

Appendices

Final Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of America, 2026



January 2026

DOE/EA-2267



U.S. DEPARTMENT
of ENERGY

NETL NATIONAL
ENERGY
TECHNOLOGY
LABORATORY

LIST OF APPENDICES

APPENDIX A: PUBLIC NOTIFICATION LETTERS

APPENDIX B: DETERMINATION OF MITIGATION ZONES

APPENDIX C: LETTER TO NMFS

APPENDIX D: BIOLOGICAL AND CONFERENCE OPINION

APPENDIX E: INCIDENTAL HARASSMENT AUTHORIZATION

APPENDIX F: REQUEST FOR IHA REISSUANCE

APPENDIX G: EFH CONSULTATION

APPENDIX H: CZMA DETERMINATION LETTER

APPENDIX A: PUBLIC NOTIFICATION LETTERS

October 18, 2024

Dear Reader:

The enclosed document, *Draft Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, 2025* (Draft EA; DOE/EA-2267D), 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 Environmental Assessment (EA) evaluates the potential environmental consequences of a project to be conducted by the University of Texas, with additional funding from the Department of Energy (DOE), involving a high-resolution 3-dimensional (HR3D) marine seismic surveys off the coast of Texas. The surveys would involve the use of up to two generator-injector (GI) airguns towed behind a source vessel in water less than 30 meters deep. The purpose of the proposed seismic surveys is to study the geologic environments beneath the Gulf of Mexico for secure, long-term, large-scale carbon dioxide storage and enhanced hydrocarbon recovery.

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 that are listed under the ESA under the National Marine Fisheries Service (NMFS) jurisdiction: 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. 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. The project may also affect fish and marine invertebrate 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). However, no adverse effects on fish or marine invertebrate species are expected.

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.

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 October 18, 2024, and ends November 18, 2024. Submit comments to:

Johnna Sholtis, Ph.D.
NEPA Compliance Officer
Department of Energy – National Energy Technology Laboratory
626 Cochran Mill Road
Pittsburgh, PA 15236
Email: Johnna.Sholtis@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 Dr. Johnna Sholtis 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,



Johnna Sholtis, Ph.D.
NEPA Compliance Officer

Attachment: Draft Environmental Assessment for Marine Geophysical Surveys by the University of Texas in the Northwestern Gulf of Mexico, 2025

October 18, 2024

Ms. Laura Zavala Garcia, Director
La Retama Central Library
805 Comanche St.
Corpus Christi, Texas 78401

Dear Ms. Garcia:

The enclosed document, *Draft Environmental Assessment for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, 2025* (Draft EA; DOE/EA-2267D), 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 Environmental Assessment (EA) evaluates the potential environmental consequences of a project to be conducted by the University of Texas, with additional funding from the Department of Energy (DOE), involving high-resolution 3-dimensional (HR3D) marine seismic surveys off the coast of Texas. The surveys would involve the use of up to two generator-injector (GI) airguns towed behind a source vessel in water less than 30 meters deep. The purpose of the proposed seismic surveys is to study the geologic environments beneath the Gulf of Mexico for secure, long-term, large-scale carbon dioxide storage and enhanced hydrocarbon recovery.

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 that are listed under the ESA under the National Marine Fisheries Service (NMFS) jurisdiction: 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. 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. The project may also affect fish and marine invertebrate 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). However, no adverse effects on fish or marine invertebrate species are expected.

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 Daily News* and the Corpus Christi *Caller Times* to announce the beginning of the 30-day public comment period on 18 October 2024. As stated in the notice, comments should be marked “Marine Geophysical Surveys Draft EA Comments” and sent to:

Johnna Sholtis, Ph.D.
NEPA Compliance Officer
Department of Energy – National Energy Technology Laboratory
626 Cochran Mill Road
Pittsburgh, PA 15236
Email: Johnna.Sholtis@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 Dr. Johnna Sholtis 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,



Johnna Sholtis, Ph.D.
NEPA Compliance Officer

Attachment: Draft Environmental Assessment for Marine Geophysical Surveys by the University of Texas in the Northwestern Gulf of Mexico, 2025

October 18, 2024

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, 2025* (Draft EA; DOE/EA-2267D), 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 Environmental Assessment (EA) evaluates the potential environmental consequences of a project to be conducted by the University of Texas, with additional funding from the Department of Energy (DOE), involving high-resolution 3-dimensional (HR3D) marine seismic surveys off the coast of Texas. The surveys would involve the use of up to two generator-injector (GI) airguns towed behind a source vessel in water less than 30 meters deep. The purpose of the proposed seismic surveys is to study the geologic environments beneath the Gulf of Mexico for secure, long-term, large-scale carbon dioxide storage and enhanced hydrocarbon recovery.

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 that are listed under the ESA under the National Marine Fisheries Service (NMFS) jurisdiction: 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. 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. The project may also affect fish and marine invertebrate 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). However, no adverse effects on fish or marine invertebrate species are expected.

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 Daily News* and the Corpus Christi *Caller Times* to announce the beginning of the 30-day public comment period on 18 October 2024. As stated in the notice, comments should be marked “Marine Geophysical Surveys Draft EA Comments” and sent to:

Johnna Sholtis, Ph.D.
NEPA Compliance Officer
Department of Energy – National Energy Technology Laboratory
626 Cochran Mill Road
Pittsburgh, PA 15236
Email: Johnna.Sholtis@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 Dr. Johnna Sholtis 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,



Johnna Sholtis, Ph.D.
NEPA Compliance Officer

Attachment: Draft Environmental Assessment for Marine Geophysical Surveys by the University of Texas in the Northwestern Gulf of Mexico, 2025

