APPENDICES

Final Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of Mexico

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

December 2023

DOE/EA-2191

APPENDIX A: PUBLIC NOTIFICATION LETTERS

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY
Albany, OR • Morgantown, WV • Pittsburgh, PA

NATIONAL ENERGY TECHNOLOGY LABORATORY

March 17, 2023

Dear Reader:

The enclosed document, *Draft Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, Fall 2023* (Draft EA; DOE/EA-2191D), was prepared by the Department of Energy's (DOE) National Energy Technology Laboratory (NETL) in accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1531 et seq., and the National Environmental Policy Act (NEPA) of 1969. The Draft EA evaluates the potential environmental consequences of a project to be conducted by the University of Texas, with additional funding from DOE, involving a high-resolution 3-dimensional (HR3D) seismic survey off the coast of Texas. The survey would involve the use of two generator injector (GI) airguns towed behind a source vessel within Texas state waters less than 20 m deep. The project location is offshore San Luis Pass, which defines the southern tip of Galveston Island, Texas, and is located approximately 22 km northeast of Freeport, Texas, and 3 km from shore. Data acquired during the seismic survey would be used to validate novel dynamic acoustic positioning technology for improving the accuracy in time and space of HR3D marine seismic technology. In particular, the seismic data would be used for field validation of monitoring, verification, and account technology of offshore, sub-seabed carbon storage.

This Draft EA evaluates the potential impacts of the proposed project on various environmental resource areas. Based on initial impact screening evaluations, DOE determined that the project is likely to adversely affect (by harassment via the introduction of impulsive sound into the ocean) several species that could be found within the survey area and are listed under the ESA under the National Marine Fisheries Service (NMFS) jurisdiction, including the endangered leatherback, hawksbill, and Kemp's ridley sea turtles, and the threatened Northwest Atlantic distinct population segment (DPS) of loggerhead sea turtle, North Atlantic DPS of green sea turtle, and South Atlantic DPS of green sea turtle. No effects are anticipated on ESA-listed marine mammals, although the project may also have an incidental effect ('Take by Harassment') on non-listed dolphin species. The project may affect, but would not adversely affect, fish species that are known to occur in the survey area, including those listed as threatened under the ESA (oceanic whitetip shark and giant manta ray). With the planned monitoring and mitigation measures, unavoidable impacts to each species of marine mammal or sea turtle that could be encountered would be expected to be limited to short-term, localized changes in behavior and distribution near the seismic vessel.

DOE determined that the project would have no or negligible impacts on terrestrial biological resources, land use, safety and hazardous materials and management, geological resources (topography, geology and soil), air quality, water resources, visual resources, and socioeconomics. In this Draft EA, potential cumulative impacts of the proposed project with other past, present, or future actions are also evaluated, and no adverse cumulative impacts are identified.

3610 Collins Ferry Road, Morgantown, WV 26505
Mark.Lusk@netl.doe.gov Phone (304) 285-4145 www.netl.doe.gov

Invitation to Comment

Under the NEPA process, DOE is consulting with interested federal, state, regional, and local agencies, as well as the public. DOE invites interested parties to comment on this Draft EA during a 30-day public comment period that begins on March 17, 2023, and ends April 16, 2023. Submit comments to:

Mr. Mark W. Lusk
U.S. Department of Energy
National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, West Virginia, 26505
Email: mark.lusk@netl.doe.gov

Envelopes and the subject line of emails should be labeled "Marine Geophysical Surveys Draft EA Comments." Comments received after the close of the comment period will be considered to the extent practicable.

Individual names and addresses, including email addresses, received as part of the comment documents normally are considered part of the public record. Persons wishing to withhold his or her name, address, or other identifying information from the public record must state this request prominently at the beginning of the comment document. DOE will honor this request to the extent allowable by law. All submissions from organizations, businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses will be included in the public record and open to public inspection in their entirety.

Thank you for your interest in the Marine Geophysical Surveys in the Northwestern Gulf of Mexico and this Draft EA. For further information on the Draft EA or to request additional copies, please contact Mr. Mark W. Lusk as noted above. The Draft EA can also be accessed from DOE's National Energy Technology Laboratory website at https://netl.doe.gov/node/6939.

Sincerely,

Mark W. Lusk
NEPA Compliance Officer

Attachment: Draft Environmental Assessment for Marine Geophysical Surveys by the University of Texas in the Northwestern Gulf of Mexico, Fall 2023

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY
Albany, OR • Morgantown, WV • Pittsburgh, PA

NATIONAL ENERGY TECHNOLOGY LABORATORY

March 16, 2023

Ms. Nancy M. Smith, Director
Rosenberg Library
2310 Sealy Avenue
Galveston, Texas 77550

Dear Ms. Smith:

The enclosed document, *Draft Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, Fall 2023* (Draft EA; DOE/EA-2191D), was prepared by the Department of Energy's (DOE) National Energy Technology Laboratory (NETL) in accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1531 et seq., and the National Environmental Policy Act (NEPA) of 1969. The Draft EA evaluates the potential environmental consequences of a project to be conducted by the University of Texas, with additional funding from DOE, involving a high-resolution 3-dimensional (HR3D) seismic survey off the coast of Texas. The survey would involve the use of two generator injector (GI) airguns towed behind a source vessel within Texas state waters less than 20 m deep. The project location is offshore San Luis Pass, which defines the southern tip of Galveston Island, Texas, and is located approximately 22 km northeast of Freeport, Texas, and 3 km from shore. Data acquired during the seismic survey would be used to validate novel dynamic acoustic positioning technology for improving the accuracy in time and space of HR3D marine seismic technology. In particular, the seismic data would be used for field validation of monitoring, verification, and account technology of offshore, sub-seabed carbon storage.

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A Notice of Availability will be published in the Galveston County *The Dailey News* to announce the beginning of the 30-day public comment period on March 17, 2023. As stated in the notice, comments should be marked "Marine Geophysical Surveys Draft EA Comments" and sent to:

Mr. Mark W. Lusk
U.S. Department of Energy
National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, West Virginia, 26505
Email: mark.lusk@netl.doe.gov

Individual names and addresses, including email addresses, received as part of the comment documents normally are considered part of the public record. Persons wishing to withhold his or her name, address, or other identifying information from the public record must state this request prominently at the beginning of the comment document. DOE will honor this request to the extent allowable by law. All submissions from organizations, businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses will be included in the public record and open to public inspection in their entirety.

The public comment period formally ends on April 16, 2023. DOE will consider late submissions to the extent practicable. Please make the enclosed document available to interested members of the public. The Draft EA can also be accessed from DOE's National Energy Technology Laboratory website at https://netl.doe.gov/node/6939.

Our assistance in making this document available to the public is greatly appreciated. If you have any questions or comments, please contact Mr. Mark W. Lusk as noted above.

Sincerely,

Mark W. Lusk
NEPA Compliance Officer

Attachment: Draft Environmental Assessment for Marine Geophysical Surveys by the University of Texas in the Northwestern Gulf of Mexico, Fall 2023

APPENDIX B: DETERMINATION OF MITIGATION ZONES[1]

[1] Prepared by L-DEO.

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* NFS and USGS 2011). as a function of distance from the airguns, for the two 105-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).

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 NSF and USGS (2011) 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.

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 105-in^3 GI guns (separated by up to 2.4 m) at a tow depth of ~3–4 m. Table A-1 shows the distances at which the 160-dB re 1µPa$_{rms}$ sound level is expected to be received for the 2-GI airgun configuration (totaling 210 in^3) at a 4-m tow depth. 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 and A-2). The radii for intermediate water depths (100–1000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 in Appendix H of the PEIS).

The shallow-water radii are obtained by scaling the empirically derived measurements from the GoM calibration survey to account for the differences in volume and tow depth between the calibration survey (6600 in^3 at 6 m tow depth) and the proposed survey (210 in^3 at 4 m tow depth). A simple scaling factor is calculated from the ratios of the isopleths calculated by the deep-water L-DEO model, which are essentially a measure of the energy radiated by the source array:

- <u>150 decibel (dB) Sound Exposure Level (SEL)</u>[1] corresponds to deep-water maximum radii of 725.96 m for the two 105 in^3 GI-guns at 4 m tow depth (Fig. A-1), and 7,244 m for the 6600 in^3 at 6-m tow depth (Fig. A-2), yielding a scaling factor of 0.10 to be applied to the shallow-water 6-m tow depth results.
- <u>165 dB SEL</u> corresponds to deep-water maximum radii of 128.2 m for the two 105 in^3 GI-guns at a 4 m tow depth, and 1,284 m for a 6-m tow depth, yielding a scaling factor of 0.10 to be applied to the shallow-water 6-m tow depth results.
- <u>170 dB SEL</u> corresponds to deep-water maximum radii of 72.7 for the two 105 in^3 GI-guns at a 4 m tow depth (Fig. A-1), and 719 m for the 6600 in^3 at 6-m tow depth (Fig. A-2), yielding a scaling factor of 0.10.
- <u>185 dB SEL</u> corresponds to deep-water maximum radii of 12.86 m for the two 105 in^3 at 4-m tow depth, and 126.3 m for a 6-m tow depth, yielding a scaling factor of 0.11 to be applied to the shallow-water 6-m tow depth results.

Measured 160-, 175-, 180-, 190- and 195-dB re $1\mu Pa_{rms}$ distances in shallow water for the 36-airgun array towed at 6 m depth were 17.5 km, 2.84 km, 1.6 km, 458 m and 240 m, respectively, based on a 95th percentile fit (Tolstoy et al. 2009). Multiplying by the scaling factor to account for the tow depth and discharge volume differences between the 6600 in^3 airgun array at 6 m tow depth and the 210 in^3 GI airgun array at 4 m tow depth yields distances of 1.75 km, 284 m, 160 m, 46 m, and 26 m, respectively.

Table A-1 shows the distances at which the 160-, 175-, 180-, 190 and 195-dB re $1\mu Pa_{rms}$ sound levels are expected to be received for the two 105 in^3 GI-guns at 4 m tow depth. The 160-dB level is the behavioral disturbance criterion (Level B) that is used by NMFS to estimate anticipated takes for marine mammals; a 175-dB level is used by the National Marine Fisheries Service (NMFS), based on U.S. DoN (2017), to determine behavioral disturbance for sea turtles.

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[1] SEL (measured in dB re 1 $\mu Pa^2 \cdot s$) 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.

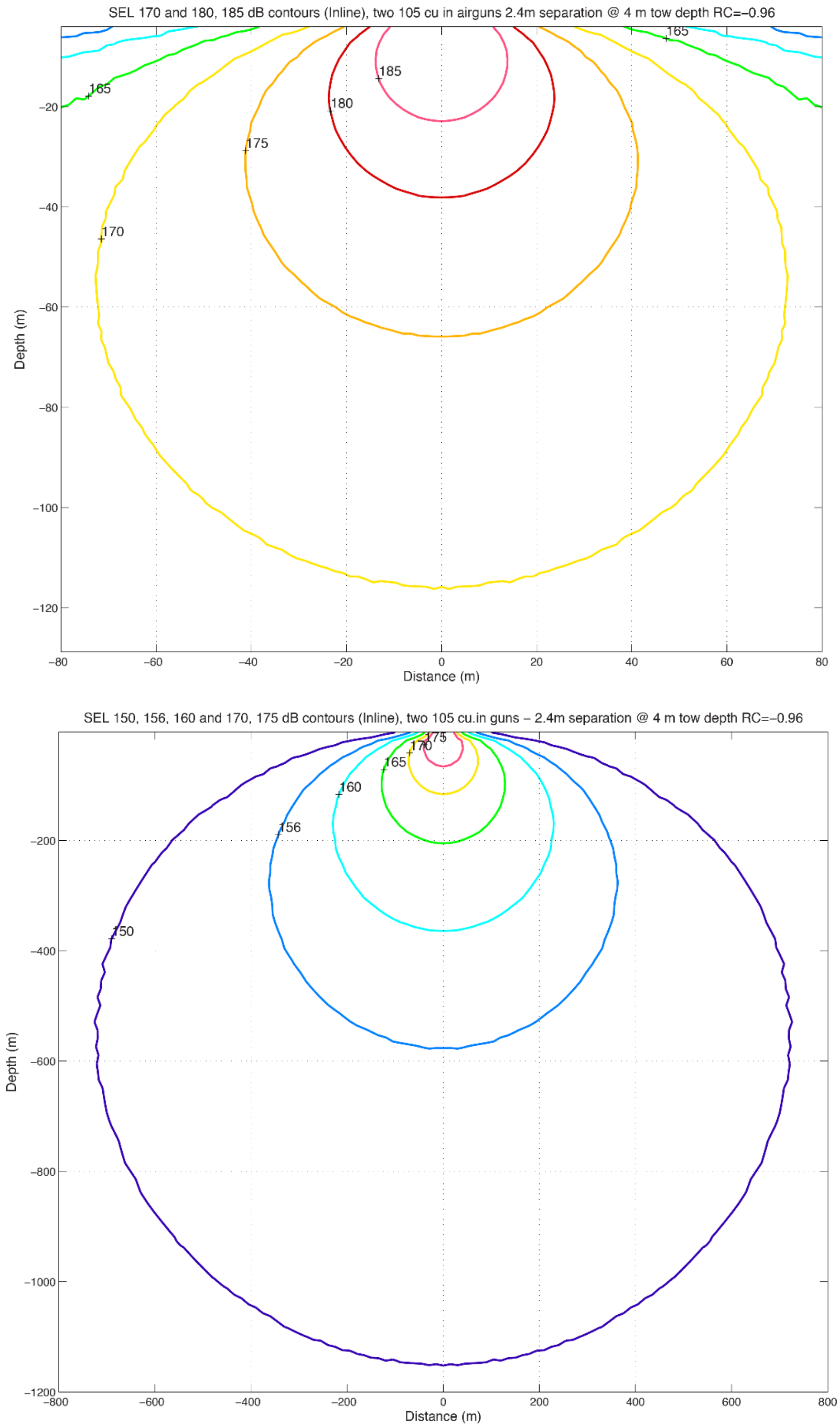

FIGURE A-1. Modeled deep-water received sound exposure levels (SELs) from the two 105-in^3 GI guns, with a 2.4-m gun separation, planned for use during the proposed surveys at a 4-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The radius to the 150-dB SEL isopleth is a proxy for the 160-dB rms isopleth. The upper plot is a zoomed-in version of the lower plot.

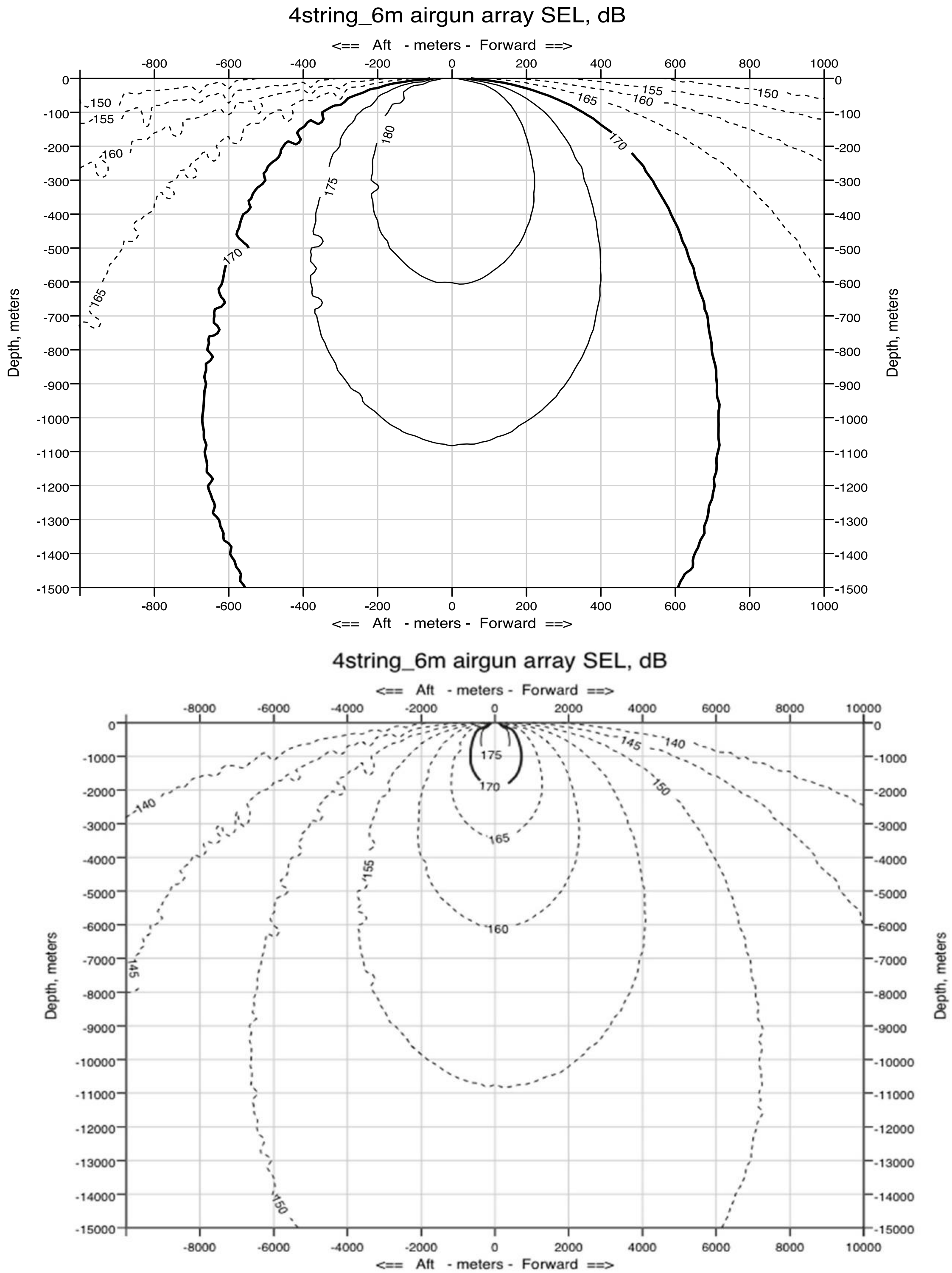

FIGURE A-2. Modeled deep-water received sound exposure levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

TABLE A-15. Level B. Predicted distances to the 160 dB and 175 dB re 1 μPa_{rms} sound levels that could be received from two 105-in^3 GI guns (separated by 2.4 m, at a tow depth of 4 m) that would be used during the seismic surveys in the Gulf of Mexico (model results provided by L-DEO).

Airgun Configuration	**Water Depth (m)**[1]	**Predicted rms Distances (m)**	
		160 dB	**175 dB**
Two 105-in^3 GI guns	>1000	726[1]	128[1]
	100-1000	1,089[2]	192[2]
	<100	1,750[3]	284[3]

[1] Distance is based on L-DEO model results.
[2] Distance is based on L-DEO model results with a 1.5 × correction factor between deep and intermediate water depths.
[3] Distance is based on empirically derived measurements in the GoM with scaling applied to account for differences in tow depth.

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[3] have confirmed that the L-DEO model generated conservative mitigation zones, resulting in significantly larger zones than required by NMFS.

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 for permanent threshold shift (PTS) onset or Level A Harassment (injury), for marine mammal species, but did not establish new thresholds for Level B Harassment. The new noise exposure criteria for marine mammals account for the 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).

[3] 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).

Literature Cited

Barton, P., J. Diebold, and S. Gulick. 2006. Balancing mitigation against impact: a case study from the 2005 Chicxulub seismic survey. **Eos Trans. Amer. Geophys. Union** 87(36), Joint Assembly Suppl., Abstr. OS41A-04. 23–26 May, Balitmore, MD.

Costa, D.P. and T.M. Williams. 1999. Marine mammal energetics. p. 176-217 *In:* J.E. Reynolds III and S.A. Rommel (eds.), Biology of marine mammals. Smithsonian Institution Press, Washington. 578 p.

Crone, T.J., M. Tolstoy, and H. Carton. 2014. Estimating shallow water sound power levels and mitigation radii for the R/V *Marcus G. Langseth* using an 8 km long MCS streamer. **Geochem., Geophys., Geosyst.** 15(10):3793-3807.

Crone, T.J., M. Tolstoy, and H. Carton. 2017. Utilizing the R/V *Marcus G. Langseth*'s streamer to measure the acoustic radiation of its seismic source in the shallow waters of New Jersey's continental shelf. **PloS ONE** 12(8):e0183096. http://doi.org/10.1371/journal.pone.0183096.

Diebold, J.B., M. Tolstoy, P.J. Barton, and S.P. Gulick. 2006. Propagation of exploration seismic sources in shallow water. **Eos Trans. Amer. Geophys. Union** 87(36), Joint Assembly Suppl., Abstr. OS41A-03. 23–26 May, Baltimore, MD.

Diebold, J.B., M. Tolstoy, L. Doermann, S.L. Nooner, S.C. Webb, and T.J. Crone. 2010. R/V *Marcus G. Langseth* seismic source: modeling and calibration. **Geochem. Geophys. Geosyst.** 11(12):Q12012. http://doi.org/10.1029/2010GC003126. 20 p.

DoN (U.S. Department of the Navy). 2017. Criteria and thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical Report prepared by the U.S. Navy.

Lucke, K., S.B. Martin, and R. Racca. 2020. Evaluating the predictive strength of underwater noise exposure criteria for marine mammals. **J. Acoust. Soc. Am.** 147:3985. doi:10.1121/10.0001412.

NMFS. 2016. Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: underwater acoustic thresholds for onset of permanent and temporary threshold shifts. U.S. Dept. of Commer., NOAA. 178 p.

NMFS. 2018. 2018 revision to: technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (version 2.0). Underwater thresholds for onset of permanent and temporary threshold shifts. Office of Protected Resources Nat. Mar. Fish. Serv., Silver Spring, MD. 167 p.

Tolstoy, M., J. Diebold, L. Doermann, S. Nooner, S.C. Webb, D.R. Bohenstiehl, T.J. Crone, and R.C. Holmes. 2009. Broadband calibration of R/V *Marcus G. Langseth* four-string seismic sources. **Geochem. Geophys. Geosyst.** 10:Q08011. https//doi.org/10.1029/2009GC002451.

APPENDIX C: LETTER TO NMFS

January 10, 2023

Ms. Amy Lueders
Regional Director, Southwest Region
U.S. Fish & Wildlife Service
500 Gold Ave. SW
Albuquerque, NM 87102

Re: Proposed HR3D seismic surveys in the northern Gulf of Mexico

Dear Ms. Lueders:

The Department of Energy's (DOE) National Energy Technology Laboratory (NETL) proposes to fund the University of Texas to conduct a high-resolution 3-dimensional (HR3D) seismic survey in the northwestern Gulf of Mexico. The seismic survey would use two 2 GI airguns towed behind the source vessel in nearshore waters off the coast of Texas (Fig. 1). The area of interest is offshore San Luis Pass, which defines the southern tip of Galveston Island, Texas, and is located approximately 22 km northeast of Freeport, TX, and 3 km from shore. The water depth at the area of interest is <20 m, and in some parts, it is as shallow as 10–12 m. The proposed survey would occur within Texas state waters during fall 2023.

DOE is currently preparing an environmental assessment (EA) to assess the potential environmental impacts associated with the proposed Project. As part of the National Environmental Policy Act of 1969 (NEPA) process, DOE will consult with interested federal, state, regional, and local agencies. This letter requests the USFWS' concurrence with DOE's determination that the proposed activities would have no effect on ESA-listed species and critical habitat under USFWS jurisdiction pursuant to Section 7 of the ESA of 1973 (16 U.S.C. 1531-1544), as amended, and that no further consultation with USFWS is required.

Project Details

The proposed seismic survey would use two 2 GI guns towed by the TDI-Brooks vessel R/V *Brooks McCall* (or similar) in nearshore waters off the coast of Texas. Data acquired during the proposed seismic survey would be used to validate novel dynamic acoustic positioning technology for improving the accuracy in time and space of HR3D marine seismic technology. In particular, the seismic data would be used for field validation of monitoring, verification, and account technology of offshore carbon sequestration. The source vessel would tow up to 2 GI airguns (with a volume of up to 105 in^3 each) and a total discharge volume of approximately 210 in^3 at a depth of 3 m. The source level is up to 233.8 $dB_{0\text{-}pk}$ re 1 μPa · m. The receiving system would consist of four 25-m solid-state (solid flexible polymer – not gel or oil filled) hydrophone streamers, spaced 10-m apart (i.e., 30-m spread) and towed at a 2-m depth. The airguns would fire at a shot interval of approximately 12.5 m (5–10 s). As the airgun(s) are towed along the survey lines at a speed of approximately 4-5 knots (7.4-9.3 km/h), the hydrophone streamers would transfer the data to the on-board processing system. The University of Texas Gulf Coast Carbon Center designed and built GPS receivers that can be used to accurately position the streamer receivers and the acoustic source via tail buoys. Approximately 1704 km of seismic acquisition are proposed within an area covering approximately 222 km^2. There could be 142 possible lines 12 km long, spaced approximately 62.5 m apart. The proposed seismic survey would take place in the fall of 2023 for about 10 days of seismic acquisition. The source vessel would likely leave out of and return to port in Freeport or Galveston, TX.

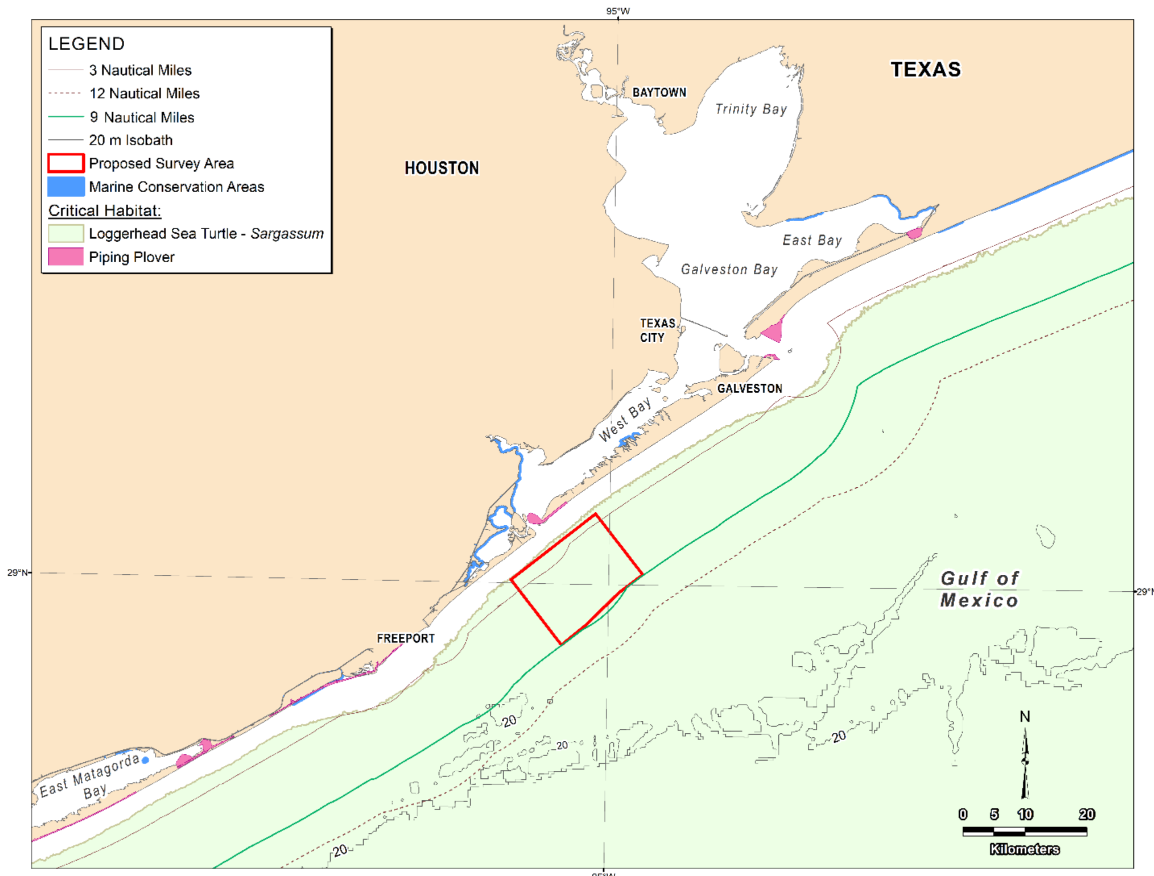

FIGURE 1. Location of the area of interest for the proposed seismic survey off Galveston Island at San Luis Pass, northwestern Gulf of Mexico. Critical habitat for ESA-listed species is also shown, along with nearshore conservation areas.

An integral part of the planned survey would include a monitoring and mitigation program designed to minimize potential impacts of the proposed activities on marine animals present during the proposed survey, and to document, as much as possible, the nature and extent of any effects. Potential impacts of the proposed seismic survey on the environment would be primarily a result of the operation of the airguns. The increased underwater anthropogenic sounds associated with airgun operations could result in avoidance behavior by marine mammals and sea turtles. Injurious impacts to marine mammals and sea turtles have not been proven to occur near airguns or the other types of sound sources to be used. However, a precautionary approach would be taken, and the planned monitoring and mitigation measures would reduce the possibility of any effects. Proposed protection measures designed to mitigate the potential environmental impacts to marine mammals and sea turtles would include ramp ups of the 2-GI airgun array; at least one dedicated observer maintaining a visual watch during all daytime airgun operations; two observers before and during startups during the day; and shutdowns when marine mammals and sea turtles are detected in or about to enter designated exclusion zones.

ESA-Listed Species under USFWS Jurisdiction and Critical Habitat

The piping plover (*Charadrius melodus*) is the only ESA-listed species managed by USFWS that is likely to occur within or near the proposed survey area. Critical habitat for this species has been designated along the coast (Figure 1), but none occurs within the proposed survey area. Although occasional sightings of the Florida manatee (*Trichechus manatus latirostris*) are also made in the northwestern Gulf of Mexico, this species is unlikely to be encountered during the proposed survey. Through avoidance, and the monitoring and mitigation measures outlined above, potential impacts of known occurrences of these two species would be avoided or minimized so that no effects are anticipated. There would be no effect on piping plover habitat, which is located outside of the survey area. Thus, DOE's determination is that the proposed activities would have no effect on ESA-listed species and critical habitat under USFWS jurisdiction.

The DOE believes we have used the best scientific data available to reach this conclusion. For discussion regarding the Proposed Action, please do not hesitate to contact me. You can reach me by email at mark.lusk@netl.doe.gov, by telephone at (304) 285-4145, or at the address listed on the front page with any questions or comments.

Sincerely,

Mark W. Lusk
NEPA Compliance Officer

cc: Kyle Smith, NETL

APPENDIX D: LETTER TO USWFS

March 16, 2023

Ms. Nancy M. Smith, Director
Rosenberg Library
2310 Sealy Avenue
Galveston, Texas 77550

Dear Ms. Smith:

The enclosed document, *Draft Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, Fall 2023* (Draft EA; DOE/EA-2191D), was prepared by the Department of Energy's (DOE) National Energy Technology Laboratory (NETL) in accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1531 et seq., and the National Environmental Policy Act (NEPA) of 1969. The Draft EA evaluates the potential environmental consequences of a project to be conducted by the University of Texas, with additional funding from DOE, involving a high-resolution 3-dimensional (HR3D) seismic survey off the coast of Texas. The survey would involve the use of two generator injector (GI) airguns towed behind a source vessel within Texas state waters less than 20 m deep. The project location is offshore San Luis Pass, which defines the southern tip of Galveston Island, Texas, and is located approximately 22 km northeast of Freeport, Texas, and 3 km from shore. Data acquired during the seismic survey would be used to validate novel dynamic acoustic positioning technology for improving the accuracy in time and space of HR3D marine seismic technology. In particular, the seismic data would be used for field validation of monitoring, verification, and account technology of offshore, sub-seabed carbon storage.

This Draft EA evaluates the potential impacts of the proposed project on various environmental resource areas. Based on initial impact screening evaluations, DOE determined that the project is likely to adversely affect (by harassment via the introduction of impulsive sound into the ocean) several species that could be found within the survey area and are listed under the ESA under the National Marine Fisheries Service (NMFS) jurisdiction, including the endangered leatherback, hawksbill, and Kemp's ridley sea turtles, and the threatened Northwest Atlantic distinct population segment (DPS) of loggerhead sea turtle, North Atlantic DPS of green sea turtle, and South Atlantic DPS of green sea turtle. No effects are anticipated on ESA-listed marine mammals, although the project may also have an incidental effect ('Take by Harassment') on non-listed dolphin species. The project may affect, but would not adversely affect, fish species that are known to occur in the survey area, including those listed as threatened under the ESA (oceanic whitetip shark and giant manta ray). With the planned monitoring and mitigation measures, unavoidable impacts to each species of marine mammal or sea turtle that could be encountered would be expected to be limited to short-term, localized changes in behavior and distribution near the seismic vessel.

DOE determined that the project would have no or negligible impacts on terrestrial biological resources, land use, safety and hazardous materials and management, geological resources (topography, geology and soil), air quality, water resources, visual resources, and socioeconomics. In this Draft EA, potential cumulative impacts of the proposed project with other past, present, or future actions are also evaluated, and no adverse cumulative impacts are identified.

A Notice of Availability will be published in the Galveston County *The Dailey News* to announce the beginning of the 30-day public comment period on March 17, 2023. As stated in the notice, comments should be marked "Marine Geophysical Surveys Draft EA Comments" and sent to:

Mr. Mark W. Lusk
U.S. Department of Energy
National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, West Virginia, 26505
Email: mark.lusk@netl.doe.gov

Individual names and addresses, including email addresses, received as part of the comment documents normally are considered part of the public record. Persons wishing to withhold his or her name, address, or other identifying information from the public record must state this request prominently at the beginning of the comment document. DOE will honor this request to the extent allowable by law. All submissions from organizations, businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses will be included in the public record and open to public inspection in their entirety.

The public comment period formally ends on April 16, 2023. DOE will consider late submissions to the extent practicable. Please make the enclosed document available to interested members of the public. The Draft EA can also be accessed from DOE's National Energy Technology Laboratory website at https://netl.doe.gov/node/6939.

Our assistance in making this document available to the public is greatly appreciated. If you have any questions or comments, please contact Mr. Mark W. Lusk as noted above.

Sincerely,

Mark W. Lusk
NEPA Compliance Officer

Attachment: Draft Environmental Assessment for Marine Geophysical Surveys by the University of Texas in the Northwestern Gulf of Mexico, Fall 2023

APPENDIX E: BIOLOGICAL OPINION

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

11/6/23

Refer to NMFS No.: OPR-2023-00050

Mr. Mark Lusk
NEPA Compliance Officer
National Energy Technology Laboratory, Department of Energy
3610 Collins Ferry Road
Morgantown, West Virginia 26505

RE: Endangered Species Act Section 7 Biological Opinion on the United States Department of Energy National Energy Technology Laboratory funding of the University of Texas at Austin's seismic survey in the Gulf of Mexico

Dear Mr. Lusk:

Enclosed is the National Marine Fisheries Service (NMFS) Endangered Species Act (ESA) Interagency Cooperation Division's biological opinion on the effects of the Department of Energy's proposed funding and the University of Texas at Austin's execution of a high-resolution 3-dimensional marine geophysical seismic survey off Texas in the Gulf of Mexico in fall 2023 on threatened and endangered species and critical habitat that has been designated for those species under NMFS's jurisdiction in the action area. We have 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 conclude that the proposed action is likely to adversely affect, but not likely to jeopardize the continued existence of the North Atlantic distinct population segment (DPS) of green turtle (*Chelonia mydas*), Kemp's ridley turtle (*Lepidochelys kempii*), leatherback turtle (*Dermochelys coriacea*), and Northwest Atlantic Ocean DPS of loggerhead turtle (*Caretta caretta*). We also conclude that the proposed action may affect, but is not likely to adversely affect the hawksbill turtle (*Eretmochelys imbricata*), giant manta ray (*Manta birostris*), and oceanic whitetip shark (*Carcharhinus longimanus*); and designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle that occur in the action area.

This concludes section 7 consultation on this action. Consultation on this action must be reinitiated if: (1) the amount or extent of incidental take specified in the incidental take statement is exceeded; (2) new information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to the ESA-listed species or critical habitat not considered in this consultation; or (4) a new species is listed or critical habitat designated under the ESA that may be affected by the 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

Cc: Tip Meckel, Ramon Trevino, Meike Holst, Darren Ireland

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION

Title:	Biological Opinion on the United States Department of Energy National Energy Technology Laboratory funding of the University of Texas at Austin's seismic survey in the Gulf of Mexico
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Action Agency:	United States Department of Energy
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:	November 14, 2023
Consultation Tracking number:	OPR-2023-00050
Digital Object Identifier (DOI):	https://doi.org/10.25923/7mry-s606

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND UNITS

°C – Degrees Celsius

°N – Degrees North

°S – Degrees South

°W – Degrees West

3-D – Three-dimensional

AMAPPS – Atlantic Marine Assessment Program for Protected Species

C.F.R – Code of Federal Regulations

cm – centimeters

cm^3 – centimeters cubed

dB – Decibels

dB re 1 µPa – Decibels referenced to a pressure of 1 microPascal (unit to specify intensity of a sound underwater)

dB re 1 $\mu Pa^2 s$ – Decibels referenced to a pressure of 1 microPascal squared second (unit of sound exposure level)

dB re 1 $\mu Pa^2/Hz$ at 1m – Decibels referenced to a pressure of 1 microPascal squared per hertz (decibel unit for the pressure spectral density in underwater acoustics)

DDT – Dichlorodiphenyltrichoroethane

DNA – Deoxyribonucleic acid

DOE – Department of Energy

DPS – Distinct Population Segment

ESA – Endangered Species Act

FR – Federal Register

ft – feet

g – grams

gal – gallon

GI – Generator Injector

GPS – Global Positioning System

h – hour

hp – horsepower

HR3D – High-resolution Three-dimensional

Hz – Hertz

IHA – Incidental Harassment Authorization

in – inch

in^3 – inches cubed

ITS – Incidental Take Statement

kHz – kilohertz

km – kilometers

km/h – kilometers per hour

km^2 – kilometers squared

kts – knots

lbs – pounds

L-DEO – Lamont-Doherty Earth Observatory

m – meter

m/m % – percent by mass

m^3 – meters cubed

mi - miles

mi^2 – miles squared

min – minutes

MMPA – Marine Mammal Protection Act

mph – miles per hour

NEFSC – Northeast Fisheries Science Center

NM – nautical miles

NMFS – National Marine Fisheries Service

NSF – National Science Foundation

OBIS-SEAMAP – Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations

PAM – Passive Acoustic Monitoring

PBFs – Physical and Biological Features

PCBs – Polychlorinated biphenyls

psi – pounds per square inch

PSOs – Protected Species Observers

PTS – Permanent Threshold Shift

R/V – Research Vessel

rms – root mean square

RPMs – Reasonable and Prudent Measures

s – seconds

SD – Standard Deviation

SEFSC – Southeast Fisheries Science Center

SEL_{cum} – Cumulative Sound Exposure Level

SERO – Southeast Regional Office

SIO – Scripps Institution of Oceanography

SPL_{peak} – Peak Sound Pressure Level

SWOT – State of the World’s Sea Turtles

TEDs – Turtle Excluder Devices

TTS – Temporary Threshold Shift

U.S. – United States

U.S.C – United States Code

USFWS – United States Fish and Wildlife Service

UT – University of Texas at Austin

1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of threatened or endangered species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 C.F.R. §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" ESA-listed species or designated critical habitat and NMFS concurs with that determination for species under NMFS jurisdiction, consultation concludes informally (50 CFR §402.13(c)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency is able to insure its action is not likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify 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 incidental take of an ESA-listed species is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS), which exempts take incidental to an otherwise lawful action, and specifies the impact of any incidental taking, including necessary or appropriate reasonable and prudent measures (RPMs) to minimize such impacts and terms and conditions to implement the RPMs. NMFS, by regulation, has determined that an ITS must be prepared when take is "reasonably certain to occur" as a result of the proposed action (50 C.F.R. §402.14(g)(7)).

The Federal action agency for this consultation is the United States (U.S.) Department of Energy National Energy Technology Laboratory (henceforth referred to as DOE). The DOE is proposing to partially fund the University of Texas at Austin (UT) to conduct a marine geophysical (seismic) survey in the northwestern Gulf of Mexico in late fall (October or November) of 2023.

This formal consultation was conducted and this opinion and ITS were prepared by NMFS, Office of Protected Resources, ESA Interagency Cooperation Division (hereafter referred to as "we") in accordance with section 7(a)(2) of the ESA (16 U.S.C. 1536 (a)(2)) and associated implementing regulations at 50 C.F.R. §§402.01–402.17, and agency policy and guidance.

In August 2019, the USFWS and NMFS (i.e., the Services) enacted a series of regulations that modified how the Services implemented the ESA. On July 5, 2022, the United States District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 C.F.R. Part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 1, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5, 2022 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order 2 days later on November 16, 2022. As a result, the 2019 regulations are in effect and we are applying the 2019 regulations here. For purposes of this consultation, we considered whether the substantive analysis and its conclusions regarding the effects of the proposed action articulated in the opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

This document represents the NMFS ESA Interagency Cooperation Division's opinion on the effects of these actions on threatened and endangered species and critical habit that has been designated for those species (Section 6) in the action area. A complete record of this consultation is on file electronically at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

Marine seismic surveys have occurred in every ocean basin and ESA section 7 consultations have been completed for them in waters off the U.S. in the Pacific and Atlantic Oceans, Gulf of Mexico, Gulf of Alaska, Caribbean, and Arctic and Antarctic waters. The DOE is proposing to fund UT's seismic survey in the northwestern Gulf of Mexico, off the coast of Texas. Data collected from this project will characterize the upper ~1 km (~0.62 mi) of the geologic subsurface. These data will then be used for field validation of monitoring, verification, and accounting technology of sub-seabed carbon storage. In conjunction with this action, UT, on behalf of itself and DOE, requested an Incidental Harassment Authorization from the NMFS Permits Division to authorize incidental harassment of small numbers of marine mammals under the Marine Mammal Protection Act, should this occur during the survey. Because the Incidental Harassment Authorization will not authorize take of ESA-listed marine mammals, that action is not included in this opinion. Previous ESA section 7 consultations that addressed seismic surveys around the world, including those of substantially higher energy than this proposed survey, determined that the authorized activities were not likely to jeopardize the continued existence of proposed or ESA-listed species, or result in the destruction or adverse modification of designated critical habitat, when applicable.

1.2 Consultation History

We were given the consultation by our Southeast Regional Office (SERO). Our communication with the NMFS SERO and DOE regarding this consultation is summarized as follows:

- On January 11, 2023, SERO received a request from DOE for ESA section 7 consultation for a proposed seismic survey in the northwestern Gulf of Mexico in the fall of 2023.
- On March 27, 2023, SERO received a revised request for consultation and draft Environmental Assessment from DOE.
- On July 17, 2023, SERO transferred the consultation to the NMFS ESA Interagency Cooperation Division.

- On July 21, 2023, we provided DOE with questions on their draft Environmental Assessment. DOE provided responses to our questions on July 27 and July 28, 2023. DOE declined to conference on the proposed North Atlantic DPS of green turtle and Rice's whale critical habitat.
- On July 28, 2023 we determined that there was sufficient information to initiate formal consultation with DOE. We provided DOE with an initiation letter on August 1, 2023.

2 The Assessment Framework

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of threatened or endangered species; or adversely modify or destroy their designated critical habitat.

"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 an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical and biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

The final designations of critical habitat for various species used the term primary constituent element or essential features prior to 2016. The critical habitat regulation revisions (81 FR 7414; February 11, 2016) replaced this term with physical and 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 primary constituent elements, PBFs, or essential features. In this opinion, we use the term PBFs to mean primary constituent elements or essential features, as appropriate for the specific designated critical habitat in the action area.

An ESA section 7 assessment involves the following steps:

Description of the Proposed Action (Section 3): We describe the proposed action and the avoidance and minimization measures that have been incorporated into the project to reduce the effects to ESA-listed species and designated critical habitat.

Potential Stressors (Section 4): We identify and describe the stressors that could occur as a result of the proposed action that may result in effects on the physical, chemical, and biotic environment within the action area.

Action Area (Section 5): We describe the action area with the spatial extent of those stressors caused by the proposed action.

Endangered Species Act-Listed Species and Designated Critical Habitat Present in the Action Area (Section 6): We identify the ESA-listed species and designated critical habitat that are subject to this consultation because they co-occur with the stressors produced by the proposed action in space and time.

Species and Critical Habitat Not Likely to be Adversely Affected (Section 7): During consultation, we determined that some ESA-listed species and critical habitat that occur in the action area were not likely to be adversely affected by the stressors produced by the proposed action, and we detail our effects analysis for these species and critical habitats.

Species Likely to be Adversely Affected (Section 8): During the ESA section 7 consultation process, we identify the ESA-listed species that are likely be adversely affected. In this section, we describe the status of ESA-listed species that may be adversely affected by the proposed action.

Environmental Baseline *(*Section 9): We describe the environmental baseline, which refers to the condition of the ESA-listed species in the action area, without the consequences to the ESA-listed species caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 C.F.R. §402.02).

Effects of the Actions (Section 10): Effects of the action are all consequences to ESA-listed species that are caused by the proposed action, including the consequences of other activities that are caused by the proposed 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 in time and may include consequences occurring outside the immediate area involved in the action (50 C.F.R. §402.02). The effects analysis is broken into analyses of exposure and response. To characterize exposure, we identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and populations or sub-populations to which those individuals belong. We also consider whether the PBFs of designated critical habitat will be exposed. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how the PBFs of designated critical habitat exposed to stressors from the proposed action will respond. This is our response analysis.

Cumulative Effects (Section 11): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 C.F.R. §402.02). Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Section 12): In this section we integrate and synthesize the analyses in the opinion to summarize the consequences to ESA-listed species and designated critical habitat under NMFS's jurisdiction.

With full consideration of the status of the species and the designated critical habitat, we consider the effects of the actions within the action area on populations or subpopulations and on PBFs of designated critical habitat when added to the environmental baseline and the cumulative effects to determine whether the action would reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

The results of our jeopardy and destruction and adverse modification analyses are summarized in the Conclusion (Section 13). If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (50 C.F.R. §402.14).

In addition, we include an ITS (Section 14), if necessary, that specifies the impact of the take, RPMs to minimize the impact of the take, and terms and conditions to implement the RPMs (ESA section 7(b)(4); 50 C.F.R. §402.14(i)). We also provide discretionary Conservation Recommendations (Section 15) that may be implemented by the action agency (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which Reinitiation of Consultation is required (Section 16; 50 C.F.R. §402.16).

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of *Google Scholar*, literature cited sections of peer reviewed articles, species listing documentation, and reports published by government and private entities. This opinion is based on our review and analysis of various information sources, including:

- Information submitted by the DOE;
- Government reports (including NMFS biological opinions and 5-year reviews);
- NOAA technical memorandums;
- Monitoring reports; and
- Peer-reviewed scientific literature.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS's jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species. Collectively, we consider the foregoing to comprise the best scientific information available for this biological opinion.

3 Description of the Proposed Action

"Action" means all activities or programs of any kind, authorized, funded, or carried out, in whole or in part, by Federal agencies (50 C.F.R. §402.02).

The proposed action addressed by this consultation is DOE's proposal to fund UT to conduct a seismic survey in the northwestern Gulf of Mexico in fall of 2023.

The DOE has a continuing need to fund research that meets their vision to deliver integrated solutions to enable transformation to a sustainable energy future. The seismic survey will be used to fulfill a research project under the DOE funding opportunity announcement for "Development of Technologies for Sensing, Analyzing, and Utilizing Novel Subsurface Signals in Support of the Subsurface Technology and Engineering Crosscut Initiative," which has undergone the DOE merit review process and meets the agency's mission to drive innovation and deliver solutions for an environmentally sustainable and prosperous energy future.

The information presented here is based primarily on the draft Environmental Assessment provided by the DOE (DOE 2023) as part of their initiation package.

3.1 Seismic Survey Overview and Objectives

Researchers from UT, with funding from the DOE, propose to conduct a marine seismic survey to validate novel dynamic acoustic positioning technology for improving the accuracy in time and space of HR3D marine seismic technology. The main goal for the seismic survey proposed by Principle Investigator Dr. T. Meckle is to collect data using HR3D marine seismic technology to interpret the upper ~1 km (~0.62 mi) of the geologic substrate. In particular, the collected data will be used for field validation of monitoring, verification, and accounting technology of sub-seabed carbon storage. This will help identify offshore carbon sequestration potential in the Gulf of Mexico.

The proposed survey will take place in the Gulf of Mexico, off Texas, in the fall of 2023. DOE and UT determined fall to be the most feasible time for the proposed survey due to favorable weather conditions, operational requirements, availability of the researchers, and because it does not coincide with sea turtle nesting season in the Gulf of Mexico when sea turtle densities are highest. The survey will occur over 10 days (7 days of seismic acquisition, 3 days of transit to and from either the Port of Galveston or the Port of Freeport). The survey area is located at approximately 28.9–29.1°N and 94.9–95.2°W, within Texas state waters and within the U.S. Exclusive Economic Zone. The survey will occur offshore of San Luis Pass (the southern tip of Galveston Island, Texas) 22 km (~13.67 mi) northeast of Freeport, Texas, ~3 km from shore, and encompass an area of 222 km^2 (~85.71 mi^2). Water depths of the survey area are no deeper than 20 m (~65.6 ft). The closest approach to shore would be 3.2 km (~2 mi).

3.2 Research Vessel Specifications

The airguns and hydrophone streamers will be towed by a single source vessel, the R/V *Brooks McCall*, or similar vessel, owned by TDI-Brooks. TDI-Brooks has over 25 years of chartering vessels and the R/V *Brooks McCall* operates primarily in the Gulf of Mexico and U.S. East Coast. The R/V *Brooks McCall* has a length of ~48.5 m (~159 ft), a beam of ~12.2 m (~40 ft), and a maximum draft of ~3 m (~9.8 ft). Its maximum speed is 11 kts (~20.4 km/h); however, during the seismic survey, the vessel will travel at ~4–5 kts (7.4–9.3 km/h). The R/V *Brooks McCall* propulsion system uses 3 Detroit 16V92 diesel engines, each of which produces 700 hp. The maximum continuous power is 2,100 hp. The R/V *Brooks McCall* can hold ~238 m^3 (~62,872 gal) of fuel and will use low-sulfur fuel.

The research vessel will be self-contained, UT researchers and technicians, and the ship's crew, will live aboard the R/V *Brooks McCall* for the entirety of the seismic survey. The R/V *Brooks McCall* has a maximum capacity of 32 persons. All waste will be retained and returned to shore, rather than being appropriately disposed of at sea. The R/V *Brooks McCall* will also serve as the platform for protected species observers (PSOs), from which they will visually monitor the surrounding area for protected species.

3.3 Airgun Description

The R/V *Brooks McCall* will tow up to 2 Generator-Injector (GI) airguns. A 2 GI airgun source was chosen by DOE and UT to be the lowest practical source that could meet the scientific objectives. An airgun is a device used to emit acoustic energy pulses downward through the water column and into the seafloor. It generally consists of a steel cylinder that is charged with high-pressure (compressed) air. The release of the compressed air into the water column produces a pressurized air bubble, which produces a sound wave. The sound wave propagates outward, reflecting or refracting off the seafloor and subsurface. That reflected or refracted signal is detected by the receiving system (usually towed behind the vessel) and then analyzed later on a computer. A GI airgun is slightly different in that it has 2 independent air chambers within the same cylinder casing: the Generator, which generates the primary pulse creating the main air bubble, and the Injector, which injects air into the main air bubble, causing it to collapse quickly. This improves data quality because the quick collapse of the main air bubble reduces bubble oscillation and leads to a cleaner acoustic signal.

Each GI airgun will have a volume of ~1,721 cm^3 (105 in^3), for a total possible discharge volume of ~3,441 cm^3 (210 in^3). The airguns will be towed 2 m (~6.6 ft) apart and at a depth of 3 m (~9.8 ft). Airguns will fire at a shot interval of 12.5 m or ~41 ft (~5–10 s). Total firing pressure of the airguns would be approximately 2,000 psi. During firing, a brief pulse of sound (~0.1 s) is emitted, and airguns would be silent during the intervening periods. Airguns will be operated 24 h a day during the survey, excluding transit time to and from the port and the survey area (a total of approximately 168 h of airgun operations) and any unscheduled shutdowns. The total distance the seismic source would be towed while active during the survey is 1,704 km (~1,058.8 mi). See Table 1 for specifications of the 2 GI airgun source.

Table 1. Specifications of the 2 GI airguns to be used by the Research Vessel *Brooks McCall* during the seismic survey in the Gulf of Mexico

2 GI Airgun Specifications	
Energy Source – Number of Airguns	2 Sercel GI aiguns (105 in^3 each) Firing pressure of 2,000 psi
Source Output (Downward)	Peak-to-Peak = 239.6 dB re 1 µPa m [rms] 0-to-Peak = 233.8 dB re 1 µPa m [rms]
Position	2 string, in-line 2 m apart
Tow Depth	3–4 m
Air Discharge Volume	Approximately 210 in^3
Dominant Frequency Components	0–188 Hz
Pulse Duration	Approximately 0.113 s
Shot Interval	Approximately 12.5 m or 5–10 s

in^3=cubic inches, psi=pounds per square inch, dB=decibel, µPa=micro Pascal, rms=root mean square, m=meters, Hz=Hertz

The receiving system consists of 4 solid-state (solid flexible polymer, not gel or oil filled) hydrophone streamers. Each hydrophone streamer is 25 m (~82 ft) long and will be spaced 10 m (~32.8 ft) apart (i.e., the total spread of the hydrophone streamers will be 30 m or ~98.4 ft). Hydrophone streamers will be towed at a depth of 2 m (~6.6 ft). The towed hydrophone streamers receive the returning acoustic signals and transfer the data to an onboard processing system. The UT Gulf Coast Carbon Center designed and built GPS receivers, which can be used to accurately position the receivers on the hydrophone streamer and the acoustic source (airguns) via tail buoys. The turning rate of the R/V *Brooks McCall* will be limited when towing the airguns and hydrophone streamers.

3.4 Conservation Measures

DOE and UT plan to implement conservation measures (i.e., mitigation [during pre-survey planning and operations], monitoring, and reporting measures) to reduce the likelihood of adverse effects to ESA-listed species and their designated critical habitat from their proposed action. Mitigation is a measure that avoids or reduces the severity of the effects of the action on ESA-listed species. Monitoring is used to observe or check the progress of the mitigation over time and to ensure that any measure implemented to reduce or avoid adverse effects on ESA-listed species are successful.

In the draft Environmental Assessment provided by DOE, DOE and UT have considered mitigation and monitoring measures implemented during previous seismic surveys (including past NMFS Permits Division Incidental Harassment Authorizations and ITSs) and recommended best practices in Simmonds et al. (2014), Wright (2014), and Dolman and Jasny (2015). They have incorporated the following mitigation and monitoring measures into the proposed action based on the above sources:

- Exclusion and buffer zones;
- Shutdown and ramp-up procedures;
- Vessel-based monitoring by NMFS-approved PSOs;
- Additional measures considered; and
- Reporting.

Details on the above conservation measures are in the sections below.

3.4.1 Exclusion and Buffer Zones

DOE and UT will implement exclusion and buffer zones around the R/V *Brooks McCall* to minimize any potential adverse effects of sound from the 2 GI airguns on ESA-listed species. The exclusion zone is the area within which an occurrence of an ESA-listed species triggers a shutdown of the airguns. This reduces the exposure of ESA-listed species to sound levels that would be expected to have adverse effects on the species or habitats. The buffer zone is an area beyond the exclusion zone that will be monitored for the presence of ESA-listed species that may enter the exclusion zone. In the past, NMFS required a 100 m (~328.08 ft) exclusion zone and a 100 m (~328.08 ft) buffer zone for low-energy seismic surveys. Thus, DOE and UT will establish and monitor a 100 m (~328.08 ft) exclusion zone and a 100 m (~328.08 ft) buffer zone beyond the exclusion zone.

3.4.2 Shutdown and Ramp-Up Procedures

Shutdown of the airguns is the immediate deactivation of all airguns. Shutdown will occur if an ESA-listed species is observed within or approaching the 100 m (~328.08 ft) exclusion zone. Any PSO on duty will have the authority to delay the start of seismic survey activities or to call for a shutdown of the airguns if an ESA-listed species is observed within the exclusion zone. When a shutdown is called for by a PSO, the airguns must be immediately deactivated and any dispute regarding a PSO shutdown must be resolved only following deactivation. Following a shutdown, airgun activity will not resume until the ESA-listed species has cleared the exclusion zone.

The animal will be considered cleared from the exclusion zone if:

- It was visually observed to have left the exclusion zone, or
- It was not seen within the exclusion zone for 15 min (for sea turtles).

A ramp-up will begin by activating a single GI airgun and adding the second GI airgun 5 min later. During ramp-up, PSOs will monitor the exclusion and buffer zone, and, if an ESA-listed species is observed within or entering the exclusion zone, a shutdown will be implemented. If an ESA-listed species has not cleared the exclusion zone described in the shutdown procedures, a ramp-up will not occur.

A ramp-up will be implemented if a shutdown lasts 30 min or longer, as long as PSOs have maintained constant visual observation and no ESA-listed species were observed within the exclusion zone. A ramp-up will also be implemented if a shutdown is less than 30 min and PSOs have not maintained constant visual observation. If a shutdown lasts longer than 30 min and PSOs have not maintained constant visual observation, PSOs will monitor the exclusion and buffer zones for 30 min before ramp-up begins.

3.4.3 Vessel-Based Visual Monitoring

Visual monitoring of the exclusion and buffer zone is intended to establish and, when visual conditions allow, maintain zones around the sound source that are clear of ESA-listed species, thereby reducing the potential for adverse effects.

Visual monitoring requires the use of trained PSOs to scan the ocean surface visually for the presence of protected species (e.g., marine mammals, sea turtles, and fish). The area to be scanned visually includes primarily the exclusion zone, within which observation of certain protected species requires shutdown of the airgun array, but also the buffer zone. The buffer zone means an area beyond the shutdown zone to be monitored for the presence of protected species that may enter the shutdown zone.

Three independently contracted PSOs will be onboard the survey vessel during all seismic survey operations. During daytime, PSOs will scan the area around the vessel systematically with reticle binoculars (e.g., 7x50 Fujinon), Big-eye binoculars (25x150), and with the naked eye. No nighttime visual monitoring will be conducted. PSOs will have rotating shifts to allow for at least 1 observer (2 observers are recommended, although there will be times [e.g., breaks, meal times] when only 1 observer will be on duty) where to monitor for protected species.

3.4.4 Reporting

A monitoring report will be provided to NMFS. This comprehensive report detailing all seismic survey activities and monitoring results will be provided to NMFS ESA Interagency Cooperation Division within 90 days of the completion of the seismic survey.

4 Potential Stressors

The proposed action involves multiple activities, each of which can create stressors. Stressors are any physical, chemical, or biological entity that may induce an adverse effect either in an ESA-listed species or their designated critical habitat. During consultation, we deconstructed the proposed action to identify stressors that are reasonably certain to occur from the proposed action. These can be categorized as pollution (e.g., exhaust, fuel, oil, and trash), vessel strike, visual and acoustic disturbance (research vessel, airguns, and hydrophone streamers), and entanglement and/or interaction with towed seismic equipment (airguns and hydrophone streamers).

Below we provide information on the effects of these potential stressors. The proposed action includes several conservation measures (Section 3.3) that are designed to minimize effects from these potential stressors. Although these conservation measures are important and we expect them to be effective in minimizing the effects of these potential stressors, they do not completely eliminate the stressors. We treat them as part of the proposed action and fully consider them when evaluating the effects of the proposed action.

4.1 Pollution

Operation of the R/V *Brooks McCall* may result in pollution from exhaust, fuel, oil, and trash. Air and water quality are the basis of a healthy environment for all species. Emissions pollute the air, which could be harmful to air-breathing organisms and lead to ocean pollution (Chance et al. 2015; Duce et al. 1991). Emissions include carbon dioxide, methane, nitrous oxide, and other fluorinated gases that can deplete the ozone, affect natural earth cycles, and ultimately contribute to climate change (see https://www.epa.gov/ghgemissions/overview-greenhouse-gases for additional information). Pollutants in discharges of gray water and wastewater from the research vessel can degrade habitat for marine life.

Release of marine debris such as paper, plastic, wood, glass, and metal associated with vessel operations can also have adverse effects on marine species by risk of entanglement or ingestion (Gall and Thompson 2015). While lethal and non-lethal effects to air-breathing marine animals are well documented, marine debris also adversely affects marine fish (Gall and Thompson 2015).

4.2 Vessel Strike

Transit of any vessel in waters inhabited by ESA-listed species carries the risk of a vessel strike. If an animal is struck by a research vessel, it may experience minor, non-lethal injuries, serious injuries or death.

The probability of a vessel strike and associated response depends on the size and speed of the vessel, as well as the distribution, abundance, and behavior of the species. Vessel strike risk in sea turtles is not as well understood as it is in marine mammals. However, vessel strike is still considered a significant threat to sea turtles, which generally swim slower than other mobile marine species. Vessel strike is of particular concern for sea turtles occupying shallow coastal waters with high recreational boat density (Fuentes et al. 2021). Evidence of vessel strike has been documented in stranded and dead sea turtles in the Gulf of Mexico and U.S. Atlantic Ocean, as well as internationally (Barco et al. 2016; Denkinger et al. 2013; Foley et al. 2019; Hazel and Gyuris 2006; Reneker et al. 2018; Sobin and Tucker 2008; Tomás et al. 2008). Based on behavioral observations of green turtle avoidance of a small vessel (6 m in length), green turtles may be susceptible to vessel strikes at speeds as low as ~2 kts (4 km/h; Hazel et al. 2007a).

ESA-listed fishes considered in this opinion are elasmobranchs (e.g., sharks, rays, skates, and sawfish), which spend at least some time throughout their life in the upper portions of the water column where they may be susceptible to vessel strike.

4.3 Visual and Acoustic Disturbance

The proposed action will produce different sounds (vessel noise, noise from seismic survey equipment) that may produce an acoustic disturbance or otherwise affect ESA-listed species (e.g., auditory injury, changes in hearing ability, masking of important sounds, behavioral responses, and physical or physiological responses). The presence of the research vessel and towed seismic survey equipment may also produce a visual disturbance that may affect ESA-listed species.

The research vessel associated with the proposed action may cause visual or auditory disturbance to ESA-listed species that spend time near the surface of the water. There have been limited studies on how sea turtles and fishes respond to vessel presence; however, avoidance behaviors (i.e., diving, swimming away) have been documented in green turtles and fish exposed to an approaching vessel (Brehmer et al. 2019; De Robertis and Handegard 2013; Hazel et al. 2007a). For elasmobranchs in particular, it is uncertain how they may or may not be disturbed by vessel presence and noise. However, they are able to detect particle motion (the movement of the water), and in addition to visual cues, are able to sense an oncoming vessel and move away.

