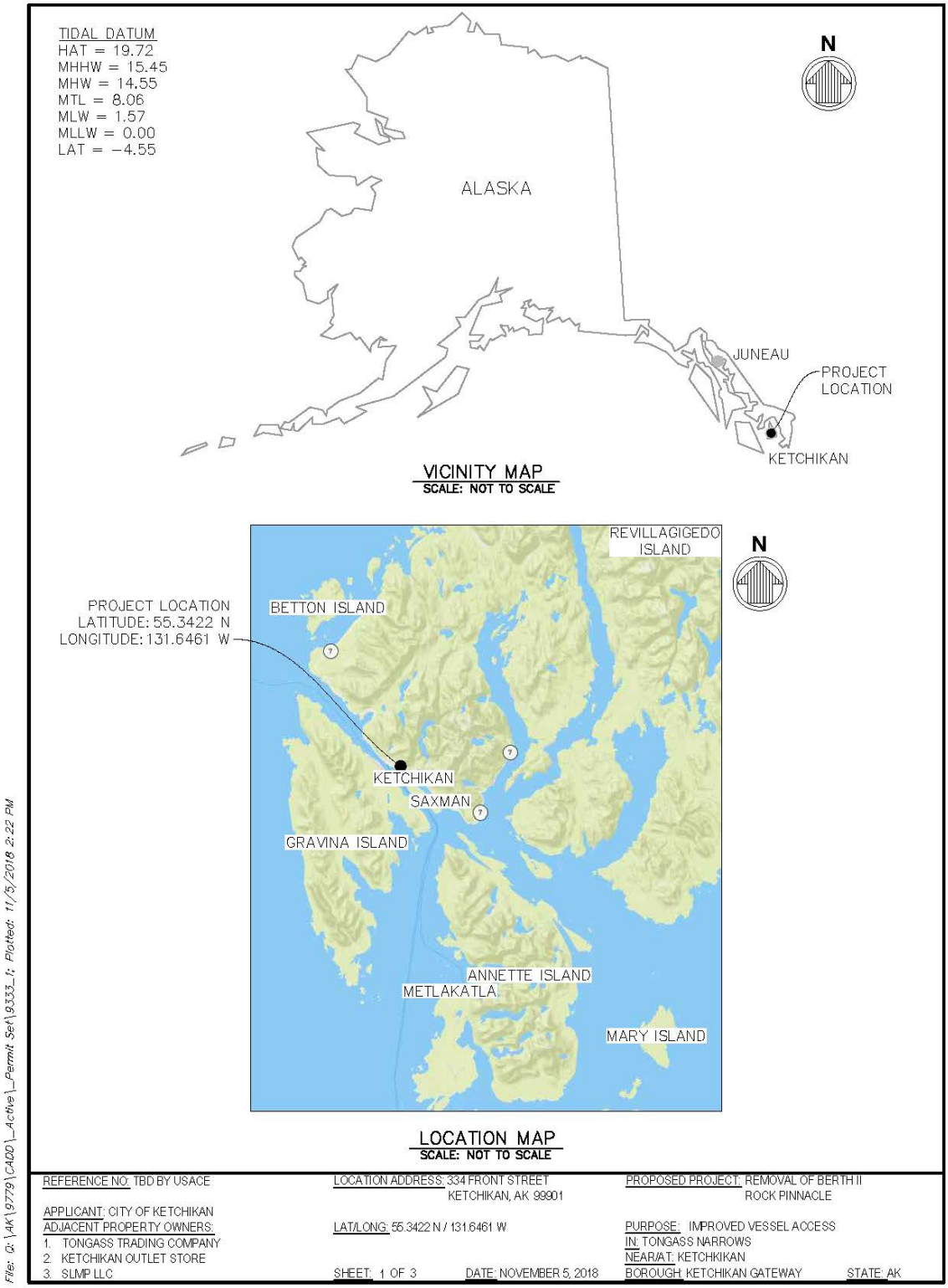

Figure 1. Action vicinity in Tongass Narrows, Ketchikan, Alaska (figure from GeoEngineers 2018c).

2.1.1 Proposed activities

A submerged rock pinnacle sits in the channel near Berth II cruise ship dock, limiting vessel navigation during low tide and high wind conditions (Figure 2). This pinnacle must be removed to allow ship traffic safe access in and out of the berths. This pinnacle, roughly 320 ft (97.5 m) by 150 ft (45.7 m), requires blasting for removal to a depth of approximately 42 ft (12.8 m) mean lower low water (MLLW) (Figure 3). Work includes equipment mobilization, drilling of small boreholes (less than 8 inches), rock pinnacle removal through blasting, dredging of blasted material, transport of the material to an appropriate upland stockpile or placement site, and equipment demobilization.

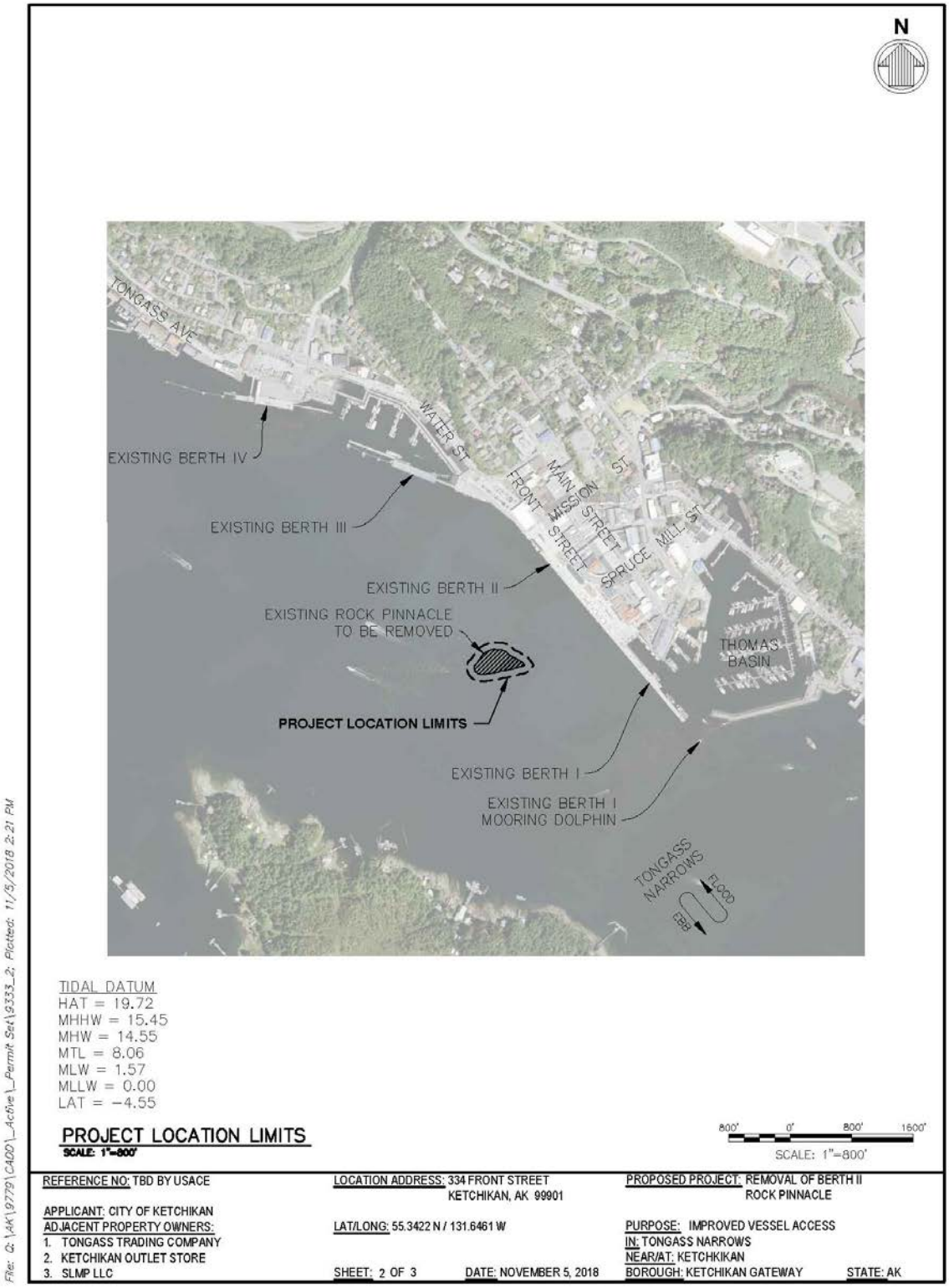

Figure 2. Location of rock pinnacle requiring removal near City of Ketchikan Berth II (figure from GeoEngineers 2018c).

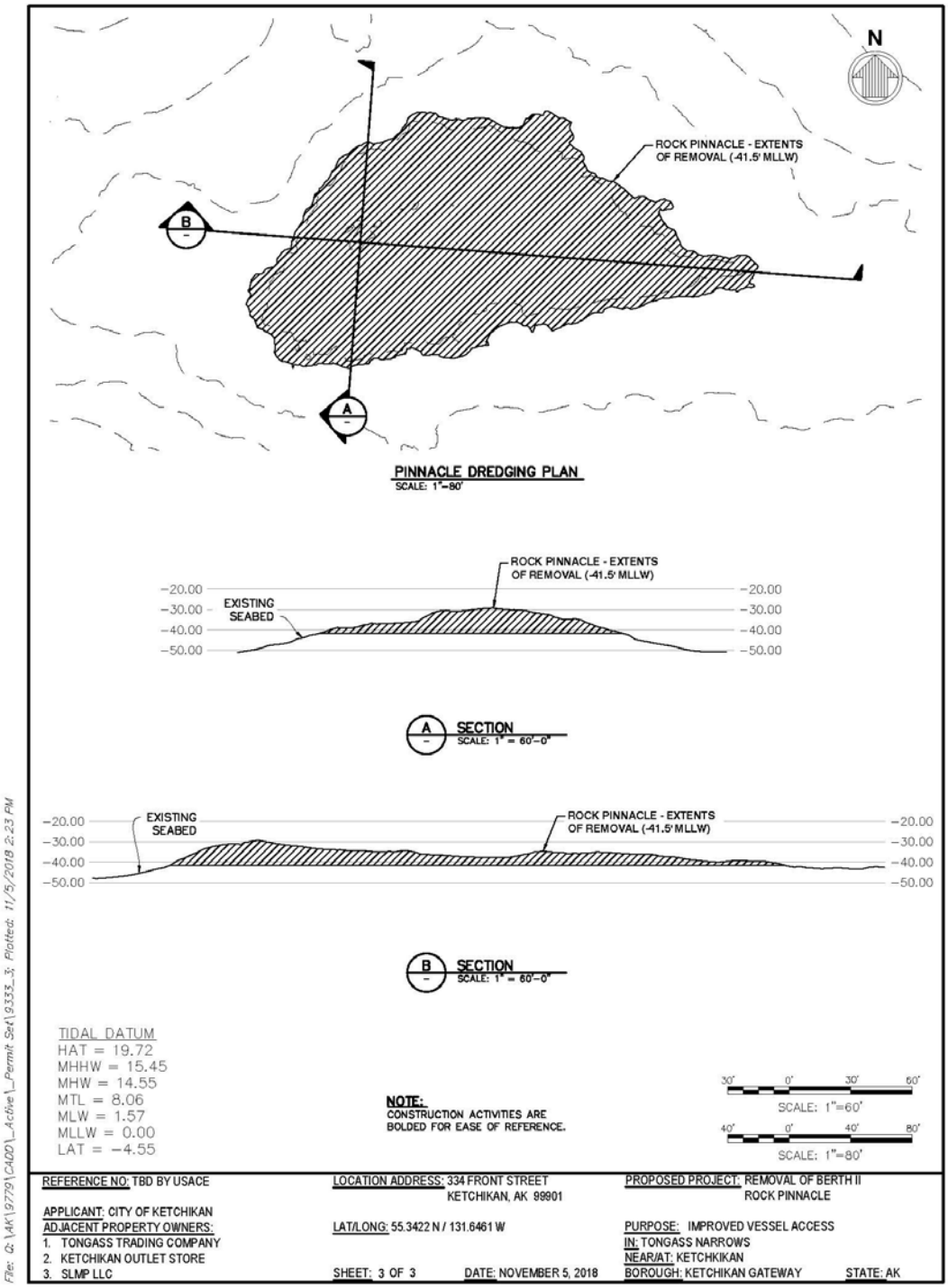

Figure 3. Diagram of planned extent of rock pinnacle removal by blasting and dredging (figure from GeoEngineers 2018c).

Mobilization of construction vessels and equipment

Construction vessels will be required for mobilization, drilling, blasting, dredging, and disposal of dredged material, marine mammal monitoring, and demobilization. Construction vessels will likely arrive at the project site within a week of construction commencement, and will leave within one-week post-project completion. Vessels are anticipated to transit from Ketchikan, but may come from other communities following standard transit routes. One to two tugboats to transport construction barges to and from the site are anticipated. The City of Ketchikan will provide moorage space for the vessels at their existing facilities. Construction vessels will be required to adhere to all permit conditions and U.S. Coast Guard regulations (speeds for vessels over 23 feet in length is to be lower than 7 knots and is lower as vessels navigate closer to the berths). Four to five vessels would consistently be in the water during the project (up to a maximum of 50 days is assumed for blasting, although fewer are anticipated given the amount of material proposed for removal). These vessels would include one drill barge, one dredge barge, one dump scow or flat-deck barge (to collect dredged material), and one to two smaller crew boats. Upon reaching the project site these vessels would move slowly within the smaller area conducting drilling or blasting activities. In addition to the equipment used for drilling and blasting there would be one to three small skiffs used for marine mammal monitoring during drilling and blasting activities, as mandated by the permits. These skiffs would move around the site and survey for marine mammals.

Borehole drilling and blasting

Boreholes will be drilled through casings and from stationary barges, held on site by spuds and/or anchors. Boreholes will be approximately 3 inches in diameter, but could be as large as 4.5 inches in diameter.

There will be up to 50 days of blasting (currently anticipating between 25 and 50 total blasts) limited to at most, one blast per day. A blast consists of a detonation of a series of sequential charges, delayed from one another at an interval of 8 milliseconds (ms), with the total blast typically lasting less than 1 second (one second = 1000 milliseconds). Each delayed charge in the blast will contain a maximum of 75 total lb (34 kg) of explosive. The timing of the blast must assure that the maximum pounds per delay does not exceed 75 lb. The proposed daily blast will consist of a grid of boreholes, each containing a delayed charge (total number may vary but typically it ranges between 30 to 60 holes), with the top section of the hole then filled in with stone (this process is referred to as “rock stemming”). This borehole grid pattern will likely have a minimal spacing of four feet between each charge, but this spacing could increase to six or more feet based on observations of how the rock is responding to blasting. For the purposes of impact modeling, four foot spacing was assumed as this minimal distance results in the most conservative impact zone estimates. Rock stemming locks the explosive material into the borehole to assure that most of the resulting energy enters the surrounding rock rather than the water column. This mitigates, or reduces, the blast energy released into the water. When the blast is detonated, each small borehole is triggered in a sequential manner to optimize rock fragmentation while minimizing underwater overpressure. This sequence is also important in reducing the amount of energy required to fracture the rock.

The use of multiple boreholes, confinement of the blast (rock stemming), and use of planned sequential delays, all help to direct the blast energy into the rock rather than the water column.

Other best management practices (BMPs) include adherence to a winter in-water work window (September 16, 2019, through April 30, 2020) to avoid fish spawning periods and when humpback whales are more likely to be in the action area, accurate drilling, minimal blast duration, and limiting the blasts to a maximum of one per day. The action will adhere to all federal and state blasting regulations, which includes the development and adherence to blasting plans, monitoring, and reporting. All of the proposed BMPs support the reduction of potential adverse impacts on protected species from in-water noise and overpressure.

Dredging

Dredging will generally occur immediately after blasting to clear the area in preparation for the next day's blast; however, there will be some variability in the dredging schedule based on the contractor's schedule, the blasting plan, and site conditions. Dredging may occur for up to 8 hours in a day. Dredging is expected to occur on 25–50 days during the construction window, roughly equivalent to the number of days of blasting. Approximately 7,500 cubic yards (approximately 5,734 m^3) of material will be removed by blasting and dredging to deepen the area to approximately 42 ft below MLLW. Material will be removed using a mechanical dredge such as a clamshell dredge or excavator deployed on a stationary barge. Dredged material will be placed on up to five barges and transported to shore by tug for stockpiling in an upland location. No more than 5 trips are expected for the tug to transport the loaded barges to and from the site. The dredged rock is expected to be reused for other construction activities. During the loading of barges with dredged material, barges will be held stationary by spuds and/or anchors.

2.1.2 Mitigation measures

The City of Ketchikan has agreed to implement the following measures to avoid and minimize impacts to the humpback whale, including the ESA-listed Mexico DPS of humpback whale.

2.1.2.1 General Conditions

- Mexico DPS humpback whale is the only ESA-listed species with authorized Level B take.
- No Level A take is authorized for Mexico DPS humpback whale.
- The City of Ketchikan will conduct a maximum of 50 days of blasting.
- The City of Ketchikan must only conduct one blast in a 24-hour period.
- The City of Ketchikan blasting activities must occur only between September 16, 2019, and April 30, 2020.
- *Daily briefings*: The City of Ketchikan must conduct briefings for blasting supervisors and crews, the monitoring team, and the City of Ketchikan staff each day prior to the start of all blasting activity, and when new personnel join the work, in order to explain responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.

2.1.2.2 Shutdown and Monitoring Zones

2.1.2.2.1 Shutdown Zone for In-water Heavy Machinery Work including Dredging

For in-water construction, heavy machinery activities other than blasting and dredging (*e.g.*, borehole drilling), if a marine mammal comes within 10 meters (m), the City of Ketchikan must safely cease operations and/or reduce vessel speed to the minimum level required to maintain steerage and safe working conditions. If an operation requires completion due to safety reasons, that operation may be completed. Monitoring of this 10-m shutdown zone may be conducted by construction personnel as they perform their other duties.

For excavator dredging, if a marine mammal comes within 200 meters (m), the City of Ketchikan must safely cease operations and/or reduce vessel speed to the minimum level required to maintain steerage and safe working conditions. If an operation requires completion due to safety reasons, that operation may be completed. Monitoring of this 200-m shutdown zone may be conducted by construction personnel as they perform their other duties.

For clamshell dredging, if a marine mammal comes within 300 meters (m), the City of Ketchikan must safely cease operations and/or reduce vessel speed to the minimum level required to maintain steerage and safe working conditions. If an operation requires completion due to safety reasons, that operation may be completed. Monitoring of this 300-m shutdown zone may be conducted by construction personnel as they perform their other duties.

2.1.2.2.2 Monitoring and Shutdown Zones

- The City of Ketchikan must establish a shutdown zone for humpback whales that is greater than its corresponding Level A harassment zone, as measured from any charge in the blasting grid (Table 1 and Figure 4).
- The City of Ketchikan must establish Level B harassment monitoring zones (Table 1 and Figure 4).
- Marine mammal monitoring must take place from 30 minutes prior to a scheduled blast until 1 hour (60 minutes) post-blast.
    - A blast must not occur until protected species observers (PSOs) have declared the shutdown zone clear of marine mammals.
    - If a humpback whale is sighted within the monitoring zone, blasting can occur and take will be tallied against the authorized number of takes by Level B harassment. Data will be recorded on the location, behavior, and disposition of the whale as long as the whale is within this monitoring zone.
    - If a marine mammal is observed within the shutdown zone (Table 1), blasting must be delayed. In the event of a delay or shutdown of activity resulting from marine mammals in the shutdown zone (Table 1), animals must be allowed to remain in the shutdown zone (*i.e.*, must leave of their own volition) and their behavior must be monitored and documented. Blasting must not occur until the animal has voluntarily left and been visually confirmed beyond the shutdown zone, or 30 minutes have

passed without subsequent detection of the marine mammal, or up until 1 hour before sunset (to accommodate post-blast monitoring).

