LIST OF APPENDICES

APPENDIX A: DETERMINATION OF MITIGATION ZONES

During the planning phase, mitigation zones for the proposed marine seismic surveys were calculated based on modeling by L-DEO for the Level B (160 dB re 1µPa_{rms}) threshold. Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010, provided as Appendix H in the PEIS) as a function of distance from the airguns, for the two 45-in^3 GI airguns. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (~1600 m), intermediate water depth on the slope (~600–1100 m), and shallow water (~50 m) in the GoM in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

For deep and intermediate-water cases, the field measurements cannot be used readily to derive mitigation radii, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 m, which may not intersect all the sound pressure level (SPL) isopleths at their widest point from the sea surface down to the maximum relevant water depth (~2000 m) for marine mammals (Costa and Williams 1999). Figures 2 and 3 in Appendix H of the PEIS show how the values along the maximum SPL line that connects the points where the isopleths attain their maximum width (providing the maximum distance associated with each sound level) may differ from values obtained along a constant depth line. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the mitigation model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant. The results are summarized below.

In deep and intermediate-water depths, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (Fig. 12 and 14 in Appendix H of the PEIS). Consequently, isopleths falling within this domain can be predicted reliably by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At greater distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (Fig. 11, 12, and 16 in Appendix H of the PEIS). Aside from local topography effects, the region around the critical distance (~5 km in Fig. 11 and 12, and ~4 km in Fig. 16 in Appendix H of the PEIS) is where the observed levels rise closest to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Fig. 11, 12, and 16 in Appendix H of the PEIS). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for conservatively estimating mitigation radii. In shallow water (<100 m), the depth of the calibration hydrophone (18 m) used during the GoM calibration survey was appropriate to sample the maximum sound level in the water column, and the field measurements reported in Table 1 of Tolstoy et al. (2009) for the 36-airgun array at a tow depth of 6 m can be used to derive mitigation radii.

The proposed surveys would acquire data with two 45-in^3 GI airguns at a tow depth of 4 m. For deep water (>1000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m (Fig. A-1).

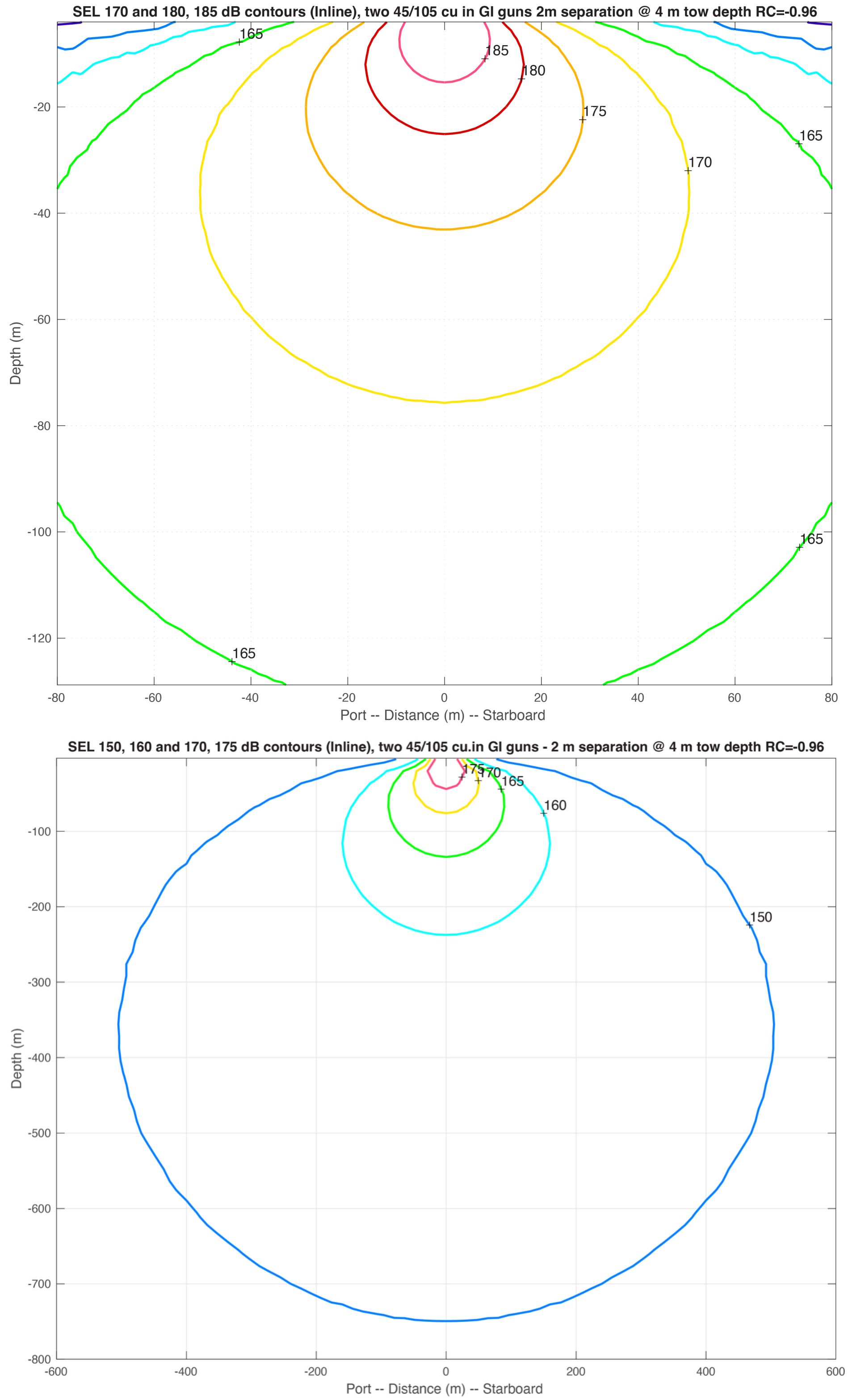

FIGURE A-1. Modeled deep-water received sound exposure levels (SELs) from the two 45-in^3 GI guns, with a 2-m GI airgun separation, at a 4 m two depth, planned for use during the proposed surveys at the Cascadia Subduction Zone. Received rms levels (SPLs) are expected to be ~10 dB higher. The radius to the 150-dB SEL isopleth is a proxy for the 160-dB rms isopleth. The upper plot is a zoomed-in version of the lower plot.

Table A-1 shows the distances at which the 160- and 175-dB re 1µPa_{rms} sound exposure levels (SEL)[7] are expected to be received for the 2-GI airgun array at the maximum 4-m tow depth in deep water. The 160-dB level is the behavioral disturbance criterion that is used to estimate anticipated Level B takes for marine mammals; a 175-dB level is used by NMFS, as well as the U.S. Navy (DON 2017), to determine behavioral disturbance for sea turtles. A recent retrospective analysis of acoustic propagation of R/V *Langseth* sources in a coastal/shelf environment from the Cascadia Margin off Washington suggests that predicted (modeled) radii (using an approach similar to that used here) for R/V *Langseth* sources were 2–3 times larger than measured in shallow water, so in fact, as expected, were very conservative (Crone et al. 2014). Similarly, data collected by Crone et al. (2017) during a survey off New Jersey in 2014 and 2015 confirmed that in situ measurements and estimates of the 160- and 180-dB distances collected by R/V *Langseth* hydrophone streamer were 2–3 times smaller than the predicted operational mitigation radii. In fact, five separate comparisons conducted of the L-DEO model with in situ received level[8] have confirmed that the L-DEO model generated conservative mitigation zones, resulting in significantly larger zones than required by NMFS.

TABLE A-1. Level B. Predicted distances to the 160 and 175-dB re 1 µPa_{rms} sound levels that could be received from two 45/105 in^3 GI guns (at a tow depth of 4 m) that would be used during the seismic surveys at the Cascadia Subduction Zone.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted distance (in m) to the 160-dB Received Sound Level	Predicted distance (in m) to the 175-dB Received Sound Level
Two 45-in^3 GI guns, 2-m separation distance	4	>1000 m	505	89

[7] SEL (measured in dB re 1 µ$Pa^2 \cdot s$) is a measure of the received energy in the pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period. Because actual seismic pulses are less than 1 s in duration in most situations, this means that the SEL value for a given pulse is usually lower than the SPL calculated for the actual duration of the pulse. In this EA, we assume that rms pressure levels of received seismic pulses would be 10 dB higher than the SEL values predicted by L-DEO's model.

[8] L-DEO surveys off the Yucatán Peninsula in 2004 (Barton et al. 2006; Diebold et al. 2006), in the Gulf of Mexico in 2008 (Tolstoy et al. 2009; Diebold et al. 2010), off Washington and Oregon in 2012 (Crone et al. 2014), and off New Jersey in 2014 and 2015 (Crone et al. 2017).

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APPENDIX B: DETERMINATION OF LEVEL A RADII

In July 2016, NMFS released technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (NMFS 2016, 2018). The guidance established new thresholds, at the time, for permanent threshold shift (PTS) onset or Level A Harassment (injury), for marine mammal species. The noise exposure criteria for marine mammals accounted for newly-available scientific data on temporary threshold shifts (TTS), the expected offset between TTS and PTS thresholds, differences in the acoustic frequencies to which different marine mammal groups are sensitive, and other relevant factors, as summarized by Finneran (2016). Thresholds differed for various hearing groups including low-frequency (LF) cetaceans (e.g., baleen whales), mid-frequency (MF) cetaceans (e.g., most delphinids), high-frequency (HF) cetaceans (e.g., harbor porpoise and *Kogia* spp.), phocids underwater (PW), and otariids underwater (OW) (NMFS 2018).

Southall et al. (2019) provided updated scientific recommendations regarding noise exposure criteria which were similar to those presented by NMFS (2018), but included all marine mammals (including sirenians) and a re-classification of hearing groups. NMFS (2024) incorporated Southall et al. (2019) recommendations into updated guidance regarding noise exposure criteria. The new guidance incorporates marine mammal auditory weighting functions (Fig. B-1) and dual metrics of cumulative sound exposure level (SEL_{cum} over 24 hours) and peak sound pressure levels (SPL_{flat}). Different thresholds for various hearing groups were provided by NMFS (2024), including for LF cetaceans, HF cetaceans (e.g., most delphinids; previously known as mid-frequency cetaceans), very-high frequency (VHF) cetaceans (e.g., porpoise and *Kogia* spp.; previously known as HF cetaceans), PW, and OW. Thresholds are also available for sea turtles (DoN 2017).

The thresholds for PTS onset for marine mammals and sea turtles for impulsive sounds, such as airgun pulses, use dual metrics of cumulative sound exposure level (SEL_{cum} over 24 hours) and peak sound pressure levels (SPL_{flat}). Onset of PTS is assumed to be 15 dB higher when considering SEL_{cum} and 6 dB higher when considering SPL_{flat}. Per NMFS (2024), the largest distance of the dual criteria (SEL_{cum} or Peak SPL_{flat}) was used to calculate Level A takes and threshold distances for marine mammals. Below we provide the methodology for determining the Level A radii for the two 45-in^3 GI airguns, with 2-m aft-fore, and a two depth of 4 m.

The SEL_{cum} for the array is derived from calculating the modified farfield signature. The farfield signature is often used as a theoretical representation of the source level. To compute the farfield signature, the source level is estimated at a large distance directly below the array (e.g., 9 km), and this level is back projected mathematically to a notional distance of 1 m from the array's geometrical center. However, it has been recognized that the source level from the theoretical farfield signature is never physically achieved at the source when the source is an array of multiple airguns separated in space (Tolstoy et al. 2009). Near the source (at short ranges, distances <1 km), the pulses of sound pressure from each individual airgun in the source array do not stack constructively as they do for the theoretical farfield signature.

The pulses from the different airguns spread out in time such that the source levels observed or modeled are the result of the summation of pulses from a few airguns, not the full array (Tolstoy et al. 2009). At larger distances, away from the source array center, sound pressure of all the airguns in the array stack coherently, but not within one time sample, resulting in smaller source levels (a few dB) than the source level derived from the farfield signature. Because the farfield signature does not take into account the large array effect near the source and is calculated as a point source, the farfield signature is not an appropriate measure of the sound source level for large arrays.

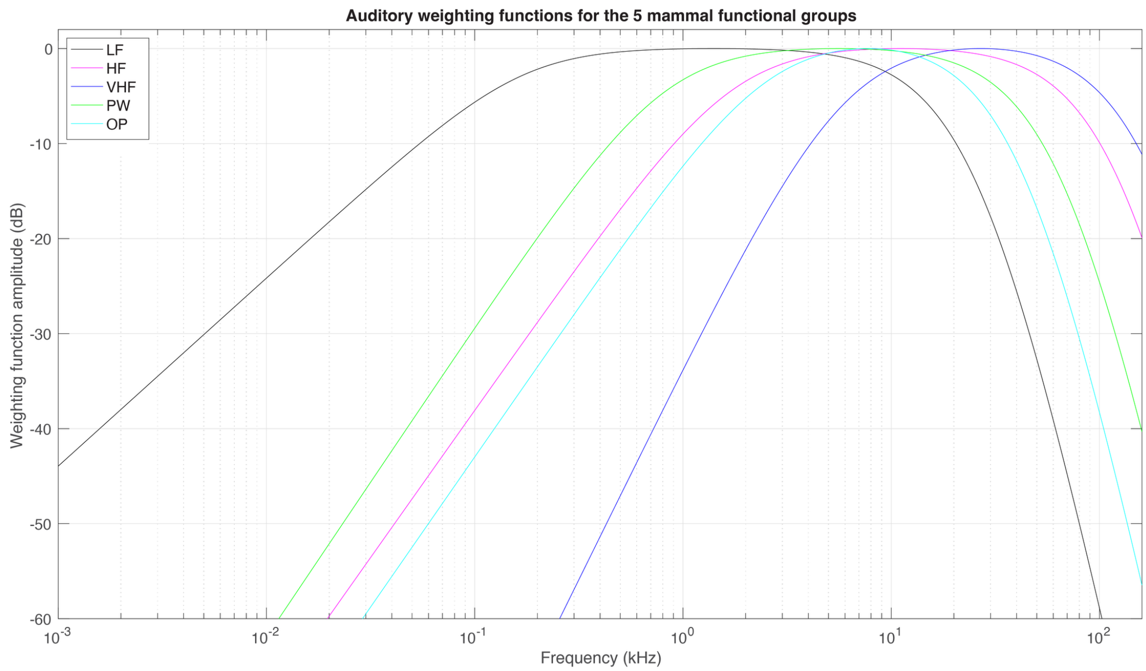

FIGURE B-1. Auditory weighting functions for five marine mammal hearing groups from the NMFS Technical Guidance Spreadsheet.

To estimate SEL_{cum} and Peak SPL, we used the acoustic modeling developed at L-DEO (same as used for Level B takes) with a small grid step in both the inline and depth directions. The propagation modeling takes into account all airgun interactions at short distances from the source including interactions between subarrays which we do using the NUCLEUS software to estimate the notional signature and the MATLAB software to calculate the pressure signal at each mesh point of a grid.

PTS onset acoustic thresholds estimated in the NMFS User Spreadsheet rely on overriding the default values and calculating individual adjustment factors (dB) based on the modified farfield and by using the difference between levels with and without weighting functions for each of the five categories of hearing groups. The new adjustment factors in the spreadsheet allow for the calculation of SEL_{cum} isopleths and account for the accumulation (Safe Distance Methodology) using the source characteristics (source velocity and duty) after Sivle et al. (2014).

SEL_{cum} methodology† (spreadsheet – Sivle et al. 2014)

Source Velocity (meters/second)	2.5722 *
1/Repetition rate^ (seconds)	4.862 **

† Methodology assumes propagation of 20 log R; Activity duration (time) independent
^ Time between onset of successive pulses.
* 5 kts
** 12.5 m at 5 knots (this shot spacing is conservative relative to the longer shot spacing of 25 m).

For the low-frequency cetaceans, we estimated a new adjustment value by computing the distance from the geometrical center of the source to where the 183 dB SEL cum isopleth is the largest. We first run the modeling for one single shot without applying any weighting function. The maximum 183 dB SEL_{cum} isopleth is located at 14.1 m from the source. We then run the modeling for one single shot with the low-frequency cetaceans weighting function applied to the full spectrum. The maximum 183 dB SEL_{cum} isopleth is located at 8.45 m from the source. Difference between 14.1 and 8.45 gives an adjustment factor of 4.45 dB (Table B-1) assuming a propagation of 20log10(R).

However, for HF and VHF cetaceans (and OW and PW pinnipeds, the modeling for a single shot with the weighted function applied leads to 0-m isopleths; the adjustment factors thus cannot be derived the same way as for LF cetaceans. Hence, the difference between weighted and unweighted spectral source levels at each frequency up to 3 kHz was integrated to actually calculate these adjustment factors in dB. These calculations also account for the accumulation (Safe Distance Methodology) using the source characteristics (duty cycle and speed) after Sivle et al. (2014).

For the 2-GI airgun array, the results for single shot SEL source level modeling are shown in Table B-1. The weighting function calculations, thresholds for SEL_{cum}, and the distances to the PTS thresholds for the array are shown in Table B-2. Figure B-2 shows the impact of weighting functions by hearing group. Figures B-3–B-5 show the modeled received sound levels for single shot SEL without applying auditory weighting functions for various hearing groups. Figure B-6 shows the modeled received sound levels for single shot SEL with weighting for LF cetaceans.

TABLE B-1. One single SEL SL modeling without and with applying weighting function to the 5 hearing groups. The modified farfield signature is estimated using the distance from the source array geometrical center to where the SEL_{cum} threshold is the largest. A propagation of 20 log10 (Radial distance) is used to estimate the modified farfield SEL.

SEL_{cum} Threshold	**183**	**193**	**159**	**183**	**185**	**184**
Distance(m) (no weighting function)	14.1095	4.4093	239.0067	14.1095	11.2000	12.4020
Modified Farfield SEL*	205.9902	205.8874	206.5682	205.9902	205.9844	205.8698
Distance (m) (with weighting function)	8.4492	N/A	N/A	N/A	N/A	N/A
Adjustment (dB)	-4.4539	N/A	N/A	N/A	N/A	N/A

* Propagation of 20 log R. N/A = not applicable.

TABLE B-2. Results for single shot SEL source level modeling for the two 45-in^3 GI airguns, at a 5 kt speed and 12.5 m shot interval, with weighting function calculations for SEL_{cum} criteria.

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	
PROJECT/SOURCE INFORMATION	source : SIO portable system = 2 x 45/105 cu.in GI-gun at a 4m towed depth - 2m separation
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	NA	Override WFA: Using LDEO modeling

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

NOTE: LDEO modeling relies on Method F2

F2: ALTERNATIVE METHOD[†] TO CALCULATE PK and SEL_{cum} (SINGLE STRIKE/SHOT/PULSE EQUIVALENT)

SEL_{cum}

Source Velocity (meters/second)	2.5722
1/Repetition rate^ (seconds)	4.86

†Methodology assumes propagation of 20 log R; Activity duration (time) independent

^Time between onset of successive pulses.

Modified farfield SEL	205.9902	205.8874	206.5682	205.9902	205.9844	205.8698
Source Factor	8.17304E+19	7.98185E+19	9.33649E+19	8.17304E+19	8.16213E+19	7.94957E+19

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	High-Frequency Cetaceans	Very High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds	Sea Turtles
SEL_{cum} Threshold	183	193	159	183	185	184
AUD INJ SEL_{cum} Isopleth to threshold (meters)	**17.9**	**0.0**	**0.0**	**0.3**	**0.0**	**6.0**

WEIGHTING FUNCTION CALCULATIONS

Marine Mammal Weighting Function Parameters	Low-Frequency Cetaceans	High-Frequency Cetaceans	Very High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds	Sea Turtles	Sea Turtle weighting (inverse audiogram)
a	0.99	1.55	2.23	1.63	1.58	225.1	Wo
b	5	5	5	5	5	41.56	A
f_1	0.168	1.73	5.93	0.81	2.53	39640	F1
f_2	26.6	129	186	68.3	43.8	0.08069	F2
C	0.12	0.32	0.91	0.29	1.37	1.944	B
Adjustment (dB)†	**-4.45**	**-30.56**	**-56.32**	**-22.67**	**-34.52**	**-8.0714**	

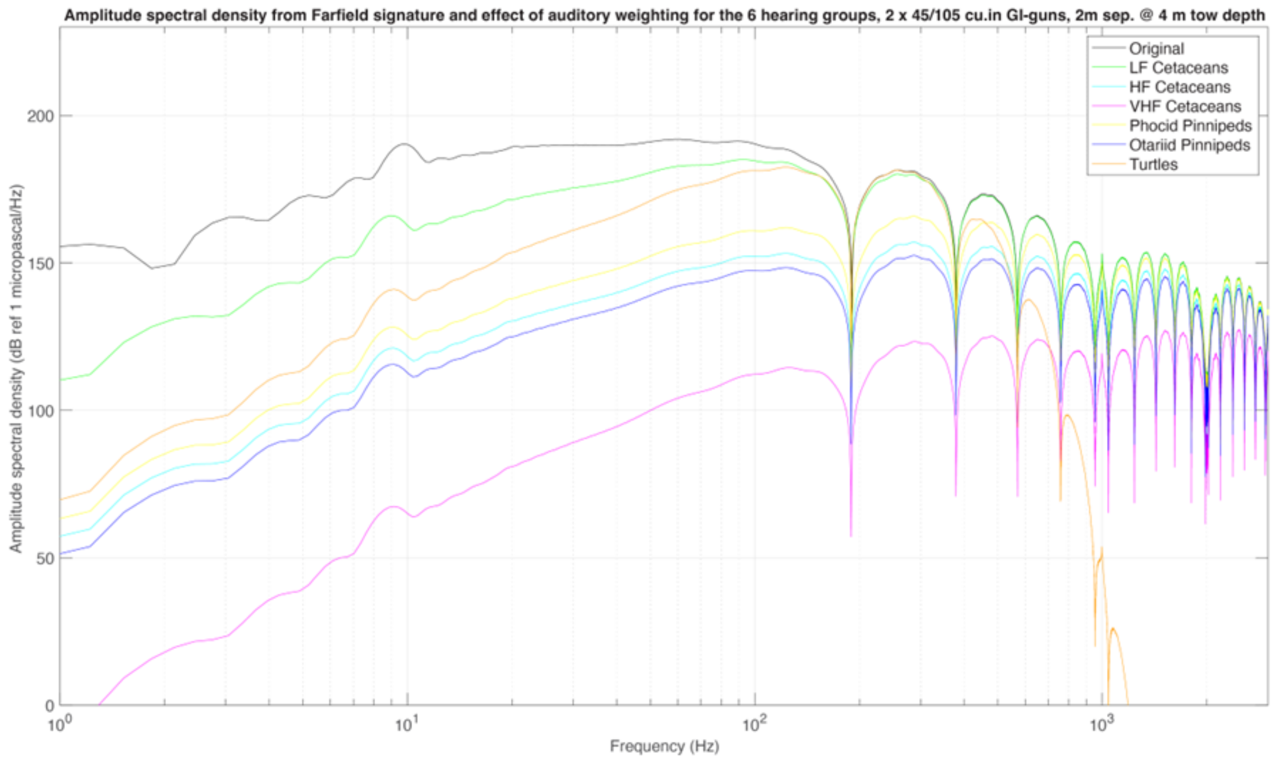

FIGURE B-2. Modeled amplitude spectral density of the two 45-in^3 GI airgun farfield signature. Amplitude spectral density before (black) and after (colors) applying the auditory weighting function for the low-frequency (LF) cetaceans, high-frequency (HF) cetaceans, very high-frequency (VHF) cetaceans, phocids, otariids, and sea turtles. Modeled spectral levels in micropascals are used to calculate the difference between the unweighted and weighted source level at each frequency and to derive the adjustment factors for the phocid pinnipeds, otariid pinnipeds, mid-frequency cetaceans, and high-frequency cetaceans as inputs into the NMFS user spreadsheet.

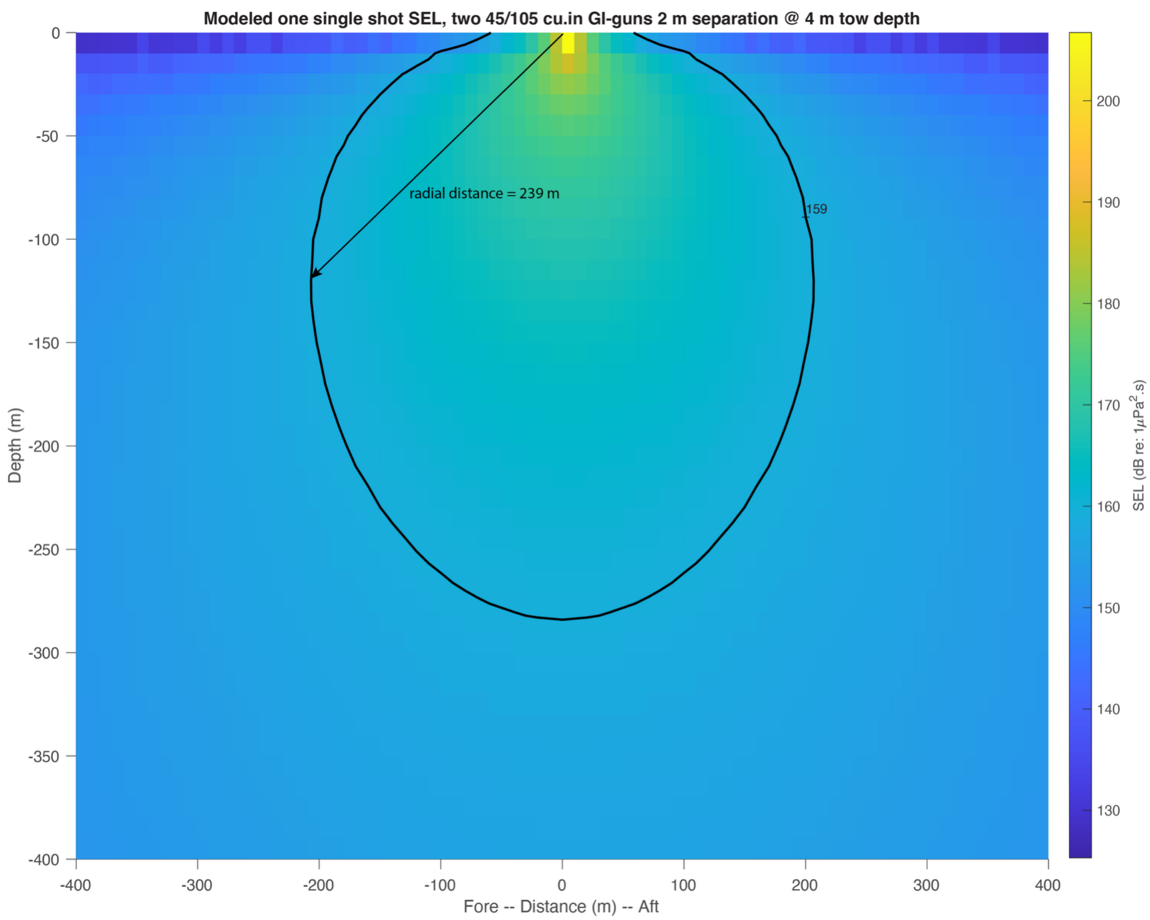

FIGURE B-3. Modeled received sound levels (SELs) in deep water from the two 45 in^3 GI aiguns at a 4-m tow depth. The plot provides the distance from the geometrical center of the source array to the 159-dB SEL isopleth.

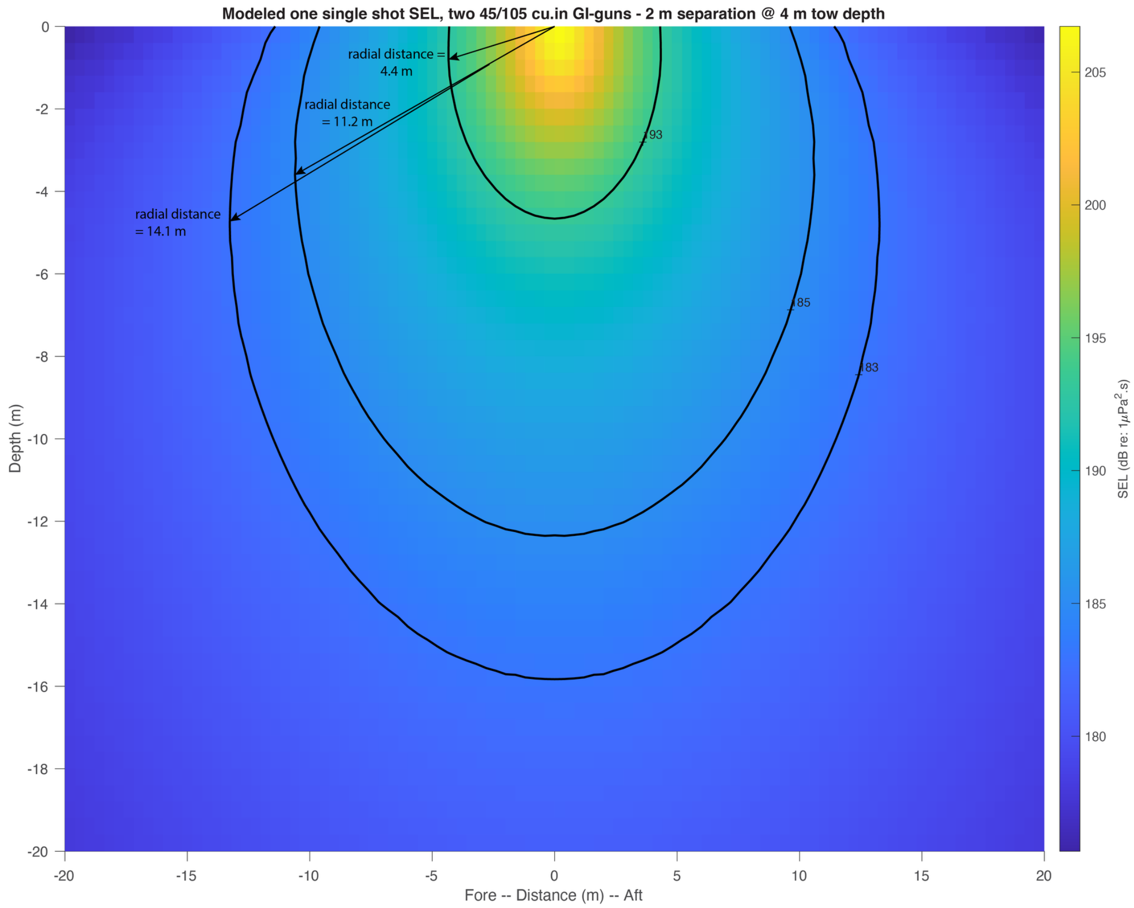

FIGURE B-4. Modeled received sound levels (SELs) in deep water from the two 45 in^3 GI aiguns at a 4-m tow depth. The plot provides the distance from the geometrical center of the source array to the 183, 185, and 193 dB isopleths.

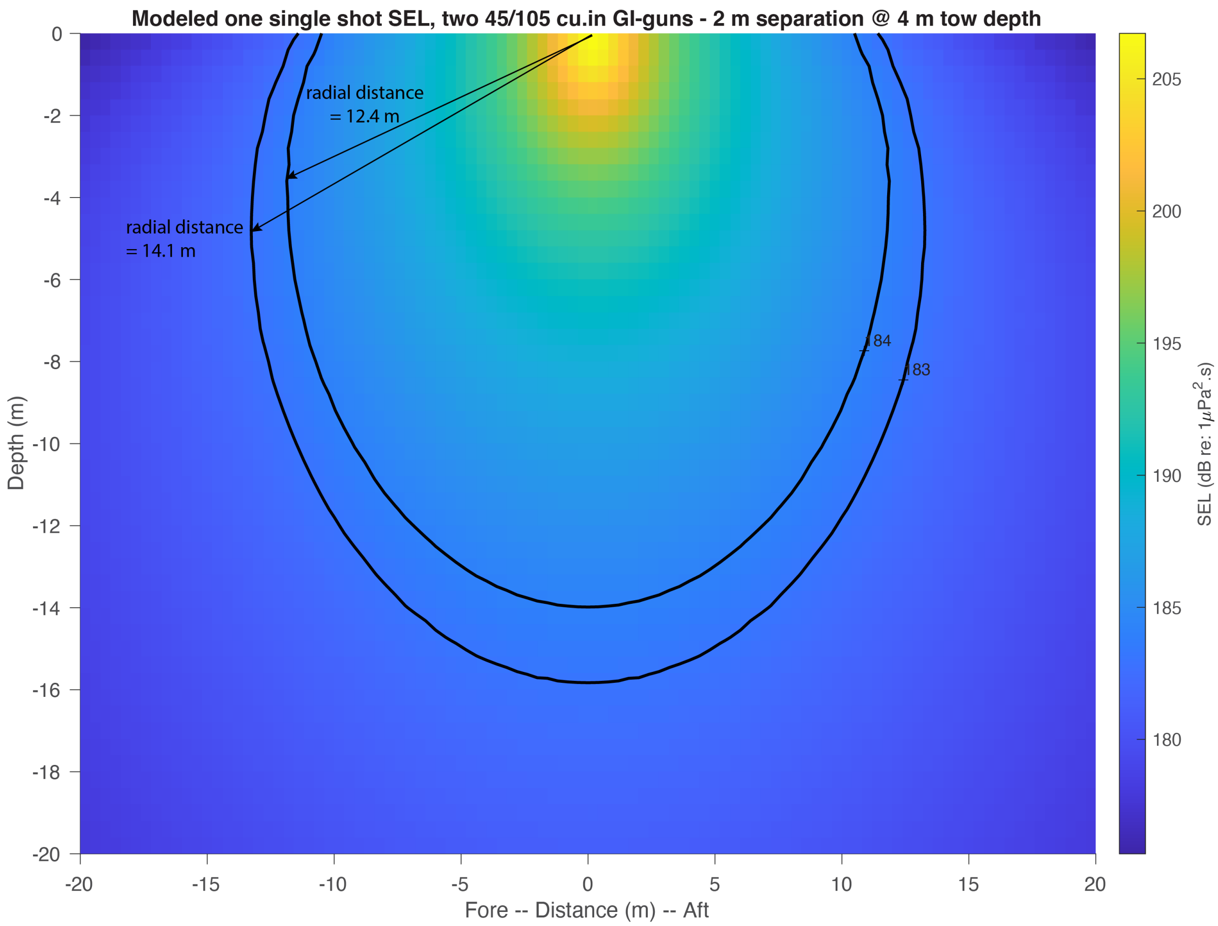

FIGURE B-5 : Modeled received sound levels (SELs) in deep water from the two 45 in^3 GI airguns at a 4-m tow depth. The plot provides the distance from the geometrical center of the source array to the 183 and 184 dB SEL isopleths.

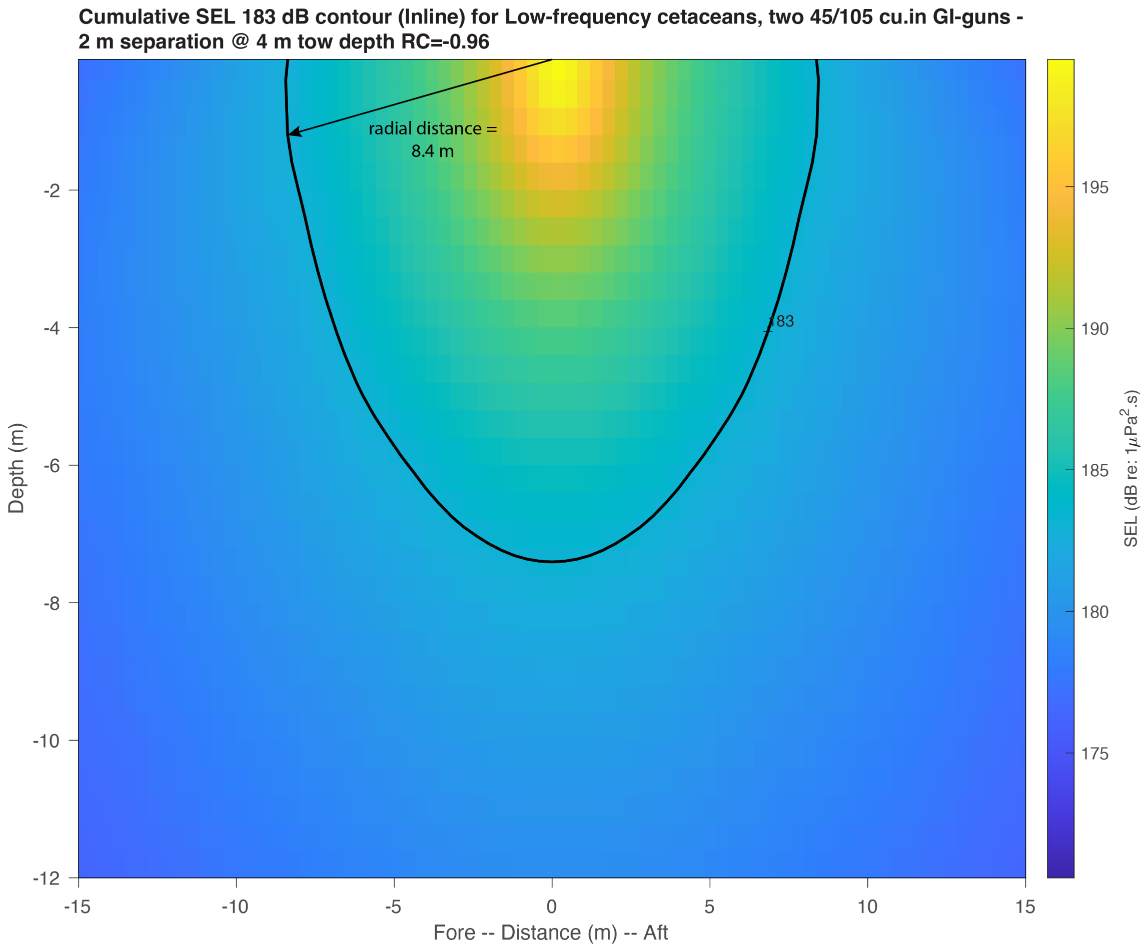

FIGURE B-6: Modeled received sound exposure levels (SELs) from the two 45 in^3 GI-airguns at a 4-m tow depth, after applying the auditory weighting function for the low-frequency cetaceans hearing group following the NMFS technical guidance. The plot provides the radial distance to the 183-dB SEL_{cum} isopleth for one shot. The difference in radial distances between Fig. B-4 (14.1 m) and this figure (8.4 m) allows us to estimate the adjustment in dB.

Peak Sound Pressure Level

The thresholds for Peak SPL_{flat} for the 2-GI airgun array, as well as the distances to the PTS thresholds, are shown in Table B-3. Figures B-7–B-9 show the modeled received sound levels to the Peak SPL_{flat} thresholds, for a single shot.

TABLE B-3. Level A. NMFS Level A acoustic thresholds (Peak SPL_{flat}) for impulsive sources for marine mammals and predicted radial distances to Level A thresholds for various marine mammal hearing groups and sea turtles that could be received from the two 45 in^3 GI airguns (separated by 2 m) at a 4 m tow depth during the proposed seismic surveys.

Hearing Group	Low-Frequency Cetaceans	High-Frequency Cetaceans	Very High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds	Sea Turtles
PK Threshold	222	230	202	223	230	232
Radius to threshold (m)	4.0	1.3	37.5	3.5	1.3	0.8

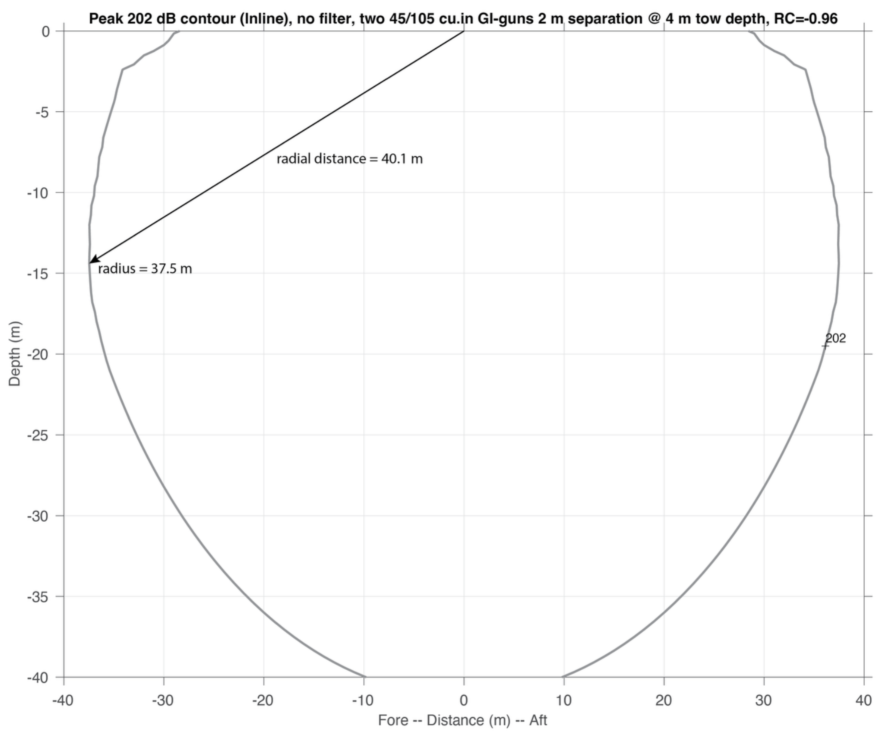

FIGURE B-7: Modeled deep-water received Peak SPL from two 45 in^3 GI airguns at a 4-m tow depth. The plot provides the radius of the 202-dB peak isopleth.

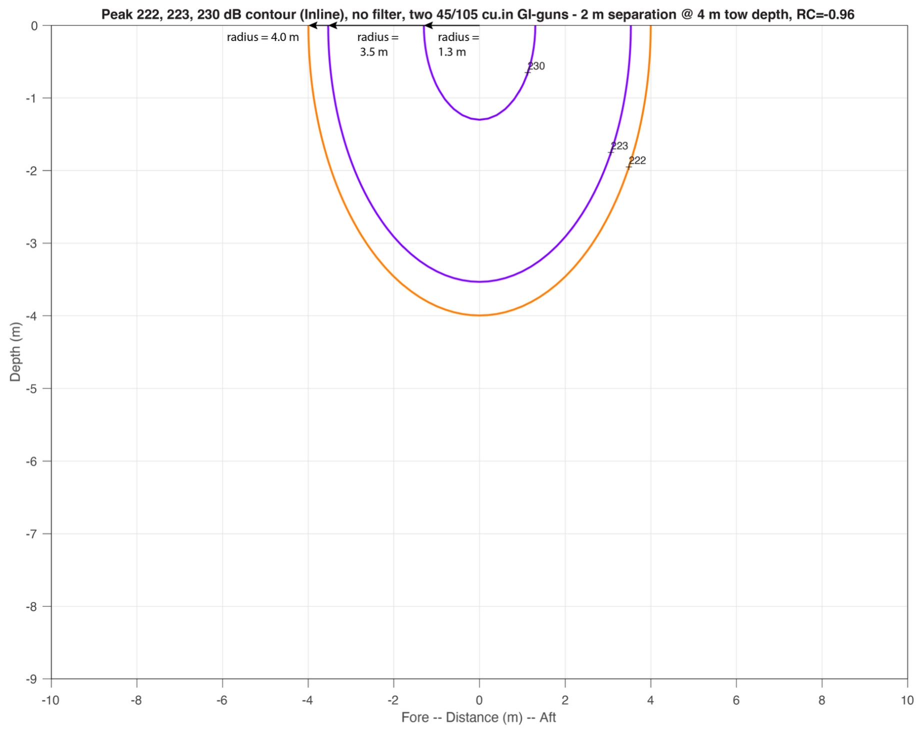

FIGURE B-8: Modeled deep-water received Peak SPL from two 45 in^3 GI airguns at a 4-m tow depth. The plot provides the radii of the 222, 223, and 230 dB peak isopleths.