Documented behavioral changes in sea turtles and fishes due to seismic survey noise include avoidance, habituation, dive/startle responses, higher levels of stress hormones, and disrupted schooling of fish (DeRuiter and Larbi Doukara 2012; McCauley et al. 2003a; Nelms et al. 2016; Weilgart 2018). Loggerhead and green turtles displayed avoidance behavior such as faster swimming speeds, changes in swimming direction, and rapid dives in response to airgun noise (DeRuiter and Larbi Doukara 2012; McCauley et al. 2003a). For some species of shark, behavioral changes have been documented in response to the presence of loud and high intensity sound sources (Klimley and Myrberg 1979; Myrberg et al. 1978) and in the presence of artificially generated sound (Chapuis et al. 2019). In a study off Australia, some acoustically tagged sharks displayed possible avoidance to seismic survey operations (i.e., changing their swimming speed during seismic survey operations or changing their diel movement patterns post-survey) but others moved in and out of the area and even into the seismic survey area (Bruce et al. 2018). However, other studies show that some shark species may be attracted to low frequency pulsed sounds (Myrberg 2001). Thus, noise from both the research vessel and airguns remains a potential stressor associated with the proposed action.

4.4 Gear Entanglement and Interaction

The towed seismic equipment (i.e., airguns and towed hydrophone streamers) may pose an entanglement risk to ESA-listed species. Entanglement can result in injury or death of ESA-listed species. Sea turtles that are entangled in gear may starve from restricted movement, be injured from line or rope leading to lacerations and amputations, and may die from drowning/asphyxiation or even exertional myopathy, a muscle disease resulting from strenuous exercise or exercise under extreme stress (e.g., Duncan et al. (2017); Hamelin et al. 2017; Phillips et al. 2015). Injury and death from entanglement have been documented during all life stages of ESA-listed sea turtles (Duncan et al. 2017).

Entanglement of elasmobranchs is relatively understudied compared to marine mammal and sea turtle entanglements; however, studies have documented entanglement in both sharks and rays (see Parton et al. 2019 for a review). Entanglement in elasmobranchs can also result in injury, including laceration and abnormal anatomical development, and mortality (Afonso and Fidelis 2023).

Though unlikely, the towed hydrophone streamer could come in direct contact with ESA-listed species and sea turtle entanglement has occurred in towed gear from seismic survey vessels. For example, a National Science Foundation-funded seismic survey off the coast of Costa Rica in 2011 recovered a dead olive ridley turtle (*Lepidochelys olivacea*) in the deflector foil of towed seismic equipment; it is unclear whether the sea turtle became lodged in the deflector foil pre- or post-mortem (Spring 2011).

5 ACTION AREA

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02).

The proposed DOE action will occur at approximately 28.9–29.1°N and 94.9–95.2°W, within Texas state waters and within the U.S. Exclusive Economic Zone (Figure 1). Tracklines could occur anywhere in the proposed survey area (Figure 1), with ~222 km (~138 mi) of tracklines surveyed in one day, and a total of 1,704 km (~1,058.8 mi) of seismic acquisition.

The action area also includes all areas where stressors from the proposed action could occur: transit routes from the Port of Galveston or Port of Freeport and areas to which the sound from the airguns would travel (the ensonified area). It is difficult to measure the entire area that would be ensonified by the airguns, because to do so would require information on the ambient, or background, noise levels in the proposed survey area and then calculating at what distance from the source vessel the sound from the airguns would be similar to ambient noise levels. Ambient noise level measurements are difficult to find for a specific area because they can vary based on location, time, and environmental conditions such as water depth, wind, rain, sea ice coverage, and presence of vocalizing marine species (Hildebrand 2009a; Wenz 2005). However, as an alternative, sound propagation loss was estimated using a spreading loss equation to the 120 dB level. The 120 dB level is a lower threshold than any threshold used by NMFS to estimate acoustic impacts to ESA-listed species (see Summary of Endangered Species Act Acoustic Thresholds at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance), meaning that it is a conservative estimate of how far we would expect the sound from the airguns to travel and still have some effect on ESA-listed species. The distance to the 120 dB level based on the estimate source level of 2 GI airguns is

78–123 km or ~48.5–76.4 mi (M. Lusk, DOE, pers. comm to E. Chou, NMFS ESA Interagency Cooperation Division, July 27, 2023). This is less than approximately half the distance of trackline the research vessel would survey in 1 day.

The action area would not extend beyond the total area shown in Figure 1 (survey area in the red box). We do not anticipate any effects outside the area shown in Figure 1.

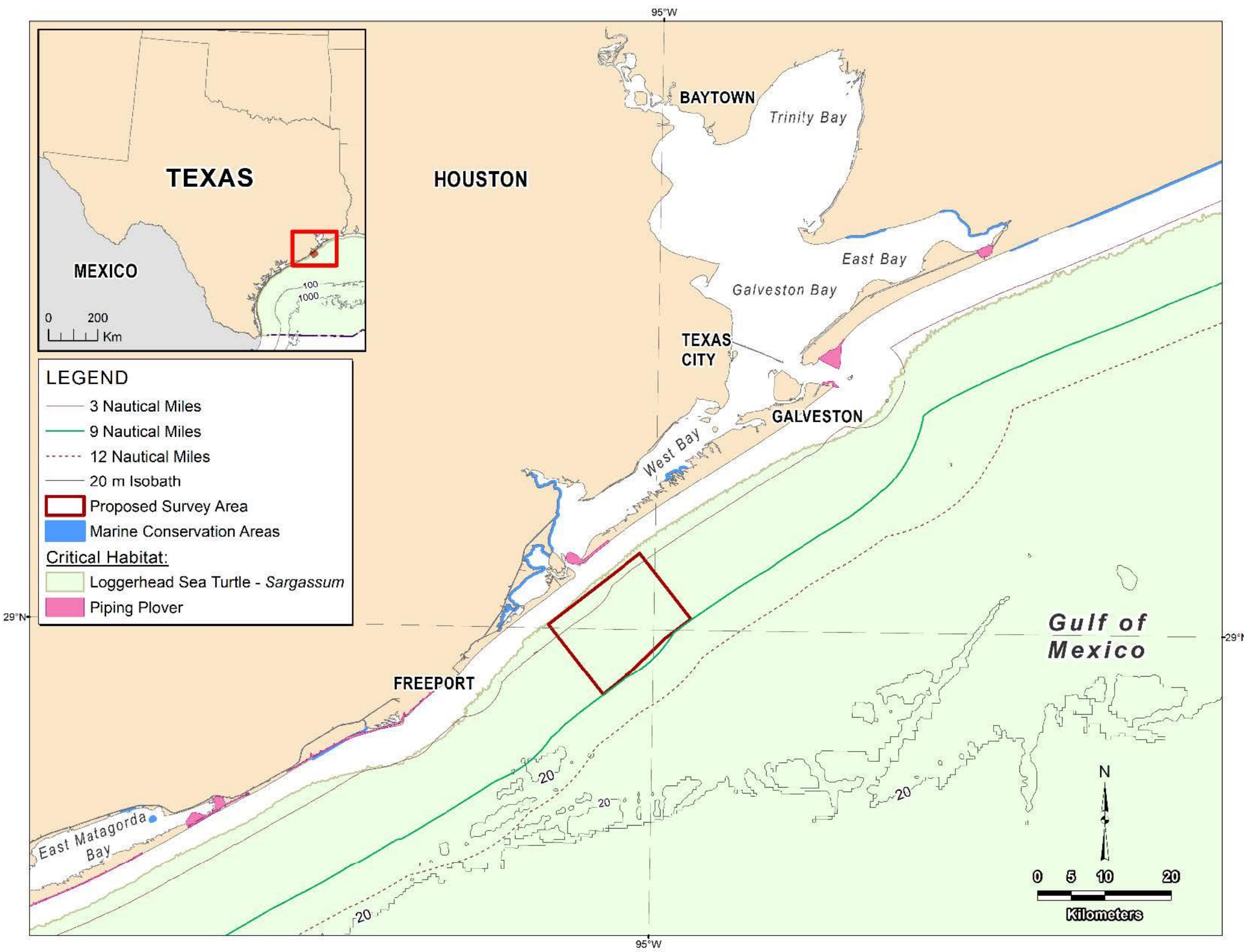

Figure 1. Map of the Department of Energy National Energy Technology Laboratory and University of Texas at Austin's proposed seismic survey in the Gulf of Mexico off Texas (DOE 2023)

6 Endangered Species Act-Listed Species and Designated Critical Habitat in the Action Area

This section identifies the ESA-listed species and designated critical habitat that potentially occur within the action area (Table 2) and thus may be affected by the stressors introduced to the action area by the proposed action.

Table 2. Endangered Species Act-Listed threatened and endangered species and designated critical habitat that potentially occur in the action area

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693* and 88 FR 46572 (Proposed)	10/1991 – U.S. Atlantic
Hawksbill Turtle (*Eretmochelys imbricata*)	E – 35 FR 8491	63 FR 46693*	57 FR 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170*	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39855	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009 – Northwest Atlantic
Fishes			
Giant Manta Ray (*Manta birostris*)	T – 83 FR 2916	-- --	10/2019 (Outline)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --	9/2018 (Outline)

ESA= Endangered Species Act, T=Threatened, E=Endangered, FR=*Federal Register*, DPS=Distinct Population Segment, * = critical habitat not in action area

7 Species and Designated Critical Habitat Not Likely to be Adversely Affected

NMFS uses 2 criteria to identify the ESA-listed species or designated critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are consequences of the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between 1 or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities. The second criterion is the probability of a response given exposure. An ESA-listed species or designated critical habitat that co-occurs with a stressor of the action, but is not likely to respond to the stressor, is also not likely to be adversely affected by the proposed action. We applied these 2 criteria to the ESA-listed species and designated critical habitat in Section 6 and we summarize our results below.

The applicable standard to find that a proposed action is not likely to adversely affect (NLAA) ESA-listed species or designated critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or wholly beneficial. 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 size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when species or critical habitat will be exposed to stressors, but the response will not be detectable outside of normal behaviors/habitat function. Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat.

This same decision model applies to individual stressors associated with the proposed action. For stressors that meet these criteria for wholly beneficial, discountable, or insignificant, the appropriate conclusion is NLAA.

In Section 7.1, we evaluate the proposed action’s stressors (Section 4) that are not likely to adversely affect ESA-listed species and designated critical habitat. In Sections 7.2–7.4, we also identify the ESA-listed species and designated critical habitat that are not likely to be adversely affected by all stressors from the proposed action.

Stressors that may affect, but are not likely to adversely affect the ESA-listed sea turtles, fishes, and designated critical habitat considered in this opinion (see Table 2) include pollution, vessel strike, vessel noise and visual disturbance, and gear entanglement and interaction. The following sections describe how we reached our effects determinations for these stressors.

7.1 Stressors Not Likely to Adversely Affect Species or Designated Critical Habitat

Stressors that may affect, but are not likely to adversely affect the ESA-listed sea turtles, fishes, and designated critical habitat considered in this opinion (see Table 2) include pollution, vessel strike, vessel noise and visual disturbance, and gear entanglement and interaction. The following sections describe how we reached our effects determinations for these stressors.

7.1.1 Pollution

Pollution in the form of exhaust, fuel or oil spills or leaks, and trash or other debris resulting from the use of the research vessel as part of the proposed action could result in impacts to ESA-listed sea turtles, fishes, and PBFs for the Northwest Atlantic Ocean Distinct Population Segment (DPS) of loggerhead turtle designated critical habitat.

Exhaust (i.e., air pollution, including carbon dioxide, nitrogen oxides, and sulfur oxides) from the research vessel would occur during the entirety of the proposed action (transit and operations), and could affect air-breathing ESA-listed species such as sea turtles. The R/V

Brooks McCall (or similar vessel) uses low-sulfur fuel (sulfur content between 0.1 and 1.5 m/m %). It is unlikely that exhaust resulting from the operation of the R/V *Brooks McCall* (or similar vessel) will have a measureable effect on ESA-listed sea turtles given the relatively short duration of the seismic survey (10 days) and the brief amount of time that sea turtles spend at the water's surface. In addition, due to the relatively large size of the action area and overall small contribution of air emissions from the R/V *Brooks McCall* (or similar vessel) compared to all ocean-going vessels in the action area, we expect that potential effects to ESA-listed species from vessel exhaust during the proposed action is immeasurable. For these reasons, the effects that may result from exhaust on ESA-listed sea turtles, fishes, and the Northwest Atlantic Ocean DPS of loggerhead turtle designated critical habitat are insignificant.

Discharges into the water from the research vessel (e.g., wastewater, leakages of fuel or oil) are unlikely, and effects of any spills to ESA-listed sea turtles, fishes, and designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtles will be minimal, if they occur at all. The potential for fuel or oil leakages is extremely unlikely. The R/V *Brooks McCall* has not had a spill in over 5 years. DOE and UT will dispose of all project-related wastes in accordance with international, U.S. state, and federal requirements. In particular, for a vessel that remains close to shore, as the R/V *Brooks McCall* will in the proposed seismic survey, all waste will be retained onboard and returned to shore rather than appropriately disposed of at sea. Thus, we expect the risk from fuel or oil spills, leaks, and waste, on ESA-listed sea turtles, fishes, and the Northwest Atlantic Ocean DPS of loggerhead turtle designated critical habitat to be extremely unlikely to occur and thus discountable.

Trash or other debris resulting from the proposed action may affect ESA-listed sea turtles, fishes, and designated critical habitat. Any marine debris (e.g., plastic, paper, wood, metal, glass) that might be released would be accidental. The gear used in the proposed seismic survey may also result in marine debris if lost at sea. However, because the potential for accidental release of trash or loss of gear is extremely unlikely to occur, we expect that the effects from debris on ESA-listed sea turtles, fishes, and the Northwest Atlantic Ocean DPS of loggerhead turtle designated critical habitat are discountable.

For the reasons stated above, we conclude that pollution by vessel exhaust, waste, fuel or oil spills or leaks, and trash or other debris, may affect, but is not likely to adversely affect ESA-listed species and designated critical habitat in the action area.

7.1.2 Vessel Strike

While vessel strikes of sea turtles and fishes during the seismic survey are possible, we are not aware of any definitive case of a sea turtle or fish being struck by a vessel associated with seismic surveys. While the risk of vessel strike to sea turtles is of particular concern in shallow coastal waters (Fuentes et al. 2021), we believe vessel strike to be extremely unlikely due to the general expected movement of sea turtles and fishes away from or parallel to the research vessel, as well as the relatively slow speed of the research vessel. The research vessel used for the proposed seismic survey will be traveling at a relatively slow speed (~4–5 kts [7.4–9.3 km/h]) during airgun operations, with a maximum transit speed of 11 kts (~20.4 km/h), thereby reducing the potential for vessel strike. We also expect vessel strike risk to ESA-listed elasmobranchs considered in this opinion to be extremely unlikely because they are able to detect approaching vessels, through visual cues or hearing, and move away. Elasmobranchs are able to detect particle motion, especially in shallow water, and are able to move quickly to avoid vessel strike (Myrberg 2001; Popper and Hawkins 2016).

In addition to the rationale above, adherence to conservation measures such as vessel-based visual monitoring of exclusion and buffer zones, is expected to further reduce the likelihood of vessel strikes of ESA-listed sea turtles and fishes. We expect that vessel strikes to ESA-listed sea turtles and fishes in the action area are extremely unlikely to occur, and the effect is therefore discountable. We conclude that vessel strike may affect, but is not likely to adversely affect ESA-listed species.

7.1.3 Vessel Noise and Visual Disturbance

The research vessel to be used for the proposed seismic survey may cause visual or auditory disturbance to ESA-listed species that spend time near the surface or upper parts of the water column, such as sea turtles and fishes. Visual and auditory disturbance may also affect the PBFs for loggerhead turtle designated critical habitat, particularly important species in *Sargassum* habitat (i.e., copepods that make up the PBF for available prey). Vessel noise and visual disturbance may disrupt species’ behavior resulting in avoidance when a vessel moves towards them. However, it is difficult to distinguish whether these responses are caused by the physical presence of a vessel, the underwater noise generated by the vessel, or an interaction between the two.

The research vessel’s passage past ESA-listed sea turtles or fishes would be brief, and not likely to significantly impact any individual’s ability to feed, reproduce, or avoid predators. Conservation measures proposed by DOE and UT (e.g., shutdown and ramp-up procedures, and vessel-based visual monitoring) will also minimize the risk of noise from the airguns. In addition, sea turtles are most likely to habituate to the vessel noise, and were observed to be less affected by vessel noise at distances greater than 10 m or ~32.8 ft (Hazel et al. 2007a). The relatively slow traveling speed of the research vessel would also reduce underwater noise (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007).

Regarding impacts on the PBFs for the Northwest Atlantic Ocean DPS of loggerhead turtle, impacts of vessel presence (visual and auditory, though most scientific literature is focused on the auditory impacts) on prey species such as copepods are largely unknown. Some studies have shown vessel noise to elicit anti-predatory defense behavior and a reduction in egg production and size of copepods (Aspirault 2019); however, other studies have shown a lack of response in zooplankton (Prosnier et al. 2022; Sabet et al. 2019).

Because the potential visual and auditory disturbance from the research vessel is expected to be nearly undetectable, or so minor that it cannot be meaningfully evaluated, we expect that this risk to ESA-listed sea turtles, fishes, and the Northwest Atlantic Ocean DPS of loggerhead turtle designated critical habitat is insignificant. Therefore, we conclude that vessel noise and visual disturbance may affect, but is not likely to adversely affect ESA-listed species or designated critical habitat.

7.1.4 Gear Entanglement and Interaction

The towed seismic survey equipment (airguns and hydrophone streamers) may pose a risk of entanglement and interaction to ESA-listed sea turtles and fishes. Although the towed seismic survey equipment could come in direct contact with an ESA-listed species, resulting in entanglement or interaction, we expect this to be extremely unlikely. The airguns and towed hydrophone streamers are rigid and, as such, are not expected to encircle, wrap around, or, in any other way, entangle any ESA-listed sea turtles or fishes considered in this opinion. Furthermore, we expect sea turtles and fishes to avoid areas where the airguns are actively being used, meaning they would likely avoid the towed hydrophone streamers as well. Instances of entanglement and interaction of ESA-listed species in towed seismic survey equipment are unknown to us. Based upon the material of the gear, the conservation measures that will be implemented by DOE and UT (e.g., vessel-based visual monitoring, exclusion and buffer zones), and the extensive deployments of this type of equipment with no reported entanglements or interactions, we find the probability of adverse impacts to ESA-listed sea turtles and fishes from this stressor to be extremely unlikely to occur, and any effects are discountable. Therefore, we conclude that gear entanglement and interaction may affect, but are not likely to adversely affect ESA-listed sea turtles and fishes.

7.1.5 Potential Stressors Considered Further

The remaining potential stressor that may affect ESA-listed species and designated critical habitat within the action area is the sound produced by the 2 GI airguns. This stressor associated with the proposed seismic survey may affect ESA-listed species and designated critical habitat. ESA-listed species and designated critical habitat that are not likely to be adversely affected by this stressor are evaluated in the sections below. ESA-listed species that are likely to be adversely affected by this stressor are further analyzed and evaluated in Section 10.

7.2 Elasmobranchs

ESA-listed elasmobranchs considered in this opinion (giant manta ray and oceanic whitetip shark) may be exposed to and be able to detect sound generated by the 2 GI airguns used in the seismic survey. Elasmobranchs are able to detect particle motion, rather than sound pressure, because they lack a swim bladder like most teleost fish (Myrberg 2001; Popper and Hawkins 2016). They use their inner ears and lateral line, which is capable of detecting relative motion between the body’s surface and the surrounding water, to detect nearby (generally within 2 body lengths) sound sources (Popper et al. 2014a). Given their assumed hearing range, elasmobranchs are anticipated to be able to detect the low-frequency sound from the airguns, if exposed. However, the duration and intensity of low-frequency sound sources and implementation of conservation measures (e.g., shutdown and ramp-up procedures, vessel-based visual monitoring) will likely minimize the effect of airgun noise on elasmobranchs. Furthermore, elasmobranchs generally are not considered especially sensitive to sound (Casper et al. 2012).

For some species of elasmobranchs, behavioral changes have been documented in response to the presence of sound. A study on southern stingrays in a very shallow (35–75 cm depth) ocean net pen (5x5 m), observed changes in swimming behavior in response of low-frequency tones (50–500 Hz) at 140 dB re 1 µPa in females, and 160 dB re 1 µPa in males (Mickle et al. 2020). Some species of sharks also temporarily changed their behavior in response to loud and high intensity sound sources (Klimley and Myrberg 1979; Myrberg et al. 1978) and in the presence of artificially generated sound (Chapuis et al. 2019). In a study off Australia, some acoustically tagged sharks displayed possible avoidance of seismic survey operations (i.e., changing their swimming speed during seismic survey operations or changing their diel movement patterns post-survey) but others moved in and out of the area and even into the seismic survey area (Bruce et al. 2018). Other studies show that some shark species are attracted to low-frequency pulsed sounds (Myrberg 2001). Pulsed sounds are not unlike the sound from airguns, and a review of sound effects on fishes concluded that the relative risk of elasmobranchs exhibiting a behavioral response, injury, or mortality to impulsive sound sources was low (Popper et al. 2014a).

The precise expected response of ESA-listed elasmobranchs to low-frequency acoustic energy is not completely understood; however, given the signal of the airgun sound and level of exposure to the signal, we do not expect a measureable response. The most likely response of ESA-listed elasmobranchs exposed to the airguns, if any, would be minor temporary behavioral changes in orientation to the sound source, none of which would be detectable outside of normal behavioral responses or result in adverse effects to the individual. Therefore, the potential effect of the airgun noise on ESA-listed elasmobranchs is considered insignificant. We conclude that noise from the airguns may affect, but is not likely to adversely affect ESA-listed elasmobranchs (giant manta ray and oceanic whitetip shark).

7.3 Hawksbill Sea Turtle

The ESA-listed hawksbill turtle may occur in the action area and may be affected by sound generated by the 2 GI airguns used in the seismic survey. The hawksbill turtle is generally found throughout the tropics and subtropics, including coastal and pelagic areas, in the Atlantic, Indian, and Pacific Oceans (NMFS 2013). Hawksbill turtles nest at low densities throughout the southern Gulf of Mexico (April–September; Cuevas et al. 2019) and wider Caribbean region (Piniak and Eckert 2011), with infrequent nesting in southern Texas (Eckert and Eckert 2019; Valverde and Holzwart 2017). Based on telemetry data compiled by The State of the World’s Sea Turtles (SWOT 2022) and sightings recorded in the Ocean Biodiversity Information System Spatial Ecological analysis of Megavertebrate Populations (OBIS-SEAMAP) database, hawksbill turtles are rare in the northern Gulf of Mexico. For hawksbill turtles, the DOE effects determination was may affect, likely to adversely affect. However, based on the best available science, summarized above and in the DOE's draft environmental assessment (DOE 2023), it is extremely unlikely that the proposed seismic survey will overlap with hawksbill turtles. In addition, the closest OBIS-SEAMAP record of a hawksbill turtle to the proposed survey area is ~200 km (~124 mi) south, off Corpus Christi, Texas, and only one other sighting has been made off Texas, in deep water (Halpin et al. 2009). Because of the low probability of occurrence of hawksbill turtles in the action area, the potential of exposure to effects from the airgun noise is extremely unlikely to occur and thus discountable. Therefore, we conclude that DOE and UT's seismic survey may affect, but is not likely to adversely affect ESA-listed hawksbill turtles.

7.4 Designated Critical Habitat – Loggerhead Turtle Northwest Atlantic Ocean Distinct Population Segment

On July 10, 2014, NMFS and the U.S. Fish and Wildlife Service (USFWS) designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtles along the U.S. Atlantic and Gulf of Mexico coasts (79 FR 39856; Figure 2). The Final Rule designated 5 different units of critical habitat, each supporting PBFs for loggerhead turtles. These units include nearshore reproductive habitat, winter area, *Sargassum*, breeding areas, and migratory corridors. In total, the designated critical habitat is composed of 38 occupied marine areas and 1,102.4 km (685 mi) of nesting beaches. Loggerhead designated critical habitat occurs within the action area; however, only the *Sargassum* unit overlaps with the action area. PBFs for *Sargassum* habitat include: 1) areas where there are concentrated components of the *Sargassum* community in water temperatures suitable for optimal growth of *Sargassum* and loggerhead inhabitance; 2) *Sargassum* in concentrations that support adequate prey abundance and cover; 3) available prey and other material associated with *Sargassum* habitat; and 4) sufficient water depth and proximity to available currents for offshore transport, foraging, and cover for post-hatchling loggerheads.

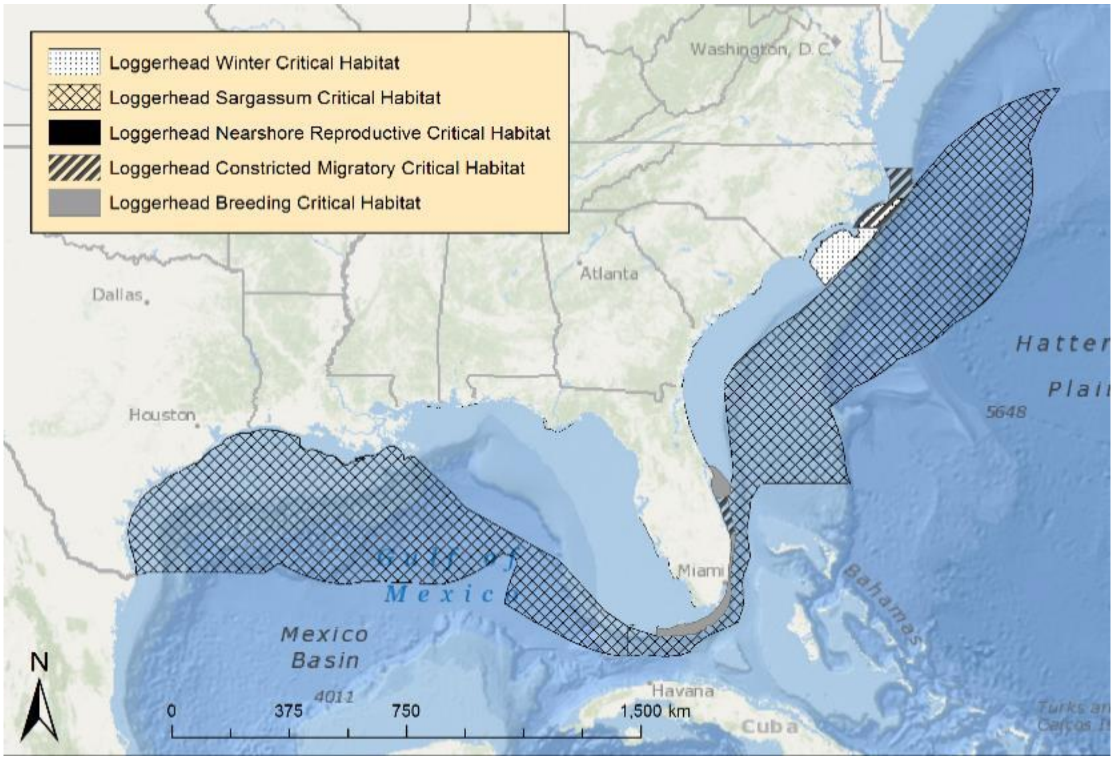

Figure 2. Designated critical habitat for the Northwest Atlantic Ocean Distinct Population Segment of loggerhead sea turtles

The entire proposed survey area (222 km^2 or 85.7 mi^2) overlaps with *Sargassum* habitat. The proposed seismic survey may affect the third PBF of *Sargassum* habitat: available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods. We found very little information regarding airgun noise impacts on hydroids, although Solé et al. (2016) observed acoustic trauma in true jellyfish when exposed to low-frequency sounds. There was also little information on airgun noise effects on copepods in the action area; however, evidence indicates that seismic airguns may lead to a significant reduction in zooplankton (McCauley et al. 2017). McCauley et al. (2017) found that the use of a single airgun with a volume of 150 in^3 led to a decrease in zooplankton abundance by over 50% and a 2 to 3-fold increase in dead adult and larval zooplankton when compared to control scenarios. Copepods, an abundant zooplankton species, in particular experienced a 50% reduction in abundance around 509–658 m (1,670–2,159 ft) from the airgun (McCauley et al. 2017). However, Fields et al. (2019) observed limited effects on *Calanus spp.* (a genus of copepod) mortality within 10 m from an airgun source (4,260.6 cm^3 or 260 in^3), and no measureable effects at distances greater than 10 m. At distances within 5 m (16.4 ft) from the airguns, Fields et al. (2019) observed significantly higher immediate mortality (within 1 h after exposure) in copepods exposed to the airgun noise compared to the control. Mortality 1 week after exposure to the airguns was 9% higher than controls in copepods placed 10 m (32.8 ft) from the airgun blast but was not significantly different from the controls at a distance of 20 m (65.6 ft) from the airgun blast.

McCauley et al. (2017) noted that, for seismic 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, 3-D seismic surveys, which involve the use of multiple overlapping tracklines to extensively and intensively survey a particular area, could be of concern McCauley et al. 2017. In part, this is because, for such activities to have a measurable effect, they need to outweigh the naturally fast turnover rate of zooplankton McCauley et al. 2017.

Given the results from each of these studies, it is difficult to assess the exact effect seismic airguns may have on the instantaneous or long-term survivability of hydroids or copepods that are exposed. The majority of copepod prey available to loggerhead sea turtles in *Sargassum* habitat are expected to be near the surface (Witherington et al. 2012), but the results of McCauley et al. (2017) provide little information on the effects to copepods at the surface because their analyses excluded zooplankton in the surface bubble layer. Nonetheless, given that airguns primarily transmit sound downward, and airguns associated with the proposed action will be towed at depths between 3–4 m (9.8–13.1 ft), we expect that sounds from seismic airguns will be relatively low at the surface and, as such, would affect copepod prey in *Sargassum* critical habitat less than that reported in McCauley et al. (2017). We also anticipate that seismic survey operators will actively avoid *Sargassum* patches within the action area because *Sargassum* may get tangled in the towed seismic equipment and propellers, and could damage the seismic equipment. Further, the proposed survey will be temporary (7 days of seismic acquisition), overlap a relatively small portion of *Sargassum* (222 km^2 or 85.7 mi^2) habitat, and is not likely to have significant effects on zooplankton given the high turnover rate of zooplankton.

In summary, while the proposed seismic survey may temporarily alter copepod abundance in designated loggerhead *Sargassum* critical habitat, we expect such effects to be insignificant because 1) most copepods will be near the surface where sound levels from seismic airguns are expected to be relatively low, 2) seismic survey operators will actively avoid *Sargassum* patches, and 3) the high turnover rate of zooplankton will minimize any effects. Therefore, we find that the proposed action may affect, but is not likely to adversely affect designated loggerhead *Sargassum* critical habitat.

8 SPECIES LIKELY TO BE ADVERSELY AFFECTED

This section identifies and examines the status of ESA-listed sea turtles that are expected to be adversely affected by sound generated by the airguns from the proposed action's seismic survey activities. The status includes the existing level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and ESA-listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §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 these NMFS websites: https://www.fisheries.noaa.gov/species-directory/threatened-endangered. One factor affecting the range-wide status of sea turtles and marine habitat at large is climate change. The localized effects of climate change in the action area are discussed in the Environmental Baseline (Section 9).

8.1 Green turtle – North Atlantic Distinct Population Segment

The green turtle was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed 11 DPSs of green turtles as threatened or endangered under the ESA (81 FR 20057). The North Atlantic DPS of green turtle is listed as threatened. The North Atlantic DPS of green turtle is found in the North Atlantic Ocean and Gulf of Mexico (Figure 3).

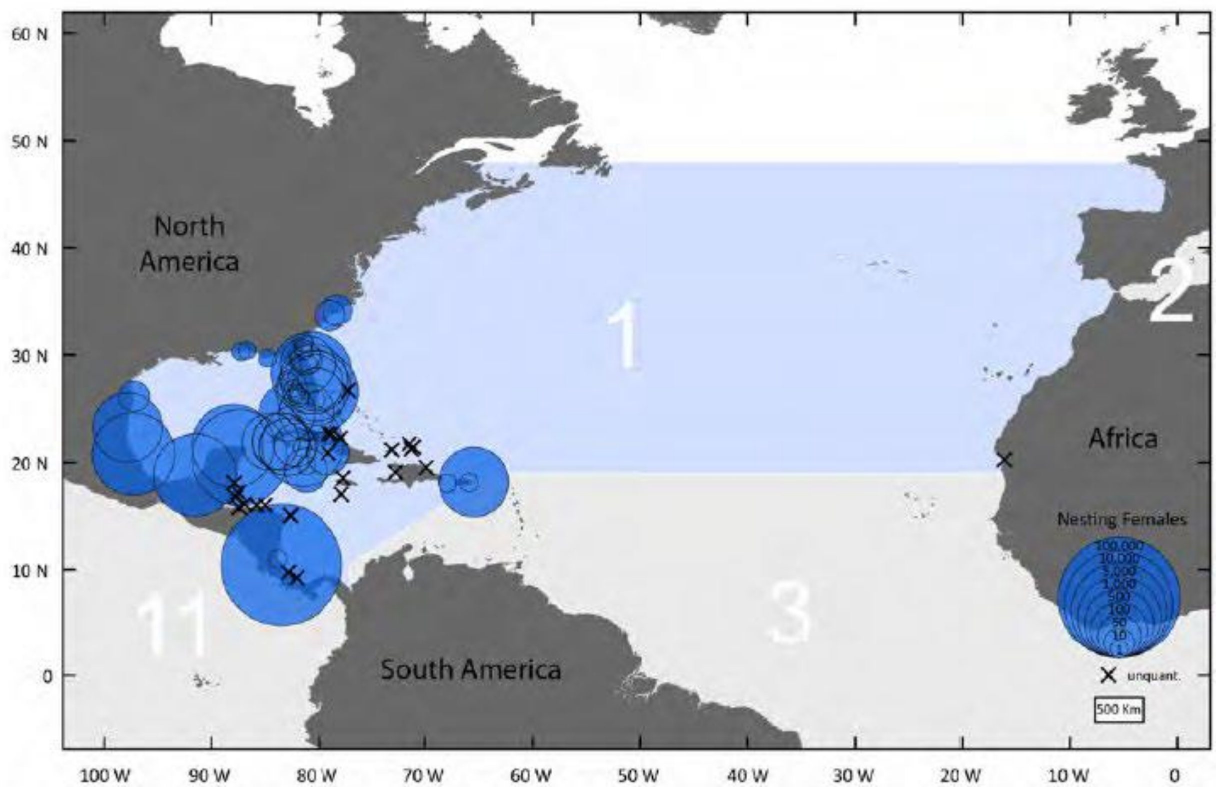

Figure 3. Map of geographic range of the North Atlantic distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015)

8.1.1 Life History

Green turtles have a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. Mating occurs in waters off nesting beaches. Females are usually 20 to 40 years at first reproduction. Green turtles lay an average of three nests per season with an average of 100 eggs per nest. The remigration interval (i.e., return to natal beaches) is 2–5 years for females. Males are known to reproduce every year (Balazs 1983). In the southeastern U.S., females generally nest between June through September, and peak nesting occurs in June through July (Witherington and Ehrhart 1989). During the nesting season, females nest at approximately 2-week intervals, laying an average of 3–4 clutches (Johnson and Ehrhart 1996) of approximately 110–115 eggs. Eggs incubate for approximately 2 months before hatching. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months.

After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. This early oceanic phase remains one of the mostly poorly understood aspects of the life history of green turtles (NMFS and USFWS 2007a). Green turtles exhibit particularly slow growth rates of about 1–5 cm (0.4–2 in) per year (Green 1993; McDonald-Dutton and Dutton 1998), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal 1982). At approximately 20–25 cm (8–10 in) carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in seagrass and marine algae. Growth studies using skeletochronology indicate that green turtles in the western Atlantic Ocean shift from the oceanic phase to nearshore developmental habitats after approximately 5–6 years (Bresette et al. 2006; Zug and Glor 1998). Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel 1974), although some populations are known to also feed heavily on invertebrates (Carballo et al. 2002). Adult green turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges, and other invertebrate prey. Green turtles mature slowly, requiring 20 to 50 years to reach sexual maturity (Chaloupka and Musick 1997; Hirth and USFWS 1997).

8.1.2 Population Dynamics

Accurate population estimates for marine turtles do not exist because of the difficulty in sampling turtles over their geographic ranges and within their marine environments. Nonetheless, researchers have used nesting data to study trends in reproducing sea turtles over time. Worldwide, nesting data at 464 sites indicate that 563,826–564,464 female green turtles nest each year (Seminoff et al. 2015). A summary of nesting trends and nester abundance is provided in the most recent status review for the species (Seminoff et al. 2015), with information for the North Atlantic DPSs.

The range of the North Atlantic DPS extends from the boundary of South and Central America, north to Nova Scotia/Newfoundland, and east across the Atlantic Ocean to the western coasts of Africa and Europe (Figure 3). In the waters of the U.S. Atlantic Ocean and Gulf of Mexico, green turtles are distributed throughout inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern U.S. include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957; Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and Wershoven 1992). The summer developmental habitat for green turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997). Additional important foraging areas in the western Atlantic Ocean include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Sea coast of Panama, scattered areas along Colombia and Brazil (Hirth 1971), and the northwestern coast of the Yucatán Peninsula.

Compared to other DPSs, the North Atlantic DPS of green turtle exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites (Figure 3; Seminoff et al. 2015). Eight of the nesting sites have high levels of abundance (i.e., >1,000 nesters), located in Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), U.S. (Florida), and Cuba (Seminoff et al. 2015). All major nesting populations demonstrate long-term increases in abundance (Seminoff et al. 2015).

Tortuguero, Costa Rica is by far the predominant nesting site, accounting for an estimated 79% of nesting for the DPS (Seminoff et al. 2015). Nesting at Tortuguero appears to have been increasing since the 1970's, when monitoring began. For instance, from 1971–1975 there were approximately 41,250 average annual emergences documented and this number increased to an average of 72,200 emergences from 1992–1996 (Bjorndal et al. 1999). Troëng and Rankin (2005) collected nest counts from 1999–2003 and also reported increasing trends in the population consistent with the earlier studies, with nest count data suggesting 17,402–37,290 nesting females per year (NMFS and USFWS 2007a). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica population's growing at 4.9% annually.

In the U.S., green turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf Coast of Florida, Georgia, North Carolina, and Texas (Meylan et al. 1995). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9% at that time. Increases have been even more rapid in recent years. In Florida, index beaches were established to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green turtle nesting has generally shown biennial peaks in abundance with a positive trend during the 10 years of regular monitoring. According to data collected from Florida's index nesting beach survey from 1989–2022, green sea turtle nest counts across Florida have increased dramatically, from a low of 267 in the early 1990s to a high of 40,911 in 2019. Similar to the nesting trend found in Florida, in-water studies in Florida have also recorded increases in green turtle captures at the Indian River Lagoon site, with a 661% increase over 24 years (Ehrhart et al. 2007), and the St Lucie Power Plant site, with a significant increase in the annual rate of capture of immature green turtles (straight carapace length < 90 cm) from 1977 to 2002 (3,557 green turtles total; M. Bressette, Inwater Research Group, unpubl. data; Witherington et al. 2006).

Differences in DNA of green turtles from different nesting regions can indicate different genetic subpopulations (Bowen et al. 1992; Fitzsimmons et al. 2006). For example, the North Atlantic DPS of green turtle has a globally unique haplotype, which was a factor in defining the discreteness of this population. Evidence from mitochondrial DNA studies indicates that there are at least 4 independent nesting subpopulations in Florida, Cuba, Mexico, and Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016). Although green turtles may nest in different regions, individuals from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. For example, in the South Atlantic DPS, genetic analysis of green turtles on the foraging grounds off Ubatuba and Almofala, Brazil show mixed stocks coming primarily from Ascension, Suriname and Trindade as a secondary source, but also Aves, and even sometimes Costa Rica (North Atlantic DPS) (Naro-Maciel et al. 2007; Naro-Maciel et al. 2012).

Within U.S. waters, individuals from both the North Atlantic DPS and South Atlantic DPS can be found on foraging grounds. While there are currently no in-depth studies available to determine the percent of North Atlantic DPS and South Atlantic DPS individuals in any given location two small-scale studies provide an insight into the degree of mixing on the foraging grounds. An analysis of cold-stunned green turtles in St. Joseph Bay, Florida (northeastern Gulf of Mexico; North Atlantic DPS) found approximately 4% of individuals came from nesting stocks in the South Atlantic DPS (specifically Suriname, Aves Island, Brazil, Ascension Island, and Guinea Bissau; Foley et al. 2007). On the Atlantic Ocean coast of Florida (North Atlantic DPS), a study on the foraging grounds off Hutchinson Island found that approximately 5% of the green turtles sampled came from the Aves Island/Suriname nesting assemblage, which is part of the South Atlantic DPS (Bass and Witzell 2000). All of the individuals in both studies were benthic juveniles. Available information on green turtle migratory behavior indicates that long distance dispersal is only seen for juvenile green turtles. This suggests that larger adult-sized green turtles return to forage within the region of their natal rookeries, thereby limiting the potential for gene flow across larger scales (Monzón-Argüello et al. 2010). Currently, there is no indication that South Atlantic DPS turtles occur off Texas (northwestern Gulf of Mexico).

8.1.3 Vocalization and Hearing

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz–2 kHz, with a range of maximum sensitivity between 100–800 Hz (Bartol et al. 1999a; Lenhardt 1994, 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2016) found green turtle juveniles capable of hearing underwater sounds at frequencies of 50 Hz–1,600 kHz (maximum sensitivity at 200–400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Based upon auditory brainstem responses of green turtles have been measured to hear in the 50 Hz–1.6 kHz range (Dow et al. 2008), with greatest response at 300 Hz (Yudhana et al. 2010); a value verified by Moein Bartol and Ketten (2006). Other studies have similarly found greatest sensitivities between 200–400 Hz for the green turtle with a range of 100–500 Hz (Bartol and Ketten 2006; Ridgway et al. 1969) and around 250 Hz or below for juveniles (Bartol et al. 1999a). However, Dow et al. (2008) found best sensitivity between 50–400 Hz.

These hearing sensitivities are similar to those reported for 2 terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200–700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3 kHz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3–4 kHz (Patterson 1966).

In the French West Indies, a recent study recorded vocalizations of free-ranging juvenile green turtles (Charrier et al. 2022). Four main categories of vocalizations were recorded: pulses, low-amplitude calls, frequency-modulated calls, and squeaks. Pulses (mono, doublet, triplets, and multipulses consisting of an average of 5 pulses) had a main frequency around 1 kHz. Low-amplitude calls consisted of croaks and rumbles. The frequency range for croaks was 725 ± 330 Hz and the frequency range for rumbles was 323 ± 94 Hz. Frequency-modulated calls were either ascending, descending, or both, and ranged between 31–1,047 Hz. Squeaks were more than 3 kHz. Received levels of all vocalizations ranged between 102–124 dB re 1 μPa (rms).

8.1.4 Status

Once abundant in tropical and sub-tropical waters, green turtles worldwide exist at a fraction of their historical abundance, as a result of over-exploitation for food and other products. Globally, egg harvest, the harvest of females on nesting beaches and directed hunting of sea turtles in foraging areas remain the three greatest threats to their recovery. In addition, bycatch in drift-net, long-line, set-net, pound-net, and trawl fisheries kill thousands of green turtles annually. Other threats include pollution, habitat loss through coastal development or stabilization, destruction of nesting habitat from storm events, artificial lighting, poaching, global climate change, natural predation, disease, cold-stunning events, and oil spills. On a regional scale, the different DPSs experience these threats as well, to varying degrees. Differing levels of abundance combined with different intensities of threats and effectiveness of regional regulatory mechanisms make each DPS uniquely susceptible to future perturbations. While the threats continue, the green turtle appears to be somewhat resilient to future perturbations.

Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population's decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green turtle generation, up to 50 years. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS of green turtle appears to be somewhat resilient to future perturbations.

8.1.5 Status in the Action Area

Green turtles nest throughout the Gulf of Mexico from May through September (Valverde and Holzwart 2017). In the Gulf of Mexico, major nesting beaches are located in Mexico and Florida, but there have been nesting females recorded on South Padre Island and Padre Island National Seashore off the southern tip of Texas (Eckert and Eckert 2019; Seminoff et al. 2015; SWOT 2022; Valverde and Holzwart 2017). Telemetry data on green turtles recorded animals in waters off Texas, as well as in the rest of the northern Gulf of Mexico; however, most records were in the southern portion of the Gulf of Mexico, which is outside of the action area (SWOT 2022). Dispersal modeling by Putman et al. (2020) indicates that hatchlings could occur throughout the Gulf of Mexico, including the proposed survey area. There is one OBIS-SEAMAP record from near the 20-m isobath more than 50 km southeast of the proposed survey area; this record is for February (Halpin et al. 2009).

8.2 Kemp's ridley turtle

The Kemp's ridley turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). Its range extends from the Gulf of Mexico to the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas (Figure 4). Kemp's ridley sea turtles have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomás and Raga 2008). Juvenile Kemp's ridley turtles, possibly carried by oceanic currents, have been recorded as far north as Nova Scotia. The species was listed as endangered under the ESA since 1970.

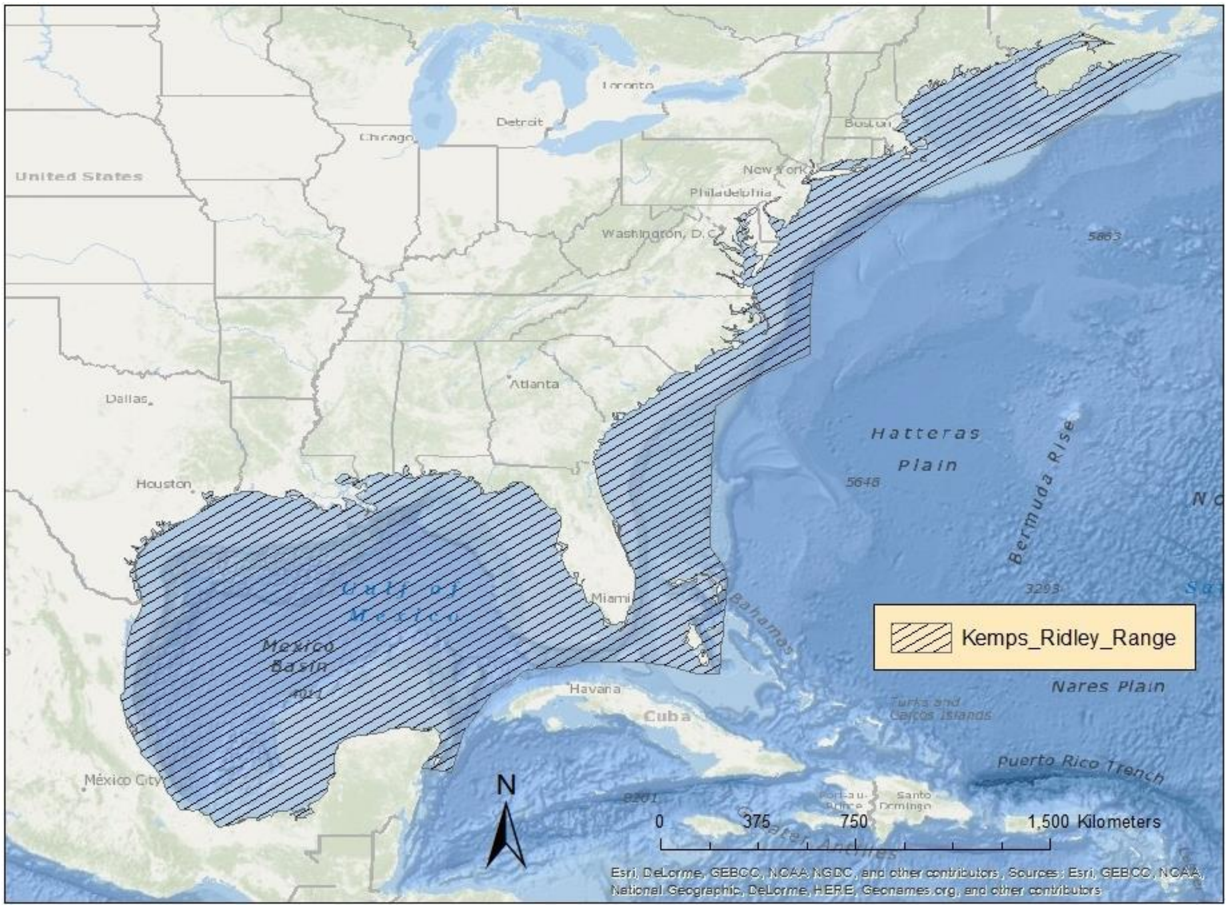

Figure 4. Map identifying the range of the endangered Kemp's ridley turtle off the U.S. coast

8.2.1 Life History

Kemp's ridley turtles share a general life history pattern similar to other sea turtles. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. After 45–58 days of embryonic development, the hatchlings emerge and swim offshore into deeper, oceanic waters where they feed and grow until returning at a larger size. Their return to nearshore coastal habitats typically occurs around 2 years of age (Ogren 1989), although the time spent in the oceanic habitat may vary from 1–4 years or perhaps more (TEWG 2000). Females generally reach maturity at 12 years of age, but may range from 5–16 years. The average remigration is 2 years, although some animals nest annually. Nesting occurs from April through July in arribadas (large aggregations) mainly on beaches in the Gulf of Mexico, but primarily at Rancho Nuevo, Mexico. Historic records indicate a nesting range from Mustang Island, Texas, in the north to Veracruz, Mexico, in the south. Kemp's ridley turtles have also recently been nesting along the Atlantic coast of the U.S., with nests recorded from beaches in Florida, Georgia, North Carolina, South Carolina, and Virginia.

Females lay an average of 2.5 clutches per season. The annual average clutch size is 97–100 eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately 2 years before returning to nearshore coastal habitats. Juvenile Kemp's ridley turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 37 m (120 ft) deep, although they can also be found in deeper offshore waters. As adults, Kemp's ridley turtles forage on swimming crabs, fish, jellyfish, mollusks, and tunicates (NMFS and USFWS 2011).

8.2.2 Population Dynamics

Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. Nesting steadily increased through the 1990s, and then accelerated during the first decade of the 21st century. Following a significant, unexplained one-year decline in 2010, Kemp's ridley turtle nests in Mexico reached a record high of 21,797 in 2012 (NPS 2013). In 2013, there was a second significant decline, with 16,385 nests recorded. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from 3 primary nesting beaches in Mexico (NMFS and USFWS 2015). The number of nests in Padre Island, Texas has increased over the past 2 decades, with 1 nest observed in 1985, 4 in 1995, 50 in 2005, 197 in 2009, and 119 in 2014 (NMFS and USFWS 2015). Gallaway et al. (2013) estimated the female population size for age 2 and older in 2012 to be 188,713 (SD = 32,529). If females comprise 76% of the population, the total population of age 2+ of Kemp's ridley turtles was estimated to have been 248,307 in 2012 (Gallaway et al. 2013).

Kemp's ridley turtle nesting population was exponentially increasing (NMFS et al. 2011c); however, since 2009 there has been concern over the slowing of recovery (Gallaway et al. 2016a; Gallaway et al. 2016b; Plotkin 2016). From 1980 through 2003, the number of nests at 3 primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15% annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2015). In fact, nest counts dropped by more than a third in 2010 and continue to remain below predictions (Caillouet et al. 2018).

Genetic variability in Kemp's ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS and USFWS 2011). Additional analysis of the mitochondrial DNA taken from samples of Kemp's ridley turtles at Padre Island, Texas, showed 6 distinct haplotypes, with 1 found at both Padre Island and Rancho Nuevo (Dutton et al. 2006). Additionally, the genetic diversity of immature Kemp's ridley turtles foraging in the northern Gulf of Mexico (along the Florida panhandle) closely correspond to that of nesting females in

Rancho Nuevo, Mexico (Lamont et al. 2021). Despite recent declines in Kemp's ridley turtle populations, a recent study found that genetic diversity, as assessed through the mitochondrial genome, has remained stable (Frandsen et al. 2020).

8.2.3 Vocalization and Hearing

As noted in Section 9.1.3, sea turtles are low frequency hearing specialists. Juvenile Kemp's ridley turtles can hear from 100–500 Hz, with a maximum sensitivity between 100–200 Hz at thresholds of 110 dB re 1 μPa (Bartol and Ketten 2006).

8.2.4 Status

Kemp's ridley turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease.

The Kemp's ridley turtle was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances in Mexico prohibited the harvest of sea turtles from May through August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a sanctuary. A successful head-start program has resulted in the re-establishment of nesting at Texan beaches. While fisheries bycatch remains a threat, the use of sea turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species. The Deepwater Horizon oil spill event reduced nesting abundance and associated hatchling production as well as exposures to oil in the oceanic environment which has resulted in large losses of the population across various age classes, and likely had an important population-level effect on the species. We do not have an understanding of those impacts on the population trajectory for the species into the future. The species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

8.2.5 Status in the Action Area

In the northern Gulf of Mexico on the Texas coast, Kemp's ridley turtles primarily nest at Padre Island National Seashore, with a few hundred nesting attempts annually (Eckert and Eckert 2019; NMFS et al. 2011a; Piniak and Eckert 2011; Shaver and Caillouet Jr 1998; Shaver et al. 2016; SWOT 2022). Nesting has also been reported for the shoreline closest to the proposed survey area (Eckert and Eckert 2019; NMFS et al. 2011a; Seney and Landry Jr 2008; Shaver et al. 2016). According to the Turtle Island Restoration Network, in 2023, there were 256 Kemp's ridley turtle nests on the Texas coast: 217 on North and South Padre Island and Padre Island National Seashore, and 10 nests in the action area, between Freeport and Galveston (https://seaturtles.org/turtle-count-texas-coast/). The nesting season in the Gulf of Mexico is April–July (Valverde and Holzwart 2017).

Satellite-tagged adult female Kemp's ridley turtles from Padre Island National Seashore and Rancho Nuevo showed post-nesting movements to foraging sites along the coast of the northern Gulf of Mexico, including nearshore waters off Texas (Shaver et al. 2013). Foraging sites were observed in water less than 26 m deep, averaging 33.2 km from shore (Shaver et al. 2013). Similarly, Seney and Landry Jr 2008, 2011) noted that, during the nesting season, adult female turtles tagged at Texas beaches typically stayed in nearshore waters of Texas, with core areas of activity located within and near the proposed survey area; post-nesting turtles also spent time within and near the proposed survey area during summer, but mainly foraged on the shelf off Louisiana. Tagged juveniles showed a preference for tidal passes, bays, coastal lakes, and nearshore waters, in water <5 m deep, particularly during the warmer months of May–October (Seney and Landry Jr 2008; Valverde and Holzwart 2017). Tagged juveniles typically did not occur in the proposed survey area. Several of the tracked adult turtles nested multiple times on the coast of Texas in one season (Seney and Landry Jr 2008). Hart et al. (2018) also found that post-nesting adult females satellite-tagged in the Gulf of Mexico foraged near the proposed survey area off Texas, as well as most coastal waters along the northern and eastern Gulf of Mexico. Based on telemetry data compiled by SWOT (2022), Kemp's ridley turtle locations were reported along the entire northern coast of the Gulf of Mexico, including Texas. Dispersal modeling by Putman et al. (2020) indicated that hatchlings could also occur in the proposed survey areas. There are numerous sighting records in OBIS-SEAMAP of Kemp's ridley turtles in the proposed survey area (Halpin et al. 2009).

8.3 Leatherback turtle

The leatherback turtle ranges from tropical to subpolar latitudes, worldwide (Figure 5). It was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973.

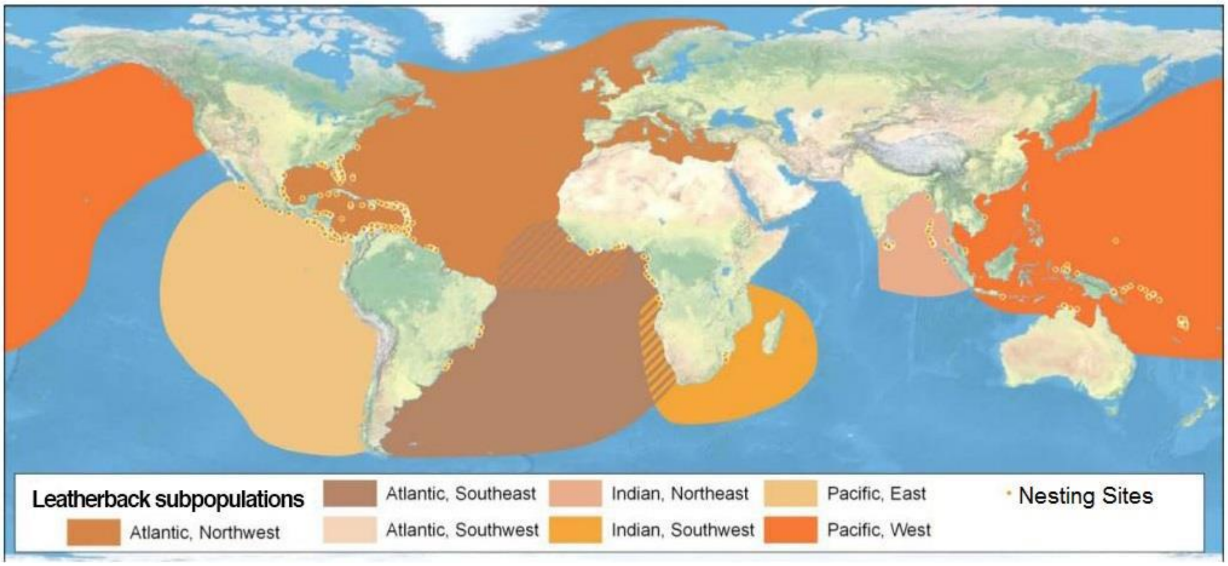

Figure 5. Map identifying the range of the endangered leatherback turtle. Adapted from Wallace et al. 2013

8.3.1 Life History

Leatherback turtles share a general life history pattern similar to other sea turtles. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. While a robust estimate of the life span does not exist, the current best estimate for the maximum age is 43 (Avens et al. 2009a). Age at maturity has been difficult to ascertain, with estimates ranging from 16–29 years (Avens et al. 2009b; Spotila et al. 1996). On average, they reach maturity at approximately 20 years (Jones et al. 2011).

Females usually lay up 5–7 clutches (7–15 days apart) per nesting season (3–6 months generally during the summer), with 20 to more than 100 eggs per clutch and eggs weighing greater than 80 g (0.17 lbs) (Eckert et al. 2012; Eckert et al. 2015; Reina et al. 2002; Wallace et al. 2007). The number of leatherback turtle hatchlings that make it out of the nest onto the beach (i.e., emergent success) is approximately 50% worldwide (Eckert et al. 2012) and approximately 30% of the eggs may be infertile. Eggs hatch after about 2 months (60–65 days; Eckert et al. 2015). Females nest on sandy, tropical beaches at intervals of every 1–11 (average of 2–4) years (Eckert et al. 2015). Nesting females exhibit low site-fidelity to their natal beaches, returning to the same region, but not necessarily the same beach, to nest (Dutton et al. 1999; Dutton et al. 2007). Females have been observed with fertility spans as long as 25 years (Hughes 1996). Natal homing, at least within an ocean basin, results in reproductive isolation between 5 broad geographic regions: eastern and western Atlantic Ocean, Indian Ocean, and eastern and western Pacific Ocean.

In the Northwest Atlantic Ocean, the sex ratio appears to be skewed toward females. Hatchling sex ratios range from 30–100% females in Suriname, Tobago, Colombia, and Costa Rica (Dutton et al. 1985; Godfrey et al. 1996; Mickelson and Downie 2010; Mrosovsky 1994; Patino-Martinez et al. 2012). The proportion of females documented in foraging individuals and strandings ranges from 57–70% (James et al. 2007; Murphy et al. 2006; TEWG 2007), and the ratio of females to males during an individual breeding season is thought to be closer to 1:1 (Stewart and Dutton 2014). Reports of nearshore and onshore stranding data from the Atlantic Ocean and Gulf of Mexico coasts indicate that 60% of strandings were females (TEWG 2007). James et al. (2007) collected size and sex data from large subadult and adult leatherback turtles off Nova Scotia and also concluded a bias toward females at a ratio of 1.86:1.

Leatherback turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherback turtles must consume large quantities to support their body weight. Leatherback turtles weigh about 33% more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James et al. 2005b; Wallace et al. 2006). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals (the time between nesting) are dependent upon prey availability foraging success and duration (Hays 2000; Price et al. 2004).

Unlike other sea turtles, leatherback turtles have several unique traits that enable them to live in cold water. For example, leatherback turtles have a countercurrent circulatory system (Greer et al. 1973), a thick layer of insulating fat (Davenport et al. 1990a; Goff and Lien 1988), gigantothermy (Paladino et al. 1990), and they can increase their body temperature through increased metabolic activity (Bostrom and Jones 2007; Southwood et al. 2005). These adaptations allow leatherback turtles to be comfortable in a wide range of temperatures, which helps them travel further than any other sea turtle species (NMFS and USFWS 1995). For example, a leatherback turtle may swim more than 10,000 km (6,000 mi) in a single year (Benson et al. 2007a; Benson et al. 2011b; Eckert 2006a; Eckert et al. 2006). They search for food between latitudes 71°N and 47°S, in all oceans, and travel extensively to and from their tropical nesting beaches.

While leatherback turtles will look for food in coastal waters, they appear to prefer the open ocean at all life stages (Heppell et al. 2003b). Leatherback turtles have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied prey such as jellyfish and salps. A leatherback turtle’s mouth and throat also have backward-pointing spines that help retain jelly-like prey as water is expelled. Leatherback turtles favorite prey occur commonly in temperate and northern or subarctic latitudes and likely has a strong influence on their distribution in these areas (Plotkin 1995). Leatherback turtles are known to be deep divers, with recorded depths in excess of 1 km (3,280.8 ft) for almost 90 min, but they may also come into shallow waters to locate prey items. In the Atlantic Ocean, they are found as far north as the North Sea, Barents Sea, Newfoundland, and Labrador, and as far south as Argentina and the Cape of Good Hope, South Africa (NMFS USFWS 2013). In the U.S., important nesting areas include Florida, St.

Croix, and Puerto Rico. Other islands of the Caribbean Sea south to Brazil and Venezuela are also important nesting areas in the Western Atlantic Ocean (NMFS USFWS 2013).

The survival and mortality rates for leatherback turtles are difficult to estimate and vary by location. For example, the annual mortality rate for leatherback turtles that nested at Playa Grande, Costa Rica, was estimated to be 34.6% in 1993–1994 and 34% in 1994–1995 (Spotila et al. 2000b). In contrast, overall survival rates for nesting females is relatively high at 85% (Pfaller et al. 2018), with mean estimated annual survival rates of 70–99% in French Guiana (Rivalan et al. 2005), 89% in St. Croix (Dutton et al. 2005), and 89–96% on the coast of the Atlantic Ocean of Florida (Stewart et al. 2014), respectively. For the St. Croix population the average annual juvenile survival rate was estimated to be approximately 63% and the total survival rate from hatchling to first year of reproduction for a female was estimated to be between 0.4–2% (assuming age at first reproduction is between 9–13 years; Eguchi et al. 2006). Spotila et al. (1996)estimated first-year survival rates for leatherback turtles at 6.25%.