- If blasting is delayed for a reason other than marine mammal presence, and this delay will be greater than 30 minutes, marine mammal monitoring does not need to occur during the delay. However, if monitoring is halted, a new period of the 30-minute pre-blast monitoring must occur before the rescheduled blast.
- Blasting must not occur if the shutdown zone cannot be entirely monitored and cleared, due to weather conditions or other obstructions. Blasting activities will not occur until conditions in the shutdown zone return to acceptable levels and the entire shutdown zone can be monitored and cleared.

Table 1. Shutdown, monitoring, Level A, and Level B harassment zones for blasting, dredging, and other in-water construction activities. For blasting, distances are measured from the outermost points of the grid of charges that make up a blast. For other activities, distances are measured from the sound source. Because no Level B take is authorized for dredging or other in-water construction activities, a shutdown must be implemented when a humpback whale is observed approaching that zone.

Activity	Shutdown Zone (m)	Monitoring Zone (m)	Level A Harassment Zone (m)	Level B Harassment Zone (m)
Blasting	1,000	2,500	430	2,350
Excavator dredging	200	n/a	n/a	175
Clamshell dredging	300	n/a	n/a	277
Borehole drilling and other in-water construction	10	n/a	n/a	1

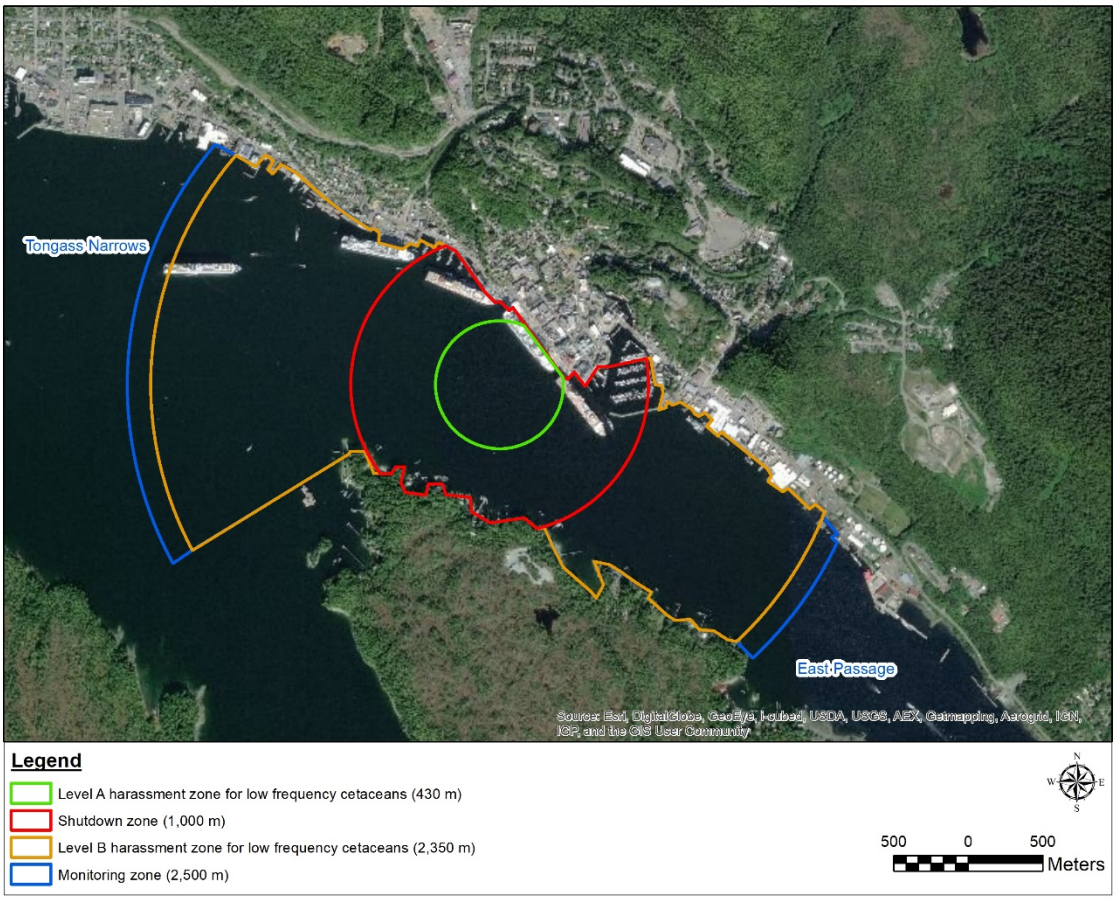

Figure 4. Monitoring and shutdown zones, and level A and B harassment zones for blasting for the City of Ketchikan's pinnacle removal project.

2.1.2.3 Timing and Daylight Restrictions

- In-water blasting work is expected to occur from November 15, 2019, to March 15, 2020, but will be limited to September 16, 2019, to April 30, 2020.
- The City of Ketchikan must conduct blasting only during daylight hours, no earlier than 30 minutes after sunrise and no later than 1 hour before sunset.
- Non-blasting activities, including but not limited to borehole drilling and dredging, may occur outside of daylight hours, but the 10-m shutdown zone for drilling, and 200- or 300-m shutdown zone for dredging must be maintained.

2.1.2.4 Non-authorized Take Prohibited

If a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized takes are met, is observed approaching or within the monitoring zone (Table 1 and Figure 4), a blast must not occur. Activities must not resume until the animal has been confirmed to have left the area or the observation time period has elapsed.

2.1.2.5 Blasting Best Management Practices (BMPs)

The City of Ketchikan will use industry BMPs to reduce the potential adverse impacts on protected species from in-water noise and overpressure. BMPs include:

- Using stemming procedures for blasting;
- The City of Ketchikan's individual daily blasts must be composed of no more than 60 delayed charges;
- Charges must be no closer than 4 feet from other charges; and
- The weight of explosive per delayed charge must not exceed 75 pounds.

The contractor will adhere to all federal and state blasting regulations, which include the development and adherence to blasting plans, monitoring, and reporting.

2.1.2.6 Visual Monitoring by Protected Species Observers

2.1.2.6.1 General requirements for visual monitoring

- PSOs able to accurately identify and distinguish species of Alaskan marine mammals will be present before and during in-water pile installation and removal.
- Blasting will not be conducted during periods when conditions such as low light, high sea state, fog, ice, rain, glare, or other conditions prevent effective marine mammal monitoring and visibility of all waters within the shutdown zone.
- PSOs will have the following to aid in determining the location of observed listed species, to take action if listed species enter the shutdown zone, and to record these events:
    - Binoculars
    - Range finder
    - GPS
    - Compass
    - Two-way radio communication with construction foreman/superintendent
    - A log book of all activities, which will be made available to NMFS upon request

2.1.2.6.2 Number and location of PSOs

- During blasting, there must be a minimum of two land-based PSOs and one lead PSO on the barge used for blasting operations, with no duties other than monitoring. These PSOs are not required for monitoring of the shutdown zones in place for non-blasting activities.
- The monitoring positions for the PSOs will provide the best practical vantage points and have the following characteristics:
    - Unobstructed view of blasting area;

- Unobstructed view of all water within the shutdown zone;
- Clear view of operator or construction foreman in the event of radio failure (lead biologist); and
- Safe distance from activities in the construction area.

2.1.2.6.3 Qualifications of PSOs

- Independent PSOs (*i.e.*, not construction personnel) who have no other assigned tasks during monitoring periods must be used.
- At least one PSO must have prior experience working as a marine mammal observer during construction activities.
- Other PSOs may substitute education (degree in biological science or related field) or training for experience.
- Where a team of three or more PSOs are required, a lead observer or monitoring coordinator must be designated. The lead observer must have prior experience working as a marine mammal observer during construction.
- The City of Ketchikan must submit curriculum vitae for PSOs for approval by NMFS Office of Protected Resources (see Section 2.1.2.12 *Contact Information*) prior to the onset of blasting.
- All PSOs must have the qualifications:
  - Ability to conduct field observations and collect data according to assigned protocols.
  - Experience or training in the field identification of marine mammals, including the identification of behaviors.
  - Sufficient training, orientation, or experience with the blasting operation to provide for personal safety during observations.
  - Writing skills sufficient to prepare a report of observations including, but not limited to, the number and species of marine mammals observed; dates and times when in-water construction activities were conducted; dates, times, and reason for implementation of mitigation (or why mitigation was not implemented when required); and marine mammal behavior.
  - Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area as necessary.

2.1.2.7 Test and Production Blasting Sound Source Verification (SSV) Monitoring

Acoustic and overpressure monitoring of the test blast and at least one production blast must be conducted. The following data, at minimum, must be collected during acoustic monitoring:

- Hydrophone/pressure transducer equipment and methods: model and make of recording device, frequency response and sensitivity of the hydrophone(s), signal gain, sampling rate, distance of the recording devices from the blasts where recordings were made; depth of recording devices.

- Number of charges and the weight of each charge detonated during the blasts.
- Representative spectra (in power spectral density format dB re 1 $\mu Pa^2/Hz$) and waveform of blasts.
- For each blast, measures of mean, median, and maximum sound levels (dB re: 1µPa) SPL_{rms}, SEL_{cum}, single-shot SEL, and the maximum SPL_{peak} from an individual charge.

2.1.2.7.1 Test blast reporting

The City of Ketchikan must submit the SSV report and results of their test blast by email to NMFS Office of Protected Resources (see Section 2.1.2.12 *Contact Information*) prior to beginning production blasting.

- If the sound produced by the test blast is less than the established thresholds, the City of Ketchikan may proceed with production blasts without notification from the NMFS Office of Protected Resources.
- If the sound produced by the test blast is greater than the established thresholds, the City of Ketchikan may not proceed with production blasts until they have been notified of any necessary modifications to the monitoring and shutdown zones by the NMFS Office of Protected Resources.
- The NMFS Office of Protected Resources will provide notification to the City of Ketchikan as quickly as possible to avoid delays in the construction schedule.

2.1.2.7.2 Production blast reporting

The City of Ketchikan must submit the report and results of their first production blast by email to NMFS Office of Protected Resources (see Section 2.1.2.12 *Contact Information*) within 24 hr of the blast.

- If the sound produced by the first production blast is less than the established thresholds, the City of Ketchikan may proceed with production blasts without notification from the NMFS Office of Protected Resources.
- If the sound produced by the first production blast is greater than the established thresholds, the City of Ketchikan may not proceed with additional production blasts until they have been notified of any necessary modifications to the monitoring and shutdown zones by the NMFS Office of Protected Resources.
- The NMFS Office of Protected Resources will provide notification to the City of Ketchikan as quickly as possible to avoid delays in the construction schedule.
- The City of Ketchikan must submit the report and results of all recorded production blast(s) with the final report as described in Section 2.1.2.8.5.

2.1.2.8 Reporting

2.1.2.8.1 Notification of intent to commence construction

At least 24 hours (± 4 hours) prior to blasting, including the test blast, the City of Ketchikan will notify the Office of Protected Resources, NMFS Alaska Regional Office, and the Alaska Region 24-hour Stranding Hotline (see Section 2.1.2.12 *Contact Information*) that blasting is planned to occur, as well as notify these parties within 24 hours (± 4 hours) after blasting that blasting actually occurred.

2.1.2.8.2 Estimation of Take

Estimated takes will be calculated based on the total number of humpback whales observed (or estimated) in the Level B monitoring zone multiplied by 6.1% (the percentage of humpback whales in the action area estimated to be from the listed Mexico DPS (Wade et al. 2016)). Therefore, for every 16 humpback whales observed in the monitoring zone one will be considered take of a Mexico DPS humpback whale allowed by the Incidental Take Statement issued with this opinion.

2.1.2.8.3 Daily activity logs

For each day of blasting that requires a PSO, the following information will be recorded:

- Date and time that each monitoring period begins and ends;
- Prevailing environmental conditions in each monitoring period (*e.g.*, wind speed, percent cloud cover, visibility, sea state, tide state);
- Description of in-water construction activities occurring during each monitoring period; and
- Indication of whether marine mammals were sighted. For each marine mammal sighting, the PSO will complete a "Marine Mammal Sighting Form." (Appendix A, (GeoEngineers 2018b).

2.1.2.8.4 Interim monthly reports

During construction, the City of Ketchikan will submit brief, monthly reports to the NMFS Alaska Region Protected Resources Division that summarize PSO observations and recorded takes. Monthly reporting will allow NMFS to track the amount of take (including estimated takes), to allow re-initiation of consultation in a timely manner, if necessary. The monthly reports will be submitted by email to NMFS Alaska Region Protected Resources Division (Julie.Scheurer@noaa.gov).

The reporting period for each monthly PSO report will be the entire calendar month, and reports will be submitted by close of business on the tenth day of the month following the end of the reporting period (*e.g.*, the monthly report covering September 1–30, 2019, would be submitted to NMFS by close of business on October 10, 2019).

2.1.2.8.5 Final report

The City of Ketchikan will submit a draft final report on all monitoring conducted under the IHA within ninety calendar days of the completion of marine mammal and acoustic monitoring or sixty days prior to the issuance of any subsequent IHA for this action, whichever comes first.

- A final report will be prepared and submitted within thirty days following resolution of comments on the draft report from NMFS.
- If no comments are received from NMFS within 30 days, the draft final report will be considered the final report.
- This report must contain, at minimum, the following information:
    - Summary of in-water construction and blasting activities including beginning and completion dates;
    - Description of any deviation from initial proposal in number of days of blasting;
    - Table summarizing all marine mammal sightings during the construction period including:
        - dates, times, species, number, location, and behavior of any observed ESA-listed marine mammals, including all observed humpback whales;
        - daily average number of individuals of each species (differentiated by month as appropriate) detected within the Level B monitoring zone, and estimated as taken, if appropriate;
    - Number of shutdowns throughout all monitoring;
    - Table summarizing any incidents resulting in take of ESA-listed species;
    - Brief description of any impediments to obtaining reliable observations during construction period;
    - Description of any impediments to complying with these mitigation measures; and
    - Appendices containing all PSO daily logs, marine mammal sighting forms, and complete SSV results.
- Draft and final reports will be submitted by email to NMFS Office of Protected Resources and NMFS Alaska Region Protected Resources Division (See Section 2.1.2.12 *Contact Information*).

2.1.2.9 Reporting Injured or Dead Marine Mammals

2.1.2.9.1 For injuries or mortalities to animals from activities related to the action:

In the unanticipated event that the specified activity clearly causes the take of a listed marine mammal in a manner not authorized by the Incidental Take Statement, such as serious injury, or mortality, the City of Ketchikan will immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources, the NMFS Alaska Region Protected

Resources Division, and the NMFS Alaska Region 24-hour Stranding Hotline (see Section 2.1.2.12 *Contact Information*).

The report must include the following information:

- Time and date of the incident;
- Description of the incident;
- Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if available).

Activities will not resume until NMFS is able to review the circumstances of the unauthorized take. NMFS would work with the City of Ketchikan to determine what measures are necessary to minimize the likelihood of further unauthorized take and ensure ESA and MMPA compliance. The City of Ketchikan will not resume their activities until notified by NMFS.

2.1.2.9.2 For injured or dead animals unrelated to the action:

In the event that the City of Ketchikan discovers an injured or dead marine mammal within the action area, and the lead PSO determines that the cause of the injury or death is unknown or the death is relatively recent (*e.g.*, in less than a moderate state of decomposition), the City of Ketchikan must immediately report the incident to the NMFS Office of Protected Resources, the NMFS Alaska Region Protected Resources Division, and the NMFS Alaska Region 24-hour Stranding Hotline (see Section 2.1.2.12 *Contact Information*).

- The report must include the same information identified in Section 2.1.2.9.1 above.
- Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with the City of Ketchikan to determine whether additional mitigation measures or modifications to the activities are appropriate.

In the event that the City of Ketchikan discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.*, evidence of prior injury or a carcass with moderate to advanced decomposition, or scavenger damage), the City of Ketchikan must report the incident to the NMFS Office of Protected Resources, the NMFS Alaska Region Protected Resources Division, and the NMFS Alaska Region 24-hour Stranding Hotline (see Section 2.1.2.12 *Contact Information*).within 24 hours of the discovery.

2.1.2.10 Strike Avoidance

Vessels will adhere to the Alaska Humpback Whale Approach Regulations when transiting to and from the project site (see 50 CFR §§ 216.18, 223.214, and 224.103(b)). Under these regulations it is prohibited for a vessel to:

- approach, by any means, including by interception (*i.e.*, placing a vessel in the path of an oncoming humpback whale so that the whale surfaces within 100 yards (91.4 m) of the vessel), within 100 yards (91.4 m) of any humpback whale;
- cause a vessel or other object to approach within 100 yards (91.4 m) of a humpback whale; or
- disrupt the normal behavior or prior activity of a whale by any other act or omission. A disruption of normal behavior may be manifested by, among other actions on the part of the whale, a rapid change in direction or speed; escape tactics such as prolonged diving, underwater course changes, underwater exhalation, or evasive swimming patterns; interruptions of breeding, nursing, or resting activities, attempts by a whale to shield a calf from a vessel or human observer by tail swishing or by other protective movement; or the abandonment of a previously frequented area.
- Notwithstanding the prohibitions above, vessels must operate at a slow, safe speed when near a humpback whale (safe speed is defined in regulation (see 33 CFR § 83.06)).

Additionally,

- Vessels used in the construction of the project will follow established transit routes and will travel at slow speeds (< 10 knots) while in the action area.
- If a humpback whale comes within 10 m (32.8 ft) of a vessel during construction, the vessel will reduce speed to the minimum level required to maintain safe steerage and working conditions until the humpback whale is at least 10 m away from the vessel.

2.1.2.11 Oil and Spill Prevention

The contractor will be responsible for the preparation of a Spill Prevention, Control, and Countermeasure (SPCC) Plan to be used for the duration of the action. The SPCC Plan will be submitted to the Project Engineer prior to the commencement of any construction activities. A copy of the SPCC Plan, and any updates, will be maintained at the work site by the contractor and will include the following:

- The SPCC Plan will identify construction planning elements and recognize potential spill sources at the work site. The SPCC Plan will outline responsive actions in the event of a spill or release and will describe notification and reporting procedures. The SPCC Plan will outline contractor management elements such as personnel responsibilities, project site security, site inspections, and training.
- The SPCC Plan will outline what measures will be taken by the contractor to prevent the release or spread of hazardous materials, either found on site and encountered during

construction but not identified in contract documents, or any hazardous materials that the contractor stores, uses, or generates on the construction site during construction activities. These items include, but are not limited to, gasoline, oils, and chemicals.

- If contaminated or hazardous materials are spilled or released during construction, all work in the vicinity of the contaminated site will be stopped until the Alaska Department of Environmental Conservation (ADEC) is contacted, and a corrective action plan is approved by ADEC and implemented.
- The contractor will provide and maintain a spill cleanup kit on-site at all times, to be implemented as part of the SPCC Plan, as well as the Hazardous Material Control Plan and Water Quality Control Plan, in the event of a spill or if any oil products are observed in the water.
- Fuel hoses, oil drums, oil or fuel transfer valves and fittings, and similar equipment will be checked regularly for drips or leaks, and will be maintained and stored properly to prevent spills.
- Oil booms will be readily available for oil or other fuel spill containment should any release occur.
- All chemicals and petroleum products will be properly stored to prevent spills. No petroleum products, cement, chemicals, or other deleterious materials will be allowed to enter surface waters.

2.1.2.12 Contact Information

NMFS Office of Protected Resources: Amy Fowler, Amy.fowler@noaa.gov, Telephone: 301-427-8401

NMFS Alaska Region Protected Resources Division: Julie Scheurer, Julie.scheurer@noaa.gov, Telephone: 907-586-7111

NMFS Alaska Region 24-hour Stranding Hotline Telephone: 1-877-925-7773

2.2 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action (*i.e.*, all activities associated with the City of Ketchikan's rock pinnacle removal project) and not merely the immediate area involved in the action (50 CFR §402.02). For this reason, the action area is typically larger than the project area and extends out to a point where no measurable effects from the proposed action occur.