**Newspaper Legal Notice – Published in the Corpus Christi Caller and Galveston
The Daily News in October 2024**

Legal Notice

**Draft Environmental Assessment for Marine Geophysical Surveys in
the Northwestern Gulf of Mexico, 2025**

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) proposes to provide cost-shared funding to the University of Texas (UT) to conduct high-resolution 3-dimensional (HR3D) marine seismic surveys off the coast of Texas. The survey would involve the use of up to two generator injector (GI) airguns towed behind a source vessel within Texas state waters less than 30 m deep. Data acquired during the seismic surveys would be used to study the geologic environments beneath the Gulf of Mexico for secure, long-term, large-scale carbon dioxide storage. DOE prepared the Draft Environmental Assessment (EA) to evaluate the potential environmental consequences of providing financial assistance to UT for its proposed project. DOE invites public comments on the Draft EA for a period of 30 days starting with publication of this notice. The Draft EA is available for review at the Rosenberg Library, 2310 Sealy Avenue, Galveston, TX 77550, (409) 763-8854 and at La Retama Central Library, 805 Comanche, Corpus Christi, TX 78401, (361) 826-7000. Submit comments by letter to Dr. Johnna Sholtis, U.S. Department of Energy, National Energy Technology Laboratory, 626 Cochran Mill Road, Pittsburgh, PA 15236; or by e-mail to Johnna.Sholtis@netl.doe.gov. Envelopes and subject lines of e-mails should be labeled "Marine Geophysical Surveys Draft EA Comments." The public comment period ends on November 18, 2024. DOE will consider late submissions to the extent practicable. Copies of the Draft EA may be obtained by contacting Dr. Johnna Sholtis, as noted above, or accessed on NETL's website at <https://netl.doe.gov/node/6939>.

APPENDIX B: DETERMINATION OF MITIGATION ZONES¹

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 $1\mu\text{Pa}_{\text{rms}}$) 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-in³ 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 (~1,600 m), intermediate water depth on the slope (~600–1,100 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 (~2,000 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-in³ 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 $1\mu\text{Pa}_{\text{rms}}$ sound level is expected to be received for the 2-GI airgun configuration (totaling 210 in³) at a 4-m tow depth. For deep water (>1,000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2,000 m (Fig. A-1 and A-2). The radii for intermediate water depths (100–1,000 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 (6,600 in³ at 6 m tow depth) and the proposed 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:

- 150 decibel (dB) Sound Exposure Level (SEL)¹ corresponds to deep-water maximum radii of 725.96 m for the two 105 in³ GI-guns at 4 m tow depth (Fig. A-1), and 7,244 m for the 6,600 in³ 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.
- 165 dB SEL corresponds to deep-water maximum radii of 128.2 m for the two 105 in³ 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.
- 170 dB SEL corresponds to deep-water maximum radii of 72.7 for the two 105 in³ GI-guns at a 4 m tow depth (Fig. A-1), and 719 m for the 6,600 in³ at 6-m tow depth (Fig. A-2), yielding a scaling factor of 0.10.
- 185 dB SEL corresponds to deep-water maximum radii of 12.86 m for the two 105 in³ 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 μ 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 6,600 in³ airgun array at 6 m tow depth and the 210 in³ 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- and 175-dB re 1 μ Pa_{rms} sound levels are expected to be received for the two 105 in³ 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.

¹ SEL (measured in dB re 1 μ Pa² · 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.