Migratory routes of leatherback turtles are not entirely known; however, information from satellite tags have documented long travels between nesting beaches and foraging areas in the Atlantic and Pacific Ocean basins (Benson et al. 2007a; Benson et al. 2011b; Eckert 2006a; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; James et al. 2005a). Leatherback turtles nesting in the northwest Atlantic Ocean move throughout most of the North Atlantic Ocean from the equator to about 50°N latitude. Leatherback turtles nesting in Central America and Mexico travel thousands of miles through tropical and temperate waters of the South Pacific Ocean (Eckert and Sarti 1997; Shillinger et al. 2008). Data from satellite tagged animals suggest that they may be traveling in search of seasonal aggregations of jellyfish (Benson et al. 2007b; Bowlby et al. 1994; Graham 2009; Shenker 1984; Starbird et al. 1993; Suchman and Brodeur 2005). Overall, movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011a).

8.3.2 Population Dynamics

Leatherback turtles are globally distributed, with nesting beaches in the Atlantic, Indian, and Pacific Oceans. Movements of adults and sub-adults span across all major ocean basins and range from equatorial waters to temperate high-latitude regions (Shillinger and Bailey 2015). Leatherback turtles originating from the same nesting beach may forage in diverse and geographically distant regions, with variance among individuals (Benson et al. 2011a; Eckert 2006b; Eckert et al. 2006; Hays et al. 2006; Namboothri et al. 2012; Witt et al. 2011). Conversely, leatherback turtles from different nesting beaches may move to the same foraging regions as adults (Fossette et al. 2014). Patterns of leatherback turtle movements between nesting beaches and foraging areas are complex, and appear to be linked to ocean currents that facilitate hatchling dispersal (Gaspar et al. 2012) or adult movements throughout the oceans (Lambardi et al. 2008). Adults are known to return to the same foraging areas after nesting (Seminoff et al. 2012), and hatchlings from different nesting beaches may reach the same foraging areas, creating a mosaic of overlapping population ranges. Wallace et al. (2010) identified 7 global regional management units (subpopulations) by reviewing the genetic data available and performing a spatial analysis of these genetic data combined with nesting, tagging, and tracking data, these include: northwest Atlantic Ocean, southwest Atlantic Ocean, southeast Atlantic Ocean, northeast Indian Ocean, west Pacific Ocean, and east Pacific Ocean.

Detailed population structure is unknown, but is likely dependent upon nesting beach location and influenced by physical barriers (i.e., land masses), current systems, and long migrations. The total index of nesting female abundance in the Northwest Atlantic Ocean is 20,659 females (NMFS 2020b). Based on estimates calculated from nesting data, there are approximately 18,700 (10,000–31,000 nesting females) total adult leatherback turtles in the North Atlantic Ocean (TEWG 2007). The total index of nesting female abundance in the Southwest Atlantic Ocean is approximately 27 females (NMFS 2020b). The total index of nesting female abundance in the Southeast Atlantic Ocean is approximately 9,198 females (NMFS 2020). The total index of nesting female abundance in the Southwest Indian Ocean is approximately 149 females (NMFS 2020b). The total index of nesting female abundance in the Northeast Indian Ocean is approximately 109 females (NMFS 2020b). The total index of nesting female abundance in the West Pacific Ocean is approximately 1,277 females (NMFS 2020b). The total index of nesting female abundance in the East Pacific Ocean is approximately 755 females (NMFS 2020b). The total index of nesting female abundance is likely an underestimate because we did not have adequate data from many nesting beaches, which have the potential for being unmonitored or unidentified.

Declines in nesting can occur rapidly in populations of leatherback turtles. In the Pacific Ocean, nesting has declined precipitously in recent decades (Benson et al. 2015). Aerial surveys of nesting beaches in Mexico detected declines from 70,000 nesting females in 1982 to fewer than 250 in 1998, with an annual mortality rate of 22.7% (Spotila et al. 2000a). The Terengganu, Malaysia nesting population was reduced to less than 1% of its original size between the 1950s and 1995 (Chan and Liew 1996) and is now considered functionally extinct. Significant declines in nesting have been documented for other nesting aggregations, such as Gabon, French Guiana, and Indonesia.

Population growth rates for leatherback turtles vary by ocean basin. Leatherback turtles in the Northwest Atlantic Ocean exhibit a decreasing nest trend at nesting beaches with the greatest known nesting female abundance (NMFS 2020b). This decline has become more pronounced (2008 through 2017), and the available nest data reflect a steady decline for more than a decade (Eckert and Mitchell 2018a). Leatherback turtles in the Southwest Atlantic Ocean exhibit an increasing, although variable, nest trend (nearly 5% average annual increase, with the largest increase occurring in the past decade; NMFS 2020b). Leatherback turtles in the Southeast Atlantic Ocean of the coast of Gabon exhibit a declining nest trend (8.6% annually) at the largest nesting aggregation (NMFS 2020b). Leatherback turtles in the Southwestern Indian Ocean exhibit a slightly decreasing nest trend at monitored nesting beaches off the coast of South Africa

(NMFS 2020b). Leatherback turtles in the Northeast Indian Ocean exhibit a drastic population decline with extirpation of its largest nesting aggregation in Malaysia (NMFS 2020b). Leatherback turtles in the West Pacific Ocean exhibit low hatching success and a declining nest and population trend (NMFS 2020b). Leatherback turtles in the East Pacific Ocean exhibit a decreasing trend since monitoring began, with a 97.4% decline (depending on the nesting beach) since the 1980s or 1990s (Wallace et al. 2013). Despite intense conservation efforts, the decline in nesting has not been reversed as of 2011 (Benson et al. 2015).

Analyses of mitochondrial DNA from leatherback turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the Atlantic and Indian Oceans suggest that each of the rookeries represent demographically independent populations (NMFS USFWS 2013).

Subpopulations are reproductively isolated with little to no gene flow connecting them. However, within some subpopulations there is fine-scale genetic structure. Genetic analyses using microsatellite data revealed fine-scale genetic differentiation among neighboring subpopulations in the Northwest Atlantic Ocean including: Trinidad, French Guiana/Suriname, Florida, Costa Rica, and St. Croix (Dutton and H. 2013). Tagging studies indicate individual movement and gene flow among nesting aggregations.

In the Atlantic Ocean, equatorial waters appear to be a barrier between breeding populations. In the northwestern Atlantic Ocean, post-nesting female migrations appear to be restricted to north of the equator but the migration routes vary (NMFS USFWS 2013). Genetic studies support the satellite telemetry data indicating a strong difference in migration and foraging fidelity between the breeding populations in the northern and southern hemispheres of the Atlantic Ocean (NMFS USFWS 2013).

8.3.3 Vocalization and Hearing

As noted in Section 9.1.3, sea turtles are low frequency hearing specialists. Dow Piniak et al. (2012a)measured hearing of leatherback turtle hatchlings in water an in air, and observed reactions to low frequency sounds, with responses to stimuli occurring between 50 Hz–1.6 kHz in air, and between 50 Hz–1.2 kHz in water (lowest sensitivity recorded was 93 dB re 1 μPa at 300 Hz).

Leatherback eggs and hatchlings have been recorded producing sounds. Ferrara et al. (2014)recorded sounds including pulses, sounds with harmonic and nonharmonic frequency bands, sounds with frequency and amplitude modulation, and hybrid sounds with characteristics of pulsed and harmonic sounds. Pulses, sounds without harmonically related frequency bands, and sound with harmonic frequency bands were recorded in nests with both eggs and hatchlings. These were produced at a frequency range of about 187.5–1,343.8 Hz, 282.2–1,640.6 Hz, and 119–24,000 Hz, respectively. All sounds were less than 0.5 s. McKenna et al. (2019) also recorded sounds (no pulses) of leatherback turtle hatchlings. Sounds were produced at an average frequency range of 2.41 ± 3.02 kHz and average duration of 0.14 ± 0.13 s.

8.3.4 Status

The leatherback turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The status of the subpopulations in the Atlantic, Indian, and Pacific Oceans are generally declining, except for the subpopulation in the Southwest Atlantic Ocean, which is slightly increasing. Leatherback turtles show a lesser degree of nest site fidelity than occurs with hardshell sea turtle species.

The primary threats to leatherback turtles include fisheries interactions (bycatch), harvest of nesting females, and egg harvesting (NMFS 2020b). Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, vegetation changes, sand extraction, beach nourishment, shoreline stabilization, and natural disasters (e.g., storm events and tsunamis) as well as cold-stunning, vessel interaction, pollution (contaminants, marine debris and plastics, petroleum products, petrochemicals), ghost fishing gear, natural predation, parasites, and disease (NMFS 2020b). Artificial lights on or adjacent to nesting beaches alter nesting adult female behavior and are often fatal to post-nesting females and emerging hatchlings as they are drawn to light sources and away from the sea. Ingestion of marine debris (plastic) is common in leatherback turtles and can block gastrointestinal tracts leading to death (NMFS 2020b). Climate change may alter sex ratios (as temperature determines hatchling sex) and nest success, range (through expansion of foraging habitat as well as alter spatial and temporal patterns), and habitat (through the loss of nesting beaches, because of sea-level rise and storms). Oceanographic regime shifts possibly impact foraging conditions that may affect nesting female size, clutch size, and egg size of populations. The species’ resilience to additional perturbation is low.

8.3.5 Status in the Action Area

Nesting by leatherbacks in the Gulf of Mexico is generally less frequent than that of other sea turtle species (Piniak and Eckert 2011). There is only occasional nesting in southern Texas at Padre Island National Seashore, with no recorded nests in 2023 according to the Turtle Island Restoration Network (Eckert and Eckert 2019; SWOT 2022; Valverde and Holzwart 2017). Leatherback sea turtles satellite tagged at Panama nesting beaches traveled through the Yucatán Channel into the Gulf of Mexico where they spent most of their time foraging, though there were no foraging hotspots identified within the proposed survey area (Aleksa et al. 2018). One satellite-tagged leatherback migrated adjacent to the proposed survey area, occupying coastal waters off Texas from Galveston to Matagorda Bay (Aleksa et al. 2018). Based on telemetry data compiled by SWOT (2022), leatherback turtle records were reported for waters off Louisiana, but not Texas. In the OBIS-SEAMAP database, there is one record near the 20-m isobath southeast of the proposed project area for August, and another record in shallow water <20 m deep off southern Texas (Halpin et al. 2009). Most other records are for deep offshore waters in depths >1000 m (Halpin et al. 2009).

8.4 Loggerhead turtle – Northwest Atlantic Ocean DPS

Loggerhead turtles are circumglobal, and are found in continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Indian, and Pacific Oceans. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated 9 DPSs of loggerhead turtles, with the Northwest Atlantic Ocean DPS listed as threatened (75 FR 12598). The Northwest Atlantic Ocean DPS of loggerhead turtles is found along eastern North America, Central America, and northern South America (Figure 6).

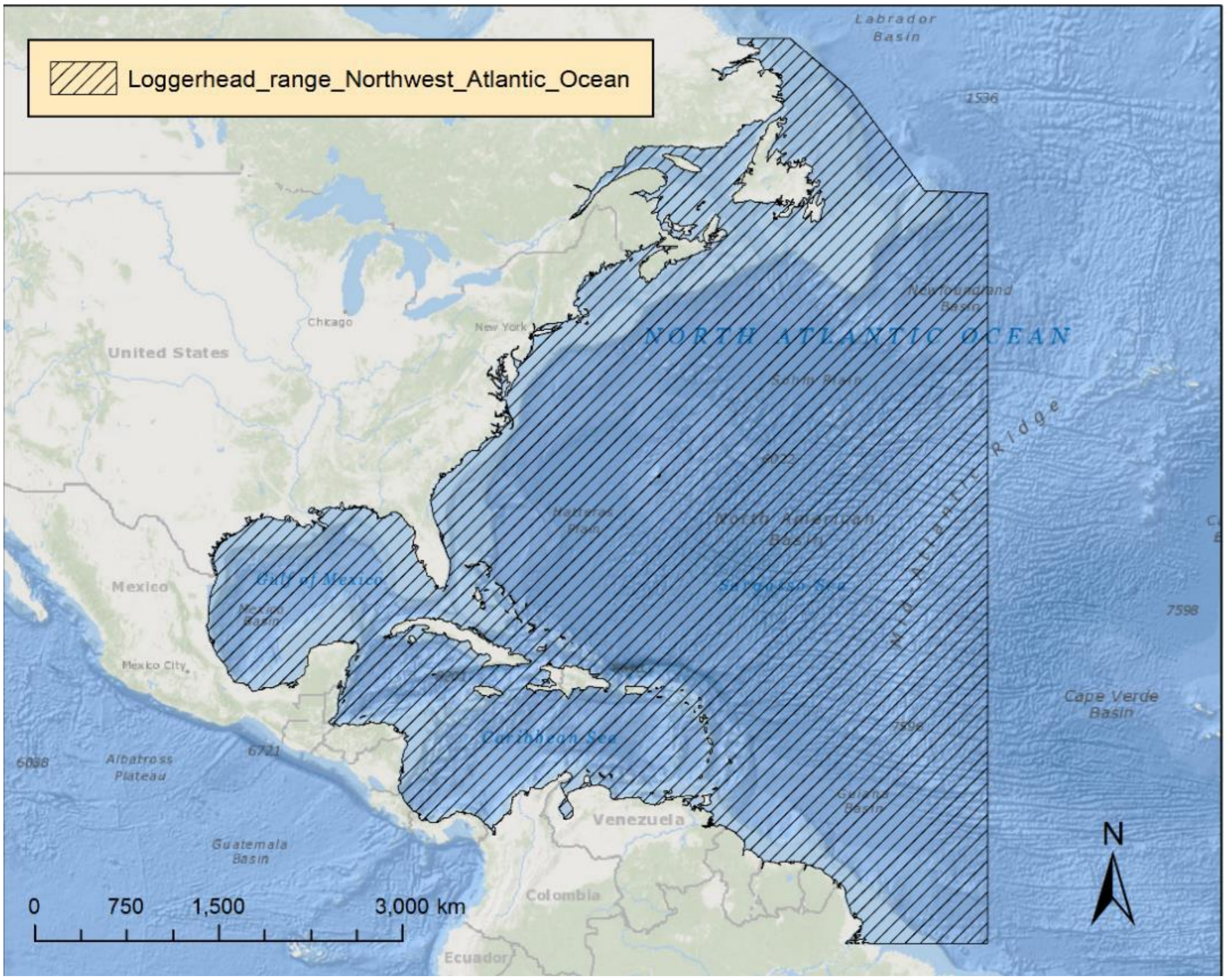

Figure 6. Map identifying the range of threatened Northwest Atlantic Ocean distinct population segment of loggerhead turtle

8.4.1 Life History

Loggerhead turtles share a general life history pattern similar to other sea turtles. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. The 8 stages of the life cycle and the ecosystems those stages generally use include: egg (terrestrial zone), hatchling (terrestrial zone), hatchling swim frenzy and transitional (neritic zone), juvenile (oceanic zone), juvenile (neritic zone), adult (oceanic zone), adult (neritic zone), nesting female (terrestrial zone) (NMFS and USFWS 2008b). Loggerhead turtles reach sexual maturity between 20–38 years of age, although this varies widely among populations (Frazer and Ehrhart 1985; NMFS 2001). Mean age at first reproduction for female loggerhead turtles is 30 years. The annual mating season occurs from late March through early June, and females lay eggs throughout the summer months. Females lay an average of 4 clutches per season (Murphy and Hopkins 1984), and an average remigration interval is 3.7 years (Tucker 2010). The annual average clutch size is 100–126 eggs per nest (Dodd 1988). Eggs incubate for 42–75 days before hatching (NMFS and USFWS 2008b). Nesting occurs on beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the loggerhead turtle during the middle of the incubation period.

The majority of nesting occurs at the western rims, concentrated in the north and south temperate zones and subtropics, of the Atlantic and Indian Oceans (NRC 1990). For the Northwest Atlantic Ocean DPS of loggerhead turtles, most nesting occurs along the East coast of the U.S., from southern Virginia to Alabama. Additional nesting occurs along the northern and western Gulf of Mexico, eastern Yucatán peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997; Addison and Morford 1996), off the southwestern coast of Cuba (Gavilan 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern islands of the Caribbean Sea. Non-nesting, adult females are reported throughout the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. Little is known about the distribution of adult males who are seasonally abundant near nesting beaches.

Habitat uses within continental shelf and estuarine environments vary by life stage. Loggerhead turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone and later in the neritic zone (i.e., coastal waters). Coastal waters provide important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerhead turtles. Neritic juvenile loggerhead turtles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the water's surface, whereas subadults and adults typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hardbottom habitats in coastal waters.

As post-hatchlings, loggerhead turtles hatched on beaches enter the "oceanic juvenile" life stage, migrating offshore and becoming associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986; Conant et al. 2009b; Witherington 2002). Oceanic juveniles grow at rates of 2.9–5.4 cm (1–2 in) per year (Bjorndal et al. 2003; Snover 2002) over a period as long as 7–12 years (Bolten et al. 1998) before moving to more coastal habitats. Studies have suggested that not all loggerhead turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (Bolten and Witherington 2003; Laurent et al. 1998). These studies suggest some animals may either remain in the oceanic habitat in the North Atlantic Ocean longer than hypothesized or they move back and forth between oceanic and coastal habitats interchangeably (Witzell 2002). When immature loggerhead turtles reach 40–60 cm (15–24 in), they begin to reside in coastal inshore waters of the continental shelf throughout the Atlantic Ocean and Gulf of Mexico (Witzell 2002).

After departing the oceanic zone, neritic juveniles in the Northwest Atlantic Ocean inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, the Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters of the U.S., including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the shorelines of the Atlantic Ocean and Gulf of Mexico, essentially all shelf waters are inhabited by loggerhead turtles (Conant et al. 2009b).

Like juveniles, non-nesting adults also use the neritic zone. However, these adults do not use the relatively enclosed shallow-water estuarine habitats with limited ocean access as frequently as juveniles. Areas such as Pamlico Sound, North Carolina, and the Indian River Lagoon, Florida, are regularly used by juveniles but not by adults. Adults do tend to use estuarine areas with more access to the open ocean, such as the Chesapeake Bay in the mid-Atlantic Ocean. Shallow-water habitats with large expanses of access to the open ocean, such as Florida Bay, provide year-round resident foraging areas for significant numbers of female and male adults (Conant et al. 2009b).

Offshore, adults primarily inhabit continental shelf waters, from New York through Florida, the Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of shelf waters in the mid-Atlantic Ocean, especially offshore of New Jersey, Delaware, and Virginia during summer months, and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has been documented (Hawkes et al. 2014; Hawkes et al. 2007). Satellite telemetry has identified the shelf waters along the west coast of Florida, the Bahamas, Cuba, and the Yucatán peninsula as important resident areas for adult females that nest in Florida (Foley et al. 2008; Girard et al. 2009; Hart et al. 2012). The southern edge of the Grand Bahama Bank is important habitat for nesting on the Cay Sal Bank in the Bahamas, but nesting females are also resident in the bights of Eleuthera, Long Island, and Ragged Islands. They also reside in Florida Bay. Moncada et al. (2010)report the recapture in Cuban waters of five adult females originally flipper-tagged in Quintana Roo, Mexico, indicating that Cuban shelf waters likely also provide foraging habitat for adult females that nest in Mexico.

8.4.2 Population Dynamics

It is difficult to estimate overall abundance for sea turtle populations because individuals spend most of their time in water, where they are difficult to count, especially considering their large range and use of many different and distant habitats. Females, however, converge on their natal beaches to lay eggs, and nests are easily counted. The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead sea turtles is over 110,000 (NMFS and USFWS 2023).

In-water estimates of abundance include juvenile and adult life stages of loggerhead males and females are difficult to perform on a wide scale. In the summer of 2010, NMFS's Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC) estimated the abundance of juvenile and adult loggerhead sea turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, based on Atlantic Marine Assessment Program for Protected Species (AMAPPS) aerial line-transect sighting survey and satellite tagged loggerheads (NMFS 2011). They provided a preliminary regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000–817,000) based on positively identified loggerhead sightings (NMFS 2011). A separate, smaller aerial survey, conducted in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, demonstrated uncorrected loggerhead sea turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (NMFS and USFWS 2023). We are not aware of any current range-wide in-water estimates for the DPS.

Based on genetic analysis of subpopulations, the Northwest Atlantic Ocean DPS of loggerhead turtle is further categorized into 5 recovery units corresponding to nesting beaches. These are Northern Recovery Unit, Peninsular Florida Recovery Unit, Dry Tortugas Recovery Unit, Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit (Conant et al. 2009a). An analysis using expanded mitochondrial DNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct, and that rookeries from Mexico's Caribbean coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS of loggerhead turtle should be considered as 10 management units: (1) South Carolina and Georgia, (2) central eastern Florida, (3) southeastern Florida, (4) Cay Sal, Bahamas, (5) Dry Tortugas, Florida, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012).

The Northern Recovery Unit, from North Carolina to northeastern Florida, is the second largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle, with an average of 5,215 nests from 1989 through 2008, and approximately 1,272 nesting females per year (NMFS and USFWS 2008c). The nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989 through 2008. Aerial surveys of nests showed a 1.9% decline annually in nesting in South Carolina from 1980 through 2008. Overall, there is strong statistical data to suggest the Northern Recovery Unit has experienced a long-term decline over that period. Data since that analysis are showing improved nesting numbers and a departure from the declining trend. Nesting in Georgia has shown an increasing trend since comprehensive nesting surveys began in 1989. Nesting in North Carolina and South Carolina has begun to show a shift away from the declining trend of the past. Increases in nesting were seen from 2009 through 2012.

The Peninsular Florida Recovery Unit is the largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle, with an average of 64,513 nests per year from 1989 through 2007, and approximately 15,735 nesting females per year (NMFS and USFWS 2008b). Following a 52% increase between 1989 through 1998, nest counts declined sharply (53%) from 1998 through 2007. However, annual nest counts showed a strong increase (65%) from 2007 through 2017 (FFWCC 2018). Index nesting beach surveys from 1989 through 2013 have identified 3 trends. From 1989 through 1998, a 30% increase was followed by a sharp decline over the subsequent decade. Large increases in nesting occurred since then. From 1989 through 2013, the decade-long decline had reversed and there was no longer a demonstrable trend. From 1989 through 2016, the Florida Fish and Wildlife Research Institute concluded that there was an overall positive change in the nest counts, but the change was not statistically significant.

The Dry Tortugas, Gulf of Mexico, and Greater Caribbean Recovery Units are much smaller nesting assemblages, but they are still considered essential to the continued existence of loggerhead turtles. The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. The only available data for the nesting subpopulation on Key West comes from a census conducted from 1995 through 2004 (excluding 2002), which provided a range of 168 to 270 (mean of 246) nests per year, or about 60 nesting females (NMFS and USFWS 2007b). There was no detectable trend during this period (NMFS and USFWS 2008b).

The Gulf of Mexico Recovery Unit has between 100 to 999 nesting females annually, and a mean of 910 nests per year. Analysis of a dataset from 1997 through 2008 of index nesting beaches in the northern Gulf of Mexico shows a declining trend of 4.7% annually. Index nesting beaches in the panhandle of Florida has shown a large increase in 2008, followed by a decline in 2009 through 2010 before an increase back to levels similar to 2003 through 2007 in 2011.

The Greater Caribbean Recovery Unit encompasses nesting subpopulations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903–2,331 nests annually (Zurita et al. 2003a). Other significant nesting sites are found throughout the Caribbean Sea, and including Cuba, with approximately 250–300 nests annually (Ehrhart et al. 2003), and over 100 nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008b). Survey effort at nesting beaches has been inconsistent, and not trend can be determined for this subpopulation (NMFS and USFWS 2008b). Zurita et al. (2003b) found an increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico from 1987 through 2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008b).

8.4.3 Vocalization and Hearing

As noted in Section 9.1.3, sea turtles are low frequency hearing specialists. Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250–750 Hz. Both yearling and 2-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re 1 μPa and 2-year olds: about 86 dB re 1 μPa), with threshold increasing rapidly above and below that frequency (Bartol and Ketten 2006). Underwater tones elicited behavioral responses to frequencies between 50–800 Hz and auditory evoked potential responses between

100–1,131 Hz in 1 adult loggerhead turtle (Martin et al. 2012). The lowest threshold recorded in this study was 98 dB re 1 μPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50–800 Hz while juveniles responded to sounds in the range of 50 Hz–1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

8.4.4 Status

Based on the currently available information, the overall nesting trend of the Northwest Atlantic DPS of loggerhead appears to be stable, neither increasing nor decreasing, for over 2 decades (NMFS and USFWS 2023). Destruction and modification of terrestrial and marine habitats threaten the Northwest Atlantic DPS of loggerhead. On beaches, threats that interfere with successful nesting, egg incubation, hatchling emergence, and transit to the sea include erosion, erosion control, coastal development, artificial lighting, beach use, and beach debris (NMFS and USFWS 2023). In the marine environment threats that interfere with foraging and movement include marine debris, oil spills and other pollutants, harmful algal blooms, and noise pollution (NMFS and USFWS 2023).

8.4.5 Status in the Action Area

Loggerhead nesting occurs along the coast of Texas, including <25 crawls (nesting crawls, including successful egg-laying and failed attempts, which can be 2 to 10 times higher than the number of actual nests) near the proposed survey area (Eckert and Eckert 2019; SWOT 2022). The nesting season for the Northwest Atlantic loggerhead DPS is from April through September (NMFS and USFWS 2008a). Post-nesting adult female loggerheads satellite-tagged in the Gulf of Mexico were found to forage near the proposed survey area off the coast of Texas, but most foraging occurred east of Texas (Hart et al. 2018; Hart et al. 2014). Similarly, no post-nesting movements of adult female loggerheads tagged off Florida were recorded off Texas, and most foraging occurred east of Texas, off Louisiana, Mississippi, and Alabama (Girard et al. 2009). According to the Turtle Island Restoration Network, no loggerhead turtle nests were recorded near the action area in 2023 (https://seaturtles.org/turtle-count-texas-coast/). Dispersal modeling by Putman et al. (2020)indicates that hatchlings could also occur in the proposed survey area, but the greatest concentrations are expected to occur in the eastern Gulf of Mexico. There are numerous loggerhead turtle records in the OBIS-SEAMAP database for waters <20 m deep in the northern Gulf of Mexico, including near but not within the proposed survey area; two of those records are for September and October (Halpin et al. 2009). In 2022, there was a record number (441) of loggerhead turtle strandings in Texas, including near the proposed survey area (see https://www.fws.gov/press-release/2022-09/sea-turtle-rehab-facilities-responding-loggerhead-strandings-texas-coast and https://coast.noaa.gov/states/stories/stranded-loggerheads.html). The cause of these strandings is unknown; however, NMFS noticed that turtles are in diminished nutritional condition.

9 Environmental Baseline

The "environmental baseline" refers to the condition of the ESA-listed species or its designated critical habitat in the action area, without the consequences to the ESA-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 other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to ESA-listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02). In this section, we discuss the environmental baseline within the action area as it applies to species that are likely to be adversely affected by the proposed action.

A number of human activities have contributed to the status of populations of ESA-listed sea turtles (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle) in the action area. Some human activities are ongoing and appear to continue to affect sea turtle populations in the action area for this consultation. The following discussion summarizes the impacts, which include climate change, sea turtle harvesting, vessel interactions (vessel strike), fisheries (fisheries interactions), pollution (marine debris, pollutants and contaminants, hydrocarbons, noise [vessel sound and commercial shipping, aircraft, seismic surveys, marine construction, active sonar, and military activities]), aquatic nuisance species, and scientific research activities.

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

9.1 Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Effects of climate change include sea level rise, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to affect ESA-listed species. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://climate.gov). This section provides some examples of impacts to ESA-listed species and their habitats that have occurred or may occur as the result of climate change in the action area.

The rising concentrations of greenhouse gases in the atmosphere, now higher than any period in the last 800,000 years, have warmed global ocean surface temperatures by 0.68–1.1°C between 1850–1900 and 2011–2020 (IPCC 2023). Over the last 100 years, sea surface temperatures have increased across much of the northwest Atlantic, consistent with the global trend of increasing sea surface temperature due to anthropogenic climate change (Beazley et al. 2021). Large-scale changes in the earth's climate are in turn causing changes locally to the northwestern Gulf of Mexico's climate and environment. Changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution, warming surface temperatures) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish), ultimately affecting primary foraging areas of proposed and ESA-listed species including ESA-listed sea turtles in the action area. For example, ocean acidification negatively affects organisms such as crustaceans, crabs, mollusks, and other calcium carbonate-dependent organisms such as pteropods (free-swimming pelagic sea snails and sea slugs). Some studies in nutrient-rich regions have found that food supply may play a role in determining the resistance of some organisms to ocean acidification (Markon et al. 2018; Ramajo et al. 2016). Reduction in 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, including prey for sea turtles.

In addition to impacts on prey species, higher trophic level marine species' ranges in the action area are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions. For example, in the Gulf of Mexico, northward shifts in seagrass-associated fish species occurred over a period where air and sea surface temperatures increased more than 3°C (Fodrie et al. 2010). This northward shift has also been observed in cetacean and sea turtle species in the North Atlantic Ocean. Chavez-Rosales et al. (2022) identified a northward shift of an average of 178 km (~110.6 mi) when examining habitat suitability models for 16 cetacean species in the western North Atlantic Ocean. Record et al. (2019) also documented a shift in North Atlantic right whale distribution, based on a climate-driven shift in their main prey source. Based on climate, energetics, and habitat modeling, loggerhead and leatherback turtle distributions are expected to shift northward in the North Atlantic Ocean so that animals can stay within the environmental characteristics of suitable habitat (Dudley et al. 2016; McMahon and Hays 2006; Patel et al. 2021).

In addition to increased ocean warming and changes in species' distribution, climate change is linked to increased extreme weather and climate events including, but not limited to, hurricanes, cyclones, tropical storms, heat waves, and droughts (IPCC 2023). Research from IPCC (2023) shows that it is likely extratropical storm tracks have shifted poleward in both the Northern and Southern Hemispheres, and heavy rainfalls and mean maximum wind speeds associated with hurricane events will increase with continued greenhouse gas warming. These extreme weather events have the potential to have adverse effects on ESA-listed sea turtles in the action area. For example, in 1999, off Florida, Hurricane Floyd washed out many loggerhead and green turtle nests, resulting in as many as 50,000–100,000 hatchling deaths (see https://conserveturtles.org/11665-2/). Hurricane Irma, also off Florida, washed more than half of green turtle nests out to sea at the Archie Carr National Wildlife Refuge, and rescuers during Hurricane Harvey dug up nests and incubated the eggs to save them from drowning (see https://usa.oceana.org/blog/simple-solution-can-save-thousands-sea-turtles/#:~:text=In%20Texas%2C%20hurricane%20Harvey%20forced,to%20save%20them%20from%20drowning.)

This review provides some examples of impacts to ESA-listed species and their habitats that may occur as the result of climate change within the action area. While it is difficult to accurately predict the consequences of climate change 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, and may be exacerbated by additional threats in the action area.

9.2 Oceanic Temperature Regimes

Oceanographic conditions in the Atlantic can be altered due to periodic shifts in atmospheric patterns. In the Atlantic Ocean, this is caused by the Atlantic Multi-decadal Oscillation, or North Atlantic Oscillation. The North Atlantic Oscillation can alter habitat conditions and prey distribution for ESA-listed species in the action area.

The North Atlantic Oscillation is a large-scale, dynamic phenomenon that exemplifies the relationship between the atmosphere and the ocean. It is an alteration in the intensity of the atmospheric pressure difference between the semi-permanent high-pressure center over the Azores Islands and the sub-polar low-pressure center over Iceland (Stenseth et al. 2002). Sea-level atmospheric pressure in the two regions tends to vary in a “see-saw” pattern – when the pressure increases in Iceland it decreases in the Azores and vice-versa (i.e., the two systems tend to intensify or weaken in synchrony). A positive phase occurs when there is high pressure over the Azores and low pressure over Iceland, and a negative phase occurs the difference in pressures weakens (Taylor et al. 1998). The North Atlantic oscillation is the dominant mode of decadal-scale variability in weather and climate in the North Atlantic Ocean region (Hurrell 1995). However, the North Atlantic Oscillation also has global significance, as it affects climate over Europe, North America, and even the Mediterranean Sea region, including sea surface temperatures, wind conditions, salinity, sea ice cover, mixed layer depth, and ocean circulation (Stenseth et al. 2002; Hurrell and Deser 2010; Curry and McCartney 2001; Greene and Pershing 2003; Pershing et al. 2001).

A strong association has been established between the variability of the North Atlantic Oscillation and changes affecting various trophic groups in North Atlantic marine ecosystems Drinkwater et al. 2003; Fromentin and Planque 1996. For example, the temporal and spatial patterns of *Calanus* copepods (zooplankton) were the first to be linked to the phases of the North Atlantic Oscillation Fromentin and Planque 1996; Stenseth et al. 2002. Such shifts in copepod patterns have a tremendous significance to upper-trophic-level species, including the North Atlantic right whale, which feeds principally on *Calanus finmarchicus* (Ganley et al. 2022;

Greene et al. 2003; Record et al. 2019). Decadal climatic regime shifts have also been related to changes in zooplankton in the North Atlantic Ocean Fromentin and Planque 1996, and decadal trends in the North Atlantic Oscillation Hurrell 1995 can affect the position of the Gulf Stream Taylor et al. 1998 and other circulation patterns in the North Atlantic Ocean that act as migratory pathways for various marine species, especially fish (Drinkwater et al. 2003). Shifts in the North Atlantic Oscillation have also been associated with shifts in the composition of fishery landings in the Gulf of Mexico (Karnauskas et al. 2015) and shifts in loggerhead turtle sightings in the eastern North Atlantic Ocean (Dellinger et al. 2022).

9.3 Sea Turtle Harvesting

Directed harvest of sea turtles and their eggs for food and other products has existed for years and was a significant factor causing the decline of several species, including the green turtle, Kemp's ridley turtle, leatherback turtle, and loggerhead turtle considered in this consultation. In the U.S., the harvest of nesting sea turtles and eggs is now illegal, and although there has been recent documented harvesting in the eastern Atlantic Ocean (see https://www.justice.gov/usao-sdfl/pr/poachers-93-protected-sea-turtle-eggs-sentenced-prison), there has been no documented harvesting in Texas.

9.4 Vessel Interactions

Within the action area, vessel interactions pose a threat to ESA-listed sea turtles. Overall, the action area has a great deal of vessel activity, from cargo and commercial shipping, to recreational vessels, and cruise ships. Vessel interactions can come in the form of vessel traffic (visual and auditory disturbance) and vessel strike.

Sea turtle vessel interactions are poorly studied compared to marine mammals; however, vessel strikes have the potential to be a significant threat to sea turtles given that they can results in serious injury and mortality (Work et al. 2010). Sea turtles can move somewhat rapidly but are not adept at avoiding vessels that are moving at more than 4 km/h (2.6 kts); most vessels move much faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007b; Work et al. 2010). All sea turtles must surface to breathe and several species are known to bask at the sea surface for long periods of time, potentially increasing the risk of vessel strike. Hazel et al. (2007b) documented live and dead sea turtles with deep cuts and fractures indicative of a vessel strike, and suggested that green turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to vessel strike or vessel speed increases. Stacy et al. (2020) analyzed Texas sea turtle stranding data for 2019, a year where sea turtle strandings were more than 2 times above average based on statewide stranding numbers for the previous 5 and 10 years, and analyzed causes of stranding by species and stranding zone. In the stranding zones that overlap the action area (zones 18 and 19), vessel strike-type injuries were the most common type of trauma observed in Kemp's ridley, green, and loggerhead turtles (Stacy et al. 2020). Approximately 71% of stranded green turtles and 61% of Kemp's ridley turtles studied had documented vessel strike injuries (Stacy et al. 2020).

9.5 Fisheries

Fisheries constitute an important and widespread use of the ocean resources throughout the action area. Fishery interactions can adversely affect ESA-listed sea turtles. Direct effects of fisheries interactions on sea turtles include entanglement, tackle/gear injuries, and bycatch, which can lead to fitness consequences or mortality because of injury or drowning. Indirect effects include reduced prey availability, including overfishing of targeted species, and habitat destruction. 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 sea turtles.

Fishing gears that are known to interact with sea turtles include trawls, longlines, purse seines, gillnets, pound nets, dredges and to a lesser extent, pots and traps (Finkbeiner et al. 2011; Lewison et al. 2013). Within the action area, both recreational and commercial fisheries occur in Texas state waters. Lost traps and disposed monofilament and other fishing lines are a documented source of mortality in sea turtles due to entanglement that may anchor an animal to the bottom leading to death by drowning. Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual’s health (Derraik 2002). Entanglements also make animals more vulnerable to additional threats (e.g., predation and vessel strikes) by restricting agility and swimming speed. The majority of ESA-species 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.

Within the action area, fisheries-related injuries (hooking injuries, entanglement, and internal injuries resulting from ingestion of fishing gear) were the second-most documented injuries in sea turtles off Texas in 2019 (Stacy et al. 2020). Approximately 18% of green turtles and 22% of Kemp’s ridley turtles studied had documented fishing-related injuries (Stacy et al. 2020).

Regulations that went into effect in the early 1990’s require shrimp trawlers in the Atlantic and Gulf of Mexico to modify their gear with turtle excluder devices (TEDs), which are designed to allow turtles to escape trawl nets and avoid drowning. Analyses by Epperly and Teas (2002) indicated that, while early versions of TEDs were effective for some species, the minimum requirements for the escape opening dimension were too small for larger sea turtles, particularly loggerheads and leatherbacks. NMFS implemented revisions to the TED regulations in 2003 to address this issue (68 FR 8456; February 21, 2003). Revised TED regulations in 2014 were estimated to reduce shrimp trawl-related mortality by 94% for loggerheads and 97% for leatherbacks (NMFS 2014). In 2019, a final rule was published (84 FR 70048) requiring TEDs on skimmer trawls greater than 12.19 m (40 ft). The conservation benefit from the 2019 rule was estimated to prevent bycatch of up to 801–1,168 sea turtles in Southeastern U.S. shrimp fisheries. Furthermore, in 2021, NMFS introduced an advanced notice of a proposed rule to require TEDs on skimmer trawls less than 12.19 m (40 ft) operating in Southeast U.S. shrimp fisheries (86 FR 20475).

9.6 Pollution

Within the action area, pollution poses a threat to ESA-listed sea turtles. Pollution can come in the form of marine debris and plastics, pollutants and contaminants, and noise pollution from anthropogenic activities.

9.6.1 Marine Debris

Marine debris is an ecological threat that is 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). Sea turtles within the action area may ingest marine debris, particularly plastics, which can cause intestinal blockage and internal injury, dietary dilution, malnutrition, and increased buoyancy. These can result in poor health, reduced fitness, growth rates, and reproduction, or even death (Nelms et al. 2016). Entanglement in plastic debris (including abandoned ‘ghost’ fishing gear) is known to cause lacerations, increased drag (thereby reducing the ability to forage effectively or avoid predators), and may lead to drowning or death by starvation. Leatherbacks appear to be most susceptible to ingesting marine debris, particularly plastic, which they misidentify as jellyfish, a primary food source (Mrosovsky et al. 2009; Schuyler et al. 2014). There are limited studies of debris ingestion in sea turtles within the action area; however, Plotkin et al. (1993) found that over half of the studied loggerhead turtles had anthropogenic debris, mainly pieces of plastic bags, present in digestive tract contents. Plotkin et al. (1993) attributed the deaths of 3 loggerhead turtles to debris ingestion, including 1 loggerhead turtle whose esophagus was perforated by a fishing hook, 1 loggerhead turtle whose stomach lining was perforated by a piece of glass, and 1 loggerhead turtle whose entire digestive tract was impacted by plastic trash bags. Along the Texas coast just south of the action area, Howell et al. (2016) found debris in over half of the stomach contents of juvenile green turtles. Elsewhere in the Gulf of Mexico, debris such as plastic, fishing gear, rubber, aluminum foil, and tar were found in green and loggerhead turtles (Bjorndal et al. 1994). At least 2 turtles died as a result of debris ingestion, although the volume of debris represented less than 10% of the volume of the turtle’s gut contents; therefore, even small quantities of debris can have severe health and fitness consequences (Bjorndal et al. 1994).

Sea turtles can also become entanglement in marine debris, namely fishing gear, which was discussed in Section 9.5.

9.6.2 Pollutants and Contaminants

Exposures to pollution and contaminants have the potential to cause adverse health effects in ESA-listed cetaceans and sea turtles. 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). Sources of pollution within or adjacent to the action area include agricultural and industrial runoff/dumping, and oil and gas exploration and extraction, each of which can degrade marine habitats used by sea turtles.

Agricultural and industrial runoff into rivers and canals empty into bays and the ocean (e.g., Mississippi River into the Gulf of Mexico). Such runoff, especially from agricultural sources, is nutrient-rich from fertilizers containing nitrogen and phosphorous, and can cause eutrophication. Eutrophication occurs when an environment becomes nutrient-loaded, stimulating plankton and algae growth. This can lead to algal blooms, which create hypoxic (low-oxygen) waters within which most marine life cannot survive (also called “dead zones”). In these hypoxic zones and adjacent waters, pelagic marine life are displaced and many benthic organisms are lost (Rabalais and Turner 2001). In the northern Gulf of Mexico, on the Louisiana and Texas continental shelf, one of the world’s largest dead zones is an annual occurrence from late-spring through late-summer (Rabalais et al. 2002), and could affect species and critical habitat in the action area. The U.S. Environmental Protection Agency’s (EPA) annual summer measurements of the dead zone were highest in 2002 and 2017, when the dead zone measured 8,494 mi^2 (~22,000 km^2) and 8,776 mi^2 (~22,729 km^2), respectively, which is larger than the state of Massachusetts (see https://www.epa.gov/ms-htf/northern-gulf-mexico-hypoxic-zone). The most recent 5-year average is 4,347 mi^2 (~11,259 km^2).

Dumping of waste and sewage from shipping and ships used for coastal construction can also contribute to nutrient-loading and coastal pollution. Adjacent to the action area, ships must pass through the Houston Ship Channel, spanning from the Gulf of Mexico through Galveston Bay, just north of the action area, to reach the Port of Houston. The Houston Ship Channel is the busiest waterway in the U.S., with more than 8,300 large ships, 231,000 commercial small craft, and 230 million tons of cargo a year (TDOT 2016). As a result, the action area contains major shipping routes, increasing the risk for pollutants to enter the marine environment.

Chemical pollutants (e.g., DDT, PCBs, polybrominated diphenyl ethers, perfluorinated compounds, and heavy metals) accumulate up trophic levels of the food chain, such that high trophic level species like sea turtles have higher levels of contaminants than lower trophic levels (Bucchia et al. 2015; D’ilio et al. 2011; Mattei et al. 2015). These pollutants can cause adverse effects including endocrine disruption, reproductive impairment or developmental effects, and immune dysfunction or disease susceptibility (Bucchia et al. 2015; Ley-Quiñónez et al. 2011). In sea turtles, maternal transfer of persistent organic pollutants threatens developing embryos with a pollution legacy and poses conservation concerns due to its potential adverse effects on subsequent generations (Muñoz and Vermeiren 2020). Although there is limited information on chemical pollutants in sea turtles in the action area, there are studies that have investigated heavy metals, brevetoxins, and persistent organic pollutants in some sea turtle species in other areas of the Gulf of Mexico and adjacent waters. Two studies have investigated heavy metals in Kemp’s ridley, loggerhead, hawksbill, and green turtles off eastern Texas and Louisiana (Kenyon et al. 2001; Presti et al. 2000). Heavy metal (mercury, copper, lead, silver, and zinc) concentrations in blood and scute (the scales on the shell, also known as carapace) samples increased with turtle size (Kenyon et al. 2001; Presti et al. 2000). After a red tide bloom near Florida's Big Bend, Perrault et al. (2017) found brevetoxins and heavy metals in Kemp's ridley and green turtles. Perrault et al. (2017) analyzed the turtles' health relative to the presence of brevetoxins and heavy metals, and found that the presence of toxic elements was related to oxidative stress, increased tumor growth, decreased body condition, inflammation, and disease progression.

Sea turtle tissues have been found to contain organochlorines and many other persistent organic pollutants. PCB concentrations in sea turtles are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (Davenport et al. 1990b; Orós et al. 2009). PCBs have been found in leatherback turtles at concentrations lower than expected to cause acute toxic effects, but might cause sub-lethal effects on hatchlings (Stewart et al. 2011). The contaminants (organochlorines) can cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007) and are known to depress immune function in loggerhead turtles (Keller et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation. Exposure to sewage effluent may also result in green turtle eggs harboring antibiotic resistant strains of bacteria (Al-Bahry et al. 2009).

Oil and gas exploration and extraction is of particular concern in the Gulf of Mexico, because it is an area of high-density offshore oil extraction. This results in an area with chronic, low-level spills and occasional massive spills (e.g., Deepwater Horizon oil spill event). Hydrocarbons that may pose a threat to ESA-listed sea turtles come from 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.

Natural seeps provide the largest petroleum input to the offshore Gulf of Mexico, about 95% of the total. Mitchell et al. (1999) estimated a range of 280,000–700,000 barrels per year (40,000–100,000 tonnes per year), with an average of 490,000 barrels (70,000 tonnes) for the northern Gulf of Mexico, excluding the Bay of Campeche. As seepage is a natural occurrence, the rate of approximately 980,000 barrels (140,000 tonnes) per year is expected to remain unchanged into the foreseeable future.

Oil spills are accidental and unpredictable events, but are a direct consequence of oil and gas development and production from oil and gas activities in the Gulf of Mexico, 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 spill are generally small (less than 1,000 barrels), but larger spills occur. Large-scale and numerous small-scale (vessel) oil spills have occurred in the Gulf of Mexico.

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 sea turtles more generally. Much of what is known comes from studies of large oil spills such as the Deepwater Horizon oil spill since no information exists on the effects of small-scale oil spills within the action area.

On April 20, 2010, while working on an exploratory well approximately 80.5 km (50 mi) offshore of Louisiana, the semi-submersible drilling rig Deepwater Horizon experienced an explosion and fire. The rig subsequently sank, and oil and natural gas began leaking into the Gulf of Mexico. Oil flowed for 86 days, until the well was capped on July 15, 2010. Millions of barrels of oil were released. Additionally, approximately 1.84 million gallons of chemical dispersant was applied both subsurface and on the surface to attempt to break down the oil. There is no question that the unprecedented Deepwater Horizon event and associated response activities (e.g., skimming, burning, and application of dispersants) have resulted in adverse effects on ESA-listed species and changed the environmental baseline for the Gulf of Mexico ecosystem. Berenshtein et al. (2020) used in situ observations and oil spill transport modeling to examine the full extent of the Deepwater Horizon spill, beyond the satellite footprint, that was at toxic concentrations to marine organisms.

The Deepwater Horizon oil spill in the Gulf of Mexico in 2010 led to the exposure of tens of thousands of sea turtles to oil, causing restricted movement, exhaustion, vulnerability to predators, and ingestion of contaminated prey or water. The Deepwater Horizon oil spill also caused significant mortality; it is estimated that 4,900–7,600 large juvenile and adult sea turtles (Kemp's ridley, loggerhead, and unidentified species), and between 55,000–160,000 small juvenile sea turtles (Kemp's ridley, green turtles, loggerhead, hawksbill, and unidentified species) were killed by the Deepwater Horizon oil spill (Deepwater Horizon Trustees 2016). Nearly 35,000 hatchling sea turtles (loggerhead, Kemp's ridley, and green turtles) were also injured by response activities. The Deepwater Horizon oil spill extensively oiled vital foraging, migratory, and breeding habitats of sea turtles throughout the northern Gulf of Mexico (Deepwater Horizon Trustees 2016). *Sargassum* habitats, benthic foraging habitats, surface and water column waters, and sea turtle nesting were all affected by the Deepwater Horizon oil spill. Sea turtles may have been exposed to Deepwater Horizon oil in contaminated habitats, through breathing oil droplets, oil vapor, and smoke, by ingesting oil-contaminated water and prey, and through maternal transfer of oil compounds to developing embryos. Translocation of eggs from the Gulf of Mexico to the Atlantic Ocean coast of Florida resulted in the loss of sea turtle hatchlings. Other response activities, including increased boat traffic, dredging, increased lighting on nesting beaches, and oil cleanup operations on nesting beaches, also contributed to sea turtle deaths.

Stacy et al. (2017) reported 319 live oiled sea turtles were rescued and showed disrupted metabolic and osmoregulatory functions, likely attributable to oil exposure, physical fouling and exhaustion, dehydration, capture, and transport. Accounting for sea turtles that are unobservable during the response efforts, high numbers of small oceanic and large sea turtles are estimated to have been exposed to oil resulting from the Deepwater Horizon event due to the duration and large footprint of the oil spill. Small juveniles were affected in the greatest numbers and suffered a higher mortality rate than large sea turtles. Leatherback turtle foraging and migratory habitat was also affected, and, though impacts to leatherback turtles were unquantified, it is likely some died as a result of the Deepwater Horizon oil spill and spill response (Deepwater Horizon NRDA Trustees 2016; NMFS and USFWS 2013).

Hatchlings from nesting beaches in the Gulf of Mexico were released in the Atlantic Ocean and not the Gulf of Mexico. Therefore, the hatchlings imprinted on the area of their release beach. It is thought that sea turtles use this imprinting information to return to the location of nesting beaches as adults. It is unknown whether these sea turtles will return to the Gulf of Mexico to nest; therefore, the damage assessment determined that the 14,796 hatchlings will be lost to the Gulf of Mexico breeding populations as a result of the Deepwater Horizon event. It is estimated that nearly 35,000 hatchling sea turtles (green, Kemp’s ridley, and loggerhead turtles) were injured by response activities, and thousands more Kemp ridley and loggerhead turtle hatchlings were lost due to unrealized reproduction of adult sea turtles that were killed by the Deepwater Horizon event.

Green turtles made up 32.2% (154,000 animals) of all sea turtles exposed to oil from the Deepwater Horizon event with 57,300 juvenile mortalities out of the total exposed animals, which removed a large number of small juvenile green turtles from the population. A total of 4 nests (580 eggs) were relocated during response efforts. While green turtles regularly use the northern Gulf of Mexico, they have a widespread distribution throughout the entire Gulf of Mexico, Caribbean Sea, and Atlantic Ocean. Nesting is relatively rare on the northern Gulf of Mexico beaches. Although it is known that adverse impacts occurred and numbers of animals in the Gulf of Mexico were reduced as a result of the Deepwater Horizon event, the relative proportion of the population that is expected to have been exposed to and directly impacted by the Deepwater Horizon event is considered low, thus, a population-level impact to green turtles is not likely.

Kemp’s ridley turtles were the most affected sea turtle species, accounting for 49% (239,000 animals) of all exposed sea turtles (478,900 animals) during the Deepwater Horizon event. Kemp’s ridley turtles were the sea turtle species most impacted by the Deepwater Horizon event at a population level. The Deepwater Horizon damage assessment calculated the number of unrealized nests and hatchlings of Kemp’s ridley turtles because all Kemp’s ridley turtles nest in the Gulf of Mexico and belong to the same population (NMFS et al. 2011b). The total population abundance of Kemp’s ridley turtles can be calculated based on numbers of hatchlings because all individuals are reasonably expected to inhabit the northern Gulf of Mexico throughout their lives. The loss of these reproductive-stage females will have contributed to some extent to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp’s ridley turtle nests is between 1,300–2,000, which translates to approximately 65,000–95,000 unrealized hatchlings. This is a minimum estimate because the sub-lethal effects of oil on sea turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years, which may have contributed substantially to additional nesting deficits observed following the Deepwater Horizon event. These sub-lethal effects could have slowed growth and maturation rates, increased remigration intervals, and decreased clutch frequency (number of nests per female per nesting season). The impact of the Deepwater Horizon event on reduced Kemp's ridley turtle nesting abundance and associated hatchling production after 2010 requires further evaluation.

Loggerhead turtles made up 12.7% (60,800 animals) of the total sea turtle exposures (478,900 animals). A total of 14,300 loggerhead turtles died as a result of exposure to oil from the Deepwater Horizon event. Unlike Kemp's ridley turtles, the majority of nesting for the Northwest Atlantic Ocean DPS of loggerhead turtles occurs on the Atlantic coast, and thus nesting was impacted to a lesser degree for this species. It is likely that impacts to the Northern Gulf of Mexico Recovery Unit of the Northwest Atlantic Ocean DPS of loggerhead turtles would be proportionally much greater than the impacts occurring to the other recovery units, and likely included impacts to mating and nesting adults. Although the long-term effects remain unknown, the impacts from the Deepwater Horizon event to the Northern Gulf of Mexico Recovery Unit may include some nesting declines in the future due to a large reduction of oceanic age classes during the Deepwater Horizon event. However, the overall impact on the population recovery of the entire Northwest Atlantic Ocean DPS of loggerhead turtles is likely small.

Available information indicates hawksbill and leatherback turtles were least affected by the oil spill. Hawksbill turtles made up 1.8% (8,850 animals) of all sea turtle exposures. Although leatherback turtles were documented in the area of the oil spill, the number of affected leatherback turtles was not estimated due to a lack of information for leatherback turtles compared to other species of sea turtles. Potential Deepwater Horizon-related impacts to leatherback turtles include direct oiling or contact with dispersants, inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources, which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred. Although adverse impacts likely occurred to hawksbill and leatherback turtles, the relative proportion of the populations of these species that are expected to have been exposed to and directly impacted by the Deepwater Horizon event is relatively low, thus a population-level impact is not believed to have occurred due to the widespread distribution and nesting locations outside of the Gulf of Mexico for both of these species of sea turtles.

The unprecedented Deepwater Horizon oil spill and associated response activities (e.g., skimming, burning, and application of dispersants) resulted in adverse effects on ESA-listed sea turtles. Despite natural weathering processes over the years since the Deepwater Horizon event, oil persists in some habitats where it continues to expose and impact resources in the northern Gulf of Mexico resulting in new environmental baseline conditions (BOEM 2016; Trustees 2016). The true impacts of offshore megafauna populations and their habitats may never be fully quantified, though it was necessary to characterize these impacts for response, damage assessment, and restoration activities (Frasier 2020). It is also unclear how restoration efforts have changed the environmental baseline relative to what it would be if those efforts had not happened.

In June of 1979, the catastrophic Ixtoc oil spill occurred in the Bay of Campeche, releasing approximately 3,000,000 barrels of oil into the Gulf of Mexico before it was capped in March of 1980. During this oil spill, prevailing northerly currents in the western Gulf of Mexico carried spilled oil toward the U.S. As a result, a 96.6 by 112.7 km (60 by 70 mi) patch of sheen containing a 91.4 by 152.4 m (300 by 500 ft) patch of heavy crude moved toward the coast of Texas. The heavy crude impacted a relatively small area and contributed to the sheen, tar balls, and other residuals through weathering. Tar balls from the oil spill impacted a 27.4 km (17 mi) stretch of beach in Texas.

9.6.3 Noise pollution

The ESA-listed sea turtles 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), and marine construction (dredging and pile-driving as well as the construction, operation, and decommissioning of offshore structures). These activities occur to varying degrees throughout the year. Anthropogenic noise is a known stressor that has the potential to affect sea turtles, although effects to sea turtles are not well understood. Within the action area, ESA-listed sea turtles may be impacted by anthropogenic sound in various ways. Responses to sound exposure may include lethal or nonlethal injury, permanent or temporary noise-induced hearing loss, behavioral harassment and stress, or no apparent response.

In the Gulf of Mexico, NOAA is working cooperatively with the ship-building industry to find technologically-based solutions to reduce the amount of sound produced by commercial vessels. Through ESA consultation with NMFS, Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE) have implemented and periodically revised Gulf of Mexico-wide measures, such as BOEM Notice to Lessees and Operators (NTL) 2016-G02, to reduce the risk of harassment to sperm whales from sound produced by geological and geophysical surveying activities and explosive removal of offshore structures.

NOAA has also implemented the CetSound Ocean Sound Strategy (https://cetsound.noaa.gov/) that provides a better understanding of manmade sound impacts on cetacean species. CetSound produced modeled ambient sound maps for several sound source types in the Gulf of Mexico. Annual average ambient sound sums of the modeled source types including seismic airgun surveys at different frequencies and depths. Other modeled events that can be viewed on the CetSound website for the Gulf of Mexico include annual average ambient sound for only seismic airgun surveys, summed sound sources without airguns, and explosive severance of an oil platform during decommissioning. In addition, the Gulf of Mexico soundscape is being studied over the long-term by NOAA’s Sound Reference Station Network (https://www.pmel.noaa.gov/acoustics/noaanps-ocean-noise-reference-station-network; see also Haver et al. 2018). This network uses static passive acoustic monitoring (PAM) hydrophone (sound recorder) units to monitor trends and changes in the ambient sound field in U.S. federal waters.

Vessel Sound and Commercial Shipping

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 $\mu Pa^2/Hz$ at 1 m for fast-moving (greater than 37 km/h [20 kts]) supertankers to 140 dB re 1 $\mu Pa^2/Hz$ at 1 m for smaller vessels (NRC 2003b). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels about 2 kHz, which may interfere with important biological functions of cetaceans (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).

Much of the increase in sound in the ocean environment is due to increased shipping, as vessels become more numerous and of larger tonnage (Hildebrand 2009b; McKenna et al. 2012; NRC 2003b, 2003c). Commercial shipping continues to be a major source of low-frequency sound in the ocean, particularly in the Northern Hemisphere where the majority of vessel traffic occurs. In the Gulf of Mexico, shipping noise dominates the low frequency soundscape (Snyder and Orlin 2007). As noted in Section 10.6.2, ships must pass through the Houston Ship Channel, spanning from the Gulf of Mexico through Galveston Bay, just north of the action area, to reach the Port of Houston. The Houston Ship Channel is the busiest waterway in the U.S., with more than 8,300 large ships, 231,000 commercial small craft, and 230 million tons of cargo a year (TDOT 2016), resulting in areas of high density vessel traffic adjacent to the action area.

Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above 2 kHz. The low frequency sounds from large vessels overlap with the estimated hearing ranges of sea turtles (approximately 50–1500 Hz; Dow Piniak et al. 2012b) and may affect their behavior and hearing. There is limited published information on how these sounds may affect important biological functions of sea turtles. Analysis of sound from vessels revealed that their propulsion systems are a dominant source of radiated underwater sound at frequencies less than 200 Hz (Ross 1976). Additional sources of vessel sound include rotational and reciprocating machinery that produces tones and pulses at a constant rate. Other commercial and recreational vessels also operate within the action area and may produce similar sounds, although to a lesser extent given their much smaller size.

Sonar and Military Activities

Sonar systems are commonly used on commercial, recreational, and military vessels and may affect sea turtles. 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 sea turtles, 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).

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 ≤ 1 kHz, mid-frequency for 1–10 kHz, high-frequency for 10–100 kHz; and very high-frequency for > 100 kHz (Hildebrand 2004). Low-frequency systems are designed for long-range detection (Popper et al. 2014b). 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 m or higher (Hildebrand 2004). Commercial sonars are designed for fish finding, depth sounds, and sub-bottom profiling. They typically generate sound at frequencies of 3–200 kHz, with sound source levels ranging from 150–235 dB re 1 µPa at 1 m (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.

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 sea turtles. While it is difficult to assess these impacts, and there is little data on sea turtle response to aircraft, several studies have documented what appear to be minor cetacean 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 1–3 km (0.5–1.6 NM) away, although the airplane noises ceased as soon as the airplanes left the area, which was relatively quick compared to a cargo vessel. Green and hawksbill turtles showed no response to drones flying at a minimum of 10 m away (Bevan et al. 2018). While such noise levels are relatively low and brief, they still have the potential to be heard by sea turtles at certain frequencies. Nevertheless, noise from aircraft is expected to be minimal due to the location of the action area, which is not located near an airport and has sparse aircraft traffic.

Seismic Surveys

There are seismic survey activities involving towed airgun arrays that may occur within the action area. Airgun surveys are the primary exploration technique to locate oil and gas 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 20066). Seismic airgun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004). Seismic surveys dominated the northern Gulf of Mexico soundscape (Estabrook et al. 2016; Wiggins et al. 2016); thus, noise produced by the seismic survey activities could impact ESA-listed sea turtles 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 10–20 s for extended periods (NRC 2003c). 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 235–240 dB 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 sea turtles (Dow Piniak et al. 2012b; Lavender et al. 2014). In the U.S., seismic surveys involving the use of airguns with the potential to take ESA-listed species, undergo formal ESA section 7 consultation. In addition, the Bureau of Ocean Energy Management authorizes oil and gas activities in domestic waters, and the NSF and U.S. Geological Survey funds and/or conducts these seismic survey activities in domestic, international, and foreign waters. In doing so, these Federal agencies consult 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 (e.g., NMFS 2020a, 2023a, 2023b). For seismic surveys for oil and gas discovery, development and production in the Gulf of Mexico, required mitigation measures can be found in Bureau of Ocean Energy Management Notice to Lessees and Operators 2016-G02 "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program" (https://www.boem.gov/sites/default/files/documents/oil-gas-energy/BOEM-NTL-No-2016-G02.pdf).

9.7 Aquatic Nuisance 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 or invasive 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 4 threats to the world's oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005; Wambiji et al. 2007). 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 shipping. Shipping is the main vector of aquatic nuisance species (species hitchhiking on vessel hulls and in ballast water) in aquatic ecosystems; globally, shipping has been found to be responsible for 69% of marine invasive species (e.g., Drake and Lodge 2007; Keller and Perrings 2011; Molnar et al. 2008).

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; Norse et al. 2005), 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 of these invasive species may have on sea turtles in the action area through the duration of the project. Therefore, the level of risk and degree of impact to ESA-listed sea turtles is unknown.

Lionfish (*Pterois* sp.) have become a major invasive species in the western North Atlantic Ocean and have rapidly dispersed into the Caribbean Sea and Gulf of Mexico. Since lionfish were first captured in the northern Gulf of Mexico in 2010 and 2011, they have rapidly dispersed throughout the northern Gulf of Mexico, with the western most collection of lionfish off Texas (Fogg et al. 2013). Lionfish are voracious predators to native fishes having decimated native fish populations on Caribbean reefs, have a broad habitat distribution, with few natural predators in the region (Ingeman 2016; Mumby et al. 2011). It is unclear what impact lionfish will have on prey species in the action area. Although it is not possible to predict which aquatic nuisance species will arrive and thrive in the northwestern Gulf of Mexico, 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.

9.8 Scientific Research Activities

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 Atlantic Ocean, some of which extend into portions of the action area for the proposed action. Marine mammals and sea turtles 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 dozens of permits on an annual basis for various forms of "take" of marine mammals and sea turtles in the action area from a variety of research activities.

