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 Section 7(a)(2) Biological Opinion
Auke Bay Ferry Terminal Modifications Project, Juneau, Alaska

NMFS Consultation Number: AKRO-2019-02254

Action Agencies: Alaska Department of Transportation and Public Facilities

Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, NOAA

Affected Species and Determinations:

ESA-Listed Species	Status	Is the Action Likely to Adversely Affect Species?	Is the Action Likely to Adversely Affect Critical Habitat?	Is the Action Likely To Jeopardize the Species?	Is the Action Likely To Destroy or Adversely Modify Critical Habitat?
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	Yes	N/A	No	N/A
Sperm Whale (*Physeter macrocephalus*)	Endangered	No	N/A	No	N/A
Steller Sea Lion, Western DPS (*Eumetopias jubatus)*	Endangered	Yes	No	No	No

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By:

for
James W. Balsiger, Ph.D.
Regional Administrator

Date: October 3, 2019

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TERMS AND ABBREVIATIONS

ADOT&PF	Alaska Department of Transportation and Public Facilities
CFR	Code of Federal Regulations
CI	Confidence Interval
CWA	Clean Water Act
dB	decibel
DPS	distinct population segment
DTH	down-the-hole
EIS	environmental impact statement
ESA	Endangered Species Act
ESCA	Endangered Species Conservation Act
FR	Federal Register
IHA	incidental harassment authorization
in	inch
ITS	Incidental take statement
kHz	kilohertz
km	kilometer
kts	knots
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
Opinion	this biological opinion
p-p	peak-to-peak
PAM	passive acoustic monitoring
PBF	physical or biological features
PCE	primary constituent element
PR1	NMFS Office of Protected Resources, Permits and Conservation Division
PSO	protected species observer
PTS	permanent threshold shift
rms	root mean square
SEL	Sound exposure level
SSV	sound source verification
TTS	temporary threshold shift
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
ZOI	zone of influence
μPa	micropascal
0-p	peak

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, 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)(1)).

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.

In this document, the action agencies are the Alaska Department of Transportation and Public Facilities (ADOT&PF), acting on behalf of the U.S. Department of Transportation and proposing construction activities associated with the Auke Bay Ferry Terminal Modifications and Improvements Project, and the NMFS Office of Protected Resources, Permits and Conservation Division (PR1), which proposes to issue an incidental harassment authorization (IHA), pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. § 1361 *et seq.*), to ADOT for the harassment of marine mammals incidental to construction operations (84 FR 22453). The consulting agency for this proposal is NMFS's Alaska Region. This document represents NMFS's Biological Opinion (Opinion) on the effects of this proposal on endangered and threatened species.

The Opinion and ITS were prepared by NMFS in accordance with section 7(b) of the ESA (16 U.S.C. §§ 1531-1544), and implementing regulations at 50 CFR §402.

The 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 is based on information provided to us in the February 2019 IHA application and marine mammal monitoring and mitigation plan(HDR 2019a), Biological Assessment (HDR 2019b), and the proposed IHA (84 FR 22453). Other sources of information relied upon included updated project proposals, emails and telephone conversations among NMFS Alaska Region, PR1, and ADOT&PF. A complete record of this consultation is on file at NMFS's office in Juneau, Alaska.

The proposed action involves the modification of the existing dolphin structures at the Auke Bay Ferry Terminal located along the north shore of Auke Bay in Juneau, AK (Figure 1).

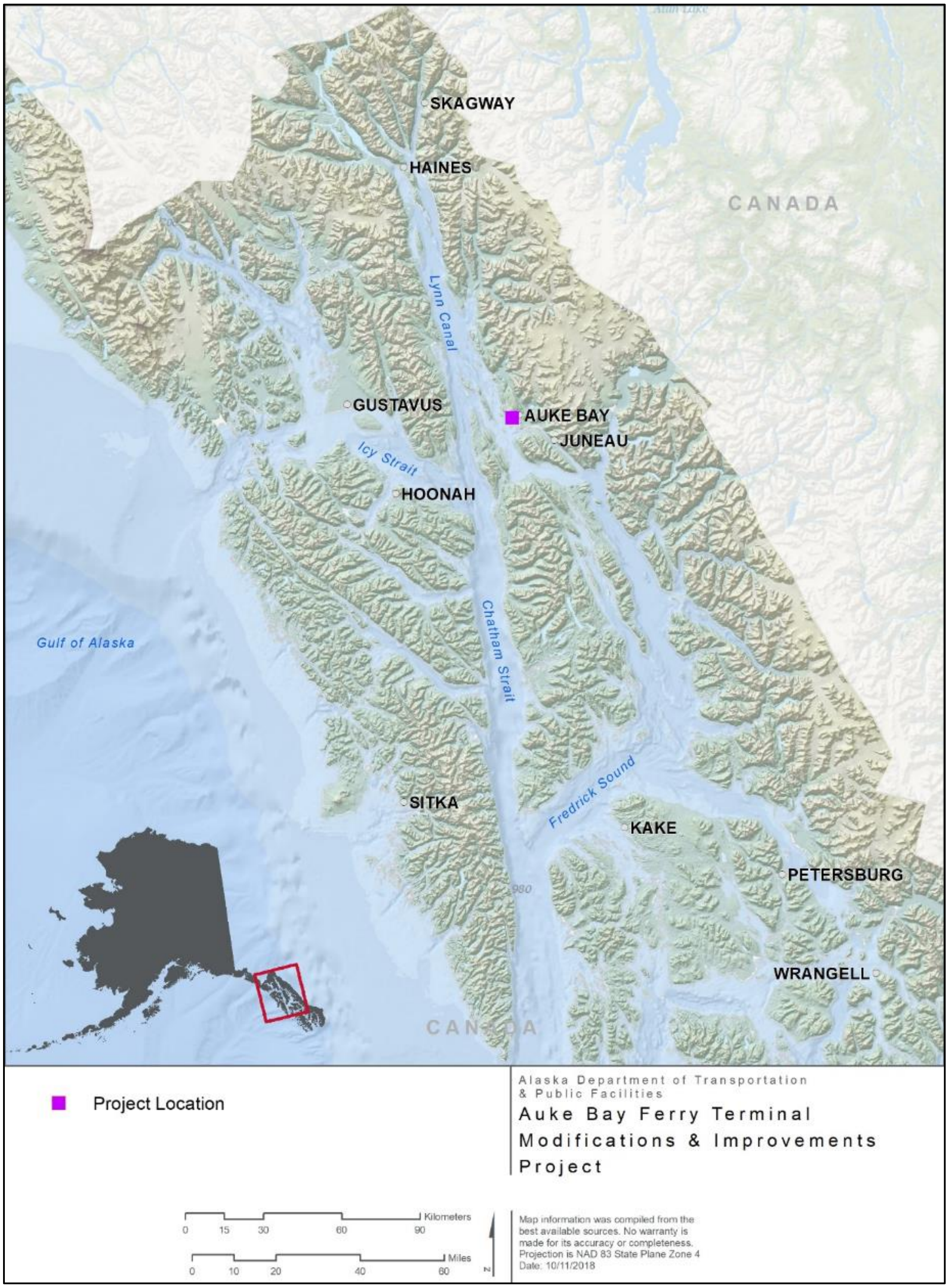

Figure 1. Vicinity Map of Auke Bay Ferry Terminal Modifications & Improvements Project (HDR 2019a).

This opinion considers the effects of the modification of the existing ferry terminal, and the associated proposed issuance of an IHA. These actions may affect the following species: Mexico distinct population segment (DPS) humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and western DPS Steller sea lions (*Eumetopias jubatus*). No designated critical habitat is located within the action area. The nearest designated critical habitat, for Steller sea lions, is Benjamin Island located ~27 km northwest of the project area.

1.2 Consultation History

Our communication with PR1 and ADOT&PF regarding this consultation is summarized as follows:

- **January 16, 2019:** ADOT&PF submitted IHA application and Draft Biological Assessment.
- **January 28, 2019:** NMFS received formal section 7 consultation initiation request from ADOT&PF (ADOT&PF 2019c) (receipt was delayed due to a lapse in appropriations and resulting partial government shutdown).
- **February 14, 2019:** ADOT&PF submitted revised IHA application
- **March 8, 2019:** ADOT&PF submitted Marine Mammal Monitoring and Mitigation Plan
- **March 15, 2019:** NMFS determined that initiation package was sufficient, and initiated consultation with ADOT&PF
- **April 10, 2019:** NMFS submitted an additional information request on the revised IHA application.
- **April 11, 2019**: ADOT&PF submitted revised IHA application
- **May 3, 2019:** NMFS's PR1 submitted a request to initiate formal section 7 consultation (NMFS 2019)
- **June 26, 2019:** ADOT&PF proposed changes to the project description
- **July 9, 2019:** NMFS's PR1 submitted revised take numbers based on proposed changes to the project.

2 DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

2.1 Proposed Action

"Action" 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 (50 CFR §402.02). There are no interdependent or interrelated activities associated with this action. All activities that would not occur but for the action are addressed in this Opinion.

This opinion considers the effects of ADOT&PF's modification and operation of the ferry terminal, as well as NMFS PR1's issuance of an IHA to take marine mammals by harassment under the MMPA incidental to these actions in Auke Bay near Juneau, AK, between January 2020 and June 2020.

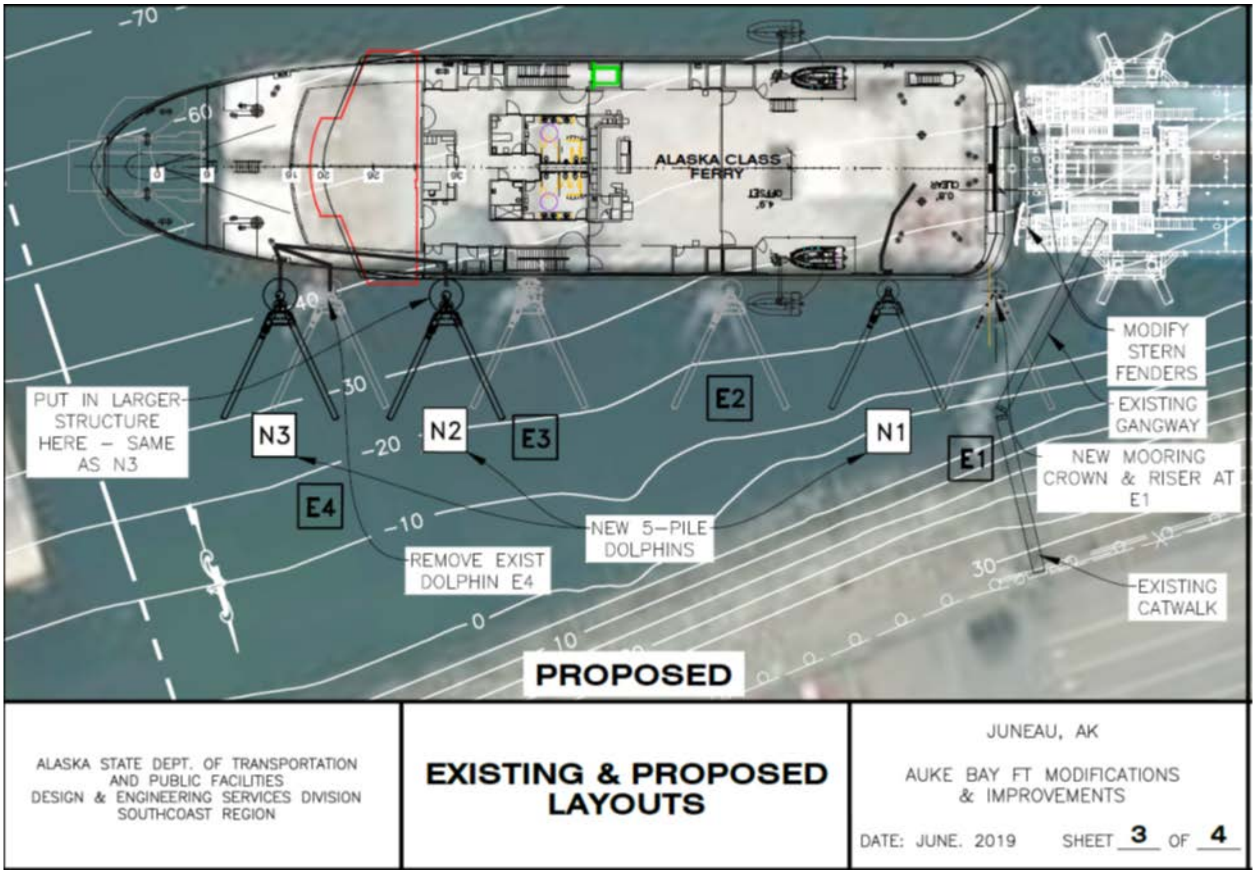

Figure 2. **Site Plan for the proposed Auke Bay Ferry Terminal Modifications Project (ADOT&PF 2019b)**

2.1.1 Terminal Modifications

ADOT&PF is proposing to modify and improve the existing dolphin structures at the Auke Bay Ferry Terminal located along the north shore of Auke Bay in Juneau, AK (Figure 2). There are currently three Alaska Marine Highway System ferry berths in Auke Bay. The proposed project will involve the East Stern Berth facility, which was originally constructed in 2003 to accommodate new fast vehicle ferries. The East Stern Berth must be renovated to accommodate two new Alaska-class ferries. M/V Tazlina entered service in May 2019, and another ferry is scheduled for fall 2019. These new ferries will functionally replace the M/V Malsaspina summer service in Lynn Canal (ADOT&PF 2019a). One existing dolphin at the ferry terminal will be removed using a vibratory driver, and three breasting dolphins will be installed using both vibratory and impact hammers. Vibratory pile removal and installation and impact pile installation would introduce underwater sounds at levels that may result in take, by Level B harassment, of marine mammals in Auke Bay.

The Project will involve the removal of one existing five-pile dolphin and construction of three new five-pile dolphins. A total of five piles will be removed and fifteen piles will be installed. Construction will include impact and vibratory installation of steel pipe piles that are 24 or 30 inches in diameter, and vibratory removal of steel pipe piles that are 20 or 24 inches in diameter (Table 1). Nine piles will be installed vertically (plumb), and six will be installed at an angle (battered). Piles will be advanced to refusal using a vibratory hammer, and the final approximately 10 feet of driving will be conducted using an impact hammer so that the structural capacity of the pile embedment can be verified. The pile installation methods used will depend on sediment depth and conditions at each pile location.

A drilled soil anchor will be used to secure approximately 12 of the piles to the glacial till layer to withstand uplift forces. Anchors will be installed within some of the pipe piles and drilled into dense glacial till below the elevation of the pile tip after the pile has been driven through the overlying sediment layer to refusal. An 8-inch diameter steel pipe casing is inserted inside the larger diameter production pile (24 or 30 inch piles) and driven into the glacier till layer. A drill bit attached to a stem rod is then inserted into the steel pipe casing and a 6- to 8-inch diameter hole is drilled into the soil with rotary and percussion drilling methods. The drilling work is contained within the steel pipe casing and the steel pipe pile. The typical depth of the drilled hole varies, but an anticipated depth of 30 feet or more is expected to be necessary. Drill fragments will be removed through the top of the casing with compressed air. After drilling, a steel anchor rod is then grouted into the drilled hole and affixed to the top of the pile. Drilled soil anchors would be installed within all dolphin piles except the fender piles, for a total of twelve piles.

Above-water work will consist of improvement and retrofitting to the dock-attached stern fenders. Additionally, a new mooring crown and riser will be installed. Existing utilities, including electrical will be replaced and improved. No in-water noise is anticipated in association with above-water and upland construction activities.

2.1.2 Dates and Duration of Activities

Construction is scheduled to begin sometime between January and June 2020. Once begun, the work window would be about two months, with in-water work occurring intermittently for 14 days. Pile driving will be intermittent during this period, depending on weather, construction and mechanical delays, and logistical constraints. Pile installation and removal can occur at variable rates, from a few minutes to several hours per day. Vibratory pile installation and removal will occur over 14 non-consecutive days within the 6-month construction window. Impact installation may occur intermittently on 10 of those 14 days.

ADOT&PF estimates that one to three piles could be installed per day. To account for inefficiencies and delays, ADOT&PF estimates a mean installation and removal rate of 1.5 piles per day.

Table 1 estimates the amount of time required for pile installation.

Table 1. Numbers and Types of Piles to be Installed and Removed (HDR 2019a).

Steel pipe pile size and driving method	Number of piles	Strikes per pile (impact driving)	Duration per pile (minutes) (vibratory driving)	Piles per day (range)	Days of activity
Pile installation					
30-inch vibratory	6	N/A	45	1.5 (1-3)	4
24-inch vibratory	9	N/A	45	1.5 (1-3)	6
30-inch impact	6	400	N/A	1.5 (1-3)	4
24-inch impact	9	400	N/A	1.5 (1-3)	6
Pile removal					
24-inch vibratory	3	N/A	30	1.5	2
20-inch vibratory	2	N/A	30	1.5	2
Total piles	20	-	-	Total days	14

Materials would be brought to the site primarily by barge. ADOT&PF expects two barges at most- one material barge and another barge used as an equipment barge (crane). Barges would be tended by at least one tug. ADOT&PF expects these vessels will be used as temporary moorage in Auke Bay, out of the way of shipping lanes and ferry traffic. Barges could be 60’-80’ wide and 200’ in length. Tugs would be approximately 40’-60’ in length. One or two work skiffs under 24’ in length will be used as smaller support boats.

2.1.3 Acoustic Sources

Acoustic sources associated with this project include vibratory pile driving, impact pile driving, and drilling. Each of these elements generates in-water and in-air noise.

Depending on the contractor, a number of hammer types may be used. The following are common pile installation equipment that have been used in the past. :

- Impact hammers: Vulcan 512 / Max Energy 60,000 foot pounds (ft-lbs); Vulcan 06/Max Energy 19,000 ft-lbs; ICE / Max Energy 19,500-60,000 ft-lbs; Delmag D30 / Max Energy 69,000 ft-lbs; Hydrohammer SC-200/ Max energy: 200 kNm,
- Vibratory hammers: APE 200-6, Frequency: 50 vpm, Force: 2270 kN,
- Rock Anchor Drill: ICE 30-30,000 ft-pound

Vibratory Hammer

Vibratory hammering is anticipated to be the predominant installation method. Generally, the pile is placed into position using a choker and crane, and then vibrated at between 1,200 and 2,400 vibrations per minute. The vibrations liquefy the sediment surrounding the pile allowing it to penetrate to the required seating depth, or to be removed. The pile driving equipment anticipated for vibratory hammer is an APE 200-6, or similar.

Sound pressure levels (SPLs)[1] are expressed in root mean square[2] (RMS). Source level broadband SPLs for vibratory hammering 30-inch piles for the project are based on measurements from the 2015 ADOT&PF Auke Bay Ferry Terminal modernization project. (Denes et al. 2016)Source level Broadband SPLs for vibratory hammering 24 inch piles were based on acoustic modeling of nearshore marine pile driving at Navy installations in Puget Sound (Navy 2015). Based on this information, we anticipate a source level RMS of 168 dB re 1 uPa at 10 m for vibratory hammering 30 inch piles, and 161 dB re 1 uPa at 10 m for 24 inch piles.

Impact Hammer

An impact hammer is a steel device that works like a piston. The pile is first moved into position and set in the proper location using a choker cable or vibratory hammer. The impact hammer is held in place by a guide (lead) that aligns the hammer with the pile. A heavy piston moves up and down, striking the top of the pile and driving it into the substrate. The proposed action anticipates using a Hydrohammer SC-200 as the largest impact hammer.

Source level broadband SPLs for impact hammering 30-inch piles for the project are based on measurements of driving 30-inch steel piles at the Auke Bay Ferry Terminal modernization project (Denes et al. 2016). The source level for impact installation of 24-inch piles is based on the averaged source level of the same type of pile reported by California Department of Transportation (Caltrans) in a pile driving source level compendium document (Caltrans 2015). Based on this information, we anticipate a source level RMS of 177 SEL dB re 1 μPa2s at 10 m and 191 SPL dB re 1 μPa at 10 m for impact hammering 30 inch piles. For 24 inch piles we anticipate a source level RMS of 177 SEL dB re 1 μPa2s at 10 m and 190 SPL dB re 1 μPa at 10 m. For more detail on the description of Level A and Level B impacts, see Section 6.1.2.2 Acoustic Thresholds.

Soil Anchor Drill

Underwater noise from soil anchor installation is anticipated to be low considering the double encasement surrounding the drill rod and the depth of the overlying sediments. The glacial till layer is overlain with 35 to 75 feet of sediments, and is expected to attenuate noise production from drilling and reduce noise propagation into the water column. Additionally, the casing used

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[1] 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 level in acoustics is 1 μPa, and the units for underwater sound pressure levels are decibels (dB) re 1 μPa.

[2] Root mean square (rms) is the square root of the arithmetic average of the squared instantaneous pressure values.

during drilling is inside the larger diameter pile, further reducing noise levels. The pile that the casing and drill will be lowered into will serve as a cofferdam and prevent drilling noise from propagating through the water column.

Up to 12 of the piles would require internal tension anchors. Noise associated with drilling an 8-in diameter hole extending about 50 ft into bedrock below the tip of the pile is anticipated to be contained entirely within the piling and is not anticipated to reach or exceed the 120 dB threshold for continuous noise sources (McLean, pers. comm. 2017).

An air impact hammer may be used to install the soil anchor.. These additional strikes are conservatively accounted for in the total estimated strikes per pile (400) for the outer production piles (Table 1).

2.1.4 Mitigation Measures

ADOT&PF Proposed Mitigation Measures

The ADOT&PF has incorporated a number of measures into the project design and construction plan that will avoid or minimize potential impacts to ESA-listed species in the action area, including:

- 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.
- 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.
- The contractor will provide and maintain a spill cleanup kit on-site at all times, to be used as part of the Spill Prevention, Control, and Countermeasure (SPCC) Plan, as well as the Hazardous Material Control Plan (HMCP) in the event of a spill or if any oil products are observed in the water.
- Work in waters of the U.S. will be conducted in accordance with the terms and conditions of the U.S. Army Corps of Engineers (ADOT&PF) permits to be obtained for the project.
- Pile installation/removal will occur only during daylight hours and during weather conditions when visual monitoring of humpback whales and Steller sea lions can be conducted.
- 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.
- ADOT&PF has agreed to avoid the designated critical habitat within 3,000 ft of WDPS Steller sea lion critical habitat during construction.

NMFS PR1 Proposed Mitigation

PR1 proposes to issue an IHA for non-lethal "takes"[3] of marine mammals by Level B harassment (as defined by the MMPA) incidental to ADOT&PF's proposed action. When issued, the IHA will be valid from January 2020 to December 2020, and will authorize the incidental harassment of one ESA-listed whale species (Mexico DPS humpback whale) and one ESA-listed sea lion species (Western DPS Steller sea lion), as well as five non-ESA-listed whale and pinniped species. Table 2 shows the amount of proposed take for the two ESA-listed species in the proposed IHA.[4]

Table 2. Amount of proposed incidental harassment (takes) of ESA-listed species in the proposed IHA 84 FR 22453.

Species	Proposed Authorized Level A Takes	Proposed Authorized Level B Takes
Western DPS Steller sea lion (*Eumatopias jubatus*)	0	307[5]
Mexico DPS Humpback whale (*Megaptera noviaengliae*)	0	4[6]

The mitigation measures described below are required per the NMFS's IHA stipulations, and will be implemented by ADOT&PF to reduce potential impacts to marine mammals from pile removal and installation activities and vessel movements. Unless otherwise noted, these measures apply to all marine mammal species.

Mitigation Measures

The holder of the IHA is required to implement the following mitigation measures:

(a) For in-water construction, such as heavy machinery activities other than pile driving (e.g., use of barge-mounted excavators), ADOT&PF must cease operations and reduce vessel speed to the minimum level required to maintain

[3] The MMPA defines "harassment" as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild" (referred to as Level A harassment) or "has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (referred to as Level B harassment). 16 U.S.C. 1362(18)(A)(i) and (ii). For the purposes of this consultation, NMFS considers that a take by "harassment" – a non-lethal take – occurs when an animal is exposed to certain sound levels described below in Section 6 of this opinion.

[4] Please see proposed IHA for MMPA-authorized takes of marine mammal species not listed under the ESA.