The action area includes: (1) the area in which blasting and other in-water work activities will take place, (2) the ensonified area around blasting, and other in-water work activities associated with the project (see Figure 4), and (3) the transit route between Ketchikan and the project site.

The City of Ketchikan is located in Southeast Alaska (Figure 1). The proposed activities will take place offshore from cruise ship Berth II in Ketchikan, Alaska, on the Tongass Narrows water-body (Figure 2). Berth II is located in the southeastern portion of Ketchikan, opposite Pennock Island and near the mouth of Ketchikan Creek. The rock pinnacle to be removed sits in the channel between Pennock Island and the City of Ketchikan on Revillagigedo Island

approximately 1,000 feet (ft) (305 meters (m)) west of Berth II. The immediate area is part of the Port of Ketchikan, an active marine commercial and industrial area.

Construction-related noise will occur during underwater blasting and the operation of construction equipment. Noise will permeate the aquatic (underwater) and terrestrial (in-air) environments beyond the project site. Effects to water quality, such as increased turbidity and the potential spill of hazardous materials or petroleum-based products associated with construction machinery, will be controlled through proper implementation of BMPs and are not expected to have negative impacts on the environment. The overall action area includes the spatial extent of all project effects on the environment as shown in Figure 5. The action area includes the zones of influence for areas affected by construction-related noise and habitat alteration. The action area is anticipated to extend approximately 3.1 miles (5 km) through the water column for pinnacle blasting. Impacts from all project activities are not expected to extend further than approximately 3 miles from project location. Underwater and overwater noise will encounter land masses and is expected to attenuate at the shoreline of land masses as depicted in Figure 5.

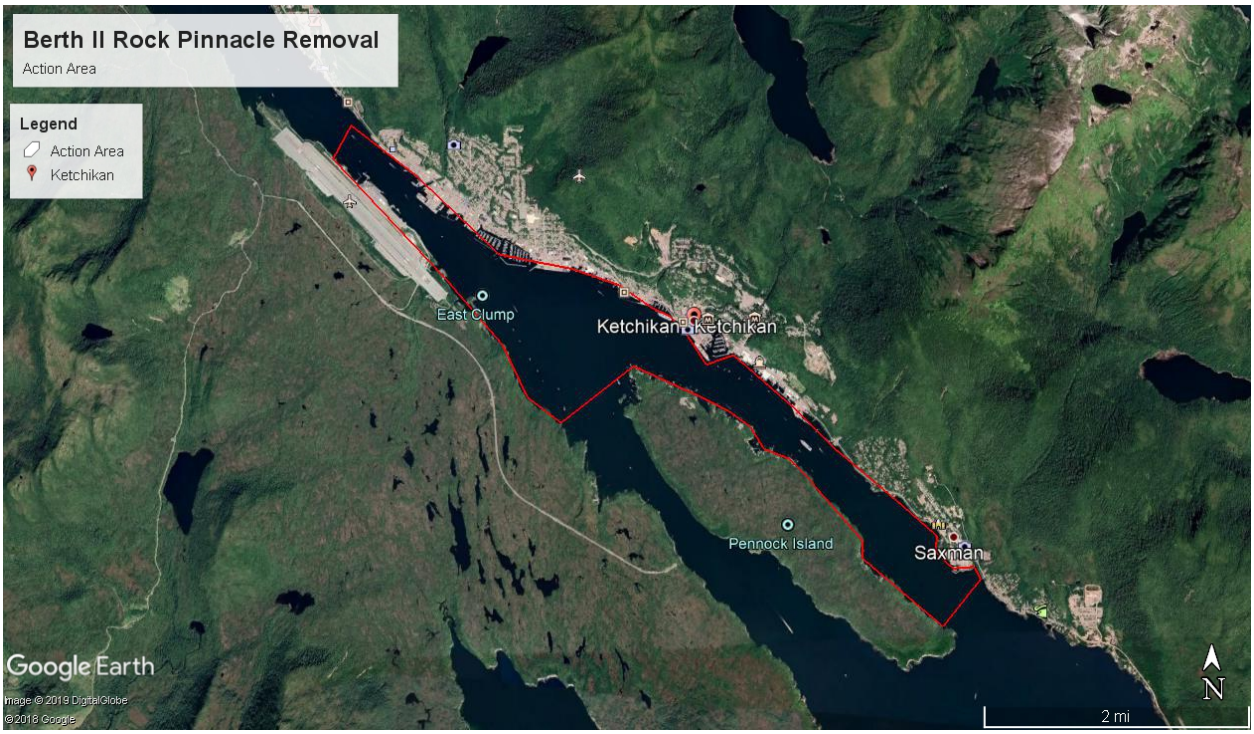

Figure 5. Action area for City of Ketchikan Berth II rock pinnacle removal project (GeoEngineers 2018a).

3. APPROACH TO THE ASSESSMENT

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat. Because there is no

critical habitat in or near the action area, we do not consider adverse modification further in this opinion.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). As NMFS explained when it promulgated this definition, NMFS considers the likely impacts to a species' survival as well as likely impacts to its recovery. Further, it is possible that in certain, exceptional circumstances, actions that impede recovery may result in a jeopardy biological opinion (51 FR 19926, 19934 (June 2, 1986)).

We use the following approach to determine whether the proposed action described in Section 2.1 is likely to jeopardize listed species:

- Identify those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on listed species. As part of this step, we identify the action area – the spatial and temporal extent of these direct and indirect effects.
- Identify the rangewide status of the species likely to be adversely affected by the proposed action. This section describes the current status of each listed species relative to the conditions needed for recovery. Status of the species is discussed in Section 4 of this biological opinion.
- Describe the environmental baseline including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation, and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 5 of this biological opinion.
- Analyze the effects of the proposed actions. Identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and sex of the individuals that are likely to be exposed to stressors and the populations or subpopulations those individuals represent. The effects of the action are described in Section 6 of this biological opinion with the exposure analysis described in Section 6.4 of this biological opinion.
- Once we identify which listed species are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed species are likely to respond given their exposure (these represent our *response analyses*). Response analysis is considered in Section 6.4 of this biological opinion.
- Describe any cumulative effects. Cumulative effects, as defined in NMFS's implementing regulations (50 CFR §402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 7 of this biological opinion.

- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat. In this step, NMFS adds the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to assess whether the action could reasonably be expected to appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution. This assessment is made in full consideration of the status of the species (Section 4). Integration and synthesis with risk analyses occur in Section 8 of this biological opinion.
- Conclusions regarding jeopardy are presented in Section 9. These conclusions flow from the logic and rationale presented in the *Integration and Synthesis* Section 8.

4. RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

One ESA-listed marine mammal species under NMFS's jurisdiction may occur in the action area: the threatened Mexico DPS humpback whale. No critical habitat for this species or any other occurs within the action area (Table 2).

Table 2. Listing status and critical habitat designation for marine mammals considered in this biological opinion.

Species	Status	Listing	Critical Habitat
Humpback whale, Mexico DPS *(Megaptera novaeangliae)*	Threatened	September 8, 2016 81 FR 62260	Not designated

4.1 Climate Change

In accordance with NMFS guidance on analyzing the effects of climate change (Sobeck 2016), NMFS assumes that climate conditions will be similar to the status quo throughout the length of the direct and indirect effects of this action. The timeframe for the proposed action is September 16, 2019, to April 30, 2020, which is a relatively short duration to detect any noticeable climate changes impacts. We present an overview of the potential climate change effects on Mexico DPS humpback whales and their habitat below.

According to the Intergovernmental Panel on Climate Change (IPCC), the average global surface temperature rose by 0.85º C from 1880 to 2012, and it continues to rise at an accelerating pace (IPCC 2014b). The 15 warmest years on record since 1880 have occurred in the 21st century, with 2015 being the warmest (NCEI 2016). The warmest year on record for average ocean temperature is also 2015 (NCEI 2016). Since 2000, the Arctic (latitudes between 60º and 90º N) has been warming at more than twice the rate of lower latitudes (Jeffries et al. 2014) due to "Arctic amplification," a characteristic of the global climate system influenced by changes in sea ice extent, atmospheric and oceanic heat transports, cloud cover, black carbon, and many other factors (Serreze and Barry 2011).

Direct effects of climate change include increases in atmospheric temperatures, decreases in sea ice, and changes in sea surface temperatures, oceanic pH, patterns of precipitation, and sea level.

Indirect effects of climate change have impacted, are impacting, and will continue to impact marine species in the following ways (IPCC 2014b):

- Shifting abundances
- Changes in distribution
- Changes in timing of migration
- Changes in periodic life cycles of species

Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2013b) and this rise has been linked to climate change (Andersson et al. 2015; Foreman and Yamanaka 2011; GAO 2014; Murray et al. 2014; Okey et al. 2014; Secretariat of the Convention on Biological Diversity 2014). Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, heat waves, and droughts (IPCC 2014a). Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014a), and species viability into the future. Climate change is also expected to result in the expansion of low oxygen zones in the marine environment (Gilly et al. 2013). Though predicting the precise consequences of climate change on highly mobile marine species, such humpback whales considered in this opinion, is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring.

Climate change is likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2009). Therefore, we expect the extinction risk of at least some ESA-listed species to rise with global warming. Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012a). Cetaceans with restricted distributions linked to water temperature may be particularly exposed to range restriction (Learmonth et al. 2006, Isaac 2009). Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. He predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses. MacLeod (2009) estimated, based upon expected shifts in water temperature, 88 percent of cetaceans would be affected by climate change, with 47 percent likely to be negatively affected.

For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott. 2009). Low reproductive success and body condition in humpback whales may have resulted from the 1997/1998 El Niño (Cerchio et al. 2005).

As temperatures in the Arctic and subarctic waters are warming and sea ice is diminishing, there is an increased potential for harmful algal blooms that produce toxins to affect marine life . Biotoxins like domoic acid and saxitoxin may pose a risk to marine mammals in Alaska. In addition, increased temperatures can increase Brucella infections. In the Lefebvre et al. (2016) study of marine mammal tissues across Alaska, 905 individuals from 13 species were sampled including humpback whales, bowhead whales, beluga whales, harbor porpoises, northern fur

seals, Steller sea lions, harbor seals, ringed seals, bearded seals, spotted seals, ribbon seals, Pacific walruses, and northern sea otters. Domoic acid was detected in all 13 species examined and had a 38% prevalence in humpback whales, and a 27% prevalence in Steller sea lions. Additionally, fetuses from a beluga whale, a harbor porpoise, and a Steller sea lion contained detectable concentrations of domoic acid documenting maternal toxin transfer in these species. Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) and a 10% prevalence in Steller sea lions (Lefebvre et al. 2016).

The indirect effects of climate change on Mexico DPS humpback whales would likely include changes in the distribution of temperatures suitable for many stages of their life history, the distribution and abundance of prey, and the distribution and abundance of competitors or predators.

4.2 Status of Listed Species

This biological opinion examines the status of the listed species that is likely to be adversely affected by the proposed action. For this action, the threatened Mexico DPS humpback whale is the only listed species that we expect to be present in the action area. The status is determined by the level of extinction risk that the Mexico DPS humpback whale faces, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. This section also helps to inform the description of the species' current reproduction, numbers, and distribution.

The sections below summarize information on the population structure and distribution of humpback whales in the action area to provide a foundation for the exposure analyses that appear later in this biological opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this biological opinion. That is, we rely on the species' status and trend to determine whether or not the action's direct or indirect effects are likely to increase the species' probability of becoming extinct or failing to recover.

More detailed background information on the status of the Mexico DPS humpback whale can be found in a number of published documents including: stock assessment reports on Alaska marine mammals (Muto et al. 2018), the humpback whale status review (Bettridge et al. 2015), and a report on estimated abundance and migratory destinations for North Pacific humpback whales (Wade et al. 2016). In addition, a Sea Grant Marine Advisory Program Officer provided information on the distribution of marine mammals for a similar action in Tongass Narrows (NMFS 2018b) that also applies to the action area considered in this biological opinion[1].

[1] Personal communication with Kate Arduser, Solstice Alaska Consulting, Inc. and Gary Freitag, Sea Grant Marine Advisory Program Officer and longtime Ketchikan resident, regarding marine mammal occurrence, behavior, and typical group size in Ketchikan vicinity, 2017.

4.2.1 Humpback whale (*Megaptera novaeangliae*)

4.2.1.1 Population Structure and Conservation Status

The humpback whale was listed as endangered under the Endangered Species Conservation Act (ESCA) on December 2, 1970 (35 FR 18319). Congress replaced the ESCA with the ESA in 1973, and humpback whales continued to be listed as endangered. NMFS recently conducted a global status review and changed the status of humpback whales under the ESA. The globally listed species was divided into 14 DPSs, four of which are endangered, one is threatened, and the remaining nine are not listed under the ESA (81 FR 62260; September 8, 2016). Three humpback whale DPSs occur in Alaska waters. The Hawaii DPS is not listed, the Mexico DPS is listed as threatened, and the Western North Pacific DPS is listed as endangered. The Mexico DPS humpback whale is the only ESA-listed species that we expect to occur within the action area. Critical habitat has not been designated for the listed Western North Pacific or Mexico DPSs (NMFS 2016).

4.2.1.2 Humpback Whales in Southeast Alaska

Wade et al. (2016) estimated abundance of humpback whales within all sampled winter and summer areas in the North Pacific, and estimated migration rates between these areas. The probability of encountering whales from each of the four North Pacific DPSs in various feeding areas is summarized in Table 3 below (NMFS 2016). As shown in Table 3 for Southeast Alaska and Northern British Columbia, only whales from the Mexico and Hawaii DPSs are likely to be present in the action area.

Table 3. Probability of encountering humpback whales from each DPS in the North Pacific Ocean in various feeding areas. Adapted from Wade et al. (2016).

Summer Feeding Areas	North Pacific Distinct Population Segments			
	Western North Pacific DPS (endangered)[1]	Hawaii DPS (not listed)	Mexico DPS (threatened)	Central America DPS (endangered)[1]
Kamchatka	100%	0%	0%	0%
Aleutian Is/ Bering/Chukchi	4.4%	86.5%	11.3%	0%
Gulf of Alaska	0.5%	89%	10.5%	0%
Southeast Alaska/ Northern BC	0%	93.9%	6.1%	0%
Southern BC/WA	0%	52.9%	41.9%	14.7%
OR/CA	0%	0%	89.6%	19.7%

[1]For the endangered DPSs, these percentages reflect the 95% confidence interval of the probability of occurrence in order to give the benefit of the doubt to the species and to reduce the chance of underestimating potential takes.

Whales from the Mexico and Hawaii DPSs overlap in Southeast Alaska. The Mexico DPS is comprised of approximately 3,264 (CV=0.06) animals (Wade et al. 2016) with an unknown population trend, though likely to be in decline (81 FR 62260). Under the MMPA, the stock

structure is being revised to match the DPSs described in Wade et al. (2016). The Central North Pacific stock (which corresponds with the Hawaii DPS) is estimated to be comprised of 10,103 (CV=0.3) animals (Muto et al. 2018). The population trend for the Central North Pacific stock is estimated to be increasing at a maximum annual rate of 7 percent (Muto et al. 2018).

Humpback whales are present in Southeast Alaska in all months of the year. Most Southeast Alaska humpback whales winter in low latitudes, but some individuals have been documented over-wintering near Sitka and Juneau (National Park Service Fact Sheet available at http://www.nps.gov/glba). Late fall and winter whale habitat in Southeast Alaska appears to correlate with areas that have over-wintering herring, such as Sitka Sound (Baker et al. 1985; Moran et al. 2018; Straley 1990).

Relatively high densities of humpback whales occur throughout much of Southeast Alaska and northern British Columbia, particularly during the summer months (Muto et al. 2018). The abundance estimate for humpback whales in Southeast Alaska is estimated to be 6,137 (CV=0.07) animals which includes whales from the Hawaii DPS (~94%) and Mexico DPS (~6%) (Wade et al. 2016). Although migration timing varies among individuals, most whales depart for Hawaii or Mexico in fall or winter and begin returning to Southeast Alaska in spring, with continued returns through the summer and a peak occurrence in Southeast Alaska during late summer to early fall. However, there are significant overlaps in departures and returns (Baker et al. 1985; Straley 1990).

4.2.1.3 Humpback Whales in the Action Area

No systematic studies have documented humpback whale abundance near Ketchikan. Based on observations of local boat charter captains and watershed stewards, humpback whales regularly utilize the surrounding waters and are occasionally observed near Ketchikan, most often on a seasonal basis. Most observations occur during the summer with sporadic occurrences during other seasons. The typical humpback whale group size in the project vicinity is between one and two animals observed at a frequency of up to three times per month (83 FR 37473, August 1, 2018, Solstice 2018), but conservatively, a group of two whales could be present every third day.

4.2.1.4 Natural History

4.2.1.4.1 Reproduction and growth

Humpbacks give birth and presumably mate on low-latitude wintering grounds in January to March in the Northern Hemisphere. Females attain sexual maturity at 5 years in some populations and exhibit a mean calving interval of approximately two years (Barlow and Clapham 1997; Clapham 1992). Gestation is about 12 months, and calves probably are weaned by the end of their first year (Perry et al. 1999).

4.2.1.4.2 Feeding and prey selection

Humpback whales tend to feed on summer grounds and not on winter grounds. However, some opportunistic winter feeding has been observed at low latitudes (Perry et al. 1999). Humpback whales engulf large volumes of water and then filter small crustaceans and fish through their fringed baleen plates.

Humpback whales are relatively generalized in their feeding compared to some other baleen whales. In the Northern Hemisphere, known prey includes euphausiids (krill), copepods, herring, juvenile salmonids, Arctic cod, walleye pollock, pteropods, and cephalopods (Johnson and Wolman 1984; Perry et al. 1999; Straley et al. 2018). Foraging is confined primarily to higher latitudes (Stimpert et al. 2007).

4.2.1.4.3 Diving and social behavior

In Hawaiian waters, humpback whales remain almost exclusively within the 1,800 m isobath and usually within water depths less than 182 m. Maximum diving depths are approximately 170 m but usually less than 60 m (Hamilton et al. 1997). Humpback whales observed feeding on Stellwagen Bank dove less than 40 m (Hain et al. 1995). Because most humpback prey is likely found above 300 m depths most humpback dives are probably relatively shallow. Hamilton et al. (1997) tracked one whale near Bermuda possibly diving and feeding to 240 m depth. The deepest dives in Southeast Alaska were recorded to 148 m (Dolphin 1987a).

Humpback whales may remain submerged during a dive for up to 21 min (Dolphin 1987a). In Southeast Alaska average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987a).

In a review of the social behavior of humpback whales, Clapham (1996) reported that they form small, unstable social groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long periods of time. There is good evidence of some territoriality on feeding grounds (Clapham 1994; Clapham 1996) and calving areas (Tyack 1981).

4.2.1.4.4 Vocalization and hearing

Humpback whales are considered low frequency cetaceans with an applied frequency range anticipated to be between 7 Hz to 35 kHz (NMFS 2018a). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Humpback whales produce a variety of vocalizations ranging from 20 Hz to 10 kHz (Au 2000; Au et al. 2006b; Erbe 2002; Frazer and Mercado III 2000; Payne and Payne 1985; Richardson et al. 1995; Silber 1986; Thompson et al. 1986; Tyack and Whitehead 1983; Vu et al. 2012; Winn et al. 1970b).

During the breeding season males sing long, complex songs, with frequencies in the 20-5000 Hz range and intensities as high as 181 dB (Payne 1970; Thompson et al. 1986; Winn et al. 1970a). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al. 1979). The songs appear to have an effective range of approximately 10 to 20 km. Animals in mating groups produce a variety of sounds (Tyack 1981).