Authorized research on ESA-listed sea turtles includes aerial and vessel surveys, close approaches, active acoustics, capture, handling, holding, restraint, and transportation, tagging, shell and chemical marking, biological sampling (i.e., biopsy, blood and tissue collection, tear, fecal and urine, and lavage), drilling, pills, imaging, ultrasound, antibiotic (tetracycline) injections, captive experiments, laparoscopy, and mortality. Most research activities involve authorized sub-lethal "takes," with some resulting mortality.

There have been numerous research permits issued since 2009 under the provisions of both the Marine Mammal Protection Act and ESA authorizing scientific research on marine mammals and sea turtles all over the world, including for research activities in the action area. The consultations 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.

9.9 Impact of the Baseline on Endangered Species Act-Listed Species

Collectively, the 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 and sea turtle harvesting), whereas others result in more indirect (e.g., fishing that impacts prey availability) or non-lethal (e.g., invasive species) 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 many of 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 resources to be the status and trends of those species. As noted in Section 9, 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 section are impacting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the activities described in the Environmental Baseline section. Therefore, while the stressors that affect the environmental baseline in the action area may slow their recovery, recovery is not being prevented. For the species that may be declining in abundance, it is possible that the suite of conditions described in the Environmental Baseline section is preventing their recovery. However, it is also possible that 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. A thorough review of the status and trends of each species is discussed in the Status of Species Likely to be Adversely Affected section (Section 9) of this consultation and what this means for the populations is discussed in the Integration and Synthesis section (Section 13).

10 Effects of the Action

Section 7 regulations define "effects of the action" as all consequences to the ESA-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. 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 (50 C.F.R. §402.02).

This effects analyses section is organized following the stressor, exposure, response, risk assessment framework described in Section 2 above.

In this section, we further describe the potential stressors associated with the proposed action, the probability of individuals of ESA-listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (give probable exposures) based on the available evidence. As described in Section 10.2, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment will consider the risk posed to the viability of the population(s) those individuals comprise and to the ESA-listed species those populations represent. For this consultation, we are particularly concerned about behavioral and stress-related physiological disruptions and potential unintentional mortality that may result in animals that fail to feed, reproduce, or survive because these responses are likely to have population-level consequences. The purpose of this assessment and, ultimately, of this consultation is to determine if it is reasonable to expect the proposed action to have effects on ESA-listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

10.1 Stressors Associated with the Proposed Action

During consultation we determined that sound fields produced by the airguns may adversely affect ESA-listed species (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle) by introducing acoustic energy into the marine environment. This stressor and the likely effects on ESA-listed species are discussed starting in Section 10.2.

10.2 Exposure Analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the action's effects on the environment in space and time, and identify the nature of that co-occurrence. This section identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the action's effects and the population(s) or sub-population(s) those individuals represent. Although there are multiple stressors associated with the proposed action, the stressor of primary concern as the one that may adversely affect listed sea turtles in the action area is the acoustic impact of the airguns.

In this section, we quantify the likely exposure of ESA-listed species to sound from the airgun array. For this consultation, the DOE and UT estimated exposure to the sounds from the airgun array that would result in ESA harassment of ESA-listed sea turtles.

Section 3 of the ESA defines take 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)). Harm is defined by regulation (50 C.F.R. §222.102) as “an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering.” NMFS does not have a regulatory definition of “harass.” However, on May 1, 2023, NMFS adopted, as final, the previous interim guidance on the term “harass,” defining it as to “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding, or sheltering.”

Under the ESA, harassment resulting from seismic survey acoustic stressors may involve a wide range of behavioral responses of ESA-listed sea turtles including, but not limited to, avoidance, or disruption of feeding, migrating, or reproductive behaviors. In the following sections, we consider the best available scientific evidence to determine the likely nature of these responses and their potential fitness consequences in accordance with the definitions of “take” related to harm or harass under the ESA.

Our exposure analysis relies on 2 basic components: (1) information on species distribution (i.e., density or occurrence within the action area), and (2) information on the level of exposure to sound (i.e., acoustic thresholds) at which species are reasonably certain to be affected (i.e., exhibit some response). Using this information, and information on the seismic survey (e.g., sound source specifications, area or volume of water that would be ensonified at certain sound levels, trackline distances, days of operation, etc.), we then estimate the number of instances in which an ESA-listed species may be exposed to sound fields from the airgun array that are likely to result in adverse effects such as harm or harassment. In many cases, estimating the potential exposure of animals to anthropogenic stressors is difficult due to limited information on animal density estimates in the action area and overall abundance, the temporal and spatial location of animals; and proximity to and duration of exposure to the sound source. For these reasons and by regulation, we evaluate the best available data and information in order to reduce the level of uncertainty in making our final exposure estimates.

10.2.1 Exposure Estimates of ESA-Listed Sea Turtles

As discussed in the Status of Species Likely to be Adversely Affected (Section 9), there are 4 ESA-listed sea turtle species that are likely to be adversely affected by the proposed action: the North Atlantic DPS of green turtle, Kemp’s ridley turtle, leatherback turtle, and the Northwest Atlantic Ocean DPS of loggerhead turtle.

The DOE and UT applied NMFS’s acoustic thresholds (NOAA 2018) to determine at what point during exposure to the airgun array sea turtles may be harmed or harassed. An estimate of the number of sea turtles that will be exposed to sounds from the airgun array is included in DOE’s draft environmental assessment (DOE 2023).

In this section, we describe the DOE and UT's analytical methods to estimate the number of ESA-listed sea turtle species that might be exposed to the airgun array's sound field.

ESA-Listed Sea Turtle Occurrence – Density Estimates

We reviewed available sea turtle densities with the DOE and UT, and agreed with them on which densities constituted the best available scientific information for each ESA-listed sea turtle species. We have adopted them for our ESA Exposure Analysis.

Estimates of sea turtle densities in the action area were utilized in the development of DOE and UT's draft environmental assessment (DOE 2023). The DOE and UT used habitat-based density estimates from Garrison et al. (2023). The habitat-based density models were produced from visual observations of sea turtles using line-transect survey methods aboard NOAA research vessels and aircraft in the Gulf of Mexico between 2003 and 2019 (as part of the Gulf of Mexico Marine Assessment Program for Protected Species, or GoMMAPPS). Only sea turtles greater than approximately 30–40 cm were recorded because smaller, post-hatchling turtles are difficult to observe from the aforementioned platforms (Rappucci et al. 2023). Therefore, the sea turtle densities in Garrison et al. (2023) represent the best available information regarding neritic-stage juvenile and adult sea turtle densities in the seismic survey area. Although we do not have current density information on post-hatchling turtles in the action area, we know that these sea turtle species are present in the region, and that there is a likelihood of exposure to the proposed seismic survey. In the absence of better information, we rely on a surrogate to estimate exposure of green, Kemp's ridley, leatherback, and loggerhead turtles, that is, the area within the 175 dB re 1 µPa (rms) isopleth is where sea turtles are likely to be adversely affected.

The habitat-based density models consisted of 40 km^2 hexagons (~3.9 km sides and ~7 km across) for each month across the entire Gulf of Mexico. Average densities in the cells for the seismic survey area (plus a 7 km [~4.3 mi] buffer to ensure that at least one full density hexagon cell immediately outside the seismic survey area in all directions was included) were calculated for each species and month. See Garrison et al. (2023) and Litz et al. (2022) for more details. The highest mean monthly density was chosen for each species from the months of September to December.

Data sources and density calculations are described in detail in DOE's draft environmental assessment (DOE 2023). There is uncertainty about the representativeness of the density data and the assumptions used to estimate exposures. For some sea turtle species, the densities derived from past surveys may not be precisely representative of the densities that may be encountered during the seismic survey. Density estimates for each ESA-listed sea turtle likely to be adversely affected by the proposed action are found in Table 3. The approach used here is based on the best available data.

Table 3. Densities of Endangered Species Act-Listed Sea Turtles in the Action Area during the Department of Energy and University of Texas at Austin's Seismic Survey off Texas

Species	Season (Month of Highest Density between September–December)	Density (Individuals per km^2)
Green turtle – North Atlantic DPS	September	0.00276
Kemp's Ridley turtle	December	0.19854
Leatherback turtle	September	0.00017
Loggerhead turtle – Northwest Atlantic Ocean DPS	December	0.05006

km^2=square kilometers.

Total Ensonified Area for ESA-listed Sea Turtles

The number of sea turtles that can be exposed to the sounds from the airgun array on 1 or more occasions is estimated for the seismic survey area using expected seasonal density of animals in the area (Table 3). Summing exposures along the total distance of trackline yields the total exposures for each species for the proposed action of the 2 GI airguns for the seismic survey. As noted in Section 3, the seismic survey would consist of ~222 km (~138 mi) of trackline surveyed in one day, for a total of 1,704 km (~1,058.8 mi) of trackline (including endcaps of each trackline) over the 7-day seismic survey. DOE and UT's model to determine radial distances from the airguns to the 175 dB re 1 µPa [rms] behavioral disturbance threshold for sea turtles is shown in Table 4.

Table 4. Predicted Distances to Received Sound Level of 175 dB re 1 µPa (rms) from 2 GI Airguns for Sea Turtles during the Proposed Seismic Survey

Source	Volume (in^3)	Water Depth (m)	Distance to 175 dB re 1 µPa (rms) Threshold (m)
2 GI airguns	210	< 100 m	284

dB re 1 µPa=decibels referenced to a pressure of one microPascal; rms=root mean square; in^3=cubed inches; m=meters

The total ensonified area for the 175 dB re 1 µPa [rms] sea turtle behavioral disturbance threshold for the seismic survey tracklines is estimated to be approximately 1,263 km^2 (~487.6 mi^2). This area was calculated by using the radial distances from the airguns to the predicted isopleths corresponding to the 175 dB re 1 µPa (rms) threshold (Table 4), along both sides of a trackline that could be surveyed in 1 day (~222 km [~138 mi]), plus the endcaps to the start and end of the trackline (the area of a half circle). The daily ensonified area is multiplied by the total number of survey days (7 days). This provides an estimate of the total area (km^2) expected to be ensonified to the behavioral disturbance thresholds for sea turtles (Table 5).

Table 5. 175 dB re 1 μPa (rms) Harassment Isopleths, Trackline Distance, Ensonified Area, Number of Survey Days, and Total Ensonified Areas During the Department of Energy and University of Texas at Austin's Seismic Survey off Texas

Threshold	Source	Daily Trackline Distance (km)	Daily Ensonified Area (km^2)*	Survey Days	Total Ensonified Area (km^2)*
175 dB re 1 μPa (rms)	2 GI Airguns	222	126.3	7	884.1

km=kilometers, km^2=square kilometers; dB re 1 μPa=decibels referenced to a pressure of one microPascal; rms=root mean square; GI=generator injector
* Including endcaps and accounting for overlap

In addition to the ensonified area noted above, DOE assessed the predicted distances to PTS and TTS thresholds for sea turtles (Table 6). Based on the small anticipated isopleths for PTS (ESA harm) and TTS, and in consideration of the conservation measures (i.e., exclusion and buffer zones, shutdown procedures, ramp-up procedures, vessel-based visual monitoring by NMFS-approved PSOs, and additional conservation measures), we do not expect injury, PTS, or TTS of ESA-listed sea turtles.

Table 6. Predicted Distances for Sea Turtles to Noise-Induced Hearing Loss Thresholds for the Department of Energy and University of Texas at Austin's Seismic Survey off Texas

Threshold	Source	Distance to Threshold (m)
PTS: SPL_{peak} 232 dB	2 GI Airguns	1
TTS: SPL_{peak} 226 dB	2 GI Airguns	2

m=meters; SPL_{peak}=peak sound pressure level; dB=decibels; GI=generator injector

Sea Turtle Exposures as a Percentage of Population

Adult, juvenile, and post-hatchling North Atlantic DPS of green, Kemp's ridley, and Northwest Atlantic Ocean DPS of loggerhead, and adult and juvenile leatherback sea turtles are likely to be exposed during the seismic survey activities. Given that the seismic survey will be conducted in the fall, we expect that most animals would be foraging. All sea turtle species are expected to be feeding, traveling, or migrating in the action area but no females are expected to be nesting. Because the seismic survey will not occur during sea turtle nesting season, we assume that the sex distribution is even for the North Atlantic DPS of green, Kemp's ridley, leatherback, and Northwest Atlantic Ocean DPS of loggerhead sea turtles, and sexes are exposed at a relatively equal level.

Table 7. Calculated Exposures for Endangered Species Act-Listed Sea Turtles during the Department of Energy and University of Texas at Austin's Seismic Survey off Texas

Species	Density (Individuals per km^2)	Total Ensonified Area (km^2)*	Calculated Exposures to Harassment (Rounded Exposures)
Green turtle – North Atlantic DPS	0.00276	884.1	2.4 (2)
Kemp's Ridley turtle	0.19854	884.1	175.5 (176)
Leatherback turtle	0.00017	884.1	0.2 (0)*
Loggerhead turtle – Northwest Atlantic Ocean DPS	0.05006	884.1	44.3 (44)

km^2=square kilometers

* Although calculated exposure is more than 0 (i.e., not discountable), due to the low density in the action area, constant movement of the research vessel and animals, and the short duration of the seismic survey, we do not expect exposure will rise to 1 individual

The exposure numbers by ESA harassment (Table 7) are expected to be conservative for multiple reasons. The number of exposures presented above represent the estimated number of instantaneous moments in which an individual from each species will be exposed to sound fields from seismic survey activities at or above the behavioral disturbance threshold. While the exposures do not necessarily represent individual sea turtles, the overall exposure is relatively low compared to the abundance of each sea turtle population that may occur within the action area. Given this, we expect that most sea turtles will not be exposed more than once, meaning the exposure numbers likely represent individual animals. As for the duration of each instance of exposure estimated, we were unable to produce estimates specific to the proposed action due to the temporal and spatial uncertainty of the research vessel and sea turtles within the action area. However, all the exposures are expected to be less than a single day due to the movement of the research vessel and animals. Sea turtles are also expected to move away from a loud sound source that represents an aversive stimulus, such as an airgun array, potentially reducing the number of exposures by ESA harassment. However, the extent to which sea turtles would move away from the sound source is difficult to quantify and is not accounted for in the exposure estimates. Finally, these exposure estimates do not account for conservation measures (i.e., exclusion and buffer zones, vessel-based visual monitoring, shutdown procedures) that will be implemented as part of the proposed action and may avoid or reduce exposure. Thus, exposure numbers are conservative estimates of the number of individuals that will be exposed.

Green Turtle – North Atlantic DPS – The estimated exposure of the regional population (a minimum of 167,424 nesting females for the North Atlantic DPS) of green turtle is a total of 2 individuals to behavioral harassment, which is approximately 0.00001% of the regional population.

Kemp's Ridley Turtle – The estimated exposure of Kemp's ridley turtles (regional population abundance unknown) is 176 individuals to behavioral harassment.

Leatherback Turtle – The estimated exposure of leatherback turtles (regional population abundance unknown) is 0 individuals to behavioral harassment.

Loggerhead Turtle – Northwest Atlantic Ocean DPS – The estimated exposure of the Northwest Atlantic Ocean DPS (population abundance unknown) of loggerhead turtle is 44 individuals to behavioral harassment.

10.3 Response Analysis

A pulse of sound from the airgun array displaces water around the airgun array and creates a wave of pressure, resulting in physical effects on the marine environment that can then affect marine organisms, including ESA-listed sea turtles considered in this consultation. Possible responses considered in this analysis consist of:

- Hearing threshold shifts;
- Auditory interference (masking);
- Behavioral responses; and
- Non-auditory physical or physiological effects.

The response analysis also considers information on the potential effects on prey of ESA-listed sea turtles in the action area that would then affect the listed species.

As discussed in the Assessment Framework (Section 2) of this consultation, response analyses determine how ESA-listed resources are likely to respond after exposure to stressors from an action that causes changes to the environment or acts directly on ESA-listed species. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might result in reduced fitness of ESA-listed individuals. Ideally, response analyses consider and weigh evidence of adverse consequences, as well as evidence suggesting the absence of such consequences.

During the proposed action, ESA-listed sea turtles may be exposed to sound from the airguns. The DOE and UT provided estimates of the expected number of ESA-listed sea turtles that could be exposed to received levels greater than or equal to 175 dB re 1 µPa (rms) from the airguns

(Section 10.2). Based on information presented in Sections 4.3 and 10.2, ESA-listed sea turtles exposed to these sound levels could be "taken" by ESA harassment.

10.3.1 Potential Response of Sea Turtles to Acoustic Sources

Acoustic Thresholds for Sea Turtles

If exposed to loud sounds, sea turtles may experience ESA harm and/or harrassment. For ESA harassment, NMFS has historically relied on a minimum acoustic threshold of 175 dB re 1 μPa (rms) for impulsive sound sources. These values are based on observations of behavioral disturbance in loggerhead and green sea turtles to seismic airguns (e.g., DeRuiter and Larbi Doukara 2012; McCauley et al. 2000b; O'hara and Wilcox 1990). For this action, we relied on this NMFS acoustic threshold to estimate the number of takes by behavioral harassment of ESA-listed sea turtles. Historically, we have considered TTS as a form of ESA harassment, whereas PTS is considered a form of ESA harm. The current TTS and PTS sea turtle thresholds use fish as a surrogate because few, if any, data are available to assess sea turtle hearing, let alone the precise sound levels that can result in TTS or PTS. The only study addressing sea turtle TTS was conducted by Moein et al. (1994) in which a loggerhead turtle experienced TTS upon multiple exposures to an airgun in a shallow water enclosure, but recovered full hearing sensitivity within 1 day. Salas et al. (2023) studied TTS in freshwater turtles in a tank, and found that turtles recovered between 1 h to 2 days.

We assume that sea turtles will not move towards a sound source that causes them stress or discomfort. Some experimental data suggest sea turtles may avoid seismic sound sources (McCauley et al. 2000a; McCauley et al. 2000c; Moein et al. 1994; Nelms et al. 2016), but monitoring reports from seismic surveys in other regions suggest that some sea turtles do not avoid airguns and were likely exposed to higher levels of pulses from a seismic airgun array (Smultea and Holst 2003. For this reason, conservation measures will be implemented to limit sea turtle exposures to 100 m (~328 ft) or more from the sound source. Although the effectiveness of conservation measures is not fully understood, we do not expect any sea turtles present in the action area to be exposed to sound levels that will result in anything other than behavioral harassment. In addition, the constant movement of both the research vessel and the ESA-listed sea turtles in the action area (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle), the short duration of exposure to loud sounds (because the research vessel is not expected to remain in any area where individual animals may concentrate for an extended period of time), and the small isopleths to PTS and TTS (1–2 m [3.3–6.6 ft]; Table 6), make TTS and PTS unlikely. Thus, we believe that take by ESA harassment via TTS and ESA harm (PTS) is unlikely and conclude that they will not occur.

Sea Turtles and Behavioral Responses

It is likely that sea turtles will experience behavioral responses in the form of avoidance. There is limited information available on sea turtle behavioral responses to airguns because of the difficulty in observing these responses in the wild; nevertheless, we present the best available information. Behavioral responses to human activity have been investigated in green and loggerhead (e.g., McCauley et al. 2000b; O'hara and Wilcox 1990), and leatherback, loggerhead, olive ridley, and 160 unidentified sea turtles hardshell species; Weir 2007. The work by O’Hara and Wilcox 1990 and McCauley et al. 2000b reported behavioral changes in sea turtles in response to seismic airgun arrays. These studies formed the basis for our 175 dB re 1 µPa (rms) threshold for determining when sea turtles will be harassed due to sound exposure because, at and above this level, loggerhead turtles were observed exhibiting avoidance behavior, increased swimming speed, and erratic behavior. Loggerhead turtles have also been observed moving towards the surface upon exposure to an airgun Lenhardt 1994; Lenhardt et al. 1983. In contrast, loggerhead turtles resting at the ocean surface were observed to startle and dive as an active seismic source approached them, with the responses decreasing with increasing distance DeRuiter and Larbi Doukara 2012. However, some of these animals may have reacted to the vessel’s presence rather than the sound source DeRuiter and Larbi Doukara 2012. Monitoring reports from seismic surveys show that some sea turtles move away from approaching airgun arrays, although sea turtles may approach active airgun arrays within 10 m (32.8 ft) with minor behavioral responses Holst et al. 2006; Holst and Smultea 2008; Holst et al. 2005; NMFS 2006, 2006h; Smultea et al. 2005.

Observational evidence suggests that sea turtles are not as sensitive to sound as are marine mammals, and that behavioral changes are only expected when sound levels rise above received sound levels of 175 dB re 1 µPa (rms). If exposed at such sound levels, based on the available data, we anticipate some change in swimming patterns. Some sea turtles may approach the airguns, but we expect them to eventually turn away in order to avoid the active airgun array, or for shutdown procedures to take place if the turtle is within the exclusion zone. As such, we expect temporary displacement of exposed individuals from some portions of the action area during the seismic survey.

Sea Turtles and Masking

Relative to marine mammals, very little is known and there have been no quantitative data, on how masking affects sea turtles. Masking of sounds can interfere with important life functions such as finding prey, finding a mate, and avoiding predators. Nunny et al. (2005) suggested that sea turtles may use acoustic cues to identify appropriate nesting sites. Sea turtles hear best at low-frequencies (e.g., Dow Piniak et al. 2012b; Lavender et al. 2014); therefore, the potential masking noises fall within the turtles’ hearing range. However, there are currently no data to show that sea turtles are affected by masking.

Sea Turtles and Physical or Physiological Effects

Direct evidence of seismic sound causing stress is lacking for sea turtles. However, animals often respond to anthropogenic stressors in a manner that resembles a prey response Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill et al. 2001; Harrington and Veitch 1992; Harris et al. 2018; Lima 1998; Romero 2004. As predators generally induce a stress response in their prey Dwyer 2004; Lopez 2001; Mateo 2007, we assume that sea turtles experience a stress response if exposed to loud sounds from airgun arrays. We expect that breeding adult females may experience a lower stress response. Female green, hawksbill, and loggerhead turtles appear to have a physiological mechanism to reduce or eliminate hormonal responses to stress (predator attack, high temperature, and capture) in order to maintain reproductive capacity at least during their breeding season; a mechanism apparently not shared with males Jessop 2001; Jessop et al. 2000; Jessop et al. 2004. Individuals may experience a stress response at levels lower than approximately 175 dB re 1 µPa (rms), but data are lacking to evaluate this possibility. Therefore, we follow the best available evidence identifying a behavioral response as the point at which we also expect a significant stress response.

10.3.2 Potential Responses of Sea Turtle Prey to Acoustic Sources

Seismic surveys may have indirect, adverse effects on ESA-listed sea turtles by affecting their prey availability (including larval stages) through lethal or sub-lethal damage, stress responses, or alterations in their behavior or distribution. 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 sea turtles. In a comprehensive 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 sea turtles is not available. Until more information specific to prey of the ESA-listed species considered in this opinion is available, we expect that prey (e.g., teleosts, zooplankton, cephalopods) of ESA-listed sea turtles considered in this consultation will react in manners similar to those fish and invertebrates described herein.

As for sea turtles, 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 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 may be 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. A more recent study by Day et al. (2017) found 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.

The prey of ESA-listed sea turtles may also exhibit behavioral responses if exposed to active seismic airguns. Based on the available data, as reviewed by Carroll et al. (2017), considerable variation exists in how fishes behaviorally respond to seismic survey activities, with some studies indicating no response and others noting startle or alarm responses and/or avoidance behavior. However, no effects to foraging or reproduction have been documented. Similarly, data on the behavioral response of invertebrates suggests some species may exhibit a startle response, but most studies do not suggest strong behavioral responses. For example, a recent study by Charifi et al. (2017) found that oysters appear to close their valves in response to low frequency sinusoidal sounds. Day et al. (2017) recently found that, when exposed to seismic airgun array sounds, scallops exhibit behavioral responses such as flinching, but none of the observed behavioral responses were considered to be energetically costly. As with sea turtles, behavioral responses by fishes and invertebrates may also be associated with a stress response.

There has been research suggesting that seismic airgun arrays may lead to a significant reduction in zooplankton, including copepods (see Section 7.4). Given the results from the studies discussed in Section 7.4, it is difficult to assess the effects seismic airgun arrays may have on the instantaneous or long-term survivability of prey species that are exposed. However, the 1) small scale of the seismic survey relative to the Gulf of Mexico, 2) downward transmission of sound from the airguns towed at a depth of 6 m (19.7 ft), 3) the energy of the seismic survey (~3,441 cm^3 [210 in^3] versus 2,458.1 or 4,260.6 cm^3 [150–260 in^3]) proposed in this consultation, and 4) the depth at which the airguns will be towed (6 m or 19.7 ft) compared to the expected surface distribution of the prey species, suggests that any copepod directly exposed to the seismic airgun array would likely suffer less mortality than described by McCauley et al. 2017.

While the seismic survey may temporarily alter prey abundance in the action area, we expect such effects to be insignificant because of the high turnover rate of copepods and ocean circulation, which will minimize any effects.

Fish or invertebrate mortality may occur from exposure to airguns, but will be 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. 2000c; McCauley et al. 2003b; Popper et al. 2005; Santulli et al. 1999. Lethal effects, if any, are expected within a few meters of the airgun array Buchanan et al. 2004; Dalen and Knutsen 1986. If fishes that are not within close range to the airgun array detect the sound and leave the area, it is because the sound is perceived as a threat or it causes some discomfort. We expect these fishes will return to the area once the disturbance abates. For example, a common response by fishes to airgun sound is a startle or distributional response, where fish react 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) observed caged *Pelates* spp., pink snapper **(***Pagrus auratus*), and trevally (*Caranx ignobilis*) to generally exhibit startle, displacement, and/or grouping responses upon exposure to airguns. This effect generally persisted for several minutes, although subsequent exposures of the same individuals did not necessarily elicit a response Fewtrell 2013a. In addition, 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 change swimming depth and horizontal position more frequently during airgun sound production Davidsen et al. 2019. We expect that, if fish detect a sound and perceive it as a threat or some other signal that induces them to leave the area, they are capable of moving away from the sound source (e.g., airgun array) if it causes them discomfort and will return to the area and be available as prey for sea turtles.

There are reports showing sub-lethal effects to some fish species from airgun arrays. Several species at various life stages have been exposed to high-intensity sound sources (220–242 dB re 1 µPa) at close distances, with some cases of injury Booman et al. 1996; McCauley et al. 2003b. Effects from TTS were not found in whitefish at received levels of approximately 175 dB re 1 $\mu Pa^2 s$, but pike did show 10–15 dB of hearing loss with recovery within 1 day Popper et al. 2005. Caged pink snapper (*Pelates* spp.) have experienced PTS when exposed over 600 times to received sound levels of 165– 209 dB re 1 µPa peak-to-peak. Exposure to airguns at close range was 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 20–60 min after firing of the airgun ceased. A downward shift was also noted by Skalski et al. 1992 at received seismic sounds of 186–191 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 3 days Skalski 1992. These fish also showed a startle response when the seismic survey vessel was as much as 2.5 km (1.3 NM) away; this response increased in severity as the vessel approached and sound levels increased, but returned to normal after about 2 h 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 1 h and returned to normal depth (sound environments of 185–192 dB re 1 µPa) despite 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 156–161 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 195–218 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 20–50 m (65.6–164 ft) 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 in salmonids receiving 142–186 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 160–180 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.

Increased swimming activity in response to airgun exposure in fish, as well as reduced foraging activity, is supported by data collected by Lokkeborg et al. 2012. Bass did not appear to vacate during a shallow-water seismic survey with received sound levels of 163–191 dB re 1 µPa 0-to-peak Turnpenny and Nedwell 1994. Similarly, European sea bass apparently did not leave their inshore habitat during a 4–5 month seismic survey Pickett et al. 1994. La Bella et al. 1996 found no differences in trawl catch data before and after seismic survey activities and echosurveys of fish occurrence did not reveal differences in pelagic biomass. However, fish kept in cages did show behavioral responses to approaching operating airguns.

Squid are important prey for some sea turtle species. 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. 2000c. The authors also noted some movement upward. During ramp-up, squid did not discharge ink but alarm responses occurred when received sound levels reached 156–161 dB re 1 µPa (rms). Moriyasu et al. (2004) summarized published and unpublished data by Norris and Mohl (1983), which observed lethal effects in squid (*Loligo vulgaris*) at levels of

246–252 dB after 3–11 min. Andre et al. (2011) exposed 4 cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to 2 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). Lobsters did not exhibit delayed mortality, or apparent damage to mechanobalancing systems up to 8 months post-exposure to airguns fired at 202–227 dB peak-to-peak pressure Christian 2013; Payne et al. 2013. However, feeding did increase for up to a month after exposure to the airguns Christian 2013; Payne et al. 2013.

In summary, the anticipated response of fishes and squids to sound from airguns is to exhibit startle responses and undergo vertical and horizontal movements away from the sound field. Based upon the best available information, prey species located within the sound fields corresponding to the approximate 175 dB re 1 µPa (rms) isopleth could vacate the area and/or dive to greater depths. We do not expect indirect effects from airgun array operations through reduced feeding opportunities for ESA-listed sea turtles to reach a measurable level. Effects are likely to be temporary and, if displaced, both sea turtles and their prey will re-distribute back into the action area once seismic survey activities have passed or concluded.

Based on the best available data, we anticipate seismic survey activities will result in temporary and minor reductions in the availability of prey for ESA-listed sea turtles near the airguns during and immediately following the use of active seismic sound sources. This may be due to changes in prey distributions (i.e., due to avoidance) or abundance (i.e., due to mortality) or both. However, we do not expect this to have a meaningful impact on ESA-listed sea turtles in the action area. As described above, we believe that, in most cases, ESA-listed sea turtles will avoid closely approaching the airgun array when it is active, and will not likely be in areas where prey could be temporarily displaced or otherwise affected.

10.4 Summary of Effects

We expect up to 2 green turtles (North Atlantic DPS), 176 Kemp's ridley turtles, and 44 Northwest Atlantic Ocean DPS of loggerhead turtles to be exposed to the airgun array within the 175 dB re 1 µPa (rms) ensonified areas during the seismic survey and exhibit responses in the form of ESA behavioral harassment.

Because of the nature of the seismic survey, as described above, we do not expect any injury or mortality to ESA-listed species from the exposure to the acoustic sources resulting from the proposed action. The proposed action will result in temporary effects including behavioral responses (e.g., avoidance, discomfort, and stress) to the exposed sea turtles (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle). Harassment is not expected to have more than short-term effects on individual ESA-listed sea turtles. Because of the large ranges of the affected ESA-listed sea turtles compared to the relatively small size of the portion of the action area where seismic surveys will occur, combined with the relatively short duration of the seismic survey activities, there may be multiple exposures of a small number of individuals in the action area.

The estimates of the number of individuals exhibiting measureable behavioral responses are considered conservative (i.e., they are likely higher than what the actual exposures would be and a lower number are likely to be harassed given the conservation measures that will be implemented).

11 Cumulative Effects

"Cumulative effects" are 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 C.F.R. §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

We expect that stressors described in the Environmental Baseline (Section 9) will continue to impact ESA-listed resources into the foreseeable future. We expect climate change, oceanic temperature regimes, sea turtle harvesting, fisheries (fisheries interactions), pollution (marine debris, pollutants and contaminants, hydrocarbons, and anthropogenic sound), aquatic nuisance species, and scientific research activities to continue into the future for ESA-listed sea turtles. Many of these activities will require ESA consultation because they have a Federal nexus and are not part of our consideration of cumulative effects for this reason.

Because of recent trends and based on available information, we expect the amount and frequency of vessel activity to persist in the action area, and that ESA-listed sea turtles will continue to be affected. Different aspects of vessel activity can affect ESA-listed species, such as vessel noise, disturbance, and the risk of vessel strike causing injury or mortality. However, movement towards bycatch reduction and greater protections (e.g., use of TEDs) are generally occurring throughout the Gulf of Mexico and may continue to aid in abating the downward trajectory of some populations due to activities such as fishing in the action area.

During this consultation, we searched for information on future state, tribal, local or private (non-Federal) actions that were reasonably certain to occur in the action area. We conducted electronic searches of *Google* and other electronic search engines for other potential future state or private activities that are likely to occur in the action area. We are not aware of any state, tribal, or private activities that are likely to occur in the action area during the foreseeable future that were not considered in the Environmental Baseline of this consultation.

The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on ESA-listed sea turtles. Thus, this consultation assumed effects in the future would be similar to those in the past and are reflected in the anticipated trends described in the Status of the Species Likely to be Adversely Affected and Environmental Baseline, respectively.

12 Integration and Synthesis

The Integration and Synthesis is the final step in our assessment of the risk posed to species and their designated critical habitat because of implementing the proposed action. In this section, we add the Effects of the Action (Section 10) to the Environmental Baseline (Section 9) and the Cumulative Effects (Section 11) to formulate the agency's biological opinion as to whether the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing its numbers, reproduction, or distribution. This assessment is made in full consideration of the Status of the Species Likely to be Adversely Affected (Section 8).

12.1 Jeopardy Analysis

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02). Therefore, the jeopardy analysis considers both the survival and recovery of the species.

Based on our effects analysis, adverse effects to ESA-listed sea turtles are likely to result from the proposed action. The following discussions summarize the probable risks that stressors resulting from the proposed action (specifically sound from seismic airguns) pose to ESA-listed sea turtles. These summaries integrate our exposure and response analyses from the Effects of the Actions (Section 10).

12.2 Green Turtle – North Atlantic Distinct Population Segment

Adult, juvenile, and post-hatchling North Atlantic DPS of green turtles are present in the action area and are expected to be exposed to noise from the seismic survey activities. The severity of an animal's response to noise associated with the seismic survey will depend on the duration and severity of exposure.

Once abundant in tropical and subtropical waters, green turtles worldwide exist at a fraction of their historical abundance, as a result of over-exploitation for food and other products. Globally, egg harvest, the harvest of females on nesting beaches and directed hunting of sea turtles in foraging areas remain the greatest threats to their recovery. In addition, bycatch in drift-net, long-line, set-net, and trawl fisheries kill thousands of green turtles annually. Other threats include pollution, habitat loss through coastal development or stabilization, destruction of nesting habitat from storm events, artificial lighting, poaching, global climate change, natural predation, disease, cold-stunning events, and oil spills.

Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population's decline. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS of green turtle appears to be somewhat resilient to future perturbations.

For the North Atlantic DPS of green turtle the available data indicate an increasing trend in nesting. There is no reliable estimates of population growth rate of the North Atlantic DPS as a whole, but estimates have been developed at a localized level. Apparent increases in nesting turtle abundance for the North Atlantic DPS of green turtle in recent years are encouraging, but must be viewed cautiously, as the datasets represent a fraction of green turtle generation, up to approximately 50 years.

No reduction in the distribution of North Atlantic DPS of green turtles from the Atlantic Ocean (northwestern Gulf of Mexico) is expected because of the DOE and UT's seismic survey.

No reduction in numbers is anticipated as part of the proposed action. Therefore, no reduction in reproduction is expected as a result of the proposed action. Non-lethal take of 2 individuals from the North Atlantic DPS of green turtles, which could be adults and/or juveniles, is expected as a result of the proposed seismic survey activities. Density data were not were not available to quantify the number of exposures for small sea turtles (< 30–40 cm [11.8–15.7 in]). Any small sea turtle found within an ensonified area of 884.1 km^2 (341.4 mi^2) is expected to be taken in the form of harassment. We anticipate temporary behavioral responses (e.g., temporary displacement and stress), and thus do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction or the distribution of North Atlantic DPS of green turtles as a result of the proposed seismic survey, a reduction in the species' likelihood of survival is not expected.

The Recovery Plan for the U.S. Atlantic population of green turtle lists recovery objectives for the species (NMFS and USFWS 1991). The following recovery criteria and recovery actions are relevant to the impacts of the proposed actions:

- A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds.
- Determine distribution and seasonal movements for all life stages in marine environment.
- Reduce threat to population and foraging habitat from marine pollution.

Because no mortalities or effects on the abundance, distribution, and reproduction of North Atlantic DPS of green turtle populations are expected, we do not anticipate that the proposed seismic survey will impede any recovery objectives for North Atlantic DPS of green turtles. In conclusion, we believe the effects associated with the proposed action are not expected to appreciably reduce the likelihood of survival and recovery of North Atlantic DPS of green turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

12.3 Kemp's Ridley Turtle

Adult, juvenile, and post-hatchling Kemp's ridley turtles are present in the action area and may be exposed and respond to noise from the seismic survey activities.

Kemp's ridley turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.) ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease.

The Kemp's ridley turtle was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May through August, and, in 1990, the harvest of all sea turtles was prohibited by presidential decrees in Mexico. In 2002, Rancho Nuevo was declared a sanctuary. A successful head-start program resulted in re-establishment of nesting on Texas beaches. While fisheries bycatch remains a threat, the use of sea turtle excluder devices mitigates take. Fishery interactions and strandings appear to be the main threats to the species. The Deepwater Horizon oil spill event reduced nesting abundance and associated hatchling production as well as exposures to oil in the oceanic environment which has resulted in large losses of the population across various age classes, and likely had an important population-level effect on the species. Kemp's ridley turtles in the area of the Deepwater Horizon oil spill event may also have been affected by prior environmental and prey conditions (e.g., Gallaway et al. 2016a; Gallaway et al. 2016b; Plotkin 2016). However, we do not have an understanding of those impacts on the population trajectory for the species into the future. The species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

Of the sea turtle species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) has fluctuated since the mid-1900's, from a low of approximately 300 nesting females in the mid-1980's to a high to 21,797 nesting females in 2012 (NPS 2013. The number of nests in Padre Island, Texas has increased over the past 2 decades, with 119 in 2014; however, recent increases in nest count are not expected to continue (NMFS and USFWS 2015).

No reduction in the distribution of Kemp's ridley turtles from the Atlantic Ocean (northwestern Gulf of Mexico) or changes to the geographic range of the species are expected because of the DOE and UT's seismic survey.

No reduction in numbers is anticipated as part of the proposed action. Therefore, no reduction in reproduction is expected because of the proposed action. Non-lethal take of 176 individuals, which could be adults and/or juveniles, is expected because of the seismic survey. Density data were not were not available to quantify the number of exposures for small sea turtles (< 30–40 cm [11.8–15.7 in]). Any small sea turtle found within an ensonified area of 884.1 km^2 (341.4 mi^2) are expected to be taken in the form of harassment. We anticipate ESA behavioral harassment, which will include temporary behavioral and physiological responses (e.g., temporary displacement and stress). We do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of Kemp's ridley turtles or a change in their distribution due to the seismic survey, a reduction in the species' likelihood of survival is not expected.

The Bi-National (U.S. and Mexico) Recovery Plan for populations of Kemp's ridley turtle lists recovery objectives for the species (NMFS et al. 2011a). The following recovery criteria and recovery actions are relevant to the impacts of the proposed actions:

- Protect and manage populations in the marine environment.
- Maintain and develop local, state, and national government partnerships.

Because no mortalities or effects on the abundance, distribution, and reproduction of Kemp's ridley turtle populations are expected, we do not anticipate the seismic survey will impede any recovery objectives for Kemp's ridley turtles. In conclusion, we believe the non-lethal effects associated with the proposed action will not appreciably reduce the likelihood of survival and recovery of Kemp's ridley turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

12.4 Leatherback Turtle

Adult and juvenile leatherback turtles are present in the action area and may be exposed and respond to noise from the seismic survey. The severity of an animal's response to noise associated with the seismic survey will depend on the duration and severity of exposure.

The leatherback turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The status of the subpopulations in the Atlantic, Indian, and Pacific Oceans are generally declining, except for the subpopulation in the Southwest Atlantic Ocean, which is slightly increasing. Leatherback turtles show a lesser degree of nest site fidelity than occurs with hardshell sea turtle species.

The primary threats to leatherback turtles include fisheries interactions (bycatch), harvest of nesting females, and egg harvesting. Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, vegetation changes, sand extraction, beach nourishment, shoreline stabilization, and natural disasters (e.g., storm events and tsunamis) as well as cold-stunning, vessel interaction, pollution (contaminants, marine debris and plastics, petroleum products, petrochemicals), ghost fishing gear, natural predation, parasites, and disease. Artificial lights on or adjacent to nesting beaches alter nesting adult female behavior and are often fatal to post-nesting females and emerging hatchlings as they are drawn to light sources and away from the sea. Ingestion of marine debris (plastic) is common in leatherback turtles and can block gastrointestinal tracts leading to death. Climate change may alter sex ratios (as temperature determines hatchling sex) and nest success, range (through expansion of foraging habitat as well as alter spatial and temporal patterns), and habitat (through the loss of nesting beaches, because of sea-level rise and storms). Oceanographic regime shifts possibly impact foraging conditions that may affect nesting female size, clutch size, and egg size of populations. The species' resilience to additional perturbation is low.

Detailed population structure is unknown, but is likely dependent upon nesting beach location and influenced by physical barriers (i.e., landmasses), current systems, and long migrations. Based on estimates calculated from nesting data, there are approximately 20,659 total adult leatherback turtles in the Northwest Atlantic Ocean (NMFS 2020b). The North Atlantic estimate of nesting leatherback turtles is the most likely to represent the portion of the population with animals that could be exposed to the proposed seismic survey. The total index of nesting female abundance is likely an underestimate because we did not have adequate data from many nesting beaches, which have the potential for being unmonitored or unidentified.

Population growth rates for leatherback turtles vary by ocean basin. Leatherback turtles in the Northwest Atlantic Ocean exhibit a decreasing nest trend at nesting beaches with the greatest known nesting female abundance. This decline has become more pronounced (2008 through 2017), and the available nest data reflect a steady decline for more than a decade (Eckert and Mitchell 2018b). Despite intense conservation efforts, the decline in nesting has not been reversed as of 2011 (Benson et al. 2015).

No reduction in the distribution of leatherback turtles from the Atlantic Ocean (northwestern Gulf of Mexico) or changes to the geographic range of the species are expected because of the DOE and UT's seismic survey.

No reduction in numbers is anticipated as part of the proposed action. Therefore, no reduction in reproduction is expected because of the proposed action. Although leatherbacks could experience adverse affects (Section 10), due to the low estimated exposure (Table 7), the continuous movement of the research vessel and animals, and the short duration of the seismic survey (7 days), we do not believe that take by harassment is reasonably certain to occur. Therefore, non-lethal take of 0 individuals is expected because of the seismic survey activities. We do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of leatherback turtles or a change in distribution due to the seismic survey, a reduction in the species' likelihood of survival is not expected.

The Recovery Plan for the U.S. Caribbean, Atlantic, and Gulf of Mexico population of leatherback turtle lists recovery objectives for the species (NMFS and USFWS 1992). The following recovery criteria and recovery actions are relevant to the impacts of the proposed actions:

- Prevent degradation of coastal habitat from industrial and sewage effluents.
- Protect and manage populations in the marine environment.

Because no mortalities or effects on the abundance, distribution, and reproduction of leatherback turtle populations are expected because of the proposed action, we do not anticipate the seismic survey will impede any recovery objectives for leatherback turtles. In conclusion, we believe the non-lethal effects associated with the proposed action will not appreciably reduce the likelihood of survival and recovery of leatherback turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

12.5 Loggerhead Turtle – Northwest Atlantic Ocean Distinct Population Segment

Adult, juvenile, and post-hatchling Northwest Atlantic Ocean DPS of loggerhead turtles are present in the action area and may be exposed and respond to noise from the seismic survey activities.

Based on the currently available information, NMFS categorizes the Northwest Atlantic Ocean DPS of loggerhead turtle population trend as being stable (NMFS 2017). Due to declines in nest counts at index beaches in the U.S. and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS of loggerhead turtle is at risk and likely to decline in the foreseeable future (Conant et al. 2009a). Other threats include pollution (contaminants) and impacts from climate change (nesting beaches).

A number of stock assessment and similar reviews have examined the status of loggerhead turtles in the Atlantic Ocean, but none have developed a reliable estimate of absolute population size (Conant et al. 2009b; Heppell et al. 2003a; NMFS-SEFSC 2001, 2009; NMFS 2008; TEWG 1998, 2000, 2009). It is difficult to estimate overall abundance for sea turtle populations because individuals spend most of their time in water, where they are difficult to count, especially considering their large range and use of many different and distant habitats. Females, however, converge on their natal beaches to lay eggs, and nests are easily counted. The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead sea turtles is over 110,000 (NMFS and USFWS 2023).

In-water estimates of abundance that include juvenile and adult life stages of loggerhead males and females are difficult to perform on a wide scale. In the summer of 2010, NMFS's NEFSC and SEFSC estimated the abundance of juvenile and adult loggerhead sea turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, based on AMAPPS aerial line-transect sighting survey and satellite tagged loggerheads (NMFS 2011). They provided a preliminary regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000–817,000) based on positively identified loggerhead sightings (NMFS 2011). A separate, smaller aerial survey, conducted in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, demonstrated uncorrected loggerhead sea turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (NMFS and USFWS 2023). We are not aware of any current range-wide in-water estimates for the DPS.

No reduction in the distribution of Northwest Atlantic Ocean DPS of loggerhead turtles from the Northwest Atlantic Ocean (northwestern Gulf of Mexico) or changes to the geographic range of the species are expected because of the DOE and UT's seismic survey.

No reduction in numbers is anticipated as part of the proposed action. Therefore, no reduction in reproduction is expected because of the proposed action. Non-lethal take of 44 individuals, which could be adults and/or juveniles, is expected because of the seismic survey. Density data were not were not available to quantify the number of exposures for small sea turtles (< 30–40 cm [11.8–15.7 in]). Any small sea turtle found within an ensonified area of 884.1 km^2 (341.4 mi^2) are expected to be taken in the form of harassment. We anticipate ESA behavioral harassment, which will include temporary behavioral responses (e.g., temporary displacement and stress). We do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of Northwest Atlantic Ocean DPS of loggerhead turtles or a change in distribution due to the seismic survey, a reduction in the species' likelihood of survival is not expected.

The Recovery Plan for the Northwest Atlantic population of loggerhead turtle lists recovery objectives for the species (NMFS and USFWS 2008a). The following recovery criteria and recovery actions are relevant to the impacts of the proposed actions:

- Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
- Manage sufficient feeding, migratory, and interesting marine habitats to ensure successful growth and reproduction.
- Develop and implement local, state, Federal, and international legislation to ensure long-term protection of loggerheads and their terrestrial and marine habitats.
- Minimize marine debris ingestion and entanglement.
- Minimize vessel strike mortality.

Because no mortalities or effects on the abundance, distribution, and reproduction of Northwest Atlantic Ocean DPS of loggerhead turtle populations are expected as a result of the proposed action, we do not anticipate the seismic survey will impede any recovery objectives for Northwest Atlantic Ocean DPS of loggerhead turtles. In conclusion, we believe the non-lethal effects associated with the proposed action will not appreciably reduce the likelihood of survival and recovery of Northwest Atlantic Ocean DPS Of loggerhead turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

13 Conclusion

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle.

It is also NMFS's biological opinion that the proposed action is not likely to adversely affect the hawksbill turtle, giant manta ray, oceanic whitetip shark, or the designated critical habitat of the Northwest Atlantic Ocean DPS of loggerhead turtle.

14 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of threatened and endangered 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 (16 U.S.C. §1532(19)). "Harm" is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 C.F.R. §222.102). NMFS has not defined "harass" under the ESA in regulation. On May 1, 2023, NMFS adopted, as final, the previous interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering." For purposes of this consultation, we relied on NMFS's definition of harassment to evaluate when the seismic survey activities are likely to harass ESA-listed sea turtles.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR §402.02). Section 7(o)(2) provides 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.

ESA section 9 take prohibitions do not apply to threatened species without ESA section 4(d) rules as specified in ESA section 9(a)(1)(g). The ESA does not prohibit the take of threatened species unless special regulations have been promulgated, pursuant to section 4(d), to promote the conservation of the species. ESA section 4(d) rules have been promulgated for the North Atlantic DPS of green turtles and Northwest Atlantic Ocean DPS of loggerhead turtles; therefore, section 9 take prohibitions apply to all ESA-listed sea turtles that are likely to be adversely affected by the proposed action.

14.1 Amount or Extent of Take

Section 7 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 FR

26832). We anticipate the seismic survey off Texas is likely to result in the incidental take of ESA-listed sea turtles by harassment (Table 8); behavioral harassment is expected to occur at received levels at or above 175 dB re 1 µPa (rms) for airgun operations for ESA-listed sea turtles.

Table 8. Estimated Amount of Incidental Take of Endangered Species Act-Listed Sea Turtles Anticipated Because of the Proposed Action off Texas

Species	Anticipated Incidental Take by Harassment (Potential Temporary Threshold Shift and Behavioral) by Seismic Survey Activities
Green Turtle – North Atlantic DPS	2
Kemp's Ridley Turtle	176
Leatherback Turtle	0*
Loggerhead Turtle – Northwest Atlantic Ocean DPS	44

DPS=distinct population segment

* No take of a species means an ITS is not required, but, in an abundance of caution, we are providing one that notes no take is anticipated. Reasonable and prudent measures, and terms and conditions, do not apply here.

14.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 C.F.R. §402.02). These actions "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)). The measures described below must be undertaken by the DOE so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, we will issue a statement that specifies the impact of any incidental taking of threatened or endangered species. To minimize such impacts, RPMs, and terms and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified RPMs and terms and conditions identified in the ITS are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

We believe the RPMs described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

1. The DOE must implement a program that should be coordinated with UT to minimize and report the potential effects of seismic survey activities, as well as the effectiveness of conservation measures for the incidental taking of sea turtles (North Atlantic DPS of

green turtles, Kemp's ridley turtles, and Northwest Atlantic Ocean DPS of loggerhead turtles).

14.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA and regulations issued pursuant to section 4(d), the Federal action agency (i.e., DOE) must comply (or must ensure that any applicant complies) with the following terms and conditions. These include the take minimization, monitoring and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)).

The terms and conditions detailed below for each of the RPMs include monitoring and minimization measures where needed:

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. Send report to nmfs.hq.esa.consultations@noaa.gov, with the subject line, "DOE Gulf of Mexico Seismic Survey Draft Report". The report should also demonstrate how effects were minimized during the seismic survey, including what conservation measures were implemented, whether there were any changes to the conservation measures in order to implement them, any information regarding whether implementation of conservation measures minimized effects based on sightings of animals prompting implementation of conservation measures, the effectiveness of conservation measures, and any observed effects on sea turtles (North Atlantic DPS of green turtles, Kemp's ridley turtles, and Northwest Atlantic Ocean DPS of loggerhead turtles).
2. Any reports of injured or dead ESA-listed species must be provided by the DOE to the NMFS ESA Interagency Cooperation Division by email at nmfs.hq.esa.consultations@noaa.gov. The subject line of the e-mail should include "DOE Gulf of Mexico Seismic Survey: Dead/Injured ESA-listed Species Report".

15 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

We make the following discretionary conservation recommendations that we believe are consistent with this obligation and may be considered by the DOE in relation to their 7(a)(1) responsibilities. These recommendations will provide information for future consultations involving seismic surveys that may affect ESA-listed species.

1. We recommend that the DOE promote and fund research examining the potential effects of seismic surveys on ESA-listed sea turtle species and their prey.
2. We recommend that the DOE develop or support a more robust propagation model that incorporates environmental variables into estimates of how far sound levels from the airguns will reach.
3. We recommend that the DOE model potential impacts to ESA-listed species, validate assumptions used when modeling the ensonified area from the airguns and any effects to ESA-listed species, through refinements of current models and use of other relevant models, and seek information and high quality data for use in such efforts.
4. We recommend that the DOE require a sound source verification in the study area (and future locations) to validate predicted and modeled isopleth distances to ESA harm and harassment thresholds and incorporate the results of that study into buffer and exclusion zones prior to starting seismic survey activities and in future seismic survey efforts.
5. We recommend the DOE use clinometers or geometers, such as those described in Hansen et al. 2020, to accurately measure lateral distances from the research vessel to ESA-listed species for potential implementation of mitigation measures (e.g., shutdown procedure).
6. We recommend the DOE 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 by providing information on the effectiveness of the conservation measures and the impact of seismic survey activities on ESA-listed species.
7. We recommend the DOE submit their monitoring data (i.e., visual sightings) from 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 research vessel operator and other relevant vessel personnel (e.g., crewmembers) on the research vessel 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.
9. We recommend the DOE require the vessel operator attempt to maintain a distance of 45 m (147.6 ft) or greater whenever possible from the research vessel, when ESA-listed sea turtles are visually sighted, as a vessel strike avoidance measure.

10. We recommend the DOE seismic survey activities actively avoid *Sargassum* mats or patches in designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle.
11. We recommend the DOE coordinate with government agencies (e.g., Bureau of Ocean Energy Management, NMFS, Southeast Fisheries Science Center, U.S. Navy), academic institutions, and/or the private sector that may be conducting long-term PAM and/or tagging studies to potentially determine responses of protected species and their prey from the seismic survey activities in the action area.
12. We recommend the DOE measure ambient noise levels in the survey area to help better understand the total ensonified area from acoustic sources (e.g., vessel noise, airgun array operations) from the seismic survey to determine the extent of the action area in future ESA section 7 consultations.

In order to be informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the DOE and UT should notify us of any conservation recommendations they implement in their final action.

16 Reinitiation Notice

This concludes formal consultation for the DOE and UT marine seismic survey in the Gulf of Mexico off Texas. Consistent with 50 C.F.R. §402.16, reinitiation of formal 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 if:

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

If the total distance of tracklines, location of tracklines, acoustic characteristics of the airguns, timing of the seismic survey, or any other aspect of the proposed action changes in such a way that the incidental take of ESA-listed species may be greater than estimated in the ITS of this opinion, then one or more of the reinitiation triggers above may be met and reinitiation of consultation may be necessary.

17 References

Addison, D. S. 1997. Sea turtle nesting on cay sal, bahamas, recorded june 2-4, 1996. Bahamas Journal of Science 5:34-35.

Addison, D. S., and B. Morford. 1996. Sea turtle nesting activity on the cay sal bank, bahamas. Bahamas Journal of Science 3:31-36.

Afonso, A. S., and L. Fidelis. 2023. The fate of plastic-wearing sharks: Entanglement of an iconic top predator in marine debris. Marine Pollution Bulletin 194:115326.

Al-Bahry, S. N., I. Y. Mahmoud, I. S. Al-Amri, T. A. Ba-Omar, K. O. Melgheit, and A. Y. Al-Kindi. 2009. Ultrastructural features and elemental distribution in eggshell during pre and post hatching periods in the green turtle, chelonia mydas at ras al-hadd, oman. Tissue and Cell 41(3):214-221.

Aleksa, K. T., C. R. Sasso, R. W. Nero, and D. R. Evans. 2018. Movements of leatherback turtles (dermochelys coriacea) in the gulf of mexico. Marine Biology 165.

Aspirault, A. 2019. Impact of boat sound on the feeding and growth behavior of planktonic species. Dissertation. University of Quebec at Rimouski.

Avens, L., J. Taylor, L. R. Goshe, T. T. Jones, and M. Hastings. 2009a. Use of skeletochronological analysis to estimate the age of leatherback sea turtles dermochelys coriacea in the western north atlantic. Endangered Species Research 8:165-177.

Avens, L., J. C. Taylor, L. R. Goshe, T. T. Jones, and M. Hastings. 2009b. Use of skeletochronological analysis to estimate the age of leatherback sea turtles *dermochelys coriacea* in the western north atlantic. Endangered Species Research 8(3):165-177.

Balazs, G. H. 1983. Recovery records of adult green turtles observed or originally tagged at french frigate shoals, northwestern hawaiian islands. NMFS, Washington, D.C.; Springfield, VA.

Barco, S., M. Law, B. Drummond, H. Koopman, C. Trapani, S. Reinheimer, S. Rose, W. M. Swingle, and A. Williard. 2016. Loggerhead turtles killed by vessel and fishery interaction in virginia, USA, are healthy prior to death. Marine Ecology Progress Series 555:221-234.

Bartol, S. M., and D. R. Ketten. 2006. Turtle and tuna hearing. Pages 98-103 *in* R. W. Y. B. Swimmer, editor. Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries, volume Technical Memorandum NMFS-PIFSC-7. U.S Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Fisheries Science Center.

Bartol, S. M., J. A. Musick, and M. Lenhardt. 1999a. Evoked potentials of the loggerhead sea turtle (caretta caretta). Copeia 1999(3):836-840.

Bartol, S. M., J. A. Musick, and M. L. Lenhardt. 1999b. Auditory evoked potentials of the loggerhead sea turtle (caretta caretta). Copeia:836-840.

Bass, A. L., and W. N. Witzell. 2000. Demographic composition of immature green turtles (chelonia mydas) from the east central florida coast: Evidence from mtdna markers. Herpetologica 56(3):357-367.

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

Beazley, L., E. Kenchington, F. J. Murillo, D. Brickman, Z. Wang, A. J. Davies, E. M. Roberts, and H. T. Rapp. 2021. Climate change winner in the deep sea? Predicting the impacts of climate change on the distribution of the glass sponge vazella pourtalesii. Marine Ecology Progress Series 657:1-23.

Benson, S., R. Tapilatu, N. Pilcher, P. Tomillo, and L. Martinez. 2015. Leatherback turtle populations in the pacific ocean. Pages 110-122 *in*.

Benson, S. R., P. H. Dutton, C. Hitipeuw, B. Samber, J. Bakarbessy, and D. Parker. 2007a. Post-nesting migrations of leatherback turtles (dermochelys coriacea) from jamursba-medi, bird's head peninsula, indonesia. Chelonian Conservation and Biology 6(1):150-154.

Benson, S. R., T. Eguchi, D. G. Foley, K. A. Forney, H. Bailey, C. Hitipeuw, B. P. Samber, R. F. Tapilatu, V. Rei, and P. Ramohia. 2011a. Large-scale movements and high-use areas of western pacific leatherback turtles, dermochelys coriacea. Ecosphere 2(7):1-27.

Benson, S. R., T. Eguchi, D. G. Foley, K. A. Forney, H. Bailey, C. Hitipeuw, B. P. Samber, R. F. Tapilatu, V. Rei, P. Ramohia, J. Pita, and P. H. Dutton. 2011b. Large-scale movements and high-use areas of western pacific leatherback turtles, dermochelys coriacea. Ecosphere 2(7).

Benson, S. R., K. A. Forney, J. T. Harvey, J. V. Carretta, and P. H. Dutton. 2007b. Abundance, distribution, and habitat of leatherback turtles (*dermochelys coriacea*) off california, 1990−2003. Fishery Bulletin 105(3):337-347.

Berenshtein, I., N. Perlin, C. H. Ainsworth, J. G. Ortega-Ortiz, A. C. Vaz, and C. B. Paris. 2020. Comparison of the spatial extent, impacts to shorelines, and ecosystem and four-dimensional characteristics of simulated oil spills. Pages 340-354 *in* Scenarios and responses to future deep oil spills. Springer.

Bevan, E., S. Whiting, T. Tucker, M. Guinea, A. Raith, and R. Douglas. 2018. Measuring behavioral responses of sea turtles, saltwater crocodiles, and crested terns to drone disturbance to define ethical operating thresholds. PLOS ONE 13(3):e0194460.

Bjarti, T. 2002. An experiment on how seismic shooting affects caged fish. University of Aberdeen.

Bjorndal, K. A. 1982. The consequences of herbivory for the life history pattern of the caribbean green turtle, *chelonia mydas*. Pages 111-116 *in* K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Bjorndal, K. A., A. B. Bolten, T. Dellinger, C. Delgado, and H. R. Martins. 2003. Compensatory growth in oceanic loggerhead sea turtles: Response to a stochastic environment. Ecology 84(5):1237-1249.

Bjorndal, K. A., A. B. Bolten, and C. J. Lagueux. 1994. Ingestion of marine debris by juvenile sea turtles in coastal florida habitats. Marine Pollution Bulletin 28(3):154-158.

Bjorndal, K. A., J. A. Wetherall, A. B. Bolten, and J. A. Mortimer. 1999. Twenty-six years of green turtle nesting at tortuguero, costa rica: An encouraging trend. Conservation Biology 13(1):126-134.

Boem. 2016. Gulf of mexico ocs proposed geological and geophysical activities draft programmatic environmental impact statement volume i: Chapters 1-8. US Department of the Interior, Bureau of Ocean Energy Management, New Orleans.

Bolten, A. B., K. A. Bjorndal, H. R. Martins, T. Dellinger, M. J. Biscoito, S. E. Encalada, and B. W. Bowen. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtdna sequence analysis. Ecological Applications 8:1-7.

Bolten, A. B., and B. E. Witherington. 2003. Loggerhead sea turtles. Smithsonian Books, Washington, D.C.

Booman, C., J. Dalen, H. Leivestad, A. Levsen, T. V. D. Meeren, and K. Toklum. 1996. Effecter av luftkanonskyting på egg, larver og yngel. Fisken Og Havet 1996(3):1-83.

Bostrom, B., and D. Jones. 2007. Exercise warms adult leatherback turtles☆. Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology 147(2):323-331.

Bowen, B. W., A. B. Meylan, J. P. Ross, C. J. Limpus, G. H. Balazs, and J. C. Avise. 1992. Global population structure and natural history of the green turtle (*chelonia mydas*) in terms of matriarchal phylogeny. Evolution 46:865-881.

Bowlby, C. E., G. A. Green, and M. L. Bonnell. 1994. Observations of leatherback turtles offshore of washington and oregon. Northwestern Naturalist 75(1):33-35.

Brehmer, P., A. Sarré, Y. Guennégan, and J. Guillard. 2019. Vessel avoidance response: A complex tradeoff between fish multisensory integration and environmental variables. Reviews in Fisheries Science & Aquaculture 27(3):380-391.

Bresette, M., D. Singewald, and E. De Maye. 2006. Recruitment of post-pelagic green turtles (*chelonia mydas*) to nearshore reefs on florida's east coast. Pages 288 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Bruce, B., R. Bradford, S. Foster, K. Lee, M. Lansdell, S. Cooper, and R. Przeslawski. 2018. Quantifying fish behaviour and commercial catch rates in relation to a marine seismic survey. Marine Environmental Research 140:18-30.

Bucchia, M., M. Camacho, M. R. Santos, L. D. Boada, P. Roncada, R. Mateo, M. E. Ortiz-Santaliestra, J. Rodríguez-Estival, M. Zumbado, and J. Orós. 2015. Plasma levels of pollutants are much higher in loggerhead turtle populations from the adriatic sea than in those from open waters (eastern atlantic ocean). Science of the Total Environment 523:161-169.

Buchanan, R. A., J. R. Christian, S. Dufault, and V. D. Moulton. 2004. Impacts of underwater noise on threatened or endangered species in united states waters. American Petroleum Institute, LGL Report SA791, Washington, D.C.

Caillouet, C. W., S. W. Raborn, D. J. Shaver, N. F. Putman, B. J. Gallaway, and K. L. Mansfield. 2018. Did declining carrying capacity for the kemp’s ridley sea turtle population within the gulf of mexico contribute to the nesting setback in 2010-2017? Chelonian Conservation and Biology 17(1).