[5] The proposed IHA indicated a requested Level B take of 1,694 Steller sea lions. Of the proposed takes, 18.1% are anticipated to occur to ESA-listed western DPS animals. Zero Level A takes are anticipated due to a small level A zone that can be effectively monitored and shut down. The basis for this apportionment is described below in Section 4.3.2

[6] The proposed IHA indicated a requested Level B take of 56 humpback whales. Of the proposed takes, 6.1% are anticipated to occur to ESA-listed Mexico DPS animals. Zero Level A takes are anticipated due to a small level A zone that can be effectively monitored and shut down. The basis for this apportionment is described below in Section 4.3.1.

steerage and safe working conditions, if a marine mammal comes within 10 m of the noise source

(b) ADOT&PF is required to conduct briefings for construction supervisors and crews, the monitoring team, and staff prior to the start of all pile driving activity, and when new personnel join the work, in order to explain responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.

(c) ADOT&PF is required to establish and implement monitoring and shutdown zones (as shown in Tables 2 and 3) for each activity.

(d) Marine mammal monitoring must take place from 30 minutes prior to initiation of pile driving activity through 30 minutes post-completion of pile driving activity. Pile driving may commence when observers have declared the shutdown zone clear of marine mammals. In the event of a delay or shutdown of activity resulting from marine mammals in the shutdown zone (Table 3), 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.

(e) If a marine mammal is entering or is observed within an established shutdown zone (Table 3), pile driving must be halted or delayed. Pile driving may not commence or resume until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone, or 15 minutes have passed without subsequent detections of the animal.

(f) ADOT&PF must use soft start techniques when impact pile driving. Soft start requires contractors to provide an initial set of strikes at reduced energy, followed by a thirty-second waiting period, then two subsequent reduced energy strike sets. A soft start must be implemented at the start of each day's impact pile driving and at any time following cessation of impact pile driving for a period of thirty minutes or longer.

(g) 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 4), pile driving and removal activities must shut down immediately using delay and shut-down procedures. Activities must not resume until the animal has been confirmed to have left the area or the observation time period, as indicated in condition 4(e) above, has elapsed.

Monitoring Measures

The holder of the IHA is required to abide by the following marine mammal and acoustic monitoring measures:

(h) Marine mammal monitoring must be conducted in accordance with the Marine Mammal Mitigation and Monitoring Plan, dated March 2019. Two PSOs are required during all pile installation and removal activities.

(i) Marine mammal monitoring during pile driving and removal must be conducted by NMFS-approved PSOs in a manner consistent with the following:

i. Independent PSOs (*i.e.*, not construction personnel) who have no other assigned tasks during monitoring periods must be used.

ii. At least one PSO must have prior experience working as an observer.

iii. PSOs other than the PSO with prior experience required by (ii) may substitute education (degree in biological science or related field) or training for experience.

iv. ADOT&PF must submit PSO CVs for approval by NMFS prior to the onset of pile driving/removal.

v. Maximum of 4 consecutive hours on watch per PSO; and

vi. Maximum of 12 hours of watch time per day per PSO

(j) PSOs must have the following additional qualifications:

i. Ability to conduct field observations and collect data according to assigned protocols.

ii. Experience or training in the field identification of marine mammals, including the identification of behaviors.

iii. Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations.

iv. 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.

v. Ability to communicate orally, by radio or in person, with each other, and project personnel (e.g., those necessary to effect activity delay or shutdown) to provide real-time information on marine mammals observed in the area as necessary.

Reporting

The holder of the IHA is required to:

(k) Submit a draft report on all monitoring conducted under the IHA within ninety calendar days of the completion of marine mammal monitoring or sixty days prior to the issuance of any subsequent IHA for this project, whichever comes first. A final report shall be prepared and submitted within thirty days following resolution of comments on the draft report from NMFS. This report must contain the informational elements described in the Marine Mammal Mitigation and Monitoring Plan, dated March 2019, including, but not limited to:

i. Dates and times (begin and end) of all marine mammal monitoring.

ii. Construction activities occurring during each daily observation period, including how many and what type of piles were driven or removed and by what method (*i.e*., impact or vibratory).

iii. Weather parameters and water conditions during each monitoring period (*e.g.*, wind speed, percent cover, visibility, sea state).

iv. The number of marine mammals observed, by species, relative to the pile location and if pile driving or removal was occurring at time of sighting.

v. Age and sex class, if possible, of all marine mammals observed.

vi. PSO locations during marine mammal monitoring.

vii. Distances and bearings of each marine mammal observed to the pile being driven or removed for each sighting (if pile driving or removal was occurring at time of sighting).

viii. Description of any marine mammal behavior patterns during observation, including direction of travel.

ix. Number of individuals of each species (differentiated by month as appropriate) detected within the monitoring zone, and estimates of number of marine mammals taken, by species (a correction factor may be applied to total take numbers, as appropriate).

x. Detailed information about any implementation of any mitigation triggered (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting behavior of the animal, if any.

xi. Description of attempts to distinguish between the number of individual animals taken and the number of incidences of take, such as ability to track groups or individuals.

(l) Reporting injured or dead marine mammals:

i. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this IHA, such as serious injury, or mortality, ADOT&PF must immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources (301-427-8401) and Alaska Region Stranding Coordinator (*907-586-7209*). The report must include the following information:

1. Time and date of the incident;

2. Description of the incident;

3. Environmental conditions (e.g., wind speed and direction, sea state, cloud cover, and visibility);

4. Description of all marine mammal observations and active sound source use in the 24 hours preceding the incident;

5. Species identification or description of the animal(s) involved;

6. Fate of the animal(s); and

7. Photographs or video footage of the animal(s).

Activities must not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with ADOT&PF to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. ADOT&PF may not resume their activities until notified by NMFS.

ii. In the event ADOT&PF discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), ADOT&PF must immediately report the incident to the NMFS Office of Protected Resources, and the NMFS Alaska Region Stranding Coordinator. The report must include the same information identified in 6(b)(i) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with ADOT&PF to determine whether additional mitigation measures or modifications to the activities are appropriate.

iii. In the event that ADOT&PF 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*., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), ADOT&PF must report the incident to the NMFS Office of Protected Resources, and NMFS Alaska Region Stranding Coordinator within 24 hours of the discovery.

Shutdown Zone (i.e., exclusion zone) – For all pile driving and removal activities, ADOT&PF will establish a shutdown zone intended to contain the area in which SPLs equal the levels that would cause auditory injury for cetaceans and pinnipeds. The purpose of a shutdown zone is to define an area within which shutdown of activity would occur upon sighting of a marine mammal (or in anticipation of an animal entering the defined area), thus preventing injury (Level A harassment) of marine mammals (see *Response Analysis* Section 6.3). The placement of PSOs during all pile driving and removal activities (Figure 3) will ensure shutdown zones are visible.

The largest Level A harassment zone for otariid pinnipeds extends 18 m from the source. ADOT&PF is planning to implement a minimum 20 m shutdown zone during all pile installation and removal activities (Table 3), which will eliminate the potential for Level A take of Steller sea lions. Therefore, no takes of Steller sea lions by Level A harassment were requested or are proposed to be authorized.

The largest Level A harassment zone for humpback whales extends 500m from the source during impact installation of 30-inch piles (Table 3). PSOs are expected to detect humpback whales before they enter the Level A harassment zone and implement shutdowns to prevent take by Level A harassment. Therefore, no Level A takes have been requested nor are proposed to be authorized.

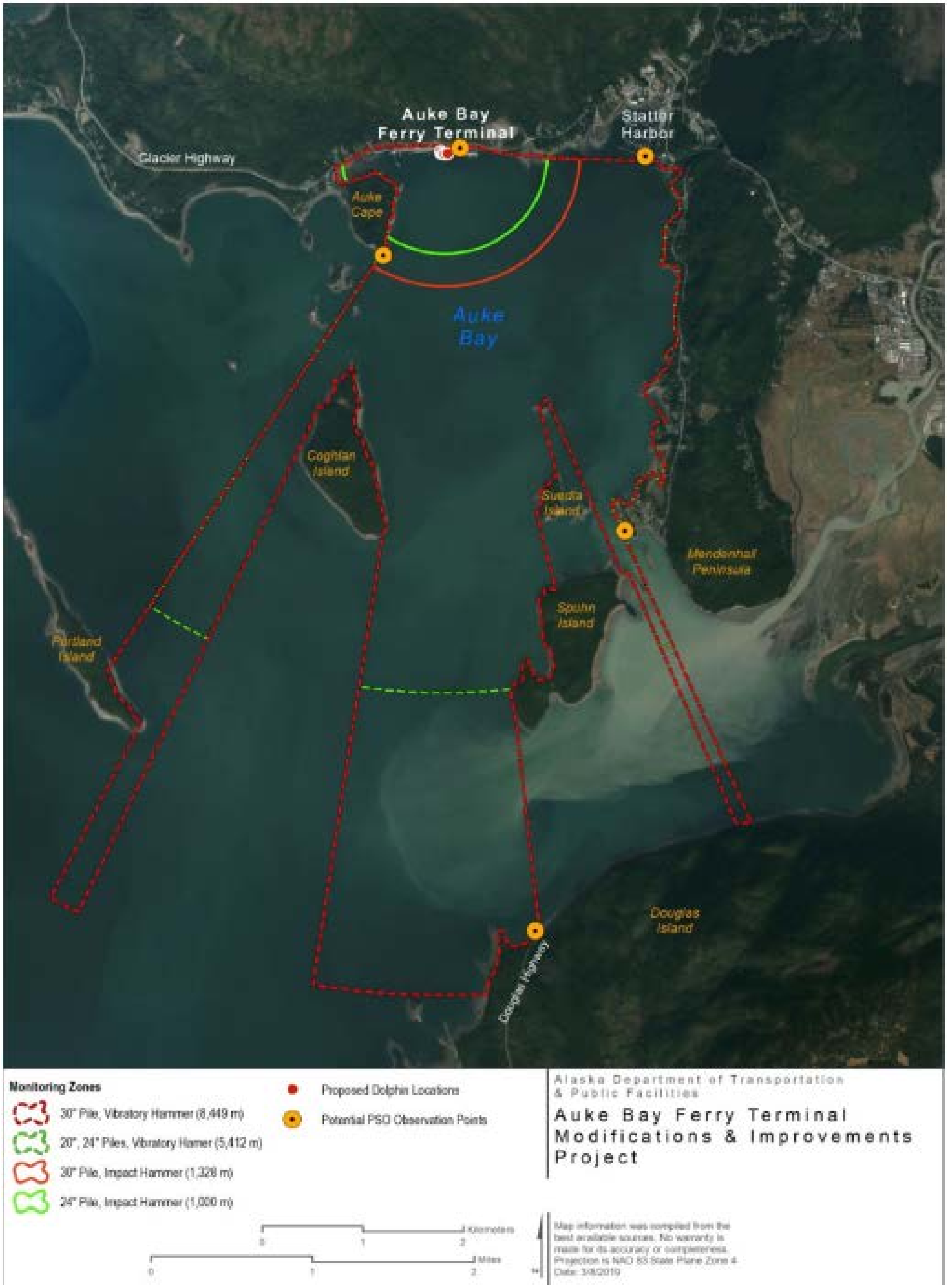

Figure 3. Proposed Monitoring Zones and PSO Locations (HDR 2019c).

Table 3. Shutdown Zones during Pile Installation and Removal.

<table>
<tr><th rowspan="2">Activity</th><th colspan="2">Level A Shutdown Zone (m)</th></tr>
<tr><th>Humpback whales</th><th>Steller sea lions</th></tr>
<tr><td>All vibratory installation and removal</td><td>50</td><td rowspan="3">20</td></tr>
<tr><td>30-inch pile impact installation</td><td>500</td></tr>
<tr><td>24-inch pile impact installation</td><td>450</td></tr>
<tr><td>Other In-Water Activities</td><td>10</td><td>10</td></tr>
</table>

Monitoring Zone – ADOT&PF would establish monitoring zones to correlate with Level B disturbance zones, or zones of influence, which are areas where SPLs are equal to or exceed the 160 dB rms threshold for impact driving and the 120 dB rms threshold during vibratory driving. Monitoring zones provide utility for observing by establishing monitoring protocols for areas adjacent to the shutdown zones. Monitoring zones enable observers to be aware of and communicate the presence of marine mammals in the project area outside the shutdown zone and thus prepare for a potential cease of activity should the animal enter the shutdown zone. However, the primary purpose of a monitoring zone is to estimate the instances of Level B harassment. The proposed monitoring zones are described in Table 4.

Placement of PSOs on the shorelines around Auke Bay allow PSOs to observe marine mammals within and near Auke Bay. Should PSOs determine the monitoring zone cannot be effectively observed in its entirety, Level B harassment exposures will be recorded and extrapolated based upon the number of observed take and the percentage of the Level B zone that was not visible Given the size of the disturbance zone for vibratory pile driving (~9 km; see Figure 4), it is impossible to guarantee that all animals would be observed or to make comprehensive observations of fine-scale behavioral reactions to sound. Plus, only a portion of the zone (*e.g.*, what may be reasonably observed by visual observers) would be observed. However, with the addition of more PSOs (up to five total) located in the proposed PSO observation points shown in Figure 3, an observable zone of no more than 2 km provides a representative sample and extrapolation of take is reasonable. These easily accessible spots are on the road system, and reasonable locations due to their respective viewsheds related to the action area. In order to document observed instances of harassment, observers record all marine mammal observations, regardless of location. The observer's location, as well as the location of the pile being driven, should be recorded, and is known from a GPS device. The location of the animal is estimated as a distance from the observer, which is then compared to the location from the pile. It may then be estimated whether the animal was exposed to sound levels constituting incidental harassment on the basis of predicted distances to relevant thresholds in post-processing of observational and acoustic data, and a precise accounting of observed incidences of harassment created. This information may then be used to extrapolate observed takes to reach an approximate understanding of total takes beyond the observable distance. The total number of exposures will be estimated by dividing the number of observed animals by the percentage of the monitoring zone that was visible. At a minimum PSOs are required to be able to fully observe out to 1,000 meters.

Table 4. Level B Harassment Monitoring Zones.

Activity	Monitoring zone (m)
20-inch vibratory removal	5,500
24-inch vibratory removal and installation	
24-inch impact installation	1,000
30-inch vibratory installation	8,500
30-inch impact installation	1,400

Soft Start - The use of soft-start procedures are believed to provide additional protection to marine mammals by providing warning and/or giving marine mammals a chance to leave the area prior to the hammer operating at full capacity. For impact pile driving, contractors would be required to provide an initial set of strikes from the hammer at reduced energy, with each strike followed by a 30-second waiting period. This procedure would be conducted a total of three times before impact pile driving begins. Soft start would be implemented at the start of each day's impact pile driving and at any time following cessation of impact pile driving for a period of thirty minutes or longer. Soft start is not required during vibratory pile driving and removal activities.

Pre-Activity Monitoring - Prior to the start of daily in-water construction activity, or whenever a break in pile driving/removal or drilling of 30 minutes or longer occurs, PSOs will observe the shutdown and monitoring zones for a period of 30 minutes. The shutdown zone will be cleared when a marine mammal has not been observed within the zone for that 30-minute period. If a marine mammal is observed within the shutdown zone, a soft-start cannot proceed until the animal has left the zone or has not been observed for 15 minutes. If the Level B harassment zone has been observed for 30 minutes and non-permitted species are not present within the zone, soft start procedures can commence and work can continue even if visibility becomes impaired within the Level B monitoring zone. When a marine mammal permitted for Level B take is present in the Level B harassment zone, activities may begin and Level B take will be recorded. As stated above, if the entire Level B zone is not visible at the start of construction, piling or drilling activities can begin. If work ceases for more than 30 minutes, the pre-activity monitoring of both the Level B and shutdown zone will commence.

Vessel Interactions

The following mitigation measures will be required to avoid or minimize exposure of marine mammals to vessel noise:

- Vessels will not approach within 100 yards of marine mammals
- All vessels associated with project construction will avoid the 3,000 ft (914 m) zones surrounding WDPS Steller sea lion critical habitat.
- If a marine mammal comes within 10 meters, operations shall cease and vessels shall reduce speed to the minimum level required to maintain steerage and safe working conditions.

2.2 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action 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 proposed project is located at the Auke Bay Ferry Terminal within Auke Bay near Juneau, Alaska. The action area includes: (1) the area in which construction activities will take place, (2) an ensonified area around the pile removal and installation activities (see Figure 4), and (3) the transit route for project-related equipment from other locations in Southeast Alaska to Juneau.

Within this area, the loudest sound source from the proposed action, with the greatest propagation distance, is anticipated to be associated with vibratory pile installation. Received levels from vibratory pile installation of 30 inch piles with a source level of 168 dB re 1 uPa (rms), may be expected on average to decline to 120 dB re 1 μPa (rms) within ~ 8,500 meters of the pile using a practical spreading model (15 log R) (HDR 2019b). The 120 dB isopleth was chosen because that is where we anticipate vibratory pile driving noise levels would approach ambient noise levels (i.e., the point where no measurable effect from the project would occur). However, the action area would be truncated where land masses obstruct underwater sound transmission (Figure 4).

The action area includes transit areas for mobilization and demobilization of construction equipment. Mobilization and demobilization is anticipated to occur in Southeast Alaska. However, considering that a contractor has not been selected at this point in time, staging areas for operations may vary. Regardless of staging area, the applicant has agreed that all vessels associated with project construction will avoid the 3,000 ft (914 m) designated critical habitat surrounding WDPS Steller sea lion haulouts and rookeries.

The Washington State Department of Transportation (WSDOT) recorded in-air noise levels from impact installation of 30-inch piles in December 2015 at the Vashon Ferry Terminal near Seattle, Washington (WSDOT 2016). In-air noise levels during impact installation were 110 dBA as measured at 15 meters (50 feet). This value was chosen as the estimate for impact installation of 30-inch-diameter steel piles for this Project. A sound study conducted in Statter Harbor in 2008 (PND Engineers 2011) found that ambient in-air sound levels generally ranged from 50 to 70 dBA in that area. Based on this study, ambient in-air noise was assumed to average 60 dBA at the Auke Bay Ferry Terminal during daylight hours. In-air noise from impact installation of 30-inch piles could extend a maximum distance of 1,524 meters (5,000 feet) inland over ambient levels due to absorption and scattering from vegetation, buildings, and other surfaces (HDR 2019b).

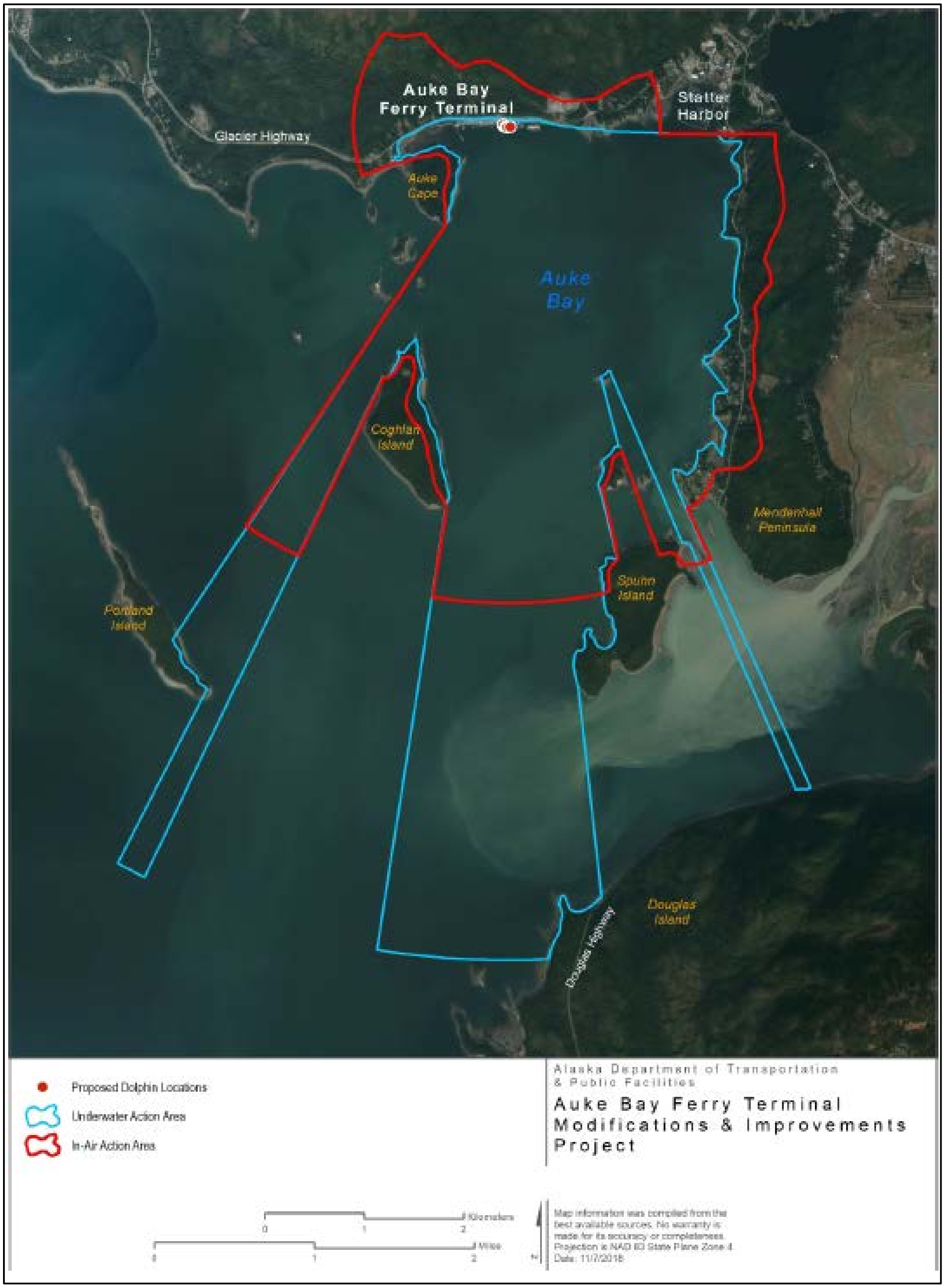

Figure 4. Estimated Level B ensonified area associated with pile installation for the Auke Bay Ferry Terminal Modifications project(HDR 2019b).

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.

"To jeopardize the continued existence of a listed species" means to engage in an action that reasonably 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, injury to recovery alone may result in a jeopardy biological opinion (51 FR 19926, 19934; June 2, 1986).

Under NMFS's regulations, the destruction or adverse modification of critical habitat "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (50 CFR § 402.02).

The designation of critical habitat for Steller sea lions uses the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (81 FR 7414; February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether the proposed action described in Section 2 of this opinion is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on listed species or critical habitat. As part of this step, we identify the action area – the spatial and temporal extent of these direct and indirect effects.
- Identify the range-wide status of the species and critical habitat likely to be adversely affected by the proposed action. This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. We determine the range-wide status of critical habitat by examining the condition of its PBFs - which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 4 of this 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 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. NMFS also evaluates the proposed action's effects on critical habitat features. The effects of the action are described in Section 6 of this opinion with the exposure analysis described in Section 6.2 of this 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 6.3 of this 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 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: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 4). Integration and synthesis with risk analyses occurs in Section 8 of this opinion.

- Reach jeopardy and adverse modification conclusions. Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 9. These conclusions flow from the logic and rationale presented in the Integration and Synthesis Section 8.

- If necessary, define a reasonable and prudent alternative to the proposed action. If, in completing the last step in the analysis, NMFS determines that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, NMFS must identify a reasonable and prudent alternative (RPA) to the action.

4 RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Three species of marine mammals listed under the ESA under NMFS's jurisdiction may occur in the action area. This opinion considers the effects of the proposed action on these species (Table 5). The nearest designated critical habitat for Steller sea lions is Benjamin Island located approximately 27 km northwest of the construction area.

Table 5. Listing status and critical habitat designation for marine mammals considered in this opinion.

Species	Status	Listing	Critical Habitat
Humpback Whale, Mexico DPS *Megaptera novaeangliae*	Threatened	NMFS 2016 81 FR 62260	Not designated
Sperm Whale *Physeter macrocephalus*	Endangered	NMFS 1970 35 FR 18319	Not designated
Steller Sea Lion, Western DPS *Eumetopias jubatus*	Endangered	NMFS 1997, 62 FR 24345	1993 58 FR 45269

4.1 Species and Critical Habitats Not Likely to be Adversely Affected

NMFS uses two criteria to identify those endangered or threatened species or critical habitat that are likely to be adversely affected. The first criterion is exposure or some reasonable expectation of a co-occurrence between one or more potential stressors associated with ADOT&PF's proposed activities and a listed species or designated critical habitat. The second criterion is the probability of a response given exposure.

We applied these criteria to the species and critical habitat listed above and determined that the following species and designated critical habitat are not likely to be adversely affected by the proposed action: sperm whales, and Steller sea lion critical habitat.