Social sounds in breeding areas associated with aggressive behavior in male humpback whales are very different than songs and extend from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz (Silber 1986; Tyack and Whitehead 1983). These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983).

Humpback whales produce sounds less frequently in their summer feeding areas. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 seconds and source levels of 175-192 dB (Thompson et al. 1986). These sounds are attractive and appear to rally animals to the feeding activity (D'Vincent et al. 1985; Sharpe and Dill 1997).

Humpback whales are in the low frequency (LF) cetacean functional hearing group (Southall et al. 2007).

4.2.1.5 Stressors and Threats

The MMPA stock delineations have not yet been revised to correspond with the 14 DPSs established for humpback whales in 2016. Therefore, estimates of rates of mortality and serious injury in the stock assessment reports (SARs) do not correspond with individual DPSs. A general description of threats and stressors to all humpback whales occurring in Alaska is provided below. Please refer to the SARs for more information about rates of mortality and serious injury by MMPA stock (Muto et al. 2018).

4.2.1.5.1 Commercial whaling

Historically, commercial whaling represented the greatest threat to every population of humpback whale and was ultimately responsible for listing the humpback whale as an endangered species. From 1900 to 1965, nearly 30,000 whales were killed in modern whaling operations in the Pacific Ocean. Prior to that, an unknown number of humpback whales were hunted and killed (Perry et al. 1999). In 1965, the International Whaling Commission banned commercial hunting of humpback whales in the Pacific Ocean.

4.2.1.5.2 Predation

Humpback whales are killed by orcas (Dolphin 1987b; Florezgonzalez et al. 1994; Naessig and Lanyon 2004; Whitehead and Glass 1985), and are probably killed by false killer whales and sharks. Calves remain protected near mothers or within a group and lone calves have been known to be protected by presumably unrelated adults when confronted with attack (Ford and Reeves 2008).

4.2.1.5.3 Toxins and parasites

Toxic algae blooms are a potential stressor for humpback whales. Out of 13 marine mammal species examined in Alaska, domoic acid was detected in all species examined with humpback whale showing 38% prevalence. Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) (Lefebvre et al. 2016). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992).

4.2.1.5.4 Subsistence harvest

Subsistence harvest of humpback whales is prohibited under the Whaling Convention Act. There are no reported takes of humpback whales from the Mexico DPS by subsistence hunters in Alaska for the 2011–2015 period (Muto et al. 2018). One humpback whale was taken illegally by Alaska Native subsistence hunters near Toksook Bay in western Alaska in 2016, and while it could have been a member of the Mexico DPS or Western North Pacific DPS, it was most likely from the non-listed Hawaii DPS (NMFS unpublished data; Wade et al. 2016).

4.2.1.5.5 Unusual Mortality Event (UME)

NMFS declared a UME for large whales in the western Gulf of Alaska that occurred between May 22 and December 31, 2015, and included 22 humpback and 12 fin whale mortalities[2]. No specific cause for the increased mortality was identified, although it was most likely related to unusual oceanographic and climatic conditions that may have led to shifts in prey distribution or harmful algal blooms. This UME has been closed.

4.2.1.5.6 Fishery interactions and entanglements

Humpback whales are occasionally entangled during interactions with commercial, recreational, and subsistence fishing gear, marine debris, vessel ground tackle, and other anchored lines (Muto et al. 2018). Mortalities and serious injuries attributed to specific fisheries and gear types are summarized in Tables 1 and 2 of Muto et al. (2018).

Aquaculture operations may pose an entanglement risk to humpback whales (Price et al. 2017). Humpback whales in Southeast Alaska have been observed feeding around and near salmon aquaculture facilities (Chenoweth et al. 2017). In June 2018, NMFS received a report of a humpback whale damaging a floating salmon net pen near Ketchikan. The encounter did not result in an entanglement, but illustrates the potential for interactions. The aquaculture industry is growing in Alaska, increasing the potential for marine mammal entanglements.

A photographic study of humpback whales in Southeast Alaska in 2003 and 2004 found at least 53% of individuals showed some kind of scarring from entanglement (Neilson et al. 2005).

4.2.1.5.7 Vessel collisions

Vessel collisions with humpback whales remain a significant management concern, given the increasing abundance of humpback whales foraging in Alaska, as well as the growing presence of marine traffic in Alaska's coastal waters. Based on these factors, injury and mortality of humpback whales as a result of vessel strike will continue into the future. The potential for ship strikes may increase as vessel traffic in northern latitudes increases with changes in sea-ice coverage (Muto et al. 2018).

Neilson et al. (2012) reviewed 108 whale-vessel collisions in Alaska from 1978–2011 and found that 86% involved humpback whales. Collision hotspots occurred in Southeast Alaska in popular whale watching locations

4.2.1.5.8 Other stressors

Elevated levels of sound from anthropogenic sources (*e.g.*, shipping, military sonar) are a potential concern for humpback whales in the North Pacific (Muto et al. 2018). A humpback was reported entangled in a research wave rider buoy off the U.S. West Coast (Carretta et al. 2017). Other potential impacts include possible changes in prey distribution with climate change, entanglement in or ingestion of marine debris, impacts from oil and gas activities, and disturbance from whale watching activities (Muto et al. 2018).

[2] NMFS Office of Protected Resources website: https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2016-large-whale-unusual-mortality-event-western-gulf-alaska. Accessed June 4, 2018.

5. ENVIRONMENTAL BASELINE

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process.

Focusing on the impacts of activities specifically within the action area allows us to assess the prior experience and condition of the animals that will be exposed to effects from the actions under consultation. This focus is important because individuals of ESA-listed species may commonly exhibit, or be more susceptible to, adverse responses to stressors in some life history states, stages, or areas within their distributions than in others. These localized stress responses or baseline stress conditions may increase the severity of the adverse effects expected from proposed actions.

The project vicinity is an area of high human use and habitat alteration. Ongoing human activity in the action area that impacts marine mammals includes marine vessel activity, pollution, climate change, noise (*e.g.*, aircraft, vessel, pile-driving, etc.), and coastal zone development.

5.1 Marine Vessel Activity

The action area experiences high levels of marine vessel traffic with highest volumes occurring May through September. Marine vessels that use the action area include cruise ships, passenger ferries, commercial freight vessels/barges, commercial tank barges, U.S. Coast Guard vessels, commercial fishing boats, charter vessels, recreational vessels, kayaks, and floatplanes[3].

Cruise ships are the largest vessels that routinely use the action area. At any given time during the summer (May–September), as many as five large cruise ships may be moored or at anchor in the Port of Ketchikan. Cruise ship stops in Ketchikan generally increased through the 1990s and peaked in 2005. Forty-six ships are expected to visit Ketchikan in 2019 with a total of 576 stops and more than 1.14 million passengers. This is an increase from 40 ships with 504 stops and 1.07 million passengers in 2018[4]. The length of the cruise ship season, size of ships, numbers of ships, numbers of stops, and numbers of passengers are all expected to increase in the future.

Two passenger ferries transport passengers across Tongass Narrows from the City of Ketchikan to the airport on Gravina Island year-round, 7 days a week, 16 hours a day, making up to 60 crossings of the channel each day. These vessels, the M/V *Ken Eichner 2* and the M/V *Oral Freeman*, are each 116 ft long and are powered by twin diesel 850 hp motors. The airport ferries can carry up to 20 vehicles and 50–100 passengers at a time. Each crossing takes approximately 3.5 minutes at speeds averaging 5 kt and not exceeding 9 kt.[5]

[3] U.S. Coast Guard (USCG). Tongass Narrows Voluntary Waterway Guide. Available at http://seapa.com/waterway/TNVWG.pdf, accessed February 2018.

[4] Ketchikan Visitors Bureau Visitor Statistics. Available at http://www.visit-ketchikan.com/Getting-Here/Getting-Here-by-Sea, accessed May 2019.

[5] Ketchikan Gateway Borough website (available at https://www.borough.ketchikan.ak.us/147/Airport-Ferry, accessed Jan. 2019), and personal communication with Mike Carney, General Manager of Ketchikan International Airport (Dec. 2018).

The Alaska Marine Highway also operates ferries year-round in Ketchikan. Ketchikan receives ferry service seven days per week in the summer, and five to six days per week in the winter. Additionally, ferries connect Ketchikan and Metlakatla five days per week year-round.[6]

The waters of the Inside Passage support marine cargo transportation. According to automatic identification system passage-line data plots obtained from the Marine Exchange of Alaska, in 2011, 1,489 vessels moved north or south between Alaska and British Columbia. The data show that 288 vessels moved east or west between the Dixon Entrance and the Pacific Ocean during the year. Cargo ships calling at Prince Rupert dominated the east-west large vessel traffic. Cruise ships, tugs, and ferries dominated the north-south traffic (Nuka Research and Planning Group 2012).

Numerous commercial and charter fishing vessels and recreational craft, such as powerboats and sailboats, operate in the project vicinity. The Ketchikan Port & Harbors Department operates and maintains five boat harbors (Bar Harbor, Thomas Basin, Casey Moran, Knudson Cove, and Hole-In-The-Wall), the Port of Ketchikan, and three launch ramps that are heavily used[7].

Vessel-based recreational activities, commercial fishing, shipping, whale-watching, and general transportation occur within the action area regularly. All of these sources of vessel traffic increase underwater noise and contribute to the risk of vessel-whale collisions.

Vessel strikes are a leading cause of mortality in large whales. Neilson et al. (2012) reported the following summary statements about humpback whale and vessel collisions in Southeast Alaska.

- Most vessels that strike whales are less than 49 ft long
- Most collisions occur at speeds over 13 knots
- Most collisions occur between May and September
- Calves and juveniles appear to be at higher risk of collisions than adult whales

NMFS implemented regulations to minimize harmful interactions between ships and humpback whales in Alaska (see 50 CFR §§ 216.18, 223.214, and 224.103(b)). See Section 2.1.2.10 *Strike Avoidance Mitigation* for additional information. In addition to the approach regulations discussed above, some whale watching companies in the Ketchikan area participate in NMFS's Whale SENSE program, agreeing to practice additional precautions around whales. NMFS implemented Whale SENSE Alaska in 2015, a voluntary program developed in collaboration with the whale-watching industry that recognizes companies who commit to responsible practices. More information is available at https://whalesense.org/.

Since 2011, cruise lines, pilots, NMFS, and National Park Service (NPS) biologists have worked together to produce weekly whale sightings maps to improve situational awareness for cruise ships and state ferries in Southeast Alaska. In 2016, NMFS and NPS launched Whale Alert, another voluntary program that receives and shares real-time whale sightings with controlled

[6] Alaska Marine Highway website. Available at https://www.dot.state.ak.us/amhs/, accessed January 2019.
[7] City of Ketchikan, Port and Harbors. Available at https://www.ktn-ak.us/port-harbors, accessed March 2018.

access to reduce the risk of ship strike and contribute to whale avoidance. More information is available at http://www.whalealert.org/.

5.2 Fishery Interactions Including Entanglements

Entanglement of marine mammals in fishing gear and other human-made material is a major threat to their survival worldwide. Other materials also pose entanglement risks including marine debris, mooring lines, anchor lines, and underwater cables. While in many instances, marine mammals may be able to disentangle themselves (see Jensen et al. 2009), other entanglements result in lethal and sublethal trauma to marine mammals including drowning, injury, reduced foraging, reduced fitness, and increased energy expenditure (van der Hoop et al. 2016).

The NMFS Alaska Marine Mammal Stranding Network database has records of 199 large whale entanglements between 1990 and 2016. Of these, 67% were humpback whales. Most humpbacks get entangled with gear between the beginning of June and the beginning of September, when they are on their nearshore foraging grounds in Alaska waters. Between 1990 and 2016, 29% of humpback entanglements were with pot gear and 37% with gillnet gear. Longline gear comprised only 1–2% of all humpback fishing gear interactions.

Based on events that have not been attributed to a specific fishery listed on the MMPA List of Fisheries (82 FR 3655; January 12, 2017), the minimum mean annual mortality and serious injury rate from gear entanglements in unknown fisheries is 8.8 humpback whales for the Central North Pacific stock 2011-2015 (Muto et al. 2018).

The minimum average annual mortality and serious injury rate due to interactions with all fisheries in 2011-2015 is 18 Central North Pacific humpback whales (8.5 in commercial fisheries + 0.7 in recreational fisheries + 0.3 in subsistence fisheries + 8.8 in unknown fisheries), and 1.8 Western North Pacific humpback whales (0.8 in commercial fisheries + 0.4 in recreational fisheries + 0.6 in unknown fisheries) (Muto et al. 2018). All events occurred within the area of known overlap between stocks. Since the stock is unknown, the mortality and serious injury is reflected in the stock assessment reports for both stocks.

Commercial fisheries may indirectly affect whales by reducing the amount of available prey or affecting prey species composition.

5.3 Harvest

Commercial whaling in the 19th and 20th centuries removed tens of thousands of whales from the North Pacific Ocean. Commercial harvest was the primary factor for ESA-listing of humpback whales. This historical exploitation has impacted populations and distributions of humpback whales in the action area, and it is likely these impacts will continue to persist into the future.

Subsistence hunters in Alaska reported one subsistence take of a humpback whale in South Norton Sound in 2006. There had not been any additional reported takes of humpback whales by subsistence hunters in Alaska or Russia until 2016 when hunters illegally harvested one near Toksook Bay in May (DeMarban and Demer 2016).

5.4 Pollution

A number of intentional and accidental discharges of contaminants pollute the marine waters of Alaska annually. Intentional sources of pollution, including domestic, municipal, and industrial wastewater discharges, are managed and permitted by the Alaska Department of Environmental Conservation (ADEC). Pollution may also occur from unintentional discharges and spills.

According to the ADEC's most recent list of impaired waterbodies, there are no impaired waterbodies in the action area[8]. However, marine water quality in the action area can be affected by discharges from seafood processing plants, timber industry activities, shipyard and other industrial activity, treated sewer system outflows, cruise ships and other vessels operating in marine waters, and sediment runoff from paved surfaces and disturbed areas (HDR 2017).

Seafood processing facilities in Ketchikan discharge fish waste via outfalls into deep waters in Tongass Narrows under an Alaska Pollutant Discharge Elimination System general permit for Alaskan shore-based seafood processors. As required by the permit, the discharge outfalls are situated in underwater areas that are continually flushed by strong tides (HDR 2017).

Cruise ships discharge treated sewage and laundry/shower/galley sink wastes ("greywater") into marine waters. The Commercial Passenger Vessel Environmental Compliance Program under ADEC regulates cruise ship and ferry waste discharged to Alaska waters (HDR 2017).

A search of the ADEC Contaminated sites database showed that there are five land-based active contaminated sites in the vicinity of Ketchikan[8]. These include the Salvation Army site (Hazard ID 26907) where diesel fuel has contaminated the soil; the former Ketchikan Hospital (Hazard ID 25353) where soils are contaminated with lead; the USCG Ketchikan Base (Hazard ID 1184) where petroleum hydrocarbon contaminated soils have been identified; the USCG Ketchikan Officer's Quarters (Hazard ID 2990) where diesel contamination from a heating oil tank has been identified; and the Ketchikan Airport Maintenance Building USTs (Hazard ID 24498) where spills during fuel transfer resulted in contaminated soil. Clean-up is in progress at four of the five sites and near completion at the fifth site.

5.5 Climate and Ocean Regime Change

As discussed in Section 4.1, there is widespread consensus within the scientific community that atmospheric temperatures on earth are increasing and that this will continue for at least the next several decades (Oreskes 2004; Watson and Albritton 2001). The IPCC estimated that average global land and sea surface temperature has increased by 0.6°C (±0.2) since the mid-1800s, with most of the change occurring since 1976. This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley 2000). The time period between 1983 and 2012 was likely the warmest 30-year period in the Northern Hemisphere in the last 1,400 years. This warming is thought to lead to increased decadal and inter-annual variability and increases in extreme weather events (IPCC 2013a). The

[8]ADEC. Division of Spill Prevention and Response. Contaminated Sites Map. Available at https://www.arcgis.com/home/webmap/viewer.html?webmap=315240bfbaf84aa0b8272ad1cef3cad3, accessed November 2018.

likelihood of further global-scale changes in weather and climate events is virtually certain (IPCC 2013a; Overland and Wang 2007; Salinger et al. 2013).

Effects to marine ecosystems from climate change include ocean acidification, expanded oligotrophic gyres, shift in temperature, circulation, stratification, and nutrient input (Doney et al. 2012b). Altered oceanic circulation and warming cause reduced subsurface oxygen concentrations (Keeling et al. 2010). These large-scale shifts have the potential to disrupt existing trophic pathways as change cascades from primary producers to top level predators (Doney et al. 2012; Salinger et al. 2013).

The indirect effects of climate change would result from changes in the distribution of temperatures suitable for the distribution and abundance of prey and the distribution and abundance of competitors or predators. For example, variations in the localized recruitment of herring in or near the action area caused by climate change could change the distribution and localized abundance of humpback whales. However, we have no information to indicate that this has happened to date. Warmer waters could favor productivity of some species of forage fish, but the impact on recruitment of important prey fish of humpback whales is unpredictable.

The strongest warming is expected in the north, exceeding the estimate for mean global warming by a factor of 3, due in part to the "ice-albedo feedback," whereby as the reflective areas of Arctic ice and snow retreat, the earth absorbs more heat, accentuating the warming (NRC 2012). Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (NRC 2012).

The indirect effects of climate change on Mexico DPS humpback whales over time would likely include changes in the distribution of ocean temperatures suitable for many stages of their life history, the distribution and abundance of prey, and the distribution and abundance of competitors or predators.

5.6 Coastal Zone Development

Coastal zone development results in the loss and alteration of nearshore marine mammal habitat and changes in habitat quality. Increased development may prevent marine mammals from reaching or using important feeding, breeding, and resting areas. The shoreline at the project site is highly developed, with man-made structures and impervious surfaces at the shoreline. Within and near the project area, there is little coastline area that has not been impacted by human development. There is moderate shoreline development on nearby Pennock and Gravina islands. The majority of the City of Ketchikan is located on Revillagigedo Island. Marine facilities include fish processing plants, small boat harbors, cruise ship and ferry terminals, float plane docks, a dry dock, shipyard, and other infrastructure. Ketchikan International Airport is located on Gravina Island.

5.7 In-Water Noise

The action area is subject to noise from many anthropogenic sources, including marine vessels, seafood processing, shoreline and dock construction, aircraft, and land vehicles. Beyond Tongass Narrows, the action area extends to the south into Revillagigedo Channel; a relatively

undeveloped area. Ambient underwater noise levels in Tongass Narrows range from 120-130 dB, depending on season, with elevated levels during summer (HDR 2018).

Because responses to anthropogenic noise vary among species and individuals within species, it is difficult to determine long-term effects to humpback whales in the action area. Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). Clark et al. (2009) identified increasing levels of anthropogenic noise as a habitat concern for whales because of its potential effect on their ability to communicate (i.e., masking). Some research (McDonald et al. 2006; Parks 2003; Parks 2009) suggests marine mammals compensate for masking by changing the frequency, source level, redundancy, and timing of their calls. However, the long-term implications of these adjustments, if any, are currently unknown.

6. EFFECTS OF THE ACTION

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR §402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. NMFS has not identified any interrelated or interdependent activities associated with the proposed action.

This biological opinion relies on the best scientific and commercial information available. We try to note areas of uncertainty, or situations where data is not available. In analyzing the effects of the action, NMFS gives the benefit of the doubt to the listed species by minimizing the likelihood of false negative conclusions (concluding that adverse effects are not likely when such effects are, in fact, likely to occur).

We organize our effects analysis using a stressor identification – exposure – response – risk assessment framework for the proposed activities.