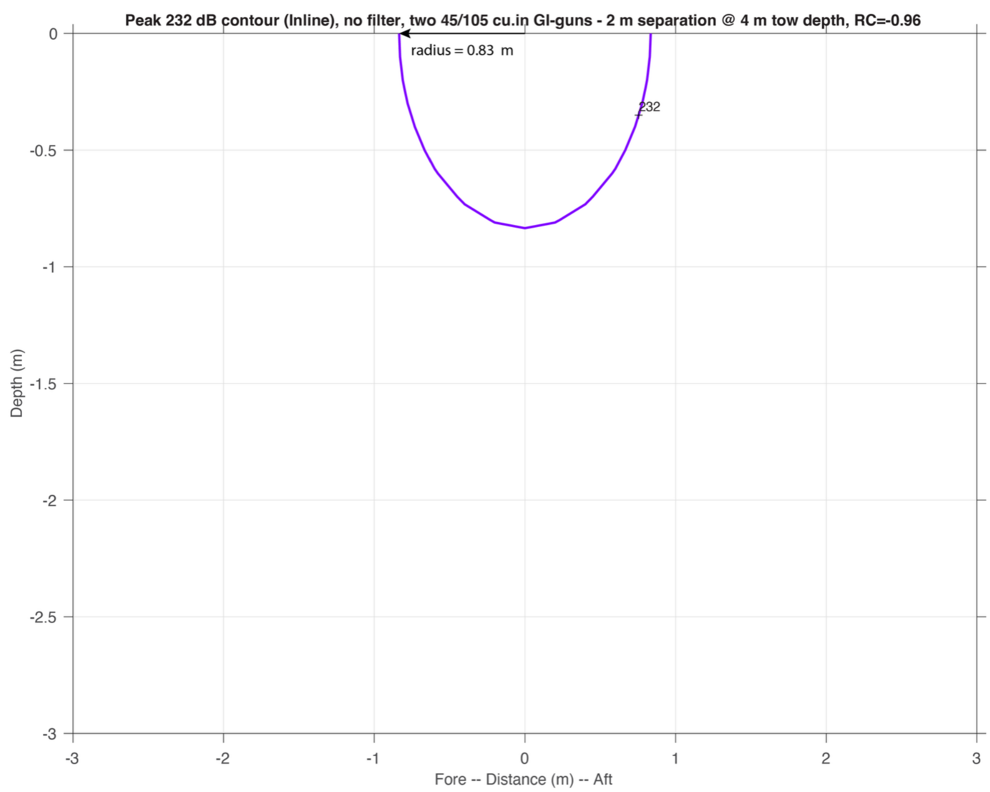

FIGURE B-9: Modeled deep-water received Peak SPL from two 45 in^3 GI airguns at a 4-m tow depth. The plot provides the radius of the 232 dB peak isopleth.

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APPENDIX C: MARINE MAMMAL OCCURRENCE

Mysticetes

North Pacific Right Whale *(Eubalaena japonica)*

North Pacific right whales summer in the northern North Pacific, primarily in the Okhotsk Sea (Brownell et al. 2001) and in the Bering Sea (Shelden et al. 2005; Wade et al. 2006). This species is divided into western and eastern North Pacific stocks. The eastern North Pacific stock that occurs in U.S. waters numbers only ~31 individuals (Wade et al. 2011a; Young et al. 2024), and critical habitat has been designated in the eastern Bering Sea and in the Gulf of Alaska, south of Kodiak Island (NOAA 2022). Wintering and breeding areas are unknown, but have been suggested to include the Hawaiian Islands, Ryukyu Islands, and Sea of Japan (Allen 1942; Banfield 1974; Gilmore 1978; Reeves et al. 1978; Herman et al. 1980; Omura 1986).

Whaling records indicate that right whales once ranged across the entire North Pacific north of 35ºN and occasionally occurred as far south as 20ºN (Kenney 2018). Although right whales were historically reported off the coast of Oregon, occasionally in large numbers (Scammon 1874; Rice and Fiscus 1968), extensive shore-based and pelagic commercial whaling operations never took large numbers of the species south of Vancouver Island (Rowlett et al. 1994). Nonetheless, Gilmore (1956) proposed that the main wintering ground for North Pacific right whales was off the Oregon coast and possibly northern California, postulating that the inherent inclement weather in those areas discouraged winter whaling (Rice and Fiscus 1968).

Since the 1960s, North Pacific right whale sightings have been relatively rare (e.g., Clapham et al. 2004; Shelden et al. 2005). However, starting in 1996, right whales have been seen regularly in the southeast Bering Sea, including calves in some years (e.g., Goddard and Rugh 1998; LeDuc et al. 2001; Moore et al. 2000, 2002a; Wade et al. 2006; Zerbini et al. 2009; Matsuoka et al. 2021); they have also been detected acoustically there (McDonald and Moore 2002; Munger et al. 2003; 2005, 2008; Berchok et al. 2009; Wright et al. 2018, 2019; Matsuoka et al. 2021). They are known to occur in the Bering Sea from May–December (e.g., Tynan et al. 2001; Hildebrand and Munger 2005; Munger et al. 2005, 2008; Wright et al. 2019).

In March 1979, a group of four right whales was seen in Yakutat Bay (Waite et al. 2003), but there were no further reports of right whale sightings in the Gulf of Alaska until July 1998, when a single whale was seen southeast of Kodiak Island (Waite et al. 2003). Since 2000, several other sightings and acoustic detections have been made in the western Gulf of Alaska during summer (e.g., Waite et al. 2003; Mellinger et al. 2004; RPS 2011; Wade et al. 2011a,b; Rone et al. 2014, 2017; Matsuoka et al. 2020; Crance et al. 2022). A biologically important area (BIA) for feeding for North Pacific right whales was delineated east of the Kodiak Archipelago, encompassing the Gulf of Alaska critical habitat and adjacent (Wild et al. 2023).

South of 50ºN in the eastern North Pacific, only 29 reliable sightings were recorded from 1900–1994 (Scarff 1986, 1991; Carretta et al. 1994). Despite many miles of systematic aerial and ship-based surveys for marine mammals off the coasts of California/Oregon/Washington, only seven documented sightings of right whales were made from 1990–2000 (Waite et al. 2003). Sightings were also made off California and B.C. from 2006 to 2023 (Crance and Kennedy 2024). In addition, two North Pacific right whale calls were detected on a bottom-mounted hydrophone (located in water 1390 m deep) off the Washington coast on 29 June 2013 (Širović et al. 2014).

Based on the very low abundance of this species, its rarity off the coasts of Washington and Oregon in recent decades, and the likelihood that animals would be feeding in the Bering Sea and Gulf of Alaska at the time of the survey, it is possible although unlikely that a North Pacific right whale would be encountered in the proposed survey area during the period of operations.

Humpback Whale (*Megaptera novaeangliae*)

The humpback whale is found throughout all oceans of the World (Clapham 2018). Based on genetic data, there could be three subspecies, occurring in the North Pacific, North Atlantic, and Southern Hemisphere (Jackson et al. 2014). Nonetheless, genetic analyses suggest some gene flow (either past or present) between the North and South Pacific (e.g., Jackson et al. 2014; Bettridge et al. 2015). Although the humpback whale population has made a dramatic recovery since the whaling er, the North Pacific population saw a 20% decline from 2012–2021, suggesting it may have reached its carrying capacity (Cheeseman et al. 2024).

Although considered to be mainly a coastal species, humpback whales often traverse deep pelagic areas while migrating (Calambokidis et al. 2001; Garrigue et al. 2002, 2015; Zerbini et al. 2011). Humpbacks migrate between summer feeding grounds in high latitudes and winter calving and breeding grounds in tropical waters (Clapham and Mead 1999). North Pacific humpback whales summer in feeding grounds along the Pacific Rim and in the Bering and Okhotsk seas (Pike and MacAskie 1969; Rice 1978; Winn and Reichley 1985; Calambokidis et al. 2000, 2001, 2008; Bettridge et al. 2015). Humpbacks winter in four different breeding areas: (1) the coast of Mexico; (2) the coast of Central America; (3) around the main Hawaiian Islands; and (4) in the western Pacific, particularly around the Ogasawara and Ryukyu islands in southern Japan and the northern Philippines (Calambokidis et al. 2008; Bettridge et al. 2015). These breeding areas are recognized as the Mexico, Central America, Hawaii, and Western Pacific DPSs, but feeding areas have no DPS status (Bettridge et al. 2015; NMFS 2016). Individuals from the Hawaii, Mexico, and Central America DPSs could occur in the proposed survey area (Calambokidis et al. 2008; Martien et al. 2021; Martínez-Loustalot et al. 2021; Carretta et al. 2024).

NMFS recently evaluated the North Pacific DPSs with respect to demographically independent populations (DIPs) and "units" that contain one or more DIPs (Martien et al. 2021; Taylor et al. 2021; Wade et al. 2021; Oleson et al. 2022). Based on these DIPs and units, NMFS has designated five stocks including: the Central America/Southern Mexico – California/Oregon/Washington stock (part of the Central America DPS), the Mainland Mexico – California/Oregon/Washington and Mexico-North Pacific stocks (part of the Mexico DPS), the Hawai'i stock, and the Western North Pacific stock (Carretta et al. 2024). Whales in the Central America/Southern Mexico – CA-OR-WA stock winter off the coasts of Nicaragua, Honduras, El Salvador, Guatemala, Panama, Costa Rica, and southern Mexico including the states of Oaxaca and Guerrero, with some animals ranging even farther north (Taylor et al. 2021); they summer off California, Oregon, and Washington (Calambokidis et al. 2017). Whales from the Mainland Mexico – CA-OR-WA stock mainly winter off the Mexican state of Nayarit and Jalisco, with some animals occurring as far south as Colima and Michoacán; this stock summers off California, Oregon, Washington (Martien et al. 2021), as well as southern B.C., Alaska, and the Bering Sea. The Mexico – North Pacific stock winters off Mexico and the Revillagigedo Archipelago, and most individuals summer in Alaska (Martien et al. 2021).

During summer, most eastern North Pacific humpback whales are on feeding grounds in Alaska, with smaller numbers summering off the U.S. West Coast (Calambokidis et al. 2001, 2008). According to Wade (2017), off southern B.C. and Washington, ~63.5%, 27.9%, and 8.7% are from the Hawaii, Mexico, and Central America DPSs, respectively; off Oregon and California, the majority are from the Central America DPS (67.2%), with 32.7% from the Mexico DPS, and none from the Hawaii DPS. Calambokidis et al. (2024) delineated a large (or parent) feeding BIA (F-BIA) for humpback whales that stretches along most of the U.S. West Coast, from Washington and Oregon to southern California; the inner boundary of the parent BIA was defined by the 30-m isobath. The smaller or core F-BIA was delineated in localized coastal areas off Washington, Oregon, and California, with a shoreward boundary at the 70-m isobath. The BIA primarily is located within the 2000-m isobath and occurs from March to November (Calambokidis et al. 2024).

The humpback whale is the most common species of large cetacean reported off the coasts of Oregon and Washington from May–November (Green et al. 1992; Calambokidis et al. 2000, 2004; Henry et al. 2020). According to Green et al. (1992) and Calambokidis et al. (2000, 2004), the highest numbers have been reported off Oregon during May and June and off Washington during July–September. Based on data from 2016–2021, Derville et al. (2020) reported that the peak in humpback occurrence on the shelf of Oregon occurs during August. Humpbacks occur primarily over the continental shelf and slope during the summer, with few reported in offshore pelagic waters (Green et al. 1992; Calambokidis et al. 2004, 2015; Becker et al. 2012; Barlow 2016; Derville et al. 2022). Humpbacks were seen east of the survey area in spring, summer, and fall during 2011–2012 (Foster 2021). Six humpback whale sightings (8 animals) were made off Washington/Oregon during the June–July 2012 L-DEO Juan de Fuca plate seismic survey. There were 98 humpback whale sightings (213 animals) during the July 2012 L-DEO seismic survey off southern Washington (RPS 2012a), and 11 sightings (23 animals) during the July 2012 L-DEO seismic survey off Oregon (RPS 2012c). Eighty-three sightings totaling 210 humpbacks were made during the June–July 2021 L-DEO Cascadia Subduction Zone seismic survey off the coast of the Pacific Northwest (including Washington, Oregon, and southern B.C.) (RPS 2022a), and 11 sightings of 24 animals were made during the April 2022 L-DEO survey off Oregon (RPS 2022b). There were no sightings during the September–October 2017 SIO cruise off Oregon and Washington (SIO n.d.). During long-term (2004–2013) passive acoustic monitoring at three sites on the shelf, slope, and a canyon off northwestern Washington, the highest number of call detections were recorded at the canyon site and lowest at the slope site (Rice et al. 2021). Most detections occurred during fall and winter, but calls were also detected at all sites during August and September (Rice et al. 2021). Similarly, monitoring at acoustic recorders deployed at different locations off Washington during 2008–2013 showed that call rates were highest during fall and winter (Emmons et al. 2020). Humpback whales could be encountered in the proposed survey area at the time of the survey.

Common Minke Whale (*Balaenoptera acutorostrata scammoni*)

The minke whale has a cosmopolitan distribution that spans from tropical to polar regions in both hemispheres (Jefferson et al. 2015). In the Northern Hemisphere, the minke whale is usually seen in coastal areas, but can also be seen in pelagic waters during its northward migration in spring and summer and southward migration in autumn (Stewart and Leatherwood 1985). In the North Pacific, the summer range of the minke whale extends to the Chukchi Sea; in the winter, the whales move south to within 2º of the Equator (Perrin et al. 2018).

The International Whaling Commission (IWC) recognizes three stocks of minke whales in the North Pacific: the Sea of Japan/East China Sea, the rest of the western Pacific west of 180ºN, and the remainder of the Pacific (Donovan 1991). Minke whales are relatively common in the Bering and Chukchi seas and in the Gulf of Alaska but are not considered abundant in any other part of the eastern Pacific (Brueggeman et al. 1990). In the far north, minke whales are thought to be migratory, but they are believed to be year-round residents in nearshore waters off the West Coast of the U.S. (Dorsey et al. 1990).

Sightings have been made off Oregon and Washington in shelf and deeper waters (Green et al. 1992; Adams et al. 2014; Barlow 2016; Henry et al. 2020; Carretta et al. 2024). An estimated abundance of 211 minke whales was reported for the Oregon/Washington region based on sightings data from 1991–2005 (Barlow and Forney 2007), whereas a 2008 survey did not record any minke whales while on survey effort (Barlow 2010). The abundance for Oregon/Washington for 2014 was estimated at 507 minke whales (Barlow 2016). There were no sightings of minke whales off Oregon/Washington during the June–July 2012 L-DEO Juan de Fuca plate seismic survey or during the July 2012 L-DEO seismic survey off Oregon (RPS 2012b,c). One minke whale was seen during the July 2012 L-DEO seismic survey off southern Washington (RPS 2012a). No sightings were made during the June–July 2021 L-DEO Cascadia survey (RPS 2022a), the April 2022 L-DEO survey off Oregon (RPS 2022b), or the September–October 2017 SIO survey off Oregon and Washington (SIO n.d.). During long-term passive acoustic monitoring at a shelf, slope, and canyon site off northwestern Washington during 2004–2013, calls were detected only at the canyon site during November 2012 and April 2013 (Rice et al. 2021). Minke whales are expected to be uncommon in the proposed survey area.

Sei Whale (*Balaenoptera borealis*)

The sei whale occurs in all ocean basins (Horwood 2018) but appears to prefer mid-latitude temperate waters (Jefferson et al. 2015). It undertakes seasonal migrations to feed in subpolar latitudes during summer and returns to lower latitudes during winter to calve (Horwood 2018). The sei whale is pelagic and generally not found in coastal waters (Harwood and Wilson 2001). It occurs in deeper waters characteristic of the continental shelf edge region (Hain et al. 1985) and in other regions of steep bathymetric relief such as seamounts and canyons (Kenney and Winn 1987; Gregr and Trites 2001). On feeding grounds, sei whales associate with oceanic frontal systems (Horwood 1987) such as the cold eastern currents in the North Pacific (Perry et al. 1999). Sei whales migrate from temperate zones occupied in winter to higher latitudes in the summer, where most feeding takes place (Gambell 1985a). During summer in the North Pacific, the sei whale can be found from the Bering Sea to the Gulf of Alaska and down to southern California, as well as in the western Pacific from Japan to Korea. Its winter distribution is concentrated at ~20°N (Rice 1998).

Sei whales are rare in the waters off California, Oregon, and Washington (Brueggeman et al. 1990; Green et al. 1992; Barlow 1994, 1997). Less than 20 confirmed sightings were reported in that region during extensive surveys during 1991–2018 (Green et al. 1992, 1993; Hill and Barlow 1992; Carretta and Forney 1993; Mangels and Gerrodette 1994; Von Saunder and Barlow 1999; Barlow 2003, 2010, 2014; Forney 2007; Carretta et al. 2024). Based on surveys conducted in 1991–2008, the estimated abundance of sei whales off the coasts of Oregon and Washington was 52 (Barlow 2010); for 2014, the abundance estimate was 468 (Barlow 2016). Two sightings of four individuals were made during the June–July 2012 L-DEO Juan de Fuca plate seismic survey off Washington/Oregon (RPS 2012b). No sei whales were sighted during the July 2012 L-DEO seismic surveys off Oregon and Washington (RPS 2012a,c), the June–July 2021 L-DEO Cascadia survey (RPS 2022a), the April 2022 L-DEO survey off Oregon (RPS 2022b), or the September–October 2017 SIO off Oregon and Washington (SIO n.d.). Nonetheless, sei whales could be encountered during the proposed survey, although this species is considered rare in these waters.

Fin Whale (*Balaenoptera physalus*)

The fin whale is widely distributed in all the World's oceans (Gambell 1985b) although it is most abundant in temperate and cold waters (Aguilar and García-Vernet 2018). Nonetheless, its overall range and distribution are not well known (Jefferson et al. 2015). A review of fin whale distribution in the North Pacific noted the lack of sightings across pelagic waters between eastern and western winter areas (Mizroch et al. 2009). Fin whales most commonly occur offshore, but can also be found in coastal areas (Jefferson et al. 2015).

Most populations migrate seasonally between temperate waters where mating and calving occur in winter, and polar waters where feeding occurs in summer (Aguilar and García-Vernet 2018). Some animals may remain at high latitudes in winter or low latitudes in summer (Edwards et al. 2015). The northern and southern fin whale populations likely do not interact owing to their alternate seasonal migration; the resulting genetic isolation has led to the recognition of two subspecies, *B. physalus quoyi* and *B. p. physalus* in the Southern and Northern hemispheres, respectively (Anguilar and García-Vernet 2018). The fin whale is known to use the shelf edge as a migration route (Evans 1987). Sergeant (1977) suggested that fin whales tend to follow steep slope contours, either because they detect them readily, or because the contours are areas of high biological productivity. However, fin whale movements have been reported to be complex (Jefferson et al. 2015). Stafford et al. (2009) noted that sea-surface temperature is a good predictor variable for fin whale call detections in the North Pacific.

North Pacific fin whales summer from the Chukchi Sea to California and winter from California southwards (Gambell 1985b). Information about the seasonal distribution of fin whales in the North Pacific has been obtained from the detection of fin whale calls by bottom-mounted, offshore hydrophone arrays along the U.S. Pacific coast, in the central North Pacific, and in the western Aleutian Islands (Moore et al. 1998, 2006; Watkins et al. 2000a,b; Stafford et al. 2007, 2009). Fin whale calls are recorded in the North Pacific year-round (e.g., Moore et al. 2006; Stafford et al. 2007, 2009; Edwards et al. 2015). In the central North Pacific, the Gulf of Alaska, and Aleutian Islands, call rates peak during fall and winter (Moore et al. 1998, 2006; Watkins et al. 2000a,b; Stafford et al. 2009).

Parent F-BIAs for fin whales have been delineated off the coasts of Oregon and Washington and lie primarily between 200 m and 2000 m in depth; parent F-BIAs have also been delineated off California, including deep, offshore waters (Calambokidis et al. 2024). The core F-BIAs are much reduced in area, and include one small area off Oregon and a larger area off California. The eastern boundaries for the parent and core BIAs extend to the 60-m and 80-m isobaths, respectively (Calambokidis et al. 2024). All BIAs span the June to November period (Calambokidis et al. 2004). Fin whales are routinely sighted during surveys off Oregon and Washington (Barlow and Forney 2007; Barlow 2010, 2016; Adams et al. 2014; Calambokidis et al. 2015; Edwards et al. 2015; Henry et al. 2020; Carretta et al. 2024), including in coastal as well as offshore waters. Based on data from 2016–2021, Derville et al. (2020) reported that peak fin whale density off Oregon occurs in December.

They have also been detected acoustically in those waters during June–November (Edwards et al. 2015). Eight fin whale sightings (19 animals) were made off Washington/Oregon during the June–July 2012 L-DEO Juan de Fuca plate seismic survey; sightings were made in waters 2369–3940 m deep (RPS 2012b). Fourteen fin whale sightings (28 animals) were made during the July 2012 L-DEO seismic surveys off southern Washington (RPS 2012a), but no fin whales were sighted during the July 2012 L-DEO seismic survey off Oregon (RPS 2012c). Fin whales were seen off southern Oregon during July 2012 in water >2000 m deep during surveys by Adams et al. (2014). Seventeen sightings (33 animals) were made during the June–July 2021 L-DEO Cascadia survey (RPS 2022a), one sighting (3 animals) was made during the April 2022 L-DEO survey off Oregon (RPS 2022b), and three fin whale sightings (five animals) were made during the September–October 2017 SIO survey off Oregon and Washington (SIO n.d.). During long-term passive acoustic monitoring at three sites (shelf, slope, canyon) off northwestern Washington during 2004–2013, the highest number of call detections were recorded at the canyon site; most detections were made during fall and winter, but calls were detected throughout the year at all three sites (Rice et al. 2021). Fin whales are likely to be encountered in the proposed survey area.

Blue Whale (*Balaenoptera musculus*)

The blue whale has a cosmopolitan distribution and tends to be pelagic, only coming nearshore to feed and possibly to breed (Jefferson et al. 2015). Although it has been suggested that there are at least five subpopulations of blue whales in the North Pacific (NMFS 1998), analysis of blue whale calls monitored from the U.S. Navy Sound Surveillance System (SOSUS) and other offshore hydrophones (see Stafford et al. 1999, 2001, 2007; Watkins et al. 2000a; Stafford 2003) suggests that there are two separate populations: the Eastern North Pacific and Central North Pacific stocks (Carretta et al. 2024). The status of these two populations could differ substantially, as little is known about the population size in the western North Pacific (Branch et al. 2016). Broad-scale acoustic monitoring indicates that blue whales occurring in the northeast Pacific during summer and fall may winter in the eastern tropical Pacific (Stafford et al. 1999, 2001).

In the North Pacific, blue whale calls are detected year-round (Stafford et al. 2001, 2009; Moore et al. 2002b, 2006; Monnahan et al. 2014). Stafford et al. (2009) reported that sea-surface temperature is a good predictor variable for blue whale call detections in the North Pacific. The distribution of the species, at least during times of the year when feeding is a major activity, occurs in areas that provide large seasonal concentrations of euphausiids (Yochem and Leatherwood 1985). The eastern North Pacific stock feeds in California waters from June–November (Calambokidis et al. 1990; Mate et al. 1999). Thus, Calambokidis et al. (2024) delineated a large parent F-BIA for blue whales that extends from the central Oregon coast to southern California from June–November; off Oregon, the BIA is confined to waters less than 2000 m deep. The core BIA occurs off most of California within the 2000-m isobath (Calambokidis et al. 2024). The eastern extent of the parent and core BIAs were defined by the 50-m and 80-m isobath, respectively (Calambokidis et al. 2024).

Buchanan et al. (2001) considered blue whales to be rare off Oregon and Washington. However, based on modeling of the dynamic topography of the region, blue whales could occur in relatively high densities off Oregon during summer and fall (Pardo et al. 2015: Hazen et al. 2017). Based on data from 2016–2021, Derville et al. (2020) reported that the peak in blue whale occurrence on the shelf of Oregon occurs during August. Densities along the U.S. West Coast, including Oregon, were predicted to be highest in shelf waters, with lower densities in deeper offshore areas (Becker et al. 2012; Calambokidis et al. 2015). Satellite-tracked individuals have been reported off Washington and Oregon (Bailey et al. 2009), and acoustic detections have been made off Oregon (McDonald et al. 1995; Stafford et al. 1998; Von Saunder and Barlow 1999). One sighting (four animals) was made during the June–July 2021 L-DEO Cascadia survey (RPS 2022a), but no sightings were made during the April 2022 L-DEO survey off Oregon (RPS 2022b), or the September–October 2017 SIO survey off Oregon and Washington (SIO n.d.). Long-term passive acoustic monitoring of three shelf, slope, and canyon sites off Washington found the highest number of call detections on the slope and the lowest at the canyon site (Rice et al. 2021). Call rates were highest during fall and winter, but vocalizations were detected at all sites throughout the year (Rice et al. 2021). Blue whales could be encountered in the proposed survey area.

Odontocetes

Sperm Whale (*Physeter macrocephalus*)

The sperm whale is widely distributed, occurring from the edge of the polar pack ice to the Equator in both hemispheres, with the sexes occupying different distributions (Whitehead 2018). In general, it is distributed over large temperate and tropical areas that have high secondary productivity and steep underwater topography, such as volcanic islands (Jaquet and Whitehead 1996). Its distribution and relative abundance can vary in response to prey availability, most notably squid (Jaquet and Gendron 2002). Females generally inhabit waters >1000 m deep at latitudes <40º where sea surface temperatures are <15ºC; adult males move to higher latitudes as they grow older and larger in size, returning to warm-water breeding grounds according to an unknown schedule (Whitehead 2018).

Sperm whales are distributed widely across the North Pacific (Rice 1989). Off California, they occur year-round (Dohl et al. 1983; Barlow 1995; Forney et al. 1995), with peak abundance from April to mid-June and from August to mid-November (Rice 1974). Off Oregon, sperm whales are seen in every season except winter (Green et al. 1992). Sperm whales were sighted during surveys off Oregon in October 2011 and off Washington in June 2011 (Adams et al. 2014). Carretta et al. (2024) also reported numerous sperm whale sightings off Oregon and Washington during shipboard surveys.

Sperm whales were detected acoustically in waters off Oregon and Washington in August 2016 during the Southwest Fisheries Service (SWFSC) Passive Acoustics Survey of Cetacean Abundance Levels (PASCAL) study using drifting acoustic recorders (Keating et al. 2018). Oleson et al. (2009) noted a significant diel pattern in the occurrence of sperm whale clicks at offshore and inshore monitoring locations off Washington, whereby clicks were more commonly heard during the day at the offshore site and at night at the inshore location, suggesting possible diel movements up and down the slope in search of prey. Sperm whale acoustic detections were also reported at an inshore site from June through January 2009, with an absence of calls during February–May (Širović et al. 2012). During long-term passive acoustic monitoring of three sites on the shelf, slope, and at a canyon off Washington during 2004–2013, sperm whale clicks were detected year-round with the highest number of call detections at the slope site (Rice et al. 2021). Similarly, monitoring at acoustic recorders deployed at different locations off Washington during 2008–2013 showed clicks were detected year-round (Emmons et al. 2020). Humpback whales could be encountered in the proposed survey area at the time of the survey. Sperm whales are likely to be encountered in the proposed survey area.

Pygmy and Dwarf Sperm Whales (*Kogia breviceps and K. sima*)

Dwarf and pygmy sperm whales are distributed throughout tropical and temperate waters of the Atlantic, Pacific and Indian oceans, but their precise distributions are unknown because much of what we know of the species comes from strandings (McAlpine 2018). They are difficult to sight at sea, because of their dive behavior and perhaps because of their avoidance reactions to ships and behavior changes in relation to survey aircraft (Würsig et al. 1998). The two species are often difficult to distinguish from one another when sighted (McAlpine 2018).

Both *Kogia* species are sighted primarily along the continental shelf edge and slope and over deeper waters off the shelf (Hansen et al. 1994; Davis et al. 1998; Jefferson et al. 2015). Stomach content analyses from stranded whales further support this distribution (McAlpine 2018). Recent data indicate that both *Kogia* species feed in the water column and on/near the seabed, likely using echolocation to search for prey (McAlpine 2018). Several studies have suggested that pygmy sperm whales live and feed mostly beyond the continental shelf edge, whereas dwarf sperm whales tend to occur closer to shore, often over the continental shelf and slope (Rice 1998; Wang et al. 2002; MacLeod et al. 2004; McAlpine 2018). It has also been suggested that the pygmy sperm whale is more temperate and the dwarf sperm whale more tropical, based at least partially on live sightings at sea from a large database from the eastern tropical Pacific (Wade and Gerrodette 1993; McAlpine 2018).

Pygmy and dwarf sperm whales are rarely sighted off Oregon and Washington, with only one sighting of an unidentified *Kogia* sp. beyond the U.S. EEZ, during the 1991–2014 NOAA vessel surveys (Carretta et al. 2024). Norman et al. (2004) reported eight confirmed stranding records of pygmy sperm whales for Oregon and Washington between 1930 and 2002. Warlick et al. (2022) reported three strandings of pygmy sperm whales in each of Oregon and Washington from 2000 to 2019. *Kogia* sp. were likely detected at drifting acoustic spar buoys recorders (DASPRs) along the 2000-isobath off southern Oregon and also possibly just south of the proposed survey area, during summer 2016 (Griffiths et al. 2020). Pygmy or dwarf sperm whales could be encountered within the proposed project area.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whale is probably the most widespread and common of the beaked whales, although it is not found in high-latitude polar waters (Heyning 1989; Baird 2018a). It is rarely observed at sea and is known mostly from strandings; it strands more commonly than any other beaked whale (Heyning 1989). Cuvier's beaked whale is found in deep water in the open ocean and over and near the continental slope (Gannier and Epinat 2008; Baird 2018a). Its inconspicuous blows, deep-diving behavior, and tendency to avoid vessels all help to explain the infrequent sightings (Barlow and Gisiner 2006).

Cuvier's beaked whale is the most common beaked whale off the U.S. West Coast (Barlow 2010), and it is the beaked whale species that has stranded most frequently on the coasts of Oregon and Washington. From 1942–2010, there were 23 reported Cuvier's beaked whale strandings in Oregon and Washington (Moore and Barlow 2013). Most (75%) Cuvier's beaked whale strandings reported occurred in Oregon (Norman et al. 2004). Warlick et al. (2022) reported another stranding in Washington in 2013. MacLeod et al. (2006) and Carretta et al. (2024) reported numerous sightings and strandings along the Pacific coast of the U.S. Four sightings were reported in water depths >2000 m off Oregon/Washington during surveys in 2008 (Barlow 2010). None were seen in 1996 or 2001 (Barlow 2003), and several were recorded from 1991–1995 (Barlow 1997). One Cuvier's beaked whale sighting was made during surveys in 2014 (Barlow 2016). Sightings were also made off Oregon and Washington in 2018 during a SWFSC California Current Ecosystem Survey (Henry et al. 2020).

Acoustic monitoring in Washington offshore waters detected Cuvier's beaked whale calls between January and November 2011 (Ŝirović et al. 2012b *in* DON 2015). Cuvier's beaked whales were also detected acoustically in the deeper waters off the U.S. West Coast during August–September 2016 using drifting acoustic recorders, with highest densities recorded off California and the lowest off Washington (Keating et al. 2018; Barlow et al. 2021). A drifting acoustic recorder detected this species off Oregon during July–October 2018 during a passive acoustic survey of deep-diving odontocetes in the California Current ecosystem (Simonis et al. 2020). During long-term passive acoustic monitoring of three sites on the shelf, slope, and at a canyon off Washington during 2004–2013, clicks were detected at the canyon site from November through June, but were most common during winter (Rice et al. 2021). Based on the acoustic detections, Barlow et al. (2021) estimated a density of 0.005 animals/km^2 and a population size of 5454 Cuvier's beaked whales within the Pacific U.S. EEZ. Cuvier's beaked whales could be encountered during the proposed survey.

Baird's Beaked Whale (*Berardius bairdii*)

Baird's beaked whale has a fairly extensive range across the North Pacific north of 30°N, and strandings have occurred as far north as the Pribilof Islands (Rice 1986). Two forms of Baird's beaked whales have been recognized – the common slate-gray form and a smaller, rare black form (Morin et al. 2017). The gray form is seen off Japan, in the Aleutians, and on the West Coast of North America, whereas the black from has been reported for northern Japan and the Aleutians (Morin et al. 2017). Recent genetic studies suggest that the black form could be a separate species (Morin et al. 2017). Baird's beaked whale is currently divided into three distinct stocks: Sea of Japan, Okhotsk Sea, and Bering Sea/eastern North Pacific (Balcomb 1989; Reyes 1991). Baird's beaked whales sometimes are seen close to shore, but their primary habitat is over or near the continental slope and oceanic seamounts in waters 1000–3000 m deep (Jefferson et al. 2015).

Along the U.S. West Coast, Baird's beaked whales have been sighted primarily along the continental slope (Green et al. 1992; Becker et al. 2012; Carretta et al. 2024) from late spring to early fall (Green et al. 1992). The whales move out from those areas in winter (Reyes 1991). In the eastern North Pacific Ocean, Baird's beaked whales apparently spend the winter and spring far offshore, and in June, they move onto the continental slope, where peak numbers occur during September and October. Green et al. (1992) noted that Baird's beaked whales on the U.S. West Coast were most abundant in the summer, and were not sighted in the fall or winter. MacLeod et al. (2006) reported numerous sightings and strandings of *Berardius* spp. off the U.S. West Coast. Warlick et al. (2022) reported five strandings of Baird's beaked whale from 2000 to 2019, including two for Oregon and three for Washington.

Green et al. (1992) sighted five groups during 75,050 km of aerial survey effort in 1989–1990 off Washington/Oregon spanning coastal to offshore waters: two in slope waters and three in offshore waters. Two groups were sighted during summer/fall 2008 surveys off Washington/Oregon, in waters >2000 m deep (Barlow 2010). Acoustic monitoring offshore Washington detected Baird's beaked whale pulses during January through November 2011, with peaks in February and July (Ŝirović et al. 2012b *in* DON 2015). Baird's beaked whales were detected acoustically in the waters off Oregon and Washington in August 2016 during the SWFSC PASCAL study using drifting acoustic recorders (Keating et al. 2018). This species was also detected by a drifting acoustic recorder off Oregon during July–October 2018 during a passive acoustic survey of deep-diving odontocetes in the California Current ecosystem (Simonis et al. 2020). Baird's beaked whales could be encountered in the proposed survey area.

Blainville's Beaked Whale (*Mesoplodon densirostris*)

Blainville's beaked whale is found in tropical and warm temperate waters of all oceans (Pitman 2018). It has the widest distribution throughout the world of all *Mesoplodon* species (Pitman 2018). Like other beaked whales, Blainville's beaked whale is generally found in waters 200–1400 m deep (Gannier 2000; Jefferson et al. 2015). Occasional occurrences in cooler, higher-latitude waters are presumably related to warm-water incursions (Reeves et al. 2002). MacLeod et al. (2006) reported stranding and sighting records in the eastern Pacific ranging from 37.3°N to 41.5°S. However, none of the 36 beaked whale stranding records in Oregon and Washington during 1930–2002 included Blainville's beaked whale (Norman et al. 2004). One Blainville's beaked whales stranded near Neah Bay, WA, in 2016 (Moore and Barlow 2017; Warlick et al. 2022).

There was one acoustic encounter with Blainville's beaked whales recorded in Quinault Canyon off Washington in waters 1400 m deep during 2011 (Baumann-Pickering et al. 2014). Blainville's beaked whales were not detected acoustically off Washington or Oregon during the August 2016 SWFSC PASCAL study using drifting acoustic recorders (Keating et al. 2018). Although Blainville's beaked whales could be encountered during the proposed survey, an encounter would be unlikely because the proposed survey area is beyond the northern limits of this tropical species' usual distribution.

Hubbs' Beaked Whale (*Mesoplodon carlhubbsi*)

Hubbs' beaked whale occurs in temperate waters of the North Pacific (Mead 1989). Its distribution appears to be correlated with the deep subarctic current (Mead et al. 1982). Numerous stranding records have been reported for the U.S. West Coast (MacLeod et al. 2006). Most are from California in the 1980s and 1990s, but two strandings for Washington/Oregon were reported by Norman et al. (2004), and one stranding occurred in Washington in 2010 (Moore and Barlow 2017; Warlick et al. 2022).

In addition, at least two sightings off Oregon, but outside the U.S. EEZ, were reported by Carretta et al. (2024). During August 2016, detections of beaked whale sounds presumed to be from Hubbs' beaked whales were made off Washington and Oregon (Keating et al. 2018; Griffiths et al. 2019). During long-term passive acoustic monitoring of three sites on the shelf, slope, and at a canyon off Washington during 2004–2013, likely Hubb's beaked whale clicks were detected at the canyon site from December through spring (Rice et al. 2021). A single sighting of two individuals was made west of the proposed survey area, ~350 km off the Columbia River mouth, in September 2021 (Ballance et al. 2024). This species seems to be less common in the proposed survey area than some of the other beaked whales, but it could be encountered during the survey.

Stejneger's Beaked Whale (*Mesoplodon stejnegeri*)

Stejneger's beaked whale occurs in subarctic and cool temperate waters of the North Pacific (Mead 1989). Most records are from Alaskan waters, and the Aleutian Islands appear to be its center of distribution (Mead 1989; Wade et al. 2003). After Cuvier's beaked whale, Stejneger's beaked whale was the second most commonly stranded beaked whale species in Oregon and Washington between 1930 and 2002 (Norman et al. 2004). Warlick et al. (2022) reported three strandings of Stejneger's beaked whale in each of Oregon and Washington from 2000 to 2019.

Stejneger's beaked whale calls were detected during acoustic monitoring offshore Washington between January and June 2011, with an absence of calls from mid-July–November 2011 (Ŝirović et al. 2012b *in* DON 2015). Analysis of these data suggest that this species could be more than twice as prevalent in this area than Baird's beaked whale (Baumann-Pickering et al. 2014). Stejneger's beaked whales were also detected acoustically in waters off Oregon and Washington in August 2016 during the SWFSC PASCAL study using drifting acoustic recorders (Keating et al. 2018). A drifting acoustic recorder also detected this species off Oregon during July–October 2018 during a passive acoustic survey of deep-diving odontocetes in the California Current ecosystem (Simonis et al. 2020). During long-term passive acoustic monitoring of three sites on the shelf, slope, and at a canyon off Washington during 2004–2013, clicks were detected at the canyon site from October through June, with the highest detection rates during winter; there were no detections from July to September (Rice et al. 2021). Stejneger's beaked whales could be encountered during the proposed survey.

Common Bottlenose Dolphin (*Tursiops truncatus*)

The bottlenose dolphin is distributed worldwide in coastal and shelf waters of tropical and temperate oceans (Jefferson et al. 2015). There are two distinct bottlenose dolphin types: a shallow water type, mainly found in coastal waters, and a deep-water type, mainly found in oceanic waters (Duffield et al. 1983; Hoelzel et al. 1998; Walker et al. 1999). Coastal common bottlenose dolphins exhibit a range of movement patterns including seasonal migration, year-round residency, and a combination of long-range movements and repeated local residency (Wells and Scott 2009).

Bottlenose dolphins occur frequently off the coast of California; although sightings have been made as far north as 41ºN, there are no offshore records for Oregon and Washington (Carretta et al. 2024). Three sightings and one stranding of bottlenose dolphins have been documented in Puget Sound since 2004 (Cascadia Research 2011 *in* DON 2015). It is possible that offshore bottlenose dolphins may range as far north as the proposed survey area during warm-water periods (Carretta et al. 2024). Adams et al. (2014) made one sighting off Washington during September 2012. It is possible, although unlikely, that bottlenose dolphins could be encountered in the proposed survey area.

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin has a cosmopolitan distribution in tropical to warm temperate waters from ~50°N to 40°S (Perrin et al. 1994; Jefferson et al. 2015). It occurs primarily in pelagic waters, but has been observed approaching shore where there is deep water close to the coast (Jefferson et al. 2015). The striped dolphin is typically found in waters outside the continental shelf and is often associated with convergence zones and areas of upwelling; however, it has also been observed approaching shore where there is deep water close to the coast (Jefferson et al. 2015).

Striped dolphins regularly occur off California (Becker et al. 2012), including as far offshore as ~300 n.mi. during the NOAA Fisheries vessel surveys (Carretta et al. 2024). However, few sightings have been made off Oregon, and no sightings have been reported for Washington; strandings have also been documented on the West Coast (Carretta et al. 2024). During surveys off the U.S. West Coast in 2014, striped dolphins were seen as far north as 44ºN; based on those sightings, Barlow (2016) calculated an abundance estimate of 13,171 striped dolphins for Oregon/Washington. The abundance estimates for 2001, 2005, and 2008 were zero (Barlow 2016). It is possible, although unlikely, that striped dolphins could be encountered in the proposed survey area.

Common Dolphin (*Delphinus delphis*)

The common dolphin is found in oceanic and nearshore waters of tropical and warm temperate oceans around the world, ranging from ~60ºN to ~50ºS (Jefferson et al. 2015). Based on Perrin (2018), here we assume that there are currently three recognized subspecies of common dolphin, including *D. delphis delphis* (the short-beaked form), *D. delphis bairdii* (the long-beaked form, formerly known as *D. capensis*), and *D. delphis tropicalis* (Indian Ocean subspecies). The common dolphin is the most abundant dolphin species in offshore areas of warm-temperate regions in the Atlantic and Pacific (Perrin 2018). It can be found in oceanic and coastal habitats; it is common in coastal waters 200–300 m deep and is also associated with prominent underwater topography, such as seamounts (Evans 1994).

The distribution of the short-beaked form of common dolphins along the U.S. West Coast is variable and likely related to oceanographic changes (Heyning and Perrin 1994; Forney and Barlow 1998). It is the most abundant cetacean off California; some sightings have been made off Oregon, in offshore waters, but there are no sightings off Washington (Carretta et al. 2024). During surveys off the West Coast in 2014 and 2017, sightings were made as far north as 44°N (Barlow 2016; SIO n.d.). Based on the absolute dynamic topography of the region, the short-beaked form could occur in relatively high densities off Oregon during July–December (Pardo et al. 2015). In contrast, habitat modeling predicted moderate densities of common dolphins off the Columbia River estuary during summer, with lower densities off southern Oregon (Becker et al. 2014). Only the short-beaked form of the common dolphin could be encountered in the proposed survey area (see Carretta et al. 2024).

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

The Pacific white-sided dolphin is found in cool temperate waters of the North Pacific from the southern Gulf of California to Alaska. Across the North Pacific, it appears to have a relatively narrow distribution between 38°N and 47°N (Brownell et al. 1999). In the eastern North Pacific Ocean, the Pacific white-sided dolphin is one of the most common cetacean species, occurring primarily in shelf and slope waters (Green et al. 1993; Barlow 2003, 2010). It is known to occur close to shore in certain regions, including (seasonally) southern California (Brownell et al. 1999).

Results of aerial and shipboard surveys strongly suggest seasonal north–south movements of the species between California and Oregon/Washington; the movements apparently are related to oceanographic influences, particularly water temperature (Green et al. 1993; Forney and Barlow 1998; Buchanan et al. 2001). During winter, this species is most abundant in California slope and offshore areas; as northern waters begin to warm in the spring, it appears to move north to slope and offshore waters off Oregon/Washington (Green et al. 1992, 1993; Forney 1994; Forney et al. 1995; Buchanan et al. 2001; Barlow 2003). The highest encounter rates off Oregon and Washington have been reported during March–May in slope and offshore waters (Green et al. 1992). Similarly, Becker et al. (2014) predicted relatively high densities off southern Oregon in shelf and slope waters.

Based on year-round aerial surveys off Oregon/Washington, the Pacific white-sided dolphin was the most abundant cetacean species, with nearly all (97%) sightings occurring in May (Green et al. 1992, 1993). Barlow (2003) also found that the Pacific white-sided dolphin was one of the most abundant marine mammal species off Oregon/Washington during 1996 and 2001 ship surveys, and it was the second most abundant species reported during 2008 surveys (Barlow 2010). Adams et al. (2014) reported numerous offshore sightings off Oregon during summer, fall, and winter surveys in 2011 and 2012. Numerous sightings were made offshore of Oregon and Washington in 2018 during a SWFSC California Current Ecosystem Survey (Henry et al. 2020). Based on surveys conducted during 2014, the abundance was estimated at 20,711 for Oregon/Washington (Barlow 2016). During long-term passive acoustic monitoring of three sites on the shelf, slope, and at a canyon off Washington during 2004–2013, the highest number of call detections was made at the slope site and the lowest at the shelf site; clicks were detected from summer to early winter (Rice et al. 2021).

One group of 10 Pacific white-sided dolphins was sighted during the 2009 ETOMO survey west of the proposed survey area (Holst 2017). Fifteen Pacific white-sided dolphin sightings (231 animals) were made off Washington/Oregon during the June–July 2012 L-DEO Juan de Fuca plate seismic survey (RPS 2012b). There were fifteen Pacific white-sided dolphin sightings (462 animals) made during the July 2012 L-DEO seismic surveys off southern Washington (RPS 2012a). However, this species was not sighted during the July 2012 L-DEO seismic survey off Oregon (RPS 2012c). One sighting (eight animals) was made during the September–October 2017 SIO survey off Oregon and Washington (SIO n.d.), and 19 sightings (224 animals) were made during the June–July 2021 L-DEO Cascadia survey (RPS 2022a). No sightings were made during the 2017 SIO survey off Oregon (SIO n.d.) or the April 2022 L-DEO survey off Oregon (RPS 2022b). Pacific white-sided dolphins are likely to be common in the proposed survey area.

Northern Right Whale Dolphin (*Lissodelphis borealis*)

The northern right whale dolphin is found in cool temperate and sub-arctic waters of the North Pacific, from the Gulf of Alaska to near northern Baja California, ranging from 30°N to 50°N (Reeves et al. 2002). In the eastern North Pacific Ocean, the northern right whale dolphin is one of the most common marine mammal species, occurring primarily in shelf and slope waters ~100 to >2000 m deep (Green et al. 1993; Barlow 2003). The northern right whale dolphin comes closer to shore where there is deep water, such as over submarine canyons (Reeves et al. 2002).