4.1.1 Steller Sea Lion Critical Habitat

NMFS designated critical habitat for Steller sea lions on August 27, 1993 (58 FR 45269). The following PBFs were identified at the time of listing:

1. Alaska rookeries, haulouts, and associated areas identified at 50 CFR 226.202(a), including:
   - 1.1. Terrestrial zones that extend 914 m (3,000 ft) landward
   - 1.2. Air zones that extend 914 m (3,000 ft) above the terrestrial zone
   - 1.3. Aquatic zones that extend 914 m (3,000 ft) seaward from each major rookery and major haulout east of 144° W. longitude
   - 1.4. Aquatic zones that extend 37 km (23 mi) seaward from each major rookery and major haulout west of 144° W. longitude
2. Three special aquatic foraging areas identified at 50 CFR 226.202(c):

2.1. Shelikof Strait

2.2. Bogoslof

2.3. Seguam Pass

The ensonified area associated with the project does not overlap with designated critical habitat. The nearest critical habitat is Benjamin Island (blue dot near Juneau in Figure 5) located 27 km northwest of Juneau, and outside of the ensonified area. While transit routes to and from the construction site are currently unknown, mitigation measures require all vessels associated with construction operations to avoid the 3,000 ft (914 m) aquatic zone surrounding any designated critical habitat in Southeast Alaska.

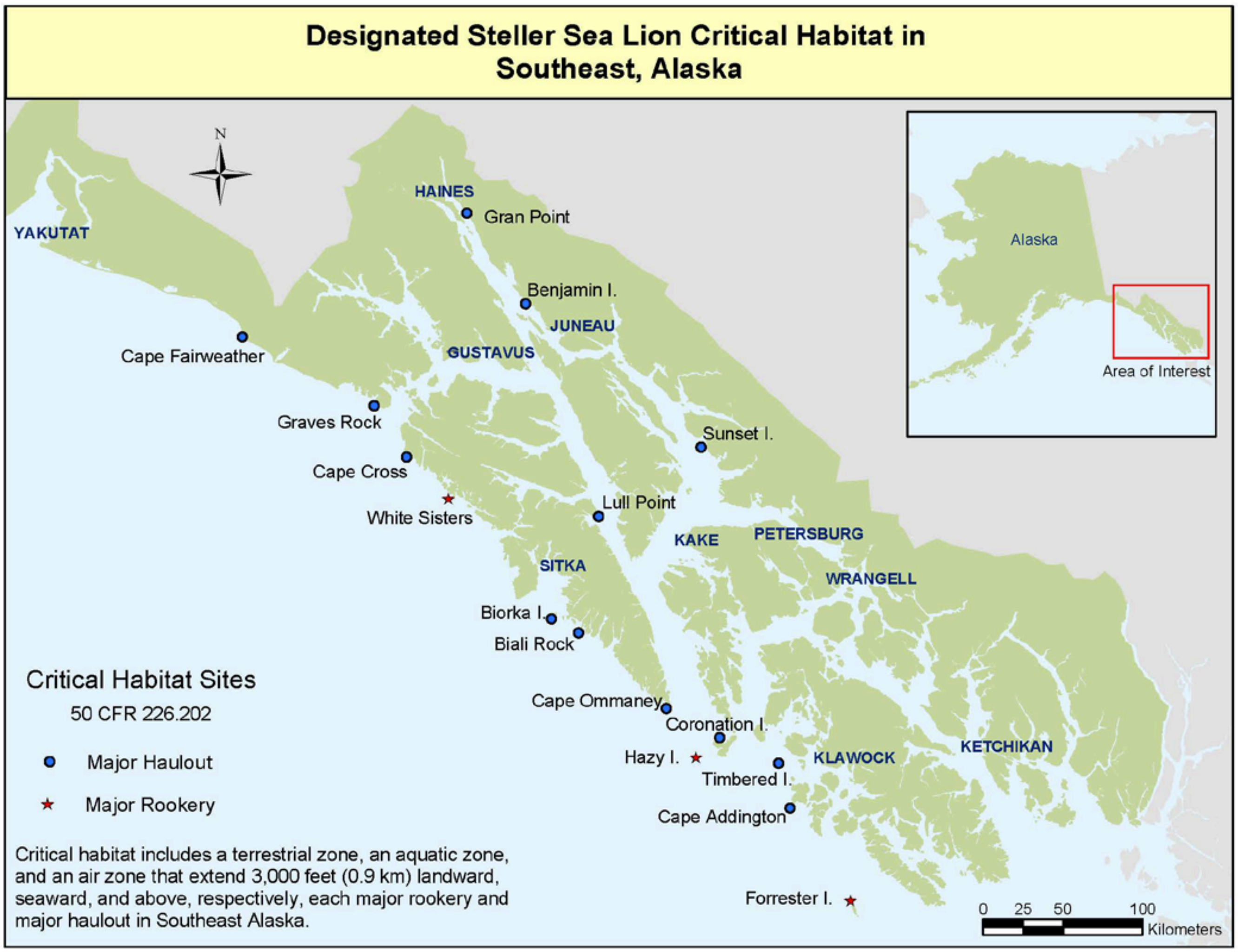

Figure 5. Designated critical habitat for Steller sea lions in Southeast Alaska.

The transit route will not pass near enough to landmasses to affect hauled-out pinnipeds; however, foraging sea lions may be encountered during vessel transit. It is unlikely that vessel transit will impact critical habitat surrounding haulouts and rookeries to any measurable degree considering vessels will avoid designated aquatic zones. We conclude any impacts to these PBFs are likely to be insignificant.

4.1.2 Sperm Whales

Tagged sperm whales have recently been tracked within the Gulf of Alaska, with two whales tracked north of Admiralty Island in Lynn Canal in 2014 and 2015. (SEASWAP 2017). In addition, one beached sperm whale was discovered north of Berners Bay on March 19, 2019, with the cause of death determined to be vessel strike.

Tagging studies primarily show that sperm whales use the deep water slope habitat extensively for foraging (Mathias et al. 2012). Interaction studies between sperm whales and the longline fishery have been focused along the continental slope of the eastern Gulf of Alaska in water depths between about 1,970 and 3,280 ft (600 and 1,000 m) (Straley et al. 2005, Straley et al. 2014). The shelf-edge/slope waters of the Gulf of Alaska are far outside of the action area.

Though we do not expect sperm whales will occur in the action area where pile driving activities will occur, it is possible these species may be encountered during transit from staging areas to the construction site in Auke Bay. Therefore, it is possible the species may be at risk for vessel strike.

However, it is unlikely that vessels will strike sperm whales for the following reasons:

- Few, if any, sperm whales are likely to be encountered because they are generally found in deeper waters than those in which the transit route will occur.
- Project duration is limited to 14 non-consecutive days within a 2-month construction window.
- NMFS's guidelines for approaching marine mammals discourage vessels approaching within 100 yards of marine mammals and ADOT&PE have agreed to follow these guidelines as part of their mitigation measures.

We conclude that the stressors associated with removal and replacement of piles are extremely unlikely to affect sperm whales because they are not anticipated to overlap in time and space, and the effects of ship strike associated with equipment mobilization and demobilization are also extremely unlikely to occur. Therefore, effects to sperm whales are discountable.

4.2 Climate Change

One potential threat common to all of the species we discuss in this opinion is global climate change. Because of this commonality, we present this narrative here rather than in each of the species-specific narratives that follow.

The timeframe for the proposed action is will occur over 14 non-consecutive days between January 2020 and August 2020, which is a relatively short duration to detect any noticeable climate change impacts. We present potential climate change effects on listed species and their habitat below.

Reflecting the long-term warming trend since pre-industrial times, observed global mean surface temperature (GMST) for the decade 2006–2015 was 0.87°C higher than the average over the 1850–1900 period . Averaged as a whole, the January 2019 global land and ocean surface temperature was 0.88°C (1.58°F) above the 20th century average and tied with 2007 as the third highest temperature since global records began in 1880. Only the years 2016 (+1.06°C / +1.91°F) and 2017 (+0.91°C / +1.64°F) were warmer. The ten warmest Januaries have all occurred since 2002, with the last five years (2015–2019) among the six warmest years in the 140-year record. January 1976 was the last time the January global land and ocean temperatures were below average at -0.02°C (-0.04°F) (NCEI 2019). . 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 2013) and this rise has been linked to climate change (Foreman and Yamanaka 2011, GAO 2014, Murray et al. 2014, Okey et al. 2014, Secretariat of the Convention on Biological Diversity 2014, Andersson et al. 2015). 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 as many of those 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. 2012). 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). For example, low reproductive success and body condition in humpback whales may have resulted from the 1997/1998 El Niño (Cerchio et al. 2005).

The effects of these changes to the marine ecosystems of the Gulf of Alaska, and how they may affect Steller sea lions, are uncertain. Warmer waters could favor productivity of some species of forage fish, but the impact on recruitment of important prey fish of Steller sea lions is unpredictable. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, but the distribution and recruitment of other fish (e.g., osmerids) could be negatively affected (NMFS 2008b).

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 (see Figure 5). 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).

All of these effects of climate change, such as increases in atmospheric temperatures, decreases in sea ice, and changes in sea surface temperatures, oceanic pH, patterns of precipitation, and sea level have impacted, are impacting, and will continue to impact marine species. However, notable climate-driven changes are not expected to be measurable over the brief period associated with this proposed action. Climate change is not expected to increase or decrease the effects of this particular action on listed species in the foreseeable future.

Figure 6. Algal toxins detected in 13 species of marine mammals from Southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016).

4.3 Status of Listed Species that are Likely to be Adversely Affected

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, 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. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in the definition of jeopardizing the continued existence of the species under 50 CFR § 402.02.

In each narrative, we present a summary of information on the population structure and distribution of each species to provide a foundation for the exposure analyses that appear later in this 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 opinion. That is, we rely on a species' status and trend to determine whether or not an action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

4.3.1 Mexico DPS Humpback Whale

We used information available in the status review (Bettridge et al. 2015), most recent stock assessment (Muto et al. 2018), NMFS species information (NMFS 2016a), report on estimated abundance and migratory destinations for North Pacific humpback whales (Wade et al. 2016), and recent biological opinions to summarize the status of the species, as follows.

Distribution

Humpback whales are widely distributed in the Atlantic, Indian, Pacific, and Southern Oceans. Individuals generally migrate seasonally between warmer, tropical and sub-tropical waters in winter months (where they reproduce and give birth to calves) and cooler, temperate and sub-Arctic waters in summer months (where they feed) (Figure 6). In their summer foraging areas and winter calving areas, they tend to occupy shallower, coastal waters; though during seasonal migrations they disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985).

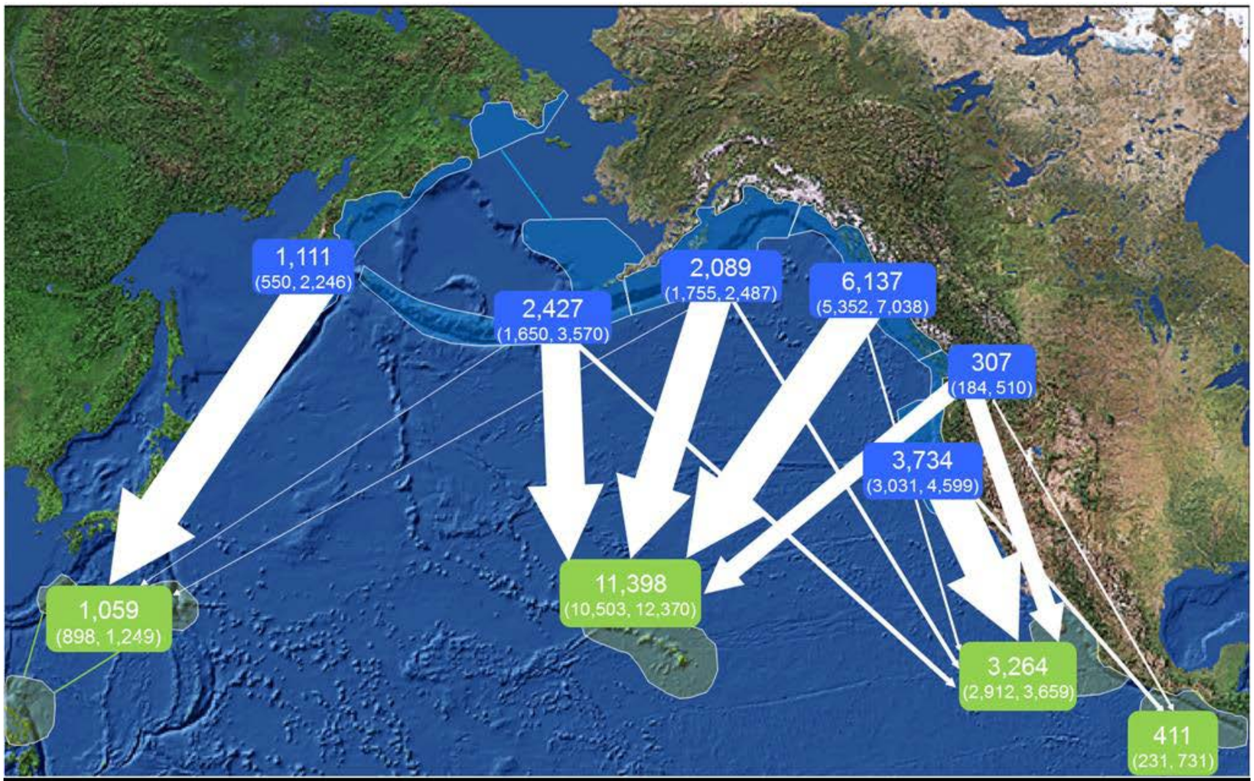

Figure 7. Abundance by summer feeding areas (blue), and winter breeding areas (green), with 95% confidence limits in parentheses (Wade et al. 2016).

Humpback whales occur in the Gulf of Alaska primarily in summer and fall, migrating to southerly breeding grounds in winter and returning to the north in spring (Calambokidis et al. 2008). However, based on recordings from moored hydrophones deployed in six locations in the Gulf of Alaska from October 1999 to May 2002, humpback calls were most commonly detected during the fall and winter (Stafford et al. 2007).

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 (NPS 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 lower Lynn Canal, Tenakee Inlet, Whale Bay, Ketchikan, and Sitka Sound), none of which are in the action area (Baker et al. 1985, Straley 1990). However, the aggregation of herring in the action area (inner Auke Bay) has the potential to provide a habitat where whales may feed on small volumes of fish and rest to conserve energy between foraging opportunities.

Given their widespread range and their opportunistic foraging strategies, humpback whales may be in the project vicinity during the proposed project activities.

Ferguson et al. (2015) identified areas around Juneau, which overlap with the action area, as a Biologically Important Area (BIA) for humpback whale feeding during summer (June-August) and fall (September-November) (Figure 7).

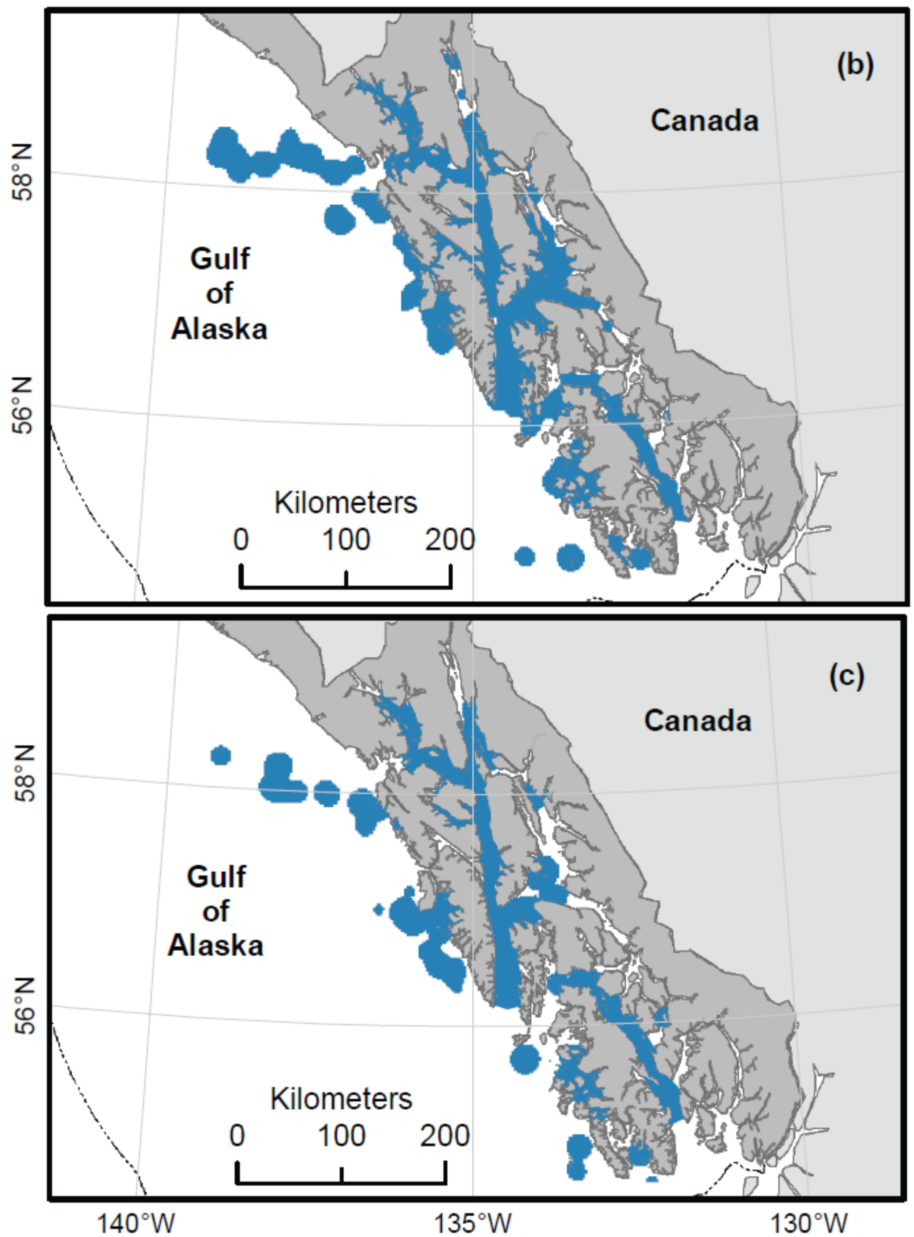

Figure 8. Seasonal humpback whale biologically important feeding areas in Southeast Alaska for (b) summer (June-August), and (c) fall (September-November) (Ferguson et al. 2015), showing overlap with the action area.

Life History
Humpback whales are large baleen whales that are primarily dark grey in appearance, with variable areas of white on their fins, bellies, and flukes. The coloration of flukes is unique to individual whales. The lifespan of humpback whales is estimated to be 80 to 100 years. Sexual maturity is reached at five to 11 years of age. The gestation period of humpback whales is 11 months, and calves are nursed for 12 months. The average calving interval is two to three years. Birthing occurs in low latitudes during winter months.

Humpback whale feeding occurs in high latitudes during summer months. They exhibit a wide range of foraging behaviors and feed on a range of prey types, such as small schooling fishes, krill, and other large zooplankton.

Humpback whales produce a variety of vocalizations ranging from 20 Hz to 10 kHz (Winn et al. 1970a, Tyack and Whitehead 1983, Payne and Payne 1985, Silber 1986, Thompson et al. 1986, Richardson et al. 1995, Au 2000, Frazer and Mercado III 2000, Erbe 2002, Au et al. 2006b, Vu et al. 2012). NMFS categorizes humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales' applied frequency range is between 7 Hz and 35 kHz (NMFS 2018).

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, Winn et al. 1970b, Thompson et al. 1986). 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 (Tyack and Whitehead 1983, Silber 1986). 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).

In summary, humpback whales produce at least three kinds of sounds:

1. Complex songs with components ranging from at least 20 Hz–5 kHz with estimated source levels from 144– 174 dB; these are mostly sung by males on the breeding grounds (Winn et al. 1970a, Richardson et al. 1995, Au 2000, Frazer and Mercado 2000, Au et al. 2006a);
2. Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson et al. 1995); and
3. Feeding area vocalizations that are less frequent, but tend to be 20 Hz–2 kHz with estimated sources levels in excess of 175 dB re 1 Pa at 1m (Thompson et al. 1986, Richardson et al. 1995).

Additional information on humpback whales can be found at:
http://www.nmfs.noaa.gov/pr/species/mammals/whales/humpback-whale.html.

Status and Population Dynamics
NMFS recently conducted a global status review and changed the status of humpback whales under the ESA (81 FR 62260; September 8, 2016). Under the final rule, 14 DPSs of humpback whales are recognized worldwide. Humpback whales in the action area may belong to the threatened Mexico DPS or the non-listed Hawaii DPSs.

In the final rule changing the status of humpback whales under the ESA (81 FR 62260; September 8, 2016), the abundances of the Mexico and Hawaii DPSs throughout their range were estimated to be 3,264 (CV = 0.06) and 11,398 (CV = 0.04) whales, respectively. The Mexico DPS has an unknown trend. The Hawaii DPS was estimated to be increasing annually between 5.5 and 6.0 percent.

Within Southeast Alaska and northern British Columbia, the abundance estimate for humpback whales is estimated to be 6,137 (CV= 0.07) animals, which includes whales from the Hawaii DPS (93.9%) and Mexico DPS (6.1%) (NMFS 2016b, Wade et al. 2016).

Table 6. Probability of encountering humpback whales from each DPS in the North Pacific Ocean (columns) in various feeding areas (on left). Gray highlighted area includes the action area 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 I/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.

There is no critical habitat designated for the Mexico DPS humpback whale.

4.3.2 Western DPS Steller Sea Lion

We used information available in the recent stock assessment report (Muto et al. 2018), recovery plan (NMFS 2008a), status review (NMFS 1995), listing document (62 FR 24345), NMFS species information, and recent biological opinions to summarize the status of the species, as follows.

Distribution
Steller sea lions are distributed throughout the northern Pacific Ocean, including coastal and inland waters in Russia (Kuril Islands and the Sea of Okhotsk), east to Alaska, and south to central California (Año Nuevo Island) (Figure 8). Animals from the eastern DPS (EDPS) occur primarily east of Cape Suckling, Alaska (144° W), and animals from the endangered western DPS (WDPS) occur primarily west of Cape Suckling. The western DPS includes Steller sea lions that reside primarily in the central and western Gulf of Alaska, Aleutian Islands, and those that inhabit and breed in the coastal waters of Asia (e.g., Japan and Russia). The eastern DPS includes sea lions living primarily in Southeast Alaska, British Columbia, California, and Oregon.

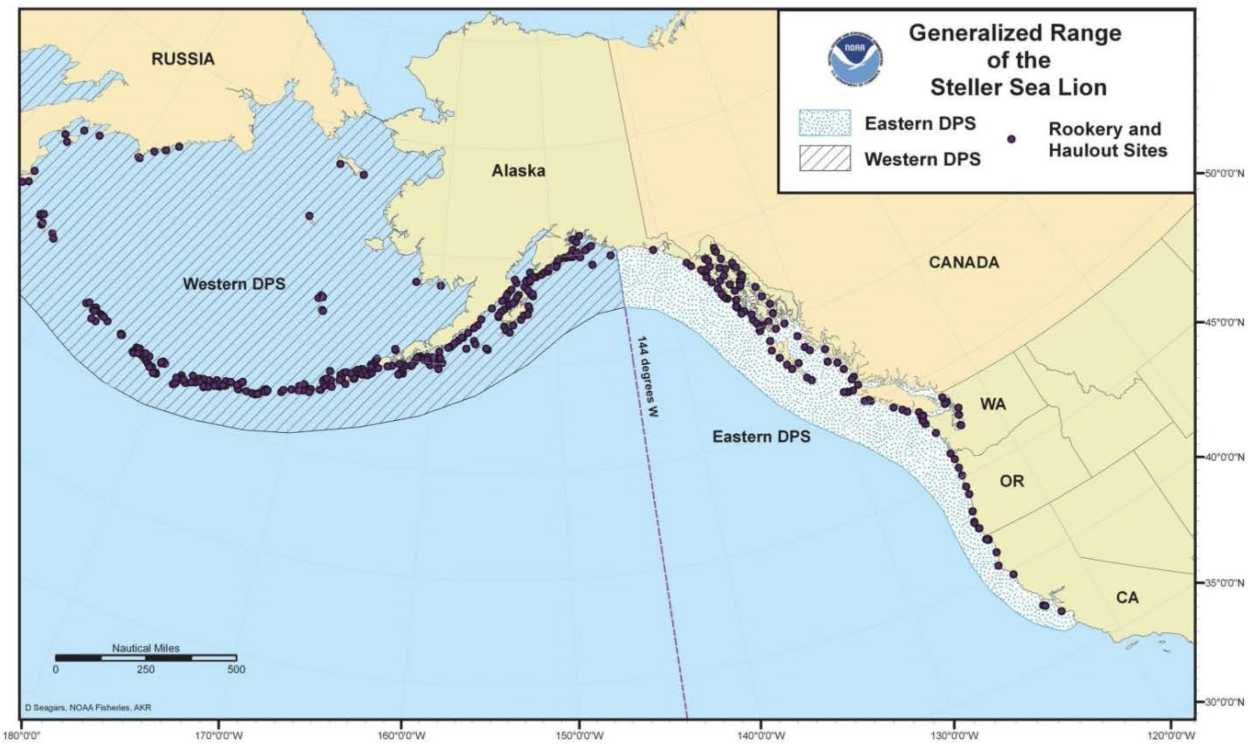

Figure 9. Generalized range of Steller sea lion, including rookery and haulout locations.