6.1 Project Stressors

Based on our review of the BA (GeoEngineers 2018a), the IHA application (GeoEngineers 2018c), personal communications, and available literature as referenced in this biological opinion, our analysis recognizes that the proposed action may cause these primary stressors:

- Underwater noise produced by impulsive noise sources such as blasting;
- Underwater noise produced by continuous noise sources such as dredging, borehole drilling, and vessel traffic;
- Injury or disturbance due to vessel traffic;
- Disturbance to seafloor, marine mammal habitat, and marine mammal prey; and
- Pollution from unauthorized spills.

6.2 Stressors Not Likely to Adversely Affect ESA-listed Species

Based on a review of available information, we determined the following stressors are either unlikely to occur or likely to have minimal impacts on listed species.

6.2.1 Underwater noise produced by continuous noise sources

The proposed action includes the use of various low-level non-impulsive acoustic sources, including dredging and small diameter borehole drilling, that would consistently emit noise for an extended period of time and increase vessel traffic in the Tongass Narrows.

Blasted material will be removed by mechanical dredging, using either an excavator or a clamshell dredge. The noise emitted from each of these dredging methods and their associated shutdown zones are discussed below.

Excavator dredging activities are considered a continuous noise source that has the potential to impact marine mammals (Todd et al. 2015). The processes which comprise sound sources associated with mechanical backhoe (excavator) dredging activities fall within several categories. Physical removal of sediment from the substrate as the bucket is inserted into the bed, forced through the bed in a "scooping" arc, and removed from the bed produces grinding and scraping sounds (Reine et al. 2012). Reine et al. (2012) calculated the source level for a backhoe dredger of 179 dB re 1 µPa at 1m. Bottom grab sounds were not detected beyond 175 m from the source. Based on Reine et al. 2012, it would be extremely unlikely for Mexico DPS humpback whales to be exposed to continuous noise levels ≥120 dB_{rms} re 1µPa if dredging operations are shut down whenever these marine mammals appear likely to approach within 200 m of the sound source. The impacts from the dredging noise are therefore expected to be negligible.

Clamshell dredging activities cause continuous noise that has the potential to impact marine mammals (Todd et al. 2015). Clamshell dredging (*e.g.*, grab dredging) in Cook Inlet measured 124 dB re 1 µPa at the 150 meter isopleth (Dickerson et al. 2001). Based on this information we anticipate that received levels would reach the 120 dB isopleth at approximately 277 m using the practical spreading model. The peak sound levels were associated with the dredger striking the hard ocean floor (Dickerson et al. 2001). The proposed dredging at the Ketchikan Berth II pinnacle removal project is thought to be similar to the Cook Inlet dredging project and will likely generate similar sound levels. In order to prevent Level B acoustic exposure to Mexico DPS humpback whales from this continuous noise source, in-water dredging work will be shut down if a humpback whale approaches a zone 300 meters from the sound source. With implementation of the appropriate shutdown zone, the impacts from clamshell dredging noise are expected to be negligible.

Drilling of boreholes is not expected to produce sound levels that would reach or exceed the 120 dB threshold for continuous noise beyond 1 meter from the source. Because a 10-m shutdown zone will be implemented during borehole drilling, no Mexico DPS humpback whales will be exposed to drilling noise at levels that would be considered take. NMFS has authorized take in association with certain types of drilling in other projects, (83 FR 53217, October, 22, 2018), but those sources have much larger holes being drilled, use different equipment for drilling (*e.g.*, down-the-hole hammering/drilling), and/or other circumstances lead to an expectation of louder sound levels than are expected here. Because of the small borehole size and 10-m shutdown

zone, acoustic impacts from drilling are likely to be immeasurably small, are not expected to rise to the level of a take, and take is not proposed to be authorized for drilling activities. The impacts from the drilling of boreholes are therefore expected to be negligible.

6.2.2 Vessel strike

Vessel strike associated with the proposed action is extremely unlikely. The contractor will mobilize up to five barges near the rock pinnacle for use as work platforms for blasting and dredging, and upon which to load dredged material for removal. Barges will be moved into location with a tugboat. Tug towing operations for construction occur at relatively low speeds (5 knots), and the maximum transit speed for tugs and barges is anticipated to be 7 knots. Once barges are towed to the construction site, they will be anchored, limiting risk of strike. Skiffs may transport workers very short distances and low speeds from shore to the work platform.

In 2017, there were seven reported vessel strikes to humpback whales in Alaska (https://alaskafisheries.noaa.gov/sites/default/files/17strandings.pdf). Between 2011 and 2015 the minimum mean annual mortality and serious injury rate due to ship strikes reported in Alaska for humpback whales was 1.8 whales (Muto et al. 2018). These incidents account for a very small fraction of the total humpback whale population (Laist et al. 2001). Of the reported vessel strikes of humpback whales in the Ketchikan vicinity between 2007 and 2017, one was reported within Tongass Narrows. That whale arrived in the Ketchikan Harbor on the bulbous bow of a cruise ship when it came into port, but it is uncertain if it was struck in Tongass Narrows or elsewhere.

Vessel activity is common throughout the action area. Most ship strikes of large whales occur when vessels are traveling at speeds of 10 knots or more (Jensen and Silber 2004; Laist et al. 2001). Because the cruise ships travel at speeds averaging less than 7 knots when entering Tongass Narrows, and must slow down to 2 knots or less when approaching Berths I and II, it is unlikely that a cruise ship will collide with a humpback whale. The removal of the rock pinnacle will allow for additional maneuvering only and approaches at higher speeds are will not be allowed, even once the pinnacle has been removed.

Vessel disturbance or strikes on Mexico DPS humpback whales are not expected due to the proposed action because 1) commercial and recreational vessels are common in the action area but there are limited recorded strikes; 2) humpbacks are uncommon in the immediate vicinity, and only a fraction (6.1%) of all humpback whales in the area are anticipated to be ESA-listed; 3) vessels associated with the action are primarily slow-moving tugboats and barges and small skiffs for transporting workers; 4) cruise ships using the berths will travel at speeds less than 2 knots near the berths and less than 7 knots within Tongass Narrows, slow down when whales are present, and announce over the radio to alert other mariners when whales are present [9]; and 6) vessels will follow NMFS's regulations that prohibit approaching within 100 yards of humpback whales. All of these factors limit the risk of strike. We conclude that vessel strikes and disturbance are extremely unlikely to occur and any effects are negligible.

[9] Personal communication with Mike Carney, Ketchikan International Airport General Manager, December 21, 2018.

6.2.3 Vessel noise

Tongass Narrows near Ketchikan is a busy industrial port with median background noise levels measured at 117.1 dB re 1 µPa (Warner and Austin 2016), and much of that noise is from vessels. Vessel noise transmitted through water is a continuous noise source. Broadband source levels for tugs and barges have been measured at 145 to 170 dB re 1 µPa, and 151 to 152 dB re 1µPa for small vessels with outboard motors (Richardson et al. 1995). Sound from vessels within this size range would reach the 120 dB threshold distances between 86 m and 233 m (282 and 764 feet) from the source (Richardson et al. 1995).

Vessel noise associated with this action will be minimal because most work will be conducted from anchored barges and work platforms. Workers will be transported to and from these platforms by skiffs traveling only short distances from shore and at slow speeds. Barges will be moved into place by tugs traveling short distances from shore at slow speeds. Up to five barges loaded with blasted rock material will be transported to shore by tug.

NMFS anticipates minimal low-level exposure of short-term duration to listed humpback whales from vessel noise. If animals are exposed and do respond, they may exhibit slight deflection from the noise source and engage in low-level avoidance behavior, short-term vigilance behavior, or short-term masking behavior, but these behaviors are not likely to result in adverse consequences for the animals. The nature and duration of response is not anticipated to be a significant disruption of important behavioral patterns such as feeding or resting. The action area is not considered high quality habitat for humpback whales so slight avoidance of the area is not likely to adversely affect them. Vessels involved in the action will travel only short distances at slow speeds. Additionally, the infrequent occurrence of humpback whales in the action area, adherence to the mitigation measures, and vessels following the Alaska Humpback Whale Approach Regulations and Marine Mammal Code of Conduct should prevent close approaches and exposure to noise from vessels related to this action. The impact of vessel noise on Mexico DPS humpback whales is therefore determined to be negligible.

6.2.4 Disturbance to seafloor, habitat, and prey resources

Blasting will permanently alter the seafloor and fish habitat directly offshore from the Ketchikan waterfront. The rock pinnacle area to be removed is roughly 320 ft by 150 ft with an average of 4 ft in height. Vertical benthic structure that provides habitat for a variety of fish species will be removed during this portion of the action. The proposed action will have temporary impacts on water quality (increases in turbidity levels) and on prey species distribution.

Construction activities that increase in-water noise may adversely affect forage fish and juvenile salmonids in the action area. While impacts from blasting to fish have the potential to be severe, including barotrauma and mortality, the blasts will last approximately one second on 25 to 50 days, making the duration of activity that could cause this impact short term. The timing of in-water construction, between September 16, 2019, and April 30, 2020, but avoiding blasting March 16–June 15, 2020, has been planned to avoid major spawning and migration times. Adverse effects on prey species populations during project construction will be short-term, based on the short duration of the project. After pinnacle blasting and associated activities are completed, habitat use and function are expected to return to similar pre-construction levels and fish are expected to repopulate the area.

Given the numbers of fish and other prey species in the vicinity, the short-term nature of effects on fish species, and the mitigation measures to protect fish and marine mammals during construction, the proposed action is not expected to have measurable effects on the distribution or abundance of potential marine mammal prey species. Any behavioral avoidance by fish of the disturbed area would still leave sufficiently large areas of fish and marine mammal foraging habitat in waters southeast and northeast of Tongass Narrows.

The surrounding area is heavily trafficked by large and small ships and is not a significant foraging ground for humpback whales. There are no known aggregations of forage fish important to humpback whales in the project vicinity that will be impacted by the action. BMPs and minimization practices used by the City of Ketchikan to minimize potential environmental effects from project activities are outlined in the *Mitigation Measures* section of this opinion (Section 2.1.2). Additionally, the City of Ketchikan has agreed to implement the EFH conservation recommendations from NMFS Habitat Conservation Division (NMFS 2019). In summary, the effects of disturbance to the seafloor, habitat, and prey resources resulting from the pinnacle removal activities are expected to have an negligible impact on Mexico DPS humpback whales.

6.2.5 Introduction of pollutants into waters

An SPCC Plan and other Best Management Practices (as described in Section 2.1.2.11 *Oil and Spill Prevention* of this opinion) will be implemented during construction to prevent contaminants from entering the water column. Plans will be in place and materials available for spill prevention and cleanup activities at the marine terminal to limit potential contamination. Construction will be conducted in accordance with Clean Water Act Section 404 and 401 regulations to minimize potential construction-related impacts on water quality, and any effects to Mexico DPS humpback whales would be immeasurably small. Therefore, we conclude that the effects from this stressor are negligible.

6.2.6 Summary of Stressors Not Likely to Adversely Affect ESA-listed Species

In conclusion, based on review of available information, we determined effects from vessel strike and disturbance are extremely unlikely to occur. We consider the effects to Mexico DPS humpback whales to be negligible.

We determined vessel noise associated with the action is not likely to have measurable impact; therefore, we consider the effects to Mexico DPS humpback whales to be negligible.

We determined drilling boreholes, disturbance of seafloor, and introduction of pollutants are not likely to have measurable impact; therefore, we consider the effects to Mexico DPS humpback whales to be negligible.

Although these five stressors are not likely to adversely affect listed species, the effects of these stressors are considered and addressed in the Integration and Synthesis portion of the opinion.

6.3 Stressors Likely to Adversely Affect ESA-listed Species

Underwater noise from blasting is likely to adversely affect Mexico DPS humpback whales. This stressor will be analyzed further in the *Exposure Analysis* and *Response Analysis.*

6.3.1 Sound measurements used in this document

"Sound pressure" is the sound force per unit micropascals (μPa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. "Sound pressure level" is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure in underwater acoustics is 1 μPa, and the units for sound pressure levels are decibels (dB) re 1 μPa. Sound pressure level (in dB) = 20 log (pressure/reference pressure).

Sound pressure level is an instantaneous measurement and can be expressed as "peak" (PK), "peak-to-peak" (p-p), or "root mean square" (rms). Root mean square, which is the square root of the arithmetic average of the squared instantaneous pressure values, is typically used in discussions of the effects of sounds on vertebrates. All references to sound pressure level in this document are expressed as rms, unless otherwise indicated. Note that sound pressure level does not take the duration of a sound into account.

6.3.2 Acoustic thresholds

The City of Ketchikan's proposed activity includes the use of an impulsive sound source, blasting. Using the best available science, NMFS has developed acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to incur temporary threshold shifts (TTS; equated to Level B harassment) or permanent threshold shifts (PTS; equated to Level A harassment) of some degree[10]. (TTS and PTS are discussed further in Section 6.5.1). Thresholds have also been developed to identify the pressure levels above which animals may incur different types of tissue damage from exposure to pressure waves from explosive detonation. Table 4 lists TTS, PTS, serious injury, and mortality thresholds. The proposed action may result in TTS for humpback whales (low frequency cetacean) that are within the Level B monitoring zone when a blast occurs.

[10] NMFS's Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). Available at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance, Accessed June 5, 2019.

Table 4. Explosive acoustic and pressure thresholds for marine mammals (84 FR 11508, March 27, 2019).

Group	Level B harassment		Level A harassment	Serious injury		Mortality
	Behavioral (multiple detonations)	TTS	PTS	Gastro-intestinal tract	Lung	
Low-freq cetacean	163 dB SEL	168 dB SEL or 213 dB SPL_{pk}	183 dB SEL or 219 dB SPL_{pk}	237 dB SPL	$39.1M^{1/3}$ $(1+[D/10.081])^{1/2}$ Pa-sec where: M = mass of the animals in kg D = depth of animal in m	$91.4M^{1/3}$ $(1+[D/10.081])^{1/2}$ Pa-sec where: M = mass of the animals in kg D = depth of animal in m
Mid-freq cetacean	165 dB SEL	170 dB SEL of 224 dB SPL_{pk}	185 dB SEL or 230 dB SPL_{pk}			
High-freq cetacean	135 dB SEL	140 dB SEL or 196 dB SPL_{pk}	155 dB SEL or 202 dB SPL_{pk}			
Phocidae	165 dB SEL	170 dB SEL or 212 dB SPL_{pk}	185 dB SEL or 218 dB SPL_{pk}			
Otariidae	183 dB SEL	188 dB SEL or 226 dB_{pk}	203 dB SEL or 232 dB SPL_{pk}			

The MMPA, as well as applicable regulations at 50 CFR § 216.3, define "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (Level B harassment).

While the ESA does not define "harass," NMFS issued guidance interpreting the term "harass" under the ESA as a means to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). For the purposes of this consultation, any incidental harassment of listed species under the MMPA—whether Level A or Level B—constitutes an incidental take under the ESA and must be authorized by the Incidental Take Statement (see Section 10).

As described below, we anticipate that exposures to listed marine mammals from noise associated with the proposed action may result in Level B harassment in the form of TTS. With the addition of mitigation measures (including shutdown zones), no Level A harassment (*i.e.*, mortality, serious injury, PTS) is expected.

6.3.3 Underwater sound sources associated with the action

Noise from blasting may have an adverse effect on Mexico DPS humpback whales. Sound sources can be divided into broad categories based on various criteria or for various purposes. With regard to temporal properties, sounds are generally considered to be either continuous or transient (*i.e.*, intermittent). Continuous sounds are those whose sound pressure level remains above ambient sound during the observation period (ANSI 2005). Intermittent sounds are defined as sounds with interrupted levels of low or no sound (NIOSH 1998). Sound sources may also be categorized by spectral property. The sounds produced by the City of Ketchikan's activities fall into two general sound types: impulsive and non-impulsive. The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing. Please see Southall et al. (2007) for an in-depth discussion of these concepts.

Impulsive sound sources (*e.g.*, explosions, gunshots, sonic booms, impact pile driving) are by definition intermittent, and produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (ANSI 1986; ANSI 2005; Harris 1998; ISO 2003; NIOSH 1998) and occur either as isolated events or repeated in some succession. All impulsive sounds are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features.

Explosives used for blasting emit an impulsive sound, which is characterized by a short duration, abrupt onset, and rapid decay. Exposure to high intensity sound may result in behavioral reactions and auditory effects such as a noise-induced threshold shift—an increase in the auditory threshold after exposure to noise (Finneran et al. 2005).

6.4 Exposure Analysis

As discussed in the *Approach to the Assessment* section of this biological opinion, exposure analyses are designed to identify the listed species that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number of individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Response analyses determine how listed species are likely to respond after being exposed to an action's effects on the environment or directly on listed species themselves. Our assessments try to detect the probability of lethal responses, physical damage, physiological responses (particular stress responses), behavioral responses, and social responses that might result in reducing the fitness of listed individuals. Ideally, our response analyses consider and weigh evidence of adverse consequences, beneficial consequences, or the absence of such consequences.

NMFS expects that humpback whales will be exposed to underwater noise from blasting associated with the pinnacle removal project. Possible responses by Mexico DPS humpback whales to the sound produced by blasting include:

- Physical Responses
  - Temporary or permanent hearing impairment (threshold shifts)

  - Non-auditory physiological effects
- Behavioral responses

6.4.1 Exposure to noise from blasting

Mexico DPS humpback whales may be present within the waters of the action area during the time that the in-water work is being conducted and could be exposed to temporarily elevated underwater noise levels resulting in harassment.

Temporarily elevated underwater noise during blasting has the potential to result in Level B harassment of marine mammals in the form of TTS. Level A harassment (resulting in injury) is not expected to occur as a result of the proposed action because shutdown zones will be implemented and the mitigation measures proposed in Section 2.1.2 will reduce the potential for exposure to levels of underwater noise above the injury threshold established by NMFS.

For this analysis we estimated take by considering: 1) acoustic thresholds above which the best available science indicates humpback whales will experience Level B harassment in the form of TTS; 2) acoustic thresholds above which the best available science indicates humpback whales will incur Level A harassment in the form of PTS, serious injury, or mortality; 3) the area that will be ensonified above these levels in a day; 4) the expected density or occurrence of listed marine mammals within these ensonified areas; and 5) and the number of days of activities.