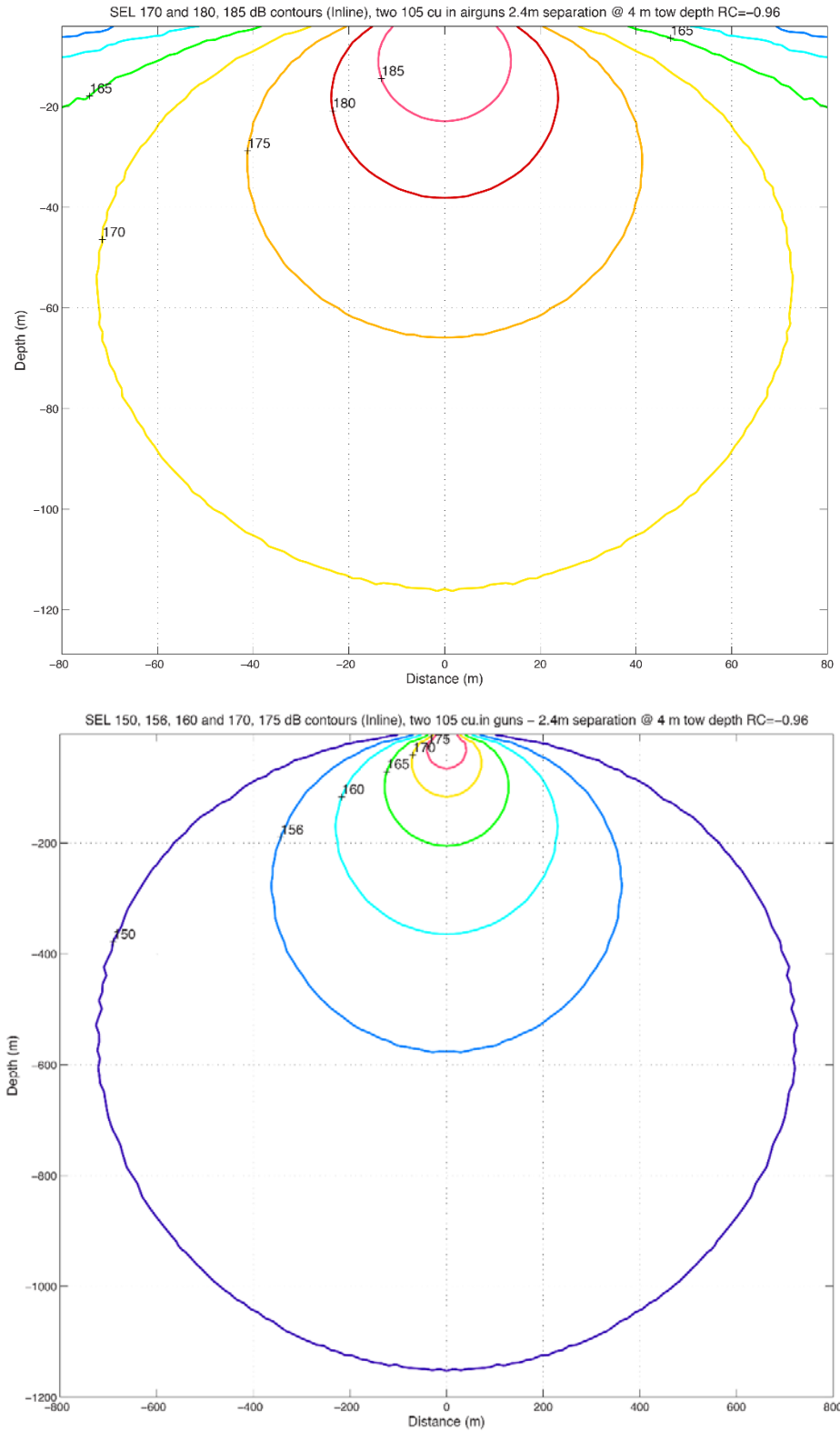


FIGURE A-1. Modeled deep-water received sound exposure levels (SELs) from the two 105-in³ GI guns, with a 2.4-m gun separation, planned for use during the proposed surveys at a 4-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The radius to the 150-dB SEL isopleth is a proxy for the 160-dB rms isopleth. The upper plot is a zoomed-in version of the lower plot.

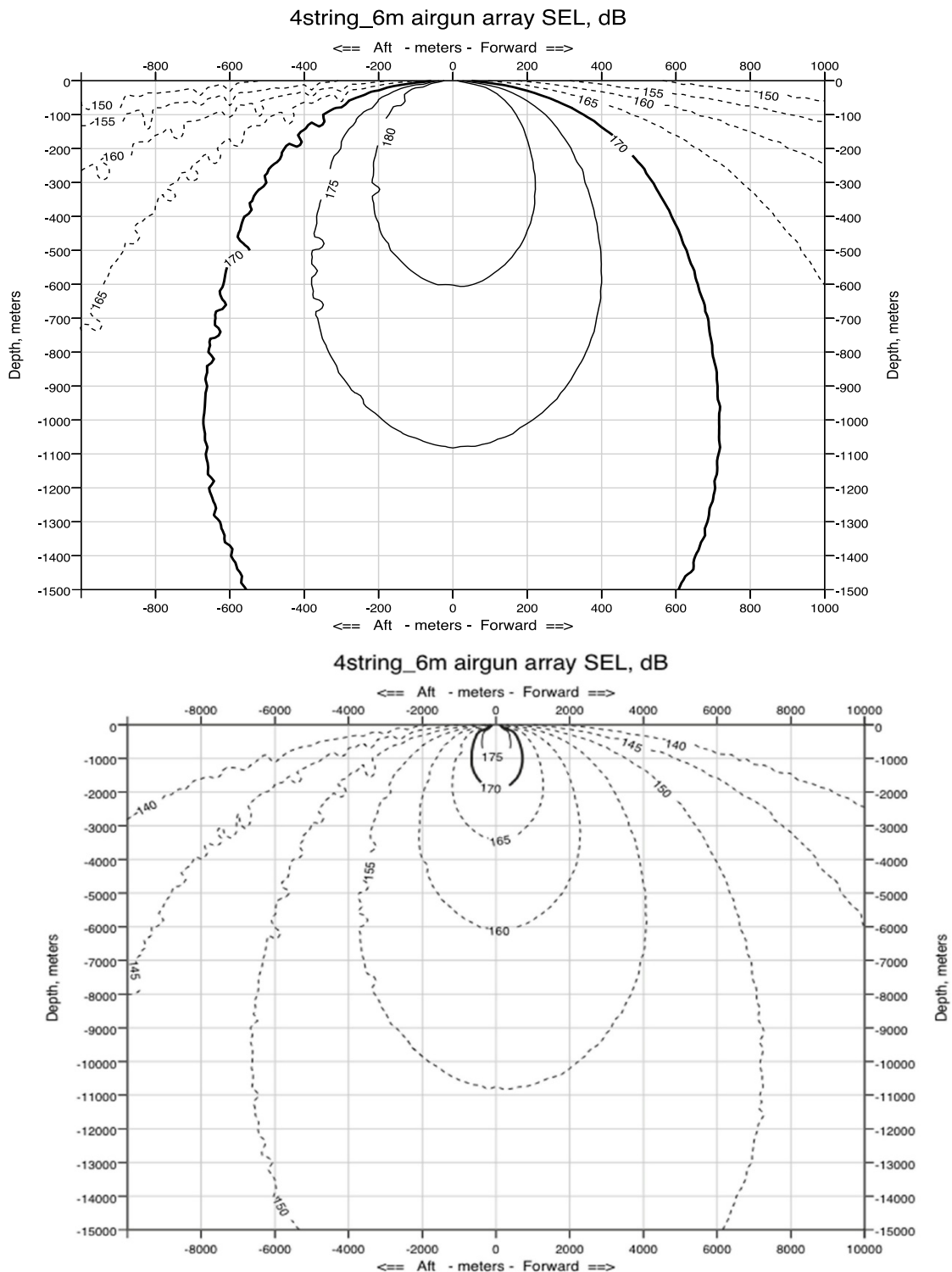


FIGURE A-2. Modeled deep-water received sound exposure levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB 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-1. Level B. Predicted distances to the 160 dB and 175 dB re 1 $\mu\text{Pa}_{\text{rms}}$ sound levels that could be received from two 105-in³ 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	>1,000	726 ¹	128 ¹
	100-1,000	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 level³ 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, Baltimore, 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.
- 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.
- 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.
- 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. Bohnstiehl, 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.