Aerial and shipboard surveys suggest seasonal inshore-offshore and north-south movements in the eastern North Pacific Ocean between California and Oregon/Washington; the movements are believed to be related to oceanographic influences, particularly water temperature and presumably prey distribution and availability (Green et al. 1993; Forney and Barlow 1998; Buchanan et al. 2001). Green et al. (1992, 1993) found that northern right whale dolphins were most abundant off Oregon/Washington during fall, less abundant during spring and summer, and absent during winter, when this species presumably moves south to warmer California waters (Green et al. 1992, 1993; Forney 1994; Forney et al. 1995; Buchanan et al. 2001; Barlow 2003).

Becker et al. (2014) predicted relatively high densities off southern Oregon, and moderate densities off northern Oregon and Washington. Based on year-round aerial surveys off Oregon/Washington, the northern right whale dolphin was the third most abundant cetacean species, concentrated in slope waters but also occurring in water out to ~550 km offshore (Green et al. 1992, 1993). Barlow (2003, 2010) also found that the northern right whale dolphin was one of the most abundant marine mammal species off Oregon/Washington during 1996, 2001, 2005, and 2008 ship surveys. Offshore sightings were made in the waters off Oregon during summer, fall, and winter surveys in 2011 and 2012 (Adams et al. 2014). Sightings were also recorded offshore of Oregon and Washington in 2018 during a SWFSC California Current Ecosystem Survey (Henry et al. 2020). There were three multiple-species sightings involving this species during the June–July 2021 L-DEO Cascadia survey (RPS 2022a), but no sightings during the 2017 SIO survey off Oregon (SIO n.d.), or the April 2022 L-DEO survey off Oregon (RPS 2022b). Northern right whale dolphins are likely to be encountered in the proposed survey area.

Risso's Dolphin (*Grampus griseus*)

Risso's dolphin is distributed worldwide in mid-temperate and tropical oceans (Kruse et al. 1999). although it shows a preference for mid-temperate waters of the shelf and slope between 30° and 45° (Jefferson et al. 2014). Although it occurs from coastal to deep water (~200–1000 m depth), it shows a strong preference for mid-temperate waters of upper continental slopes and steep shelf-edge areas (Hartman 2018). Off the U.S. West Coast, Risso's dolphin is believed to make seasonal north-south movements related to water temperature, spending colder winter months off California and moving north to waters off Oregon/Washington during the spring and summer as northern waters begin to warm (Green et al. 1992, 1993; Buchanan et al. 2001; Barlow 2003; Becker 2007).

The distribution and abundance of Risso's dolphins are highly variable from California to Washington, presumably in response to changing oceanographic conditions on both annual and seasonal time scales (Forney and Barlow 1998; Buchanan et al. 2001). The highest densities were predicted along the coasts of Washington, Oregon, and central and southern California (Becker et al. 2012). Off Oregon and Washington, Risso's dolphins are most abundant over continental slope and shelf waters during spring and summer, less so during fall, and rare during winter (Green et al. 1992, 1993). Green et al. (1992, 1993) reported most Risso's dolphin groups off Oregon between ~45 and 47ºN. Based on 2014 survey data, the abundance for Oregon/Washington was estimated at 430 (Barlow 2016). During long-term passive acoustic monitoring of three sites on the shelf, slope, and at a canyon off Washington during 2004–2013, the highest number of click detections was recorded at the canyon site during summer and early fall (Rice et al. 2021). Risso's dolphins could be encountered in the proposed survey area.

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found worldwide in tropical and temperate waters, generally between 50ºN and 50ºS (Odell and McClune 1999). It is widely distributed, but not abundant anywhere (Carwardine 1995). The false killer whale generally inhabits deep, offshore waters, but sometimes is found over the continental shelf and occasionally moves into very shallow (Jefferson et al. 2015; Baird 2018b). It is gregarious and forms strong social bonds, as is evident from its propensity to strand en masse (Baird 2018b). In the eastern North Pacific, it has been reported only rarely north of Baja California (Leatherwood et al. 1982, 1987; Mangels and Gerrodette 1994); however, the waters off the U.S. West Coast all the way north to Alaska are considered part of its secondary range (Jefferson et al. 2015). Its occurrence in Washington/Oregon is associated with warm-water incursions (Buchanan et al. 2001).

However, no sightings of false killer whales were made along the U.S. West Coast during surveys conducted from 1986–2001 (Ferguson and Barlow 2001, 2003; Barlow 2003) or in 2005 and 2008 (Forney 2007; Barlow 2010). One pod of false killer whales occurred in Puget Sound for several months during the 1990s (DON 2015). Two false killer whales were reported stranded along the Washington coast during 1930–2002, both in El Niño years (Norman et al. 2004). This species is unlikely to be encountered during the proposed survey.

Killer Whale (*Orcinus orca*)

The killer whale is cosmopolitan and globally fairly abundant; it has been observed in all oceans of the world (Ford 2018). It is very common in temperate waters and also frequents tropical waters, at least seasonally (Heyning and Dahlheim 1988). Killer whales are segregated socially, genetically, and ecologically into three distinct ecotypes: residents, transients, and offshore animals. Killer whales occur in inshore inlets, along the coast, over the continental shelf, and in offshore waters (Ford 2014).

There are eight killer whale stocks recognized in the Pacific U.S.: (1) Alaska Residents, occurring from Southeast Alaska to the Aleutians and Bering Sea; (2) Northern Residents, from B.C. through parts of Southeast Alaska; (3) Southern Residents, mainly in inland waters of Washington State and southern B.C.; (4) Gulf of Alaska, Aleutians, and Bering Sea Transients, from Prince William Sound through to the Aleutians and Bering Sea; (5) AT1 Transients, from Prince William Sound through the Kenai Fjords; (6) West Coast Transients, from California through Southeast Alaska; (7) Offshore, from California through Alaska; and (8) Hawaiian (Carretta et al. 2024). Individuals from the ***endangered*** Southern Resident stock are unlikely to be encountered in the proposed survey area, as they mostly occur in coastal waters. However, individuals from the West Coast Transient or Offshore stocks could be encountered in the proposed project area.

Resident killer whales mainly feed on salmon, in particular Chinook, and their movements coincide with those of their prey (Ford 2014). During the spring, summer, and fall, southern resident killer whales primarily occur in the southern Strait of Georgia, Strait of Juan de Fuca, Puget Sound, and the southern half of the West Coast of Vancouver Island (Ford et al. 1994; Baird 2001; Olson et al. 2018; Carretta et al. 2024). High-use areas along the coast of Washington have also been reported (Hanson et al. 2017, 2018). Southern resident killer whales occur along the outer coasts of B.C. and Washington throughout the year, but individuals have been reported as far south as California and as far north as Alaska (Hanson et al. 2017, 2018; Carretta et al. 2024). Southern resident whales appear to spend the majority of their time on the continental shelf, within 34 km from the coast, in water <100 m deep (Hanson et al. 2017). K/L pods primarily occur on the Washington coast, from Grays Harbor to the Columbia River; high use areas for J pod primarily occur at the western entrance of the Strait of Juan de Fuca and northern Strait of Georgia (Hanson et al. 2017). This small population of 73 individuals (see Carretta et al. 2024) is threatened by reduced prey availability, contaminants, and vessel disturbance including noise (e.g., Lacy et al. 2017; Murray et al. 2019). Calambokidis et al. (2024) delineated a larger year-round small and resident (S)-BIA (parent) for southern resident killer whales that overlaps the critical habitat along the entire U.S. West Coast and also includes the critical habitat in Canadian water; the core S-BIA occurs along the entire western coast of Washington and northern Oregon.

The main diet of transient killer whales consists of marine mammals, in particular porpoises and seals. West Coast transient whales (also known as Bigg's killer whales) range from Southeast Alaska to California (Young et al. 2024). The seasonal movements of transients are largely unpredictable. Green et al. (1992) noted that most groups seen during their surveys off Oregon and Washington were likely transients; during those surveys, killer whales were sighted only in shelf waters. Two of 17 killer whales that stranded in Oregon were confirmed as transient (Stevens et al. 1989 *in* Norman et al. 2004).

Little is known about offshore killer whales, but they occur primarily over shelf waters and feed on fish, especially sharks (Ford 2014). Dahlheim et al. (2008) reported sightings off Washington and Oregon in the summer, and sightings in the Strait of Juan de Fuca during spring. Eleven sightings of ~536 individuals were reported off Oregon/Washington during the 2008 SWFSC vessel survey (Barlow 2010). Killer whales were sighted offshore Washington during surveys from August 2004 to September 2008 (Oleson et al. 2009). Keating et al. (2015) analyzed cetacean whistles from recordings made during 2000–2012; several killer whale acoustic detections were made offshore Washington. Killer whale calls were detected at acoustic recorders deployed off Washington during 2008–2013 year-round (Emmons et al. 2020). Humpback whales could be encountered in the proposed survey area at the time of the survey.

Killer whales were sighted off Washington in July and September 2012 (Adams et al. 2014). One satellite-tagged individual was tracked while traversing the survey area and four others were tracked to the east during March 2013 (Schorr et al. 2022). Sightings were also made off Oregon and Washington in 2018 during a SWFSC California Current Ecosystem Survey (Henry et al. 2020). Killer whales were sighted off Oregon off the continental shelf in July 2015, August 2018, and September 2021 (McInnes et al. 2024). One multiple-species sighting involving this species was made during the June–July 2021 L-DEO Cascadia survey (RPS 2022a), but no sightings were made during the April 2022 L-DEO survey off Oregon (RPS 2022b). There was one sighting (10 animals) during the September–October 2017 SIO survey off Oregon and Washington (SIO n.d.). Killer whales could be encountered during the proposed surveys.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

The short-finned pilot whale is found in tropical and warm temperate waters (Olson 2018); it is seen as far south as ~40ºS and as far north as ~50ºN (Jefferson et al. 2015). Pilot whales are generally nomadic, but may be resident in certain locations, including California and Hawaii (Olson 2018). Short-finned pilot whales were common off southern California (Dohl et al. 1980) until an El Niño event occurred in 1982–1983 (Carretta et al. 2024). Few sightings were made off California/Oregon/Washington in 1984–1992 (Green et al. 1992; Carretta and Forney 1993; Barlow 1997), and sightings remain rare (Barlow 1997; Buchanan et al. 2001; Barlow 2010). No short-finned pilot whales were seen during surveys off Oregon and Washington in 1989–1990, 1992, 1996, and 2001 (Barlow 2003). Carretta et al. (2024) reported one sighting off Oregon during 1991–2014. Several stranding events in Oregon/southern Washington have been recorded over the past few decades, including in March 1996, June 1998, and August 2002 (Norman et al. 2004) and in 2007 (Warlick et al. 2022). Pilot whales are expected to be rare in the proposed survey area.

Dall's Porpoise (*Phocoenoides dalli*)

Dall's porpoise is found in temperate to subarctic waters of the North Pacific and adjacent seas (Jefferson et al. 2015). It is widely distributed across the North Pacific over the continental shelf and slope waters, and over deep (>2500 m) oceanic waters (Hall 1979). It is probably the most abundant small cetacean in the North Pacific Ocean, and its abundance changes seasonally, likely in relation to water temperature (Becker 2007).

Off Oregon and Washington, Dall's porpoise is widely distributed over shelf and slope waters, with concentrations near shelf edges, but is also commonly sighted in pelagic offshore waters (Morejohn 1979; Green et al. 1992; Becker et al. 2014; Fleming et al. 2018; Carretta et al. 2024). Combined results of various surveys out to ~550 km offshore indicate that the distribution and abundance of Dall's porpoise varies between seasons and years. North-south movements are believed to occur between Oregon/Washington and California in response to changing oceanographic conditions, particularly temperature and distribution and abundance of prey (Green et al. 1992, 1993; Mangels and Gerrodette 1994; Barlow 1995; Forney and Barlow 1998; Buchanan et al. 2001). Becker et al. (2014) predicted high densities off southern Oregon throughout the year, with moderate densities to the north. According to predictive density distribution maps, the highest densities off southern Washington and Oregon occur along the 500-m isobath (Menza et al. 2016).

Encounter rates reported by Green et al. (1992) during aerial surveys off Oregon/Washington were highest in fall, lowest during winter, and intermediate during spring and summer. Encounter rates during the summer were similarly high in slope and shelf waters, and somewhat lower in offshore waters (Green et al. 1992). Dall's porpoise was the most abundant species sighted off Oregon/Washington during 1996, 2001, 2005, and 2008 ship surveys up to ~550 km from shore (Barlow 2003, 2010). Oleson et al. (2009) reported 44 sightings of 206 individuals off Washington during surveys form August 2004 to September 2008. Dall's porpoise were seen in the waters off Oregon during summer, fall, and winter surveys in 2011 and 2012 (Adams et al. 2014) and in offshore waters off Oregon and Washington in 2018 (Henry et al. 2020).

Nineteen Dall's porpoise sightings (144 animals) were made off Washington/Oregon during the June–July 2012 L-DEO Juan de Fuca plate seismic survey (RPS 2012b). There were 16 Dall's porpoise sightings (54 animals) made during the July 2012 L-DEO seismic surveys off southern Washington (RPS 2012a). This species was not sighted during the July 2012 L-DEO seismic survey off Oregon (RPS 2012c). One sighting (four animals) was made during the June–July 2021 L-DEO Cascadia survey (RPS 2022a), but no sightings were made during the 2017 SIO survey off Oregon (SIO n.d.) or the April 2022 L-DEO survey off Oregon (RPS 2022b). Dall's porpoise were likely detected at DASPRs along the 2000-isobath off southern Oregon and also possibly just south of the proposed survey area, during summer 2016 (Griffiths et al. 2020). Dall's porpoise is likely to be encountered during the proposed seismic survey.

Pinnipeds

Guadalupe Fur Seal (*Arctocephalus townsendi*)

Most breeding and births occur at Isla Guadalupe, Mexico; a secondary rookery exists at Isla Benito del Este (Maravilla-Chavez and Lowry 1999; Aurioles-Gamboa et al. 2010). A few Guadalupe fur seals are known to occur at California sea lion rookeries in the Channel Islands, primarily San Nicolas and San Miguel islands, and sightings have also been made at Santa Barbara and San Clemente islands (Stewart et al. 1987; Carretta et al. 2024). Guadalupe fur seals prefer rocky habitat for breeding and hauling out. They generally haul out at the base of towering cliffs on shores characterized by solid rock and large lava blocks (Peterson et al. 1968), although they can also inhabit caves and recesses (Belcher and Lee 2002). While at sea, this species usually is solitary but typically gathers in the hundreds to thousands at breeding sites.

During the summer breeding season, most adults occur at rookeries in Mexico (Norris 2017 *in* DON 2019; Carretta et al. 2024). Following the breeding season, adult males tend to move northward to forage. Females have been observed feeding south of Guadalupe Island, making an average round trip of 2375 km (Ronald and Gots 2003). Several rehabilitated Guadalupe fur seals that were satellite tagged and released in central California traveled as far north as B.C. (Norris et al. 2015; Norris 2017 *in* DON 2019). Fur seals younger than two years old are more likely to travel to more northerly, offshore areas than older fur seals (Norris 2017 *in* DON 2019). Stranding data also indicates that fur seals younger than 2 years are more likely to occur in the proposed survey area, as this age class was most frequently reported (Lambourn et al.

2012 *in* DON 2019). In 2015–2016, 175 Guadalupe fur seals stranded on the coast of California; NMFS declared this an unusual mortality event (Carretta et al. 2024). Guadalupe fur seals could be encountered during the proposed seismic surveys off the coasts of Washington and Oregon.

Northern Fur Seal (*Callorhinus ursinus*)

The northern fur seal is endemic to the North Pacific Ocean and occurs from southern California to the Bering Sea, Okhotsk Sea, and Honshu Island, Japan (Young et al. 2024). During the breeding season, most of the worldwide population of northern fur seals inhabits the Pribilof Islands in the southern Bering Sea (NMFS 2007; Lee et al. 2014; Young et al. 2024). The rest of the population occurs at rookeries on Bogoslof Island in the Bering Sea, in Russia (Commander Islands, Robben Island, Kuril Islands), on San Miguel Island in southern California (NMFS 1993; Lee et al. 2014), and on the Farallon Islands off central California (Young et al. 2024). In the U.S., two stocks are recognized—the Eastern Pacific and the California stocks (Young et al. 2024). The Eastern Pacific stock ranges from the Pribilof Islands and Bogoslof Island in the Bering Sea during summer to California during winter (Young et al. 2024).

When not on rookery islands, northern fur seals are primarily pelagic but occasionally haul out on rocky shorelines (Young et al. 2024). During the breeding season, adult males usually come ashore in May–August and may sometimes be present until November; adult females are found ashore from June–November (Young et al. 2024). After reproduction, northern fur seals spend the next 7–8 months feeding at sea (Roppel 1984). Immature seals can remain in southern foraging areas year-round until they are old enough to mate (NMFS 2007). In November, females and pups leave the Pribilof Islands and migrate through the Gulf of Alaska to feeding areas primarily off the coasts of B.C., Washington, Oregon, and California before migrating north again to the rookeries in spring (Ream et al. 2005; Pelland et al. 2014). Males usually migrate only as far south as the Gulf of Alaska (Kajimura 1984). Ream et al. (2005) showed that migrating females moved over the continental shelf as they migrated southeasterly. Instead of following depth contours, their travel corresponded with movements of the Alaska Gyre and the North Pacific Current (Ream et al. 2005). Their foraging areas were associated with eddies, the subarctic-subtropical transition region, and coastal mixing (Ream et al. 2005; Alford et al. 2005). Some juveniles and non-pregnant females may remain in the Gulf of Alaska throughout the summer (Calkins 1986). The northern fur seals spends ~90% of its time at sea, typically in areas of upwelling along the continental slopes and over seamounts (Gentry 1981). The remainder of its life is spent on or near rookery islands or haulouts. Pups from the California stock also migrate to Washington, Oregon, and northern California after weaning (Lea et al. 2009).

Northern fur seals were seen throughout the North Pacific during surveys conducted during 1987–1990, including off Vancouver Island and in the western Gulf of Alaska (Buckland et al. 1993). Tagged adult fur seals were tracked from the Pribilof Islands to the waters off Washington/Oregon/ California, with recorded movement throughout the proposed project area (Pelland et al. 2014). Tracked adult male fur seals that were tagged on St. Paul Island in the Bering Sea in October 2009, wintered in the Bering Sea or northern North Pacific Ocean; females migrated to the Gulf of Alaska and the California Current, including off the west coasts of Haida Gwaii and Vancouver Island (Sterling et al. 2014). Some individuals reach California by December, after which time numbers increase off the west coast of North America (Ford 2014). The peak density shift over the course of the winter and spring, with peak densities occurring in California in February, April off Oregon and Washington, and May off B.C. and Southeast Alaska (Ford 2014). The use of continental shelf and slope waters of B.C. and the northwestern U.S. by adult females during winter is well documented from pelagic sealing data (Bigg 1990).

Bonnell et al. (1992) noted the presence of northern fur seals year-round off Oregon/Washington, with the greatest numbers (87%) occurring in January–May. Northern fur seals were seen as far out from the coast as 185 km, and numbers increased with distance from land; they were 5–6 times more abundant in offshore waters than over the shelf or slope (Bonnell et al. 1992). The highest densities were seen in the Columbia River plume (~46°N) and in deep offshore waters (>2000 m) off central and southern Oregon (Bonnell et al. 1992). The waters off Washington are a known foraging area for adult females, and concentrations of fur seals were also reported to occur near Cape Blanco, Oregon, at ~42.8°N (Pelland et al. 2014). Three northern fur seals were seen during the 2021 L-DEO Cascadia survey (RPS 2022a), and five were seen during the April 2022 L-DEO survey off Oregon (RPS 2022b). Northern fur seals could be observed in the proposed survey area, in particular females and juveniles. However, adult males are generally ashore during the reproductive season from May–August, and adult females are generally ashore from June through November.

Northern Elephant Seal (*Mirounga angustirostris*)

The northern elephant seal breeds in California and Baja California, primarily on offshore islands, from Cedros off the west coast of Baja California, north to the Farallons in Central California (Stewart et al. 1994). Adult elephant seals engage in two long northward migrations per year, one following the breeding season, and another following the annual molt (Stewart and DeLong 1995). Between the two foraging periods, they return to land to molt, with females returning earlier than males (March–April vs. July–August). After the molt, adults then return to their northern feeding areas until the next winter breeding season. Breeding occurs from December–March (Stewart and Huber 1993). Females arrive in late December or January and give birth within ~1 week of their arrival. Juvenile elephant seals typically leave the rookeries in April or May and head north, traveling an average of 900–1000 km. Hindell (2009) noted that traveling likely takes place at depths >200 m. Most elephant seals return to their natal rookeries when they start breeding (Huber et al. 1991).

When not at their breeding rookeries, adults feed at sea far from the rookeries. Adult females and juveniles forage in the California current off California to B.C. (Le Boeuf et al. 1986, 1993, 2000). Bonnell et al. (1992) reported that northern elephant seals were distributed equally in shelf, slope, and offshore waters during surveys conducted off Oregon and Washington, as far as 150 km from shore, in waters >2000 m deep. Telemetry data indicate that they range much farther offshore than that (Stewart and DeLong 1995). Males may feed as far north as the eastern Aleutian Islands and the Gulf of Alaska, whereas females feed south of 45ºN (Le Boeuf et al. 1993; Stewart and Huber 1993). Adult male elephant seals migrate north via the California current to the Gulf of Alaska during foraging trips, and could potentially also pass through the area off Washington in May and August (migrating to and from molting periods) and November and February (migrating to and from breeding periods), but likely their presence there is transient and short-lived. Most elephant seal sightings at sea off Washington were made during June, July, and September; off Oregon, sightings were recorded from November through May (Bonnell et al. 1992). Northern elephant seal pups have been sighted at haulouts in the inland waters of Washington State (Jeffries et al. 2000), and at least three were reported to have been born there (Hayward 2003). Pupping has also been observed at Shell Island (~43.3°N) off southern Oregon, suggesting a range expansion (Bonnell et al. 1992; Hodder et al. 1998). Thus, this species could be encountered during the proposed seismic survey.

Steller Sea Lion (*Eumetopias jubatus*)

The Steller sea lion occurs along the North Pacific Rim from northern Japan to California (Loughlin et al. 1984). There are two stocks, or DPSs, of Steller sea lions – the Western and Eastern DPSs, which are divided at 144°W longitude (Young et al. 2024). The Western DPS is listed as *endangered* and includes animals that occur in Japan and Russia (Young et al. 2024); the Eastern DPS was delisted from *threatened* in 2013 (NMFS 2013a). Only individuals from the Eastern DPS could occur in the proposed survey area.

Steller sea lions typically inhabit waters from the coast to the outer continental shelf and slope throughout their range; they are not considered migratory, although foraging animals can travel long distances (Loughlin et al. 2003; Raum-Suryan et al. 2002). Rookeries of Steller sea lions from the Eastern DPS are located in southeast Alaska, B.C., Oregon, and California; there are no rookeries in Washington (NMFS 2013a; Young et al. 2024). Breeding adults occupy rookeries from late-May to early-July (NMFS 2008a).

Non-breeding adults use haulouts or occupy sites at the periphery of rookeries during the breeding season (NMFS 2008a). Pupping occurs from mid-May to mid-July (Pitcher and Calkins 1981) and peaks in June (Pitcher et al. 2002). Territorial males fast and remain on land during the breeding season (NMFS 2008a). Females with pups generally stay within 30 km of the rookeries in shallow (30–120 m) water when feeding (NMFS 2008a). Tagged juvenile sea lions showed localized movements near shore (Briggs et al. 2005). Loughlin et al. (2003) reported that most (88%) at-sea movements of juvenile Steller sea lions in the Aleutian Islands were short (<15 km) foraging trips. The mean distance of juvenile sea lion trips at sea was 16.6 km, and the maximum trip distance recorded was 447 km. Long-range trips represented 6% of all trips at sea, and trip distance and duration increase with age (Loughlin et al. 2003; Call et al. 2007). Although Steller sea lions are not considered migratory, foraging animals can travel long distances outside of the breeding season (Loughlin et al. 2003; Raum-Suryan et al. 2002). During the summer, they mostly forage within 60 km from the coast; during winter, they can range up to 200 km from shore (Ford 2014).

During surveys off the coasts of Oregon and Washington, Bonnell et al. (1992) noted that 89% of sea lions occurred over the shelf at a mean distance of 21 km from the coast and near or in waters <200 m deep; the farthest sighting occurred ~40 km from shore, and the deepest sighting location was 1611 m deep. Sightings were made along the 200-m depth contour throughout the year (Bonnell et al. 1992). During aerial surveys over the shelf and slope off Oregon and Washington, one Steller sea lion was seen on the Oregon shelf during January 2011, and two sightings totaling eight individuals were made on September 2012 off southern Oregon (Adams et al. 2014). During a survey off Washington/Oregon June–July 2012, two Steller sea lions were seen from R/V *Langseth* (RPS 2012b) off southern Oregon. Eight sightings of 11 individuals were made from R/V *Northern Light* during a survey off southern Washington during July 2012 (RPS 2012a). Twelve sightings totaling 17 Steller sea lions were made during the 2021 L-DEO Cascadia survey, all in water <2000 m deep (RPS 2022a). This species is unlikely to be encountered in the far offshore survey area.

California Sea Lion (*Zalophus californianus*)

The primary range of the California sea lion includes the coastal areas and offshore islands of the eastern North Pacific Ocean from B.C. to central Mexico, including the Gulf of California (Jefferson et al. 2015). However, its distribution is expanding (Jefferson et al. 2015), and its secondary range extends into the Gulf of Alaska (Maniscalco et al. 2004) and southern Mexico (Gallo-Reynoso and Solórzano-Velasco 1991), where it is occasionally recorded.

California sea lion rookeries are on islands located in southern California, western Baja California, and the Gulf of California (Carretta et al. 2024). Five genetically distinct geographic populations have been identified: (1) Pacific Temperate (includes rookeries in U.S. waters and the Coronados Islands to the south),

(2) Pacific Subtropical, (3) Southern Gulf of California, (4) Central Gulf of California, and (5) Northern Gulf of California (Schramm et al. 2009). Animals from the Pacific Temperate population occur in the proposed project area.

In California and Baja California, births occur on land from mid-May to late-June. During August and September, after the mating season, the adult males migrate northward to feeding areas as far north as Washington (Puget Sound) and B.C. (Lowry et al. 1992). They remain there until spring (March–May), when they migrate back to the breeding colonies (Lowry et al. 1992; Weise et al. 2006). The distribution of immature California sea lions is less well known but some make northward migrations that are shorter in length than the migrations of adult males (Huber 1991). However, most immature seals are presumed to remain near the rookeries for most of the year, as are females and pups (Lowry et al. 1992).

California sea lions are coastal animals that often haul out on shore throughout the year, but peak numbers off Oregon and Washington occur during the fall (Bonnell et al. 1992). During aerial surveys off the coasts of Oregon and Washington during 1989–1990, California sea lions were sighted at sea during the fall and winter, but no sightings were made during June–August (Bonnell et al. 1992). Numbers off Oregon decrease during winter, as animals travel further north (Mate 1975 *in* Bonnell et al. 1992). King (1983) noted that sea lions are rarely found more than 16 km offshore. During fall and winter surveys off Oregon and Washington, mean distance from shore was ~13 km and most were observed in water <200 m deep; however, sightings were made in water as deep as 356 m (Bonnell et al. 1992). Weise et al. (2006) reported that males normally forage almost exclusively over the continental shelf, but during anomalous climatic conditions they can forage farther out to sea (up to 450 km offshore).

During aerial surveys over the shelf and slope off Oregon and Washington (Adams et al. 2014), California sea lions were seen during all survey months (January–February, June–July, September–October). Although most sightings occurred on the shelf, during February 2012, one sighting was made near the 2000-m depth contour, and during June 2011 and July 2012, sightings were made along the 200-m isobath off southern Oregon (Adams et al. 2014). During October 2011, sightings were made off the Columbia River estuary near the 200-m isopleth and on the southern Oregon shelf; during September 2012, sightings occurred in nearshore waters off Washington and in shelf waters along the coast of Oregon (Adams et al. 2014). Adams et al. (2014) reported sightings more than 60 km off the coast of Oregon. This species could be encountered in very small numbers in the offshore survey area. Four sightings of nine California sea lions were made during the 2021 L-DEO Cascadia survey; however, all sightings occurred in coastal waters (RPS 2022a).

APPENDIX D: METHODS FOR MARINE MAMMAL DENSITIES AND TAKE CALCULATIONS

Ship surveys for cetaceans in slope and offshore waters of Oregon and Washington were conducted by NMFS/SWFSC in 1991, 1993, 1996, 2001, 2005, 2008, 2014, and 2018 and synthesized by Becker et al. (2020). These surveys were conducted up to ~556 km from shore typically from July to November, but included the months of June and December in 2018 (Becker et al. 2020). These data were used by SWFSC to develop spatial models of cetacean densities for the California Current Ecosystem (CCE). Although Becker et al. (2020) did not include updated densities for sperm or small beaked whales, these models were provided by Elizabeth Becker via pers. comm. in January 2025. The density models for cetaceans in the CCE were available in the form 10 km x 10 km grid cells in GIS layers; the densities in the 215 grid cells that overlapped the proposed survey area (ie., any cell that overlapped/intersected any amount with the survey area) were averaged to calculate densities for each species. For species for which densities were not available from Becker et al. (2020), we used annual densities from the U.S. Navy Northwest Training and Testing Study area (DON 2019) to calculate takes for sei whale, offshore killer whale, short-finned pilot whale, *Kogia* spp., California sea lion, and leatherback sea turtle (DON 2019). For pinnipeds other than California sea lions, we used the highest densities for spring, summer, or fall from DON (2019), but corrected the estimates by projecting the most recent population growth/updated population estimates, when available. For Cuvier's beaked whale, we used densities from Barlow et al. (2021). The densities were multiplied by the daily ensonified area (221 km^2) and the number of survey days (2), and increased by 25%, to estimate Level B takes (Table C-1).

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TABLE D-1. Take estimates for the proposed survey area at the Cascadia Subduction Zone.

Species	Density (#/km²)	Regional Population Size	Hearing Group	Daily Ensonified Area (km²)	Number of Seismic Days	25% Increase	Estimated Level B Takes[1]	% of Pop. (Requested Takes)[2]	Requested Level B Take Authorization[3]
LF Cetaceans									
North Pacific right whale	0	*400*	*LF*	*221*	*2*	*1.25*	*0*	*0*	*0*
Humpback whale[4]	*0.000480*	*4,973*	*LF*	*221*	*2*	*1.25*	*0*	*0.04*	***2***
Blue whale	*0.000025*	*1,898*	*LF*	*221*	*2*	*1.25*	*0*	*0.11*	***2***
Fin whale	*0.004482*	*11,065*	*LF*	*221*	*2*	*1.25*	*2*	*0.02*	*2*
Sei whale	*0.000400*	*864*	*LF*	*221*	*2*	*1.25*	*0*	*0.23*	***2***
Minke whale	0.000869	915	LF	221	2	1.25	0	0.11	**1**
HF Cetaceans									
Sperm whale	*0.002731*	*2,606*	*HF*	*221*	*2*	*1.25*	*2*	*0.27*	***7***
Cuvier's beaked whale	0.005120	5,454	HF	221	2	1.25	3	0.05	3
Baird's beaked whale	0.000051	1,363	HF	221	2	1.25	0	0.51	**7**
Small beaked whale[5]	0.002320	3,044	HF	221	2	1.25	1	N.A.	**N.A.**
Blaineville's beaked whale	N.A.	3,044	HF	221	2	1.25	N.A.	0.07	**2**
Hubbs' beaked whale	N.A.	3,044	HF	221	2	1.25	N.A.	0.07	**2**
Stejneger's beaked whale	N.A.	3,044	HF	221	2	1.25	N.A.	0.07	**2**
Bottlenose dolphin	0.000002	3,477	HF	221	2	1.25	0	0.40	**14**
Striped dolphin	0.000057	29,988	HF	221	2	1.25	0	0.13	**39**
Short-beaked common dolphin	0.001305	1,056,308	HF	221	2	1.25	1	0.01	**156**
Pacific white-sided dolphin	0.069054	34,999	HF	221	2	1.25	38	0.16	**55**
Northern right-whale dolphin	0.116618	29,285	HF	221	2	1.25	64	0.22	64
Risso's dolphin	0.014357	6,336	HF	221	2	1.25	8	0.30	**19**
False killer whale	N.A.	N.A.	HF	221	2	1.25	N.A.	N.A.	**5**
Killer whale	0.000920	300	HF	221	2	1.25	1	2.33	**7**
Short-finned pilot whale	0.000250	836	HF	221	2	1.25	0	3.47	**29**
VHF Cetaceans									
Pygmy/dwarf sperm whale[6]	0.001630	4,111	VHF	221	2	1.25	1	N.A.	**N.A.**
Pgymy sperm whale	N.A.	4,111	VHF	221	2	1.25	N.A.	0.02	**1**
Dwarf sperm whale	N.A.	4,111	VHF	221	2	1.25	N.A.	0.02	**1**
Dall's porpoise	0.047357	16,498	VHF	221	2	1.25	26	0.16	26
Otariid Pinnipeds									
Northern fur seal	0.033027	626,618	OT	221	2	1.25	18	<0.01	18
Guadalupe fur seal	*0.033027*	*34,187*	OT	*221*	*2*	*1.25*	*18*	*0.05*	*18*
California sea lion	0.071400	257,606	OT	221	2	1.25	39	0.02	39
Steller sea lion	0.002771	36,308	OT	221	2	1.25	2	<0.01	2
Phocid Pinniped									
Northern elephant seal	0.041794	187,386	PW	221	2	1.25	23	0.01	23
Sea Turtle									
Leatherback Turtle[7]	0.000114	*N.A.*	*ST*	*39*	*6*	*1.25*	*0*	*N.A.*	***1***

Note: ESA-listed species are in italics. N.A. means not available. [1]Level B takes for marine mammals are based on the 160-dB criterion. [2]Requested take authorization is expressed as % of population (see Table 3). [3]Requested take authorization is based on calculated takes. Takes in bold have been increased to mean group size based on Becker et al. (2020), except for sei, killer, pygmy sperm, dwarf sperm, and short-finned pilot whales for which mean group size is from Barlow (2016), and for false killer whale which is from Mobley et al. (2000). [4]One take each is assumed for the ESA-listed Central America and Mexico DPSs. [5]Minimum group sizes are being requested as takes for each *Mesoplodon* sp. that could occur in the survey area. [6]Assigned mean group size to each species of *Kogia*. [7]Take was rounded up to 1.

APPENDIX E: ESSENTIAL FISH HABITAT CONSULTATION

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2025-01566

August 6, 2025

Kristen Hamilton
Environmental Compliance Officer
U.S. National Science Foundation
2415 Eisenhower Ave
Alexandria, VA 22314

Re: Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Marine Geophysical Surveys by R/V Sally Ride at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025

Dear Kristen Hamilton:

On June 3, 2025, NOAA's National Marine Fisheries Service (NMFS) received your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1855(b)) for the Marine Geophysical Surveys by R/V Sally Ride at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025.

We have concluded that the actions would adversely affect EFH designated under the Fishery Management Plan (FMP) for Coastal Pelagic Species, Pacific Coast Salmon, Highly Migratory Species, and Pacific Coast Groundfish, and have provided three EFH conservation recommendations.

Consultation History

The EFH consultation request was received June 3, 2025. Emails were exchanged between the assigned NMFS biologist and the National Science Foundation (NSF) project manager between July 21 and July 23, 2025. The EFH consultation was initiated on July 23, 2025. The project is also under ESA consultation with the Office of Protected Resources. The ship's operator is applying for an Incidental Harassment Authorization (IHA) under the Marine Mammal Protection Act, also with the Office of Protected Resources.

Proposed Action and Action Area

The NSF proposes to provide funding to New Mexico Tech and Oregon State University for marine geophysical research using a portable multi-channel seismic (MCS) system. The research would be conducted over a two-day period (plus an additional day for transit to the study site) in September 2025, and take place in the NE Pacific Ocean, within the U.S. Exclusive Economic

Zone and Cascadia Subduction Zone. The survey area is approximately 100km by 200km, over 100km from shore, and bounded by the following approximate coordinates: 45°N/127°W, 47°N/127°W, 47°N/ 126°W, and 45°N/ 125.5°W. Surveying would take place along transect lines within the study area. Further detail is provided in the section 2.1.2 (Proposed Activities) of the applicant's Environmental Assessment and incorporated by reference (NSF 2025).

The proposed surveys would collect marine seismic data with a towed two-airgun array (90 in3 discharge volume) at a depth of 4 meters (m) in water more than 2000 m deep, operated from the R/V Sally Ride. The receiving system for the returning acoustic signals would consist of a hydrophone streamer. No ocean bottom seismometers would be used. They would also use a multibeam, echosounder (MBES), sub-bottom profiler (SBP), and Acoustic Doppler Current Profilers (ADCP). The purpose is to quantify the thermal effects of fluid circulation in oceanic crust entering the Cascadia Subduction Zone.

The action area is comprised of the approximately 100km by 200km survey area plus a 505-meter buffer to account for the extent of project-related underwater sound above ambient background conditions.

Background and Action Agency's Effects Determinations

The NSF describes that "…no long-term or significant effects would be expected on individual marine mammals, sea turtles, seabirds, fish, the populations to which they belong, or their habitats," and that the proposed action would have no adverse effect on EFH or HAPC. The NMFS notes that the standard for EFH is will or will not adversely affect. We have determined that the effects to EFH are adverse, and provide our analysis below.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the associated physical, chemical, and biological properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH (50 CFR 600.905(b)).

EFH Affected by the Proposed Action

The proposed project would occur within EFH for various federally managed fish species within the:

- Coastal Pelagic Species FMP;
- Highly Migratory Species FMP;
- Pacific Coast Salmon FMP; and
- Pacific Coast Groundfish FMP.

In addition, the project would occur in the vicinity of rocky reefs, which are designated as a habitat area of particular concern (HAPC) for various federally managed fish species within the Pacific Coast Groundfish FMC. HAPC are described in the regulations as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under the MSA; however, federal projects with potential adverse impacts on HAPC will be more carefully scrutinized during the consultation process.

Adverse Effects on EFH

NMFS determined the proposed action would adversely affect EFH as follows:

1. Pollution;
2. Vessel strike;
3. Acoustic noise from the airgun array, vessel noise, and visual disturbance;
4. Acoustic noise from the sub-bottom profiler, multi-beam echosounder, and acoustic Doppler current profiler; and
5. Gear entanglement and interaction.

These stressors and their effects on are thoroughly described in the ESA effects analysis (Section 6 and 7) of the Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the National Science Foundation's Low-Energy Marine Geophysical Survey by the Research Vessel Marcus G. Langseth in the Northeast Pacific Ocean (NMFS 2022) and incorporated by reference.

We concluded that these effects on the essential habitat of some species protected under the MSA are adverse, albeit briefly. In particular, sound pressure waves generated may acutely modify the aquatic habitat to the detriment of northern anchovy and Pacific sardine (included in the coastal pelagic species fishery management plan), which have swim bladders connected to the inner ear for enhanced hearing and are more sensitive to sound effects from the airgun array (Popper et al. 2014; Ladich and Schulz-Mirbach 2016). Pollution diminishes water quality. Disturbance in the substrate can alter conditions supporting species and prey for those species. However, each of these modifications is expected to be spatially and temporally limited in each location where it occurs. Sound pressure waves cease when operation stops, and pollutants dilute and disperse as to no longer have the magnitude to induce an area of intense change; distributed bottom sediments settle, and benthic areas recover their ability to support EFH species quickly after disturbance.

EFH Conservation Recommendations
NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the adverse effects of the proposed action on EFH.

1. To reduce all effects, use the smallest area possible to meet the needs of the survey.

2. To reduce the risk of pollution, ensure that the research vessel and equipment are properly maintained and in good working order prior to the start of the research cruise.

3. To reduce the effects of acoustic noise, use the least powerful airguns possible to meet the needs of the survey. Utilize ramp-up procedures to allow fish to move away from the source before exposure to harmful sound levels occur. Avoid reducing speed while towing to minimize the cumulative sound exposure level and minimize the injury isopleth.

Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, NSF must provide a detailed response in writing to NMFS within 30 days after receiving an EFH conservation recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH conservation recommendations unless NMFS and the federal agency have agreed to use alternative time frames for the federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the conservation recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

Supplemental Consultation

The NSF must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600. 920(l)).

Essential Fish Habitat Consultation References

Ladich, F., and T. Schulz-Mirbach. 2016. Diversity in fish auditory systems: One of the riddles of sensory biology. Frontiers in Ecology and Evolution 4: 2-28.

NMFS 2022. Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the National Science Foundation's Low-Energy Marine Geophysical Survey by the Research Vessel Marcus G. Langseth in the Northeast Pacific Ocean and National Marine Fisheries Service Permits and Conservation Division's Issuance of an Incidental Harassment Authorization Pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (OPR-2021-03468). Office of Protected Resources, National Marine Fisheries

Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. 293pp.

NSF (National Science Foundation). 2025. Draft Environmental Assessment of Marine Geophysical Surveys by R/V Sally Ride at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025. National Science Foundation Division of Ocean Sciences. 179pp.

Popper, A., and coauthors. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

PFMC (Pacific Fishery Management Council). 2024. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

PFMC. 2008. Management of krill as an essential component of the California Current ecosystem. Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. Environmental assessment, regulatory impact review & regulatory flexibility analysis. Pacific Fishery Management Council, Portland, Oregon. February.

PFMC. 2007. U.S. West Coast highly migratory species: Life history accounts and essential fish habitat descriptions. Appendix F to the Fishery Management Plan for the U.S. West Coast Fisheries for Highly Migratory Species. Pacific Fishery Management Council, Portland, Oregon. January.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council, Portland, Oregon. November.

PFMC. 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon. December.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The biological opinion will be available through NOAA Institutional Repository. A complete record of this consultation is on file at the Oregon Washington Coastal Office in Lacey, Washington.

Please direct questions regarding this letter to Amy Kocourek in the South Washington Coast Branch of the Oregon Washington Coastal Office at amy.kocourek@noaa.gov.

Sincerely,

Kathleen Wells
Assistant Regional Administrator
Oregon-Washington Coastal Office

cc: Kristen Hamilton

APPENDIX F: ENDANGERED SPECIES ACT CONSULTATION

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

5/16/25

Refer to NMFS No: OPR-2025-01094

Ms. Kristen Hamilton
Environmental Compliance Officer
National Science Foundation
2415 Eisenhower Avenue
Alexandria, Virginia 22314

RE: Initiation of Consultation Pursuant to Section 7 of the Endangered Species Act on the National Science Foundation's Proposed Low-Energy Marine Geophysical Survey of the Cascadia Subduction Zone, September 2025

Dear Ms. Hamilton:

On February 18, 2025, the National Marine Fisheries Service (NMFS) received your request for formal consultation under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) for the National Science Foundation's proposal to fund a low-energy marine geophysical (seismic) survey of the Cascadia Subduction Zone in September 2025. This response to your request was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at (50 CFR §402), and agency guidance.

Based on our review of the submitted information, including the draft environmental assessment, and responses to our requests for additional information received on April 29 and 30, 2025, we determined that there is sufficient information, and initiated formal section 7 consultation on April 30, 2025. During consultation, we may request additional information or clarification to assist us in our analysis and in completing this consultation.

The ESA requires that, after initiation of formal consultation, the action agency may not make any irreversible or irretrievable commitment of resources that would undermine the formulation or implementation of any reasonable and prudent alternatives that would ensure the requirements of section 7(a)(2) (50 CFR §402.09) are upheld. This prohibition is in force during the consultation process and continues until the requirements of section 7(a)(2) are satisfied.

If you have any questions, please contact Emily Chou, Consultation Biologist, at (301) 427-8483, or by e-mail at Emily.Chou@noaa.gov, or me at (240) 723-6321 or by e-mail at Tanya.Dobrzynski@noaa.gov.

Sincerely,

Tanya Dobrzynski
Chief, ESA Interagency Cooperation Division
Office of Protected Resources

cc: Kate Fleming, NMFS OPR
Meike Holst, LGL

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

8/21/25

Refer to NMFS No.: OPR-2025-01094

Ms. Kristen Hamilton
Environmental Compliance Officer
National Science Foundation
2415 Eisenhower Avenue
Alexandria, Virginia 22314

RE: Conference and Biological Opinion on the National Science Foundation's Funding of a Low-Energy Marine Geophysical Survey at the Cascadia Subduction Zone, Pacific Ocean, in September 2025 and the National Marine Fisheries Service Permits and Conservation Division's Issuance of an Incidental Harassment Authorization Pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act

Dear Ms. Hamilton:

Enclosed is the National Marine Fisheries Service's (NMFS) Endangered Species Act (ESA) Interagency Cooperation Division's conference and biological opinion on the effects of the National Science Foundation's proposed funding of a marine geophysical survey by the Research Vessel *Sally Ride* in the northeast Pacific Ocean in September 2025 on listed threatened and endangered species under NMFS's jurisdiction. This consultation also considers the NMFS Permits and Conservation Division's proposed issuance and possible renewal of an incidental harassment authorization pursuant to the Marine Mammal Protection Act (16 U.S.C. 1371(a)(5)(D)) for incidental "take" of marine mammals during survey work conducted by the National Science Foundation and Scripps Institution of Oceanography. We prepared the biological opinion pursuant to section 7(a)(2) of the ESA, as amended (16 U.S.C. 1536(a)(2)).