Exposure Assumptions

- Animals occurring within the Level A and Level B ensonified zones are considered to be in each zone simultaneously, but would only be counted as one Level A take.
- Exposures are based on total number of days that blasting could occur and that animals might occur in the ensonified Action Area.
- All humpback whales occurring in the portion of the action area that is ensonified to levels that are expected to cause harassment during blasting are assumed to be incidentally taken (*i.e.,* exposures to sound levels at or above the relevant thresholds equate to take).
- An individual animal can only be taken once during a 24-hour period.
- For animals that may occur in groups, each individual in the group would be considered taken.
- Level B exposure estimates are unmitigated and do not take into account monitoring and mitigation efforts to reduce take as described in Section 2.1.2.
- The percentage of humpback whale exposures that are estimated to be from the threatened Mexico DPS (6.1%) are based on observed percentages as reported in Wade et al. (2016)

6.4.1.1 Ensonified Area and Distances to Level A and Level B Sound Thresholds

Following a method generated through consultation with the Marine Mammal Commission, NMFS computed cumulative sound exposure impact zones from the blasting information provided by the City of Ketchikan. Peak source levels of the confined blasts were calculated based on Hempen et al. (2007), using a distance of 4 feet and a weight of 75 pounds for a single charge. The total charge weight is defined as the product of the single charge weight and the

number of charges. In this case, the maximum number of charges is 60. Explosive energy was then computed from peak pressure of the single maximum charge, using the pressure and time relationship of a shock wave (Urick 1983). Due to time and spatial separation of each single charge by a distance of four feet, the accumulation of acoustic energy is added sequentially, assuming the transmission loss follows cylindrical spreading within the matrix of charges. The SEL from each charge at its source can then be calculated, followed by the received SEL from each charge. Since the charges will be deployed in a grid with a least 4 ft by 4 ft spacing, the received SELs from different charges to a given point will vary depending on the distance of the charges from the receiver. The actual spacing between charges will be determined based on how the rock responds to the blasting. Modeling was carried out using 4 ft spacing as this closest potential spacing results in the most conservative (highest) source values and largest resulting impact zones. Without specific information regarding the layout of the charges, the modeling assumes a grid of 7 by 8 charges with an additional four charges located in peripheral locations. Among the various total SELs calculated, the largest value, SELtotal(max) is selected to calculate the impact range. Using the pressure versus time relationship (Urick 1983), the frequency spectrum of the explosion can be computed by taking the Fourier transform of the pressure (Weston 1960). Frequency specific transmission loss of acoustic energy due to absorption is computed using the absorption coefficient, α (dB/km), summarized by François and Garrison (1982a and b). Seawater properties for computing sound speed and absorption coefficient were based on Ketchikan ocean temperatures recorded from November through March[11] and salinity data presented in Vanderhoof and Carls (2012). Transmission loss was calculated using the sonar equation:

$$TL = SEL_{total(m)} - SEL_{threshold}$$

where $SEL_{threshold}$ is the Level A harassment and Level B harassment (TTS) threshold. The distances, R, where such transmission loss is achieved were computed numerically by combining both geometric transmission loss, and transmission loss due to frequency-specific absorption. A spreading coefficient of 20 is assumed. While this spreading coefficient would normally indicate an assumption of spherical spreading, in this instance, the higher coefficient is actually used to account for acoustic energy loss from the sediment into the water column. The outputs from this model are summarized in Table 5 below. For the dual criteria of SEL_{cum} and SPL_{pk} shown in Table 5, distances in bold are the larger of the two isopleths, and were used in further analysis. Because the blast is composed of multiple charges arranged in a grid, these distances are measured from any individual charge, meaning that measurement begins at the outermost charges. For additional information on these calculations please refer to the "Blast Modeling Concept" document.[12]

[11] Available at National Centers for Environmental Information, Coastal Water Temperature Guide. https://www.nodc.noaa.gov/dsdt/cwtg/alaska.html, accessed November 8, 2018.

[12] Available at https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-construction-activities, under "City of Ketchikan Underwater Confined Blasting, Ketchikan, Alaska," accessed June 5, 2019.

Table 5. Model results for impact zones for blasting in meters (m)

Marine Mammal Hearing Group	Mortality*	Slight lung injury*	GI Tract	PTS: SEL_{cum}	PTS: SPL_{pk}	TTS: SEL_{cum}	TTS: SPL_{pk}
Low frequency cetacean	6	12	24	430	188	2,350	375
*Estimates for Mortality and Slight lung injury are based on body size of each individual species, so multiple estimates exist for some marine mammal hearing groups. The value entered into the table is the most conservative (largest isopleth) calculated for that group.							

6.4.1.2 Estimating marine mammal occurrence

In this section we provide the information about the presence, density, or group dynamics of humpback whales that informed the take calculations. Expected marine mammal presence is determined by past observations and general abundance near the Ketchikan waterfront during the construction window. The expected occurrence of humpback whales was estimated using local marine mammal data sets (*e.g.*, National Marine Mammal Laboratory databases; Dahlheim et al., 2009) and observations from local Ketchikan charter operators and residents. A recent IHA and associated application for nearby construction (83 FR 37473, August 1, 2018) was also reviewed to identify marine mammal group size and potential frequency of occurrence within the project vicinity.

Based on observations of local boat charter captains and watershed stewards, humpback whales regularly utilize the surrounding waters and are occasionally observed near Ketchikan. Most observations occur during the summer with sporadic occurrences during other periods. The typical humpback whale group size in the project vicinity is between one and two animals observed at a frequency of up to three times per month (83 FR 37473, August 1, 2018, Solstice 2018), but conservatively, a group of two whales could be present every third day.

The following equation was used to estimate the number of estimated exposures of Mexico DPS humpback whale to Level B harassment.

$$\text{Level B harassment estimate} = (N_{whale} \times N_{days\ of\ blasting}) \div \text{frequency of occurrence} \times 0.061.$$

Based on occurrence information in the area, we conservatively estimate that a group of two humpback whales will be sighted within the Level B harassment zone every third day. Therefore:

$$(2 \text{ x } 50) \div 3 = 33 \text{ exposures of humpback whales to Level B harassment}$$

As described in Section 4.2.1, an estimated 6.1 percent of humpback whales in Southeast Alaska are from the Mexico DPS (Wade et al. 2016). Therefore, of the 33 animals potentially exposed to Level B harassment due to blasting activities, 6.1%, or 2 of these 33 exposures would be ESA-listed Mexico DPS humpback whales, and the remaining 31 would most likely from the non-listed Hawaii DPS.

No serious injury or mortality or take by Level A harassment was requested or is authorized because these large whales can be effectively monitored and work can be halted before animals enter the shutdown zone when they are present. The distance at which PTS for humpback whales may occur from blasting is estimated to be 430 m (see Table 5). However, the applicant has agreed to monitor and shut down operations for any humpbacks within 1,000 meters. At this distance no mortalities, lung impacts, GI tract impacts, or Level A harassment would occur. In addition, this extended shutdown may reduce Level B harassments out to 1,000 meters.

Table 6. Amount of proposed incidental harassment (takes) of Mexico DPS humpback whales from blasting. Take estimates are rounded to the nearest whole number.

Species	Proposed Authorized Level A Takes	Proposed Authorized Level B Takes
Mexico DPS humpback whale (*Megaptera novaeangliae*)	0	2

In the *Response Analysis* we apply the best scientific and commercial data to describe the expected responses of humpback whales to these exposures.

6.5 Response Analysis

6.5.1 Response to noise from blasting

As described in the Exposure Analysis, Mexico DPS humpback whales are anticipated to occur in the action area and are anticipated to overlap with noise associated with blasting activities. We assume that some individuals are likely to be exposed and respond to noise sources. We do not anticipate that any Mexico DPS humpback whales will be exposed to noise levels likely to cause mortalities, serious injury, or Level A harassment due to the implementation of mitigation measures. We expect no more than 2 instances of exposure by Mexico DPS humpback whales to noise levels sufficient to cause TTS. All instances of harassment are anticipated to occur at received levels ≤ 168 dB SEL, the threshold for TTS for low frequency cetaceans for explosives.

In general, the effects of sounds from blasting could result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, and behavioral disturbance (Gordon et al. 2007; Nowacek et al. 2007; Richardson et al. 1995; Southall et al. 2007). Impacts to marine mammals from blasting activities are expected to result primarily from acoustic pathways. As such, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. The further away from the source, the less intense the exposure should be. The substrate and depth of the habitat affect the sound propagation properties of the environment. Shallow environments such as the area around the rock pinnacle are typically more structurally complex, which leads to rapid sound attenuation.

These instances of exposure assume a uniform distribution of animals and do not account for avoidance. The implementation of mitigation measures to reduce exposure to blasting noise and the short duration of blasting operations eliminate the likelihood that exposure to blasting would cause Level A harassment.

Humpback whale distribution in the action area varies seasonally, with whales occurring more frequently in summer than winter. Regardless of the time of year, humpback whales are not anticipated to occur in high numbers in the ensonified area associated with the proposed action.

6.5.1.1 Temporary or permanent hearing impairment – threshold shifts

Temporary Threshold Shift (TTS)

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1970). While experiencing TTS, the hearing threshold rises, and a sound must be stronger in order to be heard. In terrestrial mammals, TTS can last from minutes or hours to days (in cases of strong TTS). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data describe TTS elicited by exposure to multiple pulses of sound. Available data on TTS in marine mammals are summarized in Southall et al. (2007).

For low-frequency cetaceans, no behavioral or auditory evoked potential threshold data exist. Therefore, hearing thresholds were estimated by synthesizing information from anatomical measurements, mathematical models of hearing, and animal vocalization frequencies (NMFS 2016b).

Although up to 2 Level B exposures may occur, the noise thresholds for the onset of TTS are conservative and not all instances of take will result in TTS.

Permanent Threshold Shift (PTS)

When PTS occurs, there is physical damage to the sound receptors in the ear. In severe cases, there can be total or partial deafness, while in other cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter 1985). There is no specific evidence that exposure to pulses of sound can cause PTS in any marine mammal. However, given the possibility that mammals close to a sound source can incur TTS, it is possible that some individuals will incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals but are assumed to be similar to those in humans and other terrestrial mammals, based on anatomical similarities. PTS might occur at a received sound level at least several decibels above that inducing mild TTS if the animal were exposed to strong sound pulses with rapid rise time. For non-impulsive exposures (*i.e.*, vibratory pile driving), a variety of terrestrial and marine mammal data sources indicate that threshold shift up to 40 to 50 dB may be induced without PTS, and that 40 dB is a conservative upper limit for threshold shift to prevent PTS. An exposure causing 40 dB of TTS is therefore considered equivalent to PTS onset (NMFS 2016b).

No exposures are anticipated at levels resulting in PTS due to shut-down mitigation measures.

6.5.1.2 Non-auditory physiological effects

In addition to PTS and TTS, there is a potential for non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.,*change in dive profile as a result of an avoidance reaction) caused by exposure to sound. These impacts could include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007; Zimmer and Tyack 2007). The City of Ketchikan's activities involve the use explosives, which have been associated with these types of effects; however, because the City of Ketchikan plans to confine their blasts, the energy of the resultant shock wave is reduced by as much as 60-90 percent compared to unconfined, open-water detonations in a free field. Given the low weight of the charges, confined nature of the blasts, and small size of the detonation relative to large open water detonations, in conjunction with monitoring and mitigation measures discussed in Section 2.1.2, the City of Ketchikan's 25 to 50 blasting events are not likely to have severe injury or mortality effects on marine mammals in the project vicinity. Instead, NMFS considers that the City of Ketchikan's blasts are most likely to cause TTS (Level B harassment) in a few individual marine mammals. Level A harassment is not expected for humpback whales.

6.5.1.3 Behavioral effects

Based on the near instantaneous nature of blasting and the mitigation measures in place, if only single blast is being conducted each day, NMFS does not expect behavioral disturbance to occur. The City of Ketchikan’s proposed blasting is a single blast, composed of charges separated by microdelays (approximately 8 ms), and therefore behavioral disturbance is not expected to occur. As a result, because single detonation blasting is the only proposed activity for which take is expected to occur, behavioral disturbance is only discussed briefly below.

Behavioral disturbance may include a variety of effects, including subtle changes in behavior (*e.g.,*minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Behavioral responses to sound are highly variable and context-specific and any reactions depend on numerous intrinsic and extrinsic factors (*e.g.,* species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day), as well as the interplay between factors (e.g., Archer et al. 2010; Richardson et al. 1995; Southall et al. 2007; Wartzok et al. 2003; Weilgart 2007). Behavioral reactions can vary not only among individuals but also within an individual, depending on previous experience with a sound source, context, and numerous other factors (Ellison et al. 2012), and can vary depending on characteristics associated with the sound source (*e.g.,* whether it is moving or stationary, number of sources, distance from the source). A humpback whale that is present within or near the monitoring zone at the time of blasting may change its behavioral state by reducing the time spent the surface, increasing its swimming speed, changing its swimming direction to avoid the sound, changing its respiration rate, increasing dive durations, reducing feeding behavior, or altering vocalizations and social interactions (Frid and Dill 2002; Funk et al. 2010; Koski et al. 2009; Melcon et al. 2012). These effects are expected to be minor and temporary because only a single blast will occur in a day and are not considered behavioral disturbances that rise to the level of a Level B take. NMFS

does not expect that these behavioral reactions will affect the fitness or survival of Mexico DPS humpback whales.

7. CUMULATIVE EFFECTS

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, and that are reasonably certain to occur within the action area (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate change within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the *Environmental Basel*ine (Section 5).

All of the activities described in the *Environmental Baseline* are expected to continue into the future. The pinnacle removal project is intended to bring the waters off Berths I and II to an optimal depth, allowing for improved access and more efficient berthing for cruise ships during high winds. The action will provide a more reliable ingress and egress for ships over a much wider range of wind and water level conditions and is important to improving conditions contributing to a safe, accessible, and commercially viable existing navigation facility. The action does not expand the existing vessel capacity at Berths I and II nor is it intended to increase the number of cruise vessels using those berths. However, the number of visitor arriving on cruise ships continues to grow as the size of cruise ships increases, and the length of the cruise ship season increases by a few days each year. The current trend is for increasing numbers of tourists and vessels in Alaska. Tourism and community development are expected to continue, likely increasing the demands for transportation, goods, and services. Tongass Narrows will continue to function as the main transportation corridor for the City of Ketchikan and surrounding communities. We do not expect the cumulative effects of these activities to hinder population growth of Mexico DPS humpback whales.

8. INTEGRATION AND SYNTHESIS

This section is the final step of NMFS's assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 6) to the *Environmental Baseline* (Section 5) and the *Cumulative Effects* (Section 7) to formulate the agency's biological opinion as to whether the proposed action is likely to (1) result in appreciable reductions in the likelihood of the survival or recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in the adverse modification or destruction of critical habitat as measured through potential reductions in the value of designated critical habitat for the conservation of the species. These assessments are made in full consideration of the *Status of the Species* (Section 4).

As discussed in the *Approach to the Assessment* (Section 3) section of this biological opinion, we begin our risk analysis by asking whether the probable physical, physiological, behavioral, or

social responses of endangered or threatened species are likely to reduce the fitness of endangered or threatened individuals or the growth, annual survival or reproductive success, or lifetime reproductive success of those individuals.

Based on the results of the exposure and response analyses, we expect a maximum of 33 humpback whales may be harassed by noise from blasting, and 6.1% or 2 of those humpback whales are anticipated to be from the Mexico DPS. Exposure to vessel noise from transit and potential for vessel strike may occur, but adverse effects from vessel disturbance and noise are likely to be negligible due to the small marginal increase in such activities relative to the environmental baseline and the transitory nature of vessels. Adverse effects from vessel strike are considered discountable because of the few additional vessels introduced by the action and the unlikelihood of these type of interactions.

Humpback whales' probable response to noise from blasting includes brief startle reactions or short-term behavioral modification. These reactions and behavioral changes are expected to subside quickly when the exposures cease. The primary mechanism by which the behavioral changes we have discussed affect the fitness of individual animals is through the animals' energy budget, time budget, or both (the two are related because foraging requires time). Large whales such as humpbacks have the ability to store substantial amounts of energy, which allows them to survive for months on stored energy during migration and while in their wintering areas, and their feeding patterns allow them to acquire energy at high rates. The individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of humpback whales, and their probable exposure to noise sources are not likely to reduce their fitness. As discussed in the *Description of the Proposed Action* and *Status of the Species* sections, this action does not overlap in space or time with humpback whale breeding. Some Mexico DPS humpback whales feed in Southeast Alaska in the summer and fall months and migrate to Mexican waters for breeding and calving in the late winter months. As a result, the probable responses to project stressors are not likely to reduce the current or expected future reproductive success of Mexico DPS humpback whales or reduce the rates at which they grow, mature, or become reproductively active.

Therefore, these exposures are not likely to reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the populations those individuals represent. The short duration of sound generation and the implementation of mitigation measures to reduce exposure to high levels of sound reduce the likelihood that exposure would cause a behavioral response that may affect vital functions, or cause TTS or PTS. Additionally, when considered in conjunction with the effects of the proposed action, cumulative effects of future state or private activities in the action area are likely to affect humpback whales at a level comparable to present. The current and recent population trends for humpback whales in Southeast Alaska indicate that these levels of activity are not hindering population growth.

As a result, this action is not likely to appreciably reduce Mexico DPS humpback whales' likelihood of surviving or recovering in the wild.

9. CONCLUSION

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Mexico DPS of humpback whale. Critical habitat has not been designated or proposed for this species, therefore, none will be affected.

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species unless there is a special exemption.[13] "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR §402.02). Based on NMFS guidance, the term "harass" under the ESA means to: "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). The MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (16 U.S.C. §1362(18)(A)(i) and (ii)). For this consultation, NMFS anticipates that any take will be by harassment only. No serious injury, mortality, or Level A takes are contemplated or authorized.

Under the terms of Section 7(b)(4) and Section 7(o)(2) of the ESA, taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement (ITS).

Section 7(b)(4)(C) of the ESA provides that if an endangered or threatened marine mammal is involved, the taking must first be authorized by Section 101(a)(5) of the MMPA. Accordingly, **the terms of this incidental take statement and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified**. Absent such authorization, this ITS is inoperative.

The terms and conditions described below are nondiscretionary. The Corps and NMFS PR1 have a continuing duty to regulate the activities covered by this ITS. In order to monitor the impact of incidental take, the Corps and PR1 must monitor and report the progress of the action and its impact on the species as specified in the ITS (50 CFR §402.14(i)(3)). If the Corps or PR1 (1) fail to require the authorization holder to adhere to the terms and conditions of the ITS through enforceable terms that are added to the authorization, or (2) fail to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

[13] Although Section 9 of the ESA only prohibits take of endangered species, not threatened species, NMFS extended all the prohibitions of section 9 to Mexico DPS humpback whales through a rule issued pursuant to ESA section 4(d). 81 FR 62259 (Sept. 8, 2016).

10.1 Amount of Extent of Take

Section 7 regulations require NMFS to estimate the number of individuals that may be taken by proposed actions or utilize a surrogate (*e.g.*, other species, habitat, or ecological conditions) if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (50 CFR § 402.14 (i)(1); see also 80 FR 26832 (May 11, 2015). Table 7 lists the amount and timing of authorized take (incidental take by harassment) for this action.

The method for estimating the number of animals exposed to sound levels expected to result in Level B harassment is described in Section 6.4. NMFS anticipates that 33 Level B takes of humpback whales may occur. Of these 33 animals, 6.1% or 2 animals are predicted to be from the Mexico DPS. Therefore, NMFS is authorizing 2 Level B harassment takes under the ESA. As a result, NMFS will not consider that The City of Ketchikan has reached its take limit unless and until 33 humpback whales have been observed in the Level B zone during blasting activities.

Blasting activities will be halted as soon as possible when it appears a humpback whale is approaching the Level A shutdown zone and before it reaches the Level A isopleth. No Level A take was requested nor is authorized for humpback whales.

Table 7. Summary of anticipated instances of exposure to sound from blasting resulting in the incidental take of Mexico DPS humpback whales by Level B harassment (TTS). These take numbers reflect only the individuals that are expected to be from the ESA-listed DPS that may be present in the action area.

Mexico DPS humpback whale	Total Amount of Take Associated with Proposed Action		Anticipated Temporal Extent of Take
	Level A	Level B	
Total	0	2	September 15, 2019 through April 30, 2020

10.2 Effect of the Take

The only takes authorized during the proposed action are Level B takes by acoustic harassment from blasting activities. No serious injury or mortality or Level A harassment is anticipated or authorized as part of this proposed action. This consultation has assumed that exposure to blasting activities might disrupt one or more behavioral patterns that are essential to an individual animal's life history. However, any behavioral responses of these whales and any associated disruptions are not expected to affect their fitness, reproduction, survival, or recovery.

In Section 9 of this biological opinion, NMFS determined that the level of incidental take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of Mexico DPS humpback whales.

10.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR § 402.02).

The RPMs included below, along with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. NMFS concludes that the following RPMs are necessary and appropriate to minimize or to monitor the incidental take of Mexico DPS humpback whales resulting from the proposed action.

1. This ITS is valid only for the activities described in this biological opinion, and which have been authorized under section 101(a)(5) of the MMPA.
2. The taking of Mexico DPS humpback whales will be by incidental harassment only. The taking by serious injury or death is prohibited and will result in the modification, suspension, or revocation of the ITS. The City of Ketchikan will immediately report the take of listed marine mammals by serious injury or mortality to NMFS AKR.
3. The Corps and PR1 will implement a monitoring and reporting program that includes all items described in the mitigation measures section of this biological opinion (Section 2.1.2) and allows NMFS AKR to evaluate the exposure estimates contained in this biological opinion and that underlie this ITS.
4. The Corps and PR1 will implement any additional mitigation measures required by the IHA to be issued by NMFS Permits Division.