APPENDIX C: LETTER TO NMFS

August 28, 2024

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 provide funding to the University of Texas (UT) to conduct high-resolution 3-dimensional (HR3D) marine seismic surveys in the northwestern Gulf of Mexico (GoM). The seismic surveys would use one or 2 generator-injector (GI) airguns that would be towed by the TDI-Brooks vessel R/V Brooks McCall (or similar) in nearshore waters off the coast of Texas (Fig. 1). The surveys are proposed to occur within Texas state waters, within 9 nautical miles (n. mi.) from shore; however, the primary study area is no closer to shore than the 10-meter (m) isobath or ~1.3 kilometers (km) [closest point of approach or CPA is Port Aransas]. If no suitable sites (i.e., lease areas) are available within Texas state waters, the surveys would occur on the outer continental shelf (OCS) but within the 30-m isobath or between 13.3 and up to 115 km from shore (alternative study area). The actual surveys (or survey area) would occur in a limited area (~50 km²) anywhere within the proposed study area depicted in Fig. 1, although a site within the primary study area is preferred. The water depth at the site could be as shallow as 10 m and no deeper than 30 m.

Project Details

The purpose of the proposed seismic surveys would be to study the geologic environments beneath the GoM for secure, long-term, large-scale carbon dioxide (CO₂) storage and enhanced hydrocarbon recovery. The source vessel would tow up to 2 GI airguns (with a volume of up to 105 cubic inches [in³] each) and a total discharge volume of approximately 210 in³ at a depth of 3 m. The source level is up to 233.8 dB₀-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 seconds [s]). As the airgun(s) are towed along the survey lines at a speed of approximately 4-5 knots (7.4-9.3 km/hour [h]), the hydrophone streamers would transfer the data to the on board processing system.

Approximately 4,440 km of seismic acquisition are proposed in an area that spans ~50 km². Seismic transects would be acquired 18.5 m apart in tightly spaced grids, with lines extending ~7 km in one direction and ~4 km in a direction perpendicular to the longer lines. The proposed seismic surveys would take place in early 2025 (January to April), for a period of ~20 days, with an additional ~3 days for transit, equipment deployment,

and contingency. The source vessel would leave out of and return to the nearest available port.

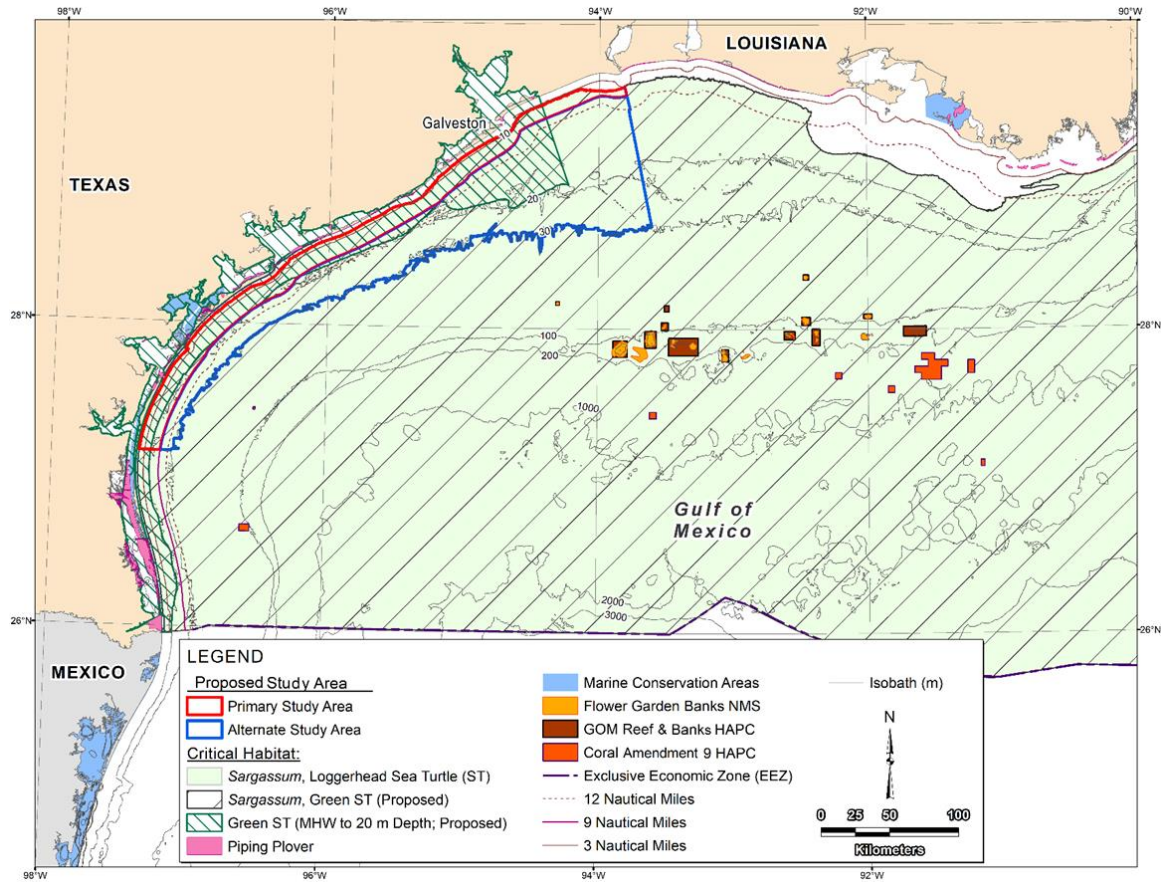


FIGURE 1. Study area for the proposed seismic surveys in the Gulf of Mexico; the seismic tracklines could occur anywhere within the primary or alternate study area but would only cover an area approximately 50 km². Also shown are marine conservation areas (including National Marine Sanctuaries or NMS), marine critical habitat, and Habitat Areas of Particular Concern (HAPC) for species other than Highly-Migratory Species.