Based on our assessment, we concluded that the proposed action is likely to adversely affect, but not likely to jeopardize, the continued existence of the following ESA-listed species: blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), Central America distinct population segment (DPS) and Mexico DPS of humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), and Guadalupe fur seal (*Arctocephalus townsendi*). We also concluded that the proposed action may affect, but is not likely to adversely affect the gray whale – Western North Pacific DPS, killer whale – Southern Resident DPS, North Pacific right whale, green turtle (*Chelonia mydas*) – East Pacific DPS, leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*) – North Pacific Ocean DPS, olive ridley turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast breeding colonies, chinook salmon (*Oncorhynchus tshawytscha*) – California coastal Evolutionarily Significant Unit (ESU), Central Valley spring-run ESU, Lower Columbia River ESU, Puget Sound ESU, Sacramento River winter-run ESU, Snake River ESU, Snake River spring/summer run ESU, Upper Columbia River spring-run ESU, and Upper Willamette River ESU, chum salmon (*Oncorhynchus keta*) – Columbia River ESU and Hood Canal summer-run ESU, coho salmon (*Oncorhynchus kisutch*) – Central California coast ESU, Lower Columbia River ESU, Oregon coast ESU, and Southern Oregon and Northern California coasts ESU, eulachon (*Thaleichthys pacificus*) – Southern DPS, green sturgeon (*Acipenser medirostris*) – Southern DPS, sockeye salmon (*Oncorhynchus nerka*) – Ozette Lake ESU and Snake River ESU, steelhead trout (*Oncorhynchus mykiss*) – California Central Valley DPS, Central California Coast DPS, Lower Columbia River DPS, Middle Columbia River DPS, Northern California DPS, Puget Sound DPS, Snake River Basin DPS, South-Central California Coast DPS, Southern California DPS, Upper Columbia River DPS, and Upper Willamette River DPS, and sunflower sea star (*Pycnopodia helianthoides*), and designated critical habitat for the Southern Resident DPS killer whale, Central America DPS and Mexico DPS humpback whale, leatherback turtle, Oregon Coast ESU coho salmon, and Southern DPS green sturgeon..

This concludes ESA section 7 consultation on this action. Reinitiation of consultation is required and shall be requested by the Federal agency where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) if the amount or extent of taking specified in the incidental take statement is exceeded; (2) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this consultation; or (4) if a new species is listed or critical habitat designated that may be affected by the identified action (50 C.F.R. §402.16).

If you have any questions regarding this biological opinion, please contact Emily Chou, Consultation Biologist, at (301) 427-8483 or emily.chou@noaa.gov, or me at (240) 723-6321 or tanya.dobrzynski@noaa.gov.

Sincerely,

Tanya Dobrzynski
Chief, ESA Interagency Cooperation Division
Office of Protected Resources

National Marine Fisheries Service
Endangered Species Act Section 7
Biological Opinion

Title:	Conference and Biological Opinion on the National Science Foundation's Funding of a Low-Energy Marine Geophysical Survey at the Cascadia Subduction Zone, Pacific Ocean, September 2025 and the National Marine Fisheries Service Permits and Conservation Division's Issuance of an Incidental Harassment Authorization Pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act
Action Agencies:	U.S. National Science Foundation Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
In Consultation With:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Publisher:	Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Approved:	
	____________________________________ Kimberly Damon-Randall Director, Office of Protected Resources
Date:	8/26/25
ECO Number:	OPR-2025-01094

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TABLE OF CONTENTS

List of Figures

List of Tables

1. Introduction

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1531 et seq.) establishes a national mandate for conserving and recovering threatened and endangered species of fish, wildlife, plants, and the habitats on which they depend. Section 7(a)(2) of the Act and its implementing regulations require every Federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Section 7(a)(4) of the ESA requires Federal agencies to confer with the Secretary on any action that is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat. For actions that are not likely to jeopardize the continued existence of a proposed species or adversely modify critical habitat, a conference can be requested by the action agency, though it is not required. If requested by the Federal action agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in 50 CFR §402.14. An opinion issued at the conclusion of the conference may be adopted as the biological opinion when the species is listed or critical habitat is designated.

Section 7(b)(3) of the ESA requires that, at the conclusion of consultation, the National Marine Fisheries Service (NMFS) provide an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify their critical habitat. Similarly, when conferring on proposed species or proposed critical habitat, we also reach a conclusion as to whether the action will satisfy 7(a)(2) for those entities as proposed. If NMFS determines that the action is likely to jeopardize ESA-listed or proposed species or destroy or adversely modify designated critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If the action (or reasonable and prudent alternative) is expected to cause incidental take without violating section 7(a)(2), section 7(b)(4), as implemented by 50 CFR §402.14(i), requires NMFS to provide an incidental take statement (ITS) that specifies the amount or extent of incidental taking. Blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), gray whale (*Eschrichtius robustus*) – Western North Pacific DPS, humpback whale (*Megaptera novaeangliae*) – Mexico DPS and Central America DPS, killer whale (*Orcinus orca*) – Southern Resident DPS, North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), and Guadalupe fur seal (*Arctocephalus townsendi*) in this consultation are regulated under the Marine Mammal Protection Act (MMPA) and the ESA. Each statute has defined the meaning of take independently. The MMPA defines take as to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. Take under the ESA is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. §1532(19)). Actions considered 'take' under one statute do not necessarily rise to the level of take under the other statute. The ITS includes reasonable and prudent measures, which are actions necessary or appropriate to minimize impacts of incidental taking, and terms and conditions to implement the reasonable and prudent measures.

The action agencies for this consultation are the National Science Foundation (NSF) and the NMFS Office of Protected Resources (OPR) Permits and Conservation Division. The NSF proposes to fund a low-energy marine geophysical (seismic) survey at the Cascadia Subduction Zone, in September 2025. The survey would quantify the thermal effects of fluid circulation in oceanic crust entering the Cascadia Subduction Zone, which contributes to understanding the thermal structure of oceanic lithosphere. The survey will be conducted by researchers from the New Mexico Institute of Mining and Technology and Oregon State University on the U.S. Navy-owned research vessel (R/V) *Sally Ride*, which will be operated by the Scripps Institution of Oceanography (SIO). The NMFS Permits and Conservation Division proposes to issue an incidental harassment authorization (IHA) to SIO, authorizing non-lethal takes of marine mammals by Level B harassment (pursuant to section 101(a)(5)(D) of the MMPA).

Updates to the regulations governing interagency consultation (50 CFR Part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). NMFS is applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act (89 Fed. Reg. 24268; 84 Fed. Reg. 45015). NMFS has considered the prior rules and affirms that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

Consultation in accordance with section 7(a)(2) of the statute (16 U.S.C. §1536(a)(2)), associated implementing regulations (50 CFR Part 402), and agency policy and guidance (USFWS and NMFS 1998) was conducted by the NMFS OPR ESA Interagency Cooperation Division (hereafter referred to as 'we' or 'us'). We prepared this conference and biological opinion (opinion) and ITS in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR Part 402. This document represents NMFS's opinion on the effects of the action on blue whale, fin whale, gray whale – Western North Pacific DPS, humpback whale – Mexico DPS and Central America DPS, killer whale – Southern Resident DPS, North Pacific right whale, sei whale, sperm whale, Guadalupe fur seal, green turtle (*Chelonia mydas*) – East Pacific DPS, leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*) – North Pacific Ocean DPS, olive ridley turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast breeding colonies, chinook salmon (*Oncorhynchus tshawytscha*) – California coastal Evolutionarily Significant Unit (ESU), Central Valley spring-run ESU, Lower Columbia River ESU, Puget Sound ESU, Sacramento River winter-run ESU, Snake River ESU, Snake River spring/summer run ESU, Upper Columbia River spring-run ESU, and Upper Willamette River ESU, chum salmon (*Oncorhynchus keta*) – Columbia River ESU and Hood Canal summer-run ESU, coho salmon (*Oncorhynchus kisutch*) – Central California coast ESU, Lower Columbia River ESU, Oregon coast ESU, and Southern Oregon and Northern California coasts ESU, eulachon (*Thaleichthys pacificus*) – Southern DPS, green sturgeon (*Acipenser medirostris*) – Southern DPS, sockeye salmon (*Oncorhynchus nerka*) – Ozette Lake ESU and Snake River ESU, steelhead trout (*Oncorhynchus mykiss*) – California Central Valley DPS, Central California Coast DPS, Lower Columbia River DPS, Middle Columbia River DPS, Northern California DPS, Puget Sound DPS, Snake River Basin DPS, South-Central California Coast DPS, Southern

California DPS, Upper Columbia River DPS, and Upper Willamette River DPS, and proposed sunflower sea star (*Pycnopodia helianthoides*).

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA; section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file electronically with the NMFS OPR in Silver Spring, Maryland, and available in the National Oceanic and Atmospheric Administration (NOAA) Library Institutional Repository https://repository.library.noaa.gov/welcome.

1.1 Background

The NSF, established by Congress with the *National Science Foundation Act* of 1950 (Public Law 810507, as amended), is dedicated to the support of fundamental research and education in all scientific and engineering disciplines. The funding of a low-energy seismic survey at the Cascadia Subduction Zone is a NSF program priority that helps fulfill NSF's mission to "promote the progress of science, advance the national health, prosperity, and welfare, and secure the national defense."

In conjunction with NSF's action, the NMFS Permits and Conservation Division proposes to issue an IHA to SIO for incidental takes of marine mammals that could occur during the low-energy seismic survey at the Cascadia Subduction Zone. Take of marine mammals is prohibited under the MMPA, with certain exceptions: under section 101(a)(5)(D) of the MMPA, NMFS may issue incidental take authorizations, which allow for the unintentional take, by harassment, of small numbers of marine mammals of a species or population stock, incidental but not intentional to specified activities.

This opinion supersedes OPR-2021-03468.

1.2 Consultation History

- **February 18, 2025:** We received NSF's request for consultation and Draft Environmental Assessment of Marine Geophysical Surveys by R/V *Sally Ride* at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025 (LGL 2025).
- **April 23, 2025:** We participated in the NMFS Permits and Conservation Division's Early Review Team meeting to discuss the NSF and SIO's low-energy seismic survey. On the same day, we requested additional information, via email to NSF, on NSF's take calculations for marine mammals, protected fish ensonified areas, and clarifications on the action area. Between April 23 and May 14, 2025, we and the NMFS Permits and Conservation Division exchanged emails and met to discuss NSF and SIO's take analysis.
- **April 29, 2025:** NSF provided responses to most of our requests for additional information. On April 30, 2025, NSF provided responses to the remainder of our requests for additional information. On the same day, we determined there was sufficient information to initiate consultation with NSF.

- **May 14, 2025:** The NMFS Permits and Conservation Division's Early Review Team determined SIO's IHA application adequate and complete.
- **July 17, 2025:** We received NMFS Permits and Conservation Division's request for consultation, draft *Federal Register* notice for the proposed IHA and request for public comment, and draft proposed IHA. On July 21, 2025, the notice and request for public comment published in the *Federal Register*.
- **July 28, 2025:** We determined there was sufficient information to initiate consultation with NMFS Permits and Conservation Division.
- **August 20, 2025:** The public comment period for the proposed IHA closed. NMFS Permits and Conservation Division notified us on August 21, 2025 that they did not receive any public comments on the proposed IHA and possible renewal.

1.3 Analytical Approach

This opinion includes a jeopardy analysis. Prior to 2016, the designation of critical habitat for the leatherback turtle, Southern DPS green sturgeon, and Oregon coast ESU coho salmon used the term primary constituent element (PCE), essential features, or generally identified aspects of critical habitat that were essential to the conservation of the species. The 2016 critical habitat regulations (50 CFR §424.12) replaced these terms 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 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 an action agency is able to insure its proposed action is not likely to jeopardize listed species:

- Identify all aspects of the proposed action (as defined in 50 CFR §402.02), including activities that rely on the action for their occurrence.
- Identify the physical, chemical, and biological modifications to land, water, and air (stressors) that result from those actions and subsequent activities.
- Establish the spatial extent of those stressors, which is the action area (50 CFR §402.02).
- Identify the listed and proposed species (as defined at 16 U.S.C. §1532(16)) and designated critical habitat (as defined at 16 U.S.C. §1532(5)) in the action area.
- Identify the species and critical habitats that are not likely to be adversely affected by the action.
- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline (as defined in 50 CFR §402.02) as it pertains to the species and critical habitat.
- Evaluate the effects of the proposed action on listed or proposed species and their designated critical habitat using a stressor-exposure-response approach. When complete, this section anticipates the amount or extent, as well as the forms (harass, harm, etc.), of take of listed species (or a surrogate) that is reasonably certain to occur as a result of the action, as well as the extent of effects to critical habitat. Because take is categorized

differently under ESA and MMPA, the initiation documents provided by NSF, NMFS's Permits and Conservation Division, and the analysis in this opinion may discuss take differently and identify different numbers of takes as the reasonably certain outcomes of this action.
- Evaluate cumulative effects (as defined at 50 CFR §402.02).
- Produce an integration and synthesis, where we add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.
- Compile our jeopardy and destruction or adverse modification analysis relying on the justification in the integration and synthesis.
- If the opinion determines the action agencies failed to insure their action is not likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat, we suggest a reasonable and prudent alternative to the proposed action and assess the effects of that alternative action.
- For actions that do not violate section 7(a)(2) of the ESA or an alternative action is identified that does not violate section 7(a)(2) of the ESA and when take of marine mammals is permitted under section 101(a)(5) of the MMPA, after we conclude our opinion, we provide an incidental take statement that specifies the impact of the take on listed species (amount or extent), reasonable and prudent measures, and terms and conditions to implement those measures.

In each of the steps above, we rely on the best scientific and commercial data available. In order to ensure we reach supportable conclusions, we used information from NSF including the Draft Environmental Assessment of Marine Geophysical Surveys by R/V *Sally Ride* at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025 (LGL 2025), NMFS Permits and Conservation Division's proposed IHA, our and NMFS Permits and Conservation Division's meetings, NSF's responses to our requests for additional information, open-source scientific databases, peer-reviewed scientific literature, government reports, and commercial studies.

2. PROPOSED FEDERAL ACTION

Action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or on the high seas. Examples include, but are not limited to: 1) actions intended to conserve listed species or their habitat; 2) the promulgation of regulations; 3) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants in aid; or 4) actions directly or indirectly causing modifications to the land, water, or air (50 CFR §402.02).

2.1 Description of the Action

National Science Foundation's Proposed Action

The following provides a brief summary of NSF's proposed action. The NSF proposes to fund a low-energy seismic survey (hereafter referred to as "survey") at the Cascadia Subduction Zone in the Northeast Pacific Ocean (Figure 1) on the R/V *Sally Ride*, which will be operated by SIO. The R/V *Sally Ride* is approximately 238 feet (ft; 72.5 meters [m]) long, 49.2 ft (15 m) wide, with a draft of approximately 15 ft (4.6 m). The R/V *Sally Ride* will transit at a speed of approximately five knots (9.3 kilometers per hour [km/hr]) during seismic operations. The survey will take place more than 62 miles (mi) or 100 km from the Oregon and Washington coasts, in water depths between approximately 6,560 and 11,483 ft (2,000 to 3,500 m). The survey will use two Generator-Injector (GI) airguns, with a maximum discharge volume of approximately 90 cubic inches (in^3; or approximately 1,475 cubic centimeters [cm^3]), 6.6 ft (2 m) separation distance, and towed approximately 82 ft (25 m) behind the R/V *Sally Ride* at a depth of approximately 13 ft (4 m). The receiving system is an approximately 0.62 mi (1 km) solid flexible polymer hydrophone streamer. In addition to the airguns, multibeam echosounders (MBES), sub-bottom profiler (SBP), and Acoustic Doppler Current Profiler (ADCP) will be operated during the survey. The survey will take place over three days in September 2025: two survey days covering approximately 276 mi (444 km) of seismic acquisition (see Figure 1 for tracklines) and one day of transit to/from Newport, Oregon.

For further details on NSF's proposed action, including specifications on the R/V *Sally Ride*, airguns, and other acoustic instruments, see the Draft Environmental Assessment of Marine Geophysical Surveys by R/V *Sally Ride* at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025 on NSF's Environmental Compliance webpage, under the subheading "Current environmental reviews" at https://www.nsf.gov/funding/environmental-compliance.

NMFS Permits and Conservation Division's Proposed Action
The following provides a brief summary of the NMFS Permits and Conservation Division proposed action. The NMFS Permits and Conservation Division proposes to issue an IHA and potential renewal authorizing non-lethal takes of marine mammals by Level B harassment (pursuant to section 101(a)(5)(D) of the MMPA) incidental to conducting the survey. The IHA will be effective from September 2, 2025 to September 1, 2026.

The IHA will authorize the following takes for threatened and endangered species: two blue whales, two fin whales, two humpback whales (Central America/Southern Mexico – CA/OR/WA, Mainland Mexico – CA/OR/WA, and Hawaii stocks; the ESA equivalent of these MMPA stocks are the Central America DPS and Mexico DPS), two sei whales, seven sperm whales, and 18 Guadalupe fur seals. A notice of the proposed IHA and request for public comments published in the *Federal Register* on July 21, 2025 (90 Fed. Reg. 34212). The public comment period closed on August 20, 2025. The NMFS Permits and Conservation Division did not receive any public comments. No revisions were made to the proposed IHA since the notice was published.

In order to issue an IHA, the NMFS Permits and Conservation Division must set forth permissible methods of taking pursuant to the activity, and other means of effecting the least practicable impact on the species or stock and its habitat. To satisfy the least practicable impact standard, the NMFS Permits and Conservation Division reviewed seismic mitigation protocols required or recommended elsewhere (see 90 Fed. Reg. 34212) and will require SIO to implement those protocols, including vessel-based visual mitigation monitoring, establish shutdown and pre-start clearance zones, pre-start clearance and ramp-up, shutdown procedures, and vessel strike avoidance mitigation measures. These protocols are nearly identical to the mitigation proposed by NSF, and are required. Thus, they are discussed in the following section together (Section 2.2).

For further details on the NMFS Permits and Conservation Division's proposed action, including background on the IHA, circumstances for renewal, mitigation, and reporting, see the proposed IHA at 90 Fed. Reg. 34212.

2.2 Conservation Measures

Conservation measures include measures that avoid or reduce the severity of the effects of the action on ESA-listed species and their critical habitats, and monitoring, which is used to observe or check the progress of the mitigation over time and to ensure that any measures implemented to reduce or avoid adverse effects on ESA-listed species and their critical habitats are successful.

NSF considered mitigation requirements of previous IHAs and best practices (Acosta et al. 2017; Chou et al. 2021; Nowacek et al. 2013; Pierson et al. 1998; Weir and Dolman 2007; Wright 2014; Wright and Cosentino 2015) when developing conservation measures. Mitigation protocols detailed in NMFS Permits and Conservation Division's proposed IHA are required. The following provides a brief summary of NSF's and the NMFS Permits and Conservation Division's conservation measures for this survey.

During the planning phase, NSF determined that the use of two GI airguns is the smallest sound source necessary to meet the research objectives. NSF also determined mitigation zones, within which a shutdown of the airguns would be implemented if a marine mammal or sea turtle were observed within the respective distances. Mitigation zones were derived from the predicted distances to sound levels associated with the NMFS marine mammal behavioral disturbance threshold (160 decibels referenced to a root-mean-square pressure of one micro Pascal [dB re 1 μPa_{rms}]) and the NMFS sea turtle behavioral disturbance threshold (175 dB re 1 μPa_{rms}), as modeled by the Lamont-Doherty Earth Observatory of Columbia University. The predicted distances are 1,567 ft (505 m) and 292 ft (89 m), to the 160 dB re 1 μPa_{rms} and 175 dB re 1 μPa_{rms} thresholds, respectively (Table 1). A shutdown zone of 492 ft (150 m) for sea turtles, which encompasses the modeled mitigation zone, will be implemented. However, for marine mammals, NSF will implement the IHA-required 328 ft (100 m) shutdown zone instead of the 1,567 ft (505 m) modeled mitigation zone.

Table 1. Predicted distances to marine mammal and sea turtle behavioral disturbance thresholds, 160 dB re 1 μPa_{rms} and 175 dB re 1 μPa_{rms}, respectively

Airgun Source and Volume	Tow Depth (m)	Water Depth (m)	Distance (m) to 160 dB re 1 μPa_{rms}	Distance (m) to 175 dB re 1 μPa_{rms}
Two 45 in^3 (737.4 cm^3) GI airguns; 6.6 ft (2 m) separation	4	>1,000	505	89

The following is a summary of the conservation measures proposed by NSF and the NMFS Permits and Conservation Division. During the survey, NSF will use two Protected Species Observers (PSOs) during all daytime seismic operations beginning 30 minutes prior to ramp up of the airguns. Pre-start clearance visual monitoring will occur prior to ramp up (i.e., gradual activation) of the airguns. Pre-start clearance monitoring will begin no less than 30 minutes prior to ramp up and must continue until one hour after use of the airguns ceases or 30 minutes past sunset. It consists of PSOs ensuring a 656.2 ft (200 m) pre-start clearance zone (which consist of a 328 ft or 100 m shutdown zone and additional 328 ft or 100 m buffer zone) from the edges of the airgun array is clear of marine mammals, or a 492 ft (150 m) zone is clear of sea turtles, prior to ramp up. If the pre-start clearance zone is clear of marine mammals and sea turtles, ramp up may begin and consists of activating a single airgun, then activating the second airgun at minimum five minutes later (so long as the zone is still clear of marine mammals and sea turtles). Ramp up would also be implemented after a specified time without airgun operations. Once ramp up has begun, observations of marine mammals within the buffer zone do not require shutdown (i.e., immediate deactivation of all airgun elements). The PSOs will monitor the shutdown zones (328 ft or 100 m for marine mammals, 492 ft or 150 m for sea turtles, and 1,640 ft or 500 m for a large whale with a calf, and groups of six or more large whales) for protected species. The airguns will be shut down prior to a marine mammal or sea turtle entering the respective shutdown zone, or immediately if a marine mammal or sea turtle is first observed within the respective shutdown zone. Seismic operations will not resume until the animal has left the shutdown zone, or until the PSO is confident the animals have left the vicinity of the R/V. PSOs will also monitor any impacts of the airguns on protected fishes. To minimize the risk of vessel strike, and as required by the IHA, the R/V will slow down, stop, and/or alter course when in the vicinity of protected species (to the extent allowed by the safety of the vessel and crew). Visual observers will also monitor a vessel strike avoidance zone around the R/V, which is 328 ft or 100 m from listed whales, and will implement a speed restriction for certain circumstances (e.g., when mother/calf pairs are observed near the R/V).

For further details on conservation measures that will be implemented during the survey, see NSF's Draft Environmental Assessment of Marine Geophysical Surveys by R/V *Sally Ride* at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025 on NSF's Environmental Compliance webpage, under the subheading "Current environmental reviews" at https://www.nsf.gov/funding/environmental-compliance and the NMFS Permits and Conservation Division's proposed IHA at 90 Fed. Reg. 34212.

Reporting to NMFS

In order to issue an IHA, the NMFS Permits and Conservation Division must also set forth requirements related to monitoring and reporting of incidental take. Monitoring and reporting requirements should contribute to the improved understanding of marine mammal occurrence, exposure and response to stressors, impacts to individual and population-level fitness and survival, impacts to habitat, and effectiveness of mitigation. NSF and SIO, to us and the NMFS Permits and Conservation Division respectively, will submit a draft comprehensive report on all activities and monitoring results within 90 days of completion of the survey. For further details, see the proposed IHA (90 Fed. Reg. 34212) and ITS reporting in Section 10.

2.3 Stressors Resulting from the Components of the Proposed Action

In this section, the direct or indirect modifications to the land, water, or air caused by an action are identified stressors. This section identifies all of the stressors that may affect listed species, as well as the sources of those stressors. Some stressors may have multiple sources. Likewise, multiple sources may combine to create a stressor that would not exist if only one of the sources were present. The following is a summarization of stressors that are reasonably certain to be caused by this action:

1. Pollution (e.g., R/V emissions, fuel);
2. Vessel strike;
3. Disturbance from the R/V (i.e., presence, visual, acoustic);
4. Acoustic instruments (MBES, SBP, ADCP);
5. Entanglement/interaction with in-water equipment; and
6. Airguns (underwater acoustic).

3. 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). The action area is defined by the extent of the environmental changes the stressors cause on the physical environment (e.g., land, air, or water, detailed in the previous section). The action area includes a portion of the Northeast Pacific Ocean, off Oregon and Washington, where the survey will take place, and waters where the survey raises sound levels above ambient levels. Because ambient underwater sound measurements are lacking where the survey will occur, we use the survey area determined by NSF (Figure 1) to delineate the extent of the area affected by the survey. The action area also includes waters between the survey area and Newport, Oregon, and Yaquina Bay where the Port of Newport is located and from where the R/V will depart and return.

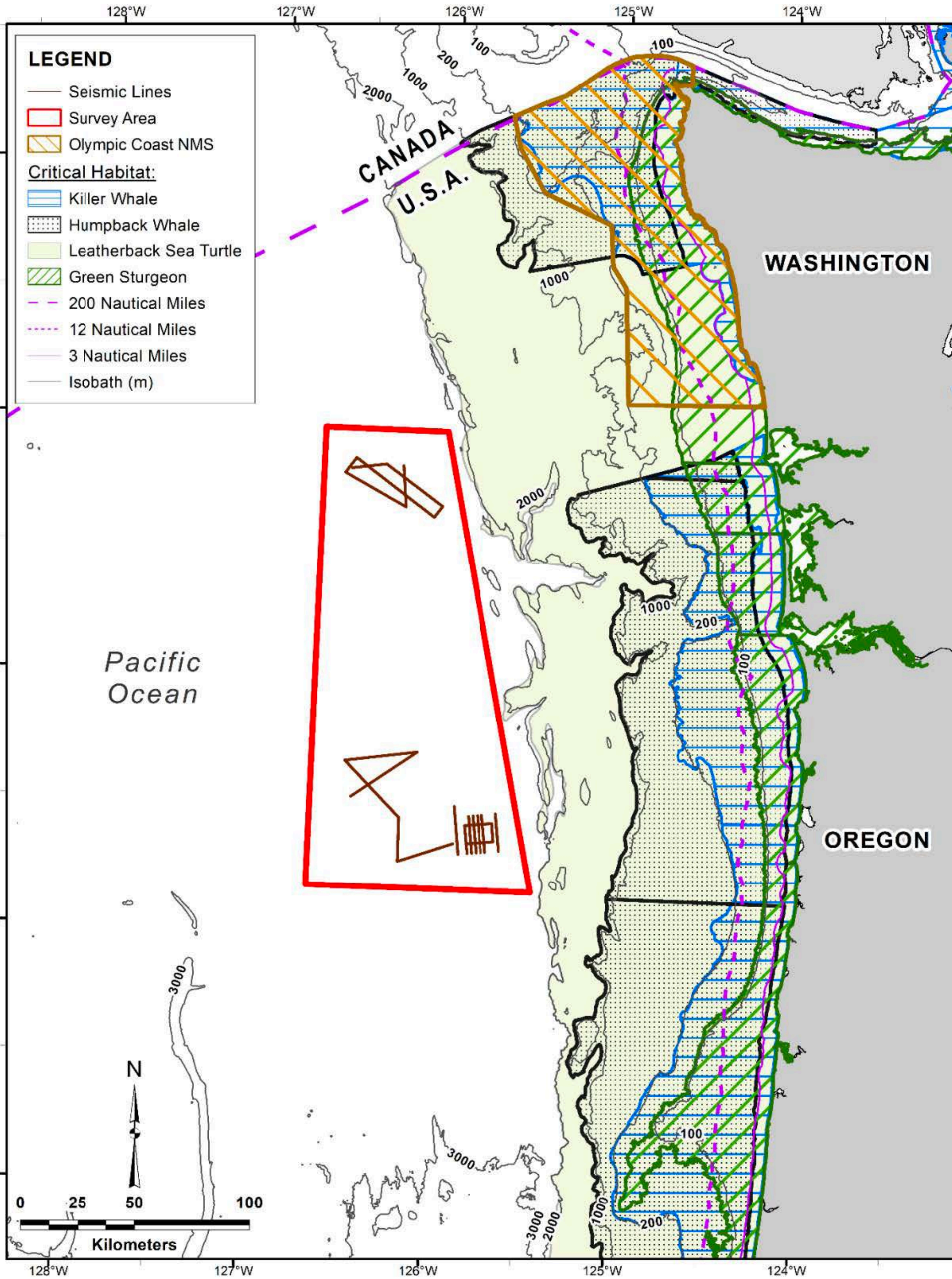

Figure 1. Map of the survey location

4. Species and Critical Habitat that May be Affected by the Proposed Action

The ESA allows for three general determinations for listed species and critical habitat: 1) no effect, 2) may affect, not likely to adversely affect (NLAA), and 3) may affect, likely to adversely affect (LAA). Action agencies, prior to requesting ESA consultation, determine whether their proposed action may affect ESA-listed or proposed species or their designated critical habitat. Generally, a "no effect" determination means there is no plausible exposure or response to stressors generated by the proposed action for any ESA-listed or proposed species or designated critical habitat. A "no effect" determination does not require consultation. Any scenario where there is a plausible exposure to stressors generated by the action, no matter how unlikely, is considered "may affect." For any action that "may affect" an ESA-listed species or its designated critical habitat, the action agency shall consult with the Services under section 7(a)(2) of the ESA. An action agency is also required to confer with the Services on any effects to proposed species or proposed critical habitat if those effects are likely to jeopardize the continued existence of the species, or destroy or adversely modify the proposed critical habitat. However, action agencies may voluntarily confer with the Services for all proposed species or proposed critical habitat in the action area when the action may affect those proposed entities without rising to a level requiring us to confer.

Table 2. Species and critical habitat present in the action area

Species	ESA Status	Critical Habitat	Recovery Plan
Blue Whale (*Balaenoptera musculus)*	E – 35 Fed. Reg. 18319	-- --	11/2020
Fin Whale (*Balaenoptera physalus)*	E – 35 Fed. Reg. 18319	-- --	07/2010
Gray Whale (*Eschrichtius robustus*) – Western North Pacific DPS	E – 35 Fed. Reg. 18319	-- --	-- --
Humpback Whale (*Megaptera novaeangliae*) – Central America DPS	E – 81 Fed. Reg. 62259	86 Fed. Reg. 21082	11/1991 06/2022 (Outline)
Humpback Whale (*Megaptera novaeangliae*) – Mexico DPS	T – 81 Fed. Reg. 62259	86 Fed. Reg. 21082	11/1991 06/2022 (Outline)
Killer Whale (*Orcinus orca*) – Southern Resident DPS	E – 70 Fed. Reg. 69903 Amendment 80 Fed. Reg. 7380	86 Fed. Reg. 41668	01/2008

Species	ESA Status	Critical Habitat	Recovery Plan
North Pacific Right Whale (*Eubalaena japonica*)	E – 73 Fed. Reg. 12024	73 Fed. Reg. 19000*	06/2013
Sei Whale (*Balaenoptera borealis*)	E – 35 Fed. Reg. 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 Fed. Reg. 18319	-- --	12/2010
Guadalupe Fur Seal (*Arctocephalus townsendi*)	T – 50 Fed. Reg. 51252	-- --	-- --
Green Turtle (*Chelonia mydas*) – East Pacific DPS	T – 81 Fed. Reg. 20057	88 Fed. Reg. 46572* (Proposed)	01/1998
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 Fed. Reg. 8491	44 Fed. Reg. 17710* 77 Fed. Reg. 4170	01/1998 – U.S. Pacific
Loggerhead Turtle (*Caretta caretta*) – North Pacific Ocean DPS	E – 76 Fed. Reg. 58868	-- --	01/1998 – U.S. Pacific
Olive Ridley Turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast Breeding Colonies	E – 43 Fed. Reg. 32800	-- --	01/1998
Chinook Salmon (*Oncorhynchus tshawytscha) –* California Coastal ESU	T – 70 Fed. Reg. 37160	70 Fed. Reg. 52488*	10/2016
Chinook Salmon (*Oncorhynchus tshawytscha) –* Central Valley Spring-Run ESU	T – 70 Fed. Reg. 37160	70 Fed. Reg. 52488*	07/2014
Chinook Salmon (*Oncorhynchus tshawytscha) –* Lower Columbia River ESU	T – 70 Fed. Reg. 37160	70 Fed. Reg. 52629*	06/2013
Chinook Salmon (*Oncorhynchus tshawytscha) –* Puget Sound ESU	T – 70 Fed. Reg. 37160	70 Fed. Reg. 52629*	01/2007

Species	ESA Status	Critical Habitat	Recovery Plan
Chinook Salmon (*Oncorhynchus tshawytscha) –* Sacramento River Winter-Run ESU	E – 70 Fed. Reg. 37160	58 Fed. Reg. 33212*	07/2014
Chinook Salmon (*Oncorhynchus tshawytscha)* – Snake River Fall-Run ESU	T – 70 Fed. Reg. 37160	58 Fed. Reg. 68543*	11/2017
Chinook Salmon (*Oncorhynchus tshawytscha)* – Snake River Spring/Summer-Run ESU	T – 70 Fed. Reg. 37160	64 Fed. Reg. 57399*	11/2017
Chinook Salmon (*Oncorhynchus tshawytscha)* – Upper Columbia River Spring-Run ESU	E – 70 Fed. Reg. 37160	70 Fed. Reg. 52629*	08/2007
Chinook Salmon (*Oncorhynchus tshawytscha)* – Upper Willamette River ESU	T – 70 Fed. Reg. 37160	70 Fed. Reg. 52629*	08/2011
Chum Salmon (*Oncorhynchus keta*) – Columbia River ESU	T – 70 Fed. Reg. 37160	70 Fed. Reg. 52629*	06/2013
Chum Salmon (*Oncorhynchus keta*) – Hood Canal Summer-Run ESU	T – 70 Fed. Reg. 37160	70 Fed. Reg. 52629*	11/2005
Coho Salmon (*Oncorhynchus kisutch*) – Central California Coast ESU	E – 70 Fed. Reg. 37160	64 Fed. Reg. 24049*	09/2012
Coho Salmon (*Oncorhynchus kisutch*) – Lower Columbia River ESU	T – 70 Fed. Reg. 37160	81 Fed. Reg. 9251*	06/2013
Coho Salmon (*Oncorhynchus kisutch*) – Oregon Coast ESU	T – 73 Fed. Reg. 7816	73 Fed. Reg. 7816	12/2016

Species	ESA Status	Critical Habitat	Recovery Plan
Coho Salmon (*Oncorhynchus kisutch*) – Southern Oregon and Northern California Coasts ESU	T – 70 Fed. Reg. 37160	64 Fed. Reg. 24049*	09/2014
Eulachon (*Thaleichthys pacificus*) – Southern DPS	T – 75 Fed. Reg. 13012	76 Fed. Reg. 65323*	09/2017
Green Sturgeon (*Acipenser medirostris*) – Southern DPS	T – 71 Fed. Reg. 17757	74 Fed. Reg. 52300	8/2018
Steelhead Trout (*Oncorhynchus mykiss*) – California Central Valley DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52487*	07/2014
Steelhead Trout (*Oncorhynchus mykiss*) – Central California Coast DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52487*	10/2016
Steelhead Trout (*Oncorhynchus mykiss*) – Lower Columbia River DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52629*	06/2013
Steelhead Trout (*Oncorhynchus mykiss*) – Middle Columbia River DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52629*	11/2009
Steelhead Trout (*Oncorhynchus mykiss*) – Northern California DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52487*	10/2016
Steelhead Trout (*Oncorhynchus mykiss*) – Puget Sound DPS	T – 72 Fed. Reg. 26722	81 Fed. Reg. 9251*	12/2019
Steelhead Trout (*Oncorhynchus mykiss*) – Snake River Basin DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52629*	11/2017
Steelhead Trout (*Oncorhynchus mykiss*) – South-	T – 71 Fed. Reg. 834	70 Fed. Reg. 52487*	12/2013

Species	ESA Status	Critical Habitat	Recovery Plan
Central California Coast DPS			
Steelhead Trout (*Oncorhynchus mykiss*) – Southern California DPS	E – 71 Fed. Reg. 834	70 Fed. Reg. 52487*	01/2012
Steelhead Trout (*Oncorhynchus mykiss*) – Upper Columbia River DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52629*	08/2007
Steelhead Trout (*Oncorhynchus mykiss*) – Upper Willamette River DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52629*	08/2011
Sunflower Sea Star (*Pycnopodia helanthoides*)	T – 88 Fed. Reg. 16212 (Proposed)	-- --	-- --

Fed. Reg. = *Federal Register*; E = Endangered; T = Threatened; DPS = Distinct Population Segment; ESU = Evolutionarily Significant Unit

* Designated critical habitat does not overlap with the action area

Table 3. Physical or Biological Features of designated or proposed critical habitat present in the action area that may be affected by the proposed action

Designated or Proposed Critical Habitat	PBFs
Killer Whale – Southern Resident DPS	Currently Designated CH: U.S. West Coast – marine waters between the 20-ft (6.1-m) depth contour and the 656.2-ft (200-m) depth contour, from the U.S.-Canada border to Point Sur, California (excluding the Quinault Range Site) Designated CH PBFs: 1. Water quality to support growth and development; 2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and 3. Passage conditions to allow for migration, resting, and foraging.
Humpback Whale – Central America DPS	Currently Designated CH: California – marine habitat within portions of the California Coastal Ecosystem Designated CH PBFs: Prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth.
Humpback Whale – Mexico DPS	Currently Designated CH: California – marine habitat within portions of the California Coastal Ecosystem Designated CH PBFs: Prey species, primarily euphausiids and small pelagic schooling fishes, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth.
Leatherback Turtle	Currently Designated CH: California coast – Point Arena to Point Arguello east of the 3,000-m depth contour Designated CH PBFs: Occurrence of prey species, primarily scyphomedusae (i.e., jellyfish) of the order Semaeostomeae, of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks

Designated or Proposed Critical Habitat	PBFs
Coho Salmon – Oregon Coast ESU	Currently Designated CH: Oregon coast – south of the Columbia River and north of Cape Blanco Designated CH PBFs: 1. Estuarine areas free of obstruction with water quality conditions supporting juvenile and adult physiological transitions between fresh- and saltwater, including juvenile and adult forage; 2. Nearshore marine areas free of obstruction with water quality conditions and forage supporting growth and maturation; and 3. Offshore marine areas with water quality conditions and forage supporting growth and maturation.
Green Sturgeon – Southern DPS	Currently Designated CH: Coastal U.S. marine waters – from Monterey Bay, California to Cape Flattery, Washington, including various rivers, bays, and estuaries such as Yaquina Bay, Oregon Designated CH PBFs (for estuarine and marine areas): 1. Food resources: abundant prey items for juvenile, subadult, and adult life stages; and 2. Water quality: including chemical characteristics necessary for normal behavior, growth, and viability of all life stages and acceptably low levels of contaminants that may disrupt normal behavior, growth, and viability of subadult and adult green sturgeon

CH = critical habitat; PBFs = physical or biological features; DPS = distinct population segment; ESU = Evolutionarily Significant Unit

4.1 May Affect, Not Likely to Adversely Affect

Once we have determined the action may affect ESA-listed or proposed species or their designated critical habitat, the next step is differentiating between stressors that are NLAA and LAA for each listed species and critical habitat in the action area. An action warrants a NLAA finding when its effects are completely beneficial, discountable, or insignificant. Completely beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Completely beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected, albeit positively. Discountable effects are those that could occur while an ESA-listed species is in the action area but, because of the intensity, magnitude, frequency, duration, or timing of the stressor, exposure to the stressor is extremely unlikely to occur. Insignificant effects relate to the response of exposed individuals where the response, in terms of an individual's growth, survival, or reproduction, would be immeasurable or undetectable, or an impact to the conservation value of a PBF would be immeasurable or undetectable. For stressors that meet these criteria for completely beneficial, discountable, or insignificant, the appropriate conclusion is NLAA.

To assist in reaching a determination, we perform a two-step assessment that considers all of the stressors identified in Section 2.3 of this opinion, all of the species in Table 2, and critical habitats identified in Table 3, to understand the likelihood of the stressors having an effect on the ESA-listed or proposed species or their designated critical habitat. First, we consider whether it is likely that a listed species or critical habitat is exposed to a stressor or there is a reasonable expectation of the stressor and an individual or habitat co-occurring. If we conclude that exposure of a species or critical habitat to a stressor caused by the proposed action or activity is discountable, we must also conclude it is NLAA. However, if exposure is probable, the second step is to evaluate the probability of a response to the stressor. When all stressors of an action are found to be NLAA for a listed species or a critical habitat, we conclude informal consultation for that species or critical habitat. Likewise, if a stressor associated with this action is found to be NLAA for all listed species and all critical habitats, there is no need to continue analyzing the consequences of that stressor in the Analysis of Effects. Where the negative effects to any species or critical habitat or from any stressor to those species or critical habitat are found to exceed the standards of insignificant or discountable, we must analyze those consequences in the Analysis of Effects.

4.1.1 Stressors Not Likely to Adversely Affect Species or Critical Habitat

This section identifies the stressors that are NLAA for every ESA-listed or proposed species and their designated critical habitat in the action area and will not be analyzed further in this opinion.

4.1.1.1 Pollution

Pollutants emitted by the R/V *Sally Ride* during the survey can include exhaust (carbon dioxide, nitrogen oxides, and sulfur oxides), fuel or oil spills, or leaks. Exhaust may affect air-breathing ESA-listed species such as marine mammals and sea turtles considered in this consultation (Table 1). Although the R/V will transit through areas where ESA-listed marine mammals and sea turtles are expected to occur in higher numbers or densities (e.g., close to shore, critical habitat), it is unlikely that pollutants in the air would have a measurable impact on ESA-listed marine mammals or sea turtles given the relatively short duration of the survey (three days), dispersion of pollutants in the air, and the brief amount of time that marine mammals and sea turtles spend at the water's surface to breathe. Thus, the effects of pollutants in the air on ESA-listed species due to the proposed action will be so small as to be immeasurable, and, thus, insignificant. Fuel or oil spills, or leaks may affect ESA-listed or proposed marine mammals, sea turtles, fishes, and invertebrates considered in this consultation (Table 1). However, a fuel or oil leakage is extremely unlikely and R/Vs used for NSF-funded marine seismic surveys have spill prevention plans on preventing a fuel or oil spill. Additionally, no plastics or toxic materials will be disposed of at sea in accordance with waste management practices on the R/V and all project-related waste will be disposed of in accordance with international and U.S. Federal requirements. Thus, the effects of pollutants in the water on ESA-listed species due to the proposed action will be extremely unlikely to occur, and discountable.

In summary, the potential effects to ESA-listed or proposed species from pollution are insignificant or discountable. We conclude that impacts from pollution to ESA-listed or proposed species in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species.

4.1.1.2 Vessel Strike

Vessel strikes are known to affect marine mammals, sea turtles, and fishes and may injure or even kill the struck animal. The potential for a vessel striking an ESA-listed or proposed species at or near the ocean's surface during the proposed survey is extremely unlikely because of minimal vessel operations and conservation measures that will be implemented during the survey. The survey consists of only three days of vessel use. Additionally, the R/V *Sally Ride* will transit at relatively slow speeds (approximately 10 knots or 18.5 km/hr during transit, and 5 knots or 9.3 km/hr during airgun operations), minimizing the risk of striking an animal (Rockwood et al. 2021; Vanderlaan and Taggart 2007b). Conservation measures including visual monitoring by PSOs and vessel strike avoidance measures (see Section 2.2) further reduce the potential for a vessel strike. Vessel strike of species that generally occur at the seafloor (e.g., Southern DPS of green sturgeon, and proposed sunflower sea star) is also unlikely. Transit of the R/V in shallow waters, where vessel strike of these species would be possible, would risk grounding of the vessel. Additionally, the draft (vertical distance between the waterline and the deepest point of the vessel) of the R/V *Sally Ride* (approximately 15.1 ft or 4.6 m) is less than the water depths that the R/V is expected to travel through (e.g., Yaquina Bay is an estuary categorized as a deep-draft development by the State of Oregon, and is maintained at more than 22 ft or 6.7 m deep; the main vessel transit channel into the Port of Newport is at least 40 ft or 12.2 m deep). Thus, the R/V *Sally Ride* would not reach the seafloor. Therefore, ESA-listed and proposed species' exposure to vessel strike is discountable. We conclude that impacts from vessel strike to ESA-listed or proposed species in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect ESA-listed or proposed species.