<u>Southeast Alaska Distribution</u>
Within the action area, Steller sea lions are anticipated to be predominantly from the EDPS; however, WDPS animals may be found there as well. Although there are no known Steller sea lion haulouts or rookeries inside the action area, the Benjamin Island haulout (over 25 km northwest of the action area) and Little Island (over 28 km northwest of the action area) are likely the predominant haulouts used by the Steller sea lions that are found transiting into and out of the action area.

Studies have confirmed movement of animals across the 144° W longitude boundary (Raum-Suryan et al. 2002, Pitcher et al. 2007, Fritz et al. 2013, Jemison et al. 2013). Jemison et al. (2013) found regularly occurring temporary movements of western DPS Steller sea lions across the 144° W longitude boundary, and some western DPS females have likely emigrated permanently and given birth at White Sisters and Graves Rock rookeries. The vast majority of these sightings have been in northern Southeast Alaska, north of Frederick Sound (the action area is in northern Southeast Alaska). Fritz et al. (2016) estimated an average annual movement of western DPS Steller sea lions to Southeast Alaska of 1,039 animals. Studies indicate the females from both stocks have produced pups at both Southeast Alaska rookeries: White Sisters and Graves Rock (Gelatt et al. 2007).

The proportion of western DPS Steller sea lion non-pups in the Lynn Canal region of the population mixing zone (northern–central Southeast Alaska) by birth region, age-class and maternal genetic lineage is 18.1% (Kelly K. Hastings* and 11 A. Jemison 2019). Birth regions were Western Stock Region, born in the new rookeries in the mixing zone of the Eastern Stock Region (Graves Rocks and White Sisters), or born in southern Southeast Alaska (Forrester and Hazy rookeries)(Kelly K. Hastings* and 11 A. Jemison 2019).

The seasonal ecology of Steller sea lions in Southeast Alaska has been studied by relating the distribution of sea lions to prey availability (Womble et al. 2009). Figure 10 depicts a likely seasonal foraging strategy for Steller sea lions in Southeast Alaska. These results suggest that seasonally aggregated high-energy prey species, such as eulachon and herring in late spring and salmon in summer and fall, influence the seasonal distribution of Steller sea lions in some areas of Southeast Alaska (Womble et al. 2009).

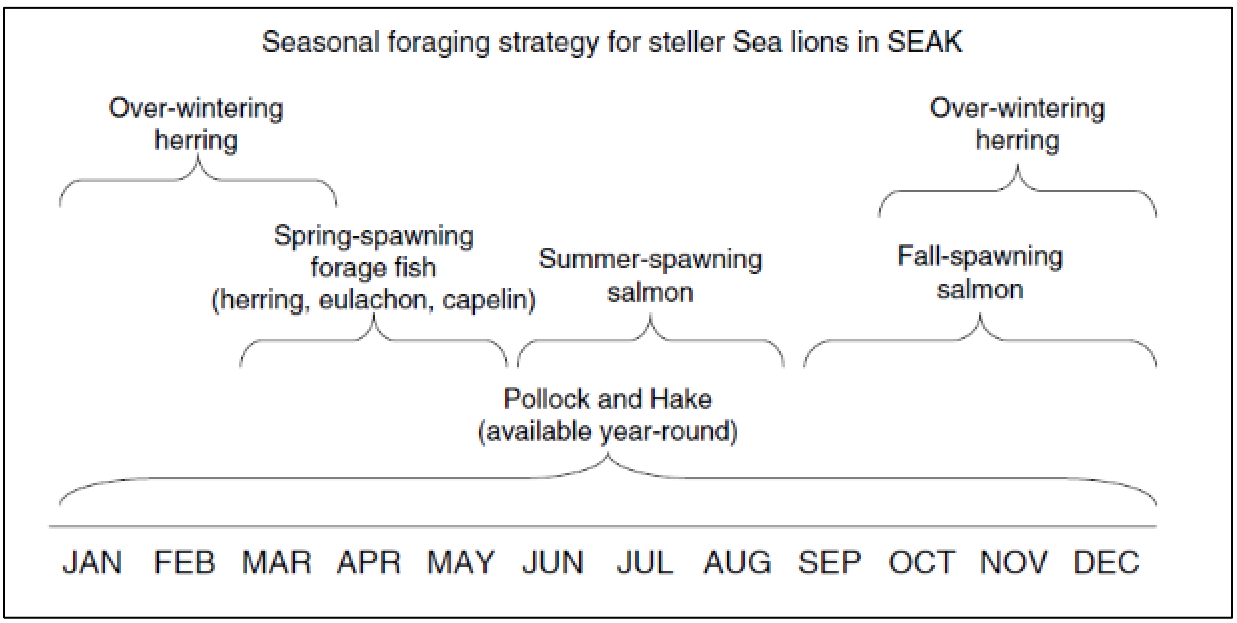

Figure 10. Seasonal foraging ecology of Steller sea lions in Southeast Alaska (Womble et al. 2009).

The action area and surrounding waters contain abundant sources of prey species, which draw Steller sea lions in to forage year-round.

Life History

Steller sea lions are the largest of the eared seals (Otariidae), though there is significant difference in size between males and females: males reach lengths of 3.3 m (10.8 ft) and can weigh up to 1,120 kg (2,469 lb) and females reach lengths of 2.9 m (9.5 ft) and can weigh up to 350 kg (772 lb). Their fur is light buff to reddish brown and slightly darker on the chest and abdomen; their skin is black. Sexual maturity is reached and fist breeding occurs between 3 and 8 years of age. Pupping occurs on rookeries between May and June and females breed approximately 11 days after giving birth. Implantation of the fertilized egg is delayed for about 3.5 months, and gestation occurs until the following May or June.

Most adult Steller sea lions occupy rookeries during pupping and breeding season (late May-early July). During the breeding season, most juvenile and non-breeding adults are at haulouts, though some occur at or near rookeries. Adult females and pups continue to stay on rookeries through August beginning a regular routine of alternating foraging trips at sea with nursing their pups on land. During the non-breeding season many Steller sea lions disperse from rookeries and increase their use of haulouts. Steller sea lions do not migrate, but they often disperse widely outside of the breeding season (Loughlin 1997). At sea, Steller sea lions commonly occur near the 200 m (656 ft) depth contour, but have been seen from near shore to well beyond the continental shelf (Kajimura and Loughlin 1988).

The ability to detect sound and communicate underwater and in-air is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group with an applied frequency range between 60 and 39 kHz in water (NMFS 2018).

Additional information on Steller sea lions can be found at: https://alaskafisheries.noaa.gov/pr/steller-sea-lions

Population Dynamics
The western DPS population declined approximately 75% from 1976 to 1990 (the year of ESA-listing). Since 2000, the abundance of the western DPS has increased, but there has been considerable regional variation in trend (Muto et al. 2018). The minimum population estimate of western DPS Steller sea lions in Alaska is 53,303 individuals. Using data collected through 2016, there is strong evidence that non-pup and pup counts of western DPS Steller sea lions in Alaska increased at ~2% per year between 2000 and 2016 (Muto et al. 2018). Populations in the eastern Gulf of Alaska (closest to the action area) are increasing at an average rate of 5.36% for non-pups and 4.61% for pups annually (Muto et al. 2018).

Status
The Steller sea lion was listed as a threatened species under the ESA on November 26, 1990 (55 FR 49204). In 1997, NMFS reclassified Steller sea lions as two DPSs based on genetic studies and other information (62 FR 24345); at that time the eastern DPS was listed as threatened and the western DPS was listed as endangered. On November 4, 2013, the eastern DPS was removed from the endangered species list (78 FR 66140).

Steller sea lions are hunted for subsistence purposes. As of 2009, data on community subsistence harvest are no longer being consistently collected; therefore, the most recent estimate of annual statewide (excluding St. Paul Island) harvest[7] is 172 individuals from the 5-year period from 2004 to 2008. More recent data from St. Paul and St. George are available; the annual harvest is 30 and 2.4 sea lions respectively from the 5-year period from 2011 to 2015. This results in a total harvest of 204 individuals (172+30+2.4) (Muto et al. 2017, 2018). In addition, data were

[7] These numbers included both harvested and struck and lost sea lions.

collected on Alaska Native harvest of Steller sea lions for 7 communities on Kodiak Island for 2011 and 15 communities in Southcentral Alaska in 2014; the Alaska Native Harbor Seal Commission and ADF&G estimated a total of 20 adult sea lions were harvested on Kodiak Island in 2011, and 7.9 sea lions (CI = 6-15.3) were harvested in Southcentral Alaska in 2014, with adults comprising 84% of the harvest (Muto et al. 2017, 2018).

Additional region wide threats to the species include environmental variability, competition with fisheries, predation by killer whales, toxic substances, incidental take due to interactions with active fishing gear, illegal shooting, entanglement in marine debris, disease and parasites, and disturbance from vessel traffic, tourism, and research activities.

Threats to the species specific to the action area are discussed further in Section 5 of this opinion.

Critical Habitat

NMFS designated critical habitat for Steller sea lions on August 27, 1993 (58 FR 45269). More information about critical habitat can be found in Section 4.1.2 of this opinion.

5 ENVIRONMENTAL BASELINE

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.

5.1 Stressors affecting Mexico DPS Humpback Whales in the Action Area

Residual effects from historic commercial whaling, disturbance and risk of vessel strike from transiting vessels, competition for prey, effects from climate change, risk of entanglement, and the risk of oil spills (or other hazardous materials) could be sources of stress to humpback whales in the action area. A short description and summary of the effects of these stressors are presented below. More detailed analyses are available in the most recent humpback whale recovery plan (NMFS 1991) and ESA Status Review (Bettridge et al. 2015).

5.1.1 Harvest

Commercial whaling in the 19th and 20th centuries removed tens of thousands of whales from the North Pacific Ocean, and 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 unlawfully harvested one near Toksook Bay in May (DeMarban and Demer 2016).

5.1.2 Vessel Disturbance and Strike

Vessel-based recreational activities, commercial fishing, shipping, whale-watching, the Alaska Marine Highway System (AMHS), 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.

Neilson et al. (2012) summarized 108 large whale ship-strike events in Alaska from 1978 to 2011, 25 of which are known to have resulted in the whale’s death. Eighty-six percent of these reports involved humpback whales. The minimum mean annual mortality and serious injury rate due to ship strikes reported in Alaska is 2.4 Central North Pacific humpback whales per year between 2011 and 2015. Most vessel collisions with humpbacks are reported from Southeast Alaska (Muto et al. 2018).

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

Further, the authors used previous locations of whale strikes to produce a kernel density estimation. The high risk areas shown in red in Figure 11 are also popular whale-watching destinations (Neilson et al. 2012). Although some of the risk factors for ship strike exist in Auke Bay (there are many vessel transits between May-Sept, with vessels less than 49 feet traveling over 13 knots), the action area is not identified as an area of high risk in this analysis.

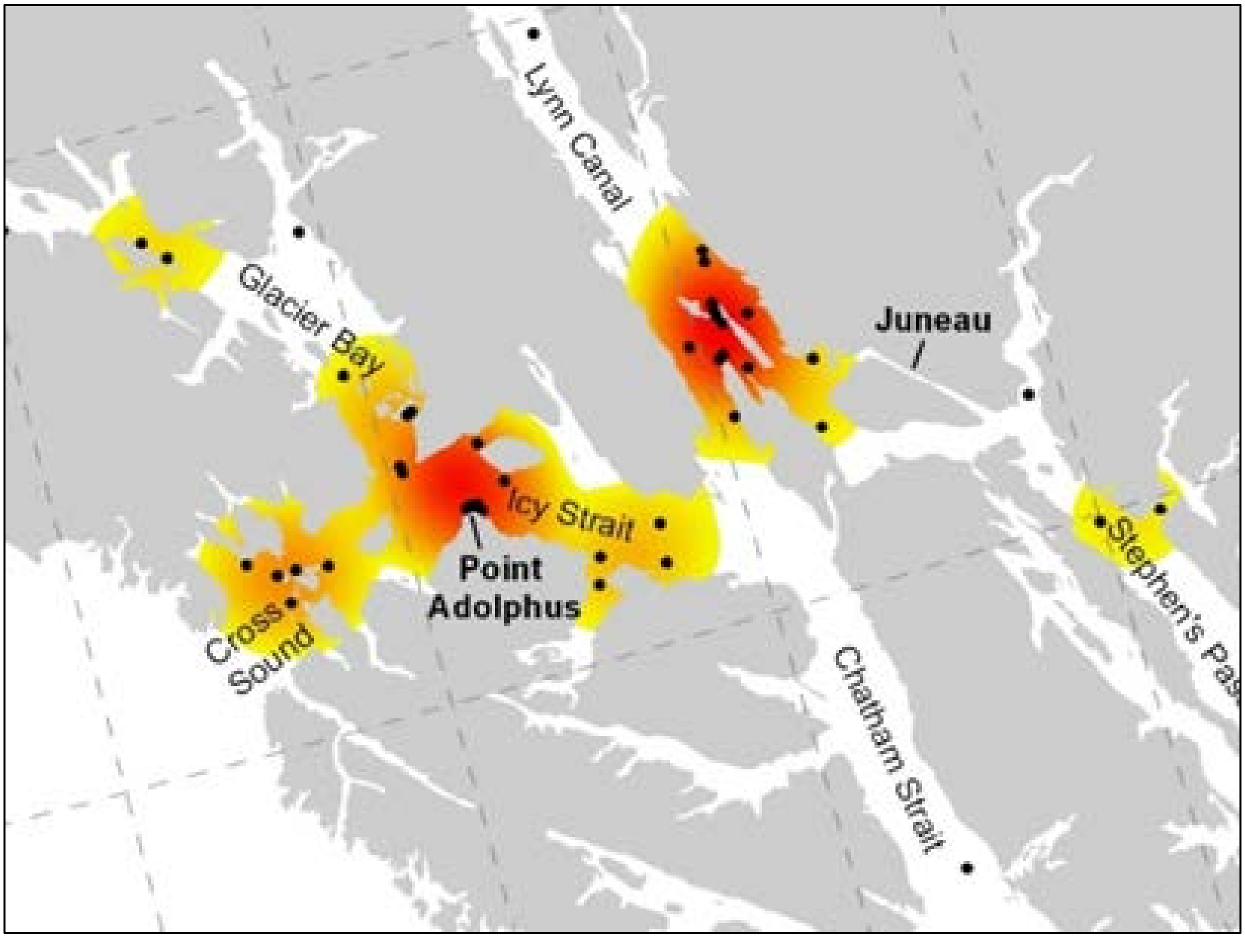

Figure 11. High Risk Areas for Vessel Strike in northern Southeast Alaska. Used with permission from (Neilson et al. 2012).

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)). These regulations require that all vessels:

a. Not approach within 100 yards of a humpback whale, or cause a vessel or other object to approach within 100 yards of a humpback whale,
b. Not place vessel in the path of oncoming humpback whales causing them to surface within 100 yards of vessel,
c. Not disrupt the normal behavior or prior activity of a whale, and
d. Operate vessel at a slow, safe speed when near a humpback whale. Safe speed is defined in regulation (see 33 CFR § 83.06).

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 access to reduce the risk of ship strike and contribute to whale avoidance.

In addition to these voluntary marine mammal viewing guidelines, many of the marine mammal viewing tour boats voluntarily subscribe to even stricter approach guidelines by participating in the Whale SENSE program. NMFS implemented Whale SENSE Alaska in 2015, which is 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/.

5.1.2 Competition for Prey

Competition for prey between humpback whales, other marine life, and humans may exist. Humpback whales feed on schooling fish, including species that are harvested by humans commercially or for personal use. Given the recent positive abundance trends for all humpback whales discussed in Section 4.3.1and the relatively small scale of the action area compared to commercial and personal use fishing grounds, NMFS expects any competition for prey in the action area to be minimal.

5.1.3 Climate Change

Overwhelming data indicate the planet is warming (IPCC 2014a), which poses a threat to most Arctic and Subarctic marine mammals.

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 as many of those considered in this opinion, is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring.

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. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, but the distribution and recruitment of other fish (e.g., osmerids) could be negatively affected (NMFS 2008a).

5.1.4 Entanglement

Entanglement of cetaceans 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).

Entangled marine mammals may drown or starve due to being restricted by gear, suffer physical trauma and systemic infections, or be hit by vessels due to an inability to avoid them. Entanglement can include many different gear interaction scenarios, but the following have occurred with humpback whales:
Gear loosely wrapped around the marine mammal's body that moves or shifts freely with the marine mammal's movement and does not indent the skin can result in disfigurement.
Gear that encircles any body part and has sufficient tension to either indent the skin or to not shift with marine mammal's movement can cause lacerations, partial or complete fin amputation, organ damage, or muscle damage and interfere with mobility, feeding, and breathing. Chronic tissue damage from line under pressure can compromise a whale's physiology. Fecal samples from entangled whales had extremely high levels of cortisols (Rolland et al. 2005), an immune system hormone. Extended periods of pituitary release of cortisols can exhaust the immune system, making a whale susceptible to disease and infection.

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.

In relation to MMPA stocks, 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 of origin for affected whales is unknown, the mortality and serious injury is reflected in the stock assessment reports for both stocks.

The humpback whale ESA listing final rule (81 FR 62259, 8 September 2016) established 14 Distinct Population Segments (DPSs) with different listing statuses. NMFS is in the process of reviewing humpback whale stock structure under the MMPA in light of the 14 DPSs, but changes to MMPA stocks have yet to be completed. Because these stocks do not correspond directly to the DPSs, their ESA listing status cannot be reported precisely, but for purposes of this analysis, the Central North Pacific stock loosely corresponds to the Hawaii and Mexico DPSs and the Western North Pacific stock corresponds to the Western North Pacific DPS.

5.1.5 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 shipyard and other industrial activity, treated sewer system outflows, vessels operating in marine waters, and sediment runoff from paved surfaces and disturbed areas (HDR 2017).

A search of the ADEC Contaminated sites database[9] showed that there are four land-based active contaminated sites in the vicinity of Auke Bay. These include the FAA Coghlan Island station site (Hazard ID 4176); a failed 550-gallon underground home heating oil tank (Hazard ID 4536); the Glacier Highway Battery Dump Site (Hazard ID 4636); and the Auke Bay RV Park (Hazard ID 26824). Clean-up is in progress at the four sites.

5.2 Stressors on WDPS Steller Sea Lions

Disturbance from vessel transit, competition for prey, effects from climate change, risk of entanglement, and the risk of oil spills (or other hazardous materials) could be sources of stress to Steller sea lions in the action area. Short descriptions and summaries of the effects of these stressors are presented below. A more detailed analysis is available in a recent Biological Opinion of the effects of Alaska Groundfish fisheries (NMFS 2014) and the SSL recovery plan (NMFS 2008).

5.2.1 Vessel Disturbance and Strike

Vessel-based recreational activities, commercial and charter fishing, shipping, and general transportation occur within the action area regularly. All of which increase ambient in-air and underwater noise and pose risk of vessel-whale collisions. NMFS provides a voluntary framework for vessel operators to follow a code of conduct to reduce marine mammal interactions including:

- remain at least 100 yards from marine mammals,
- time spent observing individual(s) should be limited to 30 minutes, and
- vessels should leave the vicinity if they observe Steller sea lion behaviors such as these:
    - Increased movements away from the disturbance, hurried entry into the water by many animals, or herd movement towards the water; or
    - Increased vocalization, aggressive behavior by many animals towards the disturbance, or several individuals raising their heads simultaneously.

These guidelines can be viewed at https://alaskafisheries.noaa.gov/pr/mm-viewing-guide.

[8] ADEC. Division of Water. Impaired Waters Map. Available at http://www.arcgis.com/home/webmap/viewer.html?webmap=5987f5c7a33846b19b9097dddcf8332a accessed December 2018.

[9] ADEC. Division of Spill Prevention and Response. Contaminated Sites Map. Available at http://www.arcgis.com/home/webmap/viewer.html?webmap=315240bfbaf84aa0b8272ad1cef3cad3&center=-131.656975,55.344914&level=15&marker=-131.656975,55.344914,,Click%20on%20arrow%20to%20get%20information%20about%20this%20site accessed December 2018.

NMFS Alaska Region Stranding Program has records of at least four occurrences of Steller sea lions being struck by vessels in Southeast Alaska; three were near Sitka, one was south of Juneau. Vessel strike has not been documented in the action area and is not considered a major threat to Steller sea lions.

5.2.2 Competition for Prey

Competition for prey species could exist between Steller sea lions and other marine life and Steller sea lions and commercial fishing. NMFS (2008) noted there are commercial fisheries that target key Steller sea lion prey, including Pacific cod, salmon, and herring in the eastern portion of their range. It was recognized that in some regions, fishery management measures appear to have reduced this potential competition (e.g., no trawl zones and gear restrictions on various fisheries in southeast Alaska) and in others a very broad distribution of prey and a lack of seasonal overlap between fisheries and prey preference by sea lions may minimize competition as well. Given the population trends discussed above in Section 4.3.2 and the relatively small scale of the action area compared to nearby fishing grounds, NMFS expects any competition for prey in the action area to be insignificant.

5.2.3 Climate Change

The Steller Sea Lion Recovery Plan ranks environmental variability as a potentially high threat to recovery of the western DPS (NMFS 2008). The Bering Sea and Gulf of Alaska are subjected to large-scale forcing mechanisms that can lead to basin-wide shifts in the marine ecosystem resulting in significant changes to physical and biological characteristics, including sea surface temperature, salinity, and sea ice extent and amount. Physical forcing affects food availability and can change the structure of trophic relationships by impacting climate conditions that influence reproduction, survival, distribution, and predator-prey relationships at all trophic levels in or near the action area. Populations of Steller sea lions in the Gulf of Alaska and Bering Sea have experienced large fluctuations due to environmental and anthropogenic forcing (Mueter et al. 2009). As we work to understand how these mechanisms affect various trophic levels in the marine ecosystem, we must consider the additional effects of global warming, which are expected to be most significant at northern latitudes (Mueter et al. 2009, IPCC 2013)

The effects of climate changes to the marine ecosystems of the Gulf of Alaska, including Lynn Canal, and how they may affect Steller sea lions are uncertain. Warmer waters could favor productivity of some species of forage fish, but the impact on recruitment of important prey fish of Steller sea lions is unpredictable. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, but the distribution and recruitment of other fish (e.g., osmerids) could be negatively affected (NMFS 2008).

5.2.4 Entanglement

Although the Steller Sea Lion Recovery Plan (NMFS 2008c) ranked interactions with fishing gear and marine debris as a low threat to the recovery of the western DPS, it is likely that many entangled sea lions may be unable to swim to shore once entangled, may die at sea, and may not be available to count (Loughlin 1986, Raum-Suryan et al. 2009). Based on data collected by ADF&G and NMFS, Helker *et al.* (2016) reported Steller sea lions to be the most common species of human-caused mortality and serious injury between 2011 and 2015. There were 468 cases of serious injuries to eastern DPS Steller sea lions from interactions with fishing gear and marine debris. While these cases are attributed to the eastern DPS because they occurred east of 144° W, eastern and western DPS animals overlap in Southeast Alaska, and these takes may have been western DPS animals. Raum-Suryan et al. (2009) observed a minimum of 386 animals either entangled in marine debris or having ingested fishing gear over the period 2000-2007 in Southeast Alaska and northern British Columbia. Over the same period, there were 241 cases of mortality and serious injury reported for the western DPS: 31 in U.S. commercial fisheries, 1.4 in unknown fisheries (commercial, recreational, or subsistence), 2 in marine debris, 2.6 due to other causes (arrow strike, entangled in hatchery net, illegal shooting, research), and 204 in subsistence harvest. These animals mostly interacted with observed trawl (13), longline (2.8), troll (1), and gillnet (15) fisheries, typically resulting in death (Muto et al. 2018).