Caldwell, D. K., and A. Carr. 1957. Status of the sea turtle fishery in florida. Pages 457-463 *in* Transactions of the 22nd North American Wildlife Conference.

Carballo, A. Y., C. Olabarria, and T. Garza Osuna. 2002. Analysis of four macroalgal assemblages along the pacific mexican coast during and after the 1997-98 el niño. Ecosystems 5(8):749-760.

Carr, A. 1984. So excellent a fishe. Charles Scribner's Sons, New York.

Carr, A. 1986. New perspectives on the pelagic stage of sea turtle development. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center, Panama City Laboratory, Panama City, FL.

Carroll, A. G., R. Przeslawski, A. Duncan, M. Gunning, and B. Bruce. 2017. A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Marine Pollution Bulletin 114(1):24-Sep.

Casper, B. M., M. B. Halvorsen, and A. N. Popper. 2012. Are sharks even bothered by a noisy environment? Pages 93-97 *in* The effects of noise on aquatic life. Springer.

Chaloupka, M., K. A. Bjorndal, G. H. Balazs, A. B. Bolten, L. M. Ehrhart, C. J. Limpus, H. Suganuma, S. Troeeng, and M. Yamaguchi. 2008. Encouraging outlook for recovery of a once severely exploited marine megaherbivore. Global Ecology and Biogeography 17(2):297-304.

Chaloupka, M. Y., and J. A. Musick. 1997. Age, growth, and population dynamics. Pages 233-276 *in* P. L. Lutz, and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton.

Chan, E. H., and H. C. Liew. 1996. Decline of the leatherback population in terengganu, malaysia, 1956-1995. Chelonian Conservation and Biology 2(2-Jan):192-203.

Chance, R., T. D. Jickells, and A. R. Baker. 2015. Atmospheric trace metal concentrations, solubility and deposition fluxes in remote marine air over the south-east atlantic. Marine Chemistry 177:45-56.

Chapman, C. J., and A. D. Hawkins. 1969. The importance of sound in fish behaviour in relation to capture by trawls. FAO Fisheries Report 62(3):717-729.

Chapuis, L., S. P. Collin, K. E. Yopak, R. D. Mccauley, R. M. Kempster, L. A. Ryan, C. Schmidt, C. C. Kerr, E. Gennari, C. A. Egeberg, and N. S. Hart. 2019. The effect of underwater sounds on shark behaviour. Scientific Reports 9(1):6924.

Charifi, M., M. Sow, P. Ciret, S. Benomar, and J. C. Massabuau. 2017. The sense of hearing in the pacific oyster, magallana gigas. PLOS ONE 12(10):e0185353.

Charrier, I., L. Jeantet, L. Maucourt, S. Régis, N. Lecerf, A. Benhalilou, and D. Chevallier. 2022. First evidence of underwater vocalizations in green sea turtles chelonia mydas. Endangered Species Research 48:31-41.

Chavez-Rosales, S., E. Josephson, D. Palka, and L. Garrison. 2022. Detection of habitat shifts of cetacean species: A comparison between 2010 and 2017 habitat suitability conditions in the northwest atlantic ocean. Frontiers in Marine Science 9:877580.

Christian, J. F. P. C. D. a. L. L. F. J. G. a. C. J. R. 2013. Are seismic surveys an important risk factor for fish and shellfish? Bioacoustics 17:262-265.

Cohen, A. N. F., Brent. 2000. The regulation of biological pollution: Preventing exotic species invasions from ballast water discharged into california coastal waters. Golden Gate University Law Review 30(4):787-773.

Conant, T. A., P. H. Dutton, T. Eguchi, S. P. Epperly, C. Fahy, M. Godfrey, S. Macpherson, E. Possardt, B. Schroeder, J. Seminoff, M. Snover, C. Upite, and B. Witherington. 2009a. Loggerhead sea turtle (*caretta caretta*) 2009 status review under the u.S. Endangered species act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service August 2009:222 pages.

Conant, T. A., P. H. Dutton, T. Eguchi, S. P. Epperly, C. C. Fahy, M. H. Godfrey, S. L. Macpherson, E. E. Possardt, B. A. Schreder, J. A. Seminoff, M. L. Snover, C. M. Upite, and B. E. Witherington. 2009b. Loggerhead sea turtle (*caretta caretta*) 2009 status review under the u.S. Endangered species act. Report of the loggerhead biological review team to the national marine fisheries service, august 2009.

Cuevas, E., M. De Los Ángeles Liceaga-Correa, and A. Uribe-Martínez. 2019. Ecological vulnerability of two sea turtle species in the gulf of mexico: An integrated spatial approach. Endangered Species Research 40:337-356.

Curry, R. G., and M. S. Mccartney. 2001. Ocean gyre circulation changes associated with the north atlantic oscillation. Journal of Physical Oceanography 31(12):3374-3400.

Czech, B., and P. R. Krausman. 1997. Distribution and causation of species endangerment in the united states. Science 277(5329):1116-1117.

D'amelio, A. S. a. M. C. M. L. C. a. C. G. R. G. F. V. 1999. Biochemical responses of european sea bass (*dicentrarchus labrax* l.) to the stress induced by offshore experimental seismic prospecting. Marine Pollution Bulletin 38(12):1105-1114.

Dalen, J., and G. M. Knutsen. 1986. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations. Pp.93-102 In: H.M. Merklinger (Ed), Progress in Underwater Acoustics. Plenum, New York. 839p.

Dalton, T., and D. Jin. 2010. Extent and frequency of vessel oil spills in us marine protected areas. Marine Pollution Bulletin 60(11):1939-1945.

Davenport, J., D. L. Holland, and J. East. 1990a. Thermal and biochemical characteristics of the lipids of the leatherback turtle (dermochelys coriacea): Evidence of endothermy. Journal of the Marine Biological Association of the United Kingdom 70:33-41.

Davenport, J., J. Wrench, J. Mcevoy, and V. Camacho-Ibar. 1990b. Metal and pcb concentrations in the" harlech" leatherback. Marine Turtle Newsletter 48:1-6.

Davidsen, J. G., H. Dong, M. Linné, M. H. Andersson, A. Piper, T. S. Prystay, E. B. Hvam, E. B. Thorstad, F. Whoriskey, S. J. Cooke, A. D. Sjursen, L. Rønning, T. C. Netland, and A. D. Hawkins. 2019. Effects of sound exposure from a seismic airgun on heart rate, acceleration and depth use in free-swimming atlantic cod and saithe. Conservation physiology 7(1):coz020-coz020.

Day, R. D., R. D. Mccauley, Q. P. Fitzgibbon, K. Hartmann, and J. M. Semmens. 2017. Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop pecten fumatus. Proceedings of the National Academies of Science 114(40):E8537-E8546.

De Robertis, A., and N. O. Handegard. 2013. Fish avoidance of research vessels and the efficacy of noise-reduced vessels: A review. ICES Journal of Marine Science 70(1):34-45.

De Soto, N. A., N. Delorme, J. Atkins, S. Howard, J. Williams, and M. Johnson. 2013. Anthropogenic noise causes body malformations and delays development in marine larvae. Scientific Reports 3(1):2831.

Deepwater Horizon Nrda Trustees. 2016. Deepwater horizon oil spill: Final programmatic damage assessment and restoration plan (pdarp) and final programmatic environmental impact statement. NOAA.

Deepwater Horizon Trustees. 2016. *Deepwater horizon* oil spill: Final programmatic damage assessment and restoration plan and final programmatic environmental impact statement. Deepwater Horizon Natural Resource Damage Assessment Trustees.

Dellinger, T., V. Zekovic, and M. Radeta. 2022. Long-term monitoring of in-water abundance of juvenile pelagic loggerhead sea turtles (caretta caretta): Population trends in relation to north atlantic oscillation and nesting. Frontiers in Marine Science 9.

Denkinger, J., M. Parra, J. P. Muñoz, C. Carrasco, J. C. Murillo, E. Espinosa, F. Rubianes, and V. Koch. 2013. Are boat strikes a threat to sea turtles in the galapagos marine reserve? Ocean & Coastal Management 80:29-35.

Derraik, J. G. B. 2002. The pollution of the marine environment by plastic debris: A review. Marine Pollution Bulletin 44(9):842-852.

Deruiter, S. L., and K. Larbi Doukara. 2012. Loggerhead turtles dive in response to airgun sound exposure. Endangered Species Research 16(1):55-63.

Dodd, C. K. 1988. Synopsis of the biological data on the loggerhead sea turtle: *Caretta caretta* (linnaeus, 1758). U.S. Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Doe. 2023. Draft environmental assessment for marine geophysical surveys in the northwestern gulf of mexico, fall 2023. National Energy Technology Laboratory, U.S. Department of Energy.

Dolman, S. J., and M. Jasny. 2015. Evolution of marine noise pollution management. Aquatic Mammals 41(4):357.

Doughty, R. W. 1984. Sea turtles in texas: A forgotten commerce. Southwestern Historical Quarterly 88:43-70.

Dow Piniak, W., C. Harms, E. Stringer, and S. Eckert. 2012a. Hearing sensitivity of hatchling leatherback sea turtles (dermochelys coriacea). 32nd Annual Symposium on Sea Turtle Biology and Conservation, Huatulco, MX.

Dow Piniak, W. E., S. A. Eckert, C. A. Harms, and E. M. Stringer. 2012b. Underwater hearing sensitivity of the leatherback sea turtle (dermochelys coriacea): Assessing the potential effect of anthropogenic noise. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA.

Dow, W. E., D. A. Mann, T. T. Jones, S. A. Eckert, and C. A. Harms. 2008. In-water and in-air hearing sensitivity of the green sea turtle (chelonia mydas). 2nd International Confernece on Acoustic Communication by Animals, Corvalis, OR.

Drake, J. M., and D. M. Lodge. 2007. Rate of species introductions in the great lakes via ships' ballast water and sediments. Canadian Journal of Fisheries and Aquatic Sciences 64(3):530-538.

Drinkwater, K. F., A. Belgrano, A. Borja, A. Conversi, M. Edwards, C. H. Greene, G. Ottersen, A. J. Pershing, and H. Walker. 2003. The response of marine ecosystems to climate variability associated with the north atlantic oscillation. Geophysical Monograph 134:211-234.

Duce, R. A., P. S. Liss, J. T. Merrill, E. L. Atlas, P. Buat-Menard, B. B. Hicks, J. M. Miller, J. M. Prospero, R. Arimoto, T. M. Church, W. Ellis, J. N. Galloway, L. Hansen, T. D. Jickells, A. H. Knap, K. H. Reinhardt, B. Schneider, A. Soudine, J. J. Tokos, S. Tsunogai, R. Wollast, and M. Zhou. 1991. The atmospheric input of trace species to the world ocean. Global Biogeochemical Cycles 5(3):193-259.

Dudley, P. N., R. Bonazza, and W. P. Porter. 2016. Climate change impacts on nesting and internesting leatherback sea turtles using 3d animated computational fluid dynamics and finite volume heat transfer. Ecological Modelling 320:231-240.

Duncan, E. M., Z. L. R. Botterell, A. C. Broderick, T. S. Galloway, P. K. Lindeque, A. Nuno, and B. J. Godley. 2017. A global review of marine turtle entanglement in anthropogenic debris: A baseline for further action. Endangered Species Research 34:431-448.

Dutton, D. L., P. H. Dutton, M. Chaloupka, and R. H. Boulon. 2005. Increase of a caribbean leatherback turtle dermochelys coriacea nesting population linked to long-term nest protection. Biological Conservation 126(2):186-194.

Dutton, K. R. S., and P. H. 2013. Variations in the operational sex ratio for breeding leatherback turtles (dermochelys coriacea) over three nesting seasons at st. Croix, usvi. Pages 242 *in* T. T. L. B. A. P. A. R. M. F. K. W. R. L. K. Stewart, editor Thirty-Third Annual

Symposium on Sea Turtle Biology and Conservation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Baltimore, Maryland.

Dutton, P. H., B. W. Bowen, D. W. Owens, A. Barragan, and S. K. Davis. 1999. Global phylogeography of the leatherback turtle (dermochelys coriacea). Journal of Zoology 248:397-409.

Dutton, P. H., C. Hitipeuw, M. Zein, S. R. Benson, G. Petro, J. Pita, V. Rei, L. Ambio, and J. Bakarbessy. 2007. Status and genetic structure of nesting populations of leatherback turtles (dermochelys coriacea) in the western pacific. Chelonian Conservation and Biology 6(1-Jan):47-53.

Dutton, P. H., V. Pease, and D. Shaver. 2006. Characterization of mtdna variation among kemp's ridleys nesting on padre island with reference to rancho nuevo genetic stock. Pages 189 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Twenty-Sixth Annual Conference on Sea Turtle Conservation and Biology.

Dutton, P. H., C. P. Whitmore, and N. Mrosovsky. 1985. Masculinization of leatherback turtle dermochelys coriacea hatchlings from eggs incubated in styrofoam boxes. Biological Conservation 31(3):249-264.

Dwyer, C. M. 2004. How has the risk of predation shaped the behavioural responses of sheep to fear and distress? Animal Welfare 13(3):269-281.

Eckert, K. L., and A. E. Eckert. 2019. An atlas of sea turtle nesting habitat for the wider caribbean region. Revised edition. WIDECAST Technical Report.

Eckert, K. L., B. P. Wallace, J. G. Frazier, S. A. Eckert, and P. C. H. Pritchard. 2012. Synopsis of the biological data on the leatherback sea turtle (dermochelys coriacea). U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.

Eckert, K. L., B. P. Wallace, J. R. Spotila, and B. A. Bell. 2015. Nesting ecology and reproductive. The Leatherback Turtle: Biology and Conservation:63.

Eckert, S. 2006a. High-use oceanic areas for atlantic leatherback sea turtles (dermochelys coriacea) as identified using satellite telemetered location and dive information. Marine Biology 149(5):1257-1267.

Eckert, S. A. 2006b. High-use oceanic areas for atlantic leatherback sea turtles (dermochelys coriacea) as identified using satellite telemetered location and dive information. Marine Biology 149:1257-1267.

Eckert, S. A., D. Bagley, S. Kubis, L. Ehrhart, C. Johnson, K. Stewart, and D. Defreese. 2006. Internesting and postnesting movements and foraging habitats of leatherback sea turtles (dermochelys coriacea) nesting in florida. Chelonian Conservation and Biology 5(2):239-248.

Eckert, S. A., and K. Mitchell. 2018a. An assessment of leatherback sea turtle population trends at matura beach, trinidad (2006-17).

Eckert, S. A., and K. Mitchell. 2018b. An assessment of leatherback sea turtle population trends at matura beach, trinidad (2006-2017). Widecast.

Eckert, S. A., and L. Sarti. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78:2-7.

Eguchi, T., P. H. Dutton, S. A. Garner, and J. Alexander-Garner. 2006. Estimating juvenile survival rates and age at first nesting of leatherback turtles at st. Croix, u.S. Virgin islands. Pages 292-293 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams,

editors. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.
Ehrhart, L. M. 1983. Marine turtles of the indian river lagoon system. Florida Scientist 46:334-346.
Ehrhart, L. M., D. A. Bagley, and W. E. Redfoot. 2003. Loggerhead turtles in the atlantic ocean: Geographic distribution, abundance, and population status. Pages 157-174 *in* A. B. B. E. W. Bolten, editor. Loggerhead sea turtles. Smithsonian Institution Press, Washington, D. C.
Ehrhart, L. M., W. E. Redfoot, and D. A. Bagley. 2007. Marine turtles of the central region of the indian river lagoon system, florida. Florida Scientist:415-434.
Engås, A., S. Løkkeborg, E. Ona, and A. Vold Soldal. 1996. Effects of seismic shooting on local abundance and catch rates of cod (*gadus morhua*) and haddock (*melanogrammus aeglefinus*). Canadian Journal of Fisheries and Aquatic Sciences 53:2238-2249.
Engås, A., S. Løkkeborg, A. V. Soldal, and E. Ona. 1993. Comparative trials for cod and haddock using commercial trawl and longline at two different stock levels. Journal of Northwest Atlantic Fisheries Science 19:83-90.
Epperly, S. P., and W. G. Teas. 2002. Turtle excluder devices--are the escape openings large enough? Fishery Bulletin 100(3):466-474.
Erbe, C., R. Williams, M. Parsons, S. K. Parsons, I. G. Hendrawan, and I. M. I. Dewantama. 2018. Underwater noise from airplanes: An overlooked source of ocean noise. Marine Pollution Bulletin 137:656-661.
Estabrook, B. J., D. W. Ponirakis, C. W. Clark, and A. N. Rice. 2016. Widespread spatial and temporal extent of anthropogenic noise across the northeastern gulf of mexico shelf ecosystem. Endangered Species Research 30:267-282.
Falk, M. R., and M. J. Lawrence. 1973. Seismic exploration: Its nature and effects on fish. Department of the Environment, Fisheries and Marine Service, Resource Management Branch, Fisheries Operations Directorate, Central Region (Environment), Winnipeg, Canada.
Ferrara, C. R., R. C. Vogt, M. R. Harfush, R. S. Sousa-Lima, E. Albavera, and A. Tavera. 2014. First evidence of leatherback turtle (dermochelys coriacea) embryos and hatchlings emitting sounds. Chelonian Conservation and Biology 13(1):110-114.
Ferraroli, S., J. Y. Georges, P. Gaspar, and Y. L. Maho. 2004. Where leatherback turtles meet fisheries. Nature 429:521-522.
Fewtrell, R. D. M. J. 2013a. Experiments and observations of fish exposed to seismic survey pulses. Bioacoustics 17:205-207.
Fewtrell, R. D. M. J. 2013b. Marine invertebrates, intense anthropogenic noise, and squid response to seismic survey pulses. Bioacoustics 17:315-318.
Ffwcc. 2018. Trends in nesting by florida loggerheads. Florida Fish and Wildlife Conservation Commission, http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trend/.
Fields, D. M., N. O. Handegard, J. Dalen, C. Eichner, K. Malde, Ø. Karlsen, A. B. Skiftesvik, C. M. F. Durif, and H. I. Browman. 2019. Airgun blasts used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod calanus finmarchicus. ICES Journal of Marine Science 76(7):2033-2044.
Finkbeiner, E. M., B. P. Wallace, J. E. Moore, R. L. Lewison, L. B. Crowder, and A. J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation.

Fitzgibbon, Q. P., R. D. Day, R. D. Mccauley, C. J. Simon, and J. M. Semmens. 2017. The impact of seismic air gun exposure on the haemolymph physiology and nutritional condition of spiny lobster, jasus edwardsii. Marine Pollution Bulletin 125(1-2):146-156.

Fitzsimmons, N. N., L. W. Farrington, M. J. Mccann, C. J. Limpus, and C. Moritz. 2006. Green turtle populations in the indo-pacific: A (genetic) view from microsatellites. Pages 111 *in* N. Pilcher, editor Proceedings of the Twenty-Third Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-536.

Fodrie, F. J., K. L. Heck Jr, S. P. Powers, W. M. Graham, and K. L. Robinson. 2010. Climate-related, decadal-scale assemblage changes of seagrass-associated fishes in the northern gulf of mexico. Global Change Biology 16(1):48-59.

Fogg, A. Q., E. R. Hoffmayber, W. B. I. Driggers, M. D. Campbell, G. J. Pellegrin, and W. Stein. 2013. Distribution and length frequency of invasive lionfish (pterois sp.) in the northern gulf of mexico. Gulf and Caribbean Research 25:111-115.

Foley, A. M., B. A. Schroeder, and S. L. Macpherson. 2008. Post-nesting migrations and resident areas of florida loggerhead turtles (caretta caretta). Pages 75-76 *in* H. J. Kalb, A. Rohde, K. Gayheart, and K. Shanker, editors. Twenty-Fifth Annual Symposium on Sea Turtle Biology and Conservation.

Foley, A. M., K. E. Singel, P. H. Dutton, T. M. Summers, A. E. Redlow, and J. Lessman. 2007. Characteristics of a green turtle (chelonia mydas) assemblage in northwestern florida determined during a hypothermic stunning event. Gulf of Mexico Science 25(2):131-143.

Foley, A. M., B. A. Stacy, R. F. Hardy, C. P. Shea, K. E. Minch, and B. A. Schroeder. 2019. Characterizing watercraft-related mortality of sea turtles in florida. The Journal of Wildlife Management 83(5):1057-1072.

Fossette, S., M. J. Witt, P. Miller, M. A. Nalovic, D. Albareda, A. P. Almeida, A. C. Broderick, D. Chacón-Chaverri, M. S. Coyne, A. Domingo, S. Eckert, D. Evans, A. Fallabrino, S. Ferraroli, A. Formia, B. Giffoni, G. C. Hays, G. Hughes, L. Kelle, A. Leslie, M. López-Mendilaharsu, P. Luschi, L. Prosdocimi, S. Rodriguez-Heredia, A. Turny, S. Verhage, and B. J. Godley. 2014. Pan-atlantic analysis of the overlap of a highly migratory species, the leatherback turtle, with pelagic longline fisheries. Proceedings of the Royal Society B: Biological Sciences 281(1780):20133065.

Frandsen, H. R., D. F. Figueroa, and J. A. George. 2020. Mitochondrial genomes and genetic structure of the kemp's ridley sea turtle (lepidochelys kempii). Ecology and Evolution 10(1):249-262.

Frasier, K. E. 2020. Evaluating impacts of deep oil spills on oceanic marine mammals. Pages 419-441 *in* Scenarios and responses to future deep oil spills.

Frazer, N. B., and L. M. Ehrhart. 1985. Preliminary growth models for green, *chelonia mydas*, and loggerhead, *caretta caretta*, turtles in the wild. Copeia 1985(1):73-79.

Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110(3):387-399.

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

Fromentin, J.-M., and B. Planque. 1996. *Calanus* and environment in the eastern north atlantic. Ii. Influence of the north atlantic oscillation on *c. Finmarchicus* and *c. Helgolandicus*. Marine Ecology Progress Series 134:111-118.

Fuentes, M. M. P. B., Z. A. Meletis, N. E. Wildermann, and M. Ware. 2021. Conservation interventions to reduce vessel strikes on sea turtles: A case study in florida. Marine Policy 128:104471.

Gall, S. C., and R. C. Thompson. 2015. The impact of debris on marine life. Marine Pollution Bulletin 92(1-2):170–179.

Gallaway, B. J., C. W. Caillouet, Jr., P. T. Plotkin, W. J. Gazey, J. G. Cole, and S. W. Raborn. 2013. Kemp's ridley stock assessment project final report.

Gallaway, B. J., W. J. Gazey, C. W. Caillouet Jr., P. T. Plotkin, A. a. F. Grobois, A. F. Amos, P. M. Burchfield, R. R. Carthy, M. a. C. Martinez, J. G. Cole, A. T. Coleman, M. Cook, S. Dimarco, S. P. Epperly, D. G. G. Fujiwara, G. L. Graham, W. L. Griffin, F. I. Martinez, M. M. Lamont, R. L. Lewison, K. J. Lohmann, J. M. Nance, J. Pitchford, N. F. Putman, S. W. Raborn, J. K. Rester, J. J. Rudloe, L. S. Martinez, M. Schexnayder, J. R. Schmid, D. J. Shaver, C. Slay, A. D. Tucker, M. Tumlin, T. Wibbels, and B. M. Z. Najera. 2016a. Development of a kemp's ridley sea turtle stock assessment model. Gulf of Mexico Science 2016(2):20.

Gallaway, B. J., W. J. Gazey, T. Wibbels, E. Bevan, D. J. Shaver, and J. George. 2016b. Evaluation of the status of the kemp's ridley sea turtle after the 2010 deepwater horizon oil spill. Gulf of Mexico Science 2016(2):192-205.

Gallo, F., C. Fossi, R. Weber, D. Santillo, J. Sousa, I. Ingram, A. Nadal, and D. Romano. 2018. Marine litter plastics and microplastics and their toxic chemicals components: The need for urgent preventive measures. Environmental Sciences Europe 30(1).

Ganley, L. C., J. Byrnes, D. E. Pendleton, C. A. Mayo, K. D. Friedland, J. V. Redfern, J. T. Turner, and S. Brault. 2022. Effects of changing temperature phenology on the abundance of a critically endangered baleen whale. Global Ecology and Conservation 38:e02193.

Garrison, L., J. Ortega-Ortiz, G. Rappucci, L. Aichinger Dias, K. Mullin, and J. Litz. 2023. Volume 3: Appendic d: Gulf of mexico sea turtle spatial density models. US Department of the Interior, Bureau of Ocean Energy Management, New Orleans, LA, USA.

Gaspar, P., S. R. Benson, P. H. Dutton, A. Réveillère, G. Jacob, C. Meetoo, A. Dehecq, and S. Fossette. 2012. Oceanic dispersal of juvenile leatherback turtles: Going beyond passive drift modeling. Marine Ecology Progress Series.

Gavilan, F. M. 2001. Status and distribution of the loggerhead turtle, (caretta caretta), in the wider caribbean region. Pages 36-40 *in* K. L. Eckert, and F. A. Abreu Grobois, editors. Marine turtle conservation in the wider caribbean region: A dialogue for effective regional management, St. Croix, U.S. Virgin Islands.

Gill, J. A., K. Norris, and W. J. Sutherland. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265-268.

Girard, C., A. D. Tucker, and B. Calmettes. 2009. Post-nesting migrations of loggerhead sea turtles in the gulf of mexico: Dispersal in highly dynamic conditions. Marine Biology 156(9):1827-1839.

Godfrey, M. H., R. Barreto, and N. Mrosovsky. 1996. Sex ratios of sea turtles in suriname: Past and present. Pages 100 *in* D. E. J. A. B. Keinath, J. A. Musick, and B. A. Bell, editors. Fifteenth Annual Symposium on Sea Turtle Biology and Conservation.

Goff, G. P., and J. Lien. 1988. Atlantic leatherback turtles, dermochelys coriacea, in cold water off newfoundland and labrador. The Canadian Field-Naturalist 102:1-5.

Goold, J. C., and R. F. W. Coates. 2006. Near source, high frequency air-gun signatures. Paper SC/58/E30, prepared for the International Whaling Commmission (IWC) Seismic Workshop, St. Kitts, 24-25 May 2006. 7p.

Graham, T. R. 2009. Scyphozoan jellies as prey for leatherback sea turtles off central california. Masters Abstracts International.

Grant, S. C. H., and P. S. Ross. 2002. Southern resident killer whales at risk: Toxic chemicals in the british columbia and washington environment. Fisheries and Oceans Canada., Sidney, B.C.

Green, D. 1993. Growth rates of wild immature green turtles in the galapagos islands, ecuador. Journal of Herpetology 27(3):338-341.

Greene, C., A. J. Pershing, R. D. Kenney, and J. W. Jossi. 2003. Impact of climate variability on the recovery of endangered north atlantic right whales. Oceanography 16(4):98-103.

Greene, C. H., and A. J. Pershing. 2003. The flip-side of the north atlantic oscillation and modal shifts in slope-water circulation patterns. Limnology and Oceanography 48(1):319-322.

Greer, A. E. J., J. D. J. Lazell, and R. M. Wright. 1973. Anatomical evidence for a counter-current heat exchanger in the leatherback turtle (dermochelys coriacea). Nature 244:181.

Groombridge, B. 1982. Kemp's ridley or atlantic ridley, *lepidochelys kemii* (garman 1880). Pages 201-208 *in* B. Groombridge, and L. Wright, editors. The iucn amphibia, reptilia red data book.

Guerra, A. a. F. G. F. R. 2004. A review of the records of giant squid in the north-eastern atlantic and severe injuries in *architeuthis dux* stranded after acoustic explorations. ICES Annual Science Conference, Vigo, Spain.

Guseman, J. L., and L. M. Ehrhart. 1992. Ecological geography of western atlantic loggerheads and green turtles: Evidence from remote tag recoveries. M. Salmon, and J. Wyneken, editors. 11th Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS.

Halpin, P. N., A. J. Read, E. Fujioka, B. D. Best, B. Donnelly, L. J. Hazen, C. Kot, K. Urian, E. Labrecque, and A. Dimatteo. 2009. Obis-seamap: The world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography 22(2):104-115.

Hamelin, K. M., M. C. James, W. Ledwell, J. Huntington, and K. Martin. 2017. Incidental capture of leatherback sea turtles in fixed fishing gear off atlantic canada. Aquatic Conservation: Marine and Freshwater Ecosystems 27(3):631-642.

Harrington, F. H., and A. M. Veitch. 1992. Calving success of woodland caribou exposed to low-level jet fighter overflights. Arctic 45(3):213-218.

Harris, C. M., L. Thomas, E. A. Falcone, J. Hildebrand, D. Houser, P. H. Kvadsheim, F.-P. A. Lam, P. J. O. Miller, D. J. Moretti, A. J. Read, H. Slabbekoorn, B. L. Southall, P. L. Tyack, D. Wartzok, V. M. Janik, and J. Blanchard. 2018. Marine mammals and sonar: Dose-response studies, the risk-disturbance hypothesis and the role of exposure context. Journal of Applied Ecology 55(1):396-404.

Hart, K. M., A. R. Iverson, I. Fujisaki, M. M. Lamont, D. Bucklin, and D. J. Shaver. 2018. Sympatry or syntopy? Investigating drivers of distribution and co-occurrence for two imperiled sea turtle species in gulf of mexico neritic waters. Ecology and Evolution 8(24):12656-12669.

Hart, K. M., M. M. Lamont, I. Fujisaki, A. D. Tucker, and R. R. Carthy. 2012. Common coastal foraging areas for loggerheads in the gulf of mexico: Opportunities for marine conservation. Biological Conservation 145(1):185-194.

Hart, K. M., M. M. Lamont, A. R. Sartain, and I. Fujisaki. 2014. Migration, foraging, and residency patterns for northern gulf loggerheads: Implications of local threats and international movements. PLOS ONE 9(7):e103453.

Hassel, A., T. Knutsen, J. Dalen, S. Løkkeborg, K. Skaar, Ø. Østensen, E. K. Haugland, M. Fonn, Å. Høines, and O. A. Misund. 2003. Reaction of sandeel to seismic shooting: A field experiment and fishery statistics study. Institute of Marine Research, Bergen, Norway.

Hassel, A., T. Knutsen, J. Dalen, K. Skaar, S. Løkkeborg, O. A. Misund, O. Ostensen, M. Fonn, and E. K. Haugland. 2004. Influence of seismic shooting on the lesser sandeel (ammodytes marinus). ICES Journal of Marine Science 61:1165-1173.

Haver, S. M., J. Gedamke, L. T. Hatch, R. P. Dziak, S. Van Parijs, M. F. Mckenna, J. Barlow, C. Berchok, E. Didonato, B. Hanson, J. Haxel, M. Holt, D. Lipski, H. Matsumoto, C. Meinig, D. K. Mellinger, S. E. Moore, E. M. Oleson, M. S. Soldevilla, and H. Klinck. 2018. Monitoring long-term soundscape trends in u.S. Waters: The NOAA/nps ocean noise reference station network. Marine Policy 90:6–13.

Hawkes, L. A., A. C. Broderick, H. Godfrey, B. Godley, and M. J. Witt. 2014. The impacts of climate change on marine turtle reproductoin success. Pages 287-310 *in* B. Maslo, and L. Lockwood, editors. Coastal conservation. Cambridge University Press, Cambridge.

Hawkes, L. A., A. C. Broderick, M. H. Godfrey, and B. J. Godley. 2007. Investigating the potential impacts of climate change on a marine turtle population. Global Change Biology 13(5):923-932.

Hays, G. C. 2000. The implications of variable remigration intervals for the assessment of population size in marine turtles. J Theor Biol 206(2):221-7.

Hays, G. C., V. J. Hobson, J. D. Metcalfe, D. Righton, and D. W. Sims. 2006. Flexible foraging movements of leatherback turtles across the north atlantic ocean. Ecology 87(10):2647-2656.

Hays, G. C., J. D. R. Houghton, and A. E. Myers. 2004. Pan-atlantic leatherback turtle movements. Nature 429:522.

Hazel, J., and E. Gyuris. 2006. Vessel-related mortality of sea turtles in queensland, australia. Wildlife Research 33(2):149-154.

Hazel, J., I. Lawler, R. , H. Marsh, and S. Robson. 2007a. Vessel speed increases collision risk for the green turtle chelonia mydas. Endangered Species Research 3(2):105-113.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. 2007b. Vessel speed increases collision risk for the green turtle chelonia mydas. Endangered Species Research 3:105-113.

Heppell, S., D. Crouse, L. Crowder, S. Epperly, W. Gabriel, T. Henwood, R. Marquez, and N. Thompson. 2005. A population model to estimate recovery time, population size, and management impacts on kemp's ridley sea turtles. Chelonian Conservation and Biology 4(4):767-773.

Heppell, S. S., L. B. Crowder, D. T. Crouse, S. P. Epperly, and N. B. Frazer. 2003a. Population models for atlantic loggerheads: Past, present, and future. Pages 255-273 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead sea turtles. Smithsonian Books, Washington.

Heppell, S. S., M. L. Snover, and L. Crowder. 2003b. Sea turtle population ecology. Pages 275-306 *in* P. L. J. A. M. J. Wyneken, editor. The biology of sea turtles. CRC Press, Boca Raton, Florida.

Hildebrand, H. H. 1982. A historical review of the status of sea turtle populations in the western gulf of mexico. Pages 447-453 *in* K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D. C.

Hildebrand, J. 2004. Impacts of anthropogenic sound on cetaceans. Unpublished paper submitted to the International Whaling Commission Scientific Committee SC/56 E 13.

Hildebrand, J. A. 2009a. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395:5-20.

Hildebrand, J. A. 2009b. Metrics for characterizing the sources of ocean anthropogenic noise. Journal of the Acoustical Society of America 125(4):2517.

Hirth, H. F. 1971. Synopsis of biological data on the green turtle *chelonia mydas* (linnaeus) 1758. Food and Agriculture Organization of the United Nations, Rome.

Hirth, H. F., and Usfws. 1997. Synopsis of the biological data on the green turtle *chelonia mydas* (linnaeus 1758). U.S. Fish and Wildlife Service, U.S. Dept. of the Interior, Washington, D.C.

Holliday, D. V., R. E. Piper, M. E. Clarke, and C. F. Greenlaw. 1987. The effects of airgun energy release on the eggs, larvae, and adults of the northern anchovy (engraulis mordax). American Petroleum Institute, Washington, D.C.

Holst, M., W. J. Richardson, W. R. Koski, M. A. Smultea, B. Haley, M. W. Fitzgerald, and M. Rawson. 2006. Effects of large and small-source seismic surveys on marine mammals and sea turtles. EOS Transactions of the American Geophysical Union 87(36):Joint Assembly Supplement, Abstract OS42A-01.

Holst, M., and M. Smultea. 2008. Marine mammal and sea turtle monitoring during lamont-doherty earth observatory's marine seismic program off central america, february-april 2008 LGL, Ltd., King City, Canada.

Holst, M., M. A. Smultea, W. R. Koski, and B. Haley. 2005. Marine mammal and sea turtle monitoring during lamont-doherty earth observatory's marine seismic program off the northern yucatán peninsula in the southern gulf of mexico, january–february 2005. LGL Ltd., LGL Report TA2822-31.

Holt, M. M. 2008. Sound exposure and southern resident killer whales (orcinus orca): A review of current knowledge and data gaps. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center.

Howell, L. N., K. J. Reich, D. J. Shaver, A. M. Landry Jr, and C. C. Gorga. 2016. Ontogenetic shifts in diet and habitat of juvenile green sea turtles in the northwestern gulf of mexico. Marine Ecology Progress Series 559:217-229.

Hughes, G. R. 1996. Nesting of the leatherback turtle (dermochelys coriacea) in tongaland, kwazulu-natal, south africa, 1963-1995. Chelonian Conservation Biology 2(2):153-158.

Hurrell, J. W. 1995. Decadal trends in the north atlantic oscillation: Regional temperatures and precipitation. Science 269:676-679.

Hurrell, J. W., and C. Deser. 2010. North atlantic climate variability: The role of the north atlantic oscillation. Journal of Marine Systems 79(3):231-244.

Ingeman, K. E. 2016. Lionfish cause increased mortality rates and drive local extirpation of native prey. Marine Ecology Progress Series 558:235-245.

Ipcc. 2023. Summary for policymakers, Geneva, Switzerland.

James, M. C., S. A. Eckert, and R. A. Myers. 2005a. Migratory and reproductive movements of male leatherback turtles (dermochelys coriacea). Marine Biology 147(4):845-853.

James, M. C., R. A. Myers, and C. A. Ottensmeyer. 2005b. Behaviour of leatherback sea turtles, dermochelys coriacea, during the migratory cycle. Proceedings of the Royal Society Biological Sciences Series B 272(1572):1547-1555.

James, M. C., S. A. Sherrill-Mix, and R. A. Myers. 2007. Population characteristics and seasonal migrations of leatherback sea turtles at high latitudes. Marine Ecology Progress Series 337:245-254.

Jessop, T. S. 2001. Modulation of the adrenocortical stress response in marine turtles (cheloniidae): Evidence for a hormonal tactic maximizing maternal reproductive investment Journal of Zoology 254:57-65.

Jessop, T. S., M. Hamann, M. A. Read, and C. J. Limpus. 2000. Evidence for a hormonal tactic maximizing green turtle reproduction in response to a pervasive ecological stressor. General and Comparative Endocrinology 118:407-417.

Jessop, T. S., J. Sumner, V. Lance, and C. Limpus. 2004. Reproduction in shark-attacked sea turtles is supported by stress-reduction mechanisms. Proceedings of the Royal Society Biological Sciences Series B 271:S91-S94.

Johnson, S. A., and L. M. Ehrhart. 1996. Reproductive ecology of the florida green turtle: Clutch frequency. Journal of Herpetology 30:407-410.

Jones, T. T., M. D. Hastings, B. L. Bostrom, D. Pauly, and D. R. Jones. 2011. Growth of captive leatherback turtles, dermochelys coriacea, with inferences on growth in the wild: Implications for population decline and recovery. Journal of Experimental Marine Biology and Ecology 399(1):84-92.

Karnauskas, M., M. J. Schirripa, J. K. Craig, G. S. Cook, C. R. Kelble, J. J. Agar, B. A. Black, D. B. Enfield, D. Lindo-Atichati, B. A. Muhling, K. M. Purcell, P. M. Richards, and C. Wang. 2015. Evidence of climate-driven ecosystem reorganization in the gulf of mexico. Global Change Biology 21(7):2554-2568.

Keller, J. M., P. D. Mcclellan-Green, J. R. Kucklick, D. E. Keil, and M. M. Peden-Adams. 2006. Effects of organochlorine contaminants on loggerhead sea turtle immunity: Comparison of a correlative field study and *in vitro* exposure experiments. Environmental Health Perspectives 114(1):70-76.

Keller, R. P., and C. Perrings. 2011. International policy options for reducing the environmental impacts of invasive species. BioScience 61(12):1005-1012.

Kenyon, L. M., A. M. Landry Jr, and G. A. Gill. 2001. Trace metal concentrations in blood of the kemp's ridley sea turtle (lepidochelys kempii). Chelonian Conservation and Biology 4(1):128-135.

Kite-Powell, H. L., A. Knowlton, and M. Brown. 2007. Modeling the effect of vessel speed on right whale ship strike risk. NMFS.

Klimley, A. P., and A. A. Myrberg, Jr. 1979. Acoustic stimuli underlying withdrawal from a sound source by adult lemon sharks, negaprion brevirostris (poey). Bulletin of marine science 29(4):447-458.

Kostyuchenko, L. P. 1973. Effects of elastic waves generated in marine seismic prospecting on fish eggs in the black sea. Hydrobiological Journal 9(5):45-48.

La Bella, G., S. Cannata, C. Froglia, A. Modica, S. Ratti, and G. Rivas. 1996. First assessment of effects of air-gun seismic shooting on marine resources in the central adriatic sea. Pages 227-238 *in* Society of Petroleum Engineers, International Conference on Health, Safety and Environment, New Orleans, Louisiana.

La Bella, G. C., S.; Froglia, C.; Modica, A.; Ratti, S.; Rivas, G. 1996. First assessment of effects of air-gun seismic shooting on marine resources in the central adriatic sea. Pages 227 *in* SPE Health, Safety and Environment in Oil and Gas Exploration and Production Conference, New Orleans, Louisiana.

Lambardi, P., J. R. E. Lutjeharms, R. Mencacci, G. C. Hays, and P. Luschi. 2008. Influence of ocean currents on long-distance movement of leatherback sea turtles in the southwest indian ocean. Marine Ecology Progress Series 353:289-301.

Lamont, M. M., N. Moreno, F. Y. Camacho-Sánchez, H. H. Acosta-Sánchez, S. Glaberman, M. A. Reyes-Lopez, and Y. Chiari. 2021. Genetic diversity of immature kemp's ridley (lepidochelys kempii) sea turtles from the northern gulf of mexico. Aquatic Conservation: Marine and Freshwater Ecosystems 31(10):3003-3010.

Laurent, L., P. Casale, M. N. Bradai, B. J. Godley, G. Gerosa, A. C. Broderick, W. Schroth, B. Schierwater, A. M. Levy, and D. Freggi. 1998. Molecular resolution of marine turtle stock composition in fishery bycatch: A case study in the mediterranean. Molecular Ecology 7:1529-1542.

Lavender, A. L., S. M. Bartol, and I. K. Bartol. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (caretta caretta) using a dual testing approach. Journal of Experimental Biology 217(14):2580-2589.

Lenhardt, M. L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*caretta caretta*). Pages 238-241 *in* K. A. C. Bjorndal, A. B. C. Bolten, D. A. C. Johnson, and P. J. C. Eliazar, editors. Fourteenth Annual Symposium on Sea Turtle Biology and Conservation.

Lenhardt, M. L. 2002. Sea turtle auditory behavior. Journal of the Acoustical Society of America 112(5 Part 2):2314.

Lenhardt, M. L., S. Bellmund, R. A. Byles, S. W. Harkins, and J. A. Musick. 1983. Marine turtle reception of bone conducted sound. The Journal of auditory research 23:119-125.

Lewison, R., B. Wallace, J. Alfaro-Shigueto, J. C. Mangel, S. M. Maxwell, and E. L. Hazen. 2013. Fisheries bycatch of marine turtles lessons learned from decades of research and conservation. Pages 329-351 *in* The biology of sea turtles, volume III.

Ley-Quiñónez, C., A. Zavala-Norzagaray, T. L. Espinosa-Carreon, H. Peckham, C. Marquez-Herrera, L. Campos-Villegas, and A. Aguirre. 2011. Baseline heavy metals and metalloid values in blood of loggerhead turtles (caretta caretta) from baja california sur, mexico. Marine Pollution Bulletin 62(9):1979-1983.

Lima, S. L. 1998. Stress and decision making under the risk of predation. Advances in the Study of Behavior 27:215-290.

Litz, J., L. Aichinger Dias, G. Rappucci, A. Martinez, M. S. Soldevilla, L. Garrison, K. Mullin, K. Barry, and M. Foster. 2022. Cetacean and sea turtle spatial density model outputs from visual observations using line-transect survey methods aboard NOAA vessel and aircraft platforms in the gulf of mexico from 2003-06-12 to 2019-07-31. N. N. C. f. E. Information, editor.

Løkkeborg, S. 1991. Effects of geophysical survey on catching success in longline fishing. Pages 1-9 *in* International Council for the Exploration of the Sea (ICES) Annual Science Conference.

Løkkeborg, S., and A. V. Soldal. 1993. The influence of seismic explorations on cod (*gadus morhua*) behaviour and catch rates. ICES Marine Science Symposium 196:62-67.

Løkkeborg, S. O., Egil; Vold, Aud; Salthaug, Are; Jech, Josef Michael. 2012. Sounds from seismic air guns: Gear- and species-specific effects on catch rates and fish distribution. Canadian Journal of Fisheries and Aquatic Sciences 69(8):1278-1291.

Lopez, P. M., J. 2001. Chemosensory predator recognition induces specific defensive behaviours in a fossorial amphisbaenian. Animal Behaviour 62:259-264.

Markon, C., S. Gray, L. Berman, T. Eerkes-Medrano, H. Huntington, J. Littell, M. Mccammon, R. Thoman, and S. Trainor. 2018. Alaska. Pages 1185-1241 *in* D. R. Reidmiller, and coeditors, editors. Impacts, risks, and adaptation in the united states: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, USA.

Martin, K. J., S. C. Alessi, J. C. Gaspard, A. D. Tucker, G. B. Bauer, and D. A. Mann. 2012. Underwater hearing in the loggerhead turtle (caretta caretta): A comparison of behavioral and auditory evoked potential audiograms. The Journal of Experimental Biology 215(17):3001-3009.

Mateo, J. M. 2007. Ecological and hormonal correlates of antipredator behavior in adult belding's ground squirrels (spermophilus beldingi). Behavioral Ecology and Sociobiology 62(1):37-49.

Mccauley, R., J. Fewtrell, A. Duncan, C. Jenner, M.-N. Jenner, J. Penrose, R. Prince, A. Adhitya, J. Murdoch, and K. Mckabe. 2003a. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of exposure on humpback whales, sea turtles, fishes and squid. Pages 364-521 *in* Australian petroleum production and exploration association (appea). Australian Petroleum Production and Exploration Association.

Mccauley, R. D., R. D. Day, K. M. Swadling, Q. P. Fitzgibbon, R. A. Watson, and J. M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology and Evolution 1(7):195.

Mccauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. Mccabe. 2000a. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Prepared for the Australian Petroleum Production Exploration Association by the Centre for Marine Science and Technology, Project CMST 163, Report R99-15. 203p.

Mccauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. Mccabe. 2000b. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Curtin University of Technology, Western Australia.

Mccauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdock, and K. Mccabe. 2000c. Marine seismic surveys - a study of environmental implications. Australian Petroleum Production & Exploration Association (APPEA) Journal 40:692-708.

Mccauley, R. D., J. Fewtrell, and A. N. Popper. 2003b. High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America 113:5.

Mcdonald-Dutton, D., and P. H. Dutton. 1998. Accelerated growth in san diego bay green turtles? Pages 175-176 *in* S. P. Epperly, and J. Braun, editors. Proceedings of the seventeenth annual symposium on sea turtle biology and conservation. NOAA Technical

Memorandum NMFS-SEFSC-415. National Marine Fisheries Service, Southeast Fisheries Science Center, Orlando, FL.

Mckenna, L. N., F. V. Paladino, P. S. Tomillo, and N. J. Robinson. 2019. Do sea turtles vocalize to synchronize hatching or nest emergence? Copeia 107(1):120-123.

Mckenna, M. F., D. Ross, S. M. Wiggins, and J. A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. Journal of the Acoustical Society of America 131(2):92-103.

Mckenna, M. F., D. Ross, S. M. Wiggins, and J. A. Hildebrand. 2013. Relationship between container ship underwater noise levels and ship design, operational and oceanographic conditions. Scientific Reports 3:1760.

Mcmahon, C. R., and G. C. Hays. 2006. Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Global Change Biology 12:1330-1338.

Meylan, A. B., B. A. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the state of florida, 1979-1992. Florida Department of Environmental Protection, Florida Marine Research Institute, St. Petersburg, FL.

Meylan, A. M., B. Schroeder, and A. Mosier. 1994. Marine turtle nesting activity in the state of florida, 1979-1992. Pages 83 *in* K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, editors. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351. National Marine Fisheries Service, Southeast Fisheries Science Center, Hilton Head, SC.

Mickelson, L. E., and J. R. Downie. 2010. Influence of incubation temperature on morphology and locomotion performance of leatherback (dermochelys coriacea) hatchlings. Canadian Journal of Zoology 88(4):359-368.

Mickle, M. F., R. H. Pieniazek, and D. M. Higgs. 2020. Field assessment of behavioural responses of southern stingrays (hypanus americanus) to acoustic stimuli. R Soc Open Sci 7(1):191544.

Mitchell, R., I. Macdonald, and K. Kvenvolden. 1999. Estimates of total hydrocarbon seepage into the gulf of mexico based on satellite remote sensing images. EOS Supplement 80(49):OS242.

Moein Bartol, S., and D. R. Ketten. 2006. Turtle and tuna hearing. Pp.98-103 In: Swimmer, Y. and R. Brill (Eds), Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-PIFSC-7.

Moein, S. E., J. A. Musick, J. A. Keinath, D. E. Barnard, M. Lenhardt, and R. George. 1994. Evaluation of seismic sources for repelling sea turtles from hopper dredges. Final Report submitted to the U.S. Army Corps of Engineers, Waterways Experiment Station. Virginia Institute of Marine Science (VIMS), College of William and Mary, Gloucester Point, Virginia. 42p.

Molnar, J. L., R. L. Gamboa, C. Revenga, and M. D. Spalding. 2008. Assessing the global threat of invasive species to marine biodiversity. Frontiers in Ecology and the Environment 6(9):485-492.

Moncada, F., F. A. Abreu-Grobois, D. Bagley, K. Bjorndal, A. Bolten, J. Camiñas, L. Ehrhart, A. Muhlia-Melo, G. Nodarse, and B. Schroeder. 2010. Movement patterns of loggerhead turtles caretta caretta in cuban waters inferred from flipper tag recaptures. Endangered Species Research 11(1):61-68.

Moncheva, S. P., and L. T. Kamburska. 2002. Plankton stowaways in the black sea - impacts on biodiversity and ecosystem health. Pages 47-51 *in* Alien marine organisms introduced by ships in the Mediterranean and Black seas. CIESM Workshop Monographs, Istanbul, Turkey.

Monzón-Argüello, C., L. F. López-Jurado, C. Rico, A. Marco, P. López, G. C. Hays, and P. L. M. Lee. 2010. Evidence from genetic and lagrangian drifter data for transatlantic transport of small juvenile green turtles. Pages 129 *in* J. Blumenthal, A. Panagopoulou, and A. F. Rees, editors. Thirtieth Annual Symposium on Sea Turtle Biology and Conservation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Goa, India.

Moore, S. E., and R. P. Angliss. 2006. Overview of planned seismic surveys offshore northern alaska, july-october 2006. Paper SC/58/E6 presented to IWC Scientific Committee, St Kitts and Nevis.

Moriyasu, M., R. Allain, K. Benhalima, and R. Claytor. 2004. Effects of seismic and marine noise on invertebrates: A literature review. Fisheries and Oceans.

Mrosovsky, N. 1994. Sex ratios of sea turtles. Journal of Experimental Zoology 270:16-27.

Mrosovsky, N., G. D. Ryan, and M. C. James. 2009. Leatherback turtles: The menace of plastic. Marine Pollution Bulletin 58(2):287–289.

Mumby, P. J., A. R. Harborne, and D. R. Brumbaugh. 2011. Grouper as a natural biocontrol of invasive lionfish. PLOS ONE 6(6):e21510.

Muñoz, C. C., and P. Vermeiren. 2020. Maternal transfer of persistent organic pollutants to sea turtle eggs: A meta-analysis addressing knowledge and data gaps toward an improved synthesis of research outputs. Environmental Toxicology and Chemistry 39(1):9-29.

Murphy, T. M., and S. R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. NMFS-SEFSC.

Murphy, T. M., S. R. Murphy, D. B. Griffin, and C. P. Hope. 2006. Recent occurrence, spatial distribution, and temporal variability of leatherback turtles (dermochelys coriacea) in nearshore waters of south carolina, USA. Chelonian Conservation and Biology 5(2):216-224.

Musick, J. A., and C. J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. Pages 432 *in* P. L. Lutz, and J. A. Musick, editors. The biology of sea turtles. CRC Press.

Myrberg, A. A. 2001. The acoustical biology of elasmobranchs. The behavior and sensory biology of elasmobranch fishes: an anthology in memory of Donald Richard Nelson:31-46.

Myrberg, A. A., Jr., C. R. Gordon, and A. P. Klimley. 1978. Rapid withdrawal from a sound source by open-ocean sharks. The Journal of the Acoustical Society of America 64(5):1289-1297.

Namboothri, N., A. Swaminathan, and K. Shanker. 2012. A compilation of data from satish bhaskar's sea turtle surveys of the andaman and nicobar islands. Indian Ocean Turtle Newsletter 16:4-13.

Naro-Maciel, E., J. H. Becker, E. H. Lima, M. A. Marcovaldi, and R. Desalle. 2007. Testing dispersal hypotheses in foraging green sea turtles (chelonia mydas) of brazil. Journal of Heredity 98(1):29-39.

Naro-Maciel, E., A. C. V. Bondioli, M. Martin, A. De Pádua Almeida, C. Baptistotte, C. Bellini, M. Â. Marcovaldi, A. J. B. Santos, and G. Amato. 2012. The interplay of homing and dispersal in green turtles: A focus on the southwestern atlantic. Journal of Heredity 103(6):792-805.

Nelms, S. E., W. E. D. Piniak, C. R. Weir, and B. J. Godley. 2016. Seismic surveys and marine turtles: An underestimated global threat? Biological Conservation 193:49-65.

Nieukirk, S. L., K. M. Stafford, D. K. Mellinger, R. P. Dziak, and C. G. Fox. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-atlantic ocean Journal of the Acoustical Society of America 115:1832-1843.

NMFS-Sefsc. 2001. Stock assessments of loggerhead and leatherback sea turtles: And, an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western north atlantic. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL.

NMFS-Sefsc. 2009. An assessment of loggerhead sea turtles to estimate impacts of mortality reductions on population dynamics. NMFS Southeast Fisheries Science Center.

NMFS. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western north atlantic.

NMFS. 2006. Biological opinion on permitting structure removal operations on the gulf of mexico outer continental shelf and the authorization for take of marine mammals incidental to structure removals on the gulf of mexico outer continental shelf. National Marine Fisheries Service, Silver Spring, Maryland. 131p.

NMFS. 2006h. Biological opinion on the funding and permitting of seismic surveys by the national science foundation and the national marine fisheries service in the eastern tropical pacific ocean from march to april 2006. National Marine Fisheries Service, Silver Spring, Maryland. 76p.

NMFS. 2008. Recovery plan for the northwest atlantic population of the loggerhead sea turtle (caretta caretta).

NMFS. 2011. Preliminary summer 2010 regional abundance estimate of loggerhead turtles (*caretta caretta*) in northwestern atlantic ocean continental shelf waters. Northeast and Southeast Fisheries Science Centers, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Reference Document 11-03, Woods Hole, Massachusetts.

NMFS. 2013. Hawksbill sea turtle (eretmochelys imbricata) 5-year review : Summary and evaluation.

NMFS. 2014. Reinitiation of endangered species act (esa) section 7 consultation on the continued implementation of the sea turtle conservation regulations under the esa and the continued authorization of the southeast u.S. Shrimp fisheries in federal waters under the magnuson-stevens fishery management and conservation act. NOAA. NMFS, Southeast Regional Office, Protected Resources Division.

NMFS. 2017. Recovering threatened and endangered species, fy 2015-2016 report to congress. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

NMFS. 2020a. Biological opinion on the federally regulated oil and gas program activities in the gulf of mexico.

NMFS. 2020b. Endangered species act status review of the leatherback turtle (dermochelys coriacea) 2020.

NMFS. 2023a. Biological opinion on the national science foundation’s high-energy marine geophysical survey by the research vessel marcus g. Langseth in the northwest atlantic ocean off north carolina and national marine fisheries service permits and conservation division’s issuance and possible renewal of an incidental harassment authorization pursuant to section 101(a)(5)(d) of the marine mammal protection act

NMFS. 2023b. Biological opinion on the national science foundation’s high-energy marine geophysical survey by the research vessel marcus g. Langseth of the carolina trough and blake plateau in the northwest atlantic 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

NMFS, and Usfws. 1991. Recovery plan for u.S. Population of atlantic green turtle (chelonia mydas).

NMFS, and Usfws. 1992. Recovery plan for leatherback turtles in the u.S. Caribbean, atlantic, and gulf of mexico (dermochelys coriacea).

NMFS, and Usfws. 1995. Status reviews for sea turtles listed under the endangered species act of 1973. National Marine Fisheries Service, Silver Spring, MD.

NMFS, and Usfws. 2007a. Green sea turtle (chelonia mydas) 5-year review : Summary and evaluation.

NMFS, and Usfws. 2007b. Loggerhead sea turtle (*caretta caretta*) 5-year review: Summary and evaluation. National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.

NMFS, and Usfws. 2008a. Recovery plan for the northwest atlantic population of the loggerhead sea turtle (caretta caretta).

NMFS, and Usfws. 2008b. Recovery plan for the northwest atlantic population of the loggerhead sea turtle (*caretta caretta*), second revision National Marine Fisheries Service, Silver Spring, MD.

NMFS, and Usfws. 2008c. Recovery plan for the northwest atlantic population of the loggerhead sea turtle (*caretta caretta*), second revision. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS, and Usfws. 2011. Bi-national recovery plan for the kemp's ridley sea turtle (*lepidochelys kempii*), second revision. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.

NMFS, and Usfws. 2013. Leatherback sea turtle (*dermochelys coriacea*) 5-year review: Summary and evaluation. National Marine Fisheries Service and United States Fish and Wildlife Service, Silver Spring, Maryland.

NMFS, and Usfws. 2015. Kemp's ridley sea turtle (*lepidochelys kempii*) 5-year review: Summary and evaluation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Fish and Wildlife Service.

NMFS, Usfws, and Semarnat. 2011a. Bi-national recovery plan for the kemp's ridley turtle (lepidochelys kempii).

NMFS, Usfws, and Semarnat. 2011b. Bi-national recovery plan for the kemp’s ridley sea turtle (*lepidochelys kempii*), second revision. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Fish and Wildlife Service, Silver Spring, Maryland.

NMFS, Usfws, and Semarnat. 2011c. Bi-national recovery plan for the kemp’s ridley sea turtle (*lepidochelys kempii*), second revision. Pages 156 *in*. National Marine Fisheries Service, Silver Spring, Maryland.

NMFS and Usfws. 2023. Loggerhead sea turtle (caretta caretta) northwest atlantic ocean dps 5-year review: Summary and evaluation Silver Spring, MD and Jacksonville, FL.

NMFS Usfws. 2013. Leatherback sea turtle (*dermochelys coriacea*) 5-year review: Summary and evaluation. NOAA, National Marine Fisheries Service, Office of Protected Resources and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Office.

NOAA. 2018. Revisions to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (version 2.0): Underwater thresholds for onset of permanent and temporary threshold shifts. Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, Maryland.

Norris, K. S., and B. Mohl. 1983. Can odontocetes debilitate prey with sound? The American Naturalist 122(1):85-104.

Norse, E. A., L. B. Crowder, K. Gjerde, D. Hyrenbach, C. M. Roberts, C. Safina, and M. E. Soule. 2005. Place-based ecosystem management in the open ocean. Pages 302-327 *in* L. B. E. A. C. Norse, editor. Marine conservation biology: The science of maintaining the sea's biodiversity. Island Press, Washington, D. C.

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

Nps. 2013. Padre island national seashore kemp's ridley sea turtle nesting 1985-2013. National Park Service Padre Island National Seashore.

Nrc. 1990. Decline of the sea turtles: Causes and prevention. National Academy Press, 030904247X, Washington, D.C.

Nrc. 2003a. National research council: Ocean noise and marine mammals. National Academies Press, Washington, D.C.

Nrc. 2003b. Ocean noise and marine mammals. National Academy Press, Washington, D.C.

Nrc. 2003c. Ocean noise and marine mammals. National Research Council of the National Academies of Science. The National Academies Press, Washington, District of Columbia.

Nunny, R., E. Graham, and S. Bass. 2005. Do sea turtles use acousstic cues when nesting? H. Kalb, A. S. Rohde, K. Gayheart, and K. Shanker, editors. Twenty-fifth Annual Symposium on Sea Turtle Biological and Conservation. Southeast Fisheries Science Center, Savannah, Georgia, USA.

O'hara, J., and J. R. Wilcox. 1990. Avoidance responses of loggerhead turtles, caretta caretta, to low frequency sound. Copeia (2):564-567.

Ogren, L. H. 1989. Distribution of juvenile and subadult kemp's ridley sea turtles: Preliminary results from 1984-1987 surveys. Pages 116-123 *in* A. M. C. W. L. J. Caillouet Jr., editor First International Symposium on Kemp’s Ridley Sea Turtle Biology, Conservation and Management. Texas A&M University, Sea Grant College, Galveston, Texas.

Orós, J., O. Gonzalez-Diaz, and P. Monagas. 2009. High levels of polychlorinated biphenyls in tissues of atlantic turtles stranded in the canary islands, spain. Chemosphere 74(3):473-478.

Paladino, F. V., M. P. O'connor, and J. R. Spotila. 1990. Metabolism of leatherback turtles, gigantothermy, and thermoregulation of dinosaurs. Nature 344:858-860.

Parry, G. D., S. Heislers, G. F. Werner, M. D. Asplin, and A. Gason. 2002. Assessment of environmental effects of seismic testing on scallop fisheries in bass strait. Marine and Fresh-water Resources Institute, Report No. 50.

Parton, K. J., T. S. Galloway, and B. J. Godley. 2019. Global review of shark and ray entanglement in anthropogenic marine debris. Endangered Species Research 39:173-190.

Patel, S. H., M. V. Winton, J. M. Hatch, H. L. Haas, V. S. Saba, G. Fay, and R. J. Smolowitz. 2021. Projected shifts in loggerhead sea turtle thermal habitat in the northwest atlantic ocean due to climate change. Scientific Reports 11(1):8850.

Patino-Martinez, J., A. Marco, L. Quinones, E. Abella, R. Muriel Abad, and J. Dieguez-Uribeondo. 2012. How do hatcheries influence embryonic development of sea turtle eggs? Experimental analysis and isolation of microorganisms in leatherback turtle eggs. Journal of Experimental Zoology Part A-Ecological Genetics and Physiology 317A(1):47-54.

Patterson, P. D. 1966. Hearing in the turtle. Journal of Auditory Research 6:453.

Payne, J. F., C. D. Andrews;, L. L. Fancey;, J. Guiney;, A. Cook;, and J. R. Christian. 2013. Are seismic surveys an important risk factor for fish and shellfish? Bioacoustics 17:262-265.

Payne, J. F. J. C. D. W. 2009. Potential effects of seismic airgun discharges on monkfish eggs (lophius americanus) and larvae., St. John's, Newfoundland.

Pearson, W. H., J. R. Skalski, and C. I. Malme. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (*sebastes* spp.). Canadian Journal of Fisheries and Aquatic Sciences 49:1343-1356.

Perrault, J. R., N. I. Stacy, A. F. Lehner, C. R. Mott, S. Hirsch, J. C. Gorham, J. P. Buchweitz, M. J. Bresette, and C. J. Walsh. 2017. Potential effects of brevetoxins and toxic elements on various health variables in kemp's ridley (lepidochelys kempii) and green (chelonia mydas) sea turtles after a red tide bloom event. Science of the Total Environment 605-606:967-979.

Pershing, A. J., C. H. Greene, C. Hannah, D. Sameoto, E. Head, D. G. Mountain, J. W. Jossie, M. C. Benfield, P. C. Reid, and T. G. Durbin. 2001. Oceanographic responses to climate in the northwest atlantic. Oceanography 14(3):76-82.