4.1.1.3 Disturbance from the Research Vessel

The R/V may visually disturb animals and vessel noise may cause disturbance because of elevated sound levels. The duration of R/V operations lasts three days, and is limited especially compared to the amount of recreational and commercial vessel traffic across the action area. Given the relatively small contribution of the R/V associated with the proposed survey to the overall vessel activity, effects from vessel presence are expected to be so minor that they cannot be meaningfully evaluated and are thus insignificant.

Noise from the R/V may produce an acoustic disturbance or otherwise affect the behavior of ESA-listed species that spend time near the surface, such as marine mammals, sea turtles, and fishes. Studies have shown that vessel operation can result in changes in the behavior of marine mammals, sea turtles, and fishes (Hazel et al. 2007; Holt et al. 2009; Luksenburg and Parsons 2009; Noren et al. 2009; Patenaude et al. 2002; Richter et al. 2003; Smultea et al. 2008a). However, vessel noise will not exceed that of larger commercial shipping vessels and will only be temporary (three days) compared to the constant presence of commercial vessels.

Additionally, while not specifically designed to do so, several aspects of the conservation measures will minimize effects associated with vessel acoustic disturbance to ESA-listed species (e.g., maintaining separation distances from protected species, slowing to 10 knots or less around certain species and in specific areas; see Section 2.2). Given the aforementioned conservation measures and the relatively small contribution of the R/V to the overall soundscape, effects from vessel noise are expected to be so minor that they cannot be meaningfully evaluated and are thus insignificant.

In summary, the potential effects to ESA-listed species from R/V disturbance are insignificant. We conclude that impacts from R/V disturbance to ESA-listed species in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species.

4.1.1.4 Acoustic Instruments (Multibeam Echosounder, Sub-bottom Profiler, and Acoustic Doppler Current Profiler)

Acoustic instruments other than the airguns will be operating during the survey, including MBESs, SBP, and ADCP (see NSF's Draft Environmental Assessment of Marine Geophysical Surveys by R/V *Sally Ride* at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025 on NSF's Environmental Compliance webpage, under the subheading "Current environmental reviews" at https://www.nsf.gov/funding/environmental-compliance for specifications on these instruments). These instruments (MBES, SBP, ADCP) have a limited beamwidth and are highly directional, unlike the airguns. If an ESA-listed marine mammal, sea turtle, or fish transits into the beam, the period of time the individual would be within the beam and exposed to the sound source would be very brief. Analyses that include the duration of exposure to the ensonified area created by the EM 122 and 124 indicate that the exposure would be brief, on the order of a few seconds or under a minute (Ruppel et al. 2022; Denes et al. 2021). However, it is extremely unlikely that an ESA-listed species will occur directly in the beam of these acoustic instruments because of the limited beamwidth, simultaneous movement of the R/V and the animals, and conservation measures implemented during the survey (e.g., visual monitoring, vessel strike avoidance measures). Therefore, ESA-listed species' exposure to acoustic instruments (MBES, SBP, ADCP) is discountable.

In summary, the potential effects to ESA-listed species from acoustic instruments (MBES, SBP, ADCP) are discountable. We conclude that impacts from acoustic instruments (MBES, SBP, ADCP) to ESA-listed species in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species.

4.1.1.5 Entanglement/Interaction with In-water Equipment

Towed seismic equipment (the airgun array and towed hydrophone streamer) could risk entanglement of ESA-listed marine mammals, sea turtles, and fishes; however, entanglement is extremely unlikely. The airgun array and towed hydrophone streamer are rigid, and thus, is not expected to encircle, wrap around, or in any other way entangle ESA-listed species. Furthermore, there have been no reported entanglements or interactions with the towed equipment over numerous NSF-funded marine geophysical surveys. Therefore, ESA-listed species' exposure to entanglement and interaction with equipment is discountable. We conclude that impacts from entanglement and interaction with equipment to ESA-listed species in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect ESA-listed species.

4.1.2 Species Not Likely to be Adversely Affected

In addition to the potential stressors that are not likely to adversely affect ESA-listed or proposed species discussed above in Section 4.1.1, other stressors (i.e., airguns) resulting from the proposed action, may affect, but are not likely to adversely affect a majority of ESA-listed and proposed species that may be present in the action area. This section identifies the ESA-listed or proposed species for which the underwater acoustic effects from the airguns are NLAA and are not analyzed further in this opinion.

4.1.2.1 ESA-Listed Marine Mammals

The ESA-listed marine mammal species that are not likely to be adversely affected by the underwater acoustic effects from the airguns are: Western North Pacific DPS gray whale, Southern Resident DPS killer whale, and North Pacific right whale.

Western North Pacific DPS gray whales are mainly found in eastern Asia, but some individuals migrate to coastal waters off Canada, the U.S. West Coast, and Mexico (Lang et al. 2014; Mate et al. 2015; Urbán et al. 2019b; Weller et al. 2013; Weller et al. 2012). In the summer and fall, Western North Pacific DPS gray whales feed in the Okhotsk Sea off Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Burdin et al. 2017; Tyurneva et al. 2010; Vertyankin et al. 2004; Weller et al. 2002). In the spring and fall months off the west coast of North America (Alaska, Canada, Washington, Oregon, and California), only 1.2% of gray whales are expected to belong to the Western North Pacific DPS (Cooke 2018a; Cooke et al. 2019; Cooke et al. 2017; Eguchi et al. 2023; Lang et al. 2022; Martínez-Aguilar et al. 2022; Mate et al. 2015; Urbán et al. 2019a; Weller et al. 2012). Due to the rarity of Western North Pacific DPS gray whale in the action area and seasonal migration patterns, it is extremely unlikely that Western North Pacific DPS gray whale will be exposed to sound from the airguns. Therefore, the effects are discountable.

The Southern Resident DPS killer whale mainly occurs in the Salish Sea (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound) during late spring, summer, and fall, and in coastal waters off Washington and Vancouver Island particularly between Grays Harbor and the Columbia River (Carretta et al. 2024a). Based on the intracoastal and coastal distribution of Southern Resident DPS killer whale, it is extremely unlikely that Southern Resident DPS killer whale will be exposed to sound from the airguns, which will occur much further offshore. Therefore, the effects are discountable.

North Pacific right whales are rare, though individuals have been sighted off the U.S. West Coast (Crance and Kennedy 2024). From 2006 to 2023, there are only six records (all individuals except one group of two) of North Pacific right whale off British Columbia, Canada, to the north of the action area, and only five records (all individuals) off California, to the south of the action area (Crance and Kennedy 2024). There were no sighting records of North Pacific right whale off Oregon or Washington; however, two North Pacific right whale calls were acoustically detected off Washington in June 2013 (Širović et al. 2015). Although migration patterns are unknown, North Pacific right whales appear to migrate from high-latitude summer feeding grounds to low-latitude breeding grounds, similar to other baleen whale species. North Pacific right whales are thought to spend late spring to early fall in the Bering Sea (e.g., Munger et al. 2008). Due to the rarity of North Pacific right whale in the action area and probable seasonal migration patterns, it is extremely unlikely that North Pacific right whale will be exposed to sound from the airguns. Therefore, the effects are discountable.

In summary, the potential effects to ESA-listed Western North Pacific DPS gray whale, Southern Resident DPS killer whale, and North Pacific right whale from underwater acoustic effects from airguns are discountable. Therefore, we conclude that impacts from the airguns to Western North Pacific DPS gray whale, Southern Resident DPS killer whale, and North Pacific right whale in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, Western North Pacific DPS gray whale, Southern Resident DPS killer whale, and North Pacific right whale.

4.1.2.2 ESA-Listed Sea Turtles

The ESA-listed sea turtle species that are not likely to be adversely affected by the underwater acoustic effects from the airguns are: East Pacific DPS green turtle, leatherback turtle, North Pacific Ocean DPS loggerhead turtle, and Mexico's Pacific Coast breeding colonies olive ridley turtle.

The East Pacific DPS green turtle occurs from the California/Oregon border (the north-most boundary of green turtle DPSs in the Pacific) to central Chile, and generally occurs in tropical, subtropical, or coastal temperate waters (Seminoff et al. 2015). North Pacific Ocean DPS loggerhead turtles are loggerhead turtles originating from the North Pacific Ocean, north of the Equator and south of 60 degrees (°) latitude (Conant et al. 2009). Green and loggerhead turtle sightings are rare in Oregon and Washington, and a majority of occurrences are strandings (Sato 2017b). Mexico's Pacific Coast breeding colonies olive ridley turtles typically occur in tropical and subtropical waters, and generally do not occur further north than California. However, they were historically documented as far north as Alaska (Hodge and Wing 2000) and in December 2014 and January 2015, two olive ridley turtles stranded in Washington (https://komonews.com/news/local/2nd-endangered-sea-turtle-washes-up-on-wash-state-beach?photo=1; accessed May 30, 2025). Between December 2024 and June 2025, there have been two strandings of olive ridley turtles (dead) and two strandings of loggerhead turtles (alive) in Oregon (see the Oregon Marine Mammal Stranding Network Map). Nesting of these three species does not occur in the action area. Given the rarity of East Pacific DPS green turtle, North Pacific Ocean DPS loggerhead turtle, and Mexico's Pacific Coast breeding colonies olive ridley turtle in the action area, it is extremely unlikely that these species will be exposed to sound from the airguns. Therefore, the effects are discountable.

Leatherback turtle distribution is global and they can occur as far as approximately 71°N to 47°S in the southern hemisphere. In the Pacific Ocean, leatherback turtles occur off British Columbia, in the Gulf of Alaska to Chile and New Zealand's South Island in the Pacific (NMFS and USFWS 2013). Nesting does not occur in the action area. Leatherbacks have been sighted and satellite tracked within the action area (see Benson et al. 2011 and Bailey et al. 2012). Individuals that occur within the action area most likely migrated from nesting beaches in the western Pacific (i.e., Indonesia), and forage off of Washington, Oregon, and California in the summer and fall (Sato 2017a). DON (2019), which informs marine species densities for the U.S. Navy's Phase III Northwest Training and Testing Study Area, provides the best available information on leatherback turtle densities in the action area because the offshore portion of the Northwest Training and Testing Study Area encompasses the action area. However, because of a lack of survey data in the Northwest Training and Testing Offshore Study Area, DON (2019) used leatherback turtle data from the California Current Ecosystem. The resulting density is very low, 0.000114 leatherback turtles per square kilometer (km^2), which, in addition to the short duration of the survey (three days), makes it extremely unlikely that leatherback turtles will be exposed to sound from the airguns. Therefore, the effects are discountable.

In summary, the potential effects to East Pacific PDS green turtle, leatherback turtle, North Pacific Ocean DPS loggerhead turtle, and Mexico's Pacific Coast breeding colonies olive ridley turtle from underwater acoustic effects from airguns are discountable. Therefore, we conclude that impacts from the airguns to East Pacific PDS green turtle, leatherback turtle, North Pacific Ocean DPS loggerhead turtle, and Mexico's Pacific Coast breeding colonies olive ridley turtle in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, East Pacific PDS green turtle, leatherback turtle, North Pacific Ocean DPS loggerhead turtle, and Mexico's Pacific Coast breeding colonies olive ridley turtle.

4.1.2.3 ESA-Listed Fishes

The ESA-listed fish species that are not likely to be adversely affected by the underwater acoustic effects from the airguns are: the California coastal ESU, Central Valley spring-run ESU, Lower Columbia River ESU, Puget Sound ESU, Sacramento River winter-run ESU, Snake River ESU, Snake River spring/summer run ESU, Upper Columbia River spring-run ESU, and Upper Willamette River ESU of chinook salmon, the Columbia River ESU and Hood Canal summer-run ESU of chum salmon, the Central California coast ESU, Lower Columbia River ESU, Oregon coast ESU, and Southern Oregon and Northern California coasts ESU of coho salmon, the Southern DPS of eulachon, the Southern DPS of green sturgeon, the Ozette Lake ESU and Snake River ESU of sockeye salmon, the California Central Valley DPS, Central California Coast DPS, Lower Columbia River DPS, Middle Columbia River DPS, Northern California DPS, Puget Sound DPS, Snake River Basin DPS, South-Central California Coast DPS, Southern California DPS, Upper Columbia River DPS, and Upper Willamette River DPS of steelhead trout.

Salmonids (chinook salmon, chum salmon, coho salmon, sockeye salmon, and steelhead trout) are generally anadromous, meaning they migrate from freshwater streams and rivers to marine waters and back to spawn in their natal stream/river. There is limited information on salmonids' distribution and movements in the open ocean. A handful of studies off Oregon and Washington observed chinook salmon at depths up to approximately 577 ft (176 m), with highest catch probability at depths up to 328 ft (100 m), and a majority were observed within approximately

14.9–17.4 mi (24–28 km) from shore (Bi et al. 2007; Foley et al. 2005; Freshwater et al. 2024; Roni et al. 1999; Watters et al. 2005). While most of these studies observed yearling or subadult salmon, Freshwater et al. (2024) studied depth distributions of adult chinook salmon, which occurred in waters 1,312.3 ft (400 m) or less. Coho were also observed within 34.2 mi (55 km) from shore and in depths less than 656 ft (200 m) for yearlings or 328 ft (100 m) for subadults (Bi et al. 2007; Freshwater et al. 2024). In the eastern Bering Sea, chum and sockeye salmon were captured at depths averaging 52.5 ft (16 m) and 9.8 ft (3 m), and maximum depths of 830 ft (253 m) and 272.3 ft (83 m), respectively (Walker et al. 2007). Steelhead may be distributed further from shore than other salmonids and have been observed 40 km from shore (Daly et al. 2014); however, densities are not expected to be high offshore because steelhead do not aggregate in those areas. The areas that salmonids are expected to occupy are much closer to shore than the survey area (more than 62 mi or 100 km from shore, in water depths between 6,560– 11,483 ft or 2,000–3,500 m). Thus, it is extremely unlikely that salmonids will be exposed to sound from the airguns, and the effects are discountable.

The range of the Southern DPS of eulachon is also limited to more nearshore waters than the survey area. The Southern DPS of eulachon occurs in water depths 164–656.2 ft (50–200m) off the U.S. West Coast (Gustafson et al. 2022). Thus, it is extremely unlikely that the Southern DPS of eulachon will be exposed to sound from the airguns and the effects are discountable.

The Southern DPS of green sturgeon is also an anadromous fish, spawning in their natal stream from April to July and migrating to marine waters from November to January. Spawning for the Southern DPS of green sturgeon is only known to occur in the Sacramento River. Post-spawning fish and juveniles typically rear and feed in fresh and estuarine waters for one to four years before migrating to marine waters as subadults (Nakamoto et al. 1995). Subadults and adults generally occupy coastal waters between 66–230 ft (20–70 m) depth, but have been observed in water depths up to 360.9 ft (110 m; Erickson and Hightower 2007; Huff et al. 2011). Thus, it is extremely unlikely that the Southern DPS of eulachon will be exposed to sound from the airguns, and the effects are discountable.

In summary, the potential effects to ESA-listed fishes from underwater acoustic effects from airguns are discountable. Therefore, we conclude that impacts from the airguns to the California coastal ESU, Central Valley spring-run ESU, Lower Columbia River ESU, Puget Sound ESU, Sacramento River winter-run ESU, Snake River ESU, Snake River spring/summer run ESU, Upper Columbia River spring-run ESU, and Upper Willamette River ESU of chinook salmon, the Columbia River ESU and Hood Canal summer-run ESU of chum salmon, the Central California coast ESU, Lower Columbia River ESU, Oregon coast ESU, and Southern Oregon and Northern California coasts ESU of coho salmon, the Southern DPS of eulachon, the Southern DPS of green sturgeon, the Ozette Lake ESU and Snake River ESU of sockeye salmon, the California Central Valley DPS, Central California Coast DPS, Lower Columbia River DPS, Middle Columbia River DPS, Northern California DPS, Puget Sound DPS, Snake River Basin DPS, South-Central California Coast DPS, Southern California DPS, Upper Columbia River DPS, and Upper Willamette River DPS of steelhead trout in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect these species.

4.1.2.4 Proposed Sunflower Sea Star

The proposed sunflower sea star occurs in coastal waters from the Aleutian Islands to Baja California, and is most commonly found in waters less than 82 ft (25 m) deep, and rare in waters deeper than 394 ft (120 m; (Lowry et al. 2022). Because the proposed sunflower sea star does not occur where the survey will occur, it is extremely unlikely that proposed sunflower sea star will be exposed to underwater acoustic effects from the airguns. Thus, the effects are discountable. We conclude that the proposed action may affect, but is not likely to adversely affect the proposed sunflower sea star.

4.1.3 Critical Habitat Not Likely to be Adversely Affected

This section identifies the designated critical habitat for which effects are NLAA from stressors resulting from the proposed action and are not analyzed further in this opinion. Critical habitats that are not likely to be adversely affected by the proposed action include the designated critical habitats of the Southern Resident DPS of killer whale, Central America DPS and Mexico DPS of humpback whale, leatherback turtle, Oregon Coast ESU of coho salmon, and Southern DPS of green sturgeon.

Designated critical habitat for the Southern Resident DPS of killer whale may be affected, but is not likely to be adversely affected by the following stressors: pollution, disturbance from the R/V, and other acoustic instruments. Pollution may affect the PBF related to water quality. As previously discussed, it is extremely unlikely that a fuel or oil spill will occur, or that debris and waste will enter the marine environment. Thus, the effects of pollution on the water quality of the Southern Resident DPS killer whale critical habitat are discountable. The R/V may affect the PBF related to prey quantity, quality, and availability. The R/V may temporarily displace prey for the duration of transit through critical habitat. However, the limited time that the R/V is operational (three days) and the constant movement of the R/V will not measurably affect the quantity, quality, or availability of prey in Southern Resident DPS killer whale critical habitat, and, thus, effects are insignificant. Noise from the R/V and other acoustic instruments may affect the PBF related to passage conditions to allow for migration, resting, and foraging. In the final rule designating Southern Resident DPS killer whale critical habitat, "acoustic obstructions" (e.g., chronic noise introduced by acoustic harassment devices) was identified as an obstacle or deterrent to the whales' use of an area. However, given the limited use and temporary duration of the survey overall (three days), the constant movement of the sound sources, the contribution of noise due to the proposed action compared to the overall soundscape will be so small as to be immeasurable, and thus, effects to critical habitat are insignificant.

Designated critical habitat for the Central America DPS and Mexico DPS of humpback whale may be affected, but is not likely to be affected by disturbance from the R/V. The R/V may affect prey of sufficient quality, abundance, and accessibility within humpback feeding areas. The R/V may temporarily displace prey for the duration of transit through critical habitat. However, the limited time that the R/V is operational (three days) and the constant movement of the R/V will not measurably affect the quality, abundance, and accessibility of prey within the Central America DPS and Mexico DPS humpback whale critical habitats. Thus, effects from the R/V on

Central America DPS and Mexico DPS humpback whale critical habitats will be too small to measure and thus insignificant.

Designated critical habitat for the leatherback turtle may be affected, but is not likely to be affected by disturbance from the R/V. The R/V may affect prey of sufficient condition, distribution, diversity, abundance, and density. The R/V may temporarily displace prey for the duration of transit through critical habitat. However, the limited time that the R/V is operational (three days) and the constant movement of the R/V will not measurably affect the condition, distribution, diversity, abundance, and density of prey. Thus, effects from the R/V on leatherback turtle critical habitat will be too small to measure and thus insignificant.

Designated critical habitat for the Oregon Coast ESU of coho salmon may be affected, but is not likely to be adversely affected by the following stressors: pollution and disturbance from the R/V. Pollution may affect the PBF related to water quality in estuarine, nearshore marine, and offshore marine areas. As previously discussed, it is extremely unlikely that a fuel or oil spill will occur, or that debris and waste will enter the marine environment. Thus, the effects of pollution on the water quality of the Oregon Coast ESU coho salmon critical habitat are discountable. The R/V may temporarily displace prey for the duration of transit through critical habitat. However, the limited time that the R/V is operational (three days) and the constant movement of the R/V will not measurably affect forage in estuarine, nearshore marine, or offshore marine areas. Thus, effects from the R/V on the Oregon Coast ESU coho salmon critical habitat will be too small to measure and thus insignificant.

Designated critical habitat for the Southern DPS of green sturgeon may be affected, but is not likely to be adversely affected by the following stressors: pollution and disturbance from the R/V. Pollution may affect the PBF related to water quality. As previously discussed, it is extremely unlikely that a fuel or oil spill will occur, or that debris and waste will enter the marine environment. Thus, the effects of pollution on the water quality of the Southern DPS green sturgeon critical habitat are discountable. The R/V may temporarily displace prey for the duration of transit through critical habitat. However, the limited time that the R/V is operational (three days) and the constant movement of the R/V will not measurably affect food resources for juvenile, subadult, and adult life stages. Thus, effects from the R/V on the Southern DPS green sturgeon critical habitat will be too small to measure and thus insignificant.

We conclude the proposed action may affect, but is not likely to adversely affect designated critical habitats of the Southern Resident DPS of killer whale, Central America DPS and Mexico DPS of humpback whale, leatherback turtle, Oregon Coast ESU of coho salmon, and Southern DPS of green sturgeon.

4.2 Status of the Species Likely to be Adversely Affected

The remainder of this opinion examines the status of each species that is likely to be adversely affected by the proposed actions: blue whale, fin whale, Central America DPS and Mexico DPS of humpback whale, sei whale, sperm whale, and Guadalupe fur seal. The status is an assessment of the abundance, recent trends in abundance, survival rates, life stages present, limiting factors, and sub-lethal or indirect changes in population trends such as inter-breeding period, shifts in distribution or habitat use, and shifts in predator distribution that contribute to the extinction risk that the listed species face. The status of each species below is described in terms of life history, threats, population dynamics, critical habitat, and recovery planning.

The information used in each of these sections is based on parameters considered in documents such as status reviews, recovery plans, and listing decisions and based on the best available scientific and commercial information. This section informs the description of the species' likelihood of both survival and recovery in terms of their "reproduction, numbers, or distribution" as described in 50 CFR §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register, status reviews, recovery plans, and on the NMFS OPR web site (https://www.fisheries.noaa.gov/species-directory/threatened-endangered).

4.2.1 Life History Common to Blue, Fin, Humpback, Sei, and Sperm Whales

ESA-listed whales in the action area share the same general life history, migrating from low latitude winter breeding areas where they mate, calve and nurse, to high latitude summer feeding areas. These species are long-lived, with life spans of 50–90 years. Females give birth to a single calf and calve on average every two to three years, though sperm whales calve on average every four to six years. Sexual maturity is reached between five and 15 years of age (male sperm whales reach sexual maturity around 18 to 21 years of age), and gestation is approximately one year. Calves nurse for approximately six months up to one year. While sperm whales feed primarily on squid and blue whales on krill, baleen whales generally feed on small schooling fish, zooplankton, and eupahusiids.

Baleen whales such as blue, fin, humpback, and sei whales generally hear low-frequency sounds, and are categorized in the low-frequency cetaceans hearing group, with a hearing range of seven Hertz (Hz) to 36 kiloHertz (kHz; NMFS 2024). There has only been one direct study on baleen whale hearing, which reported that wild minke whales were sensitive to frequencies as high as 45–90 kHz (Houser et al. 2024). Sperm whales, as toothed whales, are categorized in the high-frequency cetaceans hearing group, with a hearing range of 150 Hz to 160 kHz (NMFS 2024). All whales produce vocalizations, which can help determine population structure. Blue, fin, humpback, and sei whales produce calls and song (repeated patterns of calls, which are thought to be produced by males only), and sperm whales produce clicks (click sequences are called codas).

4.2.2 Threats Common to Blue, Fin, Humpback, Sei, and Sperm Whales

ESA-listed whales in the action area face numerous natural and human-induced threats that shape their status and affect their ability to recover. Many of these threats are either the same or similar in nature among the blue, fin, humpback, sei, and sperm whale.

Historically, all five species were harvested during the commercial whaling era, which reduced populations to a fraction of their historical abundance. Current threats to ESA-listed whales include vessel strikes, entanglement in fishing gear, pollution (anthropogenic underwater noise and plastic debris), and changing environmental trends.

4.2.3 Blue Whale

The blue whale was first listed as endangered in 1970 (35 Fed. Reg. 18319). The Society of Marine Mammalogy's Taxonomy Committee currently recognizes five subspecies of blue whale: *B. m. musculus* (Northern blue whales in the North Atlantic and North Pacific), *B. m. intermedia* (Antarctic blue whales), and *B. m. indica*, *B. m. brevicauda*, and an unnamed subspecies off Chile (pygmy-type blue whales; Committee on Taxonomy 2016).

Life History

Blue whales produce the lowest frequency vocalizations of any baleen whale; most vocalizations are between 12–25 Hz, with a range of 12–400 Hz (Ketten 1998; McDonald et al. 2001; McDonald et al. 1995a; Mellinger and Clark 2003). In the Northeast Pacific, the main blue whale vocalizations include tonal and pulsed calls, the former of which is very low frequency (around 16 Hz) and long (about 20 seconds), and the latter of which is a downsweeping (from high to low frequency) call (Stafford et al. 2001). These are loud calls, with average source levels ranging from 179–199 decibels referenced to a pressure of one microPascal (dB re 1 μPa; McDonald et al. 2009; Samaran et al. 2010; Širović et al. 2007). There have been no direct studies on blue whale hearing, but it is assumed that they can hear in the same frequency ranges as the vocalizations they produce.

Population Dynamics

There are three stocks of blue whales designated in U.S. waters: the Eastern North Pacific Ocean (population estimate [N]=1,898 individuals; minimum population estimate [N_{min}]=1,767 individuals; Calambokidis and Barlow 2020), Central North Pacific Ocean (N=137 individuals; 95% confidence interval [CI]=23–796 individuals; Bradford et al. 2021), and Western North Atlantic Ocean (N=402 individuals; N_{min}=402 individuals; Ramp and Sears 2013). In the Southern Hemisphere, the latest abundance estimate for Antarctic blue whales is 2,280 individuals in 1997/1998 (95% CI=1,160–4,500 individuals) with a population growth rate of 8.2% per year (95% CI=1.6–14.8%; Branch 2008). While no range-wide estimate for pygmy blue whales exists, the latest estimate for pygmy blue whales off the west coast of Australia is 662–1,559 individuals based on passive acoustic monitoring (McCauley and Jenner 2010), or 712–1,754 individuals based on photographic mark-recapture (Jenner 2008). A minimum estimate of the Chilean blue whale population is 303 individuals (95% CI=176–625; Williams et al. 2011). Due to the location of the action, the Eastern North Pacific stock of blue whales is most likely to be in the action area.

The Eastern North Pacific Stock of blue whales occurs in the Gulf of Alaska, along the U.S. West Coast (including the action area), and in the eastern tropical Pacific. The population abundance estimate for this population of blue whales is 1,878 individuals (N_{min}=1,767; CV = 0.085), based on the most recent capture-recapture data (2015–2018; Calambokidis and Barlow 2020). Monnahan et al. (2014) estimated that 3,411 blue whales (95% range = 2,593–4,114 blue whales) were removed from the population between 1905 and 1971 due to commercial whaling. While the population may have increased since the 1990's, the current population trend is unknown. Carretta et al. (2024b) cited a study by Monnahan et al. (2015) that estimated the eastern Pacific blue whale population was near carrying capacity in 2013, which may explain why population size increases have not been observed recently.

In general, blue whale distribution is driven largely by food requirements; blue whales are more likely to occur in waters with environmental conditions that support concentrations of their primary food source, krill. For example, off California, models showed that blue whales were more likely to use habitats with higher temperatures and higher chlorophyll-a concentration (proxies for prey density) and a northward shift in primary production from California to Oregon and Washington was also reflected in blue whale acoustic detections (Burtenshaw et al. 2004; Hazen et al. 2017; Irvine et al. 2014).

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS identified actions needed to recover blue whale populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the 2020 recovery plan for the blue whale for complete down-listing/delisting criteria for each of the following major actions (NMFS 2020). The recovery plan identifies two main objectives to recover blue whales:

1. Increase blue whale resiliency and ensure geographic and ecological representation by achieving sufficient and viable populations in all ocean basins and in each recognized subspecies, and
2. Increase blue whale resiliency by managing or eliminating significant anthropogenic threats.

4.2.4 Fin Whale

The fin whale was first listed as endangered in 1970 (35 Fed. Reg. 18319). The Society for Marine Mammalogy recognizes three subspecies: *B. p. physalus* in the North Atlantic and North Pacific, *B. p.quoyi* in the Southern Hemisphere, and *B. p. patachonica* the pygmy fin whale.

Life History

Fin whale vocalizations are low-frequency, often between 10–200 Hz, and are most commonly 20-Hz (range 18–35 Hz) downsweeping pulses lasting 0.5–2 seconds (Thompson et al. 1992; Watkins et al. 1987). These pulses are loud, with source levels ranging from 184–195 dB re 1 μPa (Miksis-Olds et al. 2019; Širović et al. 2007; Weirathmueller et al. 2013b). There have been no direct studies on fin whale hearing, but it is assumed that they can hear in the same frequency ranges as the vocalizations they produce. Cranford and Krysl (2015) conducted a CT scan of a stranded newborn male fin whale calf and predicted the audiogram. Because audiogram parameters have not been measured for baleen whales, Cranford and Krysl (2015) set the parameters to be similar to toothed whales, which produce and hear sounds at higher frequencies than baleen whales. They predicted sensitivity to a broad range of frequencies between 10 Hz and 12 kHz, with best sensitivity at 1.2 kHz.

Population Dynamics

The pre-exploitation estimate for the fin whale population in the North Pacific Ocean was 42,000–45,000 individuals, which was reduced to 8,000–11,000 individuals in 1973 (Ohsumi and Wada 1974). In the North Atlantic Ocean, an estimated 56,000 individuals made up the population in the early 1990's (Bérubé and Aguilar 1998). Over 725,000 fin whales were killed in the Southern Hemisphere during 1905–1976 (Allison 2017 cited in Cooke 2018b). Leaper and Miller (2011) estimated a circumpolar estimate (south of 60°S) of 5,445 individuals (95% CI=2,000–14,500 individuals). No current population estimates exist for the entire North Pacific, North Atlantic, or Southern Hemisphere, though NMFS (2019) summarizes the regional population estimates. For U.S. stocks, the best population abundance estimate are as follows:

- Western North Atlantic: 6,802 individuals (N_{min}=5,573 individuals; Hayes et al. 2024)
- Northeast Pacific: 3,168 individuals (N_{min}=2,554 individuals; Rone et al. 2017)
- Hawaii: 203 individuals (N_{min}=101 individuals; Bradford et al. 2021)
- California/Oregon/Washington: 11,065 individuals (N_{min}=7,970 individuals; Becker et al. 2020)

Overall population growth rates for the Hawaii stock, western North Atlantic stock, and Southern Hemisphere fin whales are not available at this time. Current estimates indicate an annual growth rate of 4.8% (95% CI=4.1–5.4%) for the Northeast Pacific stock, although this estimate is based on data between 1987 and 2003 and in coastal waters south of the Alaska Peninsula (Zerbini et al. 2006). A population growth rate of 7.5% was estimated for the California/Oregon/Washington stock based on data between 1991 and 2014 (Nadeem et al. 2016). However, Carretta et al. (2024b) note that it is unknown how much of this growth is due to immigration versus birth and death processes.

Fin whales have been detected acoustically and visually year-round off Oregon and Washington (Derville et al. 2022; Moore et al. 1998). However, it is not known whether the year-round presence is due to individuals moving in and out of the area or if there is a subset of the population that is resident (Soule and Wilcock 2013).

Threats

Vessel strike appears to be of particular concern for fin whales. Jensen and Silber (2003) found that approximately 26% of vessel strikes from 1975 to 2002 involved fin whales. Van Waerebeek and Leaper (2008) compiled data on vessel strikes and cetaceans between 1900 and 2000 for the International Whaling Commission Vessel Strike Data Standardisation Working Group. Out of 763 strikes, only 572 strikes had identifiable species. Of those 572 strikes, 220 (29.2%) were strikes of fin whales (Van Waerebeek and Leaper 2008).

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS identified actions needed to recover fin whale populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the 2010 recovery plan for the fin whale for complete down-listing/delisting criteria for each of the following major actions (NMFS 2010a). The recovery plan identifies two main objectives to recover fin whales:

1. Achieve sufficient and viable populations in all ocean basins, and
2. Ensure significant threats are addressed.

4.2.5 Humpback Whale – Central America DPS and Mexico DPS

The humpback whale was first listed as endangered in 1970 (35 Fed. Reg. 18319). Since then, NMFS has divided the species into 14 DPSs – four are listed as endangered and one is listed as threatened. The Central America DPS is listed as endangered and the Mexico DPS is listed as threatened (81 Fed. Reg. 62260).

Life History

Humpback whale vocalizations are among the most well-studied of all cetaceans. Humpback whale vocalizations are generally divided into song and non-song (or social) calls (Dunlop et al. 2008b; Mellinger and Clark 2003; Payne and McVay 1971). Different vocalizations correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008a). These vocalizations range from 20 Hz–12 kHz: humpback whale song, produced by males most commonly while in low-latitude breeding areas (although there have been studies documenting song on feeding grounds and on migration), generally occurs across a frequency range of 20 Hz–4 kHz with estimated source levels from 144–195 dB re 1 μPa (Au and Green 2000; Frazer and Mercado 2000; Richardson et al. 1995a; Winn et al. 1970). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hz–10 kHz with most energy below 3 kHz (Silber 1986; Tyack 1983). Such sounds can be heard up to 5.6 mi (9 km) away (Tyack 1983). Other social sounds from 50 Hz–10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995a; Tyack 1983). While in northern feeding areas, both sexes vocalize in grunts (25 Hz–1.9 kHz), pulses (25–89 Hz) and songs (ranging from 30 Hz–8 kHz but dominant frequencies of 120 Hz–4 kHz), which can be very loud with sound pressures of 175–192 decibels referenced to a pressure of one microPascal measured at one meter (dB re 1 μPa @ 1m; Au and Green 2000; Erbe 2002a; Payne 1985; Richardson et al. 1995a; Thompson et al. 1986). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995a).

Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hz–10 kHz, with maximum relative sensitivity between 2 kHz and 6 kHz (Ketten and Mountain 2014). The ability of humpback whales to hear frequencies around 3 kHz may have been demonstrated in a playback study: Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kHz at 219 dB re 1 µPa @ 1m or frequency sweep of 3.1–3.6 kHz. Tubelli et al. (2018) modeled the middle ear transfer function based on two models for how sound reaches the middle ear in humpback whales and predicted hearing ranges of 15 Hz to 3 kHz or 200 Hz to 9 kHz.

Population Dynamics

About 15,000 humpback whales were taken from the North Pacific between 1919 and 1987 (Tønnessen and Johnsen 1982). There are five stocks designated in the North Pacific: Hawaii (Hawaii DPS), Mexico-North Pacific (Mexico DPS), Mainland Mexico-California/Oregon/Washington (Mexico DPS), Central America/Southern Mexico-California/Oregon/Washington (Central America DPS), and Western North Pacific (Western North Pacific DPS). The current population estimates and population trend (if known) for the stocks are as follows:

- Hawaii: 11,278 individuals (N_{min}=7,265 individuals; Becker et al. 2022); there is evidence that the population was increasing prior to the marine heatwave in 2014–2016 and Unusual Mortality Event in 2015–2016 (see Young et al. 2023); however, it is unknown if the population is currently increasing.
- Mexico-North Pacific: 2,352 individuals (CV=0.075; Martínez-Aguilar 2011) or 918 individuals (CV=0.217; Wade et al. 2021); there is evidence that the population along the mainland Mexican coast was increasing; however, it is currently unknown whether the stock in general is increasing because of the aforementioned marine heatwave and Unusual Mortality Event on feeding grounds (see Young et al. 2023).
- Mainland Mexico-California/Oregon/Washington: 3,477 individuals (CV=0.101; Calambokidis and Barlow 2020; Curtis et al. 2022); Calambokidis and Barlow (2020) estimate an annual 8.2% increase in abundance of humpback whales in the California Current since 1989; however, it is unknown whether this is specific to the Mainland Mexico-California/Oregon/Washington stock.
- Central America/Southern Mexico-California/Oregon/Washington: 1,496 individuals (N_{min}=1,284 individuals; Curtis et al. 2022); Curtis et al. (2022) estimated an annual growth rate of 1.6% for Central America/Southern Mexico.
- Western North Pacific: 1,086 individuals (CV=0.088) for the Asia study area (Wade et al. 2021); current population trends are unknown.

The Central America DPS spends winters off the coast of Central America from Panama to southern Mexico, as far north as Michoacán and Colima (Taylor et al. 2021). This DPS primarily spends summer off California and Oregon, with the highest density of whales in southern California, although some individuals feed off the coast of Washington and southern British Columbia (Barlow et al. 2011; Calambokidis et al. 2008; Wade et al. 2021). Movement and genetics data do not suggest further population structure within this DPS (Taylor et al. 2021). Curtis et al. (2022) estimated the abundance of this DPS to be 1,496 (CV=0.171) whales with an estimated annual growth rate of 1.6% (SD=2.0%).

The Mexico DPS spends winters along the Pacific coast of mainland Mexico and in the Revillagigedo Archipelago, transits along the coast of Baja California, and spends summers feeding throughout the North Pacific from California to the Kamchatka Peninsula in Russia (Calambokidis et al. 2008; Titova et al. 2018; Wade et al. 2021). Movement and genetics data suggest the existence of further population structure within this DPS (Martien et al. 2021). There is currently no abundance estimate for this DPS, although an estimated 3,477 (CV=0.101) whales from the Mexico DPS feed off the U.S. West Coast (Calambokidis and Barlow 2020; Curtis et al. 2022). While the current trend is unknown, Calambokidis and Barlow (2020) reported an approximate 8.2% annual growth rate from 1989–2018 for humpback whales off California and Oregon waters, where whales from the Mexico and Central America DPSs overlap.

Critical Habitat

Critical habitats for the Central America DPS and Mexico DPS of humpback whale were found to be NLAA (Section 4.1.3) and is not considered further in the opinion.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover humpback whale populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the 2022 recovery outline for Central America DPS, Mexico DPS, and Western North Pacific DPS of humpback whales (NMFS 2022) for interim guidance to direct recovery efforts. The interim recovery program will focus on:

1. Management activities that continue to protect humpback whales and their critical habitat
2. Management activities that reduce medium and high risk threats to humpback whales, including vessel strike and entanglement in fishing gear
3. Research activities to fill critical information gaps necessary to inform management actions
4. Education and outreach activities to engage ocean users and to promote public involvement in humpback whale research and recovery

4.2.6 Sei Whale

The sei whale was first listed as endangered in 1970 (35 Fed. Reg. 18319). Two subspecies of sei whale are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere.

Life History

Data on sei whale vocal behavior is limited, but includes records off the Antarctic Peninsula of broadband sounds in the 100–600 Hz range with 1.5 second duration and tonal and upsweep calls in the 200–600 Hz range of one to three second durations (McDonald et al. 2005). Vocalizations from the North Atlantic Ocean consisted of single, paired, or triplet downsweeps from 50–30 Hz and 82–34 Hz, and patterned combinations of downsweeps suggesting that sei whales may produce songs (Tremblay et al. 2019). Source levels of 189 ±5.8 dB re 1 μPa @ 1m have been established for sei whales in the northeastern Pacific Ocean (Weirathmueller et al. 2013a).

Direct studies of sei whale hearing have not been conducted, but it is assumed that they can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997b; Ketten 1997a; Richardson et al. 1995a; Richardson et al. 1995b). This suggests sei whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than mid- to high-frequencies (Ketten 1997a).

Population Dynamics

There are no estimates of pre-exploitation abundance for the North Atlantic Ocean. Models indicate that total abundance declined from 42,000 individuals to 8,600 individuals between 1963 and 1974 in the North Pacific Ocean. More recently, the central and eastern North Pacific Ocean population was estimated to be 29,632 individuals (95% CI=18,576–47,267 individuals) between 2010 and 2012 (Hakamada et al. 2017). In the Southern Hemisphere, pre-exploitation abundance is estimated at 65,000 whales, with recent abundance estimated at 9,800 to 12,000 whales. Three stocks occur in U.S. waters: Nova Scotia, which covers waters from Halifax, Nova Scoita to Florida (N=6,292 individuals, N_{min}=3,098 individuals; Palka et al. 2017), Hawaii (N=401 individuals; CV=0.84; Bradford et al. 2021), and Eastern North Pacific, which covers waters off California, Oregon, and Washington (N=864 individuals, N_{min}=625 individuals; Barlow 2016), and are most likely to occur in the action area. Population growth rates for sei whales are not available at this time as there are little to no systematic survey efforts to study sei whales.

Sei whales are distributed worldwide, occurring in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere. Very little is known about the distribution of sei whales in the Northeast Pacific Ocean. Generally, the species occupies pelagic habitats, and is very rarely seen in coastal waters.

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS identified actions needed to recover sei whale populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the 2011 recovery plan for the sei whale for complete down-listing/delisting criteria for each of the following major actions (NMFS 2011). The recovery plan identifies two main objectives to recover sei whales:

1. Achieve sufficient and viable populations in all ocean basins, and
2. Ensure significant threats are addressed.

4.2.7 Sperm Whale

The sperm whale was first listed as endangered in 1970 (35 Fed. Reg. 18319).

Life History

Recordings of sperm whale vocalizations reveal that they produce a variety of sounds, such as clicks, gunshots, chirps, creaks, short trumpets, pips, squeals, and clangs (Goold 1999). Sperm whales typically produce short duration repetitive broadband clicks with frequencies below 100 Hz to greater than 30 kHz (Watkins 1977) and dominant frequencies between 1–6 kHz and 10–16 kHz. Another class of sound, "squeals," are produced with frequencies of 100 Hz to 20 kHz (e.g., Weir et al. 2007). The source levels of clicks can reach 236 dB re 1 µPa @ 1m, although lower source level energy has been suggested at around 171 dB re 1 µPa @ 1m (Goold and Jones 1995a; Goold and Jones 1995b; Mohl et al. 2003a; Mohl et al. 2003b; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997b; Weilgart and Whitehead 1997a). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low frequency (between 300 Hz and 1.7 kHz) with estimated source levels between 140– 162 dB re 1 µPa @ 1m (Madsen et al. 2003).

Long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995a; Goold and Jones 1995b; Miller et al. 2004b; Miller et al. 2004a; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997b; Weilgart and Whitehead 1997a; Whitehead and Weilgart 1991a; Whitehead and Weilgart 1991b). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are foraging and engaged in the deepest portion of their dives, with inter-click intervals and source levels being altered during these behaviors (Laplanche et al. 2005b; Laplanche et al. 2005a; Miller et al. 2004b; Miller et al. 2004a). Clicks are also used during social behavior and intragroup interactions (Weilgart and Whitehead 1993). When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals in a social unit and are considered to be primarily for intragroup communication (Rendell and Whitehead 2004a; Rendell and Whitehead 2004b; Weilgart and Whitehead 1997b; Weilgart and Whitehead 1997a). Research in the South Pacific Ocean suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al. 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects (Pavan et al. 2000a; Pavan et al. 2000b; Weilgart and Whitehead 1997b; Weilgart and Whitehead 1997a). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the Pacific Ocean (Weilgart and Whitehead 1997a). Three coda types used by male sperm whales have recently been described from data collected over multiple years: these codas are associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potential tests were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5–60 kHz and highest sensitivity to frequencies 5–20 kHz. Other hearing information consists of indirect data. For example, the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten

1992). The sperm whale may also possess better low-frequency hearing than other odontocetes, although not as low as many baleen whales (Ketten 1992). Reactions to anthropogenic sounds can provide indirect evidence of hearing capability, and several studies have made note of changes seen in sperm whale behavior in conjunction with these sounds. For example, sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins et al. 1985a; Watkins et al. 1985b; Watkins and Schevill 1975b; Watkins and Schevill 1975a). In the Caribbean Sea, Watkins et al. (1985b) observed that sperm whales exposed to 3.25–8.4 kHz pulses (presumed to be from submarine sonar) ceased activity and left the area. Similar reactions were observed from artificial sound generated by banging on a boat hull (Watkins et al. 1985b). André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al. 1997). Aaron et al. (2007); Thode et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel's propeller (110 dB re 1 μPa^2-second between 250 Hz and 1 kHz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel. Sperm whales have also been observed to stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995b).