An integral part of the planned surveys is a monitoring and mitigation program designed to minimize potential impacts of the proposed activities on marine animals present during the proposed surveys, and to document, as much as possible, the nature and extent of any effects. Potential impacts of the proposed seismic surveys 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 include ramp ups of the 2-GI airgun array; two dedicated observers maintaining a visual watch during all daytime airgun operations, before, and during start ups during the day; clearance zones prior to start up, and shut downs when

sea turtles are detected in or about to enter designated exclusion zone (EZ). For a similar low-energy survey carried out by UT in the northern GoM during March 2024, the EZ for marine mammals was replaced by NMFS with a 200-m clearance zone prior to start up, as shutdowns were not required for cetaceans entering the EZ, unless the cetaceans were species for which take was not authorized or for which take numbers were exceeded. For sea turtles, a 100-m clearance zone and 100-m EZ were used.

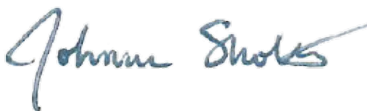
Endangered Species Act (ESA)-listed species and critical habitat

The piping plover (*Charadrius melodus*) is the only ESA-listed seabird 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, but none occurs within the proposed survey area. Although occasional sightings of the Florida manatee (*Trichechus manatus latirostris*) are also made in the northwestern GoM, this species is unlikely to be encountered during the proposed surveys. 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.

Conclusion

DOE is preparing an environmental assessment 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 our 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. The DOE believes we have used the best scientific data available to reach this conclusion. For discussions regarding the Proposed Action, please do not hesitate to contact me. You can reach me by email at Johnna.sholtis@netl.doe.gov, by telephone at (412) 386-9395, or at the address listed below with any questions or comments.

Sincerely,



Johnna Sholtis, Ph.D.
NEPA Compliance Officer
Department of Energy – National Energy Technology Laboratory
626 Cochran Mill Road, Pittsburgh, PA 15236

APPENDIX D: BIOLOGICAL AND CONFERENCE OPINION



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

Refer to NMFS No.: OPR-2025-00495

Dr. Johnna Sholtis
NEPA Compliance Officer
National Energy Technology Laboratory, Department of Energy
626 Cochran Mill Road
Pittsburgh, Pennsylvania 15236

RE: Endangered Species Act Section 7 Biological Opinion and Conference 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 America

Dear Dr. Sholtis:

Enclosed is the National Marine Fisheries Service (NMFS) Endangered Species Act (ESA) Interagency Cooperation Division's biological opinion and conference 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 America in April 2025 on threatened and endangered species and critical habitat that has been designated and proposed for those species under NMFS's jurisdiction in the action area. We have prepared the biological and conference 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 DPS of green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and Northwest Atlantic Ocean DPS of loggerhead sea turtle (*Caretta caretta*). We conclude that the proposed action may affect, but is not likely to adversely affect the hawksbill turtle (*Eretmochelys imbricata*), olive ridley sea turtle (*Lepidochelys olivacea*); leatherback sea turtle (*Dermochelys coriacea*); giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharinus longimanus*); Nassau grouper (*Epinephelus striatus*); and queen conch (*Alger gigas*). We also determined that designated critical habitat for the Northwest Atlantic distinct population segment (DPS) of loggerhead turtle and proposed critical habitat for the North Atlantic DPS of the green sea turtle are not likely to be adversely affected by the proposed action.

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).



**National Marine Fisheries Service
Endangered Species Act Section 7
Biological and Conference Opinion**

Title: Biological Opinion and Conference 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 America 2025

Action Agency: United States Department of Energy

In Consultation With: Endangered Species Act Interagency Cooperation Division,
Office of Protected Resources, National Marine Fisheries
Service, National Oceanic and Atmospheric Administration,
U.S. Department of Commerce

Publisher: Office of Protected Resources, National Marine Fisheries
Service, National Oceanic and Atmospheric Administration,
U.S. Department of Commerce

Approved:

Kimberly Damon-Randall
Director, Office of Protected Resources

Date:

ECO Number: OPR-2025-00495

Digital Object Identifier: <https://doi.org/10.25923/3zwe-we49>

TABLE OF CONTENTS

	Page
1 Introduction.....	1
Background.....	2
1.1 Consultation History	2
2 The Assessment Framework	3
3 Description of the proposed action.....	4
3.1 Description of the Action.....	5
3.1.1 Airgun Description.....	5
3.1.2 Research Vessel Specifications.....	6
3.2 Conservation Measures	6
3.2.1 Exclusion and Buffer Zones.....	7
3.2.2 Delayed Start, Ramp-Up, and Shut Down Procedures	7
3.2.3 Vessel-Based Visual Monitoring	8
3.2.4 Vessel Strike Avoidance	8
3.2.5 Reporting.....	9
4 Potential Stressors.....	9
4.1 Pollution	9
4.2 Vessel Strike.....	9
4.3 Visual and Acoustic Disturbance	10
4.4 Gear Entanglement and Interaction.....	10
5 Action Area.....	11
6 Species and Critical Habitat in the action area.....	12
7 May Affect, Not Likely to Adversely Affect	14
7.1 Stressors Not Likely to Adversely Affect Species or Critical Habitat.....	15
7.1.1 Pollution.....	15
7.1.2 Vessel Strike	16
7.1.3 Vessel Noise and Visual Disturbance	17
7.1.4 Gear Entanglement and Interaction	18
7.2 Potential Stressors Considered Further	18