The minimum estimated mortality rate of western Steller sea lions incidental to all U.S. commercial fisheries is 32 sea lions per year, based on PSO data (31) and stranding data (1.4) where PSO data were not available. Several fisheries that are known to interact with the western DPS have not been observed reaching the minimum estimated mortality rate (Muto et al. 2018).

5.2.5 Pollution

The risk of oil spills or other hazardous materials to Steller sea lions is similar to humpback whales. For more information, please see Section 5.1.5 above.

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. 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 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.

We conclude this section with an Integration and Synthesis of Effects that integrates information presented in the Status of the Species and Environmental Baseline sections of this opinion with the results of our exposure and response analyses to estimate the probable risks the proposed action poses to endangered and threatened species.

6.1 Stressors

During the course of this consultation, we identified the following potential stressors from the proposed activities:

- Vessel strike
- Disturbance of seafloor
- Airborne noise
- Above-water work
- Underwater sounds from:
  - Vessels
  - Pile Driving and Pile Removal
  - Rock anchor drilling

Below we discuss each stressor's potential to affect ESA-listed species.

6.1.1 Stressors Not Likely to Adversely Affect ESA-listed Species

Based on a review of available information, we determined the following are possible stressors which may occur, but for which the likely effects are discountable or insignificant.

6.1.1.1 *Vibratory and Impact Pile Driving Airborne Noise*

Airborne noises could affect hauled out pinnipeds. Loud noises can cause hauled-out pinnipeds to flush back into the water, leading to disturbance and possible injury. Noise generated during pile driving and removal activities would attenuate to the harbor seal in-air threshold (90 dB) at approximately 53 m and attenuate to the threshold for other pinnipeds (e.g., Steller sea lions) (100 dB) at approximately 17m (Solstice Alaska Consulting 2018).

There are no known Steller sea lion haulout sites within the in-air disturbance zone. Therefore, during pile driving, temporary in-air harassment would be limited to sea lions swimming on the surface through the portion of the action area near the dock. Any such sea lion would already have been exposed to in-water noise levels exceeding the take threshold. Further, proposed mitigation would likely prevent a take from occurring at these distances (see Section 2.1.4) or cause serious injury due to the implementation of shutdown zones. For these reasons, effects from in-air noise are considered discountable (i.e., no haulouts nearby, so in-air disturbance is extremely unlikely to occur) and insignificant (i.e., shutdown mechanisms in place, so any exposure would occur at levels likely to have immeasurably small effects) for ESA-listed pinnipeds.

6.1.1.2 *Above Water Work*

No in-water noise is anticipated in association with above-water and upland construction activities. All airborne noise associated with this project are addressed in Section 6.1.1.1 above. All effects from upland construction activities are likely to have immeasurable small effects to ESA-listed marine mammals.

6.1.1.3 *Vessel Strike*

The possibility of vessel strike is extremely unlikely. While there have been a limited number of vessel strikes of marine mammals reported near Juneau, these involved vessels transiting at high speeds. During construction activities vessel speed will be very low (i.e., 2 km/hr [1 kt] or less), and the maximum transit speed for tug and barge vessels proposed for use is 18.5 km/hr (10 kts).

Once vessels get to the construction site, they will be anchored.

In Southeast Alaska, there have been 25 reports of humpback whale collisions with vessels and one report of a Steller sea lions collision between 2010 and 2016 (see Figure 11) (NMFS 2016c). Between 2011 and 2015 the mean minimum annual human-caused mortality and serious injury rate for humpback whales based on vessel collisions in Alaska was reported in the NMFS Alaska Regional Office stranding database as 0.4 (Muto et al. 2018). However, these incidences account for a small fraction of the total humpback whale population (Laist et al. 2001).

Vessels would have a transitory presence in any specific location. NMFS is not able to quantify existing traffic conditions across the entire action area to provide context for the change in vessel activity during operation. However, the low number of reported collisions involving vessels and listed marine mammals in Southeast Alaska despite decades of spatial and temporal overlap suggests that the probability of collision is low. In addition, all vessels will be required to observe the Alaska humpback whale approach regulations, which will further reduce the likelihood of interactions.

Mitigation measures described in Section 2.1.4 require all vessels associated with project construction to avoid the 3,000 ft (914 m) designated aquatic zones surrounding major Steller sea lion rookeries or haulout locations east of 144°W longitude, to follow established transit routes, and to travel at slow speeds (< 10 knots) while in the action area. We conclude the probability of strike occurring is extremely unlikely and therefore effects are discountable.

6.1.1.4 *Disturbance of Seafloor*

Short-term turbidity increases would likely occur during in-water construction work, including pile driving, pile removal, and drilling. The physical resuspension of sediments could produce localized turbidity plumes that could last from a few minutes to several hours. In general, turbidity associated with pile installation is expected to be localized to about a 25 ft radius around the pile (Everitt et al. 1980). Contaminated sediments are not expected at the project site but any that do occur would be tightly bound to the sediment matrix. Because of the relatively small work area, any increase in turbidity would be limited to the immediate vicinity of the project site and adjacent portion of the bay. There is little potential for pinnipeds or cetaceans to be exposed to increased turbidity during construction operations. Therefore, exposure to re-suspended contaminants is expected to be negligible since sediments would not be ingested and any contaminants would be tightly bound to such sediments.

Considering local currents, tidal action, and implementation of best management practices (BMPs), any potential water quality exceedances would likely be temporary and highly localized. The local tides and currents would disperse suspended sediments from pile driving operations at a moderate to rapid rate depending on tidal stage.

Cetaceans are not expected to come close enough to the project site to encounter increased turbidity from construction activities. Any pinnipeds would avoid the short-term, localized areas of turbidity. Therefore, the impact from increased turbidity levels would be negligible to listed marine mammals and would not cause a significant disruption of behavioral patterns that would rise to the level of harassment. Therefore, we conclude the effects from this stressor are insignificant.

6.1.1.5 *Underwater Sounds from Vessels*

There are two phases of vessel noise and associated disturbance related to the proposed action. The first is vessel noise associated with construction, and the second is vessel noise associated with operation of the ferry terminal.

These acoustic impacts will result from moving sources, and for individual marine mammals that are exposed to noise from transiting vessels, the effects from each exposure will be temporary in duration, lasting only minutes. For species such as humpback whales and Steller sea lions that prey upon food items that are not tied to a particular location, effects of transient and temporary noise are expected to result in low levels of exposure and exposure that the animals can likely avoid without foregoing highly valuable foraging opportunities.

Vessel noise associated with this action will be transmitted through water and constitutes a continuous noise source. NMFS anticipates that whenever noise is produced from vessel operations, it may overlap with western DPS Steller sea lions and Mexico DPS humpback whales, and that some individuals are likely to be exposed to these continuous noise sources. Broadband source levels for have been measured at 170 to 180 dB re 1μPa for small ships and supply vessels (Richardson et al. 1995). The Alaska class ferry vessels will be 280 feet long and carry 300 passengers and 53 vehicles..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). Listed cetaceans and pinnipeds have the potential to overlap with vessel noise associated with the proposed construction activities.

(Research 2012)Reactions of marine mammals to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement. Past experiences of the animals with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow-moving vessels are less dramatic than their reactions to faster and/or erratic vessel movements. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Richardson et al. 1995, Wartzok et al. 2003).

Humpback whale reactions to approaching boats are variable, ranging from approach to avoidance (Payne 1978, Salden 1993). On rare occasions humpbacks “charge” towards a boat and “scream” underwater, apparently as a threat. Baker et al. (Baker et al. 1983) reported that humpbacks in Hawaii responded to vessels at distances of 2 to 4 km. Bauer and Herman (Bauer and Herman 1986) concluded that reactions to vessels are probably stressful to humpbacks, but that the biological significance of that stress is unknown. Humpbacks seem less likely to react to vessels when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984). Mothers with newborn calves seem most sensitive to vessel disturbance (Clapham and Mattila 1993). Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting behavioral states to active behavioral states, which would imply an energetic cost. Morete et al. (Morete et al. 2007) reported that undisturbed humpback whale cows that were accompanied by their calves were frequently observed resting while their calves circled them (milling) and rolling interspersed with dives. When vessels approached, the amount of time cows and calves spent resting and milling respectively declined significantly. There is the potential for interactions between vessels and cow calf pairs in Southeast Alaska.

In general, baleen whales react strongly and rather consistently to approaching vessels of a wide variety of types and sizes. Whales are anticipated to interrupt their normal behavior and swim rapidly away if approached by a vessel. Surfacing, respiration, and diving cycles can be affected. The flight response often subsides by the time the vessel has moved a few kilometers away. After single disturbance incidents, at least some whales are expected to return to their original locations. Vessels moving slowly and in directions not toward the whales usually do not elicit such strong reactions (Richardson and Malme 1993).

Few authors have specifically described the responses of pinnipeds to boats, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. However, the mere presence and movements of ships in the vicinity of seals and sea lions can cause disturbance to their normal behaviors (Calkins and Pitcher 1982, Kucey and Trites 2006). Disturbances from vessels may motivate seals and sea lions to leave haulout locations and enter the water (Kucey 2005). The possible impact of vessel disturbance on Steller sea lions has not been well studied, yet the response by sea lions to disturbance will likely depend on the season and life stage in the reproductive cycle.

The action area does not include Steller sea lion critical habitat, and the mitigation measures in Section 2.1.4 require all vessels associated with project construction will avoid the 3,000 ft (914 m) designated aquatic zones surrounding any major rookery or haulout as they transit to and from the project site. The limited number of vessels associated with the proposed actions are anticipated to be transiting at speeds of 10 knots or less, and vessels will primarily be anchored at the construction site unless deploying people or supplies.

We anticipate low level exposure of short-term duration to listed marine mammals from vessel noise, and do not expect significant behavioral reactions. We anticipate that noise associated with transiting vessels would drop to 120 dB within 233 meters (or less) of most vessels associated with the proposed action(Richardson et al. 1995). Steller sea lions and humpback whales in the action area encounter many vessels, and are likely habituated to the noise. If animals do respond, they may exhibit slight deflection from the noise source, engage in low-level avoidance behavior, short-term vigilance behavior, or short-term masking response 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. Temporary avoidance of the action area is not likely to adversely affect these species. Therefore, the impact of vessel transit on Mexico DPS humpback whales and western DPS Steller sea lions is not anticipated to reach the level of harassment under the ESA, and is considered insignificant.

6.1.1.6 *Rock Anchor Drilling*

Underwater noise from rock anchor installation of up to 12 tension anchors is anticipated to be low considering the double encasement surrounding the drill rod and the depth of the overlying sediments. The glacial till layer is overlain with 35 to 75 feet of sediments, and is expected to attenuate noise production from drilling and reduce noise propagation into the water column. Additionally, the casing used during drilling is inside the larger diameter pile, further reducing noise levels.(HDR 2019d).

Noise associated with drilling an 8-in diameter hole extending about 50 ft into bedrock below the tip of the pile is anticipated to be contained entirely within the piling and is not anticipated to reach or exceed the 120 dB threshold for continuous noise sources (McLean, pers. comm. 2017).

Tension anchoring is therefore not expected to produce sounds levels that will cause Level B harassment.

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

Based on review of the best available information, we determined effects from in-air noise and vessel strike are extremely unlikely to occur.

We determined disturbance of seafloor is not likely to have measurable impact.

We also determined the impact from underwater noise from vessels, and from rock anchor drilling is considered insignificant. Although these stressors individually are not likely to adversely affect listed species, the effects of these stressors combined are considered and addressed in the Integration and Synthesis portion of the opinion.

6.1.2 Stressors Likely to Adversely Affect ESA-listed Species

The following sections analyze the stressors likely to adversely affect ESA-listed species: underwater sounds from pile removal and pile installation. First, we present a brief explanation of the sound measurements used in the discussions of acoustic effects in this opinion.

6.1.2.1 *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.

6.1.2.2 *Acoustic Thresholds*

As discussed in Section 2, *Description of the Proposed Action*, ADOT&PF intends to use a wide variety of noise-generating equipment in the action area (see Section 2.1).

Since 1997, NMFS had used generic sound exposure thresholds to determine whether an activity produces underwater and in-air sounds that might result in impacts to marine mammals (70 FR 1871). NMFS recently developed comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent threshold shifts and temporary thresholds shifts (PTS and TTS; Level A harassment) (81 FR 51694). NMFS is in the process of developing guidance for behavioral disruption (Level B harassment). However, until such guidance is available, NMFS uses the following conservative thresholds of underwater sound pressure levels, expressed in rms, from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the Marine Mammal Protection Act (MMPA):

- impulsive sound: 160 dB re 1 μPa_{rms}
- continuous sound: 120 dB re 1μPa_{rms}

Under the PTS/TTS Technical Guidance, NMFS uses the following thresholds for underwater sounds that cause injury, referred to as Level A harassment under section 3(18)(A)(i) of the MMPA (NMFS 2018). These acoustic thresholds are presented using dual metrics of cumulative sound exposure level (L_E) and peak sound level (PK) for impulsive sounds[10] and L_E for non-impulsive sounds (see Table 6):

Table 7. PTS Onset Acoustic Thresholds for Level A Harassment (NMFS 2018).

Hearing Group	**PTS Onset Acoustic Thresholds* (Received Level)**	
	Impulsive	**Non-impulsive**
Low-Frequency (LF) Cetaceans	$L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	$L_{E,LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	$L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	$L_{E,MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	$L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	$L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	$L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	$L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	$L_{pk,flat}$: 232 dB $L_{E,OW,24h}$: 203 dB	$L_{E,OW,24h}$: 219 dB

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

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1$\mu Pa^2 s$. The subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

[10] For the dual metric associated with impulsive sources, the applicant must consider whichever threshold results in the largest effect distance (isopleth)(NMFS 2018).

In addition, NMFS uses the following thresholds for in-air sound pressure levels from broadband sounds that cause Level B behavioral disturbance under section 3(18)(A)(ii) of the MMPA:

- 100 dB re $20\mu Pa_{rms}$ for non-harbor seal pinnipeds

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 USC 1362(18)(A)(i) & (ii)).

While the ESA does not define "harass," NMFS recently issued guidance interpreting the term "harass" under the ESA as 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 action that amounts to incidental harassment under the MMPA—whether Level A or Level B—constitutes an incidental "take" under the ESA and must be authorized by the ITS (see Section 10).

As described below, we anticipate that exposures to listed marine mammals from noise associated with the proposed action may result in disturbance and potential injury. However, no mortalities or permanent impairment to hearing are anticipated.

6.2 Exposure

As discussed in the *Approach to the Assessment* section of this opinion, exposure analyses are designed to identify the ESA-listed resources that are likely to co-occur with the action's effects in space and time, as well as the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and sex of the individuals that are likely to be exposed to the action's effects and the population(s) or subpopulation(s) those individuals represent.

Table 8 provides the modeled distances to Level A and Level B exposure thresholds from continuous and impulsive noise sources used to estimate potential exposure to ESA-listed species (HDR 2019a)

6.2.1 Exposure to Major Noise Sources

The potential for incidental take is estimated for each species by determining the likelihood that a listed marine mammal would be present within a Level A or Level B Zone of Influence (ZOI) during active pile driving or removal activities.

Assumptions

The reported radii for 24-hr SEL (Level A) thresholds are based on the assumption that marine mammals remain stationary or at a constant exposure range during the entire 24-hr period, which is an extremely unlikely scenario. Animals would be expected to move away from the noise source before the exposure would result in a meaningful impact that might affect the individual or populations. These estimated distances for Level A exposure represent an unlikely worst-case scenario.

For the continuous noise sources (vibratory pile driving), there may be an accumulation of sound caused by both activities during a full work day when calculating Level A harassment isopleths.

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 pile driving could occur and that animals might occur in the ensonified action area;
- One day equates to any length of time that piles are driven whether it is a partial day or a 24-hour period;
- All listed marine mammals occurring in the ensonified area are assumed to be incidentally taken;
- An individual animal can only be counted as taken once during a 24-hour period;
- For animals that may occur in groups, each individual in the group would be considered taken;
- Exposures to sound levels at or above the relevant thresholds equate to take, as defined by the MMPA; and
- Level B take estimates are unmitigated and do not take into account monitoring and mitigation efforts to reduce take as described in Section 2.1.4.

Mitigation Measures to Minimize the Likelihood of Exposure to Major Noise Sources

Mitigation measures will be required through the MMPA permitting process to reduce the adverse effects of exposure to major noise sources on marine mammals from the proposed construction activities. These include the use of shutdown zone, employment of PSOs, and soft start procedures, and are described in detail in Section 2.1.4.

Approach to Estimating Exposure to Major Noise Sources

For this analysis we estimated take by considering: 1) acoustic thresholds above which the best available science indicates marine mammals will be behaviorally harassed or incur some degree of temporary or permanent hearing impairment; 2) the area that will be ensonified above these levels in a day; 3) the density or occurrence of marine mammals within these ensonified areas; and 4) and the number of days of activities.

Source Level Estimates

The project includes vibratory and impact pile installation of steel pipe piles and vibratory removal of steel pipe piles. Source levels of pile installation and removal activities are based on reviews of measurements of the same or similar types and dimensions of piles available in the literature, including past pile driving activities in Auke Bay. Source levels for each pile size and driving method are presented in Table 8. The source level for vibratory installation of 24-inch piles and vibratory removal of 24-inch and 20-inch piles are from 24-inch steel piles driven at Navy installations in Puget Sound, Washington (United States Navy 2015). As there are no measurements of source levels for these pile types in Alaska, we use the Navy's source levels as a proxy. The vibratory and impact source levels for 30-inch pile installation is from pile driving activities at the Auke Bay ferry terminal in November 2015 (Denes *et al.*, 2016). The source level for impact installation of 24-inch piles is based on the averaged source level of the same type of pile reported by California Department of Transportation (Caltrans) in a pile driving source level compendium document (Caltrans 2015). Source levels for vibratory installation and removal of piles of the same diameter are assumed to be the same.

Table 8 Sound Source Levels for Pile Sizes and Driving Methods.

Pile size	Method	Source level			Literature source
		dB RMS	dB SEL[a]	dB peak	
20-inch	vibratory	161[b]	N/A	N/A	Navy 2015
24-inch	vibratory	161	N/A	N/A	Navy 2015
24-inch	impact	190	177	203	Caltrans 2015
30-inch	vibratory	168	N/A	N/A	Denes *et al.* 2016
30-inch	impact	191	177	206	Denes *et al.* 2016

[a] Sound exposure level (dB re 1 μPa^2-sec)
[b] Source level data for 20-inch piles are not available. Source levels for 20-inch piles are conservatively assumed to be the same as 24-inch piles

Distances to Level A and Level B Sound Thresholds
Transmission loss (TL) is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. The general formula for underwater TL is:

$$TL = B * \log10(R_1/R_2)\text{, where}$$
R_1 = the distance of the modeled SPL from the driven pile, and
R_2 = the distance from the driven pile of the initial measurement.

Absent site-specific acoustical monitoring with differing measured transmission loss, a practical spreading value of 15 is used as the transmission loss coefficient in the above formula. For vibratory and impact pile driving of 30-inch piles at the Auke Bay ferry terminal, Denes et al., (2016) measured transmission loss that differed slightly from the standard practical value of 15. The transmission loss coefficient for vibratory driving of 30-inch piles was determined to be 16.4 while the coefficient for impact driving of 30-inch piles was determined to be 14.6. These transmission loss coefficients were used to calculate the Level A and Level B harassment zones for 30-inch piles. Site-specific transmission loss data for 20- and 24-inch piles are not available, therefore the default coefficient of 15 is used for these pile sizes to determine the distances to the Level A and Level B harassment thresholds.

Table 9. Pile Driving Source Levels and Distances to Level B Harassment Thresholds.

Pile Size and Method	Source Level at 10 m (dB re 1 μPa rms)	Level B Threshold (dB re 1 μPa rms)	Propagation (xLogR)	Distance to Level B Threshold (m)	Level B Harassment Ensonified Area (km^2)
20-inch vibratory	161	120	15	5,412	15.3
24-inch vibratory	161	120	15	5,412	15.3
24-inch impact	190	160	15	1,000	1.5
30-inch vibratory	168	120	16.4	8,449	22.5
30-inch impact	191	160	14.6	1,328	2.3

When the NMFS Technical Guidance (2016) was published, in recognition of the fact that ensonified area/volume could be more technically challenging to predict because of the duration component in the new thresholds, NMFS developed a User Spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to help predict takes. Because of some of the assumptions included in the methods used for these tools, it is anticipated that isopleths produced are typically going to be overestimates of some degree, which may result in some degree of overestimate of Level A harassment take. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 3D modeling methods are not available, and NMFS continues to develop ways to quantitatively refine these tools, and will qualitatively address the output where appropriate. For stationary sources (such as pile drivers), NMFS User Spreadsheet predicts the closest distance at which, if a marine mammal remained at that distance the whole duration of the activity, it would not incur PTS. Inputs used in the User Spreadsheet (Table 10), and the resulting isopleths are reported below (Table 11).

Table 10. User spreadsheet input parameters used for calculating Level A harassment isopleths.

Pile Size and Installation Method	Spreadsheet Tab Used	Weighting Factor Adjustment (kHz)	Source Level at 10 m	Propagation (xLogR)	Number of Strikes Per Pile	Number of Piles Per Day	Activity Duration (seconds)
20-inch and 24-inch Vibratory Removal	A.1) Vibratory pile driving	2.5	161 dB rms	15LogR	-	3	5,400
30-inch Vibratory Removal	A.1) Vibratory pile driving	2.5	168 dB rms	16.4LogR	-	3	5,400
24-inch Vibratory Installation	A.1) Vibratory pile driving	2.5	161 dB rms	15LogR	-	3	8,100

Pile Size and Installation Method	Spreadsheet Tab Used	Weighting Factor Adjustment (kHz)	Source Level at 10 m	Propagation (xLogR)	Number of Strikes Per Pile	Number of Piles Per Day	Activity Duration (seconds)
30-inch Vibratory Installation	A.1) Vibratory pile driving	2.5	168 dB rms	16.4LogR	-	3	8,100
24-inch Impact Installation	E.1) Impact pile driving	2	177 dB SEL	15LogR	400	1 – 3[a]	-
30-inch Impact Installation	E.1) Impact pile driving	2	177 dB SEL	14.6LogR	400	1 – 3[a]	-

[a] To account for potential variations in daily productivity during impact installation, isopleths were calculated for different numbers of piles that could be installed per day (Table 1).

Table 11. Calculated Distances to Level A Harassment Isopleths

Activity	Level A Harassment Zone (m)	
	LF-Cetaceans	Otariids
20-inch and 24-inch Vibratory Removal	9	1
30-inch Vibratory Removal	25	2
24-inch Vibratory Installation	12	1
30-inch Vibratory Installation	31	2
24-inch Impact Installation (3 piles per day)	449	18
24-inch Impact Installation (2 piles per day)	343	14
24-inch Impact Installation (1 pile per day)	216	9
30-inch Impact Installation (3 piles per day)	499	18
30-inch Impact Installation (2 piles per day)	378	14
30-inch Impact Installation (1 pile per day)	235	9

Exposure Estimates

When available, peer-reviewed scientific publications were used to estimate marine mammal abundance in the project area. However, scientific surveys and resulting data such as population estimates, densities, and other quantitative information are lacking for most marine mammal populations and most areas of southeast Alaska, including Auke Bay. Therefore, AKDOT&PF gathered qualitative information from discussions with knowledgeable local people in the Auke Bay area, including biologists, the harbormaster, a tour operator, and other individuals familiar with marine mammals in the Auke Bay area.

Western DPS Steller Sea Lion

Steller sea lions are common within Auke Bay but generally only occur in the area during winter. Most individuals that frequent Auke Bay haul out at Benjamin Island in Lynn Canal. The Auke Bay boating community observes Steller sea lions transiting between Auke Bay and Benjamin Island regularly during winter. Steller sea lions are not known to haul out on any beaches or structures within Auke Bay, but animals have been observed foraging within Auke Bay, and may rest in large raft groups in the water. Groups as large as 121 individuals have been observed in Auke Bay (Ridgway pers. observ.).