Population Dynamics

The most recent estimate indicated a global population of 300,000–450,000 individuals (Whitehead 2009). There are no reliable estimates for sperm whale abundance across the entire Atlantic Ocean. However, estimates are available for two of three U.S. stocks in the Atlantic Ocean, the Northern Gulf of Mexico stock, estimated to consist of 1,180 individuals (CV =0.22; N_{min}=983 individuals; Garrison et al. 2020) and the North Atlantic stock, underestimated to consist of 5,895 individuals (CV=0.29; N_{min}=4,639 individuals; Dias et al. 2022). There are insufficient data to estimate abundance for the Puerto Rico and U.S. Virgin Islands stock. In the eastern tropical Pacific Ocean, the abundance of sperm whales was estimated to be 22,700 individuals (95% CI=14,800–34,600 individuals) based on surveys between 1986 and 1990 (Wade and Gerrodette 1993). Population estimates are also available for three U.S. stocks that occur in the Pacific Ocean: the California/Oregon/Washington stock, estimated to consist of 2,606 individuals (CV=0.135; N_{min}=2,011 individuals; Becker et al. 2020), the Hawaii stock, estimated to consist of 5,707 individuals (CV=0.23; N_{min}=4,486 individuals; Becker et al. 2022), and the North Pacific stock, estimated to consist of a minimum of 244 individuals (Rone et al. 2017). The N_{min} for the North Pacific stock is considered an underestimate of the stock because it does not cover the stock's entire range, and there are no current population estimates. We are aware of no reliable abundance estimates specifically for sperm whales in the South Pacific Ocean, and there is insufficient data to evaluate trends in abundance and growth rates of sperm whale populations at this time.

Sperm whales mostly inhabit areas with a water depth of 1,968 ft (600 m) or more, and are uncommon in waters less than 984 ft (300 m) deep. However, sperm whales may occur closer to shore when there are shelf breaks or submarine canyons. Sperm whales distribute widely throughout the North Pacific Ocean, with movements over 3,107 mi (5,000 km), likely driven by changes in prey abundance. While both males and females may be found in latitudes less than 40°, only adult males venture into the higher latitudes near the poles. Thus, males appear to range more broadly than females (Mizroch and Rice 2013).

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS identified actions needed to recover sperm whale populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the 2010 recovery plan for the sperm whale for complete down-listing/delisting criteria for each of the following major actions (NMFS 2010b). The recovery plan identifies two main objectives to recover sperm whales:

1. Achieve sufficient and viable populations in all ocean basins, and
2. Ensure significant threats are addressed.

4.2.8 Guadalupe Fur Seal

The Guadalupe fur seal was first listed as threatened in 1985 (50 Fed. Reg. 51252).

Life History

Guadalupe fur seals prefer rocky habitats and can be found in natural recesses and caves (Fleischer 1978), using sheltered beaches and rocky platforms for breeding (Arias-del-Razo et al. 2016). Breeding occurs in June through August. Adult males return to the colonies in early June. Female Guadalupe fur seals arrive on beaches in June, with births occurring between mid-June to July (Pierson 1978); the pupping season is generally over by late July (Fleischer 1978). Breeding adult males are polygamous, and may mate with up to 12 females during a single breeding season. Females stay with pups for seven to eight days after parturition, and then alternate between foraging trips at sea and lactation on shore; nursing lasts about eight months (Figureroa-Carranza 1994). Guadalupe fur seals feed mainly on squid species (Esperon-Rodriguez and Gallo-Reynoso 2013); the Gulf of Ulloa on the Pacific side of the Baja California peninsula is an important feeding area (Aurioles-Gamboa and Szteren 2019). Based on a stable isotope analysis of male Guadalupe fur seal carcasses, there appears to be some niche segregation between coastal and oceanic males, possibly based on individual age and size (Aurioles-Gamboa and Szteren 2019). Foraging trips can last between four to 24 days (average of 14 days). Tracking data show that adult females spend 75% of their time sea, and 25% at rest (Gallo-Reynoso et al. 1995).

Though there has been no auditory assessment of the Guadalupe fur seal, its hearing likely falls within similar range as that of the Northern fur seal 2–40 kHz (Moore and Schusterman 1987). Guadalupe fur seals are categorized in the otariid hearing group, which has an estimated hearing range of 60 Hz to 68 kHz under water and 90 Hz to 40 kHz in air (NMFS 2024).

Population Dynamics

Commercial sealing during the 19th century brought the Guadalupe fur seal to near extinction in 1894 (Townsend 1931). The species was presumed extinct, until 1949, when an adult male was observed at San Nicolas Island, CA (Bartholomew Jr. 1950) and a small number of individuals were found on Guadalupe Island, Mexico in 1954 (Hubbs 1956). In 1994, the population at Guadalupe Island was estimated at 7,408 individuals (Gallo-Reynoso 1994). There have been other, more recent population abundance estimates for Guadalupe Island, with a considerable amount of variation between them: 20,000 individuals in 2010 (García-Capitanachi et al. 2017), and 34,000–44,000 individuals in 2013 (García-Aguilar et al. 2018). Guadalupe fur seals are also found on San Benito Island, likely immigrants from Guadalupe Island, as there are relatively few pups born on San Benito Island (Aurioles-Gamboa et al. 2010). Based on a total population to pup ratio of 4:1, the best estimate of population abundance is 63,850 individuals (range 57,199–72,631 individuals; Juárez-Ruiz et al. 2022; DON 2019). Juárez-Ruiz et al. (2022) estimated an annual growth rate of 8.4% (range: 8–8.8%) from 1991 to 2019.

The Guadalupe fur seal is found in waters along the west coast of North America from central Mexico (Ortega-Ortiz et al. 2019) to southern British Columbia, Canada (Norris and Elorriaga-Verplancken 2019; Norris et al. 2017), with rare sightings in Alaska (Carretta et al. 2025; Lambourn et al. 2012). In the U.S., they haul out on the California Channel Islands and a small number of pups have been observed at San Miguel Island. Satellite-tagged Guadalupe fur seals in California traveled as far north as Graham Island and Vancouver Island, British Columbia, Canada and some traveled as far offshore as 805.5 mi (1,296.3 km) west of the California/Oregon border (Norris et al. 2015).

Threats

Commercial sealers in the 19th century decimated the Guadalupe fur seal population, taking as many 8,300 Guadalupe fur seals from San Benito Island (Townsend 1924). The species was presumed extinct, until 1949, when an adult male was observed at San Nicolas Island, CA (Bartholomew Jr. 1950) and a small number of animals were found on Guadalupe Island in 1954 (Hubbs 1956). Although commercial hunting of Guadalupe fur seals does not occur at present, the effects persist today. Other human activities, such as entanglements from commercial fishing gear, are ongoing and continue to affect these species (Carretta et al. 2025). Other human impacts include entanglement in marine debris, shootings, and oil/tar.

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

There has been no recovery plan prepared for Guadalupe fur seals.

5. ENVIRONMENTAL BASELINE

The *environmental baseline* refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and stressors attributable to human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

5.1 Environmental Change

There is a large and growing body of literature on past, present, and future impacts of environmental change, exacerbated and accelerated by human activities. These changes include sea level rise, ocean acidification, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which affect ESA resources.

The rapid pace of change in greenhouse gas concentrations (e.g., carbon dioxide and methane) and atmospheric warming since the Industrial Revolution in the mid-19th century are increasing the warming of the global climate system and altering the carbonate chemistry of the ocean (i.e., ocean acidification). As carbon dioxide concentrations increase in the atmosphere, more carbon dioxide is absorbed by the oceans, causing lower pH and reduced availability of calcium carbonate in the form of aragonite. Changes in pH outside the normal range can make it difficult for marine organisms with shells to maintain their shells (Fabry et al. 2008). Many of those creatures such as crustaceans, crabs, mollusks, and other calcium carbonate-dependent organisms such as pteropods (free-swimming pelagic sea snails and sea slugs), are important parts of the food web in the North Pacific Ocean. Reduction in these prey items can create a collapse of the zooplankton populations and thereby result in potential cascading reduction of prey at various levels of the food web, thereby reducing the availability of the larger prey items of marine mammals.

Elevated ocean temperatures have been documented and are projected to increase. Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences for ESA species. Warming ocean temperatures may make it more difficult for organisms to locate or capture prey (Roemmich and Mcgowan 1995; Zamon and Welch 2005), allow for the northward expansion of predator and competitor ranges (Mcfarlane et al. 2000; Phillips et al. 2007; Rexstad and Pikitch 1986), and create larger areas of hypoxia or anoxia because warmer water holds less dissolved oxygen. 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). Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean given rising sea surface temperatures using a database of electronic tags and a global climate model. They predicted up to a 35% change in some key marine predators' core habitat area in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses. MacLeod (2009) estimated that, based on predicted shifts in water temperature, 88% of cetaceans will be affected by changing environmental conditions, with 47% predicted to experience unfavorable conditions (e.g., range contraction).

Changing environmental conditions will likely result in changes to the distribution and abundance of keystone prey species like krill and in cephalopod populations, which will likely affect marine mammal populations as they search for prey. For example, blue whales, which exclusively eat krill, are likely to shift their distribution in response to changes in the distribution of krill (Barlow et al. 2020). Pecl and Jackson (2008) predicted that changing environmental conditions will likely result in squid that hatch out smaller and earlier, undergo faster growth over shorter life-spans, and mature younger at a smaller size. This could have negative consequences for species such as sperm whales and Guadalupe fur seals, whose diets can be dominated by cephalopods. For ESA-listed species that undergo long migrations such as baleen whales, if either prey availability or habitat suitability is disrupted by changing ocean temperatures, regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

Oceanographic conditions in the Pacific Ocean can be altered due to periodic shifts in atmospheric patterns caused by the Southern oscillation in the Pacific Ocean, which leads to El Niño and La Niña events, and the Pacific decadal oscillation. These climatic events can alter habitat conditions and prey distribution for ESA-listed species (Beamish 1993; Benson and Trites 2002; Hare and Mantua 2001; Mantua et al. 1997; Mundy 2005; Mundy and Cooney 2005; Stabeno et al. 2004).

The Pacific decadal oscillation is the leading mode of variability in the North Pacific and operates over longer periods than either El Niño or La Niña/Southern Oscillation events. It is capable of altering sea surface temperature, surface winds, and sea level pressure (Mantua and Hare 2002; Stabeno et al. 2004). During positive Pacific decadal oscillations, the northeastern Pacific Ocean experiences above average sea surface temperatures while the central and western Pacific Ocean undergoes below-normal sea surface temperatures (Royer 2005). Warm Pacific decadal oscillation regimes, as occurs in El Niño events, tends to decrease productivity along the U.S. west coast, as upwelling typically diminishes (Childers et al. 2005; Hare et al. 1999).

Changing environmental conditions can also increase the frequency and intensity of marine heatwaves. During the 2014–2016 northeast Pacific marine heatwave, Steller sea lion adult, sub-adults, juvenile, and pup counts on rookeries in Alaska declined (Suryan et al. 2021). Humpback and killer whale abundance in the region also declined (Gabriele et al. 2022; Suryan et al. 2021). The effects were still noticeable five years after the onset of the heatwave, with low abundance of humpback whales, lower than average calf production, calf survival, and non-calf survival, and prey species such as Pacific herring, sand lance, and capelin (Gabriele et al. 2022; Suryan et al. 2021). Santora et al. (2020) observed habitat compression in foraging whales because of the marine heatwave, which they linked to a record number of whale entanglements in the central California Current crab fishery. Guadalupe fur seal pup mortality rates were also significantly higher during the heatwave compared to the years prior to the heatwave (Gálvez et al. 2023).

This review highlights evidence of significant changes in environmental conditions that may affect ESA-listed species and their habitats. While it is difficult to accurately predict the consequences of these changing environmental conditions to a particular species or habitat, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats. This is discussed further in the Integration and Synthesis (Section 8).

5.2 Unusual Mortality Events

Under the MMPA, an unusual mortality event (UME) is defined as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response." In the past, an UME was declared for fin and humpback whales in British Columbia (including Vancouver Island) and Gulf of Alaska, from April 23, 2015 through April 16, 2016, where 52 individuals were found dead (https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2016-large-whale-unusual-mortality-event-western-gulf-alaska). The investigation did not determine a cause for the unusual mortality event, although ecological factors like the 2015 El Niño, the "warm water blob", and the Pacific Coast Domoic Acid Bloom were contributing factors.

An UME was declared for Guadalupe fur seals beginning January 1, 2015, and continuing through September 2, 2021 (https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2021-guadalupe-fur-seal-and-2015-northern-fur-seal-unusual). The UME was declared due to the increased stranding of Guadalupe fur seals in California, and was expanded to include Oregon and Washington due to the elevated number of strandings there (a total of 715 animals). At the peak of the UME in 2019, the number of Guadalupe fur seal strandings off Oregon and Washington were nearly 18 times the number of strandings in the years prior to the declaration of the UME. Stranded individuals were mostly weaned pups and juveniles, aged one to two years old. Most stranded individuals showed signs of malnutrition and had secondary bacterial and parasitic infections. The malnutrition was attributed to ecological factors in the Pacific Ocean causing suboptimal prey conditions. Unprecedented ocean warming in the Northeast Pacific Ocean that resulted in reduced or changed prey availability most likely impacted the weaned pups' ability to feed.

5.3 Sound

The ESA-listed species that occur in the action area are regularly exposed to several sources of anthropogenic sounds. These include, but are not limited to maritime activities (vessel sound and commercial shipping), aircraft, seismic surveys (exploration and research), marine construction, and military readiness activities. These activities occur to varying degrees throughout the year. Cetaceans and pinnipeds produce and rely on sound to navigate, hunt, avoid predators, and/or communicate with other individuals and anthropogenic sound can interfere with these important activities (Nowacek et al. 2007). The ESA-listed species have the potential to be impacted by either increased levels of anthropogenic-induced background sound or high intensity, short-term anthropogenic sounds.

The addition of anthropogenic sound to the marine environment is a known stressor that can possibly harm marine animals or significantly interfere with their normal activities (NRC 2005). Within the action area, ESA-listed marine mammals may be impacted by anthropogenic sound in various ways. Responses to sound exposure may include lethal or nonlethal injury, temporary hearing impairment, behavioral harassment and stress, or no apparent response. For example, some sounds may produce a behavioral response, including but not limited to, avoidance of impacted habitat areas affected by irritating sounds, changes in diving behavior, or (for cetaceans) changes in vocalization patterns (MMC 2007).

Many researchers have described behavioral responses of marine mammals to sounds produced by boats and vessels, as well as other sound sources such as helicopters and fixed-wing aircraft, and dredging and construction (reviewed in Gomez et al. 2016; and Nowacek et al. 2007). Most observations have been limited to short-term behavioral responses, which included avoidance behavior and temporary cessation of feeding, resting, or social interactions; however, in terrestrial species habitat abandonment can lead to more long-term effects, which may have implications at the population level (Barber et al. 2010). Masking may also occur, in which an animal may not be able to detect, interpret, and/or respond to biologically relevant sounds. Masking can reduce the range of communication, particularly long-range communication, such as that for blue whales. This can have a variety of implications for an animal's fitness including, but not limited to, predator avoidance and the ability to reproduce successfully (MMC 2007). Scientific evidence suggests that marine mammals, including several baleen whales, compensate for masking by changing the frequency, source level, redundancy, or timing of their signals, but the long-term implications of these adjustments are currently unknown (Mcdonald et al. 2006; Parks 2003; Parks 2009b). We assume similar impacts have occurred and will continue to affect marine species in the action area.

Despite the potential for these impacts to affect individual ESA-listed marine mammals, information is not currently available to determine the potential population-level effects of anthropogenic sound levels in the marine environment (MMC 2007). For example, we currently lack empirical data on how sound impacts growth, survival, reproduction, and vital rates, nor do we understand the relative influence of such effects on the population being considered. As a result, the consequences of anthropogenic sound on ESA-listed marine mammals at the population or species scale remain uncertain, although recent efforts have made progress in establishing frameworks to consider such effects (NAS 2017).

Vessels
Individual vessels produce unique acoustic signatures, although these signatures may change with vessel speed, vessel load, and activities that may be taking place on the vessel. Sound levels are typically higher for the larger and faster vessels. Peak spectral levels for individual commercial vessels are in the frequency band of 10-50 Hz and range from 195 dB re 1 μPa^2-second @ 1m for fast-moving (greater than 20 knots [37 km/hr]) supertankers to 140 dB re 1 μPa^2-second @ 1m for smaller vessels (NRC 2003c). The low frequency sounds from large vessels overlap with many mysticetes predicted hearing ranges and may mask their vocalizations and cause stress (Rolland et al. 2012b). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels to about 2 kHz, and small boats can produce sound in the mid-frequency (1–5 kHz) range and at moderate (150 to

180 dB re 1 μPa at 1 meter) sound source levels (Erbe 2002b; Gabriele et al. 2003; Kipple and Gabriele 2004), which may interfere with important biological functions of odontocetes such as sperm whales (Blair et al. 2016; Holt 2008). At frequencies below 300 Hz, ambient sound levels are elevated by 15–20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013).

Measurements made over the period 1950 through 1970 indicated low frequency (50 Hz) vessel traffic sound in the eastern North Pacific Ocean was increasing by 0.55 dB per year (Ross 1976; Ross 1993; Ross 2005). Most data indicate vessel sound is likely still increasing (Hildebrand 2009; Kaplan and Solomon 2016). Efforts are underway to better document changes in ambient sound (Haver et al. 2018), which will help provide a better understanding of current and future impacts of vessel sound on ESA-listed species. NOAA is working cooperatively with the ship building industry to find technologically-based solutions to reduce the amount of sound produced by commercial vessels.

Sonar

Sonar systems are used on commercial, recreational, and military vessels and may also affect cetaceans (NRC 2003a). The action area may host many of these vessel types during any time of the year. Although little information is available on potential effects of multiple commercial and recreational sonars to ESA-listed marine mammals, the distribution of these sounds would be small because of their short durations and the fact that the high frequencies of the signals attenuate quickly in seawater (Nowacek et al. 2007). However, military sonar, particularly low frequency active sonar, often produces intense sounds at high source levels, and these may impact cetacean behavior (Southall et al. 2016). For further discussion on active sonar and anthropogenic sound from military activities on ESA-listed species located within the action area and considered in this consultation, see below.

Aircraft

Aircraft within the action area may consist of small commercial or recreational airplanes or helicopters, to large commercial airliners. These aircraft produce a variety of sounds that can potentially impact marine mammals. While it is difficult to assess these impacts, several studies have documented what appear to be minor behavioral disturbances in response to aircraft presence (Nowacek et al. 2007). Erbe et al. (2018) recorded underwater noise from commercial airplanes reaching as high as 36 dB above ambient noise. Sound pressure levels received at depth were comparable to cargo and container ships traveling at distances of 0.6–1.9 mi (1–3 km) away, although the airplane noises ceased as soon as the airplanes left the area, which was relatively quickly compared to a cargo vessel. Most observations have been limited to short-term behavioral responses, which included cessation of feeding, resting, or social interactions. Smultea et al. (2008b) documented a recognized “stress behavioral reaction” by a group of sperm whales in response to small aircraft fly-bys. The group ceased forward movement, moved closer together in a parallel flank-to-flank formation, and formed a fan-shaped semi-circle with the lone calf remaining near the middle of the group. Kuehne et al. (2020) found that sounds from military aircraft at Whidbey Island, Washington, were detectable 98.4 ft (30 m) below the water surface at levels of 134 dB re 1 μPa (root-mean-square [rms]).

While such noise levels are relatively low and brief, they still have the potential to be heard by cetaceans and pinnipeds at certain frequencies. Nevertheless, noise from aircraft is expected to be minimal due to the location of the action area, which is far from a populated area and has sparse aircraft traffic.

Seismic Surveys

There are seismic survey activities involving towed airgun arrays that may occur within the action area. They are the primary exploration techniques to locate hydrocarbon deposits, fault structure, and other geological hazards. Airguns contribute a massive amount of anthropogenic energy to the world's oceans (3.9×10^{13} Joules cumulatively), second only to nuclear explosions (Moore and Angliss 2006). Although most energy is in the low-frequency range, airguns emit a substantial amount of energy up to 150 kHz (Goold and Coates 2006). Seismic airgun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004). These activities may produce noise that could impact ESA-listed marine mammals within the action area.

These airgun arrays generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of ten to 20 seconds for extended periods (NRC 2003b). Most of the energy from the airguns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from airguns usually reach 235 to 240 dB re 1 μPa_{rms} at dominant frequencies of 5–300 Hz (NRC 2003a). Most of the sound energy is at frequencies below 500 Hz, which is within the hearing range of baleen whales and sperm whales (Nowacek et al. 2007). In the U.S., seismic surveys involving the use of airguns with the potential to take marine mammals are generally covered by incidental take authorizations under the MMPA, and if they involve ESA-listed species, undergo formal ESA section 7 consultation. In addition, the Bureau of Ocean Energy Management authorizes oil and gas activities in domestic federal waters and the NSF and U.S. Geological Survey funds and/or conducts these seismic survey activities in domestic, international, and foreign waters, and in doing so, consults with NMFS to ensure their actions do not jeopardize the continued existence of ESA-listed species or adversely modify or destroy designated critical habitat. More information on the effects of these activities on ESA-listed species, including authorized takes, can be found in recent biological opinions.

The NSF funded and L-DEO conducted seismic surveys in the Northeast Pacific Ocean on the R/V Maurice Ewing, R/V Wecoma, R/V Marcus G. Langseth, or other research vessels in 2004, 2007, 2008, 2009, 2010, 2012, 2017, 2019, 2021, and 2022. Each of these seismic surveys include a MMPA IHA and each are subject to a separate ESA section 7 consultation. The finalized consultations all resulted in a "no jeopardy" opinion.

Marine Construction

Marine construction activities in the action area that produces sound includes drilling, dredging, pile-driving, cable-laying, and explosions. These activities are known to cause behavioral disturbance and physical damage to marine mammals (NRC 2003a). While most of these activities are coastal, offshore construction does occur in the Northeast Pacific Ocean. All or some of these activities may occur within the action area and can affect ESA-listed marine mammals.

Active Sonar

Active sonar emits high-intensity acoustic energy and receives reflected and/or scattered energy. A wide range of sonar systems are in use for both civilian and military applications. The primary sonar characteristics that vary with application are the frequency band, signal type (pulsed or continuous), rate of repetition, and sound source level. Sonar systems can be divided into categories, depending on their primary frequency of operation; low-frequency for one kilohertz and less, mid-frequency for 1–10 kHz, high-frequency for 10–100 kHz; and very high-frequency for greater than 100 kHz (Hildebrand 2004). Low-frequency systems are designed for long-range detection (Popper et al. 2014). The effective sound source level of a low-frequency airgun array, when viewed in the horizontal direction can be 235 dB re 1 μPa at 1 meter or higher (Hildebrand 2004). Signal transmissions are emitted in patterned sequences that may last for days or weeks. Mid-frequency military sonars include tactical anti-submarine warfare sonars, designed to detect submarines over several tens of kilometers, depth sounders, and communication sonars. High-frequency military sonars includes those incorporated into weapons (e.g., torpedoes and mines) or weapon countermeasures (mine countermeasures or anti-torpedo devices), as well as side-scan sonar for seafloor mapping. Commercial sonars are designed for fish finding, depth sounds, and sub-bottom profiling. They typically generate sound at frequencies of approximately 200 kHz, with sound source levels ranging from 150–235 dB re 1 μPa at 1 meter (Hildebrand 2004). Depth sounders and sub-bottom profilers are operated primarily in nearshore and shallow environments; however, fish finders are operated in both deep and shallow areas.

Military Operations

Within the action area, multiple stressors associated with military activities pose a threat to ESA-listed marine mammals. The U.S. Navy conducts training, testing, and other military readiness activities on range complexes throughout coastal and offshore areas in the United States and on the high seas. The U.S. Navy's Northwest Training and Testing range complex overlaps with the action area. During training, existing and established weapon systems and tactics are used in realistic situations to simulate and prepare for combat. Activities include: routine gunnery, missile, surface fire support, amphibious assault and landing, bombing, sinking, torpedo, tracking, and mine exercises. Testing activities are conducted for different purposes and include at-sea research, development, evaluation, and experimentation. The U.S. Navy performs testing activities to ensure that its military forces have the latest technologies and techniques available to them.

The majority of the training and testing and research activities the U.S. Navy conducts in the action area are similar, if not identical to activities that have been occurring in the same locations for decades; therefore, the ESA-listed species located in the action area have been exposed to these military activities often and repeatedly.

Based on the currently available scientific information, behavioral responses that result from stressors associated with these training and testing and research activities are expected to be temporary and will not affect the reproduction, survival, or recovery of these species. Sound (in-air and in-water) produced during U.S. Navy activities is also expected to result in instances of auditory injury, temporary threshold shifts, and behavioral harassment to marine mammals. The U.S. Navy's activities constitute a federal action and take of ESA-listed marine mammals and designated critical habitat considered for these activities have previously undergone separate

ESA section 7 consultation. Through these consultations with NMFS, the U.S. Navy has implemented monitoring and conservation measures to reduce the potential effects of in-air and underwater sound from their activities on ESA-listed species in the Pacific Ocean. Conservation measures include employing visual observers and implementing mitigation zones during activities using active sonar and explosives.

The U.S. Air Force conducts training and testing activities on range complexes on land and in U.S. waters. Aircraft operations and air-to-surface activities may occur in the action area. U.S. Air Force activities generally involve the firing or dropping of munitions (e.g., bombs, missiles, rockets, and gunnery rounds) from aircraft towards targets located on the surface, though U.S. Air Force training exercises may also involve boats. These activities have the potential to impact ESA-listed species by physical disturbance, boat strikes, debris, ingestion, and effects from noise and pressure produced by detonations. U.S. Air Force training and testing activities constitute a Federal action and take of ESA-listed species considered for these U.S. Air Force activities have previously undergone separate section 7 consultations

5.4 Fisheries Interactions

Fisheries constitute an important and widespread use of the ocean resources throughout the action area. Fisheries can adversely affect fish populations, other species, and habitats. Direct effects of fisheries interactions on marine mammals include entanglement and entrapment, which can lead to fitness consequences or mortality as a result of injury or drowning. Non-target species are captured in fisheries (i.e., bycatch), and can represent a significant threat to non-target populations. Indirect effects include reduced prey availability, including overfishing of targeted species, and destruction of habitat. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals.

Fisheries can have a profound influence on fish populations. In a study of retrospective data, Jackson et al. (2001) concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic changes to environmental conditions. Marine mammals are known to feed on several species of fish that are harvested by humans (Waring et al. 2008). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of several populations of marine mammals.

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox et al. 2015). Marine mammal entanglement (bycatch) is a global problem that every year results in the death of hundreds of thousands of animals worldwide. Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in cetaceans (see Dietrich et al. 2007). Materials entangled tightly around a body part may cut into tissue, enable infection, and severely compromise an individual's health (Derraik 2002). Entanglements also make animals more vulnerable to additional threats (e.g., predation, vessel strikes, loss of foraging opportunities) by restricting movement. The majority of marine mammals that die from entanglement in fishing gear likely sink at sea rather than strand ashore, making it difficult to accurately determine the extent of such mortalities. In excess of 97% of entanglement is caused by derelict fishing gear (Baulch and Perry 2014a).

The number of confirmed whale entanglements per year detected off the West Coast of the U.S. has increased significantly from 2001 to 2016 (Santora et al. 2020). The number of confirmed whale entanglements, most notably humpback whales, increased markedly throughout the 2014 through 2016 marine heat wave event in the Pacific Ocean. The latest mean annual mortalities and serious injuries over the latest five-years related to commercial fisheries interactions for the ESA-listed marine mammals likely to be found in the action area within U.S. waters are given in Table 4 below (Carretta et al. 2024a; Carretta et al. 2025; Jannot et al. 2022). Data represent only known mortalities and serious injuries; more, undocumented mortalities and serious injuries for these and other marine mammals found within the action area have likely occurred.

Table 4. Mean annual mortalities and serious injuries related to fisheries interactions for ESA-listed marine mammals within the action area.

Species	Time Period	Mean Annual Mortality/Serious Injury
Blue Whale	2017–2021	Greater than or equal to 0.61
Fin Whale	2017–2021	Greater than or equal to 0.5
Humpback Whale – Multiple DPSs	2016–2020	19.5
Sei Whale	2017–2021	0
Sperm Whale	2017–2021	0.52
Guadalupe Fur Seal	2018–2022	Greater than or equal to 7.2

DPS=distinct population segment

There have been reports of Guadalupe fur seals stranding with evidence of entanglement in fishing gear or other marine debris (Carretta et al. 2025). There are several records of Guadalupe fur seals being hooked in the mouth by longline gear in the Hawai'i shallow set longline fishery (Carretta et al. 2025). Between 1990 and 2022, no Guadalupe fur seals were observed entangled in California gillnet fisheries (Carretta 2023; Julian and Beeson 1998). Other human-related mortalities and serious injuries between 2018 and 2022 include eight Guadalupe fur seals observed entangled in marine debris, three that were involved in shootings, two unidentified human interactions, and one oil/tar (Carretta et al. 2025).

Marine mammals are also known to ingest fishing gear, likely mistaking it for prey, which can lead to fitness consequences and mortality. Necropsies of stranded whales have found that ingestion of net pieces, ropes, and other fishing debris has resulted in gastric impaction and ultimately death (Jacobsen et al. 2010b). As with vessel strikes, entanglement or entrapment in fishing gear likely has the greatest impact on populations of ESA-listed species with the lowest abundance (e.g., Kraus et al. 2016). Nevertheless, all species of marine mammals may face threats from derelict fishing gear.

Recreational fishing occurs throughout the action area. Commercial and recreational fisheries may impact marine mammals as they migrate through the action area through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations.

5.5 Oil and Gas

Hydrocarbons that may pose a threat to ESA-listed marine mammals consist of natural seeps as well as oil spills. Hydrocarbons also have the potential to impact prey populations, and therefore may affect ESA-listed species indirectly by reducing food availability.

Oil spills are accidental and unpredictable events, but are a direct consequence of oil and gas development and production from oil and gas activities, as well as from the use of vessels. Oil releases can occur at any number of points during the exploration, development, production, and transport of oil. Most instances of oil spills are generally small (less than 1,000 barrels), but larger spills occur as well.

There has not yet been a large-scale oil spill in the action area, but numerous small-scale spills are likely to occur. A nationwide study examining vessel oil spills from 2002 through 2006 found that over 1.8 million gallons of oil were spilled from vessels in all U.S. waters (Dalton and Jin 2010). In this study, "vessel" included numerous types of vessels, including barges, tankers, tugboats, and recreational and commercial vessels, demonstrating that the threat of an oil spill can come from a variety of vessel types. Below, we review the effects of oil spills on marine mammals more generally. Much of what is known comes from studies of large oil spills such as the *Deepwater Horizon* oil spill because no information exists on the effects of small-scale oil spills within the action area.

In 1989, the *Exxon Valdez* released at least 11 million gallons of Alaska crude oil into one of the largest and most productive estuaries in North America. The Alaska Department of Environmental Conservation estimated that 92.6 mi (149 km) of shoreline was heavily oiled and 285.2 mi (459 km) were at least lightly oiled. Oil spills, both small and large, occur widely along U.S. shores at refining and transfer facilities and extraction sites. The *Exxon Valdez* oil spill was the worst in U.S. history until the 2010 *Deepwater Horizon* event.

The *Deepwater Horizon* oil spill in the Gulf of Mexico in 2010 led to the exposure of tens of thousands of marine mammals to oil, causing reproductive failure, adrenal disease, lung disease, and poor body condition. For example, as a result of the *Deepwater Horizon* oil spill, sperm whales were likely exposed to toxic oil components through inhalation, aspiration, ingestion, and dermal exposure. There were 19 observations of 33 sperm whales either swimming in *Deepwater Horizon* surface oil or with visible oil on their bodies (Diaz 2015 as cited in Deepwater Horizon NRDA Trustees 2016). The effects of oil exposure likely included physical and toxicological damage to organ systems and tissues, reproductive failure, and death. Large whales may have experienced multiple routes of exposure at the same time, over intermittent timeframes and at varying rates, doses, and chemical compositions of oil. This estimation of effects to large whales is largely based on observed impacts to bottlenose dolphins resulting from exposure to oil from the *Deepwater Horizon* event. The oil spill from the *Deepwater Horizon* event occurred in deep water, which includes sperm whale habitat. The same routes of internal oil exposure (ingestion, inhalation, and aspiration) would have occurred in sperm whales that have been shown to adversely affect bottlenose dolphins in coastal habitat. The surface oil and vapors at the water's surface were more concentrated offshore near the leaking well head that could have exposed sperm whales to high levels of contaminants between dives that were known to have occurred with bottlenose dolphins. Linnehan et al. (2021) concluded that bottlenose dolphins impacted by oil showed evidence of cardiac abnormalities (i.e., significantly thinner left ventricular walls, smaller left atria, and higher prevalence of valvular abnormalities) as well as pulmonary hypertension. Hydrocarbons also have the potential to impact prey populations, and therefore may affect ESA-listed species indirectly by reducing food availability.

As noted above, to our knowledge, the past and present impacts of oil spills on ESA-listed species (blue whale, fin whale, Central America DPS and Mexico DPS of humpback whale, sei whale, sperm whale, and Guadalupe fur seal) within the action area are limited to those associated with small-scale vessel spills. Nevertheless, we consider the documented effects of oil spills outside the action area, such as the *Deepwater Horizon* oil spill, examples of the possible impacts that oil spill can have on ESA-listed species in the action area.

5.6 Vessel Interactions

Within the action area, vessel interactions pose a threat to ESA-listed marine mammals. Overall, the action area sees a great deal of vessel activity, from cargo and commercial shipping, to recreational vessels, cruise ships, and whale watching vessels.

Vessels have the potential to affect animals through strikes, sound, and disturbance associated with their physical presence. Responses to vessel interactions include interruption of vital behaviors and social groups, separation of mothers and young, and abandonment of resting areas (Boren et al. 2001; Constantine 2001; Mann et al. 2000; Nowacek 2001; Samuels et al. 2000). A blue whale aborted its ascent when it was 188.6 ft (57.5 m) from the vessel, and stayed underwater for three minutes beyond its projected surfacing time (Szesciorka et al. 2019). A study focusing on Southern Resident DPS of killer whales showed that individuals altered their foraging behavior when near vessels. When vessels were at an average distance of less than 1,200.8 ft (366 m), individuals made fewer dives involving prey capture, and spent less time in these dives. The researchers found differences in response between the sexes, with females making fewer dives than males when vessels were less than 1,200.8 ft away (366 m; Holt et al. 2021).

Vessel Strike

Vessel strikes are considered a serious and widespread threat to ESA-listed marine mammals (especially large whales) and are the most well-documented "marine road" interaction with large whales (Pirotta et al. 2019). This threat is increasing as commercial shipping lanes cross important breeding and feeding habitats and as whale populations recover and populate new areas or areas where they were previously extirpated (Swingle et al. 1993; Wiley et al. 1995). Blue whales are especially susceptible where shipping lanes overlap with common feeding areas, such as in the Santa Barbara Channel (Redfern 2013). As vessels become faster and more widespread, an increase in vessel interactions with cetaceans is to be expected. All sizes and types of vessels can hit whales, but most lethal and severe injuries are caused by vessels 262.5 ft (80 m) or longer (Laist et al. 2001). For whales, studies show that the probability of fatal injuries from vessel strikes increases as vessels operate at speeds above 14 knots (26 km/hr; Laist et al. 2001). Evidence suggests that not all whales killed as a result of vessel strike are detected, particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination (Glass et al. 2010). The vast majority of commercial vessel strike mortalities of cetaceans are likely undetected and unreported, as most are likely never observed. Most animals killed by vessel strike likely end up sinking rather than washing up on shore (Cassoff 2011). Kraus et al. (2005) estimated that only 17% of vessel strikes are actually detected. Therefore, it is likely that the number of documented cetacean mortalities related to vessel strikes is much lower than the actual number of moralities associated with vessel strikes, especially for less buoyant species such as blue, humpback, and fin whales (Rockwood et al. 2017). Rockwood et al. (2017) modeled vessel strike mortalities of blue, humpback, and fin whales off California using carcass recovery rates of 5–17% and conservatively estimated that vessel strike mortality may be as high as 7.8, 2.0, and 2.7 times the recommended limit for blue, humpback, and fin whale stocks in this area, respectively.

The potential lethal effects of vessel strikes are particularly profound on species with low abundance. However, all whale species have the potential to be affected by vessel strikes. Of 11 species of cetaceans known to be threatened by vessel strikes in the Northern Hemisphere, fin whales are the mostly commonly struck species (Laist et al. 2001; Vanderlaan and Taggart 2007a). Vessel traffic within the action area can come from both private (e.g., commercial, recreational) and Federal (e.g., military, research) sources, but traffic that is most likely to result in vessel strikes comes from commercial shipping. The latest five-year annual average mortalities and serious injuries related to vessel strikes for ESA-listed marine mammal stocks within U.S. waters likely to be found in the action area and experience adverse effects as a result of the proposed action are given in Table 5 below (Carretta et al. 2024a; Carretta et al. 2025; Jannot et al. 2022). These data represent only known mortalities and serious injuries. It is probably that more undocumented mortalities and serious injuries within the action area have likely occurred.

Table 5. Mean annual mortalities and serious injuries related to vessel strikes for ESA-listed marine mammals for stocks in the Pacific Ocean within the action area.

Species	Time Period	Mean Annual Mortality/Serious Injury
Blue Whale	2017–2021	0.6
Fin Whale	2017–2021	1.6

Humpback Whale – Multiple DPSs	2016–2020	16.6
Sei Whale	2017–2021	0
Sperm Whale	2017–2021	0
Guadalupe Fur Seal	2018–2022	NA

DPS=distinct population segment, NA=not available

Whale Watching

Whale watching is a profitable and rapidly growing business with more than 3,300 operators worldwide, serving 13 million participants in 119 countries and territories, and may increase types of disturbance and negatively affect the species (Hoyt 2001; O'Connor et al. 2009). As of 2010, commercial whale watching was a one billion dollar global industry per year (Lambert et al. 2010). Private vessels may partake in this activity as well. NMFS has issued regulations and guidelines relevant to whale watching. As noted previously, many of the cetaceans and pinnipeds considered in this consultation are highly migratory, and may be exposed to whale watching activity occurring outside of the action area. Whale watching companies operate from the coast of Oregon, primarily seeing gray whales and humpback whales. Whale watching from the coast of Washington target killer whales and other species (e.g., humpback whales) in the Salish Sea and Puget Sound.

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational and scientific benefits, whale watching is not without potential negative impacts (reviewed in Parsons 2012). Whale watching has the potential to harass whales by altering feeding, breeding, and social behavior, or even injure them if the vessel gets too close or strikes the animal. Preferred habitats may be abandoned if disturbance levels are too high. Animals may also become more vulnerable to vessel strikes if they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995).

Several studies have examined the short-term effects of whale watching vessels on marine mammals (Au and Green 2000; Corkeron 1995; Erbe 2002b; Felix 2001; Magalhaes et al. 2002; Richter et al. 2003; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002). A whale's behavioral response to whale watching vessels may depend on the distance of the vessel from the whale, vessel speed, vessel direction, vessel sound, the number of vessels, and the animal's behavior. In some circumstances, whales do not appear to respond to vessels, but in other circumstances, whales change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Disturbance by whale watch vessels has also been noted to cause newborn calves to separate briefly from their mother's sides, which leads to greater energy expenditures by the calves (NMFS 2006).

Although numerous short-term behavioral responses to whale watching vessels were documented, little information is available on whether long-term negative effects result from whale watching (NMFS 2006). Christiansen et al. (2014) estimated the cumulative time minke whales spent with whale watching boats in Iceland to assess the biological significance of whale watching disturbances and found that, through some whales were repeatedly exposed to whale watching boats throughout the feeding season, the estimated cumulative time they spent with boats was very low. Christiansen et al. (2014) suggested that the whale watching industry, in its current state, is likely not having any long-term negative effects on vital rates.

It is difficult to precisely quantify or estimate the magnitude of the risks posed to marine mammals in general from vessel approaches associated with whale watching. However, the survey will take place approximately 62 mi (100 km) from the Oregon/Washington coast, which is generally further from shore than whale watching vessels are expected to travel.

5.7 Research Permits

Regulations for section 10(a)(1)(A) of the ESA allow issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research. Prior to the issuance of such a permit, the proposal must be reviewed for compliance with section 7 of the ESA. Scientific research permits issued by NMFS currently authorize studies of ESA-listed species in the Northeast Pacific Ocean, some of which extend into portions of the action area for the proposed actions. Marine mammals have been the subject of field studies for decades. The primary objective of most of these field studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued many permits on an annual basis for various forms of "take" of marine mammals in the action area from a variety of research activities.

Authorized research on ESA-listed marine mammals includes aerial and vessel surveys, close approaches, photography, videography, behavioral observations, active acoustics, prey mapping, remote ultrasound, passive acoustic monitoring, biological sampling (i.e., body and weight measurements, biopsy, blood, breath, clipped hair, fecal, muscle, oral and nasal, sloughed skin, urine), and tagging. In addition, capture and restraint of pinnipeds may be conducted for the injection of sedative, administration of drugs (intramuscular, subcutaneous, or topical), attachment of instruments to hair or flippers, and ultrasound. Research activities generally involve non-lethal "takes" of these marine mammals.

There have been numerous research permits issued since 2009 under the provisions of both the MMPA and ESA authorizing scientific research on marine mammals all over the world, including for research activities in the action area. The consultations which took place on the issuance of these ESA scientific research permits each found that the authorized research activities will have no more than short-term effects on individuals or populations and were not determined to result in jeopardy to the species or adverse modification of designated critical habitat.

Additional "take" is likely to be authorized in the future as additional permits are issued. It is noteworthy that although the numbers tabulated below in the Effects of the Action section represent the maximum number of "takes" authorized in a given year, monitoring and reporting indicate that the actual number of "takes" rarely approach the number authorized. Therefore, it is unlikely that the level of exposure indicated below has or will occur in the near term. However, our analysis assumes that these "takes" will occur since they have been authorized. It is also noteworthy that these “takes” are distributed across the Pacific Ocean. Although marine mammals are generally wide-ranging, we do not expect many of the authorized “takes” to involve individuals that will also be “taken” under the proposed survey.

5.8 Aquaculture

Marine aquaculture systems are diverse, ranging from highly controlled land-based systems to open water cages that release wastes directly to the environment. Species produced in the marine environment are also diverse, and include seaweeds, bivalve mollusks, echinoderms, crustaceans, and finfish (Langan 2004). Globally, aquaculture supplies more than 50% of all seafood produced for human consumption, and that percentage will likely continue to rise (NOAA Marine Aquaculture; https://www.fisheries.noaa.gov/topic/aquaculture). Marine aquaculture is expected to expand in the U. S. Exclusive Economic Zone (EEZ) due to increased demand for domestically grown seafood, coupled with improved technological capacity to farm in the open ocean. The National Offshore Aquaculture Act of 2005 (S. 1195) promotes offshore aquaculture development within the EEZ and established a permitting process that encourages private investment in aquaculture operations, demonstrations, and research. Additionally, Executive Order 13921, “Promoting American Seafood Competitiveness and Economic Growth”, highlights effective permitting related to offshore aquaculture and a renewed focus on aquaculture.

Aquaculture opportunity areas (AOA’s) have not yet been identified for Oregon and Washington; however, given the National Offshore Aquaculture Act of 2005 and Executive Order 13921, it is reasonable to conclude that aquaculture will continue to expand in the U.S. Pacific, and that aquaculture may introduce potential stress to native biota which may affect either the health or prey base of native fauna.

Potential impacts to ESA-listed species can occur at all stages of aquaculture development, operation, and decommissioning, and can include attraction to farms or displacement from important habitats, resulting in changes to distribution, behaviors, or social structures (Clement 2013; Price et al. 2017). Aquaculture has the potential to affect protected species via entanglement and/or other interaction with aquaculture gear (i.e., buoys, nets, and lines), introduction or transfer of pathogens, increased vessel traffic and noise, impacts to habitat and benthic organisms, and water quality (Clement 2013; Lloyd 2003; Price et al. 2017; Price and Morris 2013). Current data suggest that interactions and entanglements of ESA-listed marine mammals with aquaculture gear are rare (Price et al. 2017). This may be because worldwide the number and density of aquaculture farms are low, and thus there is a low probability of interactions, or because they pose little risk to ESA-listed marine mammals. It is not always possible to determine if the gear animals become entangled in originates from aquaculture or commercial fisheries (Price et al. 2017). Some aquaculture gear has the potential for behavioral effects on marine mammals. For example, aquaculture gear may act as a "fish aggregating device” which may attract marine mammals seeking prey for food, and subsequent marine mammal depredation may occur (Callier et al. 2018). Aquaculture gear may also block migration routes (MPI 2013) or at least cause animals to have to circumnavigate the aquaculture gear.

5.9 Invasive Species

Aquatic nuisance species are nonindigenous species that threaten the diversity or abundance of native species, the ecological stability of infested waters, or any commercial, agricultural or recreational activities dependent on such waters. Aquatic nuisance species include nonindigenous species that may occur within inland, estuarine, or marine waters and that presently or potentially threaten ecological processes and natural resources. Invasive species have been referred to as one of the top four threats to the world's oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005). Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Wilcove et al. 1998). A variety of vectors are thought to have introduced non-native species, including, but not limited to, aquarium and pet trades, recreation, and ballast water discharges from ocean-going vessels. Common impacts of invasive species are alteration of habitat and nutrient availability, as well as altering species composition and diversity within an ecosystem (Strayer 2010). Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002), potentially affecting prey availability and habitat suitability for ESA-listed species. They have been implicated in the endangerment of 48% of ESA-listed species (Czech and Krausman 1997). Currently, there is little information on the level of aquatic nuisance species and the impacts these invasive species may have on marine mammals in the action area through the duration of the project. Therefore, the level of risk and degree of impact to ESA-listed marine mammals is unknown.