7.3	Species Not Likely to be Adversely Affected.....	19
7.3.1	ESA-Listed Fish.....	19
7.3.2	ESA-Listed Sea Turtles.....	20
7.3.3	ESA-Listed Invertebrates.....	20
7.4	Critical Habitat Not Likely to be Adversely Affected	21
8	Species Likely to be Adversely Affected	24
8.1	Green sea turtle – North Atlantic Distinct Population Segment	24
8.1.1	Life History.....	25
8.1.2	Population Dynamics	26
8.1.3	Status.....	28
8.1.4	Status in the action area	29
8.2	Kemp’s ridley sea turtle	29
8.2.1	Life History.....	30
8.2.2	Population Dynamics	31
8.2.3	Status.....	32
8.2.4	Status in the action area	32
8.3	Loggerhead sea turtle – Northwest Atlantic Ocean DPS	33
8.3.1	Life History.....	34
8.3.2	Population Dynamics	36
8.3.3	Status.....	38
8.3.4	Status in the action area	38
8.4	Changing Environmental Conditions Effects to Sea Turtle Status	39
9	Environmental Baseline.....	40
9.1	Vessel Interactions	41
9.2	Fisheries	42
9.3	Pollution.....	42
9.3.1	Marine Debris	42
9.3.2	Pollutants and Contaminants.....	43
9.3.3	Noise pollution.....	46
9.4	Aquatic Nuisance Species	48

9.5	Scientific Research Activities	48
10	Analysis of Effects.....	49
10.1	Exposure Analysis.....	49
10.1.1	Exposure Estimates of ESA-Listed Sea Turtles.....	50
	<i>ESA-Listed Sea Turtle Hearing Abilities</i>	<i>50</i>
10.2	Response Analysis.....	55
10.2.1	Potential Response of Sea Turtles to Acoustic Sources.....	55
10.2.2	Potential Responses of Sea Turtle Prey to Acoustic Sources	56
10.3	Summary of Effects.....	61
11	Cumulative Effects.....	61
12	Integration and Synthesis.....	62
12.1	Jeopardy Analysis	62
12.1.1	Green Sea turtle – North Atlantic DPS	62
12.1.2	Kemp’s Ridley Sea turtle	63
12.1.3	Loggerhead Sea turtle – Northwest Atlantic Ocean DPS	65
13	Conclusion	66
14	Incidental Take Statement	66
14.1	Amount or Extent of Take.....	67
14.2	Reasonable and Prudent Measures	67
14.3	Terms and Conditions	67
15	Conservation Recommendations.....	68
16	Reinitiation Notice	68
17	References	69

LIST OF TABLES

Table 1. Specifications of the two GI airguns to be used by the Research Vessel *Brooks McCall* during the seismic survey in the Gulf of America..... 5

Table 2. Endangered Species Act-Listed threatened and endangered species and designated critical habitat that potentially occur in the action area 13

Table 3. Predicted Distances to Received Sound Level of 175 dB re 1 μ Pa (rms) from two GI Airguns for Sea Turtles during the Proposed Seismic Survey..... 52

Table 4. 175 dB re 1 μ Pa (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 53

Table 5. 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 53

Table 6. 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 54

Table 7. Estimated Amount of Incidental Take of Endangered Species Act-Listed Sea Turtles Anticipated Because of the proposed action off Texas..... 67

LIST OF FIGURES

Figure 1. Primary study area shown in red along the Texas coast with a larger possible area that can be studied if necessary shown in blue 11

Figure 2. Designated critical habitat for the Northwest Atlantic Ocean Distinct Population Segment of loggerhead sea turtles 22

Figure 3. North Atlantic DPS of green sea turtle proposed critical habitat showing both the PBF for nearshore foraging and for *Sargassum* habitat..... 22

Figure 4. Map of geographic range of the North Atlantic distinct population segment of green sea turtle, with location and abundance of nesting females (Seminoff et al. 2015) 25

Figure 5. Map identifying the range of the endangered Kemp’s ridley sea turtle off the U.S. coast 30

Figure 6. Map identifying the range of threatened Northwest Atlantic Ocean distinct population segment of loggerhead sea turtle..... 34

LIST OF ACRONYMS AND UNITS

°C	Degrees Celsius
°N	Degrees North
°S	Degrees South
°W	Degrees West
3-D	Three-dimensional
CFR	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 µPa ² s	Decibels referenced to a pressure of 1 microPascal squared second (unit of sound exposure level)
dB re 1 µPa 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	Dichlorodiphenyltrichloroethane
DNA	Deoxyribonucleic acid
DOE	Department of Energy
DPS	Distinct Population Segment
ESA	Endangered Species Act
Fed. Reg.	Federal Register
ft	feet
g	grams
gal	gallon
GI	Generator Injector
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
NM	nautical miles
NMFS	National Marine Fisheries Service
OBIS-SEAMAP	Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations
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
s	seconds
SD	Standard Deviation
SERO	Southeast Regional Office
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 mandate for conserving and recovering threatened and endangered species of fish, wildlife, plants, and the habitats on which they depend. Section 7(a)(2) of the Act and its implementing regulations require every Federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, National Marine Fisheries Service (NMFS) provide 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. Similarly, when conferring on proposed species or proposed critical habitat, we also reach a conclusion as to whether the action will, if finalized, satisfy 7(a)(2) for those entities as proposed. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify designated or proposed critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If the action (or reasonable and prudent alternative) is expected to cause incidental take without violating section 7(a)(2), section 7(b)(4), as implemented by 50 CFR §402.14(i), requires NMFS to provide an incidental take statement (ITS) that specifies the amount or extent of incidental taking. Take in the ESA is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. §1532(19)). The ITS includes reasonable and prudent measures, which are actions necessary or appropriate to minimize impacts of incidental taking and terms and conditions to implement the reasonable and prudent measures.

The 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 high-resolution 3-dimensional (HR3D) marine seismic surveys from the research vessel (R/V) *Brooks McCall* (or a similar vessel operated by TDI-Brooks) in the Gulf of America (see Executive Order 14172; formerly Gulf of Mexico) in water <30 m deep off the coast of Texas over 23 days in the spring of 2025.

Updates to the regulations governing interagency consultation (50 CFR Part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to NMFS's existing practice in implementing section 7(a)(2) of the Act (84 Fed. Reg. at 45015; 89 Fed. Reg. at 24268). We

have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this opinion would not have been any different under the 2019 regulations or pre-2019 regulations.