10.4 Terms and Conditions

"Terms and conditions" implement the reasonable and prudent measures (50 CFR § 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps and PR1 or any contractor must comply with the following terms and conditions, which implement the RPMs described above. The Corps and PR1 or any contractor has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR §402.14).

Partial compliance with these terms and conditions may result in more take than anticipated, and may invalidate this take exemption. These terms and conditions constitute no more than a minor change to the proposed action because they are consistent with the basic design of the proposed action.

To carry out RPM #1, the Corps, PR1, or its authorization holder must undertake the following:

1. Require the permitted operators to possess a current and valid Incidental Harassment Authorization issued by NMFS under section 101(a)(5) of the MMPA, and any take must occur in compliance with all terms, conditions, and requirements included in such authorizations.
2. Conduct the action as described in this biological opinion including all mitigation measures and observation and shut-down zones.

To carry out RPM #2, the Corps, PR1, or its authorization holder must undertake the following:

3. The taking of any marine mammal in a manner other than that described in this ITS must be reported immediately to NMFS AKR, Protected Resources Division at 907-586-7636.

4. If operations conducted under the proposed action cause a take of a marine mammal that results in a serious injury or mortality, or other unauthorized take, all operations will immediately cease, and the City of Ketchikan will follow the reporting requirements described in the Mitigation Measures.
5. The City of Ketchikan will immediately notify NMFS AKR, Protected Resources Division at 907-586-7636, if and when a total of 16 humpback whales have been detected in the Level B zone during blasting activities that would expose them to noise levels exceeding the Level B threshold. This would equate to one take of Mexico DPS humpback whales, and half of the authorized take for this action, and would allow NMFS to determine if additional mitigation measures need to be applied prior to take being exceeded.

To carry out RPMs #3 and 4, the Corps, PR1, or its authorization holder must undertake the following:

6. Comply with all monitoring and reporting requirements as detailed in the mitigation measures of this biological opinion (Section 2.1.2) and the IHA issued by NMFS under section 101(a)(5) of the MMPA.

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR §402.02).

1. Project vessel crews should participate in the WhaleAlert program to report real-time sightings of whales while transiting in the waters of Southeast Alaska and to minimize the risk of vessel strikes. More information is available at https://alaskafisheries.noaa.gov/pr/whale-alert.

In order to keep NMFS's Protected Resources Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Corps and PR1 should notify NMFS of any conservation recommendations they implement in their final action.

12. REINITIATION OF CONSULTATION

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this biological opinion; (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this biological opinion; or 4) a new species is listed or critical habitat

designated that may be affected by the action. In instances where the amount of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

13. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act (DQA)) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the biological opinion addresses these DQA components, documents compliance with the DQA, and certifies that this biological opinion has undergone pre-dissemination review.

13.1 Utility

This document records the results of an interagency consultation. The information presented in this document is useful to NMFS, the USACE, the City of Ketchikan, and the general public. These consultations help to fulfill multiple legal obligations of the named agencies. The information is also useful and of interest to the general public as it describes the manner in which public trust resources are being managed and conserved. The information presented in these documents and used in the underlying consultations represents the best available scientific and commercial information and has been improved through interaction with the consulting agency.

This consultation will be posted on the NMFS Alaska Region website http://alaskafisheries.noaa.gov/pr/biological-opinions/. The format and name adhere to conventional standards for style.

13.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

13.3 Objectivity

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 et seq.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the literature cited section. The analyses in this biological opinion contain background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA implementation, and reviewed in accordance with Alaska Region ESA quality control and assurance processes.

14. REFERENCES

Andersson, A. J., D. I. Kline, P. J. Edmunds, S. D. Archer, N. Bednarsek, R. C. Carpenter, M. Chadsey, P. Goldstein, A. G. Grottoli, T. P. Hurst, A. L. King, J. E. Kubler, I. B. Kuffner, K. R. M. Mackey, B. A. Menge, A. Paytan, U. Riebesell, A. Schnetzer, M. E. Warner, and R. C. Zimmerman. 2015. Understanding ocean acidification impacts on organismalto ecological scales. Oceanography 28(2):16-27.

ANSI (American National Standards Institute). 1986. Methods of measurement for impulse noise 3 (ANSI S12.7-1986). Acoustical Society of America, Woodbury, NY.

ANSI (American National Standards Institute). 2005. Measurement of sound pressure levels in air (ANSI S1.13-2005). Acoustical Society of America, Woodbury, NY.

Archer, F. I., S. L. Mesnick, and A. C. Allen. 2010. Variation and predictors of vessel response behavior in a tropical dolphin community. NOAA Technical Memorandum NMFS-SWFSC-457, National Marine Fisheries Service: 53 p.

Au, D., and W. Perryman. 1982. Movement and speed of dolphin schools responding to an approaching ship. Fishery Bulletin 80(2):371-379.

Au, W. W. L. 2000. Hearing in whales and dolphins: An overview. Pages 1-42 *in* W. W. L. Au, A. N. Popper, and R. R. Fay, editors. Hearing by Whales and Dolphins. Springer-Verlag, New York.

Au, W. W. L., and M. Green. 2000. Acoustic interaction of humpback whales and whale-watching boats. Marine Environmental Research 49:469-481.

Au, W. W. L., A. A. Pack, M. O. Lammers, L. M. Herman, M. H. Deakos, and K. Andrews. 2006a. Acoustic properties of humpback whale songs. Journal of the Acoustical Society of America 120(2):1103-1110.

Au, W. W. L., A. A. Pack, M. O. Lammers, L. M. Herman, M. H. Deakos, and K. Andrews. 2006b. Acoustic properties of humpback whale songs. Journal of the Acoustical Society of America 120(August 2006):1103-1110.

Bain, D. E., J. C. Smith, R. Williams, and D. Lusseau. 2006. Effects of vessels on behavior of Southern Resident killer whales (*Orcinus* spp). National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Baker, C. S., L. M. Herman, B. G. Bays, and G. B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory.

Baker, C. S., L. M. Herman, A. Perry, W. S. Lawton, J. M. Straley, and J. H. Straley. 1985. Population characteristics and migration of summer and late-season humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. Marine Mammal Science 1(4):304-323.

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology 78(2):535-546.

Bauer, G., and L. M. Herman. 1986. Effects of vessel traffic on the behavior of humpback whales in Hawaii. National Marine Fisheries Service, Honolulu, Hawaii.

Bejder, L., S. M. Dawson, and J. A. Harraway. 1999. Responses by Hector's dolphins to boats and swimmers in Porpoise Bay, New Zealand. Marine Mammal Science 15(3):738-750.

Bejder, L., A. Samuels, H. Whitehead, N. Gales, J. Mann, R. Connor, M. Heithaus, J. Watson-Capps, C. Flaherty, and M. Krutzen. 2006. Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance. Conservation Biology 20(6):1791-1798.

Bettridge, S., C. S. Baker, J. Barlow, P. Clapham, M. Ford, D. Gouveia, D. K. Mattila, R. M. Pace, III, P. E. Rosel, G. K. Silber, and P. R. Wade. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act, U.S. Dept. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-540, 263 p.

Blane, J. M., and R. Jaakson. 1994. The impact of ecotourism boats on the St. Lawrence beluga whales (*Delphinapterus leucas*). Environmental Conservation 21(3):267-269.

Blecha, F. 2000. Immune system response to stress. Pages 111-122 *in* G. P. Moberg, and J. A. Mench, editors. The biology of animal stress: basic principles and implications for animal welfare. CABI Publishing, Oxon, United Kingdom.

Blumstein, D. T. 2003. Flight-initiation distance in birds is dependent on intruder starting distance. Journal of Wildlife Management 67(4):852-857.

Carretta, J. V., K. A. Forney, E. M. Oleson, D. W. Weller, A. R. Lang, M. M. Muto, B. Hanson, A. J. Orr, H. Huber, M. S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, and R. L. Brownell Jr. 2017. U.S. Pacific marine mammal stock assessments: 2016, NOAA-TM-NMFS-SWFSC-577.

Cerchio, S., J. K. Jacobsen, D. M. Cholewiak, and E. A. Falcone. 2005. Reproduction of female humpback whales off the Revillagigedo Archipelago during a severe El Niño event. Pages 55 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Chenoweth, E. M., J. M. Straley, M. V. McPhee, S. Atkinson, and S. Reifenstuhl. 2017. Humpback whales feed on hatchery-released juvenile salmon. Royal Society Open Science 4.

Christiansen, F., D. Lusseau, E. Stensland, and P. Berggren. 2010. Effects of tourist boats on the behaviour of Indo-Pacific bottlenose dolphins off the south coast of Zanzibar. Endangered Species Research 11(1):91-99.

Clapham, P. J. 1992. Age at attainment of sexual maturity in humpback whales, Megaptera novaeangliae. Canadian Journal of Zoology 70(7):1470-1472.

Clapham, P. J. 1994. Maturational changes in patterns of association in male and female humpback whales, *Megaptera novaeangliae*. Journal of Zoology 234:265-274.

Clapham, P. J. 1996. The social and reproductive biology of Humpback Whales: An ecological perspective. Mammal Review 26(1):27-49.

Clapham, P. J., and D. K. Mattila. 1993. Reactions of humpback whales to skin biopsy sampling on a West-Indies breeding ground. Marine Mammal Science 9(4):382-391.

Clark, C., W. T. Ellison, B. Southall, L. Hatch, S. M. Van Parijs, A. S. Frankel, D. Ponirakis, and G. C. Gagnon. 2009. Acoustic masking of baleen whale communications: potential impacts from anthropogenic sources. Pages 56 *in* Eighteenth Biennial Conference on the Biology of Marine Mammals, Quebec City, Canada.

Corkeron, P. J. 1995. Humpback whales (*Megaptera novaeangliae*) in Hervey Bay, Queensland: behavior and responses to whale watching vessels. Canadian Journal of Zoology-Revue Canadienne De Zoologie 73(7):1290-1299.

Cox, T. M., T. Ragen, A. Read, E. Vos, R. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, and L. Crum. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Space and Naval Warfare Systems Center, San Diego, CA.

Crowley, T. J. 2000. Causes of climate change over the past 1000 years. Science 289(5477):270-277.

D'Vincent, C. G., R. M. Nilson, and R. E. Hanna. 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. Scientific Reports of the Whales Research Institute 36:41–47.

David, L. 2002. Disturbance to Mediterranean cetaceans caused by vessel traffic. Pages Section 11 *in* G. N. d. Sciara, editor. Cetaceans of the Mediterranean and Black Seas: State of Knowledge and Conservation Strategies. ACCOBAMS Secretariat, Monaco.

Department of Navy. 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000.

Dolphin, W. F. 1987a. Dive behavior and estimated energy expenditure of foraging humpback whales in southeast Alaska. Canadian Journal of Zoology 65(2):354-362.

Dolphin, W. F. 1987b. Observations of humpback whale, Megaptera novaeangliae and killer whale, Orcinus orca, interactions in Alaska: comparison with terrestrial predator-prey relationships. Canadian Field-Naturalist 101(1):70-75.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, and N. Knowlton. 2012a. Climate change impacts on marine ecosystems. Marine Science 4.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012b. Climate change impacts on marine ecosystems. Annual Reviews in Marine Science 4:11-37.

Ellison, W. T., B. L. Southall, C. W. Clark, and A. S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology 26(1):21-28.

Erbe, C. 2002. Hearing abilities of baleen whales. Atlantic report CR 2002-065. Contract Number: W7707-01-0828. Defence R&D Canada.

Evans, P. G. H., P. J. Canwell, and E. Lewis. 1992. An experimental study of the effects of pleasure craft noise upon bottle-nosed dolphins in Cardigan Bay, West Wales. European Research on Cetaceans 6:43-46. Proceedings of the Sixth Annual Conference of the European Cetacean Society, San Remo, Italy, 20-22 February.

Evans, P. G. H., Q. Carson, P. Fisher, W. Jordan, R. Limer, and I. Rees. 1994. A study of the reactions of harbour porpoises to various boats in the coastal waters of southeast Shetland. European Research on Cetaceans 8:60-64.

Fair, P. A., and P. R. Becker. 2000. Review of stress in marine mammals. Journal of Aquatic Ecosystem Stress and Recovery 7(4):335-354.

Finneran, J. J. 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. The Journal of the Acoustical Society of America 138(3):1702-26.

Finneran, J. J., D. A. Carder, C. E. Schlundt, and S. H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. Journal of the Acoustical Society of America 118(4):2696-2705.

Finneran, J. J., C. E. Schlundt, R. Dear, D. A. Carder, and S. H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America 111(6):2929-2940.

Florezgonzalez, L., J. J. Capella, and H. C. Rosenbaum. 1994. Attack of killer whales (*Orcinus orca*) on humpback whales (*Megaptera novaeangliae*) on a South American Pacific breeding ground. Marine Mammal Science 10(2):218-222.

Ford, J. K. B., and R. R. Reeves. 2008. Fight or flight: antipredator strategies of baleen whales. Mammal Review 38(1):50-86.

Foreman, M. G., and Y. E. Yamanaka. 2011. Report of Working Group 20 on Evaluations of Climate Change Projections, PICES Sci. Rep. No. 40, 165 pp.

Francis, C. D., and J. R. Barber. 2013. A framework for understanding noise impacts on wildlife: An urgent conservation priority. Frontiers in Ecology and the Environment 11(6):305-313.

François, R. E., and G. R. Garrison. 1982a. Sound absorption based on ocean measurements. Part I: Pure water and magnesium sulfate contributions. J Acoust Soc Am 72:896-907.

François, R. E., and G. R. Garrison. 1982b. Sound absorption based on ocean measurements. Part II: Boric acid contribution and equation for total absorption. J Acoust Soc Am 72:1879-1890.

Frazer, L. N., and E. Mercado. 2000. A sonar model for humpback whale song. IEEE Journal of Oceanic Engineering 25(1):160-182.

Frazer, L. N., and E. Mercado III. 2000. A sonar model for humpback whale song. Ieee Journal of Oceanic Engineering 25(1):160-182.

Frid, A., and L. M. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. 6(1): 11. [online] URL: . Conservation Ecology 6(1):1-16.

Funk, D. W., R. Rodrigues, D. S. Ireland, and W. R. Koski. 2010. Joint monitoring program in the Chukchi and Beaufort seas, open water seasons, 2006–2008.

GAO. 2014. Ocean Acidification. Report to Congress, . September 2014. United States Government Accountability Office GAO 14-736. 41 p.

GeoEngineers. 2018a. Biological Assessment for the Removal of Berth II Rock Pinnacle Project, prepared by GeoEngineers for the City of Ketchikan, Ketchikan, AK, December 7, 2018.

GeoEngineers. 2018b. Marine Mammal Monitoring Plan for the Removal of Berth II Rock Pinnacle Project, prepared by GeoEngineers for the City of Ketchikan, Ketchikan, AK, December 7, 2018.

GeoEngineers. 2018c. Request for Incidental Harrassment Authorization for the Removal of Berth II Rock Pinnacle Project, prepared by GeoEngineers for the City of Ketchikan, Ketchikan, AK, December 7, 2018.

Gilly, W. F., J. M. Beman, S. Y. Litvin, and B. H. Robison. 2013. Oceanographic and Biological Effects of Shoaling of the Oxygen Minimum Zone. Annual Review of Marine Science 5:393.

Goertner, J. F. 1982. Prediction of underwater explosion safe ranges for sea mammals, NSWC TR 82-188. Naval Surface Weapons Center, Dahlgren, Virginia.

Goodwin, L., and P. A. Cotton. 2004. Effects of boat traffic on the behaviour of bottlenose dolphins (*Tursiops truncatus*). Aquatic Mammals 30(2):279-283.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M. P. Simmonds, R. Swift, and D. Thompson. 2004. A review of the effecs of seismic surveys on marine mammals. Marine Technology Society Journal 37(4):16-34.

Gordon, J., D. Thompson, D. Gillespie, M. Lonergan, S. Calderan, B. Jaffey, and V. Todd. 2007. Assessment of the potential for acoustic deterrents to mitigate the impact on marine

mammals of underwater noise arising from the construction of offshore windfarms, Commissioned by COWRIE Ltd. (project reference DETER-01-07). .

Götz, T., G. Hastie, L. T. Hatch, O. Raustein, B. L. Southall, M. Tasker, F. Thomsen, J. Campbell, and B. Fredheim. 2009. Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR Biodiversity Series.

Hain, J. H. W., S. L. Ellis, R. D. Kenney, P. J. Clapham, B. K. Gray, M. T. Weinrich, and I. G. Babb. 1995. Apparent bottom feeding by humpback whales on Stellwagen Bank. Marine Mammal Science 11(4):464-479.

Hamilton, P. K., G. S. Stone, and S. M. Martin. 1997. Note on a deep humpback whale *Megaptera novaeangliae* dive near Bermuda. Bulletin of Marine Science 61(2):491-494.

Harris, C. M., editor. 1998. Handbook of Acoustical Measurements and Noise Control. Acoustical Society of America, Woodbury, NY.

Hazen, E. L., S. Jorgensen, R. R. Rykaczewski, S. J. Bograd, D. G. Foley, I. D. Jonsen, S. A. Shaffer, J. P. Dunne, D. P. Costa, L. B. Crowder, and B. A. Block. 2012. Predicted habitat shifts of Pacific top predators in a changing climate. Nature Climate Change Letters.

HDR. 2017. Gravina Access Project Record of Decision and Final Supplemental Environmental Impact Statement DOT&PF Project No: 67698 Federal Project No: ACHP-0922(5). Prepared for the Alaska Department of Transportation and Public Facilities by HDR. As viewed December 2017 at <http://dot.alaska.gov/sereg/projects/gravina_access/index.shtml>.

HDR. 2018. Biological Assessment for the Tongass Narrows Project, prepared by HDR, Inc., for ADOT&PF, Anchorage, AK, September 4, 2018.

Hempen, G. L., T. M. Keevin, and T. L. Jordan. 2007. Underwater blast pressures from a confined rock removal during the Miami Harbor Deepening Project. In Proceedings of the Thirty-third Annual Conference on Explosives and Blasting Technique, Nashville, Tennessee. International Society of Explosive Engineers, Cleveland (p. 23-32). .

Hewitt, R. P. 1985. Reaction of dolphins to a survey vessel: Effects on census data. Fishery Bulletin 83(2):187-193.

Hill, S. H. 1978. Guide to the effects of underwater shock waves on Arctic marine mammals and fish. Canada Department of Fisheries and the Environment, Pacific Marine Science Report, 78-26.

IPCC. 2013a. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, United Kingdom and New York, NY.

IPCC. 2013b. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, New York, NY.

IPCC. 2014a. Climate change 2014: Impacts, adaptation, and vulnerability. IPCC Working Group II contribution to AR5. Intergovernmental Panel on Climate Change.

IPCC, editor. 2014b. Summary for policymakers. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

ISO (International Organization for Standardization). 2003. Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures (ISO 1996-1:2003(E)). International Organization for Standardization, Geneva.

Jeffries, M. O., J. Richter-Menge, and J. E. Overland, Eds. 2014. Arctic report card 2014, Available online at: http://www.arctic.noaa.gov/reportcard.

Jensen, A., M. Williams, L. Jemison, and K. Raum-Suryan. 2009. Somebody untangle me! Taking a closer look at marine mammal entanglement in marine debris. Pages pp. 63-69 *in* M. Williams, and E. Ammann, editors. Marine Debris in Alaska: coordinating our efforts, volume 09-01. Alaska Sea Grant College Program, University of Alaska Fairbanks.

Jensen, A. S., and G. K. Silber. 2004. Large whale ship strike database. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

Jessop, T. S., A. D. Tucker, C. J. Limpus, and J. M. Whittier. 2003. Interactions between ecology, demography, capture stress, and profiles of corticosterone and glucose in a free-living population of Australian freshwater crocodiles. Gen Comp Endocrinol 132(1):161-170.