Dueñas et al. (2018) conducted a systematic literature review of the available scientific evidence on invasive species' interactions with all threatened and endangered species protected under the ESA. Relevant to this consultation, Dueñas et al. (2018) did not find any studies indicating that ESA-listed marine mammals negatively impacted by invasive species.

Many studies have demonstrated a close relationship between trade and aquatic nuisance species, with shipping being identified as the main vector of aquatic nuisance species in aquatic ecosystems (Nong 2018, Chan et al. 2019). Olson (2006) reviewed numerous studies of biological invasions and highlighted that international trade is an important vector that links to the existence and spread of invasive species internationally. Globally, shipping has been found to be responsible for 69% of marine invasive species (Molnar et al. 2008).

Risks associated with oceanic shipping come primarily from hitchhiking species on vessel hulls (fouling) and in ballast water (Drake and Lodge 2007; Keller and Perrings 2011). In general, the introduction of aquatic nuisance species is one of the primary causes decreased biodiversity in an ecosystem (Trombulak et al. 2004). The impact of aquatic nuisance species in marine systems ranges from extirpation of native species through competition or predation, shifts in ecosystem food webs, to changes to the physical structure of the habitat (Norse et al. 2005). Although it is not possible to predict which aquatic nuisance species will arrive and thrive in the Pacific Ocean (e.g., non-native species like striped bass [*Morone saxatillis*] and Japanese eelgrass [*Zostera japonica*]), it is reasonably certain that they will be yet another facet of change and potential stress to native biota which may affect either the health or prey base of native fauna.

5.10 Marine Debris

Marine debris is an ecological threat introduced into the marine environment through ocean dumping, littering, or hydrological transport of these materials from land-based sources or weather events (Gallo et al. 2018). Even natural phenomena, such as tsunamis and continental flooding, can cause large amounts of debris to enter the ocean environment (Watters et al. 2010). Marine debris has been discovered to be accumulating in gyres throughout the oceans. Marine mammals often become entangled in marine debris, including fishing gear (Baird et al. 2015). Despite debris removal and outreach to heighten public awareness, marine debris in the environment has not been reduced (NRC 2008) and continues to accumulate in the ocean and along shorelines within the action area.

Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it (Gall and Thompson 2015). Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and mortality for ESA-listed species in the action area. Entanglement can also result in drowning for air breathing marine species, including marine mammals. The ingestion of marine debris has been documented to result in blockage or obstruction of the digestive tract, mouth, and stomach lining of various species and can lead to serious internal injury or mortality (Derraik 2002). In addition to interference with alimentary processes, plastics lodged in the alimentary tract could facilitate the transfer of pollutants into the bodies of whales and dolphins (Derraik 2002). Data on marine debris in some locations of the action area is largely lacking; therefore, it is difficult to draw conclusions as to the extent of the problem and its impacts on populations of ESA-listed species in the Northeast Pacific Ocean, but we assume similar effects from marine debris documented within other ocean basins could also occur to ESA-listed species from marine debris (Werth et al. 2024).

Cetaceans are also impacted by marine debris, which includes: plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear (Baulch and Perry 2014b; Li et al. 2016). Over half of cetacean species (including blue, fin, humpback, sei, and sperm whales) are known to ingest marine debris (mostly plastic), with up to 31% of individuals in some populations containing marine debris in their guts and being the cause of death for up to 22% of individuals found stranded on shorelines (Baulch and Perry 2014a). A recent study showed that microplastics were present in nearly all fecal samples from Southern Resident DPS of killer whales (Harlacher 2020). In 2008, two sperm whales stranded along the coast of California, with an assortment of fishing related debris (e.g., net scraps and rope) and other plastics inside their stomachs (Jacobsen et al. 2010a). One whale was emaciated, and the other had a ruptured stomach. It was suspected that gastric implications was the cause of both deaths. Jacobsen et al. (2010a) speculated the debris likely accumulated over many years, possibly in the North Pacific gyre that will carry derelict Asian fishing gear into the waters of the Eastern Pacific Ocean.

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). Plastic waste in the ocean can leach chemical additives into the water or these additives, such as brominated flame retardants, stabilizers, phthalate esters, biphenyl A, and nonylphenols (Panti et al. 2019). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as polychlorinated biphenyl and dichlorodiphenyltrichloroethane. Marine mammals can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. Once consumed, plastics can act as nutritional dilutants in the gut, making the animal feel satiated before it has acquired the necessary amount of nutrients required for general fitness (reviewed in Machovsky-Capuska et al. 2019). Plastics may therefore influence the nutritional niches of animals in higher trophic levels, such as Guadalupe fur seals and other pinnipeds (Machovsky-Capuska et al. 2019). It is expected that marine mammals may be exposed to marine debris over the course of the proposed actions although the risk of ingestion or entanglement and the resulting impacts are uncertain at the time of this consultation.

5.11 Other Marine Pollution

Exposure to pollution and contaminants has the potential to cause adverse health effects in marine species. Marine ecosystems receive pollutants from a variety of local, regional, and international sources, and their levels and sources are therefore difficult to identify and monitor (Grant and Ross 2002). Marine pollutants come from multiple municipal, industrial, and household sources as well as from atmospheric transport (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata 1993). Contaminants may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation (Garrett 2004; Grant and Ross 2002; Hartwell 2004).

The accumulation of persistent organic pollutants, including polychlorinated-biphenyls, dibenzo-p-dioxins, dibenzofurans and related compounds, through trophic transfer may cause mortality and sub-lethal effects in long-lived higher trophic level animals (Waring et al. 2016), including immune system abnormalities, endocrine disruption, and reproductive effects (Krahn et al. 2007). For example, in marine mammals like Southern Resident DPS of killer whales, contamination from pollutants could lead to endocrine disruption (delayed development, changes to metabolism, reduced perinatal survival) and compromised immune systems (Mongillo et al. 2016). Persistent organic pollutants may also facilitate disease emergence and lead to the creation of susceptible “reservoirs” for new pathogens in contaminated marine mammal populations (Ross 2002). Recent efforts have led to improvements in regional water quality, and monitored pesticide levels have declined, although the more persistent chemicals are still detected and are expected to endure for years (Grant and Ross 2002; Mearns 2001).

Numerous factors can affect concentrations of persistent pollutants in marine mammals, such as age, sex and birth order, diet, and habitat use (Mongillo et al. 2012). In marine mammals, pollutant contaminant load for males increases with age, whereas females pass on contaminants to offspring during pregnancy and lactation (Addison and Brodie 1987; Borrell et al. 1995). Pollutants can be transferred from mothers to juveniles at a time when their bodies are undergoing rapid development, putting juveniles at risk of immune and endocrine system dysfunction later in life (Krahn et al. 2009). While exposure to pollutants and other contaminants is likely to continue and occur for marine mammals in the action area through the duration of the seismic survey activities, the level of risk and degree of impact is unknown.

Pollutants and contaminants cause adverse health effects in pinnipeds. Acute toxicity events may result in mass mortalities; repeated exposure to lower levels of contaminants may also result in immune suppression and/or endocrine disruption (Atkinson et al. 2008). In addition to hydrocarbons and other persistent chemicals, pinnipeds may become exposed to infectious diseases (e.g., Chlamydia and leptospirosis) through polluted waterways (Aguirre et al. 2007). In 2001, a male Guadalupe fur seal stranded and exhibited symptoms consistent with domoic acid toxicosis, and received treatment for seizures over the next 19 years prior to humane euthanasia (Schmitt et al. 2023).

Because persistent organic pollutants are both ubiquitous and persistent in the environment, marine mammals and other forms of marine life will continue to be exposed to persistent organic pollutants for all of their lives. The effects of persistent organic pollutants to ESA-listed species are unknown and not directly studied, but it is possible that the effects could be sub-lethal and long-term in nature, and include impacting reproduction, immune function, and endocrine activity. These are effects that would become more apparent as time goes on. At present, however, the effects of persistent organic pollutants in ESA-listed species are not well known.

5.12 Impact of the Baseline on ESA-Listed Species

Collectively, the environmental baseline described above has had, and likely continues to have, lasting impacts on the ESA-listed species considered in this consultation. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strikes), whereas others result in more indirect (e.g., fishing that affects prey availability) or non-lethal (e.g., whale watching) impacts.

Assessing the aggregate impacts of these stressors on the species considered in this consultation is difficult. This difficulty is compounded by the fact that the species in this consultation are wide-ranging and subject to stressors in locations throughout and outside the action area.

We consider the best indicator of the aggregate impact of the environmental baseline section on ESA-listed blue, fin, humpback, sei, and sperm whales, and Guadalupe fur seals, to be the status and trends of those species. As noted in Section 4.2, some of the species considered in this consultation are experiencing increases in population abundance, some are declining, and, for others, their status remains unknown. Taken together, this indicates that the environmental baseline is affecting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the environmental baseline. Therefore, while the environmental baseline may slow their recovery, recovery is not prevented. For the species that may be declining in abundance, it is possible the suite of conditions described in the environmental baseline section is preventing their recovery. However, it is also possible their populations are at such low levels (e.g., due to historical harvesting) that, even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself.

6. ANALYSIS OF EFFECTS

The ESA section 7 regulations (50 CFR §402.02) define *effects of the action* as "all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action." To understand the effects of the action to listed species and critical habitats, we employ a stressor-exposure-response analysis. The stressors resulting from this action were identified in Section 2.3 and the stressor analyzed here is the underwater acoustic effects from the airguns. The following analysis is structured to separately asses the exposure of listed species, followed by an assessment of the responses of listed species to that exposure. To conclude this section, we summarize the combination of exposure and response for each species.

6.1 Exposure

In this section, we consider the exposure to the various stressors that could cause an effect to ESA-listed species that are likely to co-occur with the action's modifications to the environment in space and time, and identify the nature of that co-occurrence. We describe the timing and location of the stressors to identify the populations, life stages, or sexes of each listed species likely to be exposed. We then determine to which populations those exposed individuals belong.

6.1.1 ESA-Listed Marine Mammal Exposure

The ESA-listed marine mammals likely to be adversely affected by underwater acoustic effects from the airguns are blue whale, fin whale, Central America DPS humpback whale, Mexico DPS humpback whale, sei whale, sperm whale, and Guadalupe fur seal. As discussed in Section 4.2, these species' hearing ranges encompass the dominant frequencies of the airguns (0–188 Hz). To estimate the number of marine mammals exposed to underwater sound from the airguns, NSF used the level of exposure to sound above which species are reasonably certain to be affected, marine mammal density in the action area, and the duration of the survey. Given the characteristics of the sound source (non-explosive, impulsive), NSF used the 160 dB re 1 μPa_{rms} threshold, above which, if marine mammals are exposed, NMFS predicts that marine mammals are likely to be behaviorally "harassed" based on definitions provided in the MMPA (16 U.S.C. §1362(18)(a)). Using this threshold, NSF calculated the total marine area that would be ensonified to levels within this threshold during the survey. The total ensonified area was calculated as the product of the ensonified line length around the source (i.e., two times the radius, or distance from the sound source to the 160 dB re 1 μPa level), the distance surveyed in one day (approximately 137.9 mi or 222 km) including endcaps, and the number of survey days (two). The resulting ensonified area was then increased by 25% to account for any additional seismic operations associated with airgun testing or repeat surveying of areas where initial data quality is sub-standard. To estimate the number of individuals of each species that may be exposed, the total ensonified area was multiplied by the best available species density in the area. Species densities for blue, fin, and humpback whales were obtained from Becker et al. (2020). Densities for sei whales was obtained from DON (2019) and Marine Geospatial Ecology Lab

Duke University (2021). Sperm whale densities were obtained by NSF through a personal communication with the lead author of Becker et al. (2020). Exposures for whales were rounded to the nearest average group size for each species. Guadalupe fur seal densities were calculated using formulas in DON (2019) and the most recent population abundance estimate in Carretta et al. (2025).

For more details, see NSF's Draft Environmental Assessment of Marine Geophysical Surveys by R/V *Sally Ride* at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025 on NSF's Environmental Compliance webpage, under the subheading "Current environmental reviews" at https://www.nsf.gov/funding/environmental-compliance and the NMFS Permits and Conservation Division's proposed IHA (90 Fed. Reg. 34212). Table 6 summarizes the total number of individuals exposed to underwater acoustic effects from the airguns by species.

Table 6. Exposure estimates for ESA-listed marine mammals during NSF's seismic survey

Species	**Hearing Group**	**Density (individuals per km^2)**	**Daily Ensonified Area (km^2)**	**Number of Survey Days**	**Estimated Exposures**	**Exposures**
Blue whale	Low-frequency	0.000025	221	2	0.013906	2*
Fin whale	Low-frequency	0.004482	221	2	2.493113	2
Humpback whale	Low-frequency	0.00048	221	2	0.267	2
Sei whale	Low-frequency	0.0004	221	2	0.2225	2
Sperm whale	High-frequency	0.002731	221	2	1.519119	7
Guadalupe fur seal	Otariid	0.033027	221	2	18.37127	18

km^2 = square kilometers
* Although the estimated exposure results in less than one, the NMFS Permits and Conservation Division proposed to authorize one group given observations reported during previous surveys in the project area in 2021 and 2022 (RPS 2022a; RPS 2022b; RPS 2023)

Blue, fin, Central America DPS and Mexico DPS humpback, sei, and sperm whales of all age classes are likely to be exposed during the proposed survey. Adult and juvenile Guadalupe fur seals are likely to be exposed during the proposed survey. Given that the proposed low-energy seismic survey will be conducted in late summer, we expect that most animals will be on or migrating to/from their feeding grounds. Blue, fin, Central America DPS and Mexico DPS humpback, sei, and sperm whales are expected to be feeding (for example, Central America DPS and Mexico DPS humpback whales feed off the U.S. West Coast; see Section 4.2.5), traveling, or migrating in the action area and some females will have young-of-the-year accompanying them. Mature sperm whales are generally expected to be further north in the Pacific Ocean. Therefore, we expect a bias between juvenile male and female sperm whale exposure. For sperm whales, exposure of adult males is expected to be lower than other age and sex class combinations as they are generally solitary and may migrate toward the northern portion of their range (poleward of about 40–50° latitude). For blue whales, fin whales, Central America DPS and Mexico DPS humpback whales, sei whales, sperm whales, and Guadalupe fur seals, these individuals may be exposed to the proposed survey while they are feeding in or transiting through the action area. We assume that sex distribution is even for blue whales, fin whales, Central America DPS and Mexico DPS humpback whales, sei whales, and Guadalupe fur seals, and that sexes are exposed at a relatively equal level.

Blue Whale – The estimated exposure is two individuals. While there are no abundance estimates for the entire population, the estimated regional population abundance is 1,898 individuals (lower and upper 20th percentile values of 1,767 to 2,038 individuals) in the eastern North Pacific Ocean (Calambokidis and Barlow 2020). Given this population estimate, the estimated exposure of two individuals is approximately 0.1% of the population.

Fin Whale – The estimated exposure is two individuals. While there are no abundance estimates for the entire population, the estimated regional population abundance is 11,065 individuals (95% CI=5,156–23,747 individuals) for the California/Oregon/Washington stock (Becker et al. 2020). Given this population estimate, the estimated exposure of two individuals is approximately 0.02% of the population.

Central America DPS and Mexico DPS Humpback Whale – The estimated exposure of the population is two individuals. The estimated population abundances of the Central America DPS and Mexico DPS are 1,496 individuals (CV=0.171) and 3,477 individuals (CV=0.101), respectively (Calambokidis and Barlow 2020; Curtis et al. 2022).

Humpback whales off the coasts of California, Oregon, and Washington may belong to different DPSs. Calambokidis et al. (2017) and Wade et al. (2021) estimated the probability that a humpback whale off the U.S. West Coast would belong to the Central America, Mexico, or Hawaii (non-listed) DPS (Table 7).

Table 7. Estimated probability a humpback whale off the U.S. West Coast would belong to the Central America, Mexico, or Hawaii (non-listed) DPS

Area	Probability Belonging to Central America DPS	Probability Belonging to Mexico DPS	Probability Belonging to Hawaii (non-listed) DPS
California/Oregon	42%	58%	0%
Washington	6%	25%	69%

Humpback whales from the two listed DPSs (Central America DPS and Mexico DPS) are expected to be present in the action area; however, if a humpback whale is exposed to the underwater acoustic effects from the airguns, it is not possible to immediately identify whether an individual belongs to the Central America DPS or Mexico DPS (or the non-listed Hawaii DPS, if an individual is encountered off Washington). Therefore, the estimated exposure of two individuals could be from either the Central America DPS or Mexico DPS. Based on the population estimates, the estimated exposure of two individuals is approximately 0.13% of the Central America DPS or approximately 0.06% of the Mexico DPS.

Sei Whale – The estimated exposure of the population is two individuals. While there are no abundance estimates for the entire population, the estimated regional population abundance is 864 individuals (CV=0.4) in the California Current based on ship-based line-transect surveys off California, Oregon, and Washington (Barlow 2016). Given this population estimate, the estimated exposure of two individuals is approximately 0.2% of the population.

Sperm Whale – The estimated exposure of the population is seven individuals. While there are no abundance estimates for the entire population, the estimated regional population abundance is 2,606 individuals (CV=0.135) for the California/Oregon/Washington stock (Becker et al. 2020). Given this population estimate, the estimated exposure of seven individuals is approximately 0.3% of the population.

Guadalupe Fur Seal – The estimated exposure of the population is 18 individuals. The best estimate of population abundance is 63,850 individuals (range 57,199–72,631 individuals; DON 2019; Juárez-Ruiz et al. 2022). Given this population estimate, the estimated exposure of 18 individuals is approximately 0.03% of the population.

6.2 Response

Given the potential for exposure to stressors associated with the proposed survey discussed above, in this section, we describe the range of responses ESA-listed species may display because of exposure to those stressors. Our assessment considers the potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals.

6.2.1 ESA-Listed Marine Mammal Responses

For species, we discuss responses in terms of physiological, physical, or behavioral effects to the species. These responses may rise to the level of *take* under the ESA. *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 U.S.C. §1532(19)).

Seismic airguns transmit acoustic energy into the water, which can affect ESA-listed blue whales, fin whales, Central America DPS and Mexico DPS humpback whales, sei whales, sperm whales, and Guadalupe fur seals considered in this opinion. Possible marine mammal responses include noise-induced hearing loss/noise-induced threshold shifts, behavioral responses, physiological stress or non-auditory injury, masking, and potential stranding. Where there is limited information on these species' responses to airguns within the action area, we use the best available information on similar species in other marine areas.

Hearing Loss and Threshold Shifts

Marine mammals are susceptible to noise-induced hearing loss, or noise-induced threshold shifts (i.e., a loss of hearing sensitivity), and auditory injury when exposed to high levels of sound within their limited hearing range. Types of noise-induced threshold shifts include temporary threshold shift (TTS) and auditory injury, the latter of which includes, but is not limited to, permanent threshold shift (PTS). TTS is a temporary, reversible increase in hearing threshold at a specified frequency or portion of an animal's hearing range above a previously established reference level (ANSI 1995; Yost 2007). Auditory injury consists of damage to the inner ear that can result in the destruction of tissue, such as the loss of cochlear neuron synapses or auditory neuropathy (Finneran 2024; Houser 2021), which may or may not result in PTS. Studies on terrestrial mammals have reported recoverable noise-induced threshold shifts that still resulted in neuropathy; therefore, there could be cases where auditory injury occurs but PTS does not (Kujawa and Liberman 2009; Liberman et al. 2016). PTS is a permanent, irreversible increase in hearing threshold at a specified frequency of a portion of an animal's hearing range above an established reference level (ANSI 1995; Yost 2007). The most recent NMFS Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS 2024) replaced PTS with auditory injury.

Few data are available to precisely define each ESA-listed species hearing range, let alone its sensitivity and sound levels that result in the onset of TTS or auditory injury. Baleen whales (e.g., blue, fin, humpback, and sei whales) have an estimated functional hearing frequency range of 7 Hz to 36 kHz and sperm whales have an estimated functional hearing frequency range of 150 Hz to 160 kHz (NMFS 2024). For pinnipeds underwater, data were limited to measurements of TTS in harbor seals (*Phoca vitulina*), a northern elephant seal (*Mirounga angustirostris*), and California sea lions (*Zalophus californianus*; Kastak et al. 1999). Otariid pinnipeds, such as Guadalupe fur seals, have an estimated functional underwater hearing range of 60 Hz to 68 kHz (NMFS 2024). Thus, these species' hearing ranges overlap the dominant frequencies of the airguns (0–188 Hz).

For marine mammals, auditory injury is considered to be possible when sound exposures are sufficient to produce 40 dB of TTS measured after exposure (Southall et al. 2019). There have been no direct studies on auditory injury in marine mammals with the exception of a single study which unintentionally induced PTS in a harbor seal (*Phoca vitulina*; Reichmuth et al. 2019). However, based on the small anticipated isopleths MMPA Level A harassment (equated to auditory injury), auditory injury is not expected to occur and has not been proposed to be authorized by the NMFS Permits and Conservation Division.

The best available information supports the position that sound levels at a given frequency will need to be approximately 186 dB sound exposure level (SEL) or approximately 196–201 dB re 1 μPa_{rms} in order to produce a low-level TTS from a single pulse (Finneran et al. 2013; Southall et al. 2007b). PTS is expected at levels approximately 6 dB greater than TTS levels on a peak-pressure basis, or 15 dB greater on an SEL basis than TTS (Southall et al. 2007b). TTS was observed in harbor porpoise (*Phocoena phocoena*) after exposure to ten and 20 consecutive airgun pulses from two airguns simultaneously, with cumulative SELs of 188 and 191 dB re 1 μPa^2-second (Kastelein et al. 2017). Lucke et al. (2009) observed TTS at 4 kHz when harbor porpoise were exposed to SELs of 164.3 dB re 1 1 μPa^2-second. A small (9 dB) shift was observed in bottlenose dolphins (*Tursiops truncatus*) when exposed to ten airgun pulses of increasing peak sound pressure levels, from 196– 210 dB re 1 µPa (Finneran et al. 2015).

Research on pinniped TTS responses to airguns are limited. Spotted (*Phoca largha*) and ringed seals (*Pusa hispida*) did not show evidence of TTS when exposed to single airgun pulses of between 165 and 181 dB re 1 μPa^2-second (Reichmuth et al. 2016). Bearded seals (*Erignathus barbatus*) showed TTS when exposed to four to ten consecutive airgun pulses of a cumulative SEL 191–195 dB re 1 μPa^2-second at 400 Hz, but not to single pulses at 185 dB re 1 μPa^2-second SEL and 207 dB re 1 μPa peak-to-peak sound pressure level (Sills et al. 2020).

Behavioral Responses

We expect the greatest response of marine mammals to airgun array sounds in terms of the number of responses and overall impact to be in the form of changes in behavior. ESA-listed individuals may briefly respond to underwater sound by slightly changing their behavior or relocating a short distance, in which case some of the responses can equate to harassment of individuals but are unlikely to result in meaningful behavioral responses at the population level. Displacement from important feeding or breeding areas over a prolonged period would likely be more significant for individuals and could affect the population depending on the extent of the feeding area and duration of displacement. This has been suggested for humpback whales along the Brazilian coast as a result of increased seismic survey activity (Parente et al. 2007). Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012; Harris et al. 2018); this is reflected in a variety of aquatic, aerial, and terrestrial animal responses to anthropogenic noise that may ultimately have fitness consequences (Costa et al. 2016; Fleishman et al. 2016; Francis and Barber 2013; New et al. 2014; NRC 2005). Although some studies are available that address responses of ESA-listed marine mammals considered in this consultation directly, additional studies on other related whales (such as bowhead, gray, and North Atlantic right whales) are relevant in determining the responses expected by species under consideration. Therefore, studies from non-ESA-listed or species outside the action area are also considered here.

Animals generally respond to anthropogenic perturbations as they would to predators, increasing vigilance, and altering habitat selection (Reep et al. 2011). There is increasing support that this predator like response is true for animals' response to anthropogenic sound (Harris et al. 2018). Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). Because of the similarities in hearing anatomy of terrestrial and marine mammals, we expect it is possible for ESA-listed marine mammals to behave in a similar manner as terrestrial mammals when they detect a sound stimulus. For additional information on the behavioral responses marine mammals exhibit in response to anthropogenic noise, including non-ESA-listed marine mammal species, see NSF's Draft Environmental Assessment of Marine Geophysical Surveys by R/V *Sally Ride* at the Cascadia Subduction Zone, northeast Pacific Ocean, September 2025 on NSF's Environmental Compliance webpage, under the subheading "Current environmental reviews" at https://www.nsf.gov/funding/environmental-compliance and the NMFS Permits and Conservation Division's *Federal Register* notice of the proposed IHA and request for public comment (90 Fed. Reg. 34212).

There are numerous studies on the responses of some baleen whale species to airgun arrays. Activity of individuals at the time of exposure to the sound appears to influence response

(Robertson et al. 2013), as feeding individuals respond less than mother and calf pairs and migrating individuals (Harris et al. 2007; Malme and Miles 1985; Malme et al. 1984b; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995a; Richardson et al. 1995b; Richardson et al. 1999). Migrating bowhead whales showed strong avoidance reactions to received levels of 120–130 dB re 1 μPa_{rms} at distances of 12.4–18.6 mi (20–30 km), and changed dive and respiratory patterns while feeding at received levels of 152–178 dB re 1 μPa (rms; Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995a; Richardson et al. 1995b; Richardson et al. 1999; Richardson et al. 1986a; Richardson et al. 1986b). Nations et al. (2009) also found that bowhead whales were displaced during migration in the Beaufort Sea during active seismic surveys. In fact, the available data indicate that most baleen whale species exhibit avoidance of active seismic airguns (Barkaszi et al. 2012; Castellote et al. 2012b; Castellote et al. 2012a; Gordon et al. 2003; NAS 2017; Potter et al. 2007; Southall et al. 2007a; Southall et al. 2007c; Stone et al. 2017; Stone and Tasker 2006).

Gray whales respond similarly to seismic surveys as described for bowhead whales. Gray whales discontinued feeding and/or moved away at received sound levels of 163 dB re 1 μPa_{rms} (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007a; Malme and Miles 1985; Malme et al. 1984b; Malme et al. 1987; Malme et al. 1986; Meier et al. 2007; Würsig et al. 1999; Yazvenko et al. 2007). Migrating gray whales changed their swimming patterns at approximately 160 dB re 1 μPa_{rms} and exhibited slight behavioral changes at 140–160 re 1 μPa_{rms} (Malme and Miles 1985; Malme et al. 1984a; Malme et al. 1984b). Johnson et al. (2007b) reported that gray whales exposed to airgun sounds during seismic surveys off Sakhalin Island, Russia, did not experience any biologically significant or population-level effects, based on subsequent research in the area from 2002 through 2005.

Humpback whales exhibit a pattern of lower threshold responses when not feeding. Migrating humpbacks altered their travel path (at least locally) along Western Australia at received levels as low as 140 dB re 1 μPa_{rms} when females with calves were present, or 4.3–7.5 mi (7–12 km) from the acoustic source (McCauley et al. 2000a; McCauley et al. 1998). A startle response occurred as low as 112 dB re 1 μPa_{rms}. Closest approaches were generally limited to 1.9–2.5 mi (3–4 km), although some individuals (mainly males) approached to within 0.06 mi (100 m) on occasion where sound levels were 179 dB re 1 μPa_{rms}. Changes in course and speed generally occurred at estimated received levels of 157–164 dB re 1 μPa_{rms}. Migrating humpback whales exhibited no abnormal behaviors in response to an active 3,130 in^3 (51,291.5 cm^3) airgun array (Dunlop et al. 2017). Some humpback whales reduced their speed and changed course along their migratory route within 2.5 mi (4 km) from the array at received level over 135 dB re $1\mu Pa^2$-second (Dunlop et al. 2017). Feeding humpback whales appear to be somewhat more tolerant. Humpback whales off the coast of Alaska startled at 150–169 dB re 1 μPa_{rms} and no clear evidence of avoidance was apparent at received levels up to 172 dB re 1 μPa_{rms} (Malme et al. 1984b; Malme et al. 1985). Potter et al. (2007) found that humpback whales on feeding grounds in the Atlantic Ocean exhibited localized avoidance to airgun arrays. Among humpback whales on Angolan breeding grounds, no clear difference was observed in encounter rate or point of closest approach during seismic versus non-seismic periods (Weir 2008a). Some fin and sei whale sighting data indicate similar sighting rates during seismic versus non-seismic periods, but sightings tended to be further away and individuals remained underwater longer during periods of seismic activity (Stone 2003; Stone et al. 2017; Stone and Tasker 2006). Other studies have also observed small differences in sighting rates (lower) and avoidance behavior during seismic survey activities (Moulton and Miller 2005).

Several studies have aided in assessing the various levels at which whales may modify or stop their calls in response to sounds from airguns. Whales may continue calling while seismic surveys are operating locally (Greene Jr et al. 1999; Jochens et al. 2006; Madsen et al. 2002b; McDonald et al. 1993; Mcdonald et al. 1995b; Nieukirk et al. 2004; Richardson et al. 1986a; Smultea et al. 2004; Tyack et al. 2003). However, humpback whale males increasingly stopped vocal displays on Angolan breeding grounds as received seismic airgun levels increased (Cerchio 2014). Some blue, fin, and sperm whales stopped calling for short and long periods, apparently in response to airguns (Bowles et al. 1994; Clark and Gagnon 2006; Mcdonald et al. 1995b). Fin whales, presumably adult males because the animals were singing (see Section 4.2), in the Mediterranean Sea moved out of the area of a seismic survey while airguns were operational, as well as for at least a week thereafter (Castellote et al. 2012a). The survey area affected was estimated to be about 38,610 mi^2 or 100,000 km^2 (Castellote et al. 2012b). Dunn and Hernandez (2009) tracked blue whales during a seismic survey on the R/V *Maurice Ewing* in 2007 and did not observe changes in call rates or any anomalous behavior that could be directly ascribed to the use of airguns at sound levels of approximately less than 145 dB re 1 μPa_{rms}. Blue whales may also attempt to compensate for elevated ambient sound by calling more frequently during seismic surveys (Iorio and Clark 2009). Bowhead whale calling rates were found to decrease during migration in the Beaufort Sea when seismic surveys were being conducted (Nations et al. 2009). Bowhead whale calling rates decreased when exposed to seismic airguns at estimated received levels of 116 to 129 dB re 1 μPa_{rms}, but did not change at received levels of 99 to 108 dB re 1 µPa (rms; Blackwell et al. 2013). A different study observed that bowhead whales began to increase call rates as soon as airgun sounds were detectable, but this increase leveled off at approximate 94 dB re 1 μPa^2-second over the course of ten minutes (Blackwell et al. 2015). Once sound levels exceeded approximately 127 dB re 1 μPa^2-second over ten minutes, call rates began to decline and at approximately 160 dB re 1 μPa^2-second over ten minutes, bowhead whales appeared ceased calling all together (Blackwell et al. 2015).

Sperm whales, at least under some conditions, may be particularly sensitive to airgun sounds, as they have been documented to cease calling in association with airguns being fired tens to hundreds of miles away (Bowles et al. 1994). Other studies have found no response by sperm whales to received airgun sound levels up to 146 dB re 1 µPa (peak-to-peak; Madsen et al. 2002a; McCall Howard 1999a; McCall Howard 1999b). However, some studies also found sperm whales in the Atlantic Ocean showed little or no response to seismic activity (Davis et al. 2000; Madsen et al. 2006; Miller et al. 2009; Moulton and Miller 2005; Stone 2003; Stone et al. 2017; Stone and Tasker 2006; Weir 2008a; Weir 2008b). A study of sperm whales in the Gulf of America (formerly Gulf of Mexico) suggested some alteration in foraging from less than 130–162 dB re 1 µPa peak-to-peak, and avoidance reactions by sperm whales in response to seismic ensonification (Jochens and Biggs 2004; Jochens 2003; Mate et al. 1994). Although other behavioral reactions were not noted by other studies (Gordon et al. 2006; Gordon et al. 2004; Jochens et al. 2006; Madsen et al. 2006; Winsor and Mate 2006). Miller et al. (2009) found sperm whales were not displaced from the area due to airgun exposure in the Gulf of America, although foraging behavior may have been affected based on changes in echolocation rate and slight changes in dive behavior. Responses of sperm whales to impulse noise likely varies depending on the activity/behavior at the time of exposure. For example, in the presence of abundant food or during breeding encounters, toothed whales sometimes are extremely tolerant of impulsive sound (NMFS 2010c).

Similar to other marine mammal species, behavioral responses of pinnipeds can range from a mild orienting response, or a shifting attention, to flight and panic. They may react in a number of ways depending on their experience with the sound source that what activity or behavior they are engaged in at the time of exposure. Monitoring work in the Alaskan Beaufort Sea during 1996 through 2001 provided considerable information regarding the behavior of Arctic ice seals exposed to seismic pulses (Harris et al. 2001; Moulton and Lawson 2002). These seismic survey projects usually involved airgun arrays of six to 16 airguns with total volumes of 560–1,500 in^3 (9,176.8–24,580.6 cm^3). The combined results suggest that some seals avoid the immediate area around seismic survey vessels. In most survey years, ringed seal (*Phoca hispida*) sightings tended to be farther away from the seismic survey vessel when the airgun arrays were operating than when they were not (Moulton and Lawson 2002). However, these avoidance movements were relatively small, approximately 328.1 ft (100 m) to a few hundred of meters, and many seals remained within 328.1–656.2 ft (100–200 m) of the trackline as the operating airgun array passed by the animals.

Guadalupe fur seals may not react at all until the sound source is approaching within a few hundred meters and then may alert, approach, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving (Finneran et al. 2003b; Götz and Janik 2011; Kvadsheim et al. 2010). Significant behavioral reactions would not be expected in most cases, and long-term consequences for individuals or the population are unlikely.

Physiological Stress

Individual whales exposed to airguns could experience effects that are not readily observable, such as stress (Romano et al. 2002), that may have adverse effects. Other possible responses to impulsive sound sources like airgun arrays include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007c; Tal et al. 2015; Zimmer and Tyack 2007), but similar to stress, these effects are not readily observable. Importantly, these more severe physical and physiological changes have generally been associated with explosives and/or mid-frequency tactical sonar, and not seismic airguns. Therefore, we do not expect ESA-listed marine mammals to experience these non-auditory injuries as a result of the proposed seismic survey activities.

The primary distinction between stress and distress is the cost of the response. Stress is an adaptive response and does not normally place an animal at risk. Distress involves a stress response resulting in a biological consequence to the individual. The mammalian stress response involves the hypothalamic-pituitary-adrenal axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Busch and Hayward 2009; Gregory and Schmid 2001; Gulland et al. 1999; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Thomson and Geraci 1986). These hormones subsequently can cause short-term weight loss, the release of glucose into the bloodstream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Busch and Hayward 2009; Cattet et al. 2003a; Cattet et al. 2003b; Costantini et al. 2011; Dickens et al. 2010; Dierauf and Gulland 2001; Elftman et al. 2007; Fonfara et al. 2007; Kaufman and Kaufman 1994; Mancia et al. 2008; Noda et al. 2007; Thomson and Geraci 1986). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer et al. 2005). In highly stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Cowan 2008; Herraez et al. 2007). The most widely recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the hypothalamic-pituitary-adrenal axis may persist for weeks (Dierauf and Gulland 2001). Stress levels can vary by age, sex, season, and health status (Gardiner and Hall 1997; Hunt et al. 2006; Keay et al. 2006; Romero et al. 2008; St. Aubin et al. 1996). For example, stress is lower in immature North Atlantic right whales than adults, and mammals with poor diets or undergoing dietary change tend to have higher cortisol levels (Hunt et al. 2006; Keay et al. 2006).

Loud sounds generally increase stress indicators in mammals (Kight and Swaddle 2011). Romano et al. (2004) found beluga whales and bottlenose dolphins exposed to a seismic watergun (up to 228 dB re 1 μPa at 1 m [peak-to-peak]) and single pure tones (up to 201 dB re 1 μPa) had increases in stress chemicals, including catecholamines, which could affect an individual's ability to fight off disease. During the period following September 11, 2001, shipping traffic and associated ocean noise decreased along the northeastern U.S. This decrease in ocean sound was associated with a significant decline in fecal stress hormones in North Atlantic right whales, providing evidence that chronic exposure to increased noise levels, although not acutely injurious, can produce stress (Rolland et al. 2012b; Rolland et al. 2012a). These levels returned to baseline after 24 hours of vessel traffic resuming.

Given exposure to airguns are expected to be temporary, we expect any stress responses to be short-term. Given the available data, animals will be expected to return to baseline state (e.g., baseline cortisol level) within hours to days, with the duration of the stress response depending on the severity of the exposure. Although we do not have a way to determine the health of the animal at the time of exposure, we assume that the stress responses resulting from these exposures could be more significant or exacerbate other factors if an animal is already in a compromised state.

It is possible that an animal's prior exposure to sounds from seismic surveys influences its future response. We have little information available to us as to what response individuals will have to future exposures to sources from seismic surveys compared to prior experience. If prior exposure produces a learned response, then this subsequent learned response will likely be similar to or less than prior responses to other stressors where the individual experienced a stress response associated with the novel stimuli and responded behaviorally as a consequence such as moving away and reduced time budget for activities otherwise undertaken (Andre 1997; André 1997; Gordon et al. 2006). Seismic survey activities can potentially lead to habituation, which may lead to additional energetic costs or reductions in foraging success (Nowacek et al. 2015).

Masking

Interference, or masking, occurs when a sound is of a similar frequency and similar amplitude to or louder than the sound an animal is trying to hear (Clark et al. 2009; Erbe et al. 2016). Masking can interfere with an individual's ability to gather information about its environment, such as predators, prey, conspecifics, and other environmental cues (Richardson 1995). This can result in loss of environmental cues of predatory risk, mating opportunity, or foraging options (Francis and Barber 2013). Low frequency sounds are broad and tend to have relatively constant bandwidth, whereas higher frequency bandwidths are narrower (NMFS 2006h).

As previously discussed, the operating frequencies of the airguns overlap with the assumed hearing range and vocalizations of ESA-listed marine mammals. Thus, the proposed low-energy seismic survey could mask baleen whale, sperm whale, and pinniped calls. Given the larger disparity between sperm whale and pinniped vocalizations and hearing ranges with the dominant frequencies of the airguns, masking is not likely to be significant for sperm whales and Guadalupe fur seals (NMFS 2006h). Overlap of the dominant low frequencies of airgun pulses with low frequency baleen whale calls will be expected to pose a somewhat greater risk of masking.

Nieukirk et al. (2012) analyzed ten years of recordings from the Mid-Atlantic Ridge. When several surveys were recorded simultaneously, whale sounds were masked (drowned out), and the airgun noise became the dominant source of background noise levels. In the cases of higher frequency hearing by the bottlenose dolphin (*Tursiops truncatus*), beluga whale (*Delphinapterus leucas*), and killer whale, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking sound (Bain and Dahlheim 1994; Bain et al. 1993; Bain 1993; Bain 1994; Dubrovskiy 2004). Toothed whales, and likely other marine mammals as well, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background sound (for example, see discussion on Behavioral Responses above). There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient sound toward frequencies with less noise (Au 1975; Au et al. 1974; Au 1974; Lesage 1999; Moore 1990; Romanenko and Kitain 1992; Romanenko 1992; Thomas 1990). A few marine mammal species increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Au 1993; Dahlheim 1987; Foote 2004; Holt et al. 2009; Holt 2009; Lesage 1999; Lesage 1993; Parks 2009a; Parks 2009b; Parks et al. 2007; Parks 2007; Terhune 1999).

Stranding

There is some concern regarding the coincidence of marine mammal strandings and proximal seismic surveys. No conclusive evidence exists to causally link stranding events to seismic surveys. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al. 2004) were not well founded (Iagc 2004; IWC 2007). In September 2002, two Cuvier's beaked whales (*Ziphius cavirostris*) stranded in the Gulf of California, Mexico: The R/V *Maurice Ewing* had been operating a 20 airgun array (8,490 in^3 or 139,126.2 cm^3) approximately 13.7 mi (22 km) offshore the general area at the time that stranding occurred. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence, as the individuals who happened upon the stranding were ill-equipped to perform an adequate necropsy (Taylor et al. 2004). Furthermore, the small numbers of animals involved and the lack of knowledge regarding the spatial and temporal correlation between the beaked whales and the sound source underlies the uncertainty regarding the linkage between sound sources from seismic surveys and beaked whale strandings (Cox et al. 2006).

Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Creel 2005; Fair and Becker 2000; Kerby et al. 2004; Moberg 2000; Romano et al. 2004). At present, the factors of airgun arrays from seismic surveys that may contribute to marine mammal strandings are unknown and we have no evidence to lead us to believe that aspects of the airgun array proposed for use will cause marine mammal strandings.

6.2.2 Marine Mammal Prey Responses

Seismic surveys may also have indirect, adverse effects on ESA-listed marine mammals by affecting their prey availability (including larval stages) through lethal or sub-lethal damage, stress responses, or alterations in their behavior or distribution. Such prey includes fishes, zooplankton, cephalopods, and other invertebrates such as crustaceans, molluscs, and jellyfish. Studies described herein provide extensive support for this, which is the basis for later discussion on implications for ESA-listed marine mammals. In a fairly exhaustive review, Carroll et al. (2017) summarized the available information on the impacts seismic surveys have on fishes and invertebrates. In many cases, species-specific information on the prey of ESA-listed marine mammals is not generally available. Until more specific information is available, we expect that prey (e.g., teleosts, zooplankton, cephalopods) of ESA-listed marine mammals considered in this consultation will react in manners similar to those fish and invertebrates described herein.

Like with marine mammals, it is possible that seismic surveys can cause physical and physiological responses, including direct mortality, in fishes and invertebrates. In fishes, such responses appear to be highly variable, and depend on the nature of the exposure to seismic survey activities, as well as the species in question. Current data indicate that possible physical and physiological responses include hearing threshold shifts, barotraumatic ruptures, stress responses, organ damage, and/or mortality. For invertebrates, research is more limited, but the available data suggest that exposure to seismic survey activities can result in anatomical damage and mortality in some cases. In crustaceans and bivalves, there are mixed results with some studies suggesting that seismic surveys do not result in meaningful physiological and/or physical effects, while others indicate such effects may be possible under certain circumstances. Furthermore, even within studies there are sometimes differing results depending on what aspect of physiology one examines (e.g., Fitzgibbon et al. 2017). In some cases, the discrepancies likely relate to differences in the contexts of the studies. For example, in a relatively uncontrolled field study Parry et al. (2002) did not find significant differences in mortality between oysters that were exposed to a full seismic airgun array and those that were not, but a study by Day et al.

(2017) in a more controlled setting did find significant differences in mortality between scallops exposed to a single airgun and a control group that received no exposure. However, the increased mortality documented by Day et al. (2017) was not significantly different from the expected natural mortality. All available data on echinoderms suggests they exhibit no physical or physiological response to exposure to seismic survey activities. Based on the available data, we assume that some fishes and invertebrates that serve as prey may experience physical and physiological effects, including mortality, but in most cases, such effects are only expected at relatively close distances to the sound source.

Research suggests that seismic airgun arrays may lead to a significant reduction in zooplankton, including copepods. McCauley et al. (2017) found that the use of a single airgun (approximately 150 in^3 [2,458.1 cm^3]) led to a decrease in zooplankton abundance by over 50% and a two- to three-fold increase in dead adult and larval zooplankton when compared to control scenarios. In addition, effects were observed 0.75 mi (1.2 km) away, which was the maximum distance to which sonar equipment used in the study was able to detect changes in abundance. McCauley et al. (2017) noted that for seismic survey activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale of the seismic activity must be large in comparison to the ecosystem in question. In particular, three-dimensional seismic surveys, which involve the use of multiple overlapping tracklines to extensively and intensively survey a particular area, are of concern (McCauley et al. 2017). This is in part because, in order for such activities to have a measurable effect, they need to outweigh the naturally fast turnover rate of zooplankton (McCauley et al. 2017).

However, Fields et al. (2019) has demonstrated different results through a series of control experiments using seismic shots from two airguns (260 in^3 or 4,260.6 cm^3) during 2009 and 2010 on *Calanus finmarchicus*. Their data show that seismic blasts have limited effects on the mortality or escape response of *C. finmarchicus* within 32.8 ft (10 m) of the seismic airguns, but there was no measurable impact at greater distances. The study also found significantly higher immediate mortality at distances greater than 16.4 ft (5 m) from the airgun and a higher cumulative mortality (seven days after exposure) at a distance somewhere between 32.8–65.6 ft (10–20 m) from the airgun, and observed changes in gene expression (Fields et al. 2019). Furthermore, Fields et al. (2019) demonstrated that shots from seismic airguns had no effect on the escape response of *C. finmarchicus*. They conclude that the effects of shots from seismic airguns are much less than reported by McCauley et al. (2017).