Consultation in accordance with section 7(a)(2) of the statute (16 U.S.C. §1536(a)(2)), associated implementing regulations (50 CFR Part 402), and agency policy and guidance (USFWS and NMFS 1998) was conducted by the NMFS Office of Protected Resources (OPR) ESA Interagency Cooperation Division (hereafter referred to as ‘we’ or ‘us’). We prepared this biological opinion and conference (opinion) and ITS in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR Part 402. This document represents NMFS’s opinion on the effects of these actions on North Atlantic DPS green (*Chelonia mydas*), Kemp’s ridley (*Lepidochelys kempii*), and Northwest Atlantic DPS loggerhead (*Caretta caretta*) sea turtles. This document also considers the effects of these actions on leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*), and hawksbill sea turtles (*Eretmochelys imbricata*); giant manta rays (*Manta birostris*); oceanic whitetip sharks (*Carcharhinus longimanus*); Nassau grouper (*Epinephelus striatus*); queen conch (*Aliger gigas*); loggerhead sea turtle Northwest Atlantic DPS critical habitat and North Atlantic DPS green sea turtle proposed critical habitat.

Background

Marine seismic surveys have occurred in every ocean basin, and ESA section 7 consultations have been completed in the Gulf of America with Federal agencies funding, authorizing and/or conducting these surveys. The DOE is proposing to fund UT’s seismic survey in the northwestern Gulf of America off the coast of Texas, following similar methods, but in a different location, from a survey conducted in 2023. Data collected from this project will characterize the upper ~1 km (~0.62 mi) of the geologic subsurface between 1.3 and 14.5 kms (0.8 and 9 miles) from shore. These data will 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 (IHA) 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 IHA does not consider ESA-listed marine mammals, that action was not considered in this consultation and is not included in this opinion.

1.1 Consultation History

This consultation was initially being conducted by NMFS’s Southeast Regional Office (SERO) but was then transferred to NMFS’s Office of Protected Resources (OPR, we, us) for completion. OPR’s communication with the NMFS SERO and DOE regarding this consultation is summarized as follows:

- On October 17, 2024, SERO received a request from DOE for ESA section 7 consultation for a proposed seismic survey in the Gulf of America along the Texas coast in the spring of 2025.
- On January 27, 2025, SERO transferred the consultation to the NMFS OPR ESA Interagency Cooperation Division.
- On January 30, 2025, we provided DOE with questions on their Environmental Assessment. DOE provided responses to our questions on January 31, 2025.
- On January 31, 2025, we determined that there was sufficient information to initiate formal consultation with DOE and notified them that consultation was initiated.

2 THE ASSESSMENT FRAMEWORK

This opinion includes a jeopardy analysis and an adverse modification or destruction of critical habitat analysis. Prior to 2016, the designation of critical habitat for loggerhead sea turtles used both the terms physical and biological features (PBFs) and primary constituent elements that were essential to the conservation of the species. The 2016 critical habitat regulations (50 CFR §424.12) replaced primary constituent elements (and other terms) with 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 PBF.

We use the following approach to determine whether an action agency is able to insure its proposed action is not likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat:

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

take of listed species (or a surrogate) that is reasonably certain to occur as a result of the action, as well as the extent of effects to critical habitat.

- Evaluate cumulative effects (as defined at 50 CFR §402.02).
- Produce an integration and synthesis, where we add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.
- Compile our jeopardy and destruction or adverse modification analysis conclusions relying on the justification in the integration and synthesis.
- If the opinion determines the action agency failed to insure its action is not likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat, we suggest a reasonable and prudent alternative to the proposed action and assess the effects of that alternative action.
- For actions that do not violate section 7(a)(2) of the ESA or where an alternative action is identified that does not violate section 7(a)(2) of the ESA, after we conclude our opinion, we provide an incidental take statement that specifies the impact (amount or extent) of the take on listed species, reasonable and prudent measures, and terms and conditions to implement those measures.

In each of the steps described above, we rely on the best scientific and commercial data available. In order to ensure we reach supportable conclusions, 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. They enable us 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 and commercial information available for this 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 in the United States or on the high seas. Examples include, but are

not limited to: 1) actions intended to conserve listed species or their habitat; 2) the promulgation of regulations; 3) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants in aid; or 4) actions directly or indirectly causing modifications to the land, water, or air (50 CFR §402.02).

3.1 Description of the Action

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. S. Hovorka 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 America.

The proposed survey will take place in the Gulf of America, off Texas, in the spring of 2025. DOE and UT determined the spring 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 America when sea turtle densities are highest (April to September). The survey will occur over 23 days (20 days of seismic acquisition, three days of transit to and from port).

3.1.1 Airgun Description

The vessel would tow one or two 105 in³ Generator-Injector (GI) airguns (Table 1), with a total possible discharge volume of ~210 in³, 10–20 m behind the stern, at a depth of 3 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), towed at a 2-m depth. The airguns would fire at a shot interval of 12.5 m (~5–10 s). The firing pressure of the airguns would be ~2,000 psi. During firing, a brief pulse of sound with duration of ~0.1 s would be emitted. The airguns would be silent during the intervening periods. During operations, airgun(s) would be operated 24/7 for multiple days to meet science objectives unless maintenance or mitigation measures warranted. As the airgun(s) are towed along the survey lines, the streamers would transfer the data to the on-board processing system. Approximately 4,440 km (2,759 mi) of seismic acquisition are proposed; seismic transects would be acquired in tightly spaced grids (lines spaced ~18.5 m apart), with lines extending ~7 km in one direction and ~4 km perpendicular to the longer lines.