Pfaller, J. B., M. Chaloupka, A. B. Bolten, and K. A. Bjorndal. 2018. Phylogeny, biogeography and methodology: A meta-analytic perspective on heterogeneity in adult marine turtle survival rates. Sci Rep 8(1):5852.

Phillips, B. E., S. A. Cannizzo, M. H. Godfrey, B. A. Stacy, and C. A. Harms. 2015. Exertional myopathy in a juvenile green sea turtle (chelonia mydas) entangled in a large mesh gillnet. Case Reports in Veterinary Medicine 2015.

Pickett, G. D., D. R. Eaton, R. M. H. Seaby, and G. P. Arnold. 1994. Results of bass tagging in poole bay during 1992. MAFF Direct. Fish. Res., Lowestoft, Endland.

Piniak, W. E., D. A. Mann, C. A. Harms, T. T. Jones, and S. A. Eckert. 2016. Hearing in the juvenile green sea turtle (*chelonia mydas*): A comparison of underwater and aerial hearing using auditory evoked potentials. PLoS One 11(10):e0159711.

Piniak, W. E. D., and K. L. Eckert. 2011. Sea turtle nesting habitat in the wider caribbean region. Endangered Species Research 15(2):129-141.

Plotkin, P. 1995. Adult migrations and habitat use. Pages 472 *in* P. L. Lutz, J. A. Musick, and J. Wyneken, editors. The biology of sea turtles, volume 2. CRC Press.

Plotkin, P., M. Wicksten, and A. Amos. 1993. Feeding ecology of the loggerhead sea turtle caretta caretta in the northwestern gulf of mexico. Marine Biology 115:1-5.

Plotkin, P. T. 2016. Introduction to the special issue on the kemp's ridley sea turtle (*lepidochelys kempii*). Gulf of Mexico Science 2016(2):1.

Popper, A., A. Hawkins, R. Fay, D. Mann, S. Bartol, T. Carlson, S. Coombs, W. Ellison, R. Gentry, M. Halvorsen, S. Lokkeborg, P. Rogers, B. Southall, D. Zeddies, and W. Tavolga. 2014a. Sound exposure guidelines for fishes and sea turtles: A technical report. Springer and ASA Press, Cham, Switzerland.

Popper, A., A. Hawkins, R. Fay, D. Mann, S. Bartol, T. Carlson, S. Coombs, W. Ellison, R. Gentry, M. Halvorsen, S. Lokkeborg, P. H. Rogers, B. L. Southall, B. G. Zeddies, and W. N. Tavolga. 2014b. Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ansi-accredicted standards committee s3/sc1 and registered with ansi.

Popper, A. N., and A. Hawkins. 2016. The effects of noise on aquatic life ii, volume 875. Springer.

Popper, A. N., M. E. Smith, P. A. Cott, B. W. Hanna, A. O. Macgillivray, M. E. Austin, and D. A. Mann. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. Journal of the Acoustical Society of America 117(6):3958-3971.

Presti, S. M., A. M. Landry, and A. E. Sollod. 2000. Mercury concentration in scute scrapings of sea turtles in the gulf of mexico. Proceedings of the Eighteenth International Sea Turtle Symposium 1998.

Price, E. R., B. P. Wallace, R. D. Reina, J. R. Spotila, F. V. Paladino, R. Piedra, and E. Velez. 2004. Size, growth, and reproductive output of adult female leatherback turtles *dermochelys coriacea*. Endangered Species Research 5:1-8.

Prosnier, L., E. Rojas, and V. Médoc. 2022. A freshwater zooplankton in the face to boat noise pollution. bioRxiv:2022.11.20.517267.

Pughiuc, D. 2010. Invasive species: Ballast water battles. Seaways.

Putman, N. F., E. E. Seney, P. Verley, D. J. Shaver, M. C. López-Castro, M. Cook, V. Guzmán, B. Brost, S. A. Ceriani, R. D. J. G. D. Mirón, L. J. Peña, M. Tzeek, R. A. Valverde, C. C. G. Cantón, L. Howell, J. A. Ravell Ley, M. C. Tumlin, W. G. Teas, C. W. Caillouet Jr, E. Cuevas, B. J. Gallaway, P. M. Richards, and K. L. Mansfield. 2020. Predicted distributions and abundances of the sea turtle 'lost years' in the western north atlantic ocean. Ecography 43(4):506-517.

Raaymakers, S. 2003. The gef/undp/imo global ballast water management programme integrating science, shipping and society to save our seas. Proceedings of the Institute of Marine Engineering, Science and Technology Part B: Journal of Design and Operations (B4):2-10.

Raaymakers, S., and R. Hilliard. 2002. Harmful aquatic organisms in ships' ballast water - ballast water risk assessment, 1726-5886, Istanbul, Turkey.

Rabalais, N. N., and R. E. Turner. 2001. Coastal hypoxia: Consequences for living resources and ecosystems. American Geophyical Union.

Rabalais, N. N., R. E. Turner, and W. J. Wiseman Jr. 2002. Gulf of mexico hypoxia, aka "the dead zone". Annual Review of ecology and Systematics 33(1):235-263.

Ramajo, L., E. Pérez-León, I. E. Hendriks, N. Marbà, D. Krause-Jensen, M. K. Sejr, M. E. Blicher, N. A. Lagos, Y. S. Olsen, and C. M. Duarte. 2016. Food supply confers calcifiers resistance to ocean acidification. Scientific Reports 6:19374.

Rappucci, G., L. Garrison, M. S. Soldevilla, J. Ortega-Ortiz, J. Reid, L. Aichinger Dias, K. Mullin, and J. Litz. 2023. Gulf of mexico marine assessment program for protected species (gommapps): Marine mammals. US Department of the Interior, Bureau of Ocean Energy Management, New Orleans, LA, USA.

Rebel, T. P. 1974. Sea turtles and the turtle industry of the west indies, florida, and the gulf of mexico, Revised edition. University of Miami Press, Coral Gables, FL.

Record, N. R., J. A. Runge, D. E. Pendleton, W. M. Balch, K. T. A. Davies, A. J. Pershing, C. L. Johnson, K. Stamieszkin, R. Ji, Z. Feng, S. D. Kraus, R. D. Kenney, C. A. Hudak, C. A. Mayo, C. Chen, J. E. Salisbury, and C. R. S. Thompson. 2019. Rapid climate-driven circulation changes threaten conservation of endangered north atlantic right whales. Oceanography 32(2):162-169.

Reina, R. D., P. A. Mayor, J. R. Spotila, R. Piedra, and F. V. Paladino. 2002. Nesting ecology of the leatherback turtle, dermochelys coriacea, at parque nacional marino las baulas, costa rica: 1988-1989 to 1999-2000. Copeia 2002(3):653-664.

Reneker, J. L., M. Cook, R. W. Nero, B. A. Stacy, and D. G. Stewart. 2018. Summary of sea turtle strandings, incidental captures and related survey effort in mississippi during 2017.

Ridgway, S. H., E. G. Wever, J. G. Mccormick, J. Palin, and J. H. Anderson. 1969. Hearing in the giant sea turtle, *chelonoa mydas*. Proceedings of the National Academies of Science 64.

Rivalan, P., A.-C. Prevot-Julliard, R. Choquet, R. Pradel, B. Jacquemin, and M. Girondot. 2005. Trade-off between current reproductive effort and delay to next reproduction in the leatherback sea turtle. Oecologia 145(4):564-574.

Romero, L. M. 2004. Physiological stress in ecology: Lessons from biomedical research. Trends in Ecology and Evolution 19(5):249-255.

Ross, D. 1976. Mechanics of underwater noise. Pergamon Press, New York.

Sabet, S. S., S. A. Karnagh, and F. Z. Azbari. 2019. Experimental test of sound and light exposure on water flea swimming behaviour. Proceedings of Meetings on Acoustics 37(1):010015.

Salas, A. K., A. M. Capuano, C. A. Harms, W. E. D. Piniak, and T. A. Mooney. 2023. Temporary noise-induced underwater hearing loss in an aquatic turtle (trachemys scripta elegans). The Journal of the Acoustical Society of America 154(2):1003-1017.

Santulli, A., A. Modica, C. Messina, L. C. A. Curatolo, G. Rivas, G. Fabi, and V. D'amelio. 1999. Biochemical responses of european sea bass (*dicentrarchus labrax* l.) to the stress induced by offshore experimental seismic prospecting. Marine Pollution Bulletin 38(12):1105-1114.

Schroeder, B. A., and A. M. Foley. 1995. Population studies of marine turtles in florida bay. Pages 117 *in* J. I. Richardson, and T. H. Richardson, editors. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA.

Schuyler, Q., B. D. Hardesty, C. Wilcox, and K. Townsend. 2014. Global analysis of anthropogenic debris ingestion by sea turtles. Conservation Biology 28(1):129-139.

Seminoff, H. S. H., S. R. Benson, G. M. Ylitalo, S. E. Fire, R. H. Poppenga, C. C. Fahy, and J. A. 2012. Evaluation of scyphozoan jellyfish as biological indicators for coastal marine pollution and leatherback turtle health. Pages 266 *in* T. T. J. B. P. Wallace, editor Thirty-First Annual Symposium on Sea Turtle Biology and Conservation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, San Diego, California.

Seminoff, J. A., C. A. Allen, G. H. Balazs, P. H. Dutton, T. Eguchi, H. L. Haas, S. A. Hargrove, M. Jensen, D. L. Klemm, A. M. Lauritsen, S. L. Macpherson, P. Opay, E. E. Possardt, S. Pultz, E. Seney, K. S. V. Houtan, and R. S. Waples. 2015. Status reviw of the green turtle (*chelonia mydas*) under the endnagered species act. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Seney, E. E., and A. M. Landry Jr. 2008. Movements of kemp’s ridley sea turtles nesting on the upper texas coast: Implications for management. Endangered Species Research 4(1-2):73-84.

Seney, E. E., and A. M. Landry Jr. 2011. Movement patterns of immature and adult female kemp’s ridley sea turtles in the northwestern gulf of mexico. Marine Ecology Progress Series 440:241-254.

Shamblin, B. M., A. B. Bolten, F. A. Abreu-Grobois, K. A. Bjorndal, L. Cardona, C. Carreras, M. Clusa, C. Monzon-Arguello, C. J. Nairn, J. T. Nielsen, R. Nel, L. S. Soares, K. R. Stewart, S. T. Vilaca, O. Turkozan, C. Yilmaz, and P. H. Dutton. 2014. Geographic patterns of genetic variation in a broadly distributed marine vertebrate: New insights into loggerhead turtle stock structure from expanded mitochondrial DNA sequences. Plos One 9(1):e85956.

Shamblin, B. M., A. B. Bolten, K. A. Bjorndal, P. H. Dutton, J. T. Nielsen, F. A. Abreu-Grobois, K. J. Reich, B. E. Witherington, D. A. Bagley, and L. M. Ehrhart. 2012. Expanded mitochondrial control region sequences increase resolution of stock structure among north atlantic loggerhead turtle rookeries. Marine Ecology Progress Series 469:145-160.

Shamblin, B. M., P. H. Dutton, D. J. Shaver, D. A. Bagley, N. F. Putman, K. L. Mansfield, L. M. Ehrhart, L. J. Peña, and C. J. Nairn. 2016. Mexican origins for the texas green turtle foraging aggregation: A cautionary tale of incomplete baselines and poor marker resolution. Journal of Experimental Marine Biology and Ecology.

Shaver, D. J. 1994. Relative abundance, temporal patterns, and growth of sea turtles at the mansfield channel, texas. Journal of Herpetology 28(4):491-497.

Shaver, D. J., and C. W. Caillouet Jr. 1998. More kemp's ridley turtles return to south texas to nest. Marine Turtle Newsletter 82:1-5.

Shaver, D. J., K. M. Hart, I. Fujisaki, C. Rubio, A. R. Sartain, J. Pena, P. M. Burchfield, D. G. Gamez, and J. Ortiz. 2013. Foraging area fidelity for kemp's ridleys in the gulf of mexico. Ecology and Evolution 3(7):2002-2012.

Shaver, D. J., M. M. Lamont, S. Maxwell, J. S. Walker, and T. Dillingham. 2016. Head-started kemp's ridley turtle (lepidochelys kempii) nest recorded in florida: Possible implications. Chelonian Conservation and Biology 15(1):138-143.

Shenker, J. M. 1984. Scyphomedusae in surface waters near the oregon coast, may-august, 1981. Estuarine, Coastal and Shelf Science 19(6):619-632.

Shillinger, G. L., and H. Bailey. 2015. Movements and behavior of adults and juveniles movements and behavior of adult and juvenile leatherback turtles. The Leatherback Turtle: Biology and Conservation:162.

Shillinger, G. L., D. M. Palacios, H. Bailey, S. J. Bograd, A. M. Swithenbank, P. Gaspar, B. P. Wallace, J. R. Spotila, F. V. Paladino, R. Piedra, S. A. Eckert, and B. A. Block. 2008. Persistent leatherback turtle migrations present opportunities for conservation. PLoS Biology 6(7):1408-1416.

Simmonds, M. P., S. J. Dolman, M. Jasny, E. Parsons, L. Weilgart, A. J. Wright, and R. Leaper. 2014. Marine noise pollution-increasing recognition but need for more practical action.

Skalski, J. R. P., W. H.; Malme, C. I. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*sebastes* spp.). Canadian Journal of Fisheries and Aquatic Sciences 49:1357-1365.

Slotte, A., K. Hansen, J. Dalen, and E. Ona. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the norwegian west coast. Fisheries Research 67:143-150.

Smultea, M., and M. Holst. 2003. Marine mammal monitoring during lamont-doherty earth observatory's seismic study in the hess deep area of the eastern equatorial tropical pacific, july 2003. Prepared for Lamont-Doherty Earth Observatory, Palisades, New York, and the National Marine Fisheries Service, Silver Spring, Maryland, by LGL Ltd., environmental research associates. LGL Report TA2822-16.

Smultea, M. A., W. R. Koski, and T. J. Norris. 2005. Marine mammal monitoring during lamont-doherty earth observatory's marine seismic study of the blanco fracture zone in the northeastern pacific ocean, october-november 2004. LGL Ltd. Environmental Research Associates, LGL Report TA2822-29.

Snover, M. L. 2002. Growth and ontogeny of sea turtles using skeletochronology: Methods, validation and application to conservation. Duke University.

Snyder, M. A., and P. A. Orlin. 2007. Ambient noise classification in the gulf of mexico. Naval Oceanographic Office Stennis Space Center, Mississippi.

Sobin, J. M., and T. D. Tucker. 2008. Diving behavior of female loggerhead turtles (caretta caretta) during their internesting interval and an evaluation of the risk of boat strikes. Pages 1-10 *in* OCEANS 2008.

Solé, M., M. Lenoir, J. M. Fontuño, M. Durfort, M. Van Der Schaar, and M. André. 2016. Evidence of cnidarians sensitivity to sound after exposure to low frequency noise underwater sources. Scientific Reports 6(1):37979.

Southwood, A. L., R. D. Andrews, F. V. Paladino, and D. R. Jones. 2005. Effects of diving and swimming behavior on body temperatures of pacific leatherback turtles in tropical seas. Physiological and Biochemical Zoology 78:285-297.

Spotila, J. R., A. E. Dunham, A. J. Leslie, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 1996. Worldwide population decline of *dermochelys coriacea*: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):209-222.

Spotila, J. R., R. D. Reina, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 2000a. Pacific leatherback turtles face extinction. Nature 405:529-530.

Spotila, J. R., R. D. Reina, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 2000b. Pacific leatherback turtles face extinction. Nature 405(6786):529-530.

Spring, D. 2011. L-deo seismic survey turtle mortality. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Stacy, B. A., R. Hardy, D. J. Shaver, C. Purvin, L. N. Howell, H. Wilson, M. Devlin, A. Krauss, C. Macon, M. Cook, Z. Wang, L. Flewelling, J. Keene, A. Walker, P. Baker, and T. Yaw. 2020. 2019 sea turtle strandings in texas: A summary of findings and analyses. Department of Commerce, National Marine Fisheries Service, Silver Spring, MD, USA.

Stacy, N. I., C. L. Field, L. Staggs, R. A. Maclean, B. A. Stacy, J. Keene, D. Cacela, C. Pelton, C. Cray, M. Kelley, S. Holmes, and C. J. Innis. 2017. Clinicopathological findings in sea turtles assessed during the deepwater horizon oil spill response. Endangered Species Research 33:25-37.

Starbird, C. H., A. Baldridge, and J. T. Harvey. 1993. Seasonal occurrence of leatherback sea turtles (dermochelys coriacea) in the monterey bay region, with notes on other sea turtles, 1986-1991. California Fish and Game 79(2):54-62.

Stenseth, N. C., A. Mysterud, G. Ottersen, J. W. Hurrell, K.-S. Chan, and M. Lima. 2002. Ecological effects of climate fluctuations. Science 297(5585):1292-1296.

Stewart, K. R., and P. H. Dutton. 2014. Breeding sex ratios in adult leatherback turtles (dermochelys coriacea) may compensate for female-biased hatchling sex ratios. PLOS ONE 9(2):e88138.

Stewart, K. R., J. M. Keller, R. Templeton, J. R. Kucklick, and C. Johnson. 2011. Monitoring persistent organic pollutants in leatherback turtles (dermochelys coriacea) confirms maternal transfer. Marine Pollution Bulletin 62(7):1396-1409.

Stewart, K. R., K. J. Martin, C. Johnson, N. Desjardin, S. A. Eckert, and L. B. Crowder. 2014. Increased nesting, good survival and variable site fidelity for leatherback turtles in florida, USA. Biological Conservation 176:117-125.

Storelli, M., M. G. Barone, and G. O. Marcotrigiano. 2007. Polychlorinated biphenyls and other chlorinated organic contaminants in the tissues of mediterranean loggerhead turtle caretta caretta. Science of the Total Environment 273 (2-3:456-463.

Strayer, D. L. 2010. Alien species in fresh waters: Ecological effects, interactions with other stressors, and prospects for the future. Freshwater Biology 55:152-174.

Suchman, C., and R. Brodeur. 2005. Abundance and distribution of large medusae in surface waters of the northern california current. Deep Sea Research Part II: Topical Studies in Oceanography 52(1–2):51-72.

Swot. 2022. Printed maps of sea turtle biogeography. S. o. t. W. s. S. Turtles, editor.

Taylor, A. H., M. B. Jordon, and J. A. Stephens. 1998. Gulf stream shifts following enso events. Nature 393:68.

Tdot, T. D. O. T. 2016. Overview of texas ports and waterways.

Terdalkar, S., A. S. Kulkarni, S. N. Kumbhar, and J. Matheickal. 2005. Bio-economic risks of ballast water carried in ships, with special reference to harmful algal blooms. Nature, Environment and Pollution Technology 4(1):43-47.

Tewg. 1998. An assessment of the kemp’s ridley (*lepidochelys kempii*) and loggerhead (*caretta caretta*) sea turtle populations in the western north atlantic. U. S. Dept. Commerce.

Tewg. 2000. Assessment update for the kemp's ridley and loggerhead sea turtle populations in the western north atlantic. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Turtle Expert Working Group.

Tewg. 2007. An assessment of the leatherback turtle population in the atlantic ocean. NOAA.

Tewg. 2009. An assessment of the loggerhead turtle population in the western north atlantic ocean. NOAA.

Thomsen, B. 2002. An experiment on how seismic shooting affects caged fish. University of Aberdeen, Aberdeen, Scotland.

Tomás, J., P. Gozalbes, J. A. Raga, and B. J. Godley. 2008. Bycatch of loggerhead sea turtles: Insights from 14 years of stranding data. Endangered Species Research 5(2-3):161-169.

Tomás, J., and J. A. Raga. 2008. Occurrence of kemp's ridley sea turtle (lepidochelys kempii) in the mediterranean. Marine Biodiversity Records 1:e58.

Troëng, S., and E. Rankin. 2005. Long-term conservation efforts contribute to positive green turtle chelonia mydas nesting trend at tortuguero, costa rica. Biological Conservation 121(1):111-116.

Trustees, D. H. N. 2016. Deepwater horizon oil spill: Final programmatic damage assessment and restoration plan (pdarp) and final programmatic environmental impact statement. NOAA, http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan.

Tucker, A. D. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. Journal of Experimental Marine Biology and Ecology 383(1):48-55.

Turnpenny, A. W. H., and J. R. Nedwell. 1994. The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. Consultancy Report, Fawley Aquatic Research Laboratories, Ltd. FCR 089/94. 50p.

Turnpenny, A. W. H., K. P. Thatcher, and J. R. Nedwell. 1994. The effects on fish and other marine animals of high-level underwater sound. Research Report for the Defence Research Agency, Fawley Aquatic Research Laboratories, Ltd., FRR 127/94. 34p.

Valverde, R. A., and K. R. Holzwart. 2017. Sea turtles of the gulf of mexico. Habitats and Biota of the Gulf of Mexico: Before the Deepwater Horizon Oil Spill: Volume 2: Fish Resources, Fisheries, Sea Turtles, Avian Resources, Marine Mammals, Diseases and Mortalities:1189-1351.

Vanderlaan, A. S., and C. T. Taggart. 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed. Marine Mammal Science 23(1):144-156.

Wallace, B. P., S. S. Kilham, F. V. Paladino, and J. R. Spotila. 2006. Energy budget calculations indicate resource limitation in eastern pacific leatherback turtles. Marine Ecology Progress Series 318:263-270.

Wallace, B. P., C. Y. Kot, A. D. Dimatteo, T. Lee, L. B. Crowder, and R. L. Lewison. 2013. Impacts of fisheries bycatch on marine turtle populations worldwide: Toward conservation and research priorities. Ecosphere 4(3):art40.

Wallace, B. P., R. L. Lewison, S. L. Mcdonald, R. K. Mcdonald, C. Y. Kot, S. Kelez, R. K. Bjorkland, E. M. Finkbeiner, S. R. Helmbrecht, and L. B. Crowder. 2010. Global patterns of marine turtle bycatch. Convervation Letters.

Wallace, B. P., P. R. Sotherland, P. Santidrian Tomillo, R. D. Reina, J. R. Spotila, and F. V. Paladino. 2007. Maternal investment in reproduction and its consequences in leatherback turtles. Oecologia 152(1):37-47.

Wambiji, N., P. Gwada, E. Fondo, S. Mwangi, and M. K. Osore. 2007. Preliminary results from a baseline survey of the port of mombasa: With focus on molluscs. 5th Western Indian Ocean Marine Science Association Scientific Symposium; Science, Policy and Management pressures and responses in the Western Indian Ocean region, Durban, South Africa.

Wardle, C. S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A. M. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21:1005-1027.

Weilgart, L. 2018. The impact of ocean noise pollution on fish and invertebrates. Report for OceanCare, Switzerland.

Weir, C. R. 2007. Observations of marine turtles in relation to seismic airgun sound off angola. Marine Turtle Newsletter 116:17-20.

Weishampel, J. F., D. A. Bagley, L. M. Ehrhart, and B. L. Rodenbeck. 2003. Spatiotemporal patterns of annual sea turtle nesting behaviors along an east central florida beach. Biological Conservation 110(2):295-303.

Wenz, G. M. 2005. Acoustic ambient noise in the ocean: Spectra and sources. The Journal of the Acoustical Society of America 34(12):1936-1956.

Wershoven, J. L., and R. W. Wershoven. 1992. Juvenile green turtles in their nearshore habitat of broward county, florida: A five year review. 11th Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS.

Wever, E. G., and J. A. Vernon. 1956. The sensitivity of the turtle's ear as shown by its electrical potentials. Proceedings of the National Academy of Sciences of the United States of America 42:213-222.

Wiggins, S. M., J. M. Hall, B. J. Thayre, and J. A. Hildebrand. 2016. Gulf of mexico low-frequency ocean soundscape impacted by airguns. The Journal of the Acoustical Society of America 140(1):176-183.

Wilcove, D. S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the united states. BioScience 48(8):607-615.

Witherington, B., M. Bresette, and R. Herren. 2006. Chelonia mydas–green turtle. Chelonian Research Monographs 3:90-104.

Witherington, B., and L. M. Ehrhart. 1989. Hypothermic stunning and mortality of marine turtles in the indian river lagoon system, florida. Copeia 1989:696-703.

Witherington, B., S. Hirama, and R. Hardy. 2012. Young sea turtles of the pelagic *sargassum*-dominated drift community: Habitat use, population density, and threats. Marine Ecology Progress Series 463:1–22.

Witherington, B. E. 2002. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a gulf stream front. Marine Biology 140(4):843-853.

Witt, M. J., E. Augowet Bonguno, A. C. Broderick, M. S. Coyne, A. Formia, A. Gibudi, G. A. Mounguengui Mounguengui, C. Moussounda, M. Nsafou, and S. Nougessono. 2011. Tracking leatherback turtles from the world's largest rookery: Assessing threats across the south atlantic. Proceedings of the Royal Society B: Biological Sciences 278(1716):2338-2347.

Witzell, W. N. 2002. Immature atlantic loggerhead turtles (caretta caretta): Suggested changes to the life history model. Herpetological Review 33(4):266-269.

Work, P. A., A. L. Sapp, D. W. Scott, and M. G. Dodd. 2010. Influence of small vessel operation and propulsion system on loggerhead sea turtle injuries. Journal of Experimental Marine Biology and Ecology 393(1-2):168-175.

Wright, A. 2014. Reducing impacts of noise from human activities on cetaceans: Knowledge gap analysis and recommendations.

Yudhana, A., Sunardi, J. Din, S. Abdullah, and R. B. R. Hassan. 2010. Turtle hearing capability based on abr signal assessment. Telkomnika 8:187- 194.

Zug, G. R., and R. E. Glor. 1998. Estimates of age and growth in a population of green sea turtles (chelonia mydas) from the indian river lagoon system, florida: A skeletochronological analysis. Canadian Journal of Zoology 76(8):1497-1506.

Zurita, J. C., R. Herrera, A. Arenas, M. E. Torres, C. Calderón, L. Gómez, J. C. Alvarado, and R. Villavicencia. 2003a. Nesting loggerhead and green sea turtles in quintana roo, mexico. Pages 25-127 *in* J. A. Seminoff, editor Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, Miami, Florida.

Zurita, J. C., R. Herrera, A. Arenas, M. E. Torres, C. Calderon, L. Gomez, J. C. Alvarado, and R. Villavicencio. 2003b. Nesting loggerhead and green sea turtles in quintana roo, mexico. Pages 125-126 *in* Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, Miami, FL.

Zwinenberg, A. J. 1977. Kemp's ridley, lepidochelys kempii (garman 1880), undoubtedly the most endangered marine turtle today (with notes on the current status of lepidochelys olivacea). Bulletin of the Maryland Herpetological Society 13(3):378-384.

APPENDIX F: INCIDENTAL HARASSMET 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 University of Texas at Austin (hereinafter, the Holder of the Authorization or Holder) 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 valid for one year from September 29, 2023 through September 28, 2024.

(2) This IHA authorizes take incidental to marine geophysical surveys, as specified in UT's IHA application, in coastal waters off of Texas.

(3) General Conditions

a. A copy of this IHA must be in the possession of the Holder, the vessel operator, other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of the Holder 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 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 amounts 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 that are not listed in Table 1 appear within or enter the Level B harassment zone (Table 2), the airgun array must be shut down.

e. The Holder must instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and must ensure that relevant vessel personnel and the protected species monitoring team participate in a joint onboard briefing (PSO briefing), led by the vessel operator and lead PSO, prior to beginning survey activities to ensure that responsibilities, communication procedures, protected species monitoring protocols, safety and operational procedures, and IHA requirements are clearly understood. This PSO briefing must be repeated when relevant new personnel (*e.g.*, PSOs, acoustic source operator) join the survey operations before work involving these personnel commences.

f. The airgun (hereinafter, the "acoustic source") must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. For use of airgun arrays, notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated volume exceeds notified operational capacity must be communicated to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(4) Mitigation Requirements

The Holder of this Authorization is required to implement the following mitigation measures:

a. Visual Monitoring

i. During survey operations (*e.g.*, any day on which use of the acoustic source is planned to occur, and whenever the acoustic source are 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).

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

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

iv. PSOs shall establish and monitor a pre-start clearance zone and, to the extent practicable, a Level B harassment zone (see Table 2). These zones shall be based upon the radial distance from the edges of the acoustic source (rather than being based on the center of the array or around the vessel itself).

v. The pre-start clearance zone is defined as follows: for all marine mammals listed in Table 1, the pre-start clearance zone encompasses the area at and below the sea surface out to a radius of 200 meters from the edges of the acoustic source. During pre-start clearance monitoring (i.e., before ramp-up begins), observations of any marine mammals within the pre-start clearance zone preclude acoustic source operations from beginning (i.e., ramp-up).

vi. Any observations of marine mammals by crew members shall be relayed to the PSO team.

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

viii. 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.

b. Pre-start clearance and Ramp-up

i. 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 pre-start clearance zone for 30 minutes prior to the initiation of ramp-up (pre-start clearance). During this 30 minute pre-start clearance period the entire zone must be visible, except as indicated in 4(b)(vii) below.

ii. Ramp-ups shall be scheduled so as to minimize the time spent with the source activated.

iii. A visual PSO conducting pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.

iv. Any PSO on duty has the authority to delay the start of survey operations if a marine mammal is detected within the pre-start clearance zone.

v. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that mitigation commands are conveyed swiftly while allowing PSOs to maintain watch.

vi. A ramp-up procedure must be followed at all times as part of the activation of the acoustic source, except as described under 4(b)(xi).

vii. Ramp-up may not be initiated if any marine mammal is within the pre-start clearance zone. If a marine mammal is observed within the pre-start clearance zone during the 30 minute pre-start clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zones or until an additional time period has elapsed with no further sightings (15 minutes for small delphinids (dolphins belonging to the genera of *Steno*, *Stenella*, or *Tursiops*) and 30 minutes for all other species).

viii. Ramp-up must begin by activating the first airgun for 5 minutes and then adding the second airgun.

ix. Once ramp-up has begun, observations of marine mammals for which take authorization is granted (Table 1) within the clearance zone do not require shutdown.

x. Ramp-up may occur at times of poor visibility, including nighttime, if appropriate visual monitoring has occurred with no detections of marine mammals in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at night where operational planning cannot reasonably avoid such circumstances.

xi. If the acoustic source is shut down for brief periods (i.e., less than 30 minutes) for reasons other than implementation of prescribed mitigation (e.g., mechanical difficulty), they may be activated again without ramp-up if PSOs have maintained constant visual observation and no detections of marine mammals have occurred within the clearance zone. For any longer shutdown, pre-start clearance observation and ramp-up are required.

xii. Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require a 30-minute pre-start clearance period.

c. Shutdown

i. 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 any harassment zone (Table 2).

d. Vessel strike avoidance

i. Crew and supply vessel personnel should use an appropriate reference guide that includes identifying information on all marine mammals that may be encountered. Vessel operators must comply with the below measures except under extraordinary circumstances when the safety of the vessel or crew is in doubt or the safety of life at sea is in question. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

ii. Vessel operators and crews 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 single marine mammal at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should always be exercised. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (species-specific distances detailed below), to ensure the potential for strike is minimized. 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 as a baleen whale, sperm whale, or other marine mammals.

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

iv. All vessels must maintain a minimum separation distance of 500 m from baleen whales. If a baleen whale is sighted within the relevant separation distance, the vessel must steer a course away at 10 knots or less until the 500-m separation distance has been established. If a whale is observed but cannot be confirmed as a species other than a baleen whale, the vessel operator must assume that it is a baleen whale and take appropriate action.

v. All vessels must maintain a minimum separation distance of 100 m from sperm whales.

vi. All vessels 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).

vii. When marine mammals are sighted while a vessel is underway, the vessel shall 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, reduce speed and shift the engine to neutral). This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

(5) Monitoring Requirements

Monitoring shall be conducted in accordance with the following requirements:

a. The Holder must use independent, dedicated, trained visual PSOs, meaning that the PSOs must be employed by a third-party observer provider, must have no 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 for geophysical surveys.

b. PSO names must be provided to NMFS by the Holder for review and confirmation of their approval for specific roles prior to commencement of the survey[1]. For prospective PSOs not previously approved or for PSOs whose approval is not current, NMFS must review and approve PSO qualifications. Resumes should include information related to

[1] PSO-related inquiries should be directed to *nmfs.psoreview@noaa.gov*.

relevant education, experience, and training, including dates, duration, location, and description of prior PSO experience. Resumes must be accompanied by relevant documentation of successful completion of necessary training.

c. 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.

d. PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics.

e. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests shall 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:

   i. Secondary education and/or experience comparable to PSO duties;

   ii. Previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or

   iii. Previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

f. At least one of the PSOs aboard the vessel must be unconditionally-approved[2]. One unconditionally-approved visual PSO shall be designated as the lead for the entire PSO team. This lead should typically be the PSO with the most experience, would coordinate duty schedules and roles for the PSO team[3], and serve as the primary point of contact for the vessel operator. To the maximum extent practicable, the duty schedule shall be planned such that unconditionally-approved PSOs are on duty with conditionally-approved PSOs.

g. The Holder 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, and to ensure that PSOs are capable of calibrating equipment as necessary for accurate distance estimates and species identification. Such equipment, at a minimum, must include:

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[2] NMFS may approve PSOs as conditional or unconditional. A conditionally-approved PSO may be one who is trained but has not yet attained the requisite tier- and region-specific experience. An unconditionally-approved PSO is one who has attained the necessary experience within the relevant region. For unconditional approval, the PSO must have a minimum of 90 days at sea performing the role (either visual or acoustic) at the particular Tier level (1-3), with the conclusion of the most recent relevant experience not more than 18 months previous.

[3] Responsibility for coordination of duty schedules and roles may be delegated, such as to a shore-based monitoring coordinator employed by the third-party observer provider.

i. At least one thermal (infrared) imaging device suited for the marine environment.

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

iii. Global Positioning Unit (GPS) (at least one plus backup).

iv. Digital cameras with a telephoto lens that is at least 300 mm or equivalent on a full-frame single lens reflex (SLR) (at least one plus backups). The camera or lens should also have an image stabilization system.

v. Equipment necessary for accurate measurement of distances to marine mammals.

vi. Compass (at least one plus backup)

vii. Means of communication among vessel crew and PSOs.

viii. Any other tools deemed necessary to adequately perform PSO tasks.

h. Data Collection

i. PSOs must use standardized electronic data forms to record data. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of marine mammals to the acoustic source 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 acoustic source. 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 3(d));

5. Visual monitoring equipment used (description); PSO location on vessel and height (meters) of observation location above water surface;

6. Watch status (description);

7. 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;

8. Vessel location (decimal degrees) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;

9. Vessel location (decimal degrees) at 30-second intervals if obtainable from data collection software, otherwise at practical regular interval;

10. Vessel heading (compass heading) and speed (knots) at beginning and end of visual PSO duty shifts and upon any change;

11. Water depth (meters) (if obtainable from data collection software);

12. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;

13. 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

14. Vessel/Survey activity information (and changes thereof) (description), such as acoustic source power output while in operation, number and volume of acoustic sources, tow depth of the acoustic sources, 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 and 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 (meters) and/or closest distance from any element of the acoustic source;

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 time of sighting (Visibility; Beaufort Sea State).

(6) <u>Reporting Requirements</u>

a. The Holder shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). The draft report shall also include geo-referenced time-stamped vessel tracklines for all time periods during which acoustic sources were operating. Tracklines should include points recording any change in acoustic source status (e.g., when the sources began operating, when they were turned off, or when they changed operational status such as from full array to single gun or vice versa). GIS files shall be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available. The report must summarize data collected as described above in *Data Collection*. A final report must be submitted within 30 days following resolution of any comments on the draft report.

b. Reporting injured or dead marine mammals:

i. Sighting of injured or dead marine mammal – In the event that personnel involved in the survey activities discover an injured or dead marine mammal, the Holder must report the incident to the Office of Protected Resources (OPR) (PR.ITP.MonitoringReports@noaa.gov), NMFS, and the NMFS Southeast Regional Stranding Coordinator (305-361-4586) 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 vessel strike of a marine mammal by any vessel involved in the activities covered by this authorization, the Holder must report the incident to OPR, NMFS and the Southeast Regional Stranding Coordinator 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 (e.g., reduction in pile size) 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.

______________________________ ____________________

For Kimberly Damon-Randall, Date
Director, Office of Protected Resources,
National Marine Fisheries Service.

Table 1. Numbers if Incidental Take of Marine Mammals Authorized

Species	Authorized Take by Level B Harassment
Atlantic spotted dolphin (*Stenella frontalis*)	26
Bottlenose dolphin (*Tursiops truncatus*)	2,676
Rough-toothed dolphin (*Steno bredanensis*)	28

Table 2. Level B Harassment Zones

Airgun Configuration	Water Depth (m)	Level B harassment zone (m)
Two 105 in^3 GI airguns, 210 in^3 total discharge	<100	1,750

integrated surveys. The 2022 AIES dress rehearsal and subsequent full-scale AIES collections are authorized by title 13 U.S.C. 131, 182, and 193. Response to the dress rehearsal and the AIES is mandatory per sections 224 and 225 of title 13 U.S.C. All information collected will be kept confidential, consistent with the provisions of title 13 U.S.C. 9.

The AIES covers all domestic, private, non-farm employer businesses headquartered in the U.S. as defined by the 2017 North American Industry Classification System (NAICS). Exclusions are most foreign operations of U.S. businesses and most government operations (including the U.S. Postal Service), agricultural production companies, and private households. The AIES sample is selected from a frame of approximately 5.4 million companies constructed from the Business Register (BR), which is the Census Bureau's master business list. The 2022 AIES dress rehearsal will sample approximately 8,500 employer businesses and the full-scale AIES will sample approximately 385,000 employer businesses. Of the 385,000 employer businesses, the Census Bureau will select approximately 36,500 companies with 100% probability, based on the complexity of their operations. The remaining companies in the frame will be stratified within sector by geographic category within 3-digit industry NAICS classification. This is an unequal probability sample, with company inclusion probabilities accounting for contribution(s) to both national and subnational estimates of annual payroll.

The AIES estimates will include data on employment; revenue including sales; shipments; receipts; revenue by class of customer; sources of revenue; taxes, contributions; gifts and grants; products; e-commerce activity; operating expenses including purchased services; payroll; benefits; rental payments; utilities; interest; resales; equipment; materials and supplies; research and development; other detailed operating expenses; and assets which includes capital expenditures; inventories; depreciable assets; and robotics.

The AIES will provide continuous and timely national and subnational statistical data on the economy. Government program officials, industry organization leaders, economic and social analysts, business entrepreneurs, and domestic and foreign researchers in academia, business, and government will use statistics from AIES. More details on expected uses of the statistics from the AIES are found in the 30-Day Notice for the AIES (88 FR 19906; April 4, 2023).

Public Comments: The Census Bureau published a Notice of Consideration in the **Federal Register** on November 4, 2022 (87 FR 66643) giving notice that it was considering a proposal to conduct the AIES. No comments were received in response to that notice. The Census Bureau subsequently published a Notice in the **Federal Register** on April 4, 2023 (88 FR 19906), which invited comment on the information collection request associated with the AIES. Census received one comment on that latter notice. The commenter agreed that the AIES should reduce respondent burden, increase data quality, and allow greater operational efficiencies. In addition, the commenter supported situations where the AIES may include new questions each year on policy-relevant topics such as technological advances, management and business practices, exporting practices, and globalization. The commenter also requested that Census be required to carry out additional research to ensure a reduction in NAICS code misclassification among survey respondents.

Census Bureau Response to the Public Comment: The Census Bureau supports conducting additional research and identifying opportunities to reduce NAICS misclassification. However, this effort is outside the scope of this action, research should be conducted on a larger-scale and not confined to the AIES. NAICS classification for companies selected in the AIES is driven by the Economic Census and the Census Bureau's BR. The Census Bureau is participating in discussions that are underway regarding a Federal statistical agency ''data synchronization'' effort across multiple agencies. The Census Bureau agrees to provide a research plan to address NAICS misclassification issues within one year of ICR approval.

OMB Terms of Clearance: OMB approved the 2022 AIES dress rehearsal portion of the Annual Integrated Economic Survey (AIES), including all relevant testing aspects. Prior to conducting the full-scale AIES, the Census Bureau will consult with OMB to determine next steps for clearing the full-scale AIES. In addition, in light of the Census Bureau's finding in Supporting Statement Part B ''that NAICS classifications can be unnatural or challenging for some businesses,'' the Census Bureau within 1 year of this clearance shall provide OMB a research plan (and relevant research updates) to address such NAICS classification issues. This research plan will include ways the Census Bureau plans to estimate the percentage of respondents across collections that select an incorrect NAICS code; how the Census Bureau plans to estimate the extent and source of differences in NAICS code assignments by the Census Bureau and the Bureau of Labor Statistics for the same establishments; and possible approaches the Census Bureau could take to reduce NAICS misclassification.

Paperwork Reduction Act

Notwithstanding any other provision of law, no person is required to respond to, nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act (PRA) unless that collection of information displays a currently valid Office of Management and Budget (OMB) control number. In accordance with the PRA, 44 U.S.C., Chapter 45, OMB approved the AIES under the OMB control number 0607–1024.

Based upon the foregoing, I have directed that the Annual Integrated Economic Survey be conducted for the purpose of collecting these data.

Robert L. Santos, Director, Census Bureau, approved the publication of this Notice in the **Federal Register**.

Dated: August 3, 2023.

Shannon Wink,

Program Analyst, Policy Coordination Office, U.S. Census Bureau.

[FR Doc. 2023–16926 Filed 8–7–23; 8:45 am]

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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XC993]

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey in Coastal Waters Off of Texas

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; proposed incidental harassment authorization; request for comments on proposed authorization and possible renewal.

SUMMARY: NMFS has received a request from the University of Texas at Austin (UT) for authorization to take marine mammals incidental to a marine geophysical survey in coastal waters off of Texas. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal

to issue an incidental harassment authorization (IHA) to incidentally take marine mammals during the specified activities. NMFS is also requesting comments on a possible one-time, 1-year renewal that could be issued under certain circumstances and if all requirements are met, as described in Request for Public Comments at the end of this notice. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorization and agency responses will be summarized in the final notice of our decision.

DATES: Comments and information must be received no later than September 7, 2023.

ADDRESSES: Comments should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, NMFS and should be submitted via email to *ITP.Wachtendonk@noaa.gov.* Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities.* In case of problems accessing these documents, please call the contact listed above.

Instructions: NMFS is not responsible for comments sent by any other method, to any other address or individual, or received after the end of the comment period. Comments, including all attachments, must not exceed a 25-megabyte file size. All comments received are a part of the public record and will generally be posted online at *www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities* without change. All personal identifying information (*e.g.,* name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Rachel Wachtendonk, Office of Protected Resources, NMFS, (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Background

The MMPA prohibits the ''take'' of marine mammals, with certain exceptions. Section 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) directs the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are proposed or, if the taking is limited to harassment, a notice of a proposed IHA is provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other ''means of effecting the least practicable adverse impact'' on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stocks for taking for certain subsistence uses (referred to in shorthand as ''mitigation''); and requirements pertaining to the mitigation, monitoring and reporting of the takings are set forth. The definitions of all applicable MMPA statutory terms cited above are included in the relevant sections below.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216–6A, NMFS must review our proposed action (*i.e.,* the issuance of an IHA) with respect to potential impacts on the human environment. This action is consistent with categories of activities identified in Categorical Exclusion B4 (IHAs with no anticipated serious injury or mortality) of the Companion Manual for NOAA Administrative Order 216–6A, which do not individually or cumulatively have the potential for significant impacts on the quality of the human environment and for which we have not identified any extraordinary circumstances that would preclude this categorical exclusion. Accordingly, NMFS has preliminarily determined that the issuance of the proposed IHA qualifies to be categorically excluded from further NEPA review. We will review all comments submitted in response to this notice prior to concluding our NEPA process or making a final decision on the IHA request.

Summary of Request

On March 7, 2023, NMFS received a request from UT for an IHA to take marine mammals incidental to conducting a marine geophysical survey in coastal waters off of Texas. Following NMFS' review of the application, UT submitted a revised version on April 25, 2023. The application was deemed adequate and complete on April 27, 2023. UT's request is for take of bottlenose dolphins, Atlantic spotted dolphins, and rough-toothed dolphin by Level B harassment only. Neither UT nor NMFS expect serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

Description of Proposed Activity

Overview

UT proposes to conduct a marine geophysical survey, specifically a low energy seismic survey, in coastal waters off of Texas during a 10 day period in the fall of 2023. The survey would take place in coastal waters off of Texas, in water depths of less than 20 meters (m). To complete this survey the vessel would tow one to two Generator-Injector (GI) airguns, each with a volume of 105 cubic inch (in^3; 1,721 cubic cm (cm^3)), for a total volume of 210 in^3 (3,441 cm^3). The airguns would be deployed at a depth of about 4 m below the surface, spaced about 2 m apart, while the receiving system consists of four 25 m hydrophone streamers towed at a depth of about 2 m.

The purpose of the proposed survey is to validate novel dynamic positioning technology for improving the accuracy in time and space of high resolution 3-dimensional (HR3D) seismic datasets, in particular as it pertains to field technology of offshore carbon capture systems.

Dates and Duration

The proposed survey is planned to occur over a 10 day period during the fall of 2023 (the exact dates are uncertain). During that time, the airguns would operate continuously (*i.e.,* 24-hours per day).

Specific Geographic Region

The proposed survey area is 222 km2 and would occur within the approximate area of 28.9–29.1° N latitude, 94.9–95.2° W longitude in the coastal waters off of Texas. This location is offshore San Luis Pass, which defines the southern tip of Galveston Island, Texas. The closest point of approach of the proposed survey area to the coast is approximately 3 kilometers (km). The proposed survey area is depicted in Figure 1, and the survey lines could occur anywhere within the survey area. The water depth of the proposed survey area ranges from 10 to 20 m. The survey vessel (the R/V Brooks McCall (McCall) or similar vessel operated by TDI-Brooks

International) would likely depart and return to Freeport or Galveston, Texas.

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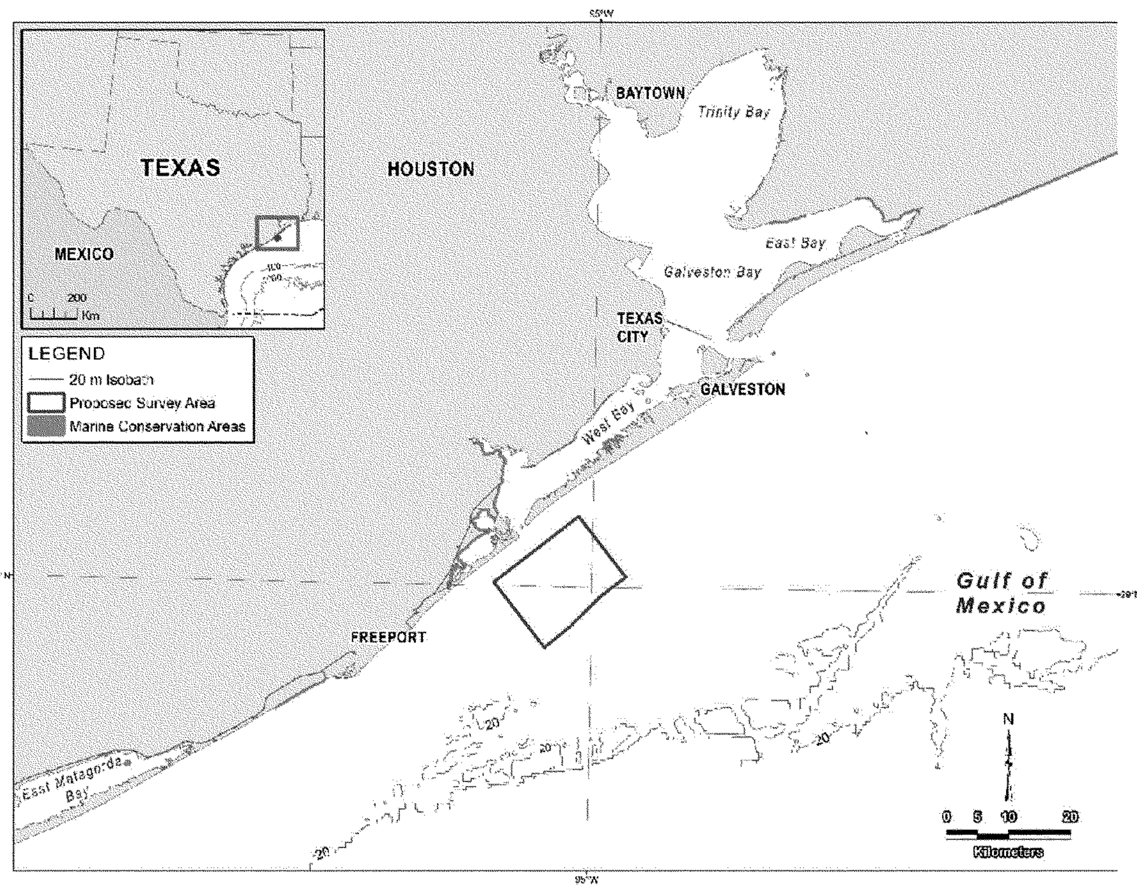

Figure 1-- Location of the Proposed Northwest Gulf of Mexico Survey.
Note: Survey tracklines could occur anywhere within the proposed survey area.

BILLING CODE 3510–22–C

Detailed Description of the Specified Activity

The proposed survey would entail use of conventional seismic methodology. The survey would involve one source vessel, the McCall or similar, and would tow one or two 105 in^3 GI airguns with a total volume of up to 210 in^3. The airgun array would be deployed at a depth of about 4 m below the surface, spaced about 2 m apart, and have a shot interval of 12.5 m about 5–10 seconds (s)). The receiving system would consist of four 25 m solid state hydrophone streamers, spaced 10 m apart and towed at a depth of 2 m. As the airguns are towed along the survey lines, the hydrophone streamer would transfer data to the on-board processing system. Approximately 1,704 km of transect lines would be surveyed within the survey area. When not towing seismic survey gear, the McCall has a maximum speed of 11 knots (kn; 20.4 kilometers per hour (kmh)), but cruises at an average speed of 4–5 kn (7.4–9.3 kmh) while towing airgun arrays. All survey effort would occur in water 10–20 m. The vessel would be self-contained, and the crew would live aboard the vessel.

Proposed mitigation, monitoring, and reporting measures are described in detail later in this Notice (please see Proposed Mitigation and Proposed Monitoring and Reporting).

Description of Marine Mammals in the Area of Specified Activities

Sections 3 and 4 of the application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species. NMFS fully considered all of this information, and we refer the reader to these descriptions, instead of reprinting the information. Additional information regarding population trends and threats may be found in NMFS' Stock Assessment Reports (SARs; *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*) and more general information about these species (*e.g.,* physical and behavioral descriptions) may be found on NMFS' website (*https://www.fisheries.noaa.gov/find-species).*

Table 1 lists all species or stocks for which take is expected and proposed to be authorized for this activity and summarizes information related to the population or stock, including regulatory status under the MMPA and Endangered Species Act (ESA) and potential biological removal (PBR), where known. PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (as described in NMFS' SARs). While no serious injury or mortality is anticipated or proposed to be authorized here, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species or stocks and other threats.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS' stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS' U.S. Atlantic and Gulf of Mexico SARs. All values presented in Table 1 are the most recent available at the time of publication (including from the draft 2022 SARs) and are available online at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.*

TABLE 1—SPECIES LIKELY IMPACTED BY THE SPECIFIED ACTIVITIES [1]

Common name	Scientific name	Stock	ESA/MMPA status; strategic (Y/N) [2]	Stock abundance (CV, N_{min}, most recent abundance survey) [3]	PBR	Annual M/SI [4]	Gulf of Mexico population abundance; (Roberts *et al.* 2016) [5]
Odontoceti (toothed whales, dolphins, and porpoises)							
Family Delphinidae:							
Atlantic spotted dolphin.	*Stenella frontalis*	Gulf of Mexico	-/-; N	21,506 (0.26; 17,339; 2018).	166	36	47,488
Rough-toothed dolphin.	*Steno bredanensis*	Gulf of Mexico	-/-; N	unk (n/a; unk; 2018)	undetermined	39	4,853
Bottlenose dolphin	*Tursiops truncatus*	Gulf of Mexico Western Coastal.	-/-; N	20,759 (0.13; 18,585; 2018).	167	36	138,602
		Northern Gulf of Mexico Continental Shelf.	-/-; N	63,280 (0.11; 57,917; 2018).	556	65	138,602

[1] Information on the classification of marine mammal species can be found on the web page for The Society for Marine Mammalogy's Committee on Taxonomy (*https://marinemammalscience.org/science-and-publications/list-marine-mammal-species-subspecies/;* Committee on Taxonomy (2022)).

[2] ESA status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.

[3] NMFS marine mammal stock assessment reports online at: *www.nmfs.noaa.gov/pr/sars/.* CV is coefficient of variation; Nmin is the minimum estimate of stock abundance.

[4] These values, found in NMFS's SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g.,* commercial fisheries, vessel strike). Annual M/SI (mortality/serious injury) often cannot be determined precisely and is in some cases presented as a minimum value or range.

As indicated above, all 3 species (with 4 managed stocks) in Table 1 temporally and spatially co-occur with the activity to the degree that take is reasonably likely to occur. All species that could potentially occur in the proposed survey areas are included in Table 2 of the IHA application. While the additional 11 species listed in Table 2 of UT's application have been infrequently sighted in the survey area, the temporal and/or spatial occurrence of these species is such that take is not expected to occur, and they are not discussed further beyond the explanation provided here. Species or stocks that only occur in deep waters (>200 m) within the Gulf of Mexico are unlikely to be observed during this survey where the maximum water depth is 20 m, and thus, the following species or stocks will not be considered further: offshore stock of bottlenose dolphins, pantropical spotted dolphin, spinner dolphin, striped dolphin, Clymene dolphin, Fraser's dolphin, Risso's dolphin, melon-headed whale, pygmy killer whale, false killer whale, killer whale, and short-finned pilot whale.

Bottlenose Dolphin

Bottlenose dolphins are cosmopolitan, occurring in tropical, subtropical, and temperate waters around the world (Wells and Scott 2018). The bottlenose dolphin is the most widespread and common delphinid in coastal waters of the Gulf of Mexico (Würsig *et al.* 2000; Würsig 2017). While there are multiple stocks of bottlenose dolphins in the Gulf of Mexico, only the Northern Gulf of Mexico Continental Shelf and Gulf of Mexico Western Coastal stocks overlap with the study area, with the shelf stock assumed to occur in waters >20 m and the coastal stock assumed to occur in waters <20 m. Fall sightings have been made throughout the northern Gulf but primarily on the shelf, including within survey waters.

There are 31 bay, sound, and estuary (BSE) stocks in the northern Gulf of Mexico, which are small, resident populations of bottlenose dolphins that live inshore or, occasionally, close to shore or in passes, and are genetically discrete. There are two of the BSE stocks that occur near the survey area, the West Bay stock and the Galveston Bay/East Bay/Trinity Bay stock. The West Bay stock occurs within roughly 20 km of the survey area, but individuals from this stock are only likely to occur in inshore waters or, occasionally, up to 1 km from shore off San Luis Pass (Hayes *et al.* 2022). The Galveston Bay/East Bay/Trinity Bay stock occurs >20 km away, with most individuals staying within 2 km from shore and up to 5 km out from the Galveston jetties and ship channel (Hayes *et al.* 2022). These areas in and near West Bay and Galveston Bay, along with numerous other ones along the coast of Texas, have been identified as year-round Biologically Important Areas (BIAs) for resident bottlenose dolphins (LeBresque *et al.* 2015). Due to the distance that the survey will occur off the coast (minimum 3 km) and general expectation that BSE dolphins are most likely to occur in inshore waters, we do not expect the survey to encounter any BSE stocks of bottlenose dolphins.

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007, 2019) recommended that marine mammals be divided into hearing groups based on directly measured (behavioral or auditory evoked potential techniques) or estimated hearing ranges (behavioral response data, anatomical modeling, etc.). Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65-decibel (dB) threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. Marine mammal hearing groups and their associated hearing ranges are provided in Table 2.

TABLE 2—MARINE MAMMAL HEARING GROUPS

[NMFS, 2018]

Hearing group	Generalized hearing range *
Low-frequency (LF) cetaceans (baleen whales)	7 hertz (Hz) to 35 kilohertz (kHz).
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz.
High-frequency (HF) cetaceans (true porpoises, *Kogia,* river dolphins, Cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*).	275 Hz to 160 kHz.
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz.
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz.

* Represents the generalized hearing range for the entire group as a composite (*i.e.,* all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall *et al.* 2007) and PW pinniped (approximation).

The pinniped functional hearing group was modified from Southall *et al.* (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al.,* 2006; Kastelein *et al.,* 2009; Reichmuth and Holt, 2013).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information.

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section provides a discussion of the ways in which components of the specified activity may impact marine mammals and their habitat. The Estimated Take of Marine Mammals section later in this document includes a quantitative analysis of the number of individuals that are expected to be taken by this activity. The Negligible Impact Analysis and Determination section considers the content of this section, the Estimated Take of Marine Mammals section, and the Proposed Mitigation section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and whether those impacts are reasonably expected to, or reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

Description of Active Acoustic Sound Sources

This section contains a brief technical background on sound, the characteristics of certain sound types, and on metrics used in this proposal inasmuch as the information is relevant to the specified activity and to a discussion of the potential effects of the specified activity on marine mammals found later in this document.

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the ''loudness'' of a sound and is typically described using the relative unit of the dB. A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 microPascal (μPa)) and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source (referenced to 1 μPa) while the received level is the SPL at the listener's position (referenced to 1 μPa).

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Root mean square is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1983). Root mean square accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Sound exposure level (SEL; represented as dB re 1 μPa^2 -s) represents the total energy contained within a pulse and considers both intensity and duration of exposure. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-p) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source and is represented in the same units as the rms sound pressure. Another common metric is peak-to-peak sound pressure (pk-pk), which is the algebraic difference between the peak positive and peak negative sound pressures. Peak-to-peak pressure is typically approximately 6 dB higher than peak pressure (Southall *et al.,* 2007).

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for pulses produced by the airgun arrays considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound. Ambient sound is defined as environmental background sound levels lacking a single source or point (Richardson *et al.,* 1995), and the sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (*e.g.,* wind and waves, earthquakes, ice, atmospheric sound), biological (*e.g.,* sounds produced by marine mammals, fish, and invertebrates), and anthropogenic (*e.g.,* vessels, dredging, construction) sound. A number of sources contribute to ambient sound, including the following (Richardson *et al.,* 1995):

- *Wind and waves:* The complex interactions between wind and water surface, including processes such as breaking waves and wave-induced bubble oscillations and cavitation, are a main source of naturally occurring ambient sound for frequencies between 200 Hz and 50 kHz (Mitson, 1995). In general, ambient sound levels tend to increase with increasing wind speed and wave height. Surf sound becomes important near shore, with measurements collected at a distance of 8.5 km from shore showing an increase of 10 dB in the 100 to 700 Hz band during heavy surf conditions;
- *Precipitation:* Sound from rain and hail impacting the water surface can become an important component of total sound at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times;
- *Biological:* Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz; and
- *Anthropogenic:* Sources of ambient sound related to human activity include transportation (surface vessels), dredging and construction, oil and gas drilling and production, seismic surveys, sonar, explosions, and ocean acoustic studies. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly. Sound from identifiable anthropogenic sources other than the activity of interest (*e.g.,* a passing vessel) is sometimes termed background sound, as opposed to ambient sound.

The sum of the various natural and anthropogenic sound sources at any given location and time—which comprise ''ambient'' or ''background'' sound—depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of this dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10–20 dB from day to day (Richardson *et al.,* 1995). The result is that, depending on the source type and its intensity, sound from a given activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals. Details of source types are described in the following text.

Sounds are often considered to fall into one of two general types: Pulsed and non-pulsed (defined in the following). The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.,* Ward, 1997 in Southall *et al.,* 2007). Please see Southall *et al.,* (2007) for an in-depth discussion of these concepts.

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

Non-pulsed sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous (ANSI, 1995; NIOSH, 1998). Some of these non-pulsed sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.,* rapid rise time). Examples of non-pulsed sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems (such as those used by the U.S. Navy). The duration of such sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

Airgun arrays produce pulsed signals with energy in a frequency range from about 10–2,000 Hz, with most energy radiated at frequencies below 200 Hz. The amplitude of the acoustic wave emitted from the source is equal in all directions (*i.e.,* omnidirectional), but airgun arrays do possess some directionality due to different phase delays between guns in different directions. Airgun arrays are typically tuned to maximize functionality for data acquisition purposes, meaning that sound transmitted in horizontal directions and at higher frequencies is minimized to the extent possible.

Acoustic Effects

Here, we discuss the effects of active acoustic sources on marine mammals.

Potential Effects of Underwater Sound—Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can potentially result in one or more of the following: Temporary or permanent hearing impairment; non-auditory physical or physiological effects; behavioral disturbance; stress; and masking (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007; Götz *et al.,* 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing, if it occurs at all, will occur almost exclusively in cases where a noise is within an animal's hearing frequency range. We first describe specific manifestations of acoustic effects before providing discussion specific to the use of airgun arrays.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological response. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.,* when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

We describe the more severe effects of certain non-auditory physical or physiological effects only briefly as we do not expect that use of airgun arrays are reasonably likely to result in such effects (see below for further discussion). Potential effects from impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.,* 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.,* change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007; Zimmer and Tyack, 2007; Tal *et al.,* 2015). The survey activities considered here do not involve the use of devices such as explosives or mid-frequency tactical sonar that are associated with these types of effects.

Threshold Shift—Marine mammals exposed to high-intensity sound or to lower-intensity sound for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Finneran, 2015). Threshold shift can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall *et al.,* 2007). Repeated sound exposure that leads to TTS could cause PTS. In severe cases of PTS, there can be total or partial deafness while in most cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985).

When PTS occurs, there is physical damage to the sound receptors in the ear (*i.e.,* tissue damage) whereas TTS represents primarily tissue fatigue and is reversible (Southall *et al.,* 2007). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.,* Ward, 1997). Therefore, NMFS does not typically consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals. There is no PTS data for cetaceans, but such relationships are assumed to be similar to those in humans and other terrestrial mammals. PTS typically occurs at exposure levels at least several dBs above (a 40-dB threshold shift approximates PTS onset; *e.g.,* Kryter *et al.,* 1966; Miller, 1974) that inducing mild TTS (a 6-dB threshold shift approximates TTS onset; *e.g.,* Southall *et al.* 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds for impulse sounds (such as airgun pulses as received close to the source) are at least 6 dB higher than the TTS threshold on a peak-pressure basis and PTS cumulative sound exposure level thresholds are 15 to 20 dB higher than TTS cumulative sound exposure level thresholds (Southall *et al.,* 2007). Given the higher level of sound or longer exposure duration necessary to cause PTS as compared with TTS, it is considerably less likely that PTS could occur.