Some documented fish or invertebrate mortality resulting from exposure to airguns was limited to close-range exposure to high amplitudes (Bjarti 2002; D'Amelio 1999; Falk and Lawrence 1973; Hassel et al. 2003; Holliday et al. 1987; Kostyuchenko 1973; La Bella et al. 1996; McCauley et al. 2000a; McCauley et al. 2000b; McCauley et al. 2003; Popper et al. 2005; Santulli et al. 1999). Lethal effects, if any, were expected within a few meters of the airgun array (Buchanan et al. 2004; Dalen and Knutsen 1986). A common response by fishes to airgun sound is a startle or distributional response, where fish react momentarily by changing orientation or swimming speed, or change their vertical distribution in the water column (Davidsen et al. 2019; Fewtrell 2013a). During airgun studies in which the received sound levels were not reported, Fewtrell (2013a) reported that caged *Pelates* spp., pink snapper, and trevally (*Caranx ignobilis*) generally exhibited startle, displacement, and/or grouping responses upon exposure to airguns.

This effect generally persisted for several minutes, although subsequent exposures to the same individuals did not necessarily elicit a response (Fewtrell 2013a). Davidsen et al. (2019) performed controlled exposure experiments on Atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*) to test their response to airgun noise. Davidsen et al. (2019) noted that cod exhibited reduced heart rate (bradycardia) in response to the particle motion component of the sound from the airgun, indicative of an initial flight response, however, no behavioral startle response to the airgun was observed. Furthermore, both the Atlantic cod and saithe changed both swimming depth and horizontal position more frequently during active airgun activity (Davidsen et al. 2019).

There are also reports showing sub-lethal effects to some fish species from airguns. Several species at various life stages exposed to high-intensity sound sources (220 to 242 dB re 1 μPa) at close distances, caused injury (Booman et al. 1996; McCauley et al. 2003). Effects from TTS were not found in whitefish at received levels of approximately 175 dB re 1 μPa^2-second, but pike did show 10 to 15 dB of hearing loss with recovery within one day (Popper et al. 2005). Caged pink snapper (*Pelates* spp.) have experienced PTS when exposed over 600 times to received sound levels of 165 to 209 dB re 1 μPa peak-to-peak. Exposure to airguns at close range were found to produce balance issues in exposed fry (Dalen and Knutsen 1986). Exposure of monkfish (*Lophius* spp.) and capelin (*Mallotus villosus*) eggs at close range to airguns did not produce differences in mortality compared to control groups (Payne 2009). Salmonid swim bladders were reportedly damaged by received sound levels of approximately 230 dB re 1 μPa (Falk and Lawrence 1973).

Startle responses were observed in rockfish at received airgun levels of 200 dB re 1 μPa 0-to-peak and alarm responses at greater than 177 dB re 1 μPa 0-to-peak (Pearson et al. 1992). Fish also tightened schools and shifted their distribution downward. Normal position and behavior resumed 20 to 60 minutes after firing of the airgun ceased. A downward shift was also noted by Skalski et al. (1992) at received seismic sounds of 186 to 191 dB re 1 μPa 0-to-peak. Caged European sea bass (*Dichentrarchus labrax*) showed elevated stress levels when exposed to airguns, but levels returned to normal after three days (Skalski 1992). These fish also showed a startle response when the seismic survey vessel was as much as 1.6 mi (2.5 km) away; this response increased in severity as the vessel approached and sound levels increased, but returned to normal after about two hours following cessation of airgun activity.

Whiting (*Merlangius merlangus*) exhibited a downward distributional shift upon exposure to 178 dB re 1 μPa 0-to-peak sound from airguns, but habituated to the sound after one hour and returned to normal depth (sound environments of 185 to 192 dB re 1 μPa) despite continued airgun activity (Chapman and Hawkins 1969). Whiting may also flee from sounds from airguns (Dalen and Knutsen 1986). Hake (*Merluccius* spp.) may re-distribute downward (La Bella et al. 1996). Lesser sand eels (*Ammodytes tobianus*) exhibited initial startle responses and upward vertical movements before fleeing from the seismic survey area upon approach of a vessel with an active source (Hassel et al. 2003; Hassel et al. 2004).

McCauley et al. (2000; 2000a) found small fish show startle responses at lower levels than larger fish in a variety of fish species and generally observed responses at received sound levels of 156 to 161 dB re 1 μPa_{rms}, but responses tended to decrease over time suggesting habituation. As with previous studies, caged fish showed increases in swimming speeds and downward vertical shifts. Pollock (*Pollachius* spp.) did not respond to sounds from airguns received at 195 to 218 dB re 1 μPa 0-to-peak, but did exhibit continual startle responses and fled from the acoustic source when visible (Wardle et al. 2001). Blue whiting (*Micromesistius poutassou*) and mesopelagic fishes were found to re-distribute 65.6–164 ft (20–50 m) deeper in response to airgun ensonification and a shift away from the seismic survey area was also found (Slotte et al. 2004). Startle responses were infrequently observed from salmonids receiving 142 to 186 dB re 1 μPa peak-to-peak sound levels from an airgun (Thomsen 2002). Cod (*Gadus* spp.) and haddock (*Melanogrammus aeglefinus*) likely vacate seismic survey areas in response to airgun activity and estimated catchability decreased starting at received sound levels of 160 to 180 dB re 1 μPa 0-to-peak (Dalen and Knutsen 1986; Engås et al. 1996; Engås et al. 1993; Løkkeborg 1991; Løkkeborg and Soldal 1993; Turnpenny et al. 1994).

Squid are known to be important prey for sperm whales. Squid responses to operating airguns have also been studied, although to a lesser extent than fishes. In response to airgun exposure, squid exhibited both startle and avoidance responses at received sound levels of 174 dB re 1 μPa_{rms} by first ejecting ink and then moving rapidly away from the area (Fewtrell 2013b; McCauley et al. 2000a; McCauley et al. 2000b). The authors also noted some movement upward. During ramp-up, squid did not discharge ink, but alarm responses occurred when received sound levels reached 156 to 161 dB re 1 μPa_{rms}. Tenera Environmental (2011) reported that Norris and Mohl (1983, summarized in Mariyasu et al. 2004) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246– 252 dB after three to 11 minutes. Andre et al. (2011) exposed four cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to two hours of continuous sound from 50–400 Hz at 157 ±5 dB re 1 μPa. They reported lesions to the sensory hair cells of the statocysts of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound. The received sound pressure level was 157 ±5 dB re 1 μPa, with peak levels at 175 dB re 1 μPa. Guerra et al. (2004) suggested that giant squid mortalities were associated with seismic surveys based upon coincidence of carcasses with the seismic surveys in time and space, as well as pathological information from the carcasses. Another laboratory observed abnormalities in larval scallops after exposure to low frequency noise in tanks (de Soto et al. 2013).

6.3 Summary of Effects

In this section, we combine the exposure analysis and response analysis to produce estimates of the amount and extent of take anticipated because of the stressors caused by this action. This summary of the anticipated effects of the action considers all consequences caused by the action and its activities. The following subsections state the anticipated effects of the action for each species that will be adversely affected by the proposed action.

6.3.1 Blue Whale

We expect two blue whales to be exposed to underwater sound from the airguns within the 160 dB re 1 μPa ensonified area within the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect blue whales' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness, decrease in survivorship or reproduction, or have population-level effects.

6.3.2 Fin Whale

We expect two fin whales to be exposed to underwater sound from the airguns within the 160 dB re 1 μPa ensonified area within the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect fin whales' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness, decrease in survivorship or reproduction, or have population-level effects.

6.3.3 Humpback Whale – Central America DPS and Mexico DPS

We expect two humpback whales from either the Central America DPS or Mexico DPS to be exposed to underwater sound from the airguns within the 160 dB re 1 μPa ensonified area within the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect humpback whales' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness, decrease in survivorship or reproduction, or have population-level effects.

6.3.4 Sei Whale

We expect two sei whales to be exposed to underwater sound from the airguns within the 160 dB re 1 μPa ensonified area within the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect sei whales' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness, decrease in survivorship or reproduction, or have population-level effects.

6.3.5 Sperm Whale

We expect seven sperm whales to be exposed to underwater sound from the airguns within the 160 dB re 1 μPa ensonified area within the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect sperm whales' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness, decrease in survivorship or reproduction, or have population-level effects.

6.3.6 Guadalupe Fur Seal

We expect 18 Guadalupe fur seals to be exposed to underwater sound from the airguns within the 160 dB re 1 μPa ensonified area within the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect Guadalupe fur seals' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness, decrease in survivorship or reproduction, or have population-level effects.

7. Cumulative Effects

Cumulative effects are defined in regulations as "those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation" (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7(a)(2) of the ESA.

We assessed the action area of this consultation for any non-Federal activities that are reasonably certain to occur. The past and ongoing impact of existing actions was described in the environmental baseline (Section 5). During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than the activities described in the environmental baseline.

An increase in non-Federal activities described in the environmental baseline (Section 5) could increase their effect on ESA-listed resources, and, for some, a future increase is considered reasonably certain to occur. Given current trends in global population growth, threats associated with changing environmental trends, sound, fisheries, vessel interactions, debris, and pollution are likely to continue to increase in the future, although any increase in effects may be somewhat countered by an increase in conservation and management, should these occur.

8. Integration and Synthesis

This opinion includes a jeopardy analysis for the ESA-listed threatened and endangered species that are likely to be adversely affected by the action. Section 7(a)(2) of the ESA and its implementing regulations require every federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The jeopardy analysis, therefore, relies upon the regulatory definitions of *jeopardize the continued existence of* and *destruction or adverse modification*.

Jeopardize the continued existence of 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). *Recovery*, used in that definition, means "improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act" (50 CFR §402.02).

The Integration and Synthesis is the final step in our jeopardy analyses. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7), taking into account the status of the species (Section 4), to formulate the agency's biological opinion as to whether the action agency can insure its proposed action is not likely to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution.

8.1 Jeopardy Analysis

The jeopardy analysis assesses the proposed action's effects on ESA-listed blue whale, fin whale, Central America DPS and Mexico DPS humpback whale, sei whale, sperm whale, and Guadalupe fur seal survival and recovery. The following sections summarize the relevant information in this opinion for each individual species considered.

8.1.1 Blue Whale

The blue whale is endangered because of past commercial whaling. While commercial whaling no longer occurs, current threats such as vessel strikes, entanglement in fishing gear, pollution, and changing environmental patterns still threaten the blue whale. While there are no abundance estimates for the entire population, estimated regional population abundances are as follows: 1,898 individuals (N_{min}=1,767 individuals) in the Eastern North Pacific Ocean stock (Calambokidis and Barlow 2020), 137 individuals (95% CI=23–796 individuals) in the Central North Pacific Ocean stock (Bradford et al. 2021), 402 individuals in the Western North Atlantic Ocean stock (Ramp and Sears 2013), 2,280 individuals in 1997/1998 (95% CI=1,160–4,500 individuals) and a population growth rate of 8.2% per year (95% CI=1.6–14.8) in the Southern Hemisphere (Branch 2008), and 303 individuals (95% CI=176–625 individuals) in the Chilean blue whale population (Williams et al. 2011). The best population estimate is 1,898 individuals (lower and upper 20th percentile values of 1,767 to 2,038 individuals) in the eastern North Pacific Ocean (Calambokidis and Barlow 2020).

Blue whales will experience TTS or behavioral and physiological stress responses in the action area from underwater sound from the airguns. We anticipate two instances of TTS or behavioral and physiological stress is reasonably certain to occur over the proposed survey.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, two TTS or behavioral and physiological stress exposures will not have measurable impacts to the population to which that individual belongs, and the effects of the stressors resulting from the airguns as part of the proposed action will not affect the survival of blue whales in the wild.

The 2020 recovery plan for the blue whale identified the major actions needed to recover this species (NMFS 2020). There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that seismic surveys (as it relates to oil and gas exploration and development) can affect blue whales and cause negative impacts including, but not limited to, injury. While we anticipate blue whales will be harassed by underwater sound from airguns, this will not impede the potential for recovery of blue whales. Therefore, the effects of the stressors resulting from the airguns as part of the proposed action will not appreciably diminish the ability of blue whales to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of blue whales in the wild.

8.1.2 Fin Whale

The fin whale is endangered because of past commercial whaling. While commercial whaling no longer occurs, current threats such as vessel strikes, entanglement in fishing gear, pollution, and changing environmental patterns still threaten the fin whale. While there are no abundance estimates for the entire population, estimated regional population abundances are as follows: 5,445 (95% CI=2,000–14,500) individuals south of 60°S (Leaper and Miller 2011), 6,802 individuals (N_{min}=5,573 individuals) in the Western North Atlantic stock (Hayes et al. 2024), 3,168 individuals (N_{min}=2,554 individuals) and an annual growth rate of 4.8% (95% CI=4.1–5.4%) in the Northeast Pacific stock (Rone et al. 2017; Zerbini et al. 2006), 203 individuals (N_{min}=101 individuals) in the Hawaii stock (Bradford et al. 2021), and 11,065 individuals (N_{min}=7,970 individuals) and a population growth rate of 7.5% between 1991 and 2014 for the California/Oregon/Washington stock (Becker et al. 2020; Nadeem et al. 2016).

Fin whales will experience TTS or behavioral and physiological stress responses in the action area from underwater sound from the airguns. We anticipate two instances of TTS or behavioral and physiological stress is reasonably certain to occur over the proposed survey.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, two TTS or behavioral and physiological stress exposures will not have measurable impacts to the population to which that individual belongs, and the effects of the stressors resulting from the airguns as part of the proposed action will not affect the survival of fin whales in the wild.

The 2010 recovery plan for the fin whale identified the major actions needed to recover this species (NMFS 2010a). There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that seismic surveys (as it relates to oil and gas exploration and development) can affect fin whales and cause negative impacts including, but not limited to, injury. While we anticipate fin whales will be harassed by underwater sound from airguns, this will not impede the potential for recovery of fin whales. Therefore, the effects of the stressors resulting from the airguns as part of the proposed action will not appreciably diminish the ability of fin whales to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of fin whales in the wild.

8.1.3 Humpback Whale – Central America DPS and Mexico DPS

The Central America DPS humpback whale is endangered, and Mexico DPS humpback whale is threatened, because of past commercial whaling. While commercial whaling no longer occurs, current threats such as vessel strikes, entanglement in fishing gear, pollution, and changing environmental patterns still threaten both DPSs of humpback whale. Curtis et al. (2022) estimated the abundance of the Central America DPS to be 1,496 (CV=0.171) whales with an estimated annual growth rate of 1.6% (SD=2.0%). While no abundance estimate currently exists for the Mexico DPS, an estimated 3,477 (CV=0.101) whales from the Mexico DPS feed off the U.S. West Coast (Calambokidis and Barlow 2020; Curtis et al. 2022). While the current trend is unknown, Calambokidis and Barlow (2020) reported an approximate 8.2% annual growth rate from 1989–2018 for humpback whales off California and Oregon waters, where whales from the Mexico and Central America DPSs overlap.

Humpback whales from either DPS will experience TTS or behavioral and physiological stress responses in the action area from underwater sound from the airguns. We anticipate two instances of TTS or behavioral and physiological stress is reasonably certain to occur over the proposed survey.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, two TTS or behavioral and physiological stress exposures will not have measurable impacts to the population to which that individual belongs, and the effects of the stressors resulting from the airguns as part of the proposed action will not affect the survival of the Central America DPS or Mexico DPS humpback whale in the wild.

The 2022 recovery outline for Central America DPS, Mexico DPS, and Western North Pacific DPS of humpback whales identified the major actions needed to recover this species (NMFS 2022). There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that chronic exposure to anthropogenic sound may affect humpback whales. While we anticipate humpback whales will be harassed by underwater sound from airguns, this will not impede the potential for recovery of the Central America DPS or Mexico DPS of humpback whale. Therefore, the effects of the stressors resulting from the airguns as part of the proposed action will not appreciably diminish the ability of the Central America DPS or Mexico DPS of humpback whale to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of the Central America DPS or Mexico DPS of humpback whale in the wild.

8.1.4 Sei Whale

The sei whale is endangered because of past commercial whaling. While commercial whaling no longer occurs, current threats such as vessel strikes, entanglement in fishing gear, pollution, and changing environmental patterns still threaten the sei whale. While there are no abundance estimates for the entire population, estimated regional population abundances are as follows: 29,632 individuals (95% CI=18,576–47,267 individuals) in the central and eastern North Pacific Ocean population between 2010 and 2012 (Hakamada et al. 2017), 6,292 individuals (N_{min}=3,098 individuals) in the Nova Scotia stock, 401 individuals (CV=0.84) in the Hawaii stock (Bradford et al. 2021), and 864 individuals (N_{min}=625 individuals) in the Eastern North Pacific stock (Barlow 2016).

Sei whales will experience TTS or behavioral and physiological stress responses in the action area from underwater sound from the airguns. We anticipate two instances of TTS or behavioral and physiological stress is reasonably certain to occur over the proposed survey.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, two TTS or behavioral and physiological stress exposures will not have measurable impacts to the population to which that individual belongs, and the effects of the stressors resulting from the airguns as part of the proposed action will not affect the survival of sei whales in the wild.

The 2011 recovery plan for the sei whale identified the major actions needed to recover this species (NMFS 2011). There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that seismic surveys (as it relates to oil and gas exploration and development) and anthropogenic noise can affect sei whales and cause negative impacts including, but not limited to, injury. While we anticipate sei whales will be harassed by underwater sound from airguns, this will not impede the potential for recovery of sei whales. Therefore, the effects of the stressors resulting from the airguns as part of the proposed action will not appreciably diminish the ability of sei whales to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of sei whales in the wild.

8.1.5 Sperm Whale

The sperm whale is endangered because of past commercial whaling. While commercial whaling no longer occurs, current threats such as vessel strikes, entanglement in fishing gear, pollution, and changing environmental patterns still threaten the sperm whale. While there are no abundance estimates for the entire population, estimated regional population abundances are as follows: 1,180 individuals (CV =0.22; N_{min}=983 individuals) in the Northern Gulf of Mexico stock (Garrison et al. 2020), 5,895 individuals (CV=0.29; N_{min}=4,639 individuals) in the North Atlantic stock (Dias et al. 2022), 2,606 individuals (CV=0.135; N_{min}=2,011 individuals) in the California/Oregon/Washington stock (Becker et al. 2020), 5,707 individuals (CV=0.23; N_{min}=4,486 individuals in the Hawaii stock (Becker et al. 2022), and a minimum of 244 individuals in the North Pacific stock (Rone et al. 2017).

Sperm whales will experience TTS or behavioral and physiological stress responses in the action area from underwater sound from the airguns. We anticipate seven instances of TTS or behavioral and physiological stress is reasonably certain to occur over the proposed survey.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, seven TTS or behavioral and physiological stress exposures will not have measurable impacts to the population to which that individual belongs, and the effects of the stressors resulting from the airguns as part of the proposed action will not affect the survival of sperm whales in the wild.

The 2010 recovery plan for the sperm whale identified the major actions needed to recover this species (NMFS 2010b). There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that seismic surveys (as it relates to oil and gas exploration and development) and anthropogenic noise can affect sperm whales and cause negative impacts, including, but not limited to, injury. While we anticipate sperm whales will be harassed by underwater sound from airguns, this will not impede the potential for recovery of sperm whales. Therefore, the effects of the stressors resulting from the airguns as part of the proposed action will not appreciably diminish the ability of sperm whales to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of sperm whales in the wild.

8.1.6 Guadalupe Fur Seal

The Guadalupe fur seal is threatened because of past commercial sealing. While commercial sealing no longer occurs, current threats such as entanglement in fishing gear, pollution, and changing environmental patterns still threaten the Guadalupe fur seal. The best estimate of population abundance for Guadalupe fur seals is 63,850 individuals (range 57,199–72,631 individuals; Juárez-Ruiz et al. 2022; DON 2019). Juárez-Ruiz et al. (2022) estimated an annual growth rate of 8.4% (range: 8–8.8%) from 1991 to 2019.

Guadalupe fur seals will experience TTS or behavioral and physiological stress responses in the action area from underwater sound from the airguns. We anticipate 18 instances of TTS or behavioral and physiological stress is reasonably certain to occur over the proposed survey.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, 18 TTS or behavioral and physiological stress exposures will not have measurable impacts to the population to which that individual belongs, and the effects of the stressors resulting from the airguns as part of the proposed action will not affect the survival of Guadalupe fur seals in the wild.

A recovery plan has not been prepared for the Guadalupe fur seal. While we anticipate Guadalupe fur seals will be harassed by underwater sound from airguns, this will not impede the potential for recovery of Guadalupe fur seals. Therefore, the effects of the stressors resulting from the airguns as part of the proposed action will not appreciably diminish the ability of Guadalupe fur seals to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of Guadalupe fur seals in the wild.

9. CONCLUSION

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the consequences of the proposed action and associated activities, and the cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the blue whale, fin whale, Central America DPS humpback whale, Mexico DPS humpback whale, sei whale, sperm whale, or Guadalupe fur seal.

NMFS also determined the proposed action may affect, but is not likely to adversely affect the Western North Pacific DPS of gray whale, Southern Resident DPS of killer whale, North Pacific right whale, East Pacific DPS of green turtle, leatherback turtle, North Pacific Ocean DPS of loggerhead turtle, Mexico's Pacific Coast breeding colonies of olive ridley turtle, California coastal, Central Valley spring-run, Lower Columbia River, Puget Sound, Sacramento River winter-run, Snake River, Snake River spring/summer run, Upper Columbia River spring-run, and Upper Willamette River ESUs of chinook salmon, Columbia River and Hood Canal summer-run ESUs of chum salmon, Central California coast, Lower Columbia River, Oregon coast, and Southern Oregon and Northern California coasts ESUs of coho salmon, Southern DPS of eulachon, Southern DPS of green sturgeon, Ozette Lake and Snake River ESUs of sockeye salmon, California Central Valley, Central California coast, Lower Columbia River, Middle Columbia River, Northern California, Puget Sound, Snake River Basin, South-Central California coast, Southern California, Upper Columbia River, and Upper Willamette River DPSs of steelhead trout, and sunflower sea star and designated critical habitats of the Southern Resident DPS killer whale, Central America DPS humpback whale, Mexico DPS humpback whale, leatherback turtle, Oregon Coast ESU coho salmon, and Southern DPS green sturgeon.

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a 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. NMFS defines the term "harass" in Policy Directive 02-110-19 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. "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR §402.02). Section 7(b)(4) and section 7(o)(2) of the ESA, as well as in regulation at 50 CFR §402.14(i)(5) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

When an action is reasonably certain to result in incidental take of ESA-listed marine mammals, section 7(b)(4) of the ESA requires that such taking be authorized under section 101(a)(5) of the MMPA in order for the Secretary to issue an ITS for ESA-listed marine mammals and that the ITS specify the measures identified as necessary to comply with section 101(a)(5) of the MMPA. As part of the proposed action, the NMFS Permits and Conservation Division proposes to issue an IHA. Accordingly, the terms of this ITS and the exemption from Section 9 of the ESA become effective only upon the issuance of the 101(a)(5) authorization. The marine mammal portion of this ITS is a preliminary statement. It will become final and effective upon the issuance of the authorization under section 101(a)(5) of the MMPA and NMFS's written confirmation to the Federal agency, for the duration of the authorization and with relevant revisions per the final authorization.

10.1 Amount or Extent of Take

Section 7(b)(4) and its implementing regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 CFR §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take specifies the impact, i.e., the amount or extent of such incidental taking on the species, which may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (see 80 Fed. Reg. 26832).

If the amount or location of tracklines during the seismic survey changes, or the number of seismic survey days is increased, then incidental take for marine mammals may be exceeded. As such, if more tracklines are conducted during the seismic survey, an increase in the number of days beyond the 25% contingency, greater estimates of sound propagation, and/or increases in airgun array source levels occur, reinitiation of consultation will be necessary.

We anticipate the low-energy seismic survey in the North Pacific Ocean off Oregon and Washington is likely to result in the incidental take of ESA-listed marine mammals by harassment. TTS and/or significant behavioral response is expected to occur at received levels at or above 160 dB re 1 μPa_{rms} for airgun array operations for ESA-listed marine mammals. In the opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Table 8. Anticipated number and type of ESA takes of marine mammals due to the proposed action

Species	Harassment: TTS / Significant Behavioral Response
Blue Whale	2
Fin Whale	2
Humpback Whale – Central America DPS or Mexico DPS	2
Sei Whale	2
Sperm Whale	7
Guadalupe Fur Seal	18

10.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of incidental take on the species (50 CFR §402.02). These measures "cannot alter the basic design, location, scope, duration, or timing of the action and may involve only minor changes" (50 CFR §402.14(i)(2)). NMFS believes the following reasonable and prudent measures are necessary and appropriate:

1. The NMFS Permits and Conservation Division must ensure that the NSF implements a program to mitigate and report the potential effects of seismic survey activities as well as the effectiveness of mitigation measures incorporated as part of the proposed IHA for the incidental taking of blue whales, fin whales, humpback whales (Central America DPS and Mexico DPS), sei whales, sperm whales, and Guadalupe fur seals pursuant to section 101(a)(5)(D) of the MMPA. In addition, the NMFS Permits and Conservation Division must ensure that the provisions of the IHA are carried out, and inform the NMFS ESA Interagency Cooperation Division if take is exceeded.
2. The NSF must implement a program to mitigate and report the potential effects of seismic survey activities as well as the effectiveness of conservation measures for endangered and threatened marine mammals.

10.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the NMFS Permits and Conservation Division and NSF must comply with the following (or must ensure that any applicant complies) with the following terms and conditions. The NMFS Permits and Conservation Division, NSF, or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR §402.14(i)(3)).

The following terms and conditions implement the above reasonable and prudent measures:

1. A copy of the draft comprehensive report on all seismic survey activities and monitoring results must be provided to the NMFS ESA Interagency Cooperation Division within 90 days of the completion of the seismic survey, or expiration of the IHA, whichever occurs first. Send the report to nmfs.hq.esa.consultations@noaa.gov, with the subject line, "OPR-2025-01094 NSF Cascadia 2025 Seismic Survey Draft Report."
2. Any reports of injured or dead ESA-listed species must be provided by the NMFS Permits and Conservation Division or NSF to the NMFS ESA Interagency Cooperation Division within 24 hours to Tanya Dobrzynski, Chief, ESA Interagency Cooperation Division by email at Tanya.Dobrzynski@noaa.gov and nmfs.hq.esa.consultations@noaa.gov, with the subject line, "OPR-2025-01094 NSF Cascadia 2025 Seismic Survey: Dead/Injured ESA-listed Species Report."

11. Conservation Recommendations

Conservation recommendations are "suggestions … regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information" (50 CFR §402.02).

The following conservation recommendations should be considered by the NMFS Permits and Conservation Division and NSF to minimize or avoid effects to threatened and endangered species associated with this action:

1. We recommend that the NSF promote and fund research examining the potential effects of seismic surveys on prey species for ESA-listed marine mammals and sea turtles.
2. We recommend that the NSF develop a more robust propagation model that incorporates environmental variables into estimates of how far sound levels reach from airgun arrays.
3. We recommend that the NSF conduct a sound source verification in the study area (and future locations) to validate predicted and modeled isopleth distances to NMFS acoustic thresholds and incorporate the results of that study into buffer and exclusion/shutdown zones prior to starting seismic survey activities.
4. We recommend the NSF use (and NMFS Permits and Conservation Division require in MMPA incidental take authorizations) thermal imaging cameras, in addition to binoculars (Big-Eye and handheld) and the naked eye, for use during daytime and nighttime visual observations and test their effectiveness at detecting ESA-listed species.
5. We recommend the NSF and NMFS Permits and Conservation Division work to make the data collected as part of the required monitoring and reporting available to the public and scientific community in an easily accessible online database that can be queried to aggregate data across PSO reports. Access to such data, which may include sightings as well as responses to seismic survey activities, will not only help us understand the biology of ESA-listed species (e.g., their range), it will inform future consultations and incidental take authorizations/permits by providing information on the effectiveness of the conservation measures and the impact of seismic survey activities on ESA-listed species.

6. We recommend the NSF use real-time cetacean sighting services such as the WhaleAlert application (http://www.whalealert.org/). We recognize that the research vessel may not have reliable internet access during operations offshore, but nearshore, where many of the cetaceans considered in this opinion are likely found in greater numbers, we anticipate internet access may be better. Monitoring such systems will help plan seismic survey activities and transits to avoid locations with recent ESA-listed cetacean sightings, and may also be valuable during other activities to alert others of ESA-listed cetaceans within the area, which they can then avoid.
7. We recommend the NSF submit their monitoring data (i.e., visual sightings) by PSOs to the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations online database so that it can be added to the aggregate marine mammal, seabird, sea turtle, and fish observation data from around the world.
8. We recommend the vessel operator and other relevant vessel personnel (e.g., crewmembers) on the R/V *Sally Ride* take the U.S. Navy's marine species awareness training available online at: https://www.youtube.com/watch?v=KKo3r1yVBBA in order to detect ESA-listed species and relay information to PSOs.

In order for NMFS Office of Protected Resources Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on ESA-listed species or their critical habitat, the NSF and NMFS Permits and Conservation Division should notify the ESA Interagency Cooperation Division of any conservation recommendations implemented in the final action. Notice can be provided to nmfs.hq.esa.consultations@noaa.gov with the Environmental Consultation Organizer (ECO) number for this consultation (OPR-2025-01094) in the subject line.

12. REINITIATION OF CONSULTATION

This concludes formal consultation on NSF and NMFS Permits and Conservation Division's proposed actions. Consistent with 50 CFR §402.16(a), reinitiation of consultation is required and shall be requested by the Federal agency, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

1. If the amount or extent of incidental taking specified in the ITS is exceeded;
2. If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
3. If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the opinion; or
4. If a new species is listed or critical habitat designated that may be affected by the identified action.

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APPENDIX G: INCIDENTAL HARASSMENT AUTHORIZATION

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

INCIDENTAL HARASSMENT AUTHORIZATION

The Scripps Institution of Oceanography (SIO) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to incidentally harass marine mammals, under the following conditions:

1. This incidental harassment authorization (IHA) is effective from September 2, 2025 through September 1, 2026.

2. This IHA is valid only for geophysical survey activity off Oregon and Washington in the Cascadia Subduction Zone of the Northeast Pacific Ocean, as specified in SIO's IHA application.

3. General Conditions

   (a) A copy of this IHA must be in the possession of SIO, the vessel operator, the lead protected species observer (PSO), and any other relevant designees of SIO operating under the authority of this IHA.

   (b) The species and/or stocks authorized for taking are listed in Table 1. Authorized take, by Level B harassment only, is limited to the species and/or stocks and numbers listed in Table 1.

   (c) The taking by Level A harassment, serious injury or death of any of the species listed in Table 1 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized numbers listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.

   (d) During use of the acoustic source, if any marine mammal species or stock not listed in Table 1 appear within or enter the Level B harassment zone (Table 2) the acoustic source must be shut down.

   (e) SIO must ensure that relevant vessel personnel and the PSO team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocols, operational procedures, and IHA requirements are clearly understood.

4. Mitigation Requirements

a. SIO must use independent, dedicated, trained visual PSOs, meaning that the PSOs must be employed by a third-party observer provider, must not have tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course.

b. At least one visual PSO must have a minimum of 90 days at-sea experience working in those roles, respectively, during a shallow penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience.

c. Visual Observation

i. During survey operations (e.g., any day on which use of the airgun array is planned to occur and whenever the airgun array is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during ramp-up of the airgun array.

ii. Visual monitoring of the exclusion and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the airgun array ceases or until 30 minutes past sunset.

iii. Visual PSOs must coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and must conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

iv. During good conditions (e.g., daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs must conduct observations when the airgun array is not operating for comparison of sighting rates and behavior with and without use of the airgun array and between acquisition periods, to the maximum extent practicable.

v. Visual PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period.

d. Shutdown zones and buffer zones

i. Except as provided in 4(d)(ii), the PSOs must establish and monitor a 100-m shutdown zone and additional 100-m buffer zone (total 200 m). The 200-m zone must serve to focus observational effort but not limit such effort; observations of marine mammals beyond this distance shall also be recorded as described in 5(c) below and/or trigger shutdown as described in 4(f) (iii) below, as appropriate. The shutdown zone encompasses the area at and below the sea surface out to a radius of 100 m from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself) (0–100 m). The buffer zone encompasses the area at and below the sea surface from the edge of the shutdown zone, out to a radius of 200 meters from the edges of the airgun array (100–200 m). During use of the airgun array, occurrence of marine mammals within the buffer zone (but outside the shutdown zone) must be communicated to the operator to prepare for the potential shutdown of the airgun array. PSOs must monitor the shutdown zone and buffer zone for a minimum of 30 minutes prior to ramp-up (i.e., pre-start clearance).

ii. An extended 500 m shutdown zone must be established for all beaked whales, a large whale with a calf, and groups of six or more large whales. No buffer zone is required.

e. Pre-start clearance and Ramp-up

i. A ramp-up procedure must be followed at all times as part of the activation of the airgun array, except as described under 4(e)(viii).

ii. The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO. The notification time should not be less than 60 minutes prior to the planned ramp-up in order to allow the PSOs time to monitor the shutdown and buffer zone for 30 minutes prior to the initiation of ramp-up.

iii. Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in.

iv. One of the PSOs conducting the pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSOs to proceed.

v. Ramp-up must not be initiated if any marine mammal is within the shutdown or buffer zone. If a marine mammal is observed within the shutdown zone or the buffer zone during the 30 minute pre-start clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zone or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and pinnipeds, and 30 minutes for mysticetes and all other odontocetes).

vi. Ramp-up must begin by activating one GI airgun followed by the second, with each stage lasting no less than 5 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed.

vii. PSOs must monitor the shutdown and buffer zones during ramp-up, and ramp-up must cease and the source must be shut down upon visual observation of a marine mammal within the shutdown zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown, but such observation must be communicated to the operator to prepare for the potential shutdown.

viii. If the airgun array is shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described for shutdown (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant observation and no detections of marine mammals have occurred within the applicable shutdown zone. For any longer shutdown, pre-start clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (e.g., BSS 4 or greater), ramp-up is required.

ix. Testing of the airgun array involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-start clearance watch.

f. Shutdown requirements

i. Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the airgun array.

ii. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the airgun array to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch.

iii. When the airgun array is active (i.e., anytime one or more airguns is active, including during ramp-up) and a marine mammal (excluding delphinids of the species described in 4(f)(iv)) appears within or enters the shutdown zone, the airgun array must be shut down. When shutdown is called for by a PSO, the airgun array must be immediately deactivated. Any dispute regarding a PSO shutdown must be resolved after deactivation.

iv. The shutdown requirement described in 4(f)(iii) shall be waived for small dolphins of the following genera: *Lagenorhynchus, Lissodelphis,* and *Delphinus.*

1. If a dolphin of these genera is visually detected within the shutdown zone, no shutdown is required unless the PSO confirms the individual to be of a genus other than those listed above, in which case a shutdown is required.

2. If there is uncertainty regarding identification, visual PSOs may use best professional judgement in making the decision to call for a shutdown.

v. Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable shutdown zone (*i.e.*, animal is not required to fully exit the buffer zone where applicable) or following a clearance period (15 minutes for small odontocetes and pinnipeds, and 30 minutes for mysticetes and all other odontocetes) with no further observation of the marine mammal(s).

vi. Shutdown of the array is required upon observation of a species for which authorization has not been granted or a species for which authorization has been granted but the authorized number of takes has been met, approaching or observed within the harassment zone (Table 2).

g. Vessel strike avoidance

i. Vessel operators and crew must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammals. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (separation distances stated below). Visual observers monitoring the vessel strike avoidance zone may be third-party observers (i.e., PSOs) or crew members, but crew members responsible for these duties must be provided sufficient training to 1) distinguish marine mammals from other phenomena and 2) broadly to identify a marine mammal to taxonomic group (i.e., as a large whale, or other marine mammal).

ii. Vessel speeds must be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

iii. The vessel must maintain a minimum separation distance of 100 m from sperm whales and all baleen whales.

iv. The vessel must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an understanding that at times this may not be possible (e.g., for animals that approach the vessel).

v. When marine mammals are sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

5. Monitoring Requirements

a. The operator must work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals. Such equipment, at a minimum, must include:

i. Reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups).

ii. Global Positioning Unit (GPS) (plus backup).

iii. Digital single-lens reflex cameras of appropriate quality that capture photographs and video (plus backup).

iv. Compass (plus backup)

v. Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups).

vi. Any other tools necessary to adequately perform necessary PSO tasks.

b. Protected Species Observers Qualifications

i. PSOs must have successfully completed an acceptable PSO training course.

ii. NMFS must review and approve PSO resumes.

iii. One visual PSO with experience as shown in 4(b) shall be designated as the lead for the PSO team. The lead must coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. (Note that the responsibility of coordinating duty schedules and roles may instead be assigned to a shore-based, third-party monitoring coordinator.) To the maximum extent practicable, the lead PSO must devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

iv. PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

v. PSOs must have successfully attained a bachelor's degree with a major in one of the natural sciences.

vi. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must be submitted to NMFS and must include written justification. Requests must be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

c. Data Collection

i. PSOs must use standardized electronic data collection forms. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of animals to the airgun array and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the airgun array. If required mitigation was not implemented, PSOs should record a description of the circumstances.

ii. At a minimum, the following information must be recorded:

1. Vessel name, vessel size and type, maximum speed capability of vessel;
2. Dates (MM/DD/YYYY) of departures and returns to port with port name;
3. PSO names and affiliations, PSO ID (initials or other identifier);
4. Date (MM/DD/YYYY) and participants of PSO briefings (as discussed in General Requirement);
5. Visual monitoring equipment used (description);
6. PSO location on vessel and height (meters) of observation location above water surface;
7. Watch status (description);
8. Dates (MM/DD/YYYY) and times (Greenwich Mean Time/UTC) of survey on/off effort and times (GMC/UTC) corresponding with PSO on/off effort;
9. Vessel location (decimal degrees) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
10. Vessel location (decimal degrees) at 30-second intervals if obtainable from data collection software, otherwise at a practical regular interval;
11. Vessel heading (compass heading) and speed (knots) at beginning and end of visual PSO duty shifts and upon any change;
12. Water depths (meters) (if obtainable from data collection software);
13. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
14. Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (description) (e.g., vessel traffic, equipment malfunctions); and

15. Vessel/survey activity information (and changes thereof) (description), such as airgun array power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).

iii. Upon visual observation of any marine mammals, the following information must be recorded:

1. Sighting ID (numeric);

2. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);

3. Location of PSO/observer (description);

4. Vessel activity at the time of the sighting (*e.g.*, deploying, recovering, testing, shooting, data acquisition, other);

5. PSO who sighted the animal/ID;

6. Time/date of sighting (GMT/UTC, MM/DD/YYYY);

7. Initial detection method (description);

8. Sighting cue (description);

9. Vessel location at time of sighting (decimal degrees);

10. Water depth (meters);

11. Direction of vessel's travel (compass direction);

12. Speed (knots) of the vessel from which the observation was made;

13. Direction of animal's travel relative to the vessel (description, compass heading);

14. Bearing to sighting (degrees);

15. Identification of the animal (*e.g.*, genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;

16. Species reliability (an indicator of confidence in identification) (1=unsure/possible, 2=probable, 3=definite/sure, 9=unknown/not recorded);

17. Estimated distance to the animal (meters) and method of estimating distance;

18. Estimated number of animals (high/low/best) (numeric);

19. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);

20. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);

21. Detailed behavior observations (*e.g.*, number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);

22. Animal's closest point of approach (CPA) (meters) and/or closest distance from any element of the airgun array;

23. Description of any actions implemented in response to the sighting (*e.g.*, delays, shutdown, ramp-up) and time and location of the action.

24. Photos (Yes/No);

25. Photo Frame Numbers (list of numbers); and

26. Conditions at a time of sighting (*e.g.*. visibility, BSS)

6. Reporting

(a) SIO must submit a draft comprehensive report to NMFS (PR.ITP.MonitoringReports@noaa.gov and ITP.Fleming@noaa.gov) on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. A final report must be submitted within 30 days following resolution of any comments on the draft report. If no comments are received from NMFS within 30 calendar days of receipt of the draft report, the report shall be considered final. The draft report must include the following:

(i) Summary of all activities conducted and sightings of marine mammals near the activities;

(ii) Summary of all data required to be collected (see condition 5(c));

(iii) Full documentation of methods, results, and interpretation pertaining to all monitoring;

(iv) Summary of dates and locations of survey operations (including (1) the number of days on which the airgun array was active and (2) the percentage of time and total time the array was active during daylight vs. nighttime hours (including dawn and dusk)) and all marine mammal sightings (dates, times, locations, activities, associated survey activities);

(v) Geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa);

(vi) GIS files in ESRI shapefile format and UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates must be referenced to the WGS84 geographic coordinate system; and

(vii) Raw observational data.

(b) Reporting Injured or Dead Marine Mammals

(i) Discovery of Injured or Dead Marine Mammal – In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, SIO must report the incident to the Office of Protected Resources (OPR) (PR.ITP.MonitoringReports@noaa.gov and ITP.Fleming@noaa.gov) as soon as feasible. The report must include the following information:

1. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

2. Species identification (if known) or description of the animal(s) involved;

3. Condition of the animal(s) (including carcass condition if the animal is dead);

4. Observed behaviors of the animal(s), if alive;

5. If available, photographs or video footage of the animal(s); and

6. General circumstances under which the animal was discovered.

(ii) Vessel Strike – In the event of a ship strike of a marine mammal by any vessel involved in the activities covered by the authorization, SIO must report the incident to OPR as soon as feasible. The report must include the following information:

1. Time, date, and location (latitude/longitude) of the incident;

2. Species identification (if known) or description of the animal(s) involved;

3. Vessel's speed during and leading up to the incident;

4. Vessel's course/heading and what operations were being conducted (if applicable);

5. Status of all sound sources in use;

6. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;

7. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

8. Estimated size and length of animal that was struck;

9. Description of the behavior of the marine mammal immediately preceding and following the strike;

10. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

11. Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

12. To the extent practicable, photographs or video footage of the animal(s).

7. This Authorization may be modified, suspended or revoked if the holder fails to abide by the conditions prescribed herein (including, but not limited to, failure to comply with monitoring or reporting requirements), or if NMFS determines: (1) the authorized taking is likely to have or is having more than a negligible impact on the species or stocks of affected marine mammals, or (2) the prescribed measures are likely not or are not effecting the least practicable adverse impact on the affected species or stocks and their habitat.

8. Renewals

On a case-by-case basis, NMFS may issue a one-time, one-year Renewal IHA following notice to the public providing an additional 15 days for public comments when (1) up to another year of identical, or nearly identical, activities are planned or (2) the specified activities would not be completed by the time this IHA expires and a Renewal would allow for completion of the activities, provided all of the following conditions are met:

(a) A request for renewal is received no later than 60 days prior to the needed Renewal IHA effective date (the Renewal IHA expiration date cannot extend beyond one year from expiration of this IHA).

(b) The request for renewal must include the following:

(i) An explanation that the activities to be conducted under the requested Renewal IHA are identical to the activities analyzed for this IHA, are a subset of the activities, or include changes so minor that the changes do not affect the previous analyses, mitigation and monitoring requirements, or take estimates (with the exception of reducing the type or amount of take).

(ii) A preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

(c) Upon review of the request for Renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures will remain the same and appropriate, and the findings made in support of this IHA remain valid.

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Kimberly Damon-Randall,

Director, Office of Protected Resources,

National Marine Fisheries Service.

Table 1. Authorized take numbers, by species

Species	Stock	Authorized Level B take
Blue whale	Eastern N. Pacific	2
Fin whale	CA/OR/WA	2
Humpback whale	Central America/Southern Mexico – CA/OR/WA	2
	Mainland Mexico – CA/OR/WA	
	Hawai'i	
Minke whale	CA/OR/WA	1
Sei whale	Eastern N. Pacific	2
Sperm whale	CA/OR/WA	7
Baird's beaked whale	CA/OR/WA	7
Mesoplodont and goose-beaked whale[1]	CA/OR/WA	2
Killer whale	Eastern N. Pacific Offshore	7
Northern right whale dolphin	CA/OR/WA	64
Pacific white-sided dolphin	CA/OR/WA	55
Risso's dolphin	CA/OR/WA	19
Short beaked common dolphin	CA/OR/WA	156
Dwarf sperm whale	CA/OR/WA	1
Pygmy sperm whale		
Dall's porpoise	CA/OR/WA	26
California sea lion	U.S.	39
Guadalupe fur seal	Mexico	18
Northern fur seal	Eastern Pacific	6
	California	
Steller sea lion	Eastern	2
Northern elephant seal	California breeding	17

[1] Includes Blaineville's, Hubbs', and Stejneger's beaked whale

Table 2. Level B Harassment Zones

Airgun configuration	Water Depth (m)	Level B harassment zone (m)
Two 45in^3 GI airguns	>1,000	505