ADOT&PF estimates that one large group (121 individuals) may be exposed to project-related underwater noise daily on 14 days of pile installation and removal activities, for a total of 1,694 exposures. As stated above in Section 4.3.2, 18.1 percent of Steller sea lions present in Auke Bay are expected to belong to the wDPS, for a total of 307 exposures of wDPS Steller sea lions.

The largest Level A harassment zone for otariid pinnipeds extends 18 m from the source (Table 11). ADOT&PF is planning to implement a minimum 20 m shutdown zone during all pile installation and removal activities (see Proposed Mitigation section), which will eliminate the potential for Level A take of Steller sea lions. Therefore, no takes of Steller sea lions by Level A harassment were requested or are proposed to be authorized.

Mexico DPS Humpback Whale

Humpback whales are the most commonly observed baleen whale in Southeast Alaska, particularly during spring and summer months. Use of Auke Bay by humpback whales is intermittent and irregular year-round. NMFS recently predicted that approximately two humpback whales per day may be exposed to underwater noise associated with the Statter Harbor Improvements Project (84 FR 11066; March 25, 2019). The Level B harassment zones from this project extend farther into Auke Bay and ensonify a larger area than the Statter Harbor Project. Based on observations of humpback whales within Auke Bay during winter, ADOT&PF estimates that up to four individuals may be exposed to project-related underwater sound each day during the 14 days of pile driving activities, for a total of 56 takes by Level B harassment. Based on Wade et al. (2016), the probability is that 93.9 percent of the humpback whales taken would be from the Hawaii DPS (not listed under ESA) and 6.1 percent of the humpback whales taken would be from the ESA-listed threatened Mexico DPS. Thus, it is anticipated that this action will result in four Level B exposure of Mexico DPS humpbacks (Table 12).

The largest Level A harassment zone for humpback whales extends 499 m from the source during impact installation of 30-inch piles (Table 11). PSOs are expected to detect humpback whales before they enter the Level A harassment zone and implement shutdowns to prevent take by Level A harassment. Therefore, no Level A takes have been requested nor proposed to be authorized.

Table 12. Amount of proposed incidental harassment (takes) of ESA-listed species in the proposed IHA.

Species	Proposed Authorized Level A Takes	Proposed Authorized Level B Takes
Western DPS Steller sea lion (*Eumatopias jubatus*)	0	307
Mexico DPS Humpback whale (*Megaptera novaeangliae*)	0	4
Note: Take estimates are rounded up to the nearest whole number		

In the *Response Analysis* (Section 6.3) we apply the best scientific and commercial data available to describe the species' expected responses to these exposures.

6.3 Response Analysis

As discussed in the *Approach to the Assessment* section of this opinion, 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.

Loud underwater noise can result in physical effects on the marine environment that can affect marine organisms. Possible responses by ESA-listed whales and pinnipeds to the impulsive and continuous sound produced by pile installation and removal include:

Physical Response
- Auditory threshold shifts
- Non-auditory physiological effects

Behavioral responses
- Auditory interference (masking)
- Tolerance or Habituation
- Change in dive, respiration, or feeding behavior
- Change in vocalizations
- Avoidance or Displacement
- Vigilance

This analysis also considers information on the potential effects on prey of ESA-listed species in the action area.

6.3.1 Responses to Major Noise Sources (Pile Driving and Removal)

As described in Section 6.2.1, Mexico DPS humpback whales and western DPS Steller sea lions are anticipated to occur in the action area and are anticipated to overlap with noise associated with impact and vibratory pile driving and removal activities. We assume that some individuals are likely to be exposed and respond to these impulsive and continuous noise sources.

We estimate zero Mexico DPS humpbacks and zero western DPS Steller sea lions may be exposed at noise levels loud enough, long enough, or at distances close enough to cause Level A harassment (see Section 6.2.1, *Exposure to Major Noise Sources*, Table 12). In addition, 4 Mexico DPS humpback whales and 307 western DPS Steller sea lions are likely to be exposed to noise levels sufficient to cause Level B harassment. All Level B instances of take are anticipated to occur at received levels $\geq$ 120 dB or 160 dB for continuous and impulsive noise sources respectively.

The effects of sounds from pile driving and removal might result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, and masking (Richardson et al. 1995, Nowacek et al. 2007, Southall et al. 2007). The effects of pile driving on marine mammals are dependent on several factors, including the size, type, and depth of the animal; the depth, intensity, and duration of the pile driving and hammering sound; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment. Impacts to marine mammals from pile driving and removal 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 are typically more structurally complex, which leads to rapid sound attenuation. In addition, substrates that are soft (e.g., sand) absorb or attenuate the sound more readily than hard substrates (e.g., rock), which may reflect the acoustic wave. Soft porous substrates would also likely require less time to drive the pile, and possibly less forceful equipment, which would ultimately decrease the intensity of the acoustic source.

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 high levels of pile driving sound, the short duration of pile driving operations, and movement of animals reduce the likelihood that exposure to pile driving would cause a behavioral response that may affect vital functions (reproduction or survival), or would result in temporary threshold shift (TTS) or permanent threshold shift (PTS).

Cetacean Responses (Mexico DPS Humpback Whale)

As discussed in the *Status of the Species* section, we have no data on baleen whale hearing so we assume that baleen whale vocalizations are partially representative of their hearing sensitivities. While there is no direct data on hearing in low-frequency cetaceans, the applied frequency range is anticipated to be between 7 Hz to 35 kHz (NMFS 2018).

Humpback whales produce a wide variety of sounds. 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, Winn et al. 1970b, Thompson et al. 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al. 1979). 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 (Tyack and Whitehead 1983, Silber 1986). 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).

This information leads us to conclude that humpback whales exposed to sounds produced by pile driving and removal activities are likely to respond behaviorally (as described below) if they are exposed to low-frequency sounds. However, because whales are not likely to communicate at source levels that would damage the tissues of other members of their species, this evidence suggests that received levels of up to 175-192 dB are not likely to damage the tissues of humpback whales (Thompson et al. 1986). Received levels associated with this project are not anticipated to exceed 168.2 dB.

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 (NPS 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 lower Lynn Canal, Tenakee Inlet, Whale Bay, Ketchikan, and Sitka Sound), none of which are in the action area (Baker et al. 1985, Straley 1990). However, the aggregation of some herring in the action area (inner Auke Bay) has the potential to provide a habitat where whales may feed on small volumes of fish and rest to conserve energy between foraging opportunities.

Pile driving and removal activities associated with the Auke Bay Ferry Terminal Modifications project would likely impact Mexico DPS humpback whales both physically and behaviorally from sounds produced during construction (details of probable responses are provided below). The level of this disturbance will depend on whether the whales are feeding or traveling, as well as other factors, such as the age of the animal, whether it tolerates the sound, etc. In addition to targeted studies in marine mammals indicating that frequency (beyond just differing sensitivities at different frequencies) can affect the likelihood of auditory impairment incurred, there is increasing evidence that contextual factors other than received sound level, including activity states of exposed animals, the nature and newness of the sound, and the relative spatial positions of sound and receiver, can strongly affect the probability of behavioral response (Ellison et al. 2012).

Pinniped Responses (Western DPS Steller Sea Lion)

The ability to detect sound and communicate underwater and in-air is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group with an applied frequency range between 60 and 39 kHz in water (NMFS 2018).

The action area and surrounding waters contain abundant sources of prey species, which draw Steller sea lions in to forage year-round.

Pile driving and removal activities associated with the Auke Bay Ferry Terminal Modifications project would likely impact western DPS Steller sea lions both physically and behaviorally from sounds produced during construction (details of probable responses are provided below). The level of this disturbance will depend on whether the sea lions are feeding or traveling, as well as other factors such as the age of the animal, whether it tolerates the sound, etc. In addition to targeted studies in marine mammals indicating that frequency (beyond just differing sensitivities at different frequencies) can affect the likelihood of auditory impairment incurred, there is increasing evidence that contextual factors other than received sound level, including activity states of exposed animals, the nature and newness of the sound, and the relative spatial positions of sound and receiver, can strongly affect the probability of behavioral response (Ellison et al. 2012).

Physical Responses
Systemic stressors usually elicit direct physical or physiological responses and, therefore do not require high-level cognitive processing of sensory information (Herman and Cullinan 1997, Anisman and Merali 1999, de Kloet et al. 2005, Wright et al. 2007). These physical responses are not influenced by the animal's assessment of whether a potential stressor poses a threat or risk.

Threshold Shifts
Exposure of marine mammals to very loud noise can result in physical effects, such as changes to sensory hairs in the auditory system, which may temporarily or permanently impair hearing. TTS is a temporary hearing change and its severity is dependent upon the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt 2013). TTS can last minutes to days. Full recovery is expected and this condition is not considered a physical injury. At higher received levels, or in frequency ranges where animals are more sensitive, PTS can occur. When PTS occurs, auditory sensitivity is unrecoverable (i.e., permanent hearing loss). Both TTS and PTS can result from a single pulse or from accumulated effects of multiple pulses from an impulsive sound source (i.e., impact pile driving) or from accumulated effects of non-pulsed sound from a continuous sound source (i.e., vibratory pile driving). In the case of exposure to multiple pulses, each pulse need not be as loud as a single pulse to have the same accumulated effect.

Few data are available to define the hearing range, frequency sensitivities, or sound levels necessary to induce TTS or PTS in whales and pinnipeds. The best available information for whales and pinnipeds comes from captive studies of toothed whales and California sea lions, studies of terrestrial mammal hearing, and extensive modeling (Finneran et al. 2000, Schlundt et al. 2000, Finneran et al. 2002, Finneran et al. 2003a, Nachtigall et al. 2003, Nachtigall et al. 2004, Finneran et al. 2005, Finneran et al. 2007, Lucke et al. 2009, Mooney et al. 2009a, Mooney et al. 2009b, Finneran et al. 2010a, Finneran et al. 2010b, Finneran and Schlundt 2010, Popov et al. 2011a, Popov et al. 2011b, Kastelein et al. 2012a, Kastelein et al. 2012b). Finneran et al. (Finneran et al. 2003b)(2003) exposed two California sea lions to single underwater pulses up to 183 dB re 1 μPa_{p-p} and found no measurable TTS following exposure. Southall et al. (Southall et al. 2007)estimated TTS will occur in pinnipeds exposed to a single pulse of sound at 212 dB re 1 μPa_{0-p} and PTS will occur at 218 dB re 1 μPa_{0-p}.

Based on this information, NMFS established Level A impulsive sound thresholds for low-frequency cetaceans and otariid pinnipeds in the water as 183 dB re1 $\mu Pa^2 \cdot s$, and 203 dB re1 $\mu Pa^2 \cdot s$ respectively (NMFS 2018). Considering the applicant has agreed to shut down if marine mammals approach or occur within the Level A zones, TTS and PTS are unlikely to occur.

Both duration and pressure level of a sound are factors in inducement of threshold shift. Exposure to non-pulsed sound (i.e., vibratory pile driving) may induce more threshold shift than exposure to a pulsed sound with the same energy; however, this is dependent on the duty cycle of the pulsed source (because some recovery may occur between exposures) (Kryter et al. 1966, Ward 1997). For example, the impairment caused by exposure to one high SPL pulse may equal the exposure of a lower SPL continuous sound. The low level continuous sound may also cause more impairment than a series of intermittent lower SPL sounds (Ward 1997). TTS was reported in toothed whales after exposure to relatively short, continuous sounds (ranging from 1 to 64 sec) at relatively high sound pressure levels ranging from 185 to 201 dB re 1 μPa_{rms} (Ridgway et al. 1997, Schlundt et al. 2000, Finneran et al. 2005, Finneran et al. 2007); however, toothed whales experienced TTS at lower sound pressure levels (160 to 179 dB re 1 μPa_{rms}) when exposed to continuous sounds of relatively long duration ranging from 30 to 54 min (Nachtigall et al. 2003, Nachtigall et al. 2004). Kastak et al. (2005) indicated pinnipeds exposed to continuous sounds in water experienced the onset of TTS from 152 to 174 dB re 1 μPa_{rms}.[11] Southall et al. (2007) estimated PTS will occur in pinnipeds exposed to continuous sound pressure levels of 218 dB re 1 μPa_{0-p}.

Based on this information NMFS established Level A continuous sound thresholds for low-frequency cetaceans and otariid pinnipeds in the water as 199 dB re 1 $\mu Pa^2 \cdot s$, and 219 dB re1 $\mu Pa^2 \cdot s$ respectively (NMFS 2018).

To experience TTS from a continuous source, a humpback whale will have to remain in the <7 m radius ZOI for continuous noise sources for an extended period of time, and will need to remain in the ZOI even longer to experience PTS. For Steller sea lions continuous Level A zones were smaller at up to 1 m (see Table 8). The reported radii for 24-hr SEL (Level A) thresholds are based on the assumption that marine mammals remain stationary or at a constant exposure range during the entire 24-hr period, which is an extremely unlikely scenario, though it is possible they may remain in the area if highly motivated by the presence of a food source. In this instance, it is possible that a whale could experience TTS if it chooses to remain in the ensonifed area for an extended period. Though the exact time a whale will need to remain in the ensonified area to experience threshold shift is not known. Based on the findings from Nachtigall et al. (2003) and Nachtigall et al. (2004), we estimate a whale will need to remain in the ensonified zone for tens of minutes to experience low-level TTS and likely several to tens of hours to experience PTS, if at all. Considering the applicant has agreed to shut down if marine mammals approach or occur within the Level A zones, TTS and PTS are unlikely to occur.

Non-auditory Physiological Effects

Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox et al. 2006, Southall et al. 2007). Studies examining such effects are limited. In general, little is known about the potential for pile driving or removal to cause auditory impairment or other physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would presumably be limited to short distances from the sound source and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall et al. 2007) or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of pile driving, including some cetaceans and some pinnipeds, are especially unlikely to incur auditory impairment or non-auditory physical effects.

An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (Moberg 2000). In many cases, an animal's first

[11] Values originally reported as sound exposure level of 183 to 206 dB re 1 μPa^2-s.

and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Neuroendocrine stress responses often involve the hypothalamus-pituitary-adrenal system. Virtually all neuroendocrine functions that are affected by stress (including immune competence, reproduction, metabolism, and behavior) are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction, altered metabolism, reduced immune competence, and behavioral disturbance (Blecha 2000). Increases in the circulation of glucocorticoids are also equated with stress (Romano et al. 2004).

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and "distress" is the cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose serious fitness consequences. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other functions. This state of distress will last until the animal replenishes its energetic reserves sufficient to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well-studied through controlled experiments and for both laboratory and free-ranging animals (Jessop et al. 2003, Lankford et al. 2005, Crespi et al. 2013). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker 2000, Romano et al. 2002) and, more rarely, studied in wild populations (Romano et al. 2002). For example, Rolland et al. (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. During the time following September 11, 2001, shipping traffic and associated ocean noise decreased along the northeastern U.S. This decrease in ocean noise was associated with a significant decline in fecal stress hormones in North Atlantic right whales, suggesting that chronic exposure to increased noise levels, although not acutely injurious, can produce stress (Rolland et al. 2012). These levels returned to their previous level within 24 hrs after the resumption of shipping traffic. Exposure to loud noise can also adversely affect reproductive and metabolic physiology (Kight and Swaddle 2011). In a variety of situations, including behavioral and physiological responses, females appear to be more sensitive or respond more strongly than males (Kight and Swaddle 2011).

These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as "distress."

As discussed throughout the *Response Analysis* of this opinion, we expect individuals are not likely to experience TTS or PTS, may experience masking, and may exhibit behavioral responses from project activities. Therefore, we expect ESA-listed whales and pinnipeds may experience stress responses due to the activities of this proposed action. If whales and pinnipeds are not displaced and remain in a stressful environment (i.e., within the ZOI pile driving activities), we expect the stress response will dissipate shortly after the cessation of pile driving. We do not expect significant or long-term harm to individuals from a stress response due to the temporary nature of the stressor.

Behavioral Responses

Processive stressors require high-level cognitive processing of sensory information (Herman and Cullinan 1997, Anisman and Merali 1999, de Kloet et al. 2005, Wright et al. 2007). Behavioral responses are influenced by an animal's assessment of whether a potential stressor poses a threat or risk. Behavioral responses may include: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where sound sources are located; and/or flight responses (e.g., pinnipeds flushing into water from haulouts or rookeries).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects growth, survival, or reproduction. Significant behavioral modifications that could potentially lead to effects on growth, survival, or reproduction include:

- Drastic changes in diving/surfacing patterns (such as those thought to cause beaked whale stranding due to exposure to military mid-frequency tactical sonar);
- Longer-term habitat abandonment due to loss of desirable acoustic environment; and
- Longer-term cessation of feeding or social interaction.

The onset of behavioral disturbance from anthropogenic sound depends on both external factors (characteristics of sound sources and their paths) and the specific characteristics of the receiving animals (hearing, motivation, experience, demography) and is difficult to predict (Southall et al. 2007). Below we describe some of the anticipated behavioral responses to major noise sources associated with the proposed action.

Tolerance, Habituation, and Sensitization

While numerous studies have shown that underwater sounds from industry activities are often readily detectable by marine mammals in the water at distances of many kilometers, few studies have attempted to address habituation, sensitization, or tolerance (Nowacek et al. 2007). Tolerance is defined as 'the intensity of disturbance that an individual tolerates without responding in a defined way' (Nisbet 2000). Tolerance levels can be measured instantaneously and are, therefore, more readily demonstrated than the longer-term processes of habituation or sensitization. In fact, habituation and sensitization are identified, and distinguished from each other, by the direction of change indicated by repeated measures of tolerance taken over time. Thus, over the course of a habituation process, individual tolerance levels will increase, whereas tolerance levels will conversely decrease as individuals become sensitized to specific stimuli (Bejder et al. 2009).

Despite activities occurring at distances of only a few kilometers away, oftentimes marine mammals show no apparent response or tolerance to industry activities of various types (Miller et al. 2005, Bain and Williams 2006). This is often true even in cases when the sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Weir (2008) observed marine mammal responses to seismic pulses from a 24 airgun array firing a total volume of either 5,085 in^3 or 3,147 in^3 in Angolan waters between August 2004 and May 2005. Weir recorded a total of 207 sightings of humpback whales (n = 66), sperm whales (n = 124), and Atlantic spotted dolphins (n = 17) and reported that there were no significant differences in encounter rates (sightings/hr) for humpback and sperm whales according to the airgun array's operational status (i.e., active versus silent). Based on the available information on pinnipeds in water exposed to multiple noise pulses, exposures in the ~150-180 dB re 1µ Pa range (rms values over the pulse duration) generally have limited potential to induce avoidance behavior in pinnipeds (Southall et al. 2007). This information indicates marine mammal tolerance of underwater sounds, and we anticipate that some humpback whales and Steller sea lions exposed to low frequency underwater sounds from impulsive construction activities in the proposed action may tolerate pile driving noise and show no apparent response. More information is needed in order to determine if the learned processes of habituation or sensitization are occurring over time as animals experience repeated exposures.

Masking

Masking occurs when anthropogenic sounds and marine mammal signals overlap at both spectral and temporal scales. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without resulting in threshold shift) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

For the pile driving/removal sound generated from the proposed construction activities, sound will consist of low frequency impulsive and continuous noise depending on if they are using an impact or vibratory hammer. Lower frequency anthropogenic sounds are more likely to affect detection of communication calls and other potentially important natural sounds, such as surf and prey noise. This could affect communication signals used by low frequency baleen whales when they occur near the noise band and thus reduce the communication space of animals (Clark et al. 2009) and cause increased stress levels (Foote et al. 2004, Holt et al. 2009). However, marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior by shifting call frequencies, and/or increasing call volume and vocalization rates. For example, blue whales are found to increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Lorio and Clark. 2010). In addition, the sound localization abilities of marine mammals suggest that, if signal and noise come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Richardson et al. 1995).

Noise from pile driving and removal is relatively short-term. It is possible that pile driving and removal noise resulting from this proposed action may mask acoustic signals important to western DPS Steller sea lions and Mexico DPS humpback whales, but the short-term duration (approximately 3 days), limited affected area, and pauses between operations would limit the impacts from masking. Any masking event that could possibly rise to Level B harassment under the MMPA would occur concurrently within the zones of behavioral harassment already estimated for vibratory pile driving, and which have already been taken into account in the exposure analysis.

Changes in Vocalization
Marine mammals vocalize for different purposes and across multiple modes, such as whistling, echolocation click production, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result from a need to compete with an increase in background noise or may reflect increased vigilance or a startle response.

In addition to these behavioral responses, whales alter their vocal communications when exposed to anthropogenic sounds. Communication is an important component of the daily activity of animals and ultimately contributes to their survival and reproductive success. Animals communicate to find food (Marler et al. 1986, Elowson et al. 1991), acquire mates (Ryan 1985), assess other members of their species (Parker 1974, Owings et al. 2002), evade predators (Greig-smith 1980), and defend resources (Zuberbuhler et al. 1997). Human activities that impair an animal's ability to communicate effectively might have significant effects on the survival and reproductive performance of animals experiencing the impairment.

At the same time, most animals that vocalize have evolved with an ability to make adjustments to their vocalizations to increase the signal-to-noise ratio, active space, and recognizability of their vocalizations in the face of temporary changes in background noise (Cody and Brown 1969, Brumm 2004, Patricelli and Blickley 2006). A few studies have demonstrated that marine mammals make the same kind of vocal adjustments in the face of high levels of background noise. For example, two studies reported that some mysticete whales stopped vocalizing – that is, adjusted the temporal delivery of their vocalizations – when exposed to active sonar (Miller et al. 2000, Melcon et al. 2012). Melcón et al. (2012) reported that during 110 of the 395 d-calls (associated with foraging behavior) they recorded during mid-frequency active sonar transmissions, blue whales stopped vocalizing at received levels ranging from 85 to 145 dB, presumably in response to the sonar transmissions. These d-calls are believed to attract other individuals to feeding grounds or maintain cohesion within foraging groups (Oleson et al. 2007).

Humpback whales have been observed to increase the length of their songs in the presence of potentially masking signals (Miller et al. 2000, Fristrup et al. 2003).

The Auke Bay Ferry Terminal Modifications project has the potential to cause changes in vocalization for both humpback whales and Steller sea lions.

Responses While Feeding
The absence of changes in the behavior of foraging humpback whales or Steller sea lions should not be interpreted to mean that the marine mammals were not affected by the noise. Animals that are faced with human disturbance must evaluate the costs and benefits of relocating to alternative locations; those decisions would be influenced by the availability of alternative locations, the distance to the alternative locations, the quality of the resources at the alternative locations, the conditions of the animals faced with the decision, and their ability to cope with or "escape" the disturbance (Lima and Dill 1990, Gill and Sutherland 2001, Frid and Dill. 2002, Beale and Monaghan 2004a, b, Bejder et al. 2006, Bejder et al. 2009). Specifically, animals delay their decision to flee from predatory stimuli they detect until they decide that the benefits of abandoning a location are greater than the costs of remaining at the location or, conversely, until

the costs of remaining at a location are greater than the benefits of fleeing (Ydenberg and Dills 1986). Ydenberg and Dill (1986) and Blumstein (2003) presented an economic model that recognized that animals will almost always choose to flee a site if it is only a short distance to more prey; at a greater distance, animals will make an economic decision that weighs the costs and benefits of fleeing or remaining; and at an even greater distance, animals will almost always choose not to flee. For example, in a review of observations of the behavioral responses of 122 minke whales, 2,259 fin whales, 833 right whales, and 603 humpback whales to various sources of human disturbance, Watkins (1986) reported that fin, humpback, minke, and North Atlantic right whales tolerated sounds that occurred at relatively low received levels, had most of their energy at frequencies below or above the hearing capacities of these species, or were from distant human activities and received levels were below ambient levels. Most of the negative reactions that were observed occurred within 100 m of a sound source or when sudden increases in received sound levels were judged to be in excess of 12 dB, relative to previous ambient sounds.

As a result of using this kind of economic model to consider whales' behavioral decisions, we would expect whales to continue foraging in the face of moderate levels of disturbance from this proposed action. For example, humpback whales, which only feed during part of the year and must satisfy their annual energetic needs during the foraging season, may continue foraging in the face of disturbance. Similarly, a humpback cow accompanied by her calf is less likely to flee or abandon an area at the cost of her calf's survival. By extension, we assume that both humpback whales and Steller sea lions that choose to continue their pre-disturbance behavior would have to cope with the costs of doing so, which will usually involve physiological stress responses and the associated energetic costs (Frid and Dill. 2002, MMS 2008).