For mid-frequency cetaceans in particular, potential protective mechanisms may help limit onset of TTS or prevent onset of PTS. Such mechanisms include dampening of hearing, auditory adaptation, or behavioral amelioration (*e.g.,* Nachtigall and Supin, 2013; Miller *et al.,* 2012; Finneran *et al.,* 2015; Popov *et al.,* 2016).

TTS is the mildest form of hearing impairment that can occur during exposure to sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard. In terrestrial and marine mammals, TTS can last from minutes or hours to days (in cases of strong TTS). In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals.

Marine mammal hearing plays a critical role in communication with other members of the species and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.,* recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother and calf interactions could have more serious impacts.

Finneran *et al.* (2015) measured hearing thresholds in three captive bottlenose dolphins before and after exposure to 10 pulses produced by a seismic airgun in order to study TTS induced after exposure to multiple pulses. Exposures began at relatively low levels and gradually increased over a period of several months, with the highest exposures at peak SPLs from 196 to 210 dB and cumulative (unweighted) SELs from 193–195 dB. No substantial TTS was observed. In addition, behavioral reactions were observed that indicated that animals can learn behaviors that effectively mitigate noise exposures (although exposure patterns must be learned, which is less likely in wild animals than for the captive animals considered in this study). The authors noted that the failure to induce more significant auditory effects was likely due to the intermittent nature of exposure, the relatively low peak pressure produced by the acoustic source, and the low-frequency energy in airgun pulses as compared with the frequency range of best sensitivity for dolphins and other mid-frequency cetaceans.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale, harbor porpoise, and Yangtze finless porpoise) exposed to a limited number of sound sources (*i.e.,* mostly tones and octave-band noise) in laboratory settings (Finneran, 2015). The existing marine mammal TTS data come from a limited number of individuals within these species.

Critical questions remain regarding the rate of TTS growth and recovery after exposure to intermittent noise and the effects of single and multiple pulses. Data at present are also insufficient to construct generalized models for recovery and determine the time necessary to treat subsequent exposures as independent events. More information is needed on the relationship between auditory evoked potential and behavioral measures of TTS for various stimuli. For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see Southall *et al.* (2007, 2019), Finneran and Jenkins (2012), Finneran (2015), and NMFS (2018).

Behavioral Effects—Behavioral disturbance may include a variety of effects, including subtle changes in behavior (*e.g.,* minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Behavioral responses to sound are highly variable and context-specific, and any reactions depend on numerous intrinsic and extrinsic factors (*e.g.,* species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day), as well as the interplay between factors (*e.g.,* Richardson *et al.,* 1995; Wartzok *et al.,* 2003; Southall *et al.,* 2007, 2019; Weilgart, 2007; Archer *et al.,* 2010). Behavioral reactions can vary not only among individuals but also within an individual, depending on previous experience with a sound source, context, and numerous other factors (Ellison *et al.,* 2012), and can vary depending on characteristics associated with the sound source (*e.g.,* whether it is moving or stationary, number of sources, distance from the source). Please see Appendices B–C of Southall *et al.* (2007) for a review of studies involving marine mammal behavioral responses to sound.

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.,* 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a ''progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial,'' rather than as, more generally, moderation in response to human disturbance (Bejder *et al.,* 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. As noted, behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al.,* 1995; NRC, 2003; Wartzok *et al.,* 2003). Controlled experiments with captive marine mammals have showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway *et al.,* 1997). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; see also Richardson *et al.,* 1995; Nowacek *et al.,* 2007). However, many delphinids approach acoustic source vessels with no apparent discomfort or obvious behavioral change (*e.g.,* Barkaszi *et al.,* 2012).

Available studies show wide variation in response to underwater sound; therefore, it is difficult to predict specifically how any given sound in a particular instance might affect marine mammals perceiving the signal. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (*e.g.,* Lusseau and Bejder, 2007; Weilgart, 2007; NRC, 2005). However, there are broad categories of potential response, which we describe in greater detail here, that include alteration of dive behavior, alteration of foraging behavior, effects to breathing, interference with or alteration of vocalization, avoidance, and flight.

Changes in dive behavior can vary widely, and may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.,* Frankel and Clark, 2000; Ng and Leung, 2003; Nowacek *et al.,* 2004; Goldbogen *et al.,* 2013a, b). Variations in dive behavior may reflect disruptions in biologically significant activities (*e.g.,* foraging) or they may be of little biological significance. The impact of an alteration to dive behavior resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.,* bubble nets or sediment plumes), or changes in dive behavior. As for other types of behavioral response, the frequency, duration, and temporal pattern of signal presentation, as well as differences in species sensitivity, are likely contributing factors to differences in response in any given circumstance (*e.g.,* Croll *et al.,* 2001; Nowacek *et al.,* 2004; Madsen *et al.,* 2006; Yazvenko *et al.,* 2007). A determination of whether foraging disruptions incur fitness consequences would require information on or estimates of the energetic requirements of the affected individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Variations in respiration naturally vary with different behaviors and alterations to breathing rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Various studies have shown that respiration rates may either be unaffected or could increase, depending on the species and signal characteristics, again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure (*e.g.,* Kastelein *et al.,* 2001, 2005, 2006; Gailey *et al.,* 2007, 2016).

Marine mammals vocalize for different purposes and across multiple modes, such as whistling, echolocation click production, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result from a need to compete with an increase in background noise or may reflect increased vigilance or a startle response. In some cases, animals may cease sound production during production of aversive signals (Bowles *et al.,* 1994).

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of sound or other stressors and is one of the most obvious manifestations of disturbance in marine mammals (Richardson *et al.,* 1995). Avoidance may be short-term, with animals returning to the area once the noise has ceased (*e.g.,* Bowles *et al.,* 1994; Goold, 1996; Stone *et al.,* 2000; Morton and Symonds, 2002; Gailey *et al.,* 2007). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.,* Bejder *et al.,* 2006; Teilmann *et al.,* 2006).

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. The flight response differs from other avoidance responses in the intensity of the response (*e.g.,* directed movement, rate of travel). Relatively little information on flight responses of marine mammals to anthropogenic signals exist, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996). The result of a flight response could range from brief, temporary exertion and displacement from the area where the signal provokes flight to, in extreme cases, marine mammal strandings (Evans and England, 2001). However, it should be noted that response to a perceived predator does not necessarily invoke flight (Ford and Reeves, 2008), and whether individuals are solitary or in groups may influence the response.

Behavioral disturbance can also impact marine mammals in more subtle ways. Increased vigilance may result in costs related to diversion of focus and attention (*i.e.,* when a response consists of increased vigilance, it may come at the cost of decreased attention to other critical behaviors such as foraging or resting). These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (*e.g.,* Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002; Purser and Radford, 2011). In addition, chronic disturbance can cause population declines through reduction of fitness (*e.g.,* decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g.,* Harrington and Veitch, 1992; Daan *et al.,* 1996; Bradshaw *et al.,* 1998). However, Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five-day period did not cause any sleep deprivation or stress effects.

Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Disruption of such functions resulting from reactions to stressors, such as sound exposure, are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than 1 day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). Note that there is a difference between multi-day substantive behavioral reactions and multi-day anthropogenic activities. For example, just because an activity lasts for multiple days does not necessarily mean that individual animals are either exposed to activity-related stressors for multiple days or, further, exposed in a manner resulting in sustained multi-day substantive behavioral responses.

Stone (2015) reported data from at-sea observations during 1,196 seismic surveys from 1994 to 2010. When arrays of large airguns (considered to be 500 in^3 or more) were firing, lateral displacement, more localized avoidance, or other changes in behavior were evident for most odontocetes.

Stress Responses—An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (*e.g.,* Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Neuroendocrine stress responses often involve the hypothalamus-pituitary-adrenal system. Virtually all neuroendocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction, altered metabolism, reduced immune competence, and behavioral disturbance (*e.g.,* Moberg, 1987; Blecha, 2000). Increases in the circulation of glucocorticoids are also equated with stress (Romano *et al.,* 2004).

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

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well-studied through controlled experiments and for both laboratory and free-ranging animals (*e.g.,* Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker, 2000; Romano *et al.,* 2002b) and, more rarely, studied in wild populations (*e.g.,* Romano *et al.,* 2002a). In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003).

Auditory Masking—Sound can disrupt behavior through masking or interfering with an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.,* those used for intraspecific communication and social interactions, prey detection, predator avoidance, navigation) (Richardson *et al.,* 1995; Erbe *et al.,* 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.,* snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.,* shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.,* signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.,* sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age or TTS hearing loss), and existing ambient noise and propagation conditions.

Under certain circumstances, significant masking could disrupt behavioral patterns, which in turn could affect fitness for survival and reproduction. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without resulting in TS) is not associated with abnormal physiological function, it is not considered a physiological effect but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in predicting any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (*e.g.,* Clark *et al.,* 2009) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.,* Miller *et al.,* 2000; Foote *et al.,* 2004; Parks *et al.,* 2007; Di Iorio and Clark, 2009; Holt *et al.,* 2009). Masking may be less in situations where the signal and noise come from different directions (Richardson *et al.,* 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.,* Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.,* Branstetter *et al.,* 2013).

Masking affects both senders and receivers of acoustic signals and can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.,* from vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (*e.g.,* Simard *et al.* 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (*e.g.,* Gedamke 2011; Guerra *et al.,* 2011, 2016; Klinck *et al.,* 2012; Guan *et al.,* 2015), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. Guerra *et al.* (2016) reported that ambient noise levels between seismic pulses were elevated as a result of reverberation at ranges of 50 km from the seismic source.

The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Vessel Noise

Vessel noise from the McCall could affect marine animals in the proposed survey areas. Houghton *et al.* (2015) proposed that vessel speed is the most important predictor of received noise levels, and Putland *et al.* (2017) also reported reduced sound levels with decreased vessel speed. Sounds produced by large vessels generally dominate ambient noise at frequencies from 20 to 300 Hz (Richardson *et al.,* 1995). However, some energy is also produced at higher frequencies (Hermannsen *et al.,* 2014); low levels of high-frequency sound from vessels has been shown to elicit responses in harbor porpoise (Dyndo *et al.,* 2015). Increased levels of vessel noise have been shown to affect foraging by porpoise (Teilmann *et al.,* 2015; Wisniewska *et al.,* 2018); Wisniewska *et al.* (2018) suggested that a decrease in foraging success could have long-term fitness consequences.

Vessel noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (*e.g.,* Richardson *et al.* 1995; Clark *et al.,* 2009; Jensen *et al.,* 2009; Gervaise *et al.,* 2012; Hatch *et al.,* 2012; Rice *et al.,* 2014; Dunlop 2015; Erbe *et al.,* 2015; Jones *et al.,* 2017; Putland *et al.,* 2017). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (Branstetter *et al.,* 2013, 2016; Finneran and Branstetter 2013; Sills *et al.,* 2017). Branstetter *et al.* (2013) reported that time-domain metrics are also important in describing and predicting masking. In order to compensate for increased ambient noise, some cetaceans are known to increase the source levels of their calls in the presence of elevated noise levels from shipping, shift their peak frequencies, or otherwise change their vocal behavior (*e.g.,* Martins *et al.,* 2016; O'Brien *et al.,* 2016; Tenessen and Parks 2016). Harp seals did not increase their call frequencies in environments with increased low-frequency sounds (Terhune and Bosker 2016). Holt *et al.* (2015) reported that changes in vocal modifications can have increased energetic costs for individual marine mammals. A negative correlation between the presence of some cetacean species and the number of vessels in an area has been demonstrated by several studies (*e.g.,* Campana *et al.,* 2015; Culloch *et al.,* 2016).

Many odontocetes show considerable tolerance of vessel traffic, although they sometimes react at long distances if confined by ice or shallow water, if previously harassed by vessels, or have had little or no recent exposure to vessels (Richardson *et al.,* 1995). Dolphins of many species tolerate and sometimes approach vessels (*e.g.,* Anderwald *et al.,* 2013). Some dolphin species approach moving vessels to ride the bow or stern waves (Williams *et al.,* 1992). Pirotta *et al.* (2015) noted that the physical presence of vessels, not just vessel noise, disturbed the foraging activity of bottlenose dolphins. Sightings of striped dolphin, Risso's dolphin, sperm whale, and Cuvier's beaked whale in the western Mediterranean were negatively correlated with the number of vessels in the area (Campana *et al.,* 2015).

Sounds emitted by the McCall are low frequency and continuous but would be widely dispersed in both space and time. Vessel traffic associated with the proposed survey is of low density compared to traffic associated with commercial shipping, industry support vessels, or commercial fishing vessels, and would therefore be expected to represent an insignificant incremental increase in the total amount of anthropogenic sound input to the marine environment, and the effects of vessel noise described above are not expected to occur as a result of this survey. In summary, project vessel sounds would not be at levels expected to cause anything more than possible localized and temporary behavioral changes in marine mammals, and would not be expected to result in significant negative effects on individuals or at the population level. In addition, in all oceans of the world, large vessel traffic is currently so prevalent that it is commonly considered a usual source of ambient sound (NSF–USGS 2011).

Vessel Strike

Vessel collisions with marine mammals, or vessel strikes, can result in death or serious injury of the animal. Wounds resulting from vessel strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). An animal at the surface may be struck directly by a vessel, a surfacing animal may hit the bottom of a vessel, or an animal just below the surface may be cut by a vessel's propeller. Superficial strikes may not kill or result in the death of the animal. These interactions are typically associated with large whales (*e.g.,* fin whales), which are occasionally found draped across the bulbous bow of large commercial vessels upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, they may also be susceptible to strike. The severity of injuries typically depends on the size and speed of the vessel, with the probability of death or serious injury increasing as vessel speed increases (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al.,* 2010; Gende *et al.,* 2011).

Pace and Silber (2005) also found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 kn (25.9 kmh), and exceeded 90 percent at 17 kn (31.5 kmh). Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death through increased likelihood of collision by pulling whales toward the vessel (Clyne 1999; Knowlton *et al.,* 1995). In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 kn (15.9 and 27.8 kmh). The chances of a lethal injury decline from approximately 80 percent at 15 kn (27.8 kmh) to approximately 20 percent at 8.6 kn (15.9 kmh). At speeds below 11.8 kn (21.9 kmh), the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward one hundred percent above 15 kn (27.8 kmh).

The McCall will travel at a speed of 4–5 kn (7.4–9.3 kmh) while towing seismic survey gear. At this speed, both the possibility of striking a marine mammal and the possibility of a strike resulting in serious injury or mortality are discountable. At average transit speed, the probability of serious injury or mortality resulting from a strike is less than 50 percent. However, the likelihood of a strike actually happening is again discountable. Vessel strikes, as analyzed in the studies cited above, generally involve commercial shipping, which is much more common in both space and time than is geophysical survey activity. Jensen and Silber (2004) summarized vessel strikes of large whales worldwide from 1975–2003 and found that most collisions occurred in the open ocean and involved large vessels (*e.g.,* commercial shipping). No such incidents were reported for geophysical survey vessels during that time period.

It is possible for vessel strikes to occur while traveling at slow speeds. For example, a hydrographic survey vessel traveling at low speed (5.5 kn; 10.2 kmh) while conducting mapping surveys off the central California coast struck and killed a blue whale in 2009. The State of California determined that the whale had suddenly and unexpectedly surfaced beneath the hull, with the result that the propeller severed the whale's vertebrae, and that this was an unavoidable event. This strike represents the only such incident in approximately 540,000 hours of similar coastal mapping activity ($p = 1.9 \times 10^{-6}$; 95% CI = $0–5.5 \times 10^{-6}$; NMFS, 2013b). In addition, a research vessel reported a fatal strike in 2011 of a dolphin in the Atlantic, demonstrating that it is possible for strikes involving smaller cetaceans to occur. In that case, the incident report indicated that an animal apparently was struck by the vessel's propeller as it was intentionally swimming near the vessel. While indicative of the type of unusual events that cannot be ruled out, neither of these instances represents a circumstance that would be considered reasonably foreseeable or that would be considered preventable.

Although the likelihood of the vessel striking a marine mammal is low, we propose a robust vessel strike avoidance protocol (see Proposed Mitigation), which we believe eliminates any foreseeable risk of vessel strike during transit. We anticipate that vessel collisions involving a seismic data acquisition vessel towing gear, while not impossible, represent unlikely, unpredictable events for which there are no preventive measures. Given the proposed mitigation measures, the relatively slow speed of the vessel towing gear, the presence of bridge crew watching for obstacles at all times (including marine mammals), and the presence of marine mammal observers, the possibility of vessel strike is discountable and, further, were a strike of a large whale to occur, it would be unlikely to result in serious injury or mortality. No incidental take resulting from vessel strike is anticipated, and this potential effect of the specified activity will not be discussed further in the following analysis.

Entanglement—Entanglements occur when marine mammals become wrapped around cables, lines, nets, or other objects suspended in the water column. During seismic operations, numerous cables, lines, and other objects primarily associated with the airgun array and hydrophone streamers will be towed behind the McCall near the water's surface. However, we are not aware of any cases of entanglement of marine mammals in seismic survey equipment. Although entanglement with the streamer is theoretically possible, it has not been documented during hundreds of thousands of miles of industrial seismic cruises. There are no meaningful entanglement risks posed by the proposed survey, and entanglement risks are not discussed further in this document.

Anticipated Effects on Marine Mammal Habitat

Effects to Prey—Marine mammal prey varies by species, season, and location and, for some, is not well documented. Fish react to sounds which are especially strong and/or intermittent low-frequency sounds, and behavioral responses such as flight or avoidance are the most likely effects. However, the reaction of fish to airguns depends on the physiological state of the fish, past exposures, motivation (*e.g.,* feeding, spawning, migration), and other environmental factors. Several studies have demonstrated that airgun sounds might affect the distribution and behavior of some fishes, potentially impacting foraging opportunities or increasing energetic costs (*e.g.,* Fewtrell and McCauley, 2012; Pearson *et al.,* 1992; Skalski *et al.,* 1992; Santulli *et al.,* 1999; Paxton *et al.,* 2017), though the bulk of studies indicate no or slight reaction to noise (*e.g.,* Miller and Cripps, 2013; Dalen and Knutsen, 1987; Pena *et al.,* 2013; Chapman and Hawkins, 1969; Wardle *et al.,* 2001; Sara *et al.,* 2007; Jorgenson and Gyselman, 2009; Blaxter *et al.,* 1981; Cott *et al.,* 2012; Boeger *et al.,* 2006), and that, most commonly, while there are likely to be impacts to fish as a result of noise from nearby airguns, such effects will be temporary. For example, investigators reported significant, short-term declines in commercial fishing catch rate of gadid fishes during and for up to five days after seismic survey operations, but the catch rate subsequently returned to normal (Engas *et al.,* 1996; Engas and Lokkeborg, 2002). Other studies have reported similar findings (Hassel *et al.,* 2004). Skalski *et al.,* (1992) also found a reduction in catch rates—for rockfish (*Sebastes* spp.) in response to controlled airgun exposure—but suggested that the mechanism underlying the decline was not dispersal but rather decreased responsiveness to baited hooks associated with an alarm behavioral response. A companion study showed that alarm and startle responses were not sustained following the removal of the sound source (Pearson *et al.,* 1992). Therefore, Skalski *et al.* (1992) suggested that the effects on fish abundance may be transitory, primarily occurring during the sound exposure itself. In some cases, effects on catch rates are variable within a study, which may be more broadly representative of temporary displacement of fish in response to airgun noise (*i.e.,* catch rates may increase in some locations and decrease in others) than any long-term damage to the fish themselves (Streever *et al.,* 2016).

Sound pressure levels of sufficient strength have been known to cause injury to fish and fish mortality and, in some studies, fish auditory systems have been damaged by airgun noise (McCauley *et al.,* 2003; Popper *et al.,* 2005; Song *et al.,* 2008). However, in most fish species, hair cells in the ear continuously regenerate and loss of auditory function likely is restored when damaged cells are replaced with new cells. Halvorsen *et al.* (2012b) showed that a TTS of 4–6 dB was recoverable within 24 hours for one species. Impacts would be most severe when the individual fish is close to the source and when the duration of exposure is long; both of which are conditions unlikely to occur for this survey that is necessarily transient in any given location and likely result in brief, infrequent noise exposure to prey species in any given area. For this survey, the sound source is constantly moving, and most fish would likely avoid the sound source prior to receiving sound of sufficient intensity to cause physiological or anatomical damage. In addition, ramp-up may allow certain fish species the opportunity to move further away from the sound source.

A recent comprehensive review (Carroll *et al.,* 2017) found that results are mixed as to the effects of airgun noise on the prey of marine mammals. While some studies suggest a change in prey distribution and/or a reduction in prey abundance following the use of seismic airguns, others suggest no effects or even positive effects in prey abundance. As one specific example, Paxton *et al.* (2017), which describes findings related to the effects of a 2014 seismic survey on a reef off of North Carolina, showed a 78 percent decrease in observed nighttime abundance for certain species. It is important to note that the evening hours during which the decline in fish habitat use was recorded (via video recording) occurred on the same day that the seismic survey passed, and no subsequent data is presented to support an inference that the response was long-lasting. Additionally, given that the finding is based on video images, the lack of recorded fish presence does not support a conclusion that the fish actually moved away from the site or suffered any serious impairment. In summary, this particular study corroborates prior studies indicating that a startle response or short-term displacement should be expected.

A recent review article concluded that, while laboratory results provide scientific evidence for high-intensity and low-frequency sound-induced physical trauma and other negative effects on some fish and invertebrates, the sound exposure scenarios in some cases are not realistic to those encountered by marine organisms during routine seismic operations (Carroll *et al.,* 2017). The review finds that there has been no evidence of reduced catch or abundance following seismic activities for invertebrates, and that there is conflicting evidence for fish with catch observed to increase, decrease, or remain the same. Further, where there is evidence for decreased catch rates in response to airgun noise, these findings provide no information about the underlying biological cause of catch rate reduction (Carroll *et al.,* 2017).

In summary, impacts of the specified activity on marine mammal prey species will likely be limited to behavioral responses, the majority of prey species will be capable of moving out of the area during the survey, a rapid return to normal recruitment, distribution, and behavior for prey species is anticipated, and, overall, impacts to prey species will be minor and temporary. Prey species exposed to sound might move away from the sound source, experience TTS, experience masking of biologically relevant sounds, or show no obvious direct effects. Mortality from decompression injuries is possible in close proximity to a sound, but only limited data on mortality in response to airgun noise exposure are available (Hawkins *et al.,* 2014). The most likely impacts for most prey species in the survey area would be temporary avoidance of the area. The proposed survey would move through an area relatively quickly, limiting exposure to multiple impulsive sounds. In all cases, sound levels would return to ambient once the survey moves out of the area or ends and the noise source is shut down and, when exposure to sound ends, behavioral and/or physiological responses are expected to end relatively quickly (McCauley *et al.,* 2000b). The duration of fish avoidance of a given area after survey effort stops is unknown, but a rapid return to normal recruitment, distribution, and behavior is anticipated. While the potential for disruption of spawning aggregations or schools of important prey species can be meaningful on a local scale, the mobile and temporary nature of this survey and the likelihood of temporary avoidance behavior suggest that impacts would be minor.

Acoustic Habitat—Acoustic habitat is the soundscape—which encompasses all of the sound present in a particular location and time, as a whole—when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.,* produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are also defined by, and acoustic habitat influenced by, the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic, or may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of airgun arrays). Anthropogenic noise varies widely in its frequency content, duration, and loudness and these characteristics greatly influence the potential habitat-mediated effects to marine mammals (please see also the previous discussion on masking under ''Acoustic Effects''), which may range from local effects for brief periods of time to chronic effects over large areas and for long durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). For more detail on these concepts see, *e.g.,* Barber *et al.,* 2010; Pijanowski *et al.,* 2011; Francis and Barber, 2013; Lillis *et al.,* 2014.

Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). Although the signals emitted by seismic airgun arrays are generally low frequency, they would also likely be of short duration and transient in any given area due to the nature of these surveys. As described previously, exploratory surveys such as these cover a large area but would be transient rather than focused in a given location over time and therefore would not be considered chronic in any given location.

Based on the information discussed herein, we conclude that impacts of the specified activity are not likely to have more than short-term adverse effects on any prey habitat or populations of prey species. Further, any impacts to marine mammal habitat are not expected to result in significant or long-term consequences for individual marine mammals, or to contribute to adverse impacts on their populations.

Estimated Take of Marine Mammals

This section provides an estimate of the number of incidental takes proposed for authorization through the IHA, which will inform both NMFS' consideration of ''small numbers,'' and the negligible impact determinations.

Harassment is the only type of take expected to result from these activities. Except with respect to certain activities not pertinent here, section 3(18) of the MMPA defines ''harassment'' as any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

Authorized takes would be by Level B harassment only, in the form of disruption of behavioral patterns for individual marine mammals resulting from exposure to sound from low energy seismic airguns. Based on the nature of the activity, Level A harassment is neither anticipated nor proposed to be authorized. As described previously, no serious injury or mortality is anticipated or proposed to be authorized for this activity. Below we describe how the proposed take numbers are estimated.

For acoustic impacts, generally speaking, we estimate take by considering: (1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) the number of days of activities. We note that while these factors can contribute to a basic calculation to provide an initial prediction of potential takes, additional information that can qualitatively inform take estimates is also sometimes available (*e.g.,* previous monitoring results or average group size). Below, we describe the factors considered here in more detail and present the proposed take estimates.

Acoustic Thresholds

NMFS recommends the use of acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur PTS of some degree (equated to Level A harassment).

Level B Harassment—Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source or exposure context (*e.g.,* frequency, predictability, duty cycle, duration of the exposure, signal-to-noise ratio, distance to the source), the environment (*e.g.,* bathymetry, other noises in the area, predators in the area), and the receiving animals (hearing, motivation, experience, demography, life stage, depth) and can be difficult to predict (*e.g.,* Southall *et al.,* 2007, 2021; Ellison *et al.,* 2012). Based on what the available science indicates and the practical need to use a threshold based on a metric that is both predictable and measurable for most activities, NMFS typically uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS generally predicts that marine mammals are likely to be behaviorally harassed in a manner considered to be Level B harassment when exposed to underwater anthropogenic noise above root-mean-squared pressure received levels (RMS SPL) of 120 dB (re 1 μPa) for continuous (*e.g.,* vibratory pile driving, drilling) and above RMS SPL 160 dB re 1 μPa for non-explosive impulsive (*e.g.,* seismic airguns) or intermittent (*e.g.,* scientific sonar) sources. Generally speaking, Level B harassment take estimates based on these behavioral harassment thresholds are expected to include any likely takes by TTS as, in most cases, the likelihood of TTS occurs at distances from the source less than those at which behavioral harassment is likely. TTS of a sufficient degree can manifest as behavioral harassment, as reduced hearing sensitivity and the potential reduced opportunities to detect important signals (conspecific communication, predators, prey) may result in changes in behavior patterns that would not otherwise occur.

UT's proposed survey includes the use of impulsive seismic sources (*e.g.,* GI-airgun) and therefore, the 160 dB re 1 μPa (rms) criteria is applicable for analysis of Level B harassment.

Level A harassment—NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). UT's proposed survey includes the use of impulsive sources.

These thresholds are provided in the Table 3 and 4 below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS' 2018 Technical Guidance, which may be accessed at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

Ensonified Area

Here, we describe operational and environmental parameters of the activity that are used in estimating the area ensonified above the acoustic thresholds, including source levels and transmission loss coefficient.

The proposed survey would entail the use of up to two 105 in^3 airguns with a maximum total discharge of 210 in^3 at a tow depth of 3–4 m. Lamont-Doherty Earth Observatory (L–DEO) model results were used to determine the 160 dB_{rms} radius for the two-airgun array in water depths >100 m. Received sound levels were predicted by L–DEO's model (Diebold *et al.,* 2010) as a function of distance from the airguns for the two 105 in^3 airguns with a maximum total discharge of 210 in^3. 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 homogenous ocean layer, unbounded by a seafloor).

The proposed surveys would acquire data with up to two 105-in^3 GI guns (separated by up to 2.4 m) at a tow depth of ~3–4 m. The shallow-water radii are obtained by scaling the empirically derived measurements from the Gulf of Mexico calibration survey to account for the differences in volume and tow depth between the calibration survey (6,600 in^3 at 6 m tow depth) and the proposed survey (210 in^3 at 4 m tow depth). A simple scaling factor is calculated from the ratios of the isopleths calculated by the deep-water L–DEO model, which are essentially a measure of the energy radiated by the source array.

L–DEO's methodology is described in greater detail in UT's IHA application. The estimated distances to the Level B harassment isopleth for the proposed airgun configuration are shown in Table 3.

TABLE 3—PREDICTED RADIAL DISTANCES FROM THE R/V BROOKS MCCALL SEISMIC SOURCE TO ISOPLETHS CORRESPONDING TO LEVEL B HARASSMENT THRESHOLD

Airgun configuration	Water depth (m)	Predicted distances (m) to 160 dB received sound level
Two 105-in GI guns	<100	[1] 1,750

[1] Distance is based on empirically derived measurements in the Gulf of Mexico with scaling applied to account for differences in tow depth.

The ensonified area associated with Level A harassment is more technically challenging to predict due to the need to account for a duration component. Therefore, NMFS developed an optional user spreadsheet tool to accompany the Technical Guidance (2018) that can be used to relatively simply predict an isopleth distance for use in conjunction with marine mammal density or occurrence to help predict potential takes. We note that because of some of the assumptions included in the methods underlying this optional tool, we anticipate that the resulting isopleth estimates are typically going to be overestimates of some degree, which may result in an overestimate of potential take by Level A harassment. However, this optional tool offers the best way to estimate isopleth distances when more sophisticated modeling methods are not available or practical. Table 4 presents the modeled PTS isopleths for mid-frequency cetaceans, the only hearing group for which takes are expected, based on L–DEO modeling incorporated in the companion User Spreadsheet (NMFS 2018).

TABLE 4—MODELED RADIAL DISTANCES TO ISOPLETHS CORRESPONDING TO LEVEL A HARASSMENT THRESHOLDS

Hearing group	MF
PTS Peak	1.5
PTS SEL_{cum}	0

Predicted distances to Level A harassment isopleths, which vary based on marine mammal hearing groups, were calculated based on modeling performed by L–DEO using the Nucleus software program and the NMFS User Spreadsheet, described below. The acoustic thresholds for impulsive sounds (*e.g.,* airguns) contained in the Technical Guidance (2018) were presented as dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure metrics (NMFS 2016a). As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (*i.e.,* metric resulting in the largest isopleth). The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group. In recognition of the fact that the requirement to calculate Level A harassment ensonified areas could be more technically challenging to predict due to the duration component and the use of weighting functions in the new SEL_{cum} thresholds, NMFS developed an optional User Spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to facilitate the estimation of take numbers.

The SEL_{cum} for the two-GI airgun 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 (right) 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 interactions of the two airguns that occur near the source center and is calculated as a point source (single airgun), the modified farfield signature is a more appropriate measure of the sound source level for large arrays. For this smaller array, the modified farfield changes will be correspondingly smaller as well, but this method is used for consistency across all array sizes.

Auditory injury for all species is unlikely to occur given the small modeled zones of injury (estimated zone less than 2 m for mid-frequency cetaceans). Additionally, animals are expected to have aversive/compensatory behavior in response to the activity (Nachtigall *et al.,* 2018) further limiting the likelihood of auditory injury for all species. UT did not request authorization of take by Level A harassment, and no take by Level A harassment is proposed for authorization by NMFS.

Marine Mammal Occurrence

In this section we provide information about the occurrence of marine mammals, including density or other relevant information which will inform the take calculations.

For the proposed survey area in the northwest Gulf of Mexico, UT determined that the best source of density data for marine mammal species that might be encountered in the project area was habitat-based density modeling conducted by Garrison *et al.* (2022). The Garrison *et al.* (2022) data provides abundance estimates for marine mammal species in the Gulf of Mexico within 40 km^2 hexagons (~3.9 km sides and ~7 km across from each side) on a monthly basis. To calculate expected densities specific to the survey area, UT created a 7-km perimeter around the survey area and used that perimeter to select the density hexagons for each species in each month. The 7-km distance was chosen for the perimeter to ensure that at least one full density hexagon outside the survey area in all directions was selected, providing a more robust sample for the calculations. They then calculated the mean of the predicted densities from the selected cells for each species and month. The highest mean monthly density was chosen for each species from the months of September to December (*i.e.,* the months within which the survey is expected to occur). NMFS concurred with this approach to calculate species density.

Rough-toothed dolphins were not modeled by Garrison *et al.* (2022) due to a lack of sightings, so habitat-based marine mammal density estimates from Roberts et al. (2016) were used. The Roberts et al. (2016) models consisted of 10 km x 10 km grid cells containing average annual densities for U.S. waters in the Gulf of Mexico. The same 7 km perimeter described above was used to select grid cells from the Roberts et al. (2016) dataset, and the mean of the selected grid cells for rough-toothed dolphins was calculated to estimate the annual average density of the species in the survey area. Estimated densities used and Level B harassment ensonified areas to inform take estimates are presented in Table 5.

TABLE 5—MARINE MAMMAL DENSITIES AND TOTAL ENSONIFIED AREA OF ACTIVITIES IN THE PROPOSED SURVEY AREA

Species	Estimated density (#/km^2)	Level B ensonified area (km^2)
Atlantic spotted dolphin	[b] 0.00082	7,866
Bottlenose dolphin [a]	[b] 0.34024	7,866
Rough-toothed dolphin	[c] 0.00362	7,866

[a] Bottlenose dolphin density estimate does not differentiate between coastal and shelf stocks.
[b] Density calculated from Garrison *et al.* (2022).
[c] Density calculated from Roberts *et al.* (2016).

Take Estimation

Here, we describe how the information provided above is synthesized to produce a quantitative estimate of the take that is reasonably likely to occur and proposed for authorization. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in Level B harassment, radial distances from the airgun array to the predicted isopleth corresponding to the Level B harassment threshold was calculated, as described above. Those radial distances were then used to calculate the area(s) around the airgun array predicted to be ensonified to sound levels that exceed the harassment thresholds. The area expected to be ensonified on 1 day was determined by multiplying the number of line km possible in 1 day by two times the 160-dB radius plus adding endcaps to the start and beginning of the line. The daily ensonified area was then multiplied by the number of survey days (10 days). The highest mean monthly density for each species was then multiplied by the total ensonified area to calculate the estimated takes of each species.

No takes by Level A harassment are expected or proposed for authorization. Estimated takes for the proposed survey are shown in Table 6.

TABLE 6—ESTIMATED TAKE PROPOSED FOR AUTHORIZATION

Species	Stock	Estimated take	Proposed authorized take	Stock abundance [1]	Percent of stock
		Level B	Level B		
Atlantic spotted dolphin	Gulf of Mexico	6	[2] 26	21,506	0.12
Bottlenose dolphin [3]	Gulf of Mexico Western Coastal	2,676	2,676	20,759	12.89
	Northern Gulf of Mexico Continental Shelf.			63,280	4.23
Rough-toothed dolphin	Gulf of Mexico	28	28	[2] 4,853	0.58

[1] Stock abundance for Atlantic spotted dolphins and bottlenose dolphins was taken from Garrison *et al.* (2022). Stock abundance for rough-toothed dolphins was taken from Roberts *et al.* (2016), as Garrison *et al.* (2022) did not create a model for this species.
[2] Proposed take increased to mean group size from Maze-Foley and Mullin (2006).
[3] Estimated take for bottlenose dolphins is not apportioned to stock, as density information does not differentiate between coastal and shelf dolphins. However, based on the proposed survey depths, we expect that most of the takes would be from the coastal stock, but some takes could be from the shelf stock. Percent of stock was calculated as if all takes proposed for authorization accrued to the single stock with the lowest population abundance.

Proposed Mitigation

In order to issue an IHA under section 101(a)(5)(D) of the MMPA, NMFS must set forth the 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, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stock for taking for certain subsistence uses (latter not applicable for this action). NMFS regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting the activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, and their habitat (50 CFR 216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, NMFS considers two primary factors:

(1) The manner in which, and the degree to which, the successful implementation of the measure(s) is expected to reduce impacts to marine mammals, marine mammal species or stocks, and their habitat. This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned), the likelihood of effective implementation (probability implemented as planned), and;

(2) The practicability of the measures for applicant implementation, which may consider such things as cost, and impact on operations.

Mitigation measures that would be adopted during the planned survey include, but are not limited to: (1) vessel speed or course alteration, provided that doing so would not compromise operation safety requirements; (2) monitoring a pre-start clearance zone; and (3) ramp-up procedures.

Vessel-Visual Based Mitigation Monitoring

Visual monitoring requires the use of trained observers (herein referred to as visual protected species observers (PSOs)) to scan the ocean surface visually for the presence of marine mammals. PSOs shall establish and monitor a pre-start clearance zone and, to the extent practicable, a Level B harassment zone (Table 3). These zones shall be based upon the radial distance from the edges of the acoustic source (rather than being based on the center of the array or around the vessel itself). During pre-start clearance (*i.e.,* before ramp-up begins), the pre-start clearance zone is the area in which observations of marine mammals within the zone would prevent airgun operations from beginning (*i.e.,* ramp-up). The pre-start clearance zone encompasses the area at and below the sea surface out to a radius of 200 meters from the edges of the airgun array.

During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur, and whenever the acoustic source 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). Visual monitoring must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset. Visual PSOs must coordinate to ensure 360 degree 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.

PSOs shall establish and monitor a pre-start clearance zone and to the extent practicable, a Level B harassment zone. These zones shall be based upon the radial distance from the edges of the acoustic source (rather than being based on the center of the array or around the vessel itself).

Any observations of marine mammals by crew members shall be relayed to the PSO team. During good conditions (*e.g.,* daylight hours, Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sightings rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

Visual PSOs may be on watch for a maximum of 4 consecutive hours followed by a break of at least 1 hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period.

Pre-Start Clearance and Ramp-Up

Ramp-up is the gradual and systematic increase of emitted sound levels from an acoustic source. Ramp-up would begin with one GI airgun 105 in^3 first being activated, followed by the second after 5 minutes. The intent of pre-clearance observation (30 minutes) is to ensure no marine mammals are observed within the pre-start clearance zone prior to the beginning of ramp-up. The intent of ramp-up is to warn marine mammals in the vicinity of survey activities and to allow sufficient time for those animals to leave the immediate vicinity. A ramp-up procedure, involving a stepwise increase in the number of airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. All operators must adhere to the following pre-clearance and ramp-up requirements:

(1) 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 PSOs time to monitor the pre-start clearance zone for 30 minutes prior to the initiation of ramp-up (pre-start clearance);

- Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in;
- One of the PSOs conducting pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed;
- Ramp-up may not be initiated if any marine mammal is within the pre-start clearance zone. If a marine mammal is observed within the pre-start clearance zone during the 30 minutes pre-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 delphinids and 30 minutes for all other species);
- Ramp-up must begin by activating the first airgun for 5 minutes and then adding the second airgun; and
- PSOs must monitor the pre-start clearance zone during ramp-up, and ramp-up must cease and the source must be shut down upon detection of a marine mammal within the pre-start clearance zone. Once ramp-up has begun, observations of marine mammals for which take authorization is granted within the pre-start clearance zone does not require shutdown.

(2) If the acoustic source is shut down for brief periods (*i.e.,* less than 30 minutes) for reasons other than implementation of prescribed mitigation (*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 pre-start clearance zone. For any longer shutdown, pre-start clearance observation and ramp-up are required. Ramp-up may occur at times of poor visibility (*e.g.,* BSS 4 or greater), including nighttime, if appropriate visual monitoring has occurred with no detections of marine mammals in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at night where operational planning cannot reasonably avoid such circumstances.

- Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require a 30 minute pre-start clearance period.

Shutdown Procedures

The shutdown requirement will be waived for small dolphins. As defined here, the small dolphin group is intended to encompass those members of the Family Delphinidae most likely to voluntarily approach the source vessel for purposes of interacting with the vessel and/or airgun array (*e.g.,* bow riding). This exception to the shutdown requirement applies solely to specific genera of small dolphins—*Steno, Stenella,* and *Tursiops.* As Tursiops and Steno are the only species expected to potentially be encountered, there is no shutdown requirement included in the proposed IHA for species for which take is proposed to be authorized.

Vessel Strike Avoidance Measures

These measures apply to all vessels associated with the planned survey activity; however, we note that these requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply. These measures include the following:

(1) Vessel operators and crews 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 mammal. A single marine mammal at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should be exercised when an animal is observed. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (specific distances detailed below), to ensure the potential for strike is minimized. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers 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 as a baleen whale, sperm whale, or other marine mammals;

(2) Vessel speeds must be reduced to 10 kn (18.5 kph) or less when mother and calf pairs, pods, or large assemblages of cetaceans are observed near a vessel;

(3) All vessels must maintain a minimum separation distance of 100 m from sperm whales;

(4) All vessels must maintain a minimum separation distance of 500 m baleen whales. If a baleen whale is sighted within the relevant separation distance, the vessel must steer a course away at 10 knots or less until the 500-m separation distance has been established. If a whale is observed but cannot be confirmed as a species other than a baleen whale, the vessel operator must assume that it is a baleen whale and take appropriate action.

(5) All vessels 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); and

(6) When marine mammals are sighted while a vessel is underway, the vessel should 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). This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

Based on our evaluation of the applicant's proposed measures, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present while conducting the activities. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to improved understanding of one or more of the following:

- Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.,* presence, abundance, distribution, density);
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) action or environment (*e.g.,* source characterization, propagation, ambient noise); (2) affected species (*e.g.,* life history, dive patterns); (3) co-occurrence of marine mammal species with the activity; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas);
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors;
- How anticipated responses to stressors impact either: (1) long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks;
- Effects on marine mammal habitat (*e.g.,* marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat); and,
- Mitigation and monitoring effectiveness.

Vessel-Based Visual Monitoring

As described above, PSO observations would take place during daytime airgun operations. Two visual PSOs would be on duty at all time during daytime hours. Monitoring shall be conducted in accordance with the following requirements:

(1) UT 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, and to ensure that PSOs are capable of calibrating equipment as

necessary for accurate distance estimates and species identification. See Condition 5(d) in the IHA for list of equipment.

PSOs must have the following requirements and qualifications:

(1) PSOs shall be independent, dedicated and trained and must be employed by a third-party observer provider;

(2) PSOs shall have no tasks other than to conduct visual observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards);

(3) PSOs shall have successfully completed an approved PSO training course appropriate for their designated task (visual);

(4) NMFS must review and approve PSO resumes accompanied by a relevant training course information packet that includes the name and qualifications (*i.e.,* experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material as well as a document stating successful completion of the course;

(5) 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;

(6) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics; and

(7) The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests shall 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:

- Secondary education and/or experience comparable to PSO duties;
- Previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or
- Previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

At least one visual PSO must be unconditionally approved (*i.e.,* have a minimum of 90 days at-sea experience working in that role at the particular Tier level (1–3) with no more than 18 months elapsed since the conclusion of the at-sea experience). One PSO with such experience shall be designated as the lead for the entire PSO team. The lead PSO shall serve as primary point of contact for the vessel operator. To the maximum extent practicable, the duty schedule shall be planned such that unconditionally-approved PSOs are on duty with conditionally-approved PSOs.

PSOs must use standardized electronic data collection forms. At a minimum, the following information must be recorded:

- Vessel name, vessel size and type, maximum speed capability of vessel;
- Dates (MM/DD/YYYY format) of departures and returns to port with port name;
- PSO names and affiliations, PSO identification (ID; initials or other identifier);
- Date (MM/DD/YYYY) and participants of PSO briefings;
- Visual monitoring equipment used (description);
- PSO location on vessel and height (in meters) of observation location above water surface;
- Watch status (description);
- Dates (MM/DD/YYYY) and times (Greenwich mean time (GMT) or coordinated universal time (UTC)) of survey on/off effort and times (GMC/UTC) corresponding with PSO on/off effort;
- Vessel location (decimal degrees) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
- Vessel location (decimal degrees) at 30-second intervals if obtainable from data collection software, otherwise at practical regular interval;
- Vessel heading (compass heading) and speed (in knots) at beginning and end of visual PSO duty shifts and upon any change;
- Water depth (in meters) (if obtainable from data collection software);
- Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
- 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
- Vessel/Survey activity information (and changes thereof) (description), such as acoustic source power output while in operation, number and volume of acoustic source operating in the array, tow depth of the acoustic source, and any other notes of significance (*i.e.,* pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, *etc.*).

The following information should be recorded upon visual observation of any marine mammal:

- Sighting ID (numeric);
- Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
- Location of PSO/observer (description);
- Vessel activity at the time of the sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other);
- PSO who sighted the animal/PSO ID;
- Time and date of sighting (GMT/UTC, MM/DD/YYYY);
- Initial detection method (description);
- Sighting cue (description);
- Vessel location at time of sighting (decimal degrees);
- Water depth (in meters);
- Direction of vessel's travel (compass direction);
- Speed (knots) of the vessel from which the observation was made;
- Direction of animal's travel relative to the vessel (description, compass heading);
- Bearing to sighting (degrees);
- 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;
- Species reliability (an indicator of confidence in identification) (1 = unsure/possible, 2 = probable, 3 = definite/sure, 9 = unknown/not recorded);
- Estimated distance to the animal (meters) and method of estimating distance;
- Estimated number of animals (high, low, and best) (numeric);
- Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
- 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);
- 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);

• Animal's closest point of approach (in meters) and/or closest distance from any element of the acoustic source;

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

• Photos (Yes or No);

• Photo Frame Numbers (List of numbers); and

• Conditions at time of sighting (Visibility; BSS).

Reporting

UT must submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report would describe the activities that were conducted and sightings of marine mammals. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of survey operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities).

The draft report shall also include 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). Geographic information system (GIS) files shall be provided in Environmental Systems Research Institute (ESRI) shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available to NMFS. A final report must be submitted within 30 days following resolution of any comments on the draft report.

Reporting Injured or Dead Marine Mammals

Sighting of injured or dead marine mammals—In the event that personnel involved in survey activities covered by the authorization discover an injured or dead marine mammal, UT shall report the incident to the OPR, NMFS, and the NMFS Southeast Regional Stranding Coordinator as soon as feasible. The report must include the following information:

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

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

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

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

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

• General circumstances under which the animal was discovered.

Vessel strike—In the event of a vessel strike of a marine mammal by any vessel involved in the activities covered by the authorization, UT shall report the incident to OPR, NMFS and to the NMFS Southeast Regional Stranding Coordinator as soon as feasible. The report must include the following information:

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

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

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

• Status of all sound sources in use;

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

• Environmental conditions (*e.g.,* wind speed and direction, BSS, cloud cover, visibility) immediately preceding the strike;

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

• Estimated size and length of the animal that was struck;

• Description of the behavior of the animal immediately preceding and following the strike;

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

• 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

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

Negligible Impact Analysis and Determination

NMFS has defined negligible impact as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.,* population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be ''taken'' through harassment, NMFS considers other factors, such as the likely nature of any impacts or responses (*e.g.,* intensity, duration), the context of any impacts or responses (*e.g.,* critical reproductive time or location, foraging impacts affecting energetics), as well as effects on habitat, and the likely effectiveness of the mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS' implementing regulations (54 FR 40338, September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

To avoid repetition, the discussion of our analysis applies to all the species listed in Table 1, given that the anticipated effects of this activity on these different marine mammal stocks are expected to be similar. There is little information about the nature or severity of the impacts, or the size, status, or structure of any of these species or stocks that would lead to a different analysis for this activity.

NMFS does not anticipate that serious injury or mortality would occur as a result from low-energy survey, and no serious injury or mortality is proposed to be authorized. As discussed in the Potential Effects of Specified Activities on Marine Mammals and Their Habitat section, non-auditory physical effects and vessel strike are not expected to occur. NMFS expects that all potential take would be in the form of Level B behavioral harassment in the form of temporary avoidance of the area or decreased foraging (if such activity was occurring), responses that are considered to be of low severity and with no lasting biological consequences (*e.g.,* Southall *et al.,* 2007, 2021).

In addition to being temporary, the maximum expected Level B harassment zone around the survey vessel is 1,750 m. Therefore, the ensonified area surrounding the vessel is relatively small compared to the overall distribution of animals in the area and their use of the habitat. Feeding behavior is not likely to be significantly impacted as prey species are mobile and are broadly distributed throughout the survey area; therefore, marine mammals that may be temporarily displaced during survey activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the short duration (10 days) of the disturbance and the availability of similar habitat and resources in the surrounding area, the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations.

There are no rookeries, mating, or calving grounds known to be biologically important to marine mammals within the planned survey area and there are no feeding areas known to be biologically important to marine mammals within the survey area. There is no designated critical habitat for any ESA-listed marine mammals within the project area.

In summary and as described above, the following factors primarily support our preliminary determination that the impacts resulting from this activity are not expected to adversely affect the species or stock through effects on annual rates of recruitment or survival:

(1) No serious injury or mortality is anticipated or proposed to be authorized;

(2) No Level A harassment is anticipated, even in the absence of mitigation measures or proposed to be authorized;

(3) Take is anticipated to be by Level B harassment only consisting of temporary behavioral changes of small percentages of the affected species due to avoidance of the area around the survey vessel. The relatively short duration of the proposed survey (10 days) would further limit the potential impacts of any temporary behavioral changes that would occur;

(4) The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the proposed survey to avoid exposure to sounds from the activity;

(5) Foraging success is not likely to be significantly impacted as effects on prey species for marine mammals would be temporary and spatially limited; and

(6) The proposed mitigation measures, including visual monitoring, ramp-ups, and shutdowns are expected to minimize potential impacts to marine mammals.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the total marine mammal take from the proposed activity will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted previously, only take of small numbers of marine mammals may be authorized under section 101(a)(5)(A) and (D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers and so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or stock in our determination of whether an authorization is limited to small numbers of marine mammals. When the predicted number of individuals to be taken is fewer than one-third of the species or stock abundance, the take is considered to be of small numbers. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

NMFS proposes to authorize incidental take by Level B harassment of 3 marine mammal species with four managed stocks. The total amount of takes proposed for authorization relative to the best available population abundance is less than 5 percent for 3 managed stocks and less than 13 percent for 1 managed stock (Gulf of Mexico Western Coastal stock of bottlenose dolphin assuming all takes by Level b harassment are of this stock; see Take Estimation subsection) (Table 6). The take numbers proposed for authorization are considered conservative estimates for purposes of the small numbers determination as they assume all takes represent different individual animals, which is unlikely to be the case.

Based on the analysis contained herein of the proposed activity (including the proposed mitigation and monitoring measures) and the anticipated take of marine mammals, NMFS preliminarily finds that small numbers of marine mammals would be taken relative to the population size of the affected species or stocks.

Unmitigable Adverse Impact Analysis and Determination

There are no relevant subsistence uses of the affected marine mammal stocks or species implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act

Section 7(a)(2) of the ESA (16 U.S.C. 1531 *et seq.*) requires that each Federal agency insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. To ensure ESA compliance for the issuance of IHAs, NMFS consults internally whenever we propose to authorize take for endangered or threatened species.

No incidental take of ESA-listed species is proposed for authorization or expected to result from this activity. Therefore, NMFS has determined that formal consultation under section 7 of the ESA is not required for this action.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to UT for conducting marine geophysical surveys in the northwest Gulf of Mexico within Texas State waters during fall 2023, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the proposed IHA can be found at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities.*

Request for Public Comments

We request comment on our analyses, the proposed authorization, and any other aspect of this notice of proposed IHA for the proposed marine geophysical survey. We also request comment on the potential renewal of this proposed IHA as described in the paragraph below. Please include with your comments any supporting data or literature citations to help inform decisions on the request for this IHA or a subsequent renewal IHA.

On a case-by-case basis, NMFS may issue a one-time, 1-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 as described in the Description of Proposed Activity section of this notice is planned, or (2) the activities as described in the Description of Proposed Activity section of this notice would not be completed by the time the IHA expires and a renewal would allow for completion of the activities beyond that described in the *Dates and Duration* section of this notice, provided all of the following conditions are met:

- A request for renewal is received no later than 60 days prior to the needed renewal IHA effective date (recognizing that the renewal IHA expiration date cannot extend beyond one year from expiration of the initial IHA).
- The request for renewal must include the following:

(1) An explanation that the activities to be conducted under the requested renewal IHA are identical to the activities analyzed under the initial IHA, are a subset of the activities, or include changes so minor (*e.g.,* reduction in pile size) 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).

(2) 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.

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 in the initial IHA remain valid.

Dated: August 3, 2023.

Kimberly Damon-Randall,

Director, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. 2023–16945 Filed 8–7–23; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XD200]

New England Fishery Management Council; Public Meeting; Correction

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of correction of a public meeting.

SUMMARY: The New England Fishery Management Council (Council) is scheduling a public meeting of its Risk Policy Working Group (RPWG) to consider actions affecting New England fisheries in the exclusive economic zone (EEZ). This meeting will be held as a webinar. Recommendations from this group will be brought to the full Council for formal consideration and action, if appropriate.

DATES: This meeting will be held on Tuesday, August 22, 2023, at 9 a.m.

ADDRESSES: This meeting will be held as a webinar only. Webinar registration URL information: *https://attendee.gotowebinar.com/register/7355629868155270240.*

Council address: New England Fishery Management Council, 50 Water Street, Mill 2, Newburyport, MA 01950.

FOR FURTHER INFORMATION CONTACT: Thomas A. Nies, Executive Director, New England Fishery Management Council; telephone: (978) 465–0492.

SUPPLEMENTARY INFORMATION: The original notice published in the **Federal Register** on July 31, 2023 (88 FR 49451). The original notice announced that the meeting would be a hybrid in-person meeting as well as a webinar. This notice corrects the meeting to be a webinar meeting only. All other information previously published remains unchanged.

Special Accommodations

This meeting is physically accessible to people with disabilities. Requests for sign language interpretation or other auxiliary aids should be directed to Thomas A. Nies, Executive Director, at (978) 465–0492, at least 5 days prior to the meeting date.

Authority: 16 U.S.C. 1801 *et seq.*

Dated: August 3, 2023.

Rey Israel Marquez,

Acting Deputy Director, Office of Sustainable Fisheries, National Marine Fisheries Service.

[FR Doc. 2023–16963 Filed 8–7–23; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

Notice of Availability of Final Management Plan and Final Environmental Assessment for Stellwagen Bank National Marine Sanctuary

AGENCY: Office of National Marine Sanctuaries (ONMS), National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), Department of Commerce (DOC).

ACTION: Notice; notice of availability of a final management plan and final environmental assessment.

SUMMARY: On February 13, 2020, NOAA initiated a review of the Stellwagen Bank National Marine Sanctuary (SBNMS or the sanctuary) management plan to evaluate substantive progress toward implementing the goals of the sanctuary and to make revisions to the management plan as necessary to fulfill the purposes and policies of the NMSA. NOAA anticipated that management plan changes would require preparation of environmental analysis under the National Environmental Policy Act (NEPA), and initiated public scoping meetings to gather information and other comments from individuals, organizations, tribes, and government agencies on the scope, types, and significance of issues related to the SBNMS management plan and the proper scope of environmental analysis for the management plan review. NOAA is providing notice of availability of a final management plan and a final environmental assessment (EA) for SBNMS.

DATES: The final management plan and final environmental assessment are now available.

ADDRESSES: To obtain a copy of the final management plan, final environmental assessment, and finding of no significant impact (FONSI), contact the Management Plan Review Coordinator at Stellwagen Bank National Marine Sanctuary, Alice Stratton, 175 Edward Foster Road, Scituate, MA 02066, 203–882–6515, *sbnmsmanagementplan@noaa.gov.* Copies can also be downloaded from the Stellwagen Bank National Marine Sanctuary website at *https://stellwagen.noaa.gov/management/.*

FOR FURTHER INFORMATION CONTACT: Alice Stratton, 203–882–6515, *sbnmsmanagementplan@noaa.gov.*

SUPPLEMENTARY INFORMATION:

127. Zhanjiang Guolian Aquatic Products Co., Ltd.
128. Zhanjiang Longwei Aquatic Products Industry Co., Ltd.
129. Zhanjiang Regal Integrated Marine Resources Co., Ltd.
130. Zhanjiang Universal Seafood Corp.
131. Zhaoan Yangli Aquatic Co., Ltd.
132. Zhejiang Evernew Seafood Co.
133. Zhejiang Tianhe Aquatic Products
134. Zhejiang Xinwang Foodstuffs Co., Ltd.
135. Zhenye Aquatic (Huilong) Ltd.
136. Zhoushan Genho Food Co., Ltd.
137. Zhoushan Green Food Co., Ltd.
138. Zhoushan Haizhou Aquatic Products
139. Zhuanghe Yongchun Marine Products

[FR Doc. 2023–21121 Filed 9–26–23; 8:45 am]

BILLING CODE 3510–DS–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XD399]

Pacific Fishery Management Council; Public Meeting

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of a public online meeting.

SUMMARY: The Groundfish and Economics Subcommittees of the Pacific Fishery Management Council's (Pacific Council) Scientific and Statistical Committee (SSC) will convene an online meeting to review the non-trawl commercial fishery sablefish trip limit model used by the Pacific Council's Groundfish Management Team (GMT). The methodology review meeting is open to the public.

DATES: The groundfish methodology review online meeting will be held Thursday, October 12, 2023, from 1 p.m. until 5 p.m. (Pacific Daylight Time) or until business for the day has been completed.

ADDRESSES: The groundfish methodology review will be conducted as an online meeting. Specific meeting information, including the agenda and directions on how to join the meeting and system requirements, will be provided in the workshop announcement on the Pacific Council's website (see *www.pcouncil.org*). You may send an email to Mr. Kris Kleinschmidt (*kris.kleinschmidt@noaa.gov*) or contact him at (503) 820–2412 for technical assistance.

Council address: Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, OR 97220.

FOR FURTHER INFORMATION CONTACT: Marlene A. Bellman, Staff Officer, Pacific Council; telephone: (503) 820–2414, email: *marlene.bellman@noaa.gov.*

SUPPLEMENTARY INFORMATION: The purpose of the groundfish methodology review meeting is a follow-up to the prior review recommendations from the May 9, 2023 meeting, which aimed to evaluate proposed data inputs, modeling approaches, potential improvements, and any other pertinent information related to the sablefish trip limit model used in commercial non-trawl fisheries management. This review is planned in preparation for the 2025–2026 biennial groundfish management cycle. The results of this review are not considered final until reviewed by the full SSC at a future Pacific Council meeting.

No management actions will be decided by the meeting participants. The participants' role will be the development of recommendations and reports for consideration by the SSC and the Pacific Council at a future Pacific Council meeting. The Pacific Council and Scientific and Statistical Committee will consider methodology review recommendations for use in informing management decisions at their November 2023 meeting in Garden Grove, California.

Although nonemergency issues not contained in the meeting agenda may be discussed, those issues may not be the subject of formal action during this meeting. Action will be restricted to those issues specifically listed in this notice and any issues arising after publication of this notice that require emergency action under Section 305(c) of the Magnuson-Stevens Fishery Conservation and Management Act, provided the public has been notified of the intent of the workshop participants to take final action to address the emergency.

Special Accommodations

Requests for sign language interpretation or other auxiliary aids should be directed to Mr. Kris Kleinschmidt (*kris.kleinschmidt@noaa.gov;* (503) 820–2412) at least 10 days prior to the meeting date.

Authority: 16 U.S.C. 1801 *et seq.*

Dated: September 21, 2023.

Rey Israel Marquez,

Acting Deputy Director, Office of Sustainable Fisheries, National Marine Fisheries Service.

[FR Doc. 2023–20948 Filed 9–26–23; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XD318]

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey in Coastal Waters Off of Texas

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; issuance of an incidental harassment authorization.

SUMMARY: In accordance with the regulations implementing the Marine Mammal Protection Act (MMPA) as amended, notification is hereby given that NMFS has issued an incidental harassment authorization (IHA) to the University of Texas at Austin (UT) to incidentally harass marine mammals during marine geophysical survey activities in coastal waters off of Texas.

DATES: This Authorization is effective from September 29, 2023 through September 28, 2024.

ADDRESSES: Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities.* In case of problems accessing these documents, please call the contact listed below.

FOR FURTHER INFORMATION CONTACT: Rachel Wachtendonk, Office of Protected Resources, NMFS, (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Background

The MMPA prohibits the "take" of marine mammals, with certain exceptions. Section 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) directs the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are proposed or, if the taking is limited to harassment, a notice of a proposed IHA is provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other ''means of effecting the least practicable adverse impact'' on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stocks for taking for certain subsistence uses (referred to in shorthand as ''mitigation''); and requirements pertaining to the mitigation, monitoring and reporting of the takings are set forth. The definitions of all applicable MMPA statutory terms cited above are included in the relevant sections below.

Summary of Request

On March 7, 2023, NMFS received a request from UT for an IHA to take marine mammals incidental to conducting a marine geophysical survey in coastal waters off of Texas. Following NMFS' review of the application, UT submitted a revised version on April 25, 2023. The application was deemed adequate and complete on April 27, 2023. UT's request is for take of bottlenose dolphins, Atlantic spotted dolphins, and rough-toothed dolphin by Level B harassment only. Neither UT nor NMFS expect serious injury or mortality to result from this activity and, therefore, an IHA is appropriate. There are no changes from the proposed IHA to the final IHA.

Description of the Specified Activity

Overview

UT plans to conduct a marine geophysical survey, specifically a low energy seismic survey, in coastal waters off of Texas during a 10 day period in the fall of 2023. The survey will take place in water depths of less than 20 meters (m). To complete this survey the vessel will tow one to two Generator-Injector (GI) airguns, each with a volume of 105 cubic inch (in^3; 1,721 cubic cm (cm^3)), for a total volume of 210 in^3 (3,441 cm^3).

The purpose of the planned survey is to validate novel dynamic positioning technology for improving the accuracy in time and space of high resolution 3-dimensional (HR3D) seismic datasets, in particular as it pertains to field technology of offshore carbon capture systems.

Dates and Duration

The survey is planned to occur over a 10 day period during the fall of 2023 (the exact dates are uncertain). During that time, the airguns will operate continuously (*i.e.,* 24-hours per day).

Specific Geographic Region

The planned survey area is 222 square kilometers (km^2) and will occur within the approximate area of 28.9–29.1° N latitude, 94.9–95.2° W longitude in the coastal waters off of Texas. This location is offshore San Luis Pass, which defines the southern tip of Galveston Island, Texas. The closest point of approach of the planned survey area to the coast is approximately 3 km. The planned survey area is depicted in Figure 1, and the survey lines could occur anywhere within the survey area. The water depth of the planned survey area ranges from 10 to 20 m. The survey vessel (the R/V Brooks McCall (McCall) or similar vessel operated by TDI-Brooks International) will likely depart and return to Freeport or Galveston, Texas.