Johnson, J. H., and A. A. Wolman. 1984. The Humpback Whale, *Megaptera novaeangliae*. Marine Fisheries Review 46(4):300-337.

Kastak, D., J. Mulsow, A. Ghoul, and C. Reichmuth. 2008. Noise-induced permanent threshold shift in a harbor seal. Journal of the Acoustical Society of America 123:2986.

Kastak, D., R. J. Schusterman, B. L. Southall, and C. J. Reichmuth. 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of the Acoustical Society of America 106(2):1142-1148.

Keeling, R. F., A. Körtzinger, and N. Gruber. 2010. Ocean deoxygenation in a warming world. Annual Review of Marine Science 2(1):199-229.

Ketten, D. R. 1997. Structure and function in whale ears. Bioacoustics 8:103-135.

Koski, W. R., D. W. Funk, D. S. Ireland, C. Lyons, K. Christie, A. M. Macrander, and S. B. Blackwell. 2009. An update on feeding by bowhead whales near an offshore seismic survey in the central Beaufort Sea.

Krieger, K., and B. L. Wing. 1984. Hydroacoustic surveys and identifications of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, southeastern Alaska, Summer 1983. U.S. Department of Commerce, NMFS/NWC-66.

Kruse, S. 1991. The interactions between killer whales and boats in Johnstone Strait, B.C. K. Pryor, and K. Norris, editors. Dolphin Societies - Discoveries and Puzzles. University of California Press, Berkeley, California.

Kryter, K. D. 1985. The handbook of hearing and the effects of noise, 2nd edn. . Academic Press., Orlando, FL.

Kryter, K. D., W.D. Ward, J.D. Miller, and D.H. Eldredge. 1966. Hazardous Exposure to Intermittent and Steady-State Noise. Journal of the Acoustical Society of America 39:451-464.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17(1):35-75.

Lambertsen, R. H. 1992. Crassicaudosis: a parasitic disease threatening the health and population recovery of large baleen whales. Rev. Sci. Technol., Off. Int. Epizoot. 11(4):1131-1141.

Lankford, S., T. Adams, R. Miller, and J. Cech Jr. 2005. The cost of chronic stress: impacts of a nonhabituating stress response on metabolic variables and swimming performance in sturgeon. Physiological and Biochemical Zoology 78(4):599-609.

Lefebvre, K. A., L. Quakenbush, E. Frame, K. B. Huntington, G. Sheffield, R. Stimmelmayr, A. Bryan, P. Kendrick, H. Ziel, T. Goldstein, J. A. Snyder, T. Gelatt, F. Gulland, B. Dickerson, and V. Gill. 2016. Prevalence of algal toxins in Alaskan marine mammals foraging in a changing arctic and subarctic environment. Harmful Algae 55:13-24.

Lord, A., J. R. Waas, J. Innes, and M. J. Whittingham. 2001. Effects of human approaches to nests of northern New Zealand dotterels. Biological Conservation 98(2):233-240.

Lusseau, D. 2003. Effects of tour boats on the behavior of bottlenose dolphins: Using Markov chains to model anthropogenic impacts. Conservation Biology 17(6):1785-1793.

Lusseau, D. 2006. The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand. Marine Mammal Science 22(4):802-818.

Lusseau, D., and L. Bejder. 2007. The long-term consequences of short-term responses to disturbance: experiences from whalewatching impact assessment. International Journal of Comparative Psychology 20(2):228-236.

Lusseau, D., R. Williams, B. Wilson, K. Grellier, T. R. Barton, P. S. Hammond, and P. M. Thompson. 2004. Parallel influence of climate on the behaviour of Pacific killer whales and Atlantic bottlenose dolphins. Ecology Letters 7:1068-1076.

Macleod, C. D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: A review and synthesis. Endangered Species Research 7(2):125-136.

Magalhaes, S., R. Prieto, M. A. Silva, J. Goncalves, M. Afonso-Dias, and R. S. Santos. 2002. Short-term reactions of sperm whales (*Physeter macrocephalus*) to whale-watching vessels in the Azores. Aquatic Mammals 28(3):267-274.

McDonald, M. A., J. A. Hildebrand, and S. M. Wiggins. 2006. Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. Journal of the Acoustical Society of America 120(2):711-718.

Melcon, M. L., A. J. Cummins, S. M. Kerosky, L. K. Roche, S. M. Wiggins, and J. A. Hildebrand. 2012. Blue whales respond to anthropogenic noise. PLoS One 7(2):e32681.

Miller, J. D. 1974. Effects of noise on people. Journal of the Acoustical Society of America 56:729-764.

Moberg, G. P. 1987. Influence of the adrenal axis upon the gonads. Pages 456-496 *in* J. Clarke, editor. Oxford Reviews in Reproductive Biology. Oxford University Press, New York.

Moberg, G. P. 2000. Biological response to stress: implications for animal welfare. The biology of animal stress: basic principles and implications for animal welfare:1-21.

Moran, J. R., R. A. Heintz, J. M. Straley, and J. J. Vollenweider. 2018. Regional variation in the intensity of humpback whale predation on Pacific herring in the Gulf of Alaska. Deep Sea Research Part II: Topical Studies in Oceanography 147:187-195.

Morete, M. E., T. L. Bisi, and S. Rosso. 2007. Mother and calf humpback whale responses to vessels around the Abrolhos Archipelago, Bahia, Brazil. Journal of Cetacean Research and Management 9(3):241-248.

Murray, C. S., A. Malvezzi, C. J. Gobler, and H. Baumann. 2014. Offspring sensitivity to ocean acidification changes seasonally in a coastal marine fish. Marine Ecology Progress Series 504:1-11.

Muto, M. M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite,

and A. N. Zerbini. 2018. Alaska marine mammal stock assessments, 2017. NOAA Tech. Memo. NMFS-AFSC-378, Alaska Fisheries Science Center 7600 Sand Point Way N.E. Seattle, WA 98115.

Naessig, P. J., and J. M. Lanyon. 2004. Levels and probable origin of predatory scarring on humpback whales (*Megaptera novaeangliae*) in east Australian waters. Wildlife Research 31(2):163-170.

NCEI. 2016. State of the climate: global analysis for annual 2015. National Centers for Environmental Information, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Published online at: http://www.ncdc.noaa.gov/sotc/global/201513.

Neilson, J., C. Gabriele, J. Straley, S. Hills, and J. Robbins. 2005. Humpback whale entanglement rates in southeast Alaska. Pages 203-204 *in* Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. Summary of reported whale-vessel collisions in Alaskan waters. Journal of Marine Biology:106282.

Ng, S. L., and S. Leung. 2003. Behavioral response of Indo-Pacific humpback dolphin (*Sousa chinensis*) to vessel traffic. Marine Environmental Research 56(5):555-567.

NIOSH (National Institute for Occupational Safety and Health). 1998. Criteria for a recommended standard: Occupational noise exposure. United States Department of Health and Human Services, Cincinnati, OH.

NMFS. 2016. Occurrence of Distinct Population Segments (DPSs) of Humpback Whales off Alaska. National Marine Fisheries Service, Alaska Region. Revised December 12, 2016.

NMFS. 2018a. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p. .

NMFS. 2018b. Endangered Species Act Section 7 biological opinion for listed species under the jurisdiction of the National Marine Fisheries Service for the Ketchikan Dock Company Berth IV expansion projects in Tongass Narrows, Ketchikan, Alaska. Alaska Region, Protected Resources Division, Juneau, AK.

NMFS. 2019. Essential Fish Habitat conservation recommendations for Ketchikan pinnacle blasting, Alaska Region Habitat Conservation Division, May 21, 2019.

Nonacs, P., and L. M. Dill. 1990. Mortality Risk vs. Food Quality Trade-Offs in a Common Currency: Ant Patch Preferences. Ecology 71(5):1886-1892.

Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2):81-115.

Nowacek, S. M., R. S. Wells, and A. R. Solow. 2001. Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. Marine Mammal Science 17(4):673-688.

NRC. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. Committee on Characterizing Biologically Significant Marine Mammal Behavior; Ocean Studies Board; Division on Earth and Life Studies; National Research Council, The National Academies Press, Washington, D.C.

NRC. 2012. Climate change: evidence, impacts, and choices. Answers to common questions about the science of climate change. National Research Council of the National Academies.

Nuka Research and Planning Group, L. 2012. Southeast Alaska Vessel Traffic Study, July 23, 2012, Revision 1.

Okey, T. A., H. M. Alidina, V. Lo, and S. Jessen. 2014. Effects of climate change on Canada's Pacific marine ecosystems: a summary of scientific knowledge. Review of Fish Biology and Fisheries 24:519-559.

Oreskes, N. 2004. Beyond the ivory tower. The scientific consensus on climate change. Science 306(5702):1686.

Overland, J. E., and M. Wang. 2007. Future climate of the North Pacific Ocean. Eos, Transactions American Geophysical Union 88(16):178-182.

Parks, S. E. 2003. Response of North Atlantic right whales (*Eubalaena glacialis*) to playback of calls recorded from surface active groups in both the North and South Atlantic. Marine Mammal Science 19(3):563-580.

Parks, S. E. 2009. Assessment of acoustic adaptations for noise compensation in marine mammals. Office of Naval Research.

Payne, K., and R. Payne. 1985. Large scale changes over 19 years in songs of humpback whales in Bermuda. Zeitschrift fur Tierpsychologie 68(2):89-114.

Payne, R. 1978. A note on harassment. Pages 89-90 *in* K. S. Norris, and R. R. Reeves, editors. Report on a workshop on problems related to humpback whals (*Megaptera novaeangliae*) in Hawaii. Sea Life Inc., Makapuu Pt., HI.

Payne, R. S. 1970. Songs of the humpback whale. Capitol Records, Hollywood, CA.

Perry, S. L., D. P. DeMaster, and G. K. Silber. 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61(1):1-74.

Price, C. S., E. Keane, D. Morin, C. Vaccaro, D. Bean, and J. A. Morris. 2017. Protected species and marine aquaculture interactions. NOAA Technical Memorandum NOS NCCOS 211:85 pp.

Reine, K., D. Clarke, and C. Dickerson. 2012. Characterization of underwater sounds produced by a backhoe dredge excavating rock and gravel. DTIC Document.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. 1995. Marine Mammals and Noise. Academic Press, Inc., San Diego, CA.

Richter, C., S. Dawson, and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. Marine Mammal Science 22(1):46-63.

Rolland, R. M., K. E. Hunt, S. D. Kraus, and S. K. Wasser. 2005. Assessing reproductive status of right whales (*Eubalaena glacialis*) using fecal hormone metabolites. Gen Comp Endocrinol 142(3):308-17.

Rolland, R. M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B: Biological Sciences 279(1737):2363-2368.

Romano, T. A., D. Felten, S. Stevens, J. Olschowka, V. Quaranta, and S. H. Ridgway. 2002a. Immune response, stress, and environment: Implications for cetaceans. Pages 253-279 *in* C. J. Pfeiffer, editor. Molecular and Cell Biology of Marine Mammals. Krieger Publishing Co., Malabar, FL.

Romano, T. A., M. J. Keogh, and K. Danil. 2002b. Investigation of the effects of repeated chase and encirclement on the immune system of spotted dolphins (Stenella attenuata) in the eastern tropical Pacific, NOAA National Marine Fisheries Service, SWFSC Administrative Report LJ-02-35C, La Jolla, CA.

Romano, T. A., M. J. Keogh, C. Kelly, P. Feng, L. Berk, C. E. Schlundt, D. A. Carder, and J. J. Finneran. 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences 61(7):1124-1134.

Salden, D. R. 1988. Humpback whale encounter rates offshore of Maui, Hawaii. Journal of Wildlife Management 52(2):301-304.

Salden, D. R. 1993. Effects of research boat approaches on humpback whale behavior off Maui, Hawaii, 1989-1993. Pages 94 *in* Tenth Biennial Conference on the Biology of Marine Mammals, Galveston, Texas.

Salinger, M. J., J. D. Bell, K. Evans, A. J. Hobday, V. Allain, K. Brander, P. Dexter, D. E. Harrison, A. B. Hollowed, B. Lee, and R. Stefanski. 2013. Climate and oceanic fisheries: recent observations and projections and future needs. Climatic Change 119(1):213-221.

Schaffar, A., B. Madon, C. Garrigue, and R. Constantine. 2013. Behavioural effects of whale-watching activities on an endangered population of humpback whales wintering in New Caledonia. Endangered Species Research 19(3):245-254.

Schlundt, C. E., J. J. Finneran, D. A. Carder, and S. H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterus leucas*, after exposure to intense tones. Journal of the Acoustical Society of America 107(6):3496-3508.

Secretariat of the Convention on Biological Diversity. 2014. An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity, Montreal, Technical Series No. 75, 99 pp.

Serreze, M. C., and R. G. Barry. 2011. Processes and impacts of Arctic amplification: a research synthesis. Global and Planetary Change 77(1):85-96.

Seyle, H. 1950. Stress and the general adaptation syndrome. British Medical Journal 17:1383-1392.

Sharpe, F. A., and L. M. Dill. 1997. The behavior of Pacific herring schools in response to artificial humpback whale bubbles. Canadian Journal of Zoology-Revue Canadienne De Zoologie 75(5):725-730.

Silber, G. K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*). Canadian Journal of Zoology-Revue Canadienne De Zoologie 64(10):2075-2080.

Simmonds, M. P., and W. J. Eliott. 2009. Climate change and cetaceans: Concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom 89(1):203-210.

Simmonds, M. P., and S. J. Isaac. 2007. The impacts of climate change on marine mammals: Early signs of significant problems. Oryx 41(1):19-26.

Sobeck. 2016. Revised Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions. Memorandum for NMFS Assistant Administrator for Fisheries to NMFS Leadership Council, June 2016, 10 p.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene Jr., D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4):411-521.

Stimpert, A. K., D. N. Wiley, W. W. L. Au, M. P. Johnson, and R. Arsenault. 2007. 'Megapclicks': Acoustic click trains and buzzes produced during night-time foraging of humpback whales (Megaptera novaeangliae). Biology Letters 3(5):467-470.

Straley, J. M. 1990. Fall and winter occurrence of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. Report of the International Whaling Commission Special Issue 12:319-323.

Straley, J. M., J. R. Moran, K. M. Boswell, J. J. Vollenweider, R. A. Heintz, T. J. Quinn Ii, B. H. Witteveen, and S. D. Rice. 2018. Seasonal presence and potential influence of humpback whales on wintering Pacific herring populations in the Gulf of Alaska. Deep Sea Research Part II: Topical Studies in Oceanography 147:173-186.

Thompson, P. O., W. C. Cummings, and S. J. Ha. 1986. Sounds, source levels, and associated behavior of humpback whales, Southeast Alaska. Journal of the Acoustical Society of America 80(3):735-740.

Thompson, T. J., H. E. Winn, and P. J. Perkins. 1979. Mysticete sounds. Pages 403-431 *in* H. E. Winn, and B. L. Olla, editors. Behavior of Marine Animals: Current Perspectives in Research Vol. 3: Cetaceans. Plenum Press, New York, NY.

Todd, V. L. G., I. B. Todd, J. C. Gardiner, E. C. N. Morrin, N. A. MacPherson, N. A. DiMarzio, and F. Thomsen. 2015. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science 72(2):328-340.

Tyack, P., and H. Whitehead. 1983. Male competition in large groups of wintering humpback whales. Behaviour 83(1/2):132-154.

Tyack, P. L. 1981. Interactions between singing Hawaiian humpback whales and conspecifics nearby. Behavioral Ecology and Sociobiology 8:105-116.

Urick, R. J. 1983. Principles of Underwater Sound. McGraw-Hill.

van der Hoop, J. M., P. Corkeron, J. Kenney, S. Landry, D. Morin, J. Smith, and M. J. Moore. 2016. Drag from fishing gear entangling North Atlantic right whales. Marine Mammal Science 32(2):619-642.

Vanderhoof, L., and M. Carls. 2012. Southeast Alaska Long-term Seawater Monitoring Program for Ocean Acidification, Alaska Marine Science Symposium, Anchorage, Alaska.

Viada, S. T., R. M. Hammer, R. Racca, D. Hannay, M. J. Thompson, B. J. Balcom, and N. W. Phillips. 2008. Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. Environmental Impact Assessment Review 28(4):267-285.

Vu, E. T., D. Risch, C. W. Clark, S. Gaylord, L. T. Hatch, M. A. Thompson, D. N. Wiley, and S. M. Van Parijs. 2012. Humpback whale song occurs extensively on feeding grounds in the western North Atlantic Ocean. Aquatic Biology 14(2):175-183.

Wade, P. R., T. J. Quinn II, J. Barlow, C. S. Baker, A. M. Burdin, J. Calambokidis, P. J. Clapham, E. Falcone, J. K. B. Ford, C. M. Gabriele, R. Leduc, D. K. Mattila, L. Rojas-Bracho, J. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, and M. Yamaguchi. 2016. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. Paper SC/66b/IA21 submitted to the Scientific Committee of the International Whaling Commission, June 2016, Bled, Slovenia. Pages 42 p. *in*. International Whaling Commission.

Ward, W. D. 1997. Effects of high-intensity sound. Pages 1497-1507 *in* M. J. Crocker, editor. Encyclopedia of Acoustics, Vol. III. Wiley & Sons, New York.

Warner, G., and M. E. Austin. 2016. Alaska DOT Hydroacoustic Pile Driving Noise Study: Ketchikan Monitoring Results. JASCO Document 01167, Version 1.0. Technical report by JASCO Applied Sciences for Alaska Department of Transportation and Public Facilities.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill. 2003. Factors Affecting the Responses of Marine Mammals to Acoustic Disturbance. Marine Technology Society Journal 37(4):6-15.

Watson, R. T., and D. L. Albritton. 2001. Climate change 2001: Synthesis report: Third assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Weilgart, L. S. 2007. A brief review of known effects of noise on marine mammals. International Journal of Comparative Psychology 20(2).

Weston, D. E. 1960. Underwater explosions as acoustic sources. Proc. Phys. Soc. 76:233-249.

Whitehead, H., and C. Glass. 1985. Orcas (killer whales) attack humpback whales. . Journal of Mammalogy 66(1):183-185.

Wieting, D. 2016. Interim Guidance on the Endangered Species Act Term "Harass". National Marine Fisheries Service, Office of Protected Resources. Silver Spring, MD. October 21, 2016.

Williams, R., D. E. Bain, J. K. B. Ford, and A. W. Trites. 2002. Behavioural responses of male killer whales to a 'leapfrogging' vessel. Journal of Cetacean Research and Management 4(3):305-310.

Winn, H. E., P. J. Perkins, and T. C. Poulter. 1970a. Sounds of the humpback whale. Pages 39-52 *in* 7th Annual Conference on Biological Sonar and Diving Mammals, Stanford Research Institute, Menlo Park.

Winn, H. E., P. J. Perkins, and T. C. Poulter. 1970b. Sounds of the humpback whale. Pages 39-52 *in* Seventh Annual Conference on Biological Sonar and Diving Mammals, Stanford Research Institute, Menlo Park, California.

Wursig, B., S. K. Lynn, T. A. Jeffereson, and K. D. Mullin. 1998. Behaviour of cetaceans in the northen Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals 24.1:41-50.

Yelverton, J. T., D. R. Richmond, E. R. Fletcher, and R. K. Jones. 1973. Safe distances from underwater explosions for mammals and birds. Report prepared by Lovelace Foundation for Medical Education and Research for the Defense Nuclear Agency, Contract Nos. DASA 01-70C-0075 and DASA 01-71C-0013, 67 p.

Zimmer, W. M. X., and P. L. Tyack. 2007. Repetitive shallow dives pose decompression risk in deep-diving beaked whales. Marine Mammal Science 23(4):888-925.