Responses While Migrating and Resting
Steller sea lions are known to rest in the water by rafting together at the surface and could respond negatively to unexpected noise in the water. Steller sea lions do not migrate but sometimes travel great distances during foraging bouts or to reach prey hotspots at particular times during the year. Unexpected noise in the environment could potentially cause sea lions to avoid certain areas they use to transit to either prey hotspots or haulouts or rookeries.

Migrating whales respond more strongly to noise than do feeding whales. While we do not have information on migrating whale responses to pile driving noise, we do have information on whale responses to other impulsive noise sources, such as seismic operations. Avoidance responses of migrating humpback whales to impulsive airgun noise appear consistent with bowhead and gray whale avoidance at received levels between 150-180 dB (Richardson et al. 1995). Migrating humpbacks showed localized avoidance of operating airguns in the range of received levels 157-164 dB. In addition, humpback whales seemed more sensitive to seismic airgun noise while exhibiting resting behavior (McCauley et al. 2000). For resting humpback pods that contained cow-calf pairs, the mean airgun noise level for avoidance was 140 dB re 1 μPa rms, and a startle response was observed at 112 dB re 1μ Pa rms (McCauley et al. 2000). When calves are small, comparatively weak and possibly vulnerable to predation and exhaustion, the potential continual dislocation of these animals in a confined area would interrupt this resting and feeding stage, with potentially more serious consequences than any localized avoidance response to an operating seismic vessel as seen during their migratory swimming behavior (McCauley et al. 2000). For comparison with the proposed action, impact pile driving (also an impulsive source) is anticipated to attenuate to the 160 dB re 1 μPa rms threshold at 263 m from the source, which greatly decreases potential impact to migrating or resting whales.

Avoidance
Avoidance is the displacement of an individual from an area or migration path as a result of the presence of a sound or other stressor(s), and is one of the most obvious manifestations of disturbance in marine mammals (Richardson et al. 1995).

Studies of bowhead, gray, and humpback whales have determined that received levels of pulses in the 160-170 dB re 1 μPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed.

Avoidance is one of many behavioral responses whales and Steller sea lions may exhibit when exposed to the pile driving and removal noise from this proposed action. Other behavioral responses include: evasive behavior to escape exposure or continued exposure to a sound that is painful, noxious, or that they perceive as threatening, which we assume would be accompanied by acute stress physiology; increased vigilance of an acoustic stimulus, which would alter the animal's time budget (that is, during the time they are vigilant, they are not engaged in other behavior); and continued pre-disturbance behavior with the physiological consequences of continued exposure.

Responses of Prey Resources
As described in the *Status of Listed Species,* in Southeast Alaska, marine mammal distributions and seasonal increases in their abundance are strongly influenced by seasonal pre-spawning and spawning aggregations of forage fish, particularly Pacific herring (*Clupea pallasii*), eulachon (*Thaleichthys pacificus*) and Pacific salmon (*Onchorynchus spp.*) (Marston et al. 2002, Sigler et al. 2004, Womble et al. 2005). Coho, pink, and chum salmon are found in the action area, as well as Dolly Varden and steelhead. These are all preyed upon by Steller sea lions. There are two anadromous streams near the project location: Peterson Creek and Indian River. Herring spawning generally occurs in April and may attract sea lions and humpback whales.

Of all known Steller sea lion prey species, only Chinook and coho salmon have been studied for effects of exposure to pile driving noise (Halvorsen et al. 2012). These studies defined very high noise level exposures (SEL_{cum} of 210 dB re $1\mu Pa^2 \cdot s$) as threshold for onset of injury, and supported the hypothesis that one or two mild injuries resulting from pile driving exposure at these or higher levels are unlikely to affect the survival of the exposed animals, at least in a laboratory environment. Hart Crowser Inc. et al. (2009) studied the effects on juvenile coho salmon from pile driving of sheet piles at the Port of Anchorage in Knik Arm of Cook Inlet. The fish were exposed in-situ (in that location) to noise from vibratory or impact pile driving at distances ranging from less than 1 meter to over 30 meters. The results of this study showed no mortality of any of the test fish within 48 hours of exposure to the pile driving activities, and for the necropsied fish, no effects or injuries were observed as a result of the noise exposure (NMFS 2016d). Noise generated from pile driving can reduce the fitness and survival of fish in areas used by foraging marine mammals; however, given the small area of pile driving within the action area relative to known feeding areas in Steller sea lions, and the fact that any physical changes to this habitat would not be likely to reduce the localized availability of fish (Fay and Popper 2012), it is unlikely that western DPS Steller sea lion prey would be affected due to the project activities. In general, we expect fish will be capable of moving away from project activities if they experience discomfort. We expect the area in which stress, injury, TTS, changes in balance, or changes in prey species may occur (if at all) will be limited to a few meters directly around the pile driving and removal operations. We consider potential adverse impacts to prey resources from pile-driving and removal in the action area to be unlikely.

Studies on euphausiids and copepods, which are some of the more abundant and biologically important groups of zookplankton, have documented the use of hearing receptors to maintain schooling structures (Wiese 1996) and detection of predators (Chu et al. 1996) respectively, and therefore have some sensitivity to sound; however any effects of pile driving and removal on zooplankton would be expected to be restricted to the area within a few feet or meters of the project and would likely be sub-lethal.

No appreciable adverse impact on zooplankton populations will occur due in part to large reproductive capacities and naturally high levels of predation and mortality of these populations. Any mortality or impacts on zooplankton as a result of construction operations is immaterial as compared to the naturally-occurring reproductive and mortality rates of these species. This is consistent with previous conclusions that crustaceans (such as zooplankton) are not particularly sensitive to sound produced by even louder impulsive sounds such as seismic operations (Wiese 1996).

6.3.2 Response Summary

No Level A take of western DPS Steller sea lion or Mexico DPS humpback whales is anticipated or authorized. The maximum distance at which Steller sea lions or humpback whales may be exposed to noise levels that exceed Level A thresholds is 18 m and 500 m respectively during impact pile driving (see Table 11). At this distance a PSO can effectively monitor and shutdown operations if a Steller sea lion or humpback whale is observed. No Level A takes are anticipated.

It is anticipated that for the major noise sources associated with the proposed action (impact pile driving, vibratory pile removal and driving), the distances to the Level B isopleth (120 dB for continuous noise sources, and 160 dB for impulsive noise sources) range from 1,000 m – 8.5 km depending on the source and threshold of concern (HDR 2019a).

Based on this information, we would not anticipate humpback whales or Steller sea lions to devote attention to a noise stimulus beyond the 120 dB isopleth (for continuous noise sources), which may be more than 8.5 km from the source, and beyond the 160 dB isopleth (for impulsive noise sources) which may reach more than 1,328 m. At these distances, a marine mammal that perceives a signal is likely to ignore such a signal and devote its attention to stimuli in its local environment (that is, they would filter the sound out as background noise or ignore it) (Miller et al. 1999, Richardson 1999). Because of their distance from the noise source, we would also not anticipate humpback whales or Steller sea lions would change their behavior or experience physiological stress responses at received levels < 120 dB or <160 dB for continuous and impulsive sources, respectively; these animals may exhibit slight deflection from the noise source, but this behavior is not likely to result in adverse consequences for the animals exhibiting that behavior. Feeding humpbacks, however, may cease calling or alter vocalization at significantly lower received levels.

Those animals that are closer to the source and not engaged in activities that would compete for their attentional resources (for example, foraging) might engage in low-level avoidance behavior (changing the direction or their movement to take them away from or tangential to the source of the disturbance) possibly accompanied by short-term vigilance behavior, but they are not likely to change their behavioral state (that is, animals that are foraging or migrating would continue to do so). We do not anticipate that low-level avoidance or short-term vigilance would occur until impulsive noise levels are >140 dB for humpback whales (McCauley et al. 2000). Females and females with calves may avoid sound sources ≥ 140 dB. However, we would not anticipate the majority of individuals to show low-level avoidance until impulsive noise levels are ≥ 150 dB (Lien et al. 1993, Richardson et al. 1995, Todd et al. 1996). Again, neither low level avoidance nor short-term vigilance is likely to result in adverse consequences for the animals exhibiting the behavior.

At some distance that is closer still, these species are likely to engage in more active avoidance behavior. Of the humpback whales and Steller sea lions that may be exposed to Level B harassment noise from the proposed action, some whales and sea lions are likely to reduce the amount of time they spend at the ocean's surface, increase their swimming speed, change their swimming direction to avoid construction operations, change their respiration rates, increase dive times, increase vigilance, reduce feeding behavior, or alter vocalizations and social interactions (Richardson et al. 1986, Ljungblad et al. 1988, Richardson and Malme 1993, Greene et al. 1999, Frid and Dill. 2002, Christie et al. 2009, Koski et al. 2009, Blackwell et al. 2010, Funk et al. 2010, Melcon et al. 2012). Based on the proposed action, we would expect these kind of responses at maximum distances out to 8.5 km for vibratory pile driving, and distances out to 1,328 m for impact pile driving (Table 9) (Solstice Alaska Consulting 2018, HDR 2019a). However, these exposures are anticipated to be separated temporally considering the applicant does not anticipate more than one installation operation occurring simultaneously (HDR 2019a).

Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Disruption of such functions resulting from reactions to stressors, such as sound exposure, are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall et al. 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall et al. 2007). Note that there is a difference between multi-day substantive behavioral reactions and multi-day anthropogenic activities. The construction activities associated with the proposed project are anticipated to last three days.

Some whales or sea lions may be less likely to respond because they are feeding. The whales and sea lions that are exposed to these sounds probably would have prior experience with similar construction stressors resulting from their exposure during previous years; that experience will make some animals more likely to avoid the construction activities while others would be less likely to avoid those activities. In addition, standard mitigation measures (ramp ups and shut downs) will be in place along with monitoring measures. Some Mexico DPS humpback whales and western DPS Steller sea lions might experience physiological stress (but not distress) responses if they attempt to avoid one construction operation and encounter another construction operation while they are engaged in avoidance behavior.

Of the responses considered above, we do not expect TTS or PTS will occur. We expect masking, behavioral responses, and physical and physiological effects may occur in Mexico DPS humpback whales and western DPS Steller sea lions. Though project activities may cause interruptions in communications (masking), avoidance of the action area, and stress associated with these disruptions in exposed individual whales and pinnipeds, we expect all effects will be temporary. Prey species may experience stress, injury, TTS, or changes in balance in a small radius directly around the pile driving or removal activities or startle and disperse when exposed to sounds from project activities. We do not expect effects to prey species will be sufficient to affect ESA-listed whales or pinnipeds.

7 CUMULATIVE EFFECTS

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, which 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, per section 7 of the ESA.

We searched for information on non-Federal actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the Environmental Baseline (Section 5 of this opinion). We expect climate change, fisheries, harvest, noise, pollutants and discharges, and ship strike will continue into the future. We expect moratoria on commercial whaling and bans on commercial sealing will remain in place, aiding in the recovery of ESA-listed whales and pinnipeds.

8 INTEGRATION AND SYNTHESIS OF EFFECTS

The Integration and Synthesis 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 we discussed in the *Approach to the Assessment* section of this opinion, we begin our risk analyses 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, reproductive success, or lifetime reproductive success of those individuals.

In Section 4.1.1 we determined that it is unlikely that vessel transit will impact critical habitat surrounding haulouts and rookeries to any measurable degree considering vessels will avoid designated aquatic zones. We concluded any impacts to these PBFs are likely to be insignificant.

In Section 4.1.2 we concluded that the stressors associated with removal and replacement of piles are extremely unlikely to affect sperm whales because they are not anticipated to overlap in time and space, and the effects of ship strike associated with equipment mobilization and demobilization are also extremely unlikely to occur. Therefore, effects to sperm whales are discountable.

Mexico DPS humpback whales and western DPS Steller sea lions in the action area may be affected by:

- Climate change
  - Prey distribution
  - Habitat quality
- Fisheries interactions
- Gear and Ocean Debris Entanglement
- Subsistence harvests
- Natural and anthropogenic noise
- Pollutants and discharges
- Ship strike

Despite these pressures, available trend information indicates western DPS Steller sea lion populations are increasing. Population trends for Mexico DPS humpbacks are not known; however, Hawaii DPS humpbacks which are also in the action area are growing at an annual rate of nearly 6 percent (Muto et al. 2018).

We concluded in the *Effects of the Action* (Section 6 of this opinion) that ESA-listed whales and pinnipeds may be harassed by the proposed activities. We expect the following number of whales and sea lions to represent the maximum number of individuals that will be exposed to Level A and Level B harassment associated with the proposed action:

- 0 (Level A) and 307 (Level B) exposure of western DPS Steller sea lions
- 0 (Level A) and 4 (Level B) exposure of Mexico DPS humpback whales

We expect these exposures may cause interruptions in communication (i.e., masking) and could elicit the following behavioral responses:

- Temporary displacement from feeding areas
- Avoidance of the ensonified area

We expect low-level, brief stress responses will accompany these responses. We do not expect whales or pinnipeds exposed to these sounds will experience a reduction in fitness.

Though project activities may cause interruptions in communications (masking), avoidance of the action area, and stress associated with these disruptions in exposed individual whales and pinnipeds, we expect all effects will be temporary.

We determined effects from in-air noise and vessel strike are extremely unlikely to occur and are discountable. We determined disturbance of seafloor is not likely to have measurable impact and associated effects are insignificant. We also determined the impact from underwater noise from vessels is considered insignificant. Finally, we determined the impact from rock anchor drilling is considered insignificant.

Prey species may experience stress, injury, TTS, changes in balance, or may be displaced when exposed to sounds from project activities. We do not expect these effects will limit the prey available to ESA-listed whales or pinnipeds.

In summary, we do not expect exposure to any of the stressors related to the proposed project to reduce fitness in any individual whale or pinniped. Therefore, we do not expect fitness, reproduction, survival, or recovery consequences to ESA-listed whale or pinniped populations or species.

9 CONCLUSION

After reviewing the current status of ESA-listed species, the environmental baseline for the action area, the anticipated effects of the proposed activities, and the possible cumulative effects, it is NMFS's biological opinion that ADOT&PF's proposed Auke Bay Ferry Terminal Modifications Project and PR1's proposed issuance of an IHA to ADOT&PF for the project are not likely to jeopardize the continued existence of the following species:

- Mexico DPS Humpback whale
- Western DPS Steller sea lion

In addition, the proposed action is not likely to adversely affect the following species or critical habitat:

- Sperm whale
- Steller sea lion critical habitat

10 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the "take" of endangered species without special exemption. "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 (16 USC 1532(19)). "Incidental take" is defined as take that results from, but is not the purpose of, the carrying out of an otherwise lawful activity (50 CFR 402.02). Based on recent 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)). Only Level B takes are anticipated and authorized for the proposed action.

Under the terms of sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the 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 this Incidental Take Statement (ITS).

Section 7(b)(4)(C) of the ESA specifies that in order to provide an Incidental Take Statement for an endangered or threatened species of marine mammal, the taking must first be authorized under 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 here**. Absent such authorization, this ITS is inoperative.

The terms and conditions described below are nondiscretionary. The ADOT&PF 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 ADOT&PF and PR1 must monitor the progress of the action and its impact on the species as specified in the ITS (50 CFR 402.14(i)(3)). If the ADOT&PF or PR1 (1) fails to require the authorization holder to adhere to the terms and conditions of the ITS through enforceable terms that are added to the authorization, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

10.1 Amount or 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)).

NMFS anticipates the proposed Auke Bay Ferry Terminal Modifications Project, between January 2020 and August 2020, is likely to result in the incidental take of ESA-listed species by Level B harassment. Based on the nature of the activity and the anticipated effectiveness of the mitigation measures (discussed in detail in Section 2.1.4), Level A harassment is neither anticipated nor proposed to be authorized. As discussed in Section 6.2 of this opinion, the proposed action is expected to take the following number of ESA-listed individuals described in Table 13.

Table 13. Summary of instances of exposure associated with the proposed pile driving and removal resulting in incidental take of ESA-listed species by Level A and Level B harassment.

Species	Proposed Authorized Level A Takes	Proposed Authorized Level B Takes	Anticipated Temporal Extent of Take
Western DPS Steller sea lion (*Eumetopias jubatus*)	0	307	January 2020 through August 2020
Mexico DPS Humpback whale (*Megaptera novaeangliae*)	0	4	

While the MMPA authorization is valid for a year, construction is expected to take approximately 14 days.

Level B harassment of these individuals will occur by exposure to received sound from continuous sound sources with received sound levels of least 120 dB re 1 μPa_{rms} (i.e., vibratory pile driving), or exposure to received sound from impulsive sound sources with received sound levels of least 160 dB re 1 μPa_{rms} (i.e., impact hammering). The take estimate is based on the best available information of whale and pinniped surveys and sightings in the area that will be ensonified from the proposed activities. Death or injury is not expected or authorized for any individual whales or pinnipeds that are exposed to these sounds.

ESA-listed whales and pinnipeds observed within the ZOI during pile removal or installation will be considered to be taken, even if they exhibit no overt behavioral reactions due to the potential for unobservable physiological responses.

Any incidental take of ESA-listed whales and pinnipeds considered in this consultation is restricted to the permitted action as proposed. If the actual incidental take exceeds the predicted level or type, the ADOT&PF and PR1 must reinitiate consultation. Likewise, if the action deviates from what is described in Section 2 of this opinion, the ADOT&PF and PR1 must reinitiate consultation.

10.2 Effect of the Take

In Section 9 of this 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 western DPS Steller sea lions or Mexico DPS humpback whales.

All of the authorized takes from the proposed action are associated with behavioral harassment from acoustic noise (Section 6.2.1). Although the biological significance of behavioral responses remains unknown, this consultation has assumed that exposure to major noise sources might disrupt one or more behavioral patterns that are essential to an individual animal's life history. However, any behavioral responses of these individual whales and pinnipeds to major noise sources and any associated disruptions are not expected to affect the fitness, reproduction, survival, or recovery of these species.

10.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures to minimize the amount or extent of incidental take (50 CFR 402.02). These measures are nondiscretionary. NMFS concludes the reasonable and prudent measures described below, along with implementing terms and conditions, are necessary and appropriate to minimize or to monitor the amount of incidental take of ESA-listed whales and pinnipeds resulting from the proposed actions.

1. This ITS is valid only for the activities described in this opinion, and which have been authorized under section 101(a)(5) of the MMPA.
2. The taking of western DPS Steller sea lion and Mexico DPS humpback whales shall be by incidental harassment only. The taking by serious injury or death is prohibited by and will result in the modification, suspension, or revocation of the ITS.
3. The ADOT&PF and PR1 must implement and monitor the effectiveness of mitigation measures incorporated as part of the proposed authorization for the incidental taking of ESA-listed marine mammals pursuant to section 101(a)(5)(D) of the MMPA, as specified below. In addition, they must submit a report to NMFS AKR that evaluates the mitigation measures and reports the results of the monitoring program, as specified below.
4. As stated below in the Terms and Conditions, to implement the reasonable and prudent measures given here, the ADOT&PF and PR1 must ensure that any applicant or

contractor adheres to all portions of the description of the action (Section 2.1 Proposed Action), especially mitigation and monitoring measures described in Section 2.1.4 of this opinion.

10.4 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the ADOT&PF and PR1 must require any applicant or contractor to comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline the mitigation, monitoring, and reporting measures required by section 7 regulations (50 CFR 402.14(i)). These terms and conditions are non-discretionary. If the ADOT&PF or PR1 fail to ensure compliance with these terms and conditions and their implementing reasonable and prudent measures, the protective coverage of section 7(o)(2) may lapse.

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 implement the reasonable and prudent measure, the ADOT&PF and PR1 must ensure that any applicant or contractor adheres to all portions of the description of the action (Section 2.1 Proposed Action), especially mitigation and monitoring measures described in Section 2.1.4 of this opinion. The ADOT&PF and PR1 must also adhere to the following Terms and Conditions:[12]

1. ADOT&PF must possess a current and valid Incidental Harassment Authorization issued by NMFS PR1 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. A final PSO report and completed marine mammal observation record forms must be provided to NMFS AKR within 90 days of completion of the project and will include all items listed in Section 2.1.4. This information should be provided to David Gann at david.gann@noaa.gov.

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 endangered and threatened species. Conservation recommendations are discretionary agency suggestions to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, help implement recovery plans, or develop information (50 CFR 402.02).

We offer the following conservation recommendation, which will provide information for future consultations involving the issuance of permits that may affect ESA-listed whales and pinnipeds:

Behavioral responses of marine mammals: We recommend that PR1 summarize findings from past IHA holders about behavioral responses of ESA-listed species to sounds from rock anchor

[12] These terms and conditions are in addition to reporting required by PR1.

drilling. Better understanding of how ESA-listed species have responded to sounds from past projects will inform our exposure and response analyses in the future.

In order for the NMFS Alaska Region to stay informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their habitats, PR1 should notify the NMFS Alaska Region of any conservation recommendations it implements.

12 REINITIATION NOTICE

This concludes formal consultation on the proposed Auke Bay Ferry Terminal Project and PR1's issuance of an IHA to ADOT&PF. 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 taking specified in the ITS is exceeded;
2. New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner, or to an extent, not considered in this opinion;
3. The agency action is subsequently modified in a manner that causes an effect to the ESA-listed species, or critical habitat not considered in this opinion; or
4. A new species is ESA-listed or critical habitat designated that may be affected by the action.

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 opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

5.2 13.1 Utility

This document records the results of an interagency consultation. The information presented in this document is useful to NMFS AKR, PR1, ADOT&PF, 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.

5.3 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.

5.4 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 opinion contain more 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

ADOT&PF. 2019a. Alaska Class Ferry Vessels.

ADOT&PF. 2019b. Auke Bay Ferry Terminal Modifications & Improvements Scoping.

ADOT&PF. 2019c. Request for Consultation under Section 7 of the Endangered Species Act (ESA) for the Proposed Auke Bay Ferry Terminal Modifications Project in Juneau Alaska.

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**:16-27.

Anisman, H., and Z. Merali. 1999. Understanding stress: Characteristics and caveats. Alcohol Research and Health **23**:241-249.

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

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., 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**:1103-1110.

Bain, D. E., and R. Williams. 2006. Long-range effects of airgun noise on marine mammals: Responses as a function of received sound level and distance. IWC Scientific Committee, St. Kitts and Nevis, West Indies.

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. Report submitted to the National Marine Mammal Laboratory, Seattle, Washington, Kewalo Basin Marine Mammal Laboratory, University of Hawaii, Honolulu, HI.

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**:304-323.

Bauer, G. B., and L. M. Herman. 1986. Effects of vessel traffic on the behavior of humpback whales in Hawai'i. Report Submitted to NMFS Southwest Region, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Western Pacific Program Office; Honolulu, Hawai'i.

Beale, C. M., and P. Monaghan. 2004a. Behavioural responses to human disturbance: a matter of choice? Animal Behaviour **68**:1065-1069.

Beale, C. M., and P. Monaghan. 2004b. Human disturbance: people as predation-free predators? Journal of Applied Ecology **41**:335-343.

Bejder, L., A. Samuels, H. Whitehead, H. Finn, and S. Allen. 2009. Impact assessment research: use and misuse of habituation, sensitisation and tolerance to describe wildlife responses to anthropogenic stimuli. Marine Ecology Progress Series **395**:177-185.

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**:1791-1798.

Bettridge, S., C. S. Baker, J. Barlow, P. J. 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. NOAA-TM-NMFS-SWFSC-540, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, La Jolla, California.

Blackwell, S. B., K. H. Kim, W. C. Burgess, R. G. Norman, and C. R. Greene. 2010. Underwater sounds near Northstar during late summer and autumn of 2005-2009. Pages 4-1 to 4-57 *in* W. J. Richardson, editor. Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea: Comprehensive report for 2005–2009.

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. CAB International, Oxon.

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

Brumm, H. 2004. The impact of environmental noise on song amplitude in a territorial bird. Journal of Animal Ecology **73**:434-440.

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. U. R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of populations, levels of abundance and status of humpback whales in the North Pacific. U.S. Department of Commerce, Western Administrative Center, Seattle, Washington.

Calkins, D. G., and K. W. Pitcher. 1982. Population assessment, ecology, and trophic relationships of Steller sea lion in the Gulf of Alaska. Pages 447-546 Environmental assessment of hte Alaska continental shelf. U.S. Department of Commerce and U.S. Department of Interior, Juneau, AK.

Caltrans. 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish.

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. Page 55 Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Christie, K., C. Lyons, W. R. Koski, D. S. Ireland, and D. W. Funk. 2009. Patterns of bowhead whale occurrence and distribution during marine seismic operations in the Alaskan Beaufort Sea. Page 55 Eighteenth Biennial Conference on the Biology of Marine Mammals, Quebec City, Canada.