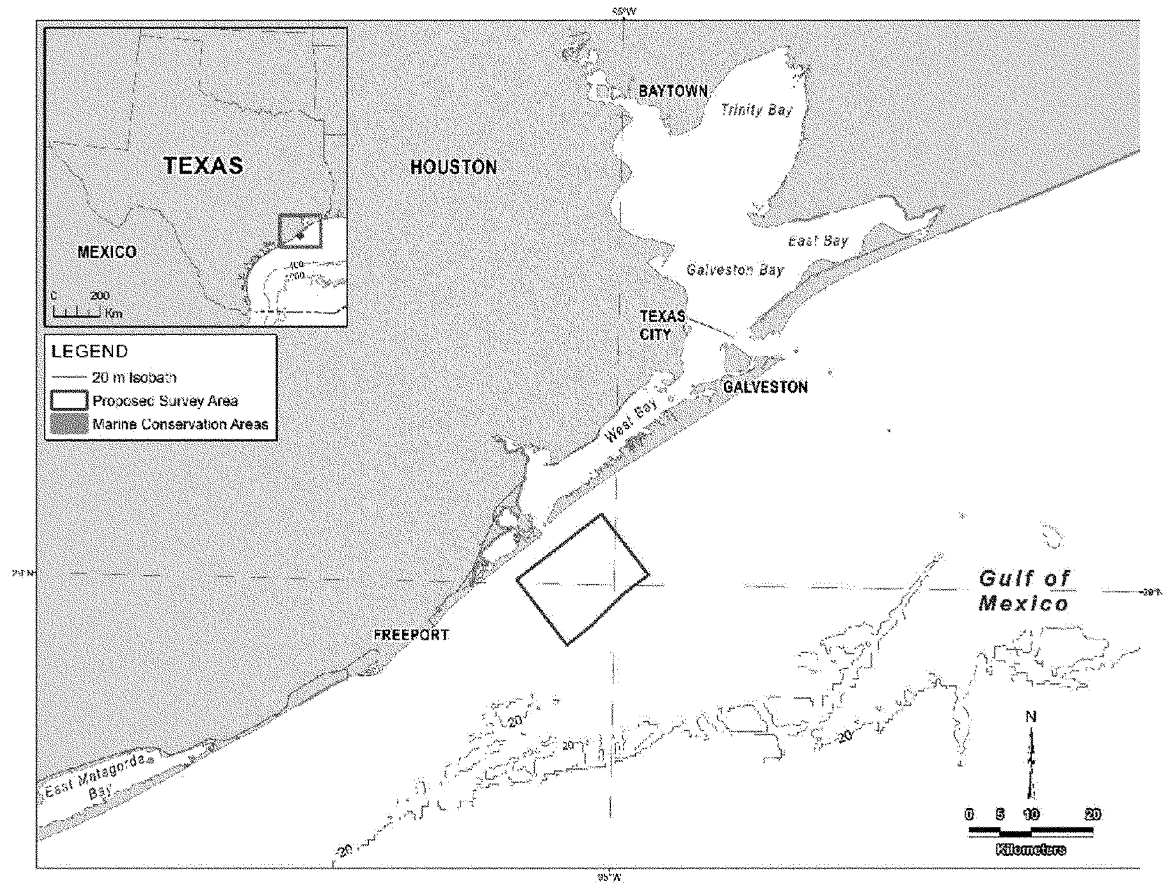

Figure 1-- Location of the Planned Northwest Gulf of Mexico Survey.
Note: Survey tracklines could occur anywhere within the planned survey area.

A detailed description of the planned geophysical survey was provided in the **Federal Register** notice of the proposed IHA (88 FR 53453, August 8, 2023). Since that time, no changes have been made to the planned survey activities. Therefore, a detailed description is not provided here. Please refer to that **Federal Register** notice for the description of the specified activity.

Comments and Responses

A notice of NMFS' proposal to issue an IHA to UT was published in the **Federal Register** on August 8, 2023 (88 FR 53453). That notice described, in detail, UT's activities, the marine mammal species that may be affected by the activities, and the anticipated effects on marine mammals. In that notice, we requested public input on the request for authorization described therein, our analyses, the proposed authorization, and any other aspect of the notice of proposed IHA, and requested that interested persons submit relevant information, suggestions, and comments. This proposed notice was available for a 30-day public comment period. NMFS received no public comments.

Description of Marine Mammals in the Area of Specified Activities

Sections 3 and 4 of the application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species. NMFS fully considered all of this information, and we refer the reader to these descriptions, instead of reprinting the information. Additional information regarding population trends and threats may be found in NMFS' Stock Assessment Reports (SARs; *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*) and more general information about these species (*e.g.,* physical and behavioral descriptions) may be found on NMFS' website (*https://www.fisheries.noaa.gov/find-species).*

Table 1 lists all species or stocks for which take is expected and authorized for this activity and summarizes information related to the population or stock, including regulatory status under the MMPA and Endangered Species Act (ESA) and potential biological removal (PBR), where known. PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (as described in NMFS' SARs). While no serious injury or mortality is anticipated or authorized here, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species or stocks and other threats.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS' stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS' U.S. Atlantic and Gulf of Mexico

SARs. All values presented in Table 1 are the most recent available at the time of publication and are available online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.*

TABLE 1—SPECIES LIKELY IMPACTED BY THE SPECIFIED ACTIVITIES [1]

Common name	Scientific name	Stock	ESA/MMPA status; strategic (Y/N) [2]	Stock abundance (CV, N_{min}, most recent abundance survey) [3]	PBR	Annual M/SI [4]	Gulf of Mexico population abundance (Roberts et al. 2016)
Odontoceti (toothed whales, dolphins, and porpoises)							
Family Delphinidae:							
Atlantic spotted dolphin.	*Stenella frontalis*	Gulf of Mexico	-/-; N	21,506 (0.26; 17,339; 2018).	166	36	47,488
Rough-toothed dolphin.	*Steno bredanensis*	Gulf of Mexico	-/-; N	unk (n/a; unk; 2018)	undetermined	39	4,853
Bottlenose dolphin	*Tursiops truncatus*	Gulf of Mexico Western Coastal.	-/-; N	20,759 (0.13; 18,585; 2018).	167	36	138,602
		Northern Gulf of Mexico Continental Shelf.	-/-; N	63,280 (0.11; 57,917; 2018).	556	65	138,602

[1] Information on the classification of marine mammal species can be found on the web page for The Society for Marine Mammalogy's Committee on Taxonomy (*https://marinemammalscience.org/science-and-publications/list-marine-mammal-species-subspecies/;* Committee on Taxonomy (2022)).

[2] ESA status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.

[3] NMFS marine mammal stock assessment reports online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.* CV is coefficient of variation; N_{min} is the minimum estimate of stock abundance.

[4] These values, found in NMFS's SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g.,* commercial fisheries, vessel strike). Annual M/SI (mortality/serious injury) often cannot be determined precisely and is in some cases presented as a minimum value or range.

As indicated above, all 3 species (with 4 managed stocks) in Table 1 temporally and spatially co-occur with the activity to the degree that take is reasonably likely to occur. All species that could potentially occur in the planned survey areas are included in Table 2 of the IHA application. While the additional 11 species listed in Table 2 of UT's application have been infrequently sighted in the survey area, the temporal and/or spatial occurrence of these species is such that take is not expected to occur, and they are not discussed further beyond the explanation provided here. Species or stocks that only occur in deep waters (>200 m) within the Gulf of Mexico are unlikely to be observed during this survey where the maximum water depth is 20 m, and thus, the following species or stocks will not be considered further: offshore stock of bottlenose dolphins, pantropical spotted dolphin, spinner dolphin, striped dolphin, Clymene dolphin, Fraser's dolphin, Risso's dolphin, melon-headed whale, pygmy killer whale, false killer whale, killer whale, and short-finned pilot whale.

A detailed description of the species likely to be affected by the geophysical survey, including brief introductions to the species and relevant stocks as well as available information regarding population trends and threats, and information regarding local occurrence, were provided in the **Federal Register** notice for the proposed IHA (88 FR 53453, August 8, 2023); since that time, we are not aware of any changes in the status of these species and stocks; therefore, detailed descriptions are not provided here. Please refer to that **Federal Register** notice for these descriptions. Please also refer to NMFS' website (*https://www.fisheries.noaa.gov/find-species*) for generalized species accounts.

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007, 2019) recommended that marine mammals be divided into hearing groups based on directly measured (behavioral or auditory evoked potential techniques) or estimated hearing ranges (behavioral response data, anatomical modeling, *etc.*). Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65-decibel (dB) threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. Marine mammal hearing groups and their associated hearing ranges are provided in Table 2.

TABLE 2—MARINE MAMMAL HEARING GROUPS

[NMFS, 2018]

Hearing group	Generalized hearing range *
Low-frequency (LF) cetaceans (baleen whales)	7 hertz (Hz) to 35 kilohertz (kHz).
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz.

TABLE 2—MARINE MAMMAL HEARING GROUPS—Continued

[NMFS, 2018]

Hearing group	Generalized hearing range *
High-frequency (HF) cetaceans (true porpoises, *Kogia,* river dolphins, Cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*).	275 Hz to 160 kHz.
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz.
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz.

* Represents the generalized hearing range for the entire group as a composite (*i.e.,* all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall *et al.* 2007) and PW pinniped (approximation).

The pinniped functional hearing group was modified from Southall *et al.* (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al.,* 2006; Kastelein *et al.,* 2009; Reichmuth and Holt, 2013).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information.

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

The effects of underwater noise from UT's survey activities have the potential to result in behavioral harassment of marine mammals in the vicinity of the survey area. The notice of proposed IHA (88 FR 53453, August 8, 2023) included a discussion of the effects of anthropogenic noise on marine mammals and the potential effects of underwater noise from UT on marine mammals and their habitat. That information and analysis is incorporated by reference into this final IHA determination and is not repeated here; please refer to the notice of proposed IHA (88 FR 53453, August 8, 2023).

Estimated Take of Marine Mammals

This section provides an estimate of the number of incidental takes authorized through the IHA, which will inform both NMFS' consideration of ''small numbers,'' and the negligible impact determinations.

Harassment is the only type of take expected to result from these activities. Except with respect to certain activities not pertinent here, section 3(18) of the MMPA defines ''harassment'' as any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

Authorized takes will be by Level B harassment only, in the form of disruption of behavioral patterns for individual marine mammals resulting from exposure to sound from low energy seismic airguns. Based on the nature of the activity, Level A harassment is neither anticipated nor authorized. As described previously, no serious injury or mortality is anticipated or authorized for this activity. Below we describe how the authorized take numbers are estimated.

For acoustic impacts, generally speaking, we estimate take by considering: (1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) the number of days of activities. We note that while these factors can contribute to a basic calculation to provide an initial prediction of potential takes, additional information that can qualitatively inform take estimates is also sometimes available (*e.g.,* previous monitoring results or average group size). Below, we describe the factors considered here in more detail and present the take estimates.

Acoustic Thresholds

NMFS recommends the use of acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur permanent threshold shift (PTS) of some degree (equated to Level A harassment).

Level B Harassment—Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source or exposure context (*e.g.,* frequency, predictability, duty cycle, duration of the exposure, signal-to-noise ratio, distance to the source), the environment (*e.g.,* bathymetry, other noises in the area, predators in the area), and the receiving animals (hearing, motivation, experience, demography, life stage, depth) and can be difficult to predict (*e.g.,* Southall *et al.,* 2007, 2021; Ellison *et al.,* 2012). Based on what the available science indicates and the practical need to use a threshold based on a metric that is both predictable and measurable for most activities, NMFS typically uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS generally predicts that marine mammals are likely to be behaviorally harassed in a manner considered to be Level B harassment when exposed to underwater anthropogenic noise above root-mean-squared pressure received levels (RMS SPL) of 120 dB (re 1 micropascal (μPa)) for continuous (*e.g.,* vibratory pile driving, drilling) and above RMS SPL 160 dB re 1 μPa for non-explosive impulsive (*e.g.,* seismic airguns) or intermittent (*e.g.,* scientific sonar) sources. Generally speaking, Level B harassment take estimates based on these behavioral harassment thresholds are expected to include any likely takes by temporary threshold shift (TTS) as, in most cases, the likelihood of TTS occurs at distances from the source less than those at which behavioral harassment is likely. TTS of a sufficient degree can manifest as behavioral harassment, as reduced hearing sensitivity and the potential reduced opportunities to detect important signals (conspecific communication, predators, prey) may result in changes in behavior patterns that would not otherwise occur.

UT's planned survey includes the use of impulsive seismic sources (*e.g.,* GI-airgun) and therefore, the 160 dB re 1 μPa (rms) criterion is applicable for analysis of Level B harassment.

Level A harassment—NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). UT's planned survey includes the use of impulsive sources.

These thresholds are provided in the Table 3 and 4 below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS' 2018 Technical Guidance, which may be accessed at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

Ensonified Area

Here, we describe operational and environmental parameters of the activity that are used in estimating the area ensonified above the acoustic thresholds, including source levels and transmission loss coefficient.

The planned survey will entail the use of up to two 105 in³ airguns with a maximum total discharge of 210 in³ at a tow depth of 3–4 m. Lamont-Doherty Earth Observatory (L–DEO) model results were used to determine the 160 dB_{rms} radius for the two-airgun array in water depths >100 m. Received sound levels were predicted by L–DEO's model (Diebold *et al.,* 2010) as a function of distance from the airguns for the two 105 in³ airguns with a maximum total discharge of 210 in³. 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 homogenous ocean layer, unbounded by a seafloor).

The planned surveys will acquire data with up to two 105-in³ GI guns (separated by up to 2.4 m) at a tow depth of ~3–4 m. The shallow-water radii are obtained by scaling the empirically derived measurements from the Gulf of Mexico calibration survey to account for the differences in volume and tow depth between the calibration survey (6,600 in³ at 6 m tow depth) and the planned survey (210 in³ at 4 m tow depth). A simple scaling factor is calculated from the ratios of the isopleths calculated by the deep-water L–DEO model, which are essentially a measure of the energy radiated by the source array.

L–DEO's methodology is described in greater detail in UT's IHA application. The estimated distances to the Level B harassment isopleth for the planned airgun configuration are shown in Table 3.

TABLE 3—PREDICTED RADIAL DISTANCES FROM THE R/V BROOKS MCCALL SEISMIC SOURCE TO ISOPLETHS CORRESPONDING TO LEVEL B HARASSMENT THRESHOLD

Airgun configuration	Water depth (m)	Predicted distances (m) to 160 dB received sound level
Two 105-in GI guns	<100	[1] 1,750

[1] Distance is based on empirically derived measurements in the Gulf of Mexico with scaling applied to account for differences in tow depth.

The ensonified area associated with Level A harassment is more technically challenging to predict due to the need to account for a duration component. Therefore, NMFS developed an optional user spreadsheet tool to accompany the Technical Guidance (2018) that can be used to relatively simply predict an isopleth distance for use in conjunction with marine mammal density or occurrence to help predict potential takes. We note that because of some of the assumptions included in the methods underlying this optional tool, we anticipate that the resulting isopleth estimates are typically going to be overestimates of some degree, which may result in an overestimate of potential take by Level A harassment. However, this optional tool offers the best way to estimate isopleth distances when more sophisticated modeling methods are not available or practical. Table 4 presents the modeled PTS isopleths for mid-frequency cetaceans, the only hearing group for which takes are expected, based on L–DEO modeling incorporated in the companion User Spreadsheet (NMFS 2018).

TABLE 4—MODELED RADIAL DISTANCES TO ISOPLETHS CORRESPONDING TO LEVEL A HARASSMENT THRESHOLDS

Hearing group	MF
PTS Peak	1.5
PTS SEL_{cum}	0

Predicted distances to Level A harassment isopleths, which vary based on marine mammal hearing groups, were calculated based on modeling performed by L–DEO using the Nucleus software program and the NMFS User Spreadsheet, described below. The acoustic thresholds for impulsive sounds (*e.g.,* airguns) contained in the Technical Guidance (2018) were presented as dual metric acoustic thresholds using both cumulative sound energy (SEL_{cum}) and peak sound pressure metrics (NMFS 2016a). As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (*i.e.,* metric resulting in the largest isopleth). The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group. In recognition of the fact that the requirement to calculate Level A harassment ensonified areas could be more technically challenging to predict due to the duration component and the use of weighting functions in the new SEL_{cum} thresholds, NMFS developed an optional User Spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to facilitate the estimation of take numbers.

The SEL_{cum} for the two-GI airgun 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 (right) 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 interactions of the two airguns that occur near the source center and is calculated as a point source (single airgun), the modified farfield signature is a more appropriate measure of the sound source level for large arrays. For this smaller array, the modified farfield changes will be correspondingly smaller as well, but this method is used for consistency across all array sizes.

Auditory injury for all species is unlikely to occur given the small modeled zones of injury (estimated zone less than 2 m for mid-frequency cetaceans). Additionally, animals are expected to have aversive/compensatory behavior in response to the activity (Nachtigall *et al.,* 2018) further limiting the likelihood of auditory injury for all species. UT did not request authorization of take by Level A harassment, and no take by Level A harassment is authorized by NMFS.

Marine Mammal Occurrence

In this section we provide information about the occurrence of marine mammals, including density or other relevant information which will inform the take calculations.

For the planned survey area in the northwest Gulf of Mexico, UT determined that the best source of density data for marine mammal species that might be encountered in the project area was habitat-based density modeling conducted by Garrison *et al.* (2022). The Garrison *et al.* (2022) data provides abundance estimates for marine mammal species in the Gulf of Mexico within 40 km^2 hexagons (~3.9 km sides and ~7 km across from each side) on a monthly basis. To calculate expected densities specific to the survey area, UT created a 7 km perimeter around the survey area and used that perimeter to select the density hexagons for each species in each month. The 7 km distance was chosen for the perimeter to ensure that at least one full density hexagon outside the survey area in all directions was selected, providing a more robust sample for the calculations. They then calculated the mean of the predicted densities from the selected cells for each species and month. The highest mean monthly density was chosen for each species from the months of September to December (*i.e.,* the months within which the survey is expected to occur). NMFS concurred with this approach to calculate species density.

Rough-toothed dolphins were not modeled by Garrison *et al.* (2022) due to a lack of sightings, so habitat-based marine mammal density estimates from Roberts *et al.* (2016) were used. The Roberts *et al.* (2016) models consisted of 10 km x 10 km grid cells containing average annual densities for U.S. waters in the Gulf of Mexico. The same 7 km perimeter described above was used to select grid cells from the Roberts *et al.* (2016) dataset, and the mean of the selected grid cells for rough-toothed dolphins was calculated to estimate the annual average density of the species in the survey area. Estimated densities used and Level B harassment ensonified areas to inform take estimates are presented in Table 5.

TABLE 5—MARINE MAMMAL DENSITIES AND TOTAL ENSONIFIED AREA OF ACTIVITIES IN THE PLANNED SURVEY AREA

Species	Estimated density (#/km^2)	Level B ensonified area (km^2)
Atlantic spotted dolphin	[b] 0.00082	7,866
Bottlenose dolphin [a]	[b] 0.34024	7,866
Rough-toothed dolphin	[c] 0.00362	7,866

[a] Bottlenose dolphin density estimate does not differentiate between coastal and shelf stocks.
[b] Density calculated from Garrison *et al.* (2022).
[c] Density calculated from Roberts *et al.* (2016).

Take Estimation

Here, we describe how the information provided above is synthesized to produce a quantitative estimate of the take that is reasonably likely to occur and authorized. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in Level B harassment, radial distances from the airgun array to the predicted isopleth corresponding to the Level B harassment threshold was calculated, as described above. Those radial distances were then used to calculate the area(s) around the airgun array predicted to be ensonified to sound levels that exceed the harassment thresholds. The area expected to be ensonified on 1 day was determined by multiplying the number of line km possible in 1 day by two times the 160-dB radius plus adding endcaps to the start and beginning of the line. The daily ensonified area was then multiplied by the number of survey days (10 days). The highest mean monthly density for each species was then multiplied by the total ensonified area to calculate the estimated takes of each species.

No takes by Level A harassment are expected or authorized. Estimated takes for the planned survey are shown in Table 6.

TABLE 6—ESTIMATED TAKE FOR AUTHORIZATION

Species	Stock	Estimated take	Authorized take	Stock abundance [1]	Percent of stock
		Level B	Level B		
Atlantic spotted dolphin	Gulf of Mexico	6	[2] 26	21,506	0.12
Bottlenose dolphin [3]	Gulf of Mexico Western Coastal	2,676	2,676	20,759	12.89
	Northern Gulf of Mexico Continental Shelf			63,280	4.23
Rough-toothed dolphin	Gulf of Mexico	28	28	[3] 4,853	0.58

[1] Stock abundance for Atlantic spotted dolphins and bottlenose dolphins was taken from Garrison *et al.* (2022). Stock abundance for rough-toothed dolphins was taken from Roberts *et al.* (2016), as Garrison *et al.* (2022) did not create a model for this species.
[2] Estimated take increased to mean group size from Maze-Foley and Mullin (2006).
[3] Estimated take for bottlenose dolphins is not apportioned to stock, as density information does not differentiate between coastal and shelf dolphins. However, based on the planned survey depths, we expect that most of the takes would be from the coastal stock, but some takes could be from the shelf stock. Percent of stock was calculated as if all takes estimated for authorization accrued to the single stock with the lowest population abundance.

Mitigation

In order to issue an IHA under section 101(a)(5)(D) of the MMPA, NMFS must set forth the 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, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stock for taking for certain subsistence uses (latter not applicable for this action). NMFS regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting the activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, and their habitat (50 CFR 216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, NMFS considers two primary factors:

(1) The manner in which, and the degree to which, the successful implementation of the measure(s) is expected to reduce impacts to marine mammals, marine mammal species or stocks, and their habitat. This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned), the likelihood of effective implementation (probability implemented as planned), and;

(2) The practicability of the measures for applicant implementation, which may consider such things as cost, and impact on operations.

Mitigation measures that will be adopted during the planned survey include, but are not limited to: (1) vessel speed or course alteration, provided that doing so would not compromise operation safety requirements; (2) monitoring a pre-start clearance zone; and (3) ramp-up procedures.

Vessel-Visual Based Mitigation Monitoring

Visual monitoring requires the use of trained observers (herein referred to as visual protected species observers (PSOs)) to scan the ocean surface visually for the presence of marine mammals. PSOs shall establish and monitor a pre-start clearance zone and, to the extent practicable, a Level B harassment zone (Table 3). These zones shall be based upon the radial distance from the edges of the acoustic source (rather than being based on the center of the array or around the vessel itself). During pre-start clearance (*i.e.,* before ramp-up begins), the pre-start clearance zone is the area in which observations of marine mammals within the zone would prevent airgun operations from beginning (*i.e.,* ramp-up). The pre-start clearance zone encompasses the area at and below the sea surface out to a radius of 200 meters from the edges of the airgun array.

During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur, and whenever the acoustic source 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). Visual monitoring must begin no less than 30 minutes prior to ramp-up and must continue until 1 hour after use of the acoustic source ceases or until 30 minutes past sunset. Visual PSOs must coordinate to ensure 360 degree 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.

PSOs shall establish and monitor a pre-start clearance zone and to the extent practicable, a Level B harassment zone. These zones shall be based upon the radial distance from the edges of the acoustic source (rather than being based on the center of the array or around the vessel itself).

Any observations of marine mammals by crew members shall be relayed to the PSO team. During good conditions (*e.g.,* daylight hours, Beaufort sea state (BSS) three or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sightings rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

Visual PSOs may be on watch for a maximum of 4 consecutive hours followed by a break of at least 1 hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period.

Pre-Start Clearance and Ramp-Up

Ramp-up is the gradual and systematic increase of emitted sound levels from an acoustic source. Ramp-up will begin with one GI airgun 105 in^3 first being activated, followed by the second after 5 minutes. The intent of pre-clearance observation (30 minutes) is to ensure no marine mammals are observed within the pre-start clearance zone prior to the beginning of ramp-up. The intent of ramp-up is to warn marine mammals in the vicinity of survey activities and to allow sufficient time for those animals to leave the immediate vicinity. A ramp-up procedure, involving a stepwise increase in the number of airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. All operators must adhere to the following pre-clearance and ramp-up requirements:

(1) 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 PSOs time to monitor the pre-start clearance zone for 30 minutes prior to the initiation of ramp-up (pre-start clearance);

- Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in;
- One of the PSOs conducting pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed;
- Ramp-up may not be initiated if any marine mammal is within the pre-start clearance zone. If a marine mammal is observed within the pre-start clearance zone during the 30 minutes pre-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 delphinids and 30 minutes for all other species);
- Ramp-up must begin by activating the first airgun for 5 minutes and then adding the second airgun; and
- PSOs must monitor the pre-start clearance zone during ramp-up, and ramp-up must cease and the source must be shut down upon detection of a marine mammal within the pre-start clearance zone. Once ramp-up has begun, observations of marine mammals for which take authorization is granted within the pre-start clearance zone does not require shutdown.

(2) If the acoustic source is shut down for brief periods (*i.e.,* less than 30 minutes) for reasons other than implementation of prescribed mitigation (*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 pre-start clearance zone. For any longer shutdown, pre-start clearance observation and ramp-up are required. Ramp-up may occur at times of poor visibility (*e.g.,* BSS 4 or greater), including nighttime, if appropriate visual monitoring has occurred with no detections of marine mammals in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at night where operational planning cannot reasonably avoid such circumstances.

- Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require a 30 minute pre-start clearance period.

Shutdown Procedures

The shutdown requirement will be waived for small dolphins. As defined here, the small dolphin group is intended to encompass those members of the Family Delphinidae most likely to voluntarily approach the source vessel for purposes of interacting with the vessel and/or airgun array (*e.g.,* bow riding). This exception to the shutdown requirement applies solely to specific genera of small dolphins—Steno, Stenella, and Tursiops. As Tursiops and Steno are the only species expected to potentially be encountered, there is no shutdown requirement included in the IHA for species for which take is authorized.

Vessel Strike Avoidance Measures

These measures apply to all vessels associated with the planned survey activity; however, we note that these requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply. These measures include the following:

(1) Vessel operators and crews 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 mammal. A single marine mammal at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should be exercised when an animal is observed. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (specific distances detailed below), to ensure the potential for strike is minimized. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers 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 as a baleen whale, sperm whale, or other marine mammals;

(2) Vessel speeds must be reduced to 10 knots (kn) (18.5 km/h) or less when mother and calf pairs, pods, or large assemblages of cetaceans are observed near a vessel;

(3) All vessels must maintain a minimum separation distance of 100 m from sperm whales;

(4) All vessels must maintain a minimum separation distance of 500 m baleen whales. If a baleen whale is sighted within the relevant separation distance, the vessel must steer a course away at 10 kn or less until the 500 m separation distance has been established. If a whale is observed but cannot be confirmed as a species other than a baleen whale, the vessel operator must assume that it is a baleen whale and take appropriate action.

(5) All vessels 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); and

(6) When marine mammals are sighted while a vessel is underway, the vessel should 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). This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

Based on our evaluation of the applicant's planned measures, NMFS has determined that the mitigation measures provide the means of effecting the least practicable impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Monitoring and Reporting

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present while conducting the activities. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to improved understanding of one or more of the following:

- Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.,* presence, abundance, distribution, density);
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) action or environment (*e.g.,* source characterization, propagation, ambient noise); (2) affected species (*e.g.,* life history, dive patterns); (3) co-occurrence of marine mammal species with the activity; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas);
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors;
- How anticipated responses to stressors impact either: (1) long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks;
- Effects on marine mammal habitat (*e.g.,* marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat); and,
- Mitigation and monitoring effectiveness.

Vessel-Based Visual Monitoring

As described above, PSO observations will take place during daytime airgun operations. Two visual PSOs will be on duty at all time during daytime hours. Monitoring shall be conducted in accordance with the following requirements:

(1) UT 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, and to ensure that PSOs are capable of calibrating equipment as necessary for accurate distance estimates and species identification. See Condition 5(d) in the IHA for list of equipment.

PSOs must have the following requirements and qualifications:

(1) PSOs shall be independent, dedicated and trained and must be employed by a third-party observer provider;

(2) PSOs shall have no tasks other than to conduct visual observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards);

(3) PSOs shall have successfully completed an approved PSO training course appropriate for their designated task (visual);

(4) NMFS must review and approve PSO resumes accompanied by a relevant training course information packet that includes the name and qualifications (*i.e.,* experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material as well as a document stating successful completion of the course;

(5) 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;

(6) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least 1 undergraduate course in math or statistics; and

(7) The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests shall 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:

- Secondary education and/or experience comparable to PSO duties;
- Previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or
- Previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

At least one visual PSO must be unconditionally approved (*i.e.,* have a minimum of 90 days at-sea experience working in that role at the particular Tier level (1–3) with no more than 18 months elapsed since the conclusion of the at-sea experience). One PSO with such experience shall be designated as the lead for the entire PSO team. The lead PSO shall serve as primary point of contact for the vessel operator. To the maximum extent practicable, the duty schedule shall be planned such that unconditionally-approved PSOs are on duty with conditionally-approved PSOs.

PSOs must use standardized electronic data collection forms. At a minimum, the following information must be recorded:

- Vessel name, vessel size and type, maximum speed capability of vessel;
- Dates (MM/DD/YYYY format) of departures and returns to port with port name;
- PSO names and affiliations, PSO identification (ID; initials or other identifier);
- Date (MM/DD/YYYY) and participants of PSO briefings;
- Visual monitoring equipment used (description);
- PSO location on vessel and height (in meters) of observation location above water surface;
- Watch status (description);
- Dates (MM/DD/YYYY) and times (Greenwich mean time (GMT) or coordinated universal time (UTC)) of survey on/off effort and times (GMC/UTC) corresponding with PSO on/off effort;
- Vessel location (decimal degrees) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
- Vessel location (decimal degrees) at 30-second intervals if obtainable from data collection software, otherwise at practical regular interval;
- Vessel heading (compass heading) and speed (in knots) at beginning and end of visual PSO duty shifts and upon any change;
- Water depth (in meters) (if obtainable from data collection software);
- Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
- 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
- Vessel/Survey activity information (and changes thereof) (description), such as acoustic source power output while in operation, number and volume of acoustic source operating in the array, tow depth of the acoustic source, and any other notes of significance (*i.e.,* pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, *etc.*).

The following information should be recorded upon visual observation of any marine mammal:

- Sighting ID (numeric);

• Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
• Location of PSO/observer (description);
• Vessel activity at the time of the sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other);
• PSO who sighted the animal/PSO ID;
• Time and date of sighting (GMT/UTC, MM/DD/YYYY);
• Initial detection method (description);
• Sighting cue (description);
• Vessel location at time of sighting (decimal degrees);
• Water depth (in meters);
• Direction of vessel's travel (compass direction);
• Speed (knots) of the vessel from which the observation was made;
• Direction of animal's travel relative to the vessel (description, compass heading);
• Bearing to sighting (degrees);
• 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;
• Species reliability (an indicator of confidence in identification) (1 = unsure/possible, 2 = probable, 3 = definite/sure, 9 = unknown/not recorded);
• Estimated distance to the animal (meters) and method of estimating distance;
• Estimated number of animals (high, low, and best) (numeric);
• Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, *etc.*);
• 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);
• 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);
• Animal's closest point of approach (in meters) and/or closest distance from any element of the acoustic source;
• Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up) and time and location of the action.
• Photos (Yes or No);
• Photo Frame Numbers (List of numbers); and
• Conditions at time of sighting (Visibility; BSS).

Reporting

UT must submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report will describe the activities that were conducted and sightings of marine mammals. The report will provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90 day report will summarize the dates and locations of survey operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities).

The draft report shall also include 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). Geographic information system (GIS) files shall be provided in Environmental Systems Research Institute (ESRI) shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available to NMFS. A final report must be submitted within 30 days following resolution of any comments on the draft report.

Reporting Injured or Dead Marine Mammals

Sighting of injured or dead marine mammals—In the event that personnel involved in survey activities covered by the authorization discover an injured or dead marine mammal, UT shall report the incident to the OPR, NMFS, and the NMFS Southeast Regional Stranding Coordinator as soon as feasible. The report must include the following information:

• Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
• Species identification (if known) or description of the animal(s) involved;
• Condition of the animal(s) (including carcass condition if the animal is dead);
• Observed behaviors of the animal(s), if alive;
• If available, photographs or video footage of the animal(s); and
• General circumstances under which the animal was discovered.

Vessel strike—In the event of a vessel strike of a marine mammal by any vessel involved in the activities covered by the authorization, UT shall report the incident to OPR, NMFS and to the NMFS Southeast Regional Stranding Coordinator as soon as feasible. The report must include the following information:

• Time, date, and location (latitude/longitude) of the incident;
• Vessel's speed during and leading up to the incident;
• Vessel's course/heading and what operations were being conducted (if applicable);
• Status of all sound sources in use;
• Description of avoidance measures/requirements that were in place at the time of the strike and what additional measure were taken, if any, to avoid strike;
• Environmental conditions (*e.g.,* wind speed and direction, BSS, cloud cover, visibility) immediately preceding the strike;
• Species identification (if known) or description of the animal(s) involved;
• Estimated size and length of the animal that was struck;
• Description of the behavior of the animal immediately preceding and following the strike;
• If available, description of the presence and behavior of any other marine mammals present immediately preceding the strike;
• 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
• To the extent practicable, photographs or video footage of the animal(s).

Negligible Impact Analysis and Determination

NMFS has defined negligible impact as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.,* population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be ''taken'' through harassment, NMFS considers other factors, such as the likely nature of any impacts or responses (*e.g.,* intensity, duration), the context of any impacts or responses (*e.g.,* critical reproductive time or location, foraging impacts affecting energetics), as well as effects on habitat, and the likely effectiveness of the mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS' implementing regulations (54 FR 40338, September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

To avoid repetition, the discussion of our analysis applies to all the species listed in Table 1, given that the anticipated effects of this activity on these different marine mammal stocks are expected to be similar. There is little information about the nature or severity of the impacts, or the size, status, or structure of any of these species or stocks that would lead to a different analysis for this activity.

NMFS does not anticipate that serious injury or mortality would occur as a result from low-energy survey, and no serious injury or mortality is proposed to be authorized. As discussed in the Potential Effects of Specified Activities on Marine Mammals and Their Habitat section, non-auditory physical effects and vessel strike are not expected to occur. NMFS expects that all potential take would be in the form of Level B behavioral harassment in the form of temporary avoidance of the area or decreased foraging (if such activity was occurring), responses that are considered to be of low severity and with no lasting biological consequences (*e.g.,* Southall *et al.,* 2007, 2021).

In addition to being temporary, the maximum expected Level B harassment zone around the survey vessel is 1,750 m. Therefore, the ensonified area surrounding the vessel is relatively small compared to the overall distribution of animals in the area and their use of the habitat. Feeding behavior is not likely to be significantly impacted as prey species are mobile and are broadly distributed throughout the survey area; therefore, marine mammals that may be temporarily displaced during survey activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the short duration (10 days) of the disturbance and the availability of similar habitat and resources in the surrounding area, the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations.

There are no rookeries, mating, or calving grounds known to be biologically important to marine mammals within the planned survey area and there are no feeding areas known to be biologically important to marine mammals within the survey area. There is no designated critical habitat for any ESA-listed marine mammals within the project area.

In summary and as described above, the following factors primarily support our determination that the impacts resulting from this activity are not expected to adversely affect the species or stock through effects on annual rates of recruitment or survival:

(1) No serious injury or mortality is anticipated or authorized;

(2) No Level A harassment is anticipated or authorized, even in the absence of mitigation measures;

(3) Take is anticipated to be by Level B harassment only consisting of temporary behavioral changes of small percentages of the affected species due to avoidance of the area around the survey vessel. The relatively short duration of the planned survey (10 days) will further limit the potential impacts of any temporary behavioral changes that would occur;

(4) The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the planned survey to avoid exposure to sounds from the activity;

(5) Foraging success is not likely to be significantly impacted as effects on prey species for marine mammals would be temporary and spatially limited; and

(6) The mitigation measures, including visual monitoring, ramp-ups, and shutdowns are expected to minimize potential impacts to marine mammals.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the monitoring and mitigation measures, NMFS finds that the total marine mammal take from the planned activity will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted previously, only take of small numbers of marine mammals may be authorized under section 101(a)(5)(A) and (D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers and so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or stock in our determination of whether an authorization is limited to small numbers of marine mammals. When the predicted number of individuals to be taken is fewer than one-third of the species or stock abundance, the take is considered to be of small numbers. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

NMFS is authorizing incidental take by Level B harassment of three marine mammal species with four managed stocks. The total amount of takes authorized relative to the best available population abundance is less than 5 percent for 3 managed stocks and less than 13 percent for 1 managed stock (Gulf of Mexico Western Coastal stock of bottlenose dolphin assuming all takes by Level b harassment are of this stock; see Take Estimation subsection) (Table 6). The take numbers authorized are considered conservative estimates for purposes of the small numbers determination as they assume all takes represent different individual animals, which is unlikely to be the case.

Based on the analysis contained herein of the planned activity (including the mitigation and monitoring measures) and the anticipated take of marine mammals, NMFS finds that small numbers of marine mammals would be taken relative to the population size of the affected species or stocks.

Unmitigable Adverse Impact Analysis and Determination

There are no relevant subsistence uses of the affected marine mammal stocks or species implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act

Section 7(a)(2) of the ESA (16 U.S.C. 1531 *et seq.*) requires that each Federal agency insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. To ensure ESA compliance for the issuance of IHAs, NMFS consults internally whenever we propose to authorize take for endangered or threatened species.

No incidental take of ESA-listed species is authorized or expected to result from this activity. Therefore, NMFS has determined that formal consultation under section 7 of the ESA is not required for this action.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216–6A, NMFS must review our action (*i.e.,* the issuance of an IHA) with respect to potential impacts on the human environment.

This action is consistent with categories of activities identified in Categorical Exclusion B4 (IHAs with no anticipated serious injury or mortality) of the Companion Manual for NOAA Administrative Order 216–6A, which do not individually or cumulatively have the potential for significant impacts on the quality of the human environment and for which we have not identified any extraordinary circumstances that would preclude this categorical exclusion. Accordingly, NMFS has determined that the issuance of the IHA qualifies to be categorically excluded from further NEPA review.

Authorization

NMFS has issued an IHA to UT for the potential harassment of small numbers of three marine mammal species incidental to the marine geophysical survey in coastal waters off of Texas that includes the previously explained mitigation, monitoring and reporting requirements.

Dated: September 22, 2023.

Catherine Marzin,

Deputy Director, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. 2023–21089 Filed 9–26–23; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XD404]

Gulf of Mexico Fishery Management Council; Public Meeting

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of a public meeting.

SUMMARY: The Gulf of Mexico Fishery Management Council will hold a one day in-person meeting of its Shrimp Advisory Panel (AP).

DATES: The meeting will convene Thursday, October 19, 2023, from 8:30 a.m. to 5 p.m., EDT. For agenda details, see **SUPPLEMENTARY INFORMATION**.

ADDRESSES: The meeting will take place at the Gulf Council office. Registration information will be available on the Council's website by visiting *www.gulfcouncil.org* and clicking on the Shrimp AP meeting on the calendar.

Council address: Gulf of Mexico Fishery Management Council, 4107 W. Spruce Street, Suite 200, Tampa, FL 33607; telephone: (813) 348–1630.

FOR FURTHER INFORMATION CONTACT: Dr. Matt Freeman, Economist, Gulf of Mexico Fishery Management Council; *matt.freeman@gulfcouncil.org;* telephone: (813) 348–1630.

SUPPLEMENTARY INFORMATION: The following items are on the agenda, though agenda items may be addressed out of order (changes will be noted on the Council's website when possible.)

Thursday, *October 19, 2023; 8:30 a.m.–5 p.m. EST (7:30 a.m.–4 p.m. CST).*

Meeting will begin with Adoption of Agenda, Approval of Summaries from the March 15–16, 2023, meeting and the May 18, 2023, meeting, and Scope of Work. The AP will review and discuss Council Actions in Response to Motions from the April and May 2023 Shrimp AP Meetings, receive a presentation on National Marine Fisheries Service (NMFS) cellular vessel monitoring system Project, discuss a collaborative path forward to Understand Inshore Shrimping Effort to Inform Sea Turtle Restoration Efforts in the Gulf of Mexico.

The AP will receive updates from Bureau of Ocean Energy Management (BOEM) on Gulf Wind Energy, on re-initiation of Shrimp Biological Opinion due to Sawfish and Giant Manta Rays, and on Endangered Species Act Listing and Critical Habitat Rule.

The AP will review and discuss SEDAR 87 Assessment update for Brown, White and Pink Shrimp and receive information update on Deepwater Horizon Natural Resource and Damage Assessment projects.

Lastly, the AP will receive any public testimony and discuss other business items.

Meeting Adjourns—

The in-person meeting will be broadcast via webinar. You may register by visiting *www.gulfcouncil.org* and clicking on the Shrimp Advisory Panel meeting on the calendar.

The Agenda is subject to change, and the latest version along with other meeting materials will be posted on *www.gulfcouncil.org* as they become available.

Although other non-emergency issues not on the agenda may come before the Advisory Panel for discussion, in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), those issues may not be the subject of formal action during this meeting. Actions will be restricted to those issues specifically identified in this notice and any issues arising after publication of this notice that require emergency action under Section 305(c) of the Magnuson-Stevens Act, provided the public has been notified of the Council's intent to take-action to address the emergency at least 5 working days prior to the meeting.

Special Accommodations

The meeting is physically accessible to people with disabilities. Requests for sign language interpretation or other auxiliary aid or accommodations should be directed to Kathy Pereira, *kathy.pereira@gulfcouncil.org,* at least 5 days prior to the meeting date.

Authority: 16 U.S.C. 1801 *et seq.*

Dated: September 22, 2023.

Rey Israel Marquez,

Acting Deputy Director, Office of Sustainable Fisheries, National Marine Fisheries Service.

[FR Doc. 2023–21060 Filed 9–26–23; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XD405]

Gulf of Mexico Fishery Management Council; Public Meeting

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of a public meeting.

SUMMARY: The Gulf of Mexico Fishery Management Council will hold a meeting of its Law Enforcement Technical Committee (LETC), in conjunction with the Gulf States Marine Fisheries Commission's Law Enforcement Committee (LEC).

DATES: The meeting will convene on Wednesday, October 18, 2023; beginning at 8:30 a.m. until 12 p.m., CDT. The Committees will be in a closed session from 7:30 a.m. until 8:15 a.m. CDT.

APPENDIX G: EFH DETERMINATION LETTER

March 29, 2023

Virginia Fay
Assistant Regional Administrator
Southeast Regional Office
Habitat Conservation Division
National Marine Fisheries Service
263 13th Avenue South
St. Petersburg, FL 33701-5505

Re: Essential Fish Habitat Consultation Request for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, Fall 2023

Dear Ms. Fay:

The University of Texas, with cost-share funding from the Department of Energy (DOE), is proposing to conduct marine geophysical surveys off the coast of Texas, in the Northwestern Gulf of Mexico (Proposed Action). The purpose of the proposed seismic surveys is to validate novel dynamic acoustic positioning technology for improving the accuracy in time and space of high-resolution 3-dimensional (HR3D) marine seismic technology. In particular, the seismic data would be used for field validation of monitoring, verification, and accounting (MVA) technology of offshore sub-seabed carbon storage. The Proposed Action would include the use of up to 2-GI airguns as the energy source within Texas state waters less than 20 m deep. The surveys would occur within the 222 km^2 survey area located at ~28.9–29.1°N, ~94.9–95.2°W (see Figure 1 in Attachment 1). Up to two 105 in^3 GI-airguns would be towed behind the source vessel as the energy source, at a depth of ~3 m; the total possible discharge volume would be ~210 in^3. The receiving system would consist of four 25-m solid-state (solid flexible polymer – not gel or oil filled) hydrophone streamers, spaced 10-m apart (i.e., 30-m spread), towed at a 2-m depth. The airguns would fire at a shot interval of ~12.5 m (~5–10 s). As the airgun(s) are towed along the survey lines, the hydrophone streamers would receive the returning acoustic signals and transfer the data to the on-board processing system. Approximately 1704 km of seismic acquisition are proposed. The surveys would take place in fall 2023 (sometime during September-December) for a period of approximately 10 days.

A Draft Environmental Assessment (Draft EA) pursuant to the National Environmental Policy Act (42 U.S.C. 4321 *et seq.*) was prepared for the Proposed Action entitled, "*Draft Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, Fall 2023*" (Attachment 1). Information about Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) identified within or near the survey area were described in the Draft EA (Attachment 1, Sections 3.6.2 and 3.6.3, respectively). The following information on EFH and HAPC was included in the Draft EA (Attachment 1, Section 3.6).

3.6.2 Essential Fish Habitat

Under the 1976 Magnuson Fisheries Conservation and Management Act (renamed Magnuson Stevens Fisheries Conservation and Management Act in 1996), Essential Fish Habitat (EFH) is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish. "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities (NOAA 2002). The Magnuson Stevens Fishery Conservation and Management Act (16 U.S.C.§1801–1882) established Regional Fishery Management Councils and mandated that Fishery Management Plans (FMPs) be developed to manage exploited fish and invertebrate species responsibly in federal waters of the U.S. When Congress reauthorized the act in 1996 as the Sustainable Fisheries Act, several reforms and changes were made. One change was to charge NMFS with designating and conserving EFH for species managed under existing FMPs.

The Gulf of Mexico fishery management council (GMFMC) is responsible for the management of fishery resources, including designation of EFH, in federal waters of the survey area. Highly migratory species (HMS) that occur in the proposed survey area, such as sharks, swordfish, billfish, and tunas, are managed by NOAA Fisheries under the Atlantic HMS FMP. FMPs for the GoM have been developed for Coastal Migratory Pelagics (such as mackerel and cobia), reef fish, coral, red drum, spiny lobster, stone crab, and shrimp (GMFMC 2022).

EFH has been designated in the GoM for several species and overlaps with the survey area for Coastal Migratory Pelagics/Reef Fish/Shrimp (Fig. 2), as well as Atlantic Highly-Mobile Species. The species and life stages associated with the Atlantic Highly-Mobile Species are described in Table 6; those for Coastal Migratory Pelagics/Reef Fish/Shrimp are shown in Table 7.

TABLE 1. Marine species associated with the Atlantic Highly-Mobile Essential Fish Habitat.

Species	**Life Stages**
Bull Shark	Juvenile/Adult
Spinner Shark	Juvenile/Adult, Neonate
Lemon Shark	Neonate
Scalloped Hammerhead Shark	Neonate
Blacktip Shark (Gulf of Mexico Stock)	Juvenile/Adult, Neonate
Blacknose Shark (Gulf of Mexico Stock)	Juvenile/Adult
Atlantic Sharpnose Shark (Gulf of Mexico Stock)	Juvenile/Adult, Neonate
Bonnethead Shark (Gulf of Mexico Stock)	Adult, Juvenile, Neonate
Finetooth Shark	All

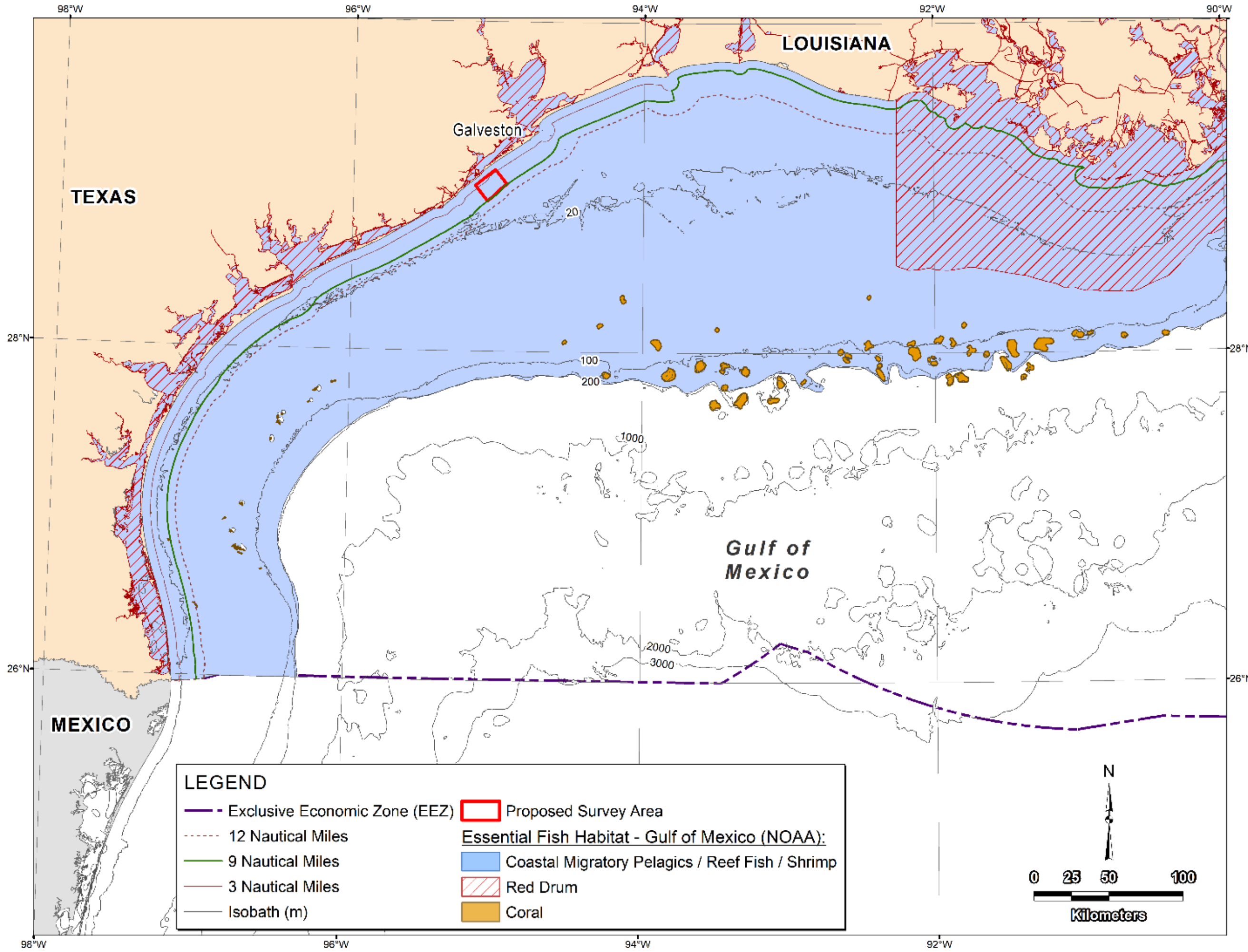

FIGURE 1. Essential Fish Habitat in the northern Gulf of Mexico (Data Source: NOAA 2021b). Not shown is EFH for Atlantic Highly-Mobile Species, as it overlaps with the Coastal Migratory Pelagics/Reef fish/Shrimp EFH.

TABLE 2. Marine species and life stages associated with the Coastal Migratory Pelagics/Reef Fish/Shrimp Essential Fish Habitat in Ecoregions 3,4, and 5 in the northern Gulf of Mexico.

		Depth Range (m) of Various Lifestages[2]						
Common Name[1]	**Species**	**Eggs**	**Larvae**	**Post-Larvae**	**Early Juveniles**	**Late Juveniles**	**Adults**	**Spawning Adults**
Almaco jack	*Seriola rivoliana*	✓	✓	✓	6.7-16.8	6.7-16.8	21-179	✓
Brown shrimp	*Penaeus aztecus*	18-110	0-82	<1	<1	1-18 (Sub-adults)	14-110	18-110
Cobia	*Rachycentron canadum*	<1	3-300	11-53	5-300	1-70	1-70	1-70
Gag	*Mycteroperca microlepis*						13-100	50-120
Goldface tilefish	*Caulolatilus chrysops*						237-345	
Goliath grouper	*Epinephelus itajara*	36-46	36-46		0.5	0-5	0-95	36-46
Gray snapper	*Lutjanus griseus*						0-180	0-180
Gray triggerfish	*Balistes capriscus*	10-100	✓	✓	✓	10-100	10-100	10-100
Greater amberjack	*Seriola dumerili*	✓	offshore	offshore	near&offshore	near&offshore	5-187	offshore
King mackerel	*Scomberomorus cavalla*	35-180	35-180		≤9	nearshore	0-200	35-180
Lane snapper	*Lutjanus synagris*	4-132	0-50	0-50	0-24	0-24	4-132	30-70
Lesser amberjack	*Seriola fasciata*	✓	✓	✓	55-348	55-348	55-348	55-348
Pink shrimp	*Penaeus duorarum*	9-48	1-50	1-50	0-3	1-65 (Sub-adults)	1-110	9-48
Red drum	*Sciaenops ocellatus*	20-30			0-3	0-5	1-70	40-70
Red snapper	*Lutjanus campechanus*	18-126	18-126	18-126	17-183	18-55	7-146	18-126
Royal red shrimp	*Pleoticus robustus*	250-550	250-550	250-550	250-550	250-550	140-730	250-550
Spanish mackerel	*Scomberomorus maculatus*	<50	9-84	9-84	2-9	2-50	3-75	<50
Spiny lobster	*Panulirus argus*		1-100					
Vermilion snapper	*Rhomboplites aurorubens*	18-100	30-40	30-40	18-100	18-100	18-100	18-100
Warsaw grouper	*Epinephelus nigritus*	40-525	40-525	40-525	20-30	20-30	40-525	40-525
Wenchman	*Pristopomoides aquilonaris*	80-200	80-200	80-200	19-481	19-481	19-481	80-200
White shrimp	*Penaeus setiferus*	9-34	0-82	<1	<1	1-30 (Sub-adults)	<27	9-34
Yellowedge grouper	*Hyporthodus flavolimbatus*	35-370	35-370	35-370	9-110	9-110	35-370	35-370
Yellowmouth grouper	*Mycteroperca interstitialis*	20-189	20-189	20-189			20-189	20-189

[1] Species in Ecoregions 3, 4, and 5 (includes waters off Texas, Louisiana, Mississippi, and western Alabama) for Nearshore and/or Offshore Habitat Zones.

[2] Lifestages of species expected to be encountered in the survey area in water <20 m deep are highlighted in gray. Depth ranges shown when available; ✓ indicates that the lifestage is present. Blanks mean that lifestage is not expected to occur in Ecoregions 3, 4, and 5.

Source: https://portal.gulfcouncil.org/EFHreview.html

3.6.3 Habitat Areas of Particular Concern

Habitat Areas of Particular Concern (HAPCs) are a subset of EFH that provide important ecological functions, are especially vulnerable to degradation, or include habitat that is rare (GMFMC 2020). HAPCs are designated by Fishery Management Councils. Although there are several HAPCs, including Coral HAPCs, in the northern GoM, none are near the proposed survey area (NCEI 2022a; Fig. 3). The closest HAPC to the survey area is Stetson Bank (a Coral HAPC) which is located ~110 km southeast (Fig. 3).

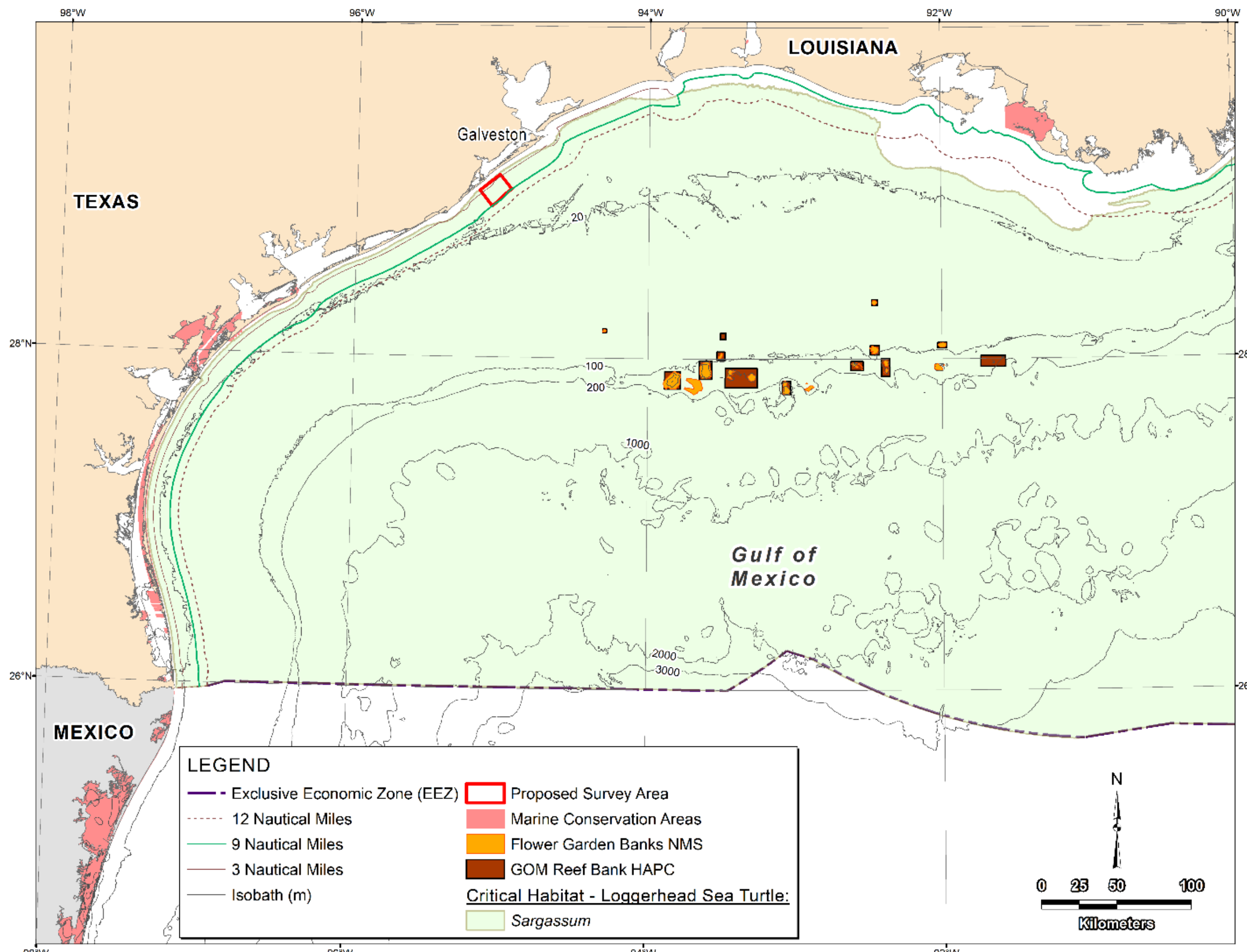

FIGURE 2. Habitat Areas of Particular Concern (HAPC) in the northwestern Gulf of Mexico (Data source: NOAA 2019a).

Effects Determination

Potential effects on EFH and HAPC were considered and included in Chapter 4 of the Draft EA. Although the proposed activities may affect EFH by increasing sound levels in the marine environment, no adverse effects on EFH and no effects on HAPC are expected, as airgun pulses would be intermittent, and activities overall would be of short-term duration (10 days maximum). Monitoring and mitigation measures for the survey were proposed in the Draft EA (Attachment 1, Section 2.1.3 and 4.1.1.4). With the proposed monitoring and mitigation measures, no long-term or significant effects would be expected on individual marine mammals, sea turtles, seabirds, fish, marine invertebrates, the populations to which they belong, or their habitats.

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act, DOE, as the lead action agency, requests consultation for the Proposed Activity. We look forward to consulting with you on this proposed action, and we stand ready to help resolve any concerns expeditiously to ensure that the research efforts may proceed in a timely and environmentally responsible manner. Please contact me if you have any questions or concerns regarding the request or the supporting information.

Sincerely,

Mark W. Lusk
NEPA Compliance Officer

Attachment 1: *DOE/EA-2191D: Draft Environmental Assessment for Marine Geophysical Surveys by University of Texas in the Northwestern Gulf of Mexico*

cc:
Ian Lungren, NOAA Fisheries, Habitat Protection/OHC, EFH Coordinator
David Dale, NOAA Fisheries, Southeast Regional Office, EFH Coordinator
Rusty Swafford, NOAA Fisheries, Habitat Conservation Division, Gulf of Mexico Branch Supervisor

From: David Dale - NOAA Federal <david.dale@noaa.gov>
Sent: Monday, April 3, 2023 6:01 PM
To: Lusk, Mark W. <Mark.Lusk@NETL.DOE.GOV>
Cc: virginia.fay@noaa.gov; rusty.swafford@noaa.gov; ian.lundgren@noaa.gov
Subject: [EXTERNAL] Re: Essential Fish Habitat Consultation Request for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, Fall 2023

Mr. Lusk,

Based on the information provided, the National Marine Fisheries Service (NMFS) agrees with your determination regarding the effects of the proposed survey activities on essential fish habitat (EFH) and, accordingly, the NMFS offers no EFH conservation recommendations for the proposed activities. Therefore, the EFH consultation requirements of the Magnuson-Stevens Fishery Conservation and Management Act have been fulfilled and no further consultation is required unless the project changes in a manner which may adversely affect EFH. Please note these comments do not satisfy consultation responsibilities under section 7 of the Endangered Species Act of 1973, as amended. If an activity "may effect" listed species or critical habitat under the purview of the NMFS, please initiate consultation with the Protected Resources Division. The NMFS appreciates the opportunity to provide these comments. Please advise if we may be of further assistance.

David Dale

Fishery Biologist, Habitat Conservation Division
Southeast Regional Office
NOAA Fisheries | U.S. Department of Commerce
Office: 727-551-5736; HCD Main: 727-824-5317; Mobile: 727-421-6816

On Wed, Mar 29, 2023 at 3:29 PM Lusk, Mark W. <Mark.Lusk@netl.doe.gov> wrote:

The Department of Energy (DOE) proposes to provide cost-shared funding to the University of Texas to conduct marine geophysical surveys off the coast of Texas, in the Northwestern Gulf of Mexico (Proposed Action). Attached are a letter describing the proposed action and our initial findings regarding essential fish habitat. Also attached is the Draft Environmental Assessment (Draft EA) prepared pursuant to the National Environmental Policy Act (42 U.S.C. 4321 *et seq*.) for this proposed action.

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act, DOE, as the lead action agency, requests consultation for the Proposed Activity. We look forward to consulting with you on this proposed action, and we stand ready to help resolve any concerns expeditiously to ensure that the research efforts may proceed in a timely and environmentally responsible manner. Please contact me if you have any questions or concerns regarding the request or the supporting information.

Thank you.

Mark W. Lusk
NEPA Compliance Officer, National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, WV 26505
Office: 304-285-4145; Cell: 412-337-9433

APPENDIX H: CZMA DETERMINATION LETTER

May 26, 2023

U.S. Department of Energy
National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, WV 26505
ATTN: Mark Lusk

Re: Marine Geophysical Surveys in the Northwestern Gulf of Mexico
CMP#: 23-1207-F2

Dear Mr. Lusk:

Pursuant to 31 Texas Administrative Code §30.30, the project referenced above has been reviewed for consistency with the Texas Coastal Management Program (CMP).

It has been determined that there are no significant unresolved consistency issues with respect to the project. Therefore, this project is consistent with the CMP goals and policies.

Please note that this letter does not authorize the use of Coastal Public Land. No work may be conducted or structures placed on State-owned land until you have obtained all necessary authorizations, including any required by the General Land Office and the U.S. Army Corps of Engineers.

If you have any questions or concerns, please contact me at (512) 463-7497 or at federal.consistency@glo.texas.gov.

Sincerely,

Leslie Koza

Leslie Koza
Federal Consistency Coordinator
Texas General Land Office