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

Energy Source – Number of Airguns	2 Sercel GI airguns (105 in ³ each) Firing pressure of 2,000 psi
-----------------------------------	--

Source Output (Downward)	Peak-to-Peak = 239.6 dB re 1 μ Pa m [rms] 0-to-Peak = 233.8 dB re 1 μ Pa m [rms]
Position	2 string, in-line 2 m apart
Distance from Stern	10 to 20 m
Tow Depth	3–4 m
Air Discharge Volume	Approximately 210 in ³
Dominant Frequency Components	0–188 Hz
Pulse Duration	Approximately 0.113 s

3.1.2 Research Vessel Specifications

The airguns and hydrophone streamers will be towed by a single source vessel, the R/V *Brooks McCall*, owned by TDI-Brooks. 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 three 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 m³ (~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 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.

3.2 Conservation Measures

DOE and UT plan to implement conservation measures to reduce the likelihood of adverse effects to ESA-listed species and their designated and proposed critical habitat from the proposed action. Conservation measures avoid, minimize, or offset the severity of the stressors produced by the action on ESA-listed species (50 CFR §402.14(c)(1)(i)). Monitoring is used to observe or check the progress of the action, including conservation measures, over time and to ensure that the action and associated stressors are carried out as intended.

In the draft Environmental Assessment provided by DOE, DOE and UT have considered conservation and monitoring measures implemented during previous seismic surveys (including past NMFS Permits Division Incidental Harassment Authorizations and ITs) and recommended best practices in Simmonds et al. (2014), Wright (2014), and Dolman and Jasny (2015). They

have incorporated the following conservation and monitoring measures into the proposed action based on the above sources:

- Exclusion and buffer zones;
- Delayed start, ramp-up, and shut down procedures;
- Vessel-based monitoring by NMFS-approved PSOs;
- Vessel strike avoidance; and
- Monitoring and reporting.

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

3.2.1 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 two 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. DOE and UT will require a 100 m (~328.08 ft) exclusion zone and a 100 m (~328.08 ft) buffer zone for low-energy seismic surveys.

3.2.2 Delayed Start, Ramp-Up, and Shut Down Procedures

Operations with the airgun(s) would not be started if a marine mammal or sea turtle is within the exclusion and buffer zones that encompass the area out to a radius of 200 m from the edges of the airgun array. Airgun activity cannot commence until the marine mammal or sea turtle has cleared the zone. The animal would be considered to have cleared the clearance zone if:

- it was visually observed to have left the clearance zone;
- it was not seen within the zone for 15 minutes in the case of small odontocetes and sea turtles; or
- it was not seen within the zone for 30 minutes in the case of mysticetes and large odontocetes.

A ramp-up procedure would be followed when the two GI airgun cluster begins operating 30 minutes without airgun operations, as long as PSOs have maintained constant visual observation and no detections within the EZ have occurred. Ramp up would not occur if a marine mammal or sea turtle has not cleared the exclusion and buffer zones. Ramp up would begin by activating a single GI airgun and adding the second GI airgun five minutes later.

If the airguns are shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described for shut down (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 or sea turtles have occurred within the exclusion and buffer zones. For longer shut downs, pre-start clearance observation and ramp up are required.

The operating airgun(s) would be shut down if an ESA-listed marine mammal species is seen at any distance from the airgun(s) or for a non-ESA listed species that has a Marine Mammal Protection Act permit that has been exceeded. Also, a shutdown would be required for sea turtles observed within or approaching a 100-m EZ. Following a shutdown, airgun activity would not resume until the marine mammal has not been seen for 15 minutes (in case of small odontocetes) or 30 minutes (for all other cetaceans), or the sea turtle has cleared the exclusion and buffer zones.

3.2.3 Vessel-Based Visual Monitoring

Visual monitoring of the exclusion and buffer zones 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, and the buffer 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 one observer (two observers are recommended, although there will be times [e.g., breaks, meal times] when only one observer will be on duty) to monitor for protected species.

3.2.4 Vessel Strike Avoidance

Three independently contracted PSOs will be on board the survey vessel with rotating shifts to allow two observers to monitor for marine species during daylight hours. The PSOs are responsible for ensuring vessels stay an an appropriate distance from ESA-listed sea turtles and non-listed marine mammals, but they also watch for ESA-listed marine mammals that are not expected to be in the action area. A monitoring report will be provided to NMFS, both the Permits and Conservation Division and the ESA Interagency Cooperation Division.

With the proposed monitoring and mitigation provisions, potential effects on most, if not all, individual marine mammals and sea turtles are expected to be limited to minor behavioral disturbance. Those potential effects are expected to have negligible impacts both on individuals and on the associated species and stocks. Ultimately, survey operations will be conducted in accordance with all applicable international and U.S. Federal regulations, including IHA and ITS requirements.

3.2.5 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

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

4.1 Pollution

While not an intentional part of the action, operation of the R/V *Brooks McCall* may result in pollution from exhaust, fuel, oil, and unintentional overboard 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 precipitates can 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 changing atmospheric conditions (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 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 would experience an injury ranging from minor, non-lethal injuries, to 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 America 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 sea turtle avoidance of a small vessel (6 m in length), green sea turtles may be susceptible to vessel strikes at speeds as low as ~2 kts (4 km/h; Hazel et al. 2007).

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, and reef fish (grouper). The extent of the stressor of vessel strike is measured as the number of transit days or transit distance.

4.3 Visual and Acoustic Disturbance

The proposed action will produce different sounds (vessel noise, noise from seismic survey equipment) that may be a stressor in the environment and otherwise affect ESA-listed species (e.g., auditory injury, changes in hearing ability, masking of important sounds, behavioral responses, and physical or physiological responses). 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. 2000; Nelms et al. 2016; Weilgart 2018).

The presence of the research vessel and towed seismic survey equipment may also produce a visual disturbance that may affect ESA-listed species. 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 sea turtles and fish exposed to an approaching vessel (Brehmer et al. 2019; De Robertis and Handegard 2013; Hazel et al. 2007).

Elasmobranchs 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.

While the intensity of the noise from this stressor will be lower than other seismic surveys due to only using two airguns, sound travels well in water and is expected to be detectable above background levels (approximately 120 dB) for approximately 78–123 km (48.5–76.4 mi) radius around the airguns.