Chu, K., C. Sze, and C. Wong. 1996. Swimming behaviour during the larval development of the shrimp *Metapenaeus ensis* (De Haan, 1844)(Decapoda, Penaeidae). Crustaceana **69**:368-378.

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**:382-391.

Clark, C. W., W. T. Ellison, B. L. Southall, L. Hatch, S. M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: Intuitions, analysis, and

implication. Marine Ecology Progress Series **395**:201-222.
Cody, M. L., and J. H. Brown. 1969. Song Asynchrony in Neighbouring Bird Species. Nature **222**:778-781.
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.
Crespi, E. J., T. D. Williams, T. S. Jessop, and B. Delehanty. 2013. Life history and the ecology of stress: how do glucocorticoid hormones influence life-history variation in animals? Functional Ecology **27**:93-106.
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.
de Kloet, E. R., M. Joels, and F. Holsboer. 2005. Stress and the brain: From adaptation to disease. Nature Reviews Neuroscience **6**:463-475.
Denes, S. L., G. A. Warner, M. E. Austin, and A. O. MacGillivray. 2016. Hydroacoustic pile driving noise study - comprehensive report. Document 001285, Version 2.0. Technical report by JASCO Applied Sciences for Alaska Department of Transportation & Public Facilities. .
Di Lorio, L., and C. W. Clark. 2010. Exposure to seismic survey alters blue whale acoustic communication. Biology Letters **6**:51-54.
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. 2012. Climate change impacts on marine ecosystems. Marine Science **4**.
Ellison, W., B. Southall, C. Clark, and A. Frankel. 2012. A New Context-Based Approach to Assess Marine Mammal Behavioral Responses to Anthropogenic Sounds. Conservation Biology **26**:21-28.
Elowson, A. M., P. L. Tannenbaum, and C. T. Snowdon. 1991. Food-associated calls correlate with food preferences in cotton-top tamarins. Animal Behaviour **42**:931-937.
Erbe, C. 2002. Hearing abilities of baleen whales. Atlantic report CR 2002-065. Contract Number: W7707-01-0828. Defence R&D Canada.
Everitt, R., C. Fiscus, and R. DeLong. 1980. Northern Puget Sound marine mammals. Interagency Energy. Environment R & D Program Report, US EPA, EPA-600/7-80-139. US EPA, Washington, DC.
Fair, P. A., and P. R. Becker. 2000. Review of stress in marine mammals. Journal of Aquatic Ecosystem Stress and Recovery **7**:335-354.
Fay, R. R., and A. N. Popper. 2012. Fish hearing: New perspectives from two senior bioacousticians. Brain, Behavior and Evolution **79**:215-217.
Ferguson, M. C., C. Curtice, and J. Harrison. 2015. Biologically important areas for cetaceans within U.S. waters - Gulf of Alaska region. Aquatic Mammals **41**:65-78.
Finneran, J. J., D. A. Carder, and S. H. Ridgway. 2003a. Temporary threshold shift (TTS) measurements in bottlenose dolphins (*Tursiops truncatus*), belugas (*Delphinapterus leucas*), and California sea lions (*Zalophus californianus*). Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, Texas
Finneran, J. J., D. A. Carder, C. E. Schlundt, and R. L. Dear. 2010a. Temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) exposed to intermittent tones. Journal of the Acoustical Society of America **127**:3267-3272.

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**:2696-2705.

Finneran, J. J., R. Dear, D. A. Carder, and S. H. Ridgway. 2003b. Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer. Journal of the Acoustical Society of America **114**:1667-1677.

Finneran, J. J., D. S. Houser, P. W. Moore, B. K. Branstetter, J. S. Trickey, and S. H. Ridgway. 2010b. A method to enable a bottlenose dolphin (*Tursiops truncatus*) to echolocate while out of water. Journal of the Acoustical Society of America **128**:1483-1489.

Finneran, J. J., and C. E. Schlundt. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (*Tursiops truncatus*). Journal of the Acoustical Society of America **128**:567-570.

Finneran, J. J., and C. E. Schlundt. 2013. Effects of fatiguing tone frequency on temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*). Journal of the Acoustical Society of America **133**:1819-1826.

Finneran, J. J., C. E. Schlundt, B. Branstetter, and R. L. Dear. 2007. Assessing temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) using multiple simultaneous auditory evoked potentials. Journal of the Acoustical Society of America **122**:1249-1264.

Finneran, J. J., C. E. Schlundt, R. Dear, D. A. Carder, and S. H. Ridgway. 2000. Masked temporary threshold shift (MTTS) in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America **108**:2515.

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**:2929-2940.

Foote, A. D., R. W. Osborne, and A. R. Hoelzel. 2004. Environment - Whale-call response to masking boat noise. Nature **428**:910-910.

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.

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

Frazer, L. N., and E. Mercado III. 2000. A sonar model for humpback whale song. Ieee Journal of Oceanic Engineering **25**: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**:1-16.

Fristrup, K. M., L. T. Hatch, and C. W. Clark. 2003. Variation in humpback whale (Megaptera novaeangliae) song length in relation to low-frequency sound broadcasts. The Journal of the Acoustical Society of America **113**:3411-3424.

Fritz, L., K. Sweeney, D. Johnson, M. Lynn, T. Gelatt, and J. Gilpatrick. 2013. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) conducted in Alaska in June-July 2008 through 2012, and an update on the status and trend of the western distinct population segment in Alaska. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center.

Funk, D. W., R. Rodrigues, D. S. Ireland, and W. R. Koski. 2010. Summary and assessment of potential effects on marine mammals. Pages 11-11 - 11-59 *in* I. D. Funk DW, Rodrigues R, and Koski WR, editor. 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.
Gill, J. A., and W. J. Sutherland. 2001. Predicting the consequences of human disturbance from behavioral decisions. Pages 51-64 *in* L. M. Gosling and W. J. Sutherland, editors. Behavior and Conservation. Cambridge University Press, Cambridge.
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.
Greene, C. R., N. S. Altman, W. J. Richardson, and R. W. Blaylock. 1999. Bowhead Whale Calls. Page 23 Marine Mammal and Acoustical Monitoring of Western Geophysical's Open-Water Seismic Program in the Alaskan Beaufort Sea, 1998. LGL Ecological Research Associates, Inc, King City, Ontario, Canada.
Greig-smith, P. W. 1980. Parental investment in nest defense by stonechats (*Saxicola torquata*). Animal Behaviour **28**:604-619.
Halvorsen, M. B., B. M. Casper, C. M. Woodley, T. J. Carlson, and A. N. Popper. 2012. Threshold for onset of injury in Chinook salmon from exposure to impulsive pile driving sounds. PLoS ONE **7**:e38968.
Hart Crowser. 2009. Acoustic Monitoring and In-situ Exposures of Juvenile Coho Salmon to Pile Driving at the Port of Anchorage Marine Terminal Redevelopment Project Knik Arm, Anchorage, Alaska. October 2009.
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, I. 2019a. Auke Bay Ferry Terminal Modifications and Improvements Project Application for Marine Mammal Protection Act Incidental Harassment Authorization.
HDR, I. 2019b. Biological Assessment
Auke Bay Ferry Terminal Modifications and Improvements Project.
HDR, I. 2019c. Marine Mammal Monitoring and Mitigation Plan for the Auke Bay Ferry Terminal Modifications and Improvements Project.
HDR, I. 2019d. Updates to Auke Bay Ferry Terminal Design.
Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-Caused Injury and Mortality of NMFS-managed Alaska Marine Mammal Stocks 2010-2014.
Herman, J. P., and W. E. Cullinan. 1997. Neurocircuitry of stress: Central control of the hypothalamo-pituitary-adrenocortical axis. Trends in Neurosciences **20**:78-84.
Holt, M. M., D. P. Noren, V. Veirs, C. K. Emmons, and S. Veirs. 2009. Speaking up: Killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America **125**:EL27-EL32.
IPCC. 2013. 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.
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.
Jemison, L. A., G. W. Pendleton, L. W. Fritz, K. K. Hastings, J. M. Maniscalco, A. W. Trites, and T. S. Gelatt. 2013. Inter-population movements of Steller sea lions in Alaska with implications for population separation. PLoS ONE **8**:e70167.
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. Alaska Sea Grant College Program, University of Alaska Fairbanks.
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**:161-170.
Kajimura, H., and T. R. Loughlin. 1988. Marine mammals in the oceanic food web of the eastern subarctic Pacific. Bulletin of the Ocean Research Institute, University of Tokyo **26**:187-223.
Kastak, D., B. L. Southall, R. J. Schusterman, and C. R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. Journal of the Acoustical Society of America **118**:3154-3163.
Kastelein, R. A., R. Gransier, L. Hoek, and C. A. F. d. Jong. 2012a. The hearing threshold of a harbor porpoise (*Phocoena phocoena*) for impulsive sounds (L). Journal of the Acoustical Society of America **132**:607-610.
Kastelein, R. A., R. Gransier, L. Hoek, and J. Olthuis. 2012b. Temporary threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4 kHz. Journal of the Acoustical Society of America **132**:3525-3537.
Kelly K. Hastings*, M. J. R., Gregory M. O'Corry-Crowe, Grey W. Pendleton, Lauri, and a. T. S. G. 11 A. Jemison. 2019. Demographic consequences and characteristics of recent population mixing and colonization in Steller sea lions, Eumetopias jubatus. Journal of Mammalogy.
Kight, C. R., and J. P. Swaddle. 2011. How and why environmental noise impacts animals: an integrative, mechanistic review. Ecology Letters.
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. J., and B. L. Wing. 1984. Hydroacoustic Surveys and Identification of Humpback Whale Forage in Glacier Bay, Stephens Passage, and Frederick Sound, Southeastern Alaska Summer 1983. NMFS; Auke Bay Lab., Auke Bay, AK.
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.
Kucey, L. 2005. Human disturbance and the hauling out behavior of steller sea lions

(*Eumetopias jubatus*). University of British Columbia, British Columbia.
Kucey, L., and A. W. Trites. 2006. A Review of the Potential Effects of Disturbance on Sea Lions: Assessing Response and Recovery. Pages 581-589 Sea Lions of the World. Alaska Sea Grant College Program, AK-SG-06-01.
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**:35-75.
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**: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.
Lien, J., S. Todd, P. Stevick, F. Marques, and D. Ketten. 1993. The reaction of humpback whales to underwater explosions: orientation, movements, and behavior. Journal of the Acoustical Society of America **94**:1849.
Lima, S. L., and L. M. Dill. 1990. Behavioral decisions made under the risk of predation - a review and prospectus. Canadian Journal of Zoology-Revue Canadienne De Zoologie **68**:619-640.
Ljungblad, D. K., B. Wursig, S. L. Swartz, and J. M. Keene. 1988. Observations on the behavioral responses of bowhead whales (Balaena mysticetus) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic **41**:183-194.
Loughlin, T. R. 1986. Incidental mortality of northern sea lions in Shelikof Strait, Alaska.
Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Molecular Genetics of Marine Mammals **Spec. Pub. 3**:159-171.
Lucke, K., U. Siebert, P. A. Lepper, and M.-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. Journal of the Acoustical Society of America **125**:4060-4070.
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**:125-136.
Marler, P., A. Dufty, and R. Pickert. 1986. Vocal communication in the domestic chicken. 1. Does a sender communicate information about the quality of a food referent to a receiver. Animal Behaviour **34**:188-193.
Marston, B. H., M. F. Willson, and S. M. Gende. 2002. Predator aggregations during eulachon *Thaleichthys pacificus* spawning runs. Marine Ecology Progress Series **231**:229-236.
Mathias, D., A. M. Thode, J. Straley, J. Calambokidis, G. S. Schorr, and K. Folkert. 2012. Acoustic and diving behavior of sperm whales (Physeter macrocephalus) during natural and depredation foraging in the Gulf of Alaska. The Journal of the Acoustical Society of America **132**:518-532.
McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys - a study of environmental implications. APPEA Journal **40**:692-708.
McLean, K., pers. comm. 2017. Response to Additional Information Request Biorka Island Dock Reconstruction Project. From Kristi McLean (R&M consultations, INC) to Alicia Bishop (NMFS) regarding tension anchor installation and vessel use. Received Monday October

9, 2017.
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**:e32681.
Miller, G., V. Moulton, R. Davis, M. Holst, P. Millman, A. MacGillivray, and D. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001-2002. Offshore oil and gas environmental effects monitoring/Approaches and technologies. Battelle Press, Columbus, OH:511-542.
Miller, G. W., R. E. Elliot, W. R. Koski, V. D. Moulton, and W. J. Richardson. 1999. Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL, Ltd.
Miller, P. J. O., N. Biassoni, A. Samuels, and P. L. Tyack. 2000. Whale songs lengthen in response to sonar. Nature **405**:903-903.
MMS (Mineral Management Service). 2008. Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 Draft environmental impact statement Alaska OCS Region, Anchorage, AK.
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.
Mooney, T. A., P. E. Nachtigall, M. Breese, S. Vlachos, and W. W. L. Au. 2009a. Predicting temporary threshold shifts in a bottlenose dolphin (*Tursiops truncatus*): The effects of noise level and duration. Journal of the Acoustical Society of America **125**:1816-1826.
Mooney, T. A., P. E. Nachtigall, and S. Vlachos. 2009b. Sonar-induced temporary hearing loss in dolphins. Biology Letters **5**:565-567.
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**:241-248.
Mueter, F. J., C. Broms, K. F. Drinkwater, K. D. Friedland, J. A. Hare, G. L. Hunt, W. Melle, and M. Taylor. 2009. Ecosystem responses to recent oceanographic variability in high-latitude Northern Hemisphere ecosystems. Progress in Oceanography **81**:93-110.
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. 2017. Alaska marine mammal stock assessments, 2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-355.
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. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-378, 382 p.
Nachtigall, P. E., J. L. Pawloski, and W. W. L. Au. 2003. Temporary threshold shifts and recovery following noise exposure in the Atlantic bottlenosed dolphin (*Tursiops truncatus*). Journal of the Acoustical Society of America **113**:3425-3429.

Nachtigall, P. E., A. Y. Supin, J. L. Pawloski, and W. W. L. Au. 2004. Temporary threshold shifts after noise exposure in the bottlenose dolphin (*Tursiops truncatus*) measured using evoked auditory potentials. Marine Mammal Science **20**:672-687.

Navy, U. S. 2015. Proxy source sound levels and potential bubble curtain attenuation for acoustic modeling of nearshore marine pile driving at Navy installations in Puget Sound.

NCEI. 2019. State of the climate: global analysis for annual 2019. . National Centers for Environmental Information, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

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 **2012**:18.

Nisbet, I. C. 2000. Disturbance, habituation, and management of waterbird colonies. Waterbirds:312-332.

NMFS. 1991. Recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

NMFS. 1995. Status review of the United States Steller sea lion (Eumetopias jubatus) population. NOAA, NMFS, AFSC, National Marine Mammal Laboratory, Seattle, Washington.

NMFS. 2008a. Recovery Plan for the Steller Sea Lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Servies, Silver Spring, MD.

NMFS. 2008b. Recovery plan for the Steller sea lion (*Eumetopias jubatus*). Revision. Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, Maryland.

NMFS. 2008c. Recovery plan for the Steller sea lion (*Eumetopias jubatus*). Revision. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS. 2016a. Humpback whale (*Megaptera novaeangliae*). Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, http://www.nmfs.noaa.gov/pr/species/mammals/whales/humpback-whale.html.

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

NMFS. 2016c. Protected Resources Division, Alaska Region Marine Mammal Stranding Database. Accessed 10/18/2016.

NMFS. 2016d. Recovery Plan for the Cook Inlet Beluga Whale (*Delphinapterus leucas*). National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

NMFS. 2018. Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

NMFS. 2019. Request for Consultation under Section 7 of the Endangered Species Act (ESA) for the Proposed Issuance of an Incidental Harassment Authorization to Take Marine Mammals Incidental to the O'Connell Bridge Lightering Float Pile Replacement Project in Sitka, Alaska.

Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack. 2007. Responses of cetaceans

to anthropogenic noise. Mammal Review **37**:81-115.
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.
Oleson, E. M., S. M. Wiggins, and J. A. Hildebrand. 2007. The impact of non-continuous recording on cetacean acoustic detection probability. Page 19 3rd International Workshop on the Detection and Classification of Marine Mammals Using Passive Acoustics, Boston, MA
Owings, D. H., M. P. Rowe, and A. S. Rundus. 2002. The rattling sound of rattlesnakes (*Crotalus viridis*) as a communicative resource for ground squirrels (*Spermophilus beecheyi*) and burrowing owls (*Athene cunicularia*). Journal of Comparative Psychology **116**:197-205.
Parker, G. A. 1974. Courtship Persistence and Female-Guarding as Male Time Investment Strategies. Behaviour **48**:157-184.
Patricelli, G. L., and J. L. Blickley. 2006. Avian communication in urban noise: Causes and consequences of vocal adjustment. Auk **123**:639-649.
Payne, K., and R. Payne. 1985. Large scale changes over 19 years in songs of humpback whales in Bermuda. Zeitschrift fur Tierpsychologie **68**: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.
Pitcher, K. W., P. F. Olesiuk, R. F. Brown, M. S. Lowry, S. J. Jeffries, J. L. Sease, W. L. Perryman, C. E. Stinchcomb, and L. F. Lowry. 2007. Abundance and distribution of the eastern North Pacific Steller sea lion (*Eumetopias jubatus*) population. Fishery Bulletin **107**:102-115.
PND Engineers, I. 2011. Statter Harbor Improvements Sound Study DH08-081.
Popov, V. V., V. O. Klishin, D. I. Nechaev, M. G. Pletenko, V. V. Rozhnov, A. Y. Supin, E. V. Sysueva, and M. B. Tarakanov. 2011a. Influence of acoustic noises on the white whale hearing thresholds. Doklady Biological Sciences **440**:332-334.
Popov, V. V., A. Y. Supin, D. Wang, K. Wang, L. Dong, and S. Wang. 2011b. Noise-induced temporary threshold shift and recovery in Yangtze finless porpoises *Neophocaena phocaenoides asiaeorientalis*. Journal of the Acoustical Society of America **130**:574-584.
Raum-Suryan, K. L., L. A. Jemison, and K. W. Pitcher. 2009. Entanglement of Steller sea lions (Eumetopias jubatus) in marine debris: identifying causes and finding solutions. Marine Pollution Bulletin **58**:1487-1495.
Raum-Suryan, K. L., K. W. Pitcher, D. G. Calkins, J. L. Sease, and T. R. Loughlin. 2002. Dispersal, rookery fidelity, and metapopulation structure of Steller sea lions (Eumetopias jubatus) in an increasing and a decreasing population in Alaska. Marine Mammal Science **18**:746-764.
Research, N. 2012. Southeast Alaska Vessel Traffic Study, Revision 1.
Richardson, W. J. 1999. Marine mammal and acoustical monitoring of Western Geophysical's openwater seismic program in the Alaskan Beaufort Sea, 1998. . TA2230-3, Report from LGL Ltd., King City, Ontario, and Greeneridge Sciences Inc., Santa Barbara, CA, for western Geophysical, Houston, TX and National Marine fisheries Service, Anchorage, AK.

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.

Richardson, W. J., and C. I. Malme. 1993. Man-made noise and behavioral responses. Pages 631-700 *in* J. J. Burns, J. J. Montague, and C. J. Cowles, editors. The Bowhead Whale. Society for Marine Mammology, .

Richardson, W. J., B. Wursig, and C. R. Greene. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. Journal of the Acoustical Society of America **79**:1117-1128.

Ridgway, S. H., D. A. Carder, R. R. Smith, T. Kamolnick, C. E. Schlunt, and W. R. Elsberry. 1997. Behavioural responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncatus*, to 1-second tones of 141 to 201 dB re 1 μPa. Naval Command, Control and Surveillance Center, RDT&E Division, San Diego, California.

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**:308-317.

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 of London Series B Biological Sciences **279**:2363-2368.

Romano, T., M. Keogh, C. Kelly, P. Feng, L. Berk, C. Schlundt, D. Carder, and 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**:1124-1134.

Romano, T. A., J. Olschowka, S. Felten, V. Quaranta, S. Ridgway, and D. Felten. 2002. Immune response, stress, and environment: Implications for cetaceans. Cell and Molecular Biology of Marine Mammals; CJ Pfeiffer, ed. Krieger Publishing Co., Inc.

Ryan, M. J. 1985. The túngara frog: a study in sexual selection and communication. The University of Chicago Press, Chicago, IL.

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

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**:3496-3508.

SEASWAP. 2017. Sperm Whale Data Tracker. Accessed September 7, 2017 at: http://seaswap.info/whaletracker/.

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**:85-96.

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**:725-730.

Sigler, M. F., J. N. Womble, and J. J. Vollenweider. 2004. Availability to Steller sea lions (Eumetopias jubatus) of a seasonal prey resource: a prespawning aggregation of eulachon (Thaleichthys pacificus). Canadian Journal of Fisheries and Aquatic Sciences **61**:1475-1484.

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**: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**: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**:19-26.

Solstice Alaska Consulting, I. 2018. Request for an Incidental Harassment Authorization

City and Borough of Sitka

O'Connell Bridge Lightering Float Pile Replacement Project.

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**:411-521.

Stafford, K. M., D. K. Mellinger, S. E. Moore, and C. G. Fox. 2007. Seasonal variability and detection range modeling of baleen whale calls in the Gulf of Alaska, 1999-2002. Journal of the Acoustical Society of America **122**:3378-3390.

Straley, J., T. O'Connell, S. Mesnick, L. Behnken, and J. Liddle. 2005. Sperm whale and longline fisheries interactions in the Gulf of Alaska. North Pacific Research Board R0309 Final Report:15.

Straley, J., G. Schorr, A. Thode, J. Calambokidis, C. Lunsford, E. Chenoweth, V. O. Connell, and R. Andrews. 2014. Depredating sperm whales in the Gulf of Alaska: local habitat use and long distance movements across putative population boundaries. Endangered Species Research **24**:125-135.

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.

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**: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, S., P. Stevick, J. Lien, F. Marques, and D. Ketten. 1996. Behavioural effects of exposure to underwater explosions in humpback whales (*Megaptera novaeangliae*). Canadian Journal of Zoology-Revue Canadienne De Zoologie **74**:1661-1672.

Tyack, P., and H. Whitehead. 1983. Male competition in large groups of wintering humpback whales. Behaviour **83**:132-154.

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

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**:619-642.

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**: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.

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

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**:6-15.

Watkins, W. A. 1986. Whale Reactions to Human Activities in Cape-Cod Waters. Marine Mammal Science **2**:251-262.

Weir, C. R. 2008. Overt responses of humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and Atlantic spotted dolphins (*Stenella frontalis*) to seismic exploration off Angola. Aquatic Mammals **34**:71-83.

Wiese, K. 1996. Sensory capacities of euphausiids in the context of schooling. Marine & Freshwater Behaviour & Phy **28**:183-194.

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.

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

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

Winn, H. E., and N. E. Reichley. 1985. Humpback whale, *Megaptera novaeangliae* (Borowski, 1781). Pages 241-274 *in* S. H. Ridgway and S. R. Harrison, editors. Handbook of marine mammals. Academic Press, London, England.

Womble, J. N., M. F. Sigler, and M. F. Willson. 2009. Linking seasonal distribution patterns with prey availability in a central-place forager, the Steller sea lion. Journal of Biogeography **36**:439-451.

Womble, J. N., M. F. Willson, M. F. Sigler, B. P. Kelly, and G. R. VanBlaricom. 2005. Distribution of Steller sea lions Eumetopias jubatus in relation to spring-spawning fish in SE Alaska. Marine Ecology Progress Series **294**:271-282.

Wright, A. J., N. A. Soto, A. Baldwin, M. Bateson, C. Beale, C. Clark, T. Deak, E. Edwards, A. Fernandez, A. Godinho, L. Hatch, A. Kakuschke, D. Lusseau, D. Martineau, L. Romero, L. Weilgart, B. Wintle, G. Notarbartolo Di Sciara, and V. Martin. 2007. Anthropogenic noise as a stressor in animals: A multidisciplinary perspective. International Journal of Comparative Psychology **201**:250-273.

WSDOT. 2016. Underwater Sound Level Report: Vashon Test Pile Project 2016.
Ydenberg, R. C., and L. M. Dills. 1986. The economics of fleeing from predators. Advances in the Study of Behavior **16**:229-249.
Zuberbuhler, K., R. Noe, and R. M. Seyfarth. 1997. Diana monkey long-distance calls: Messages for conspecifics and predators. Animal Behaviour **53**:589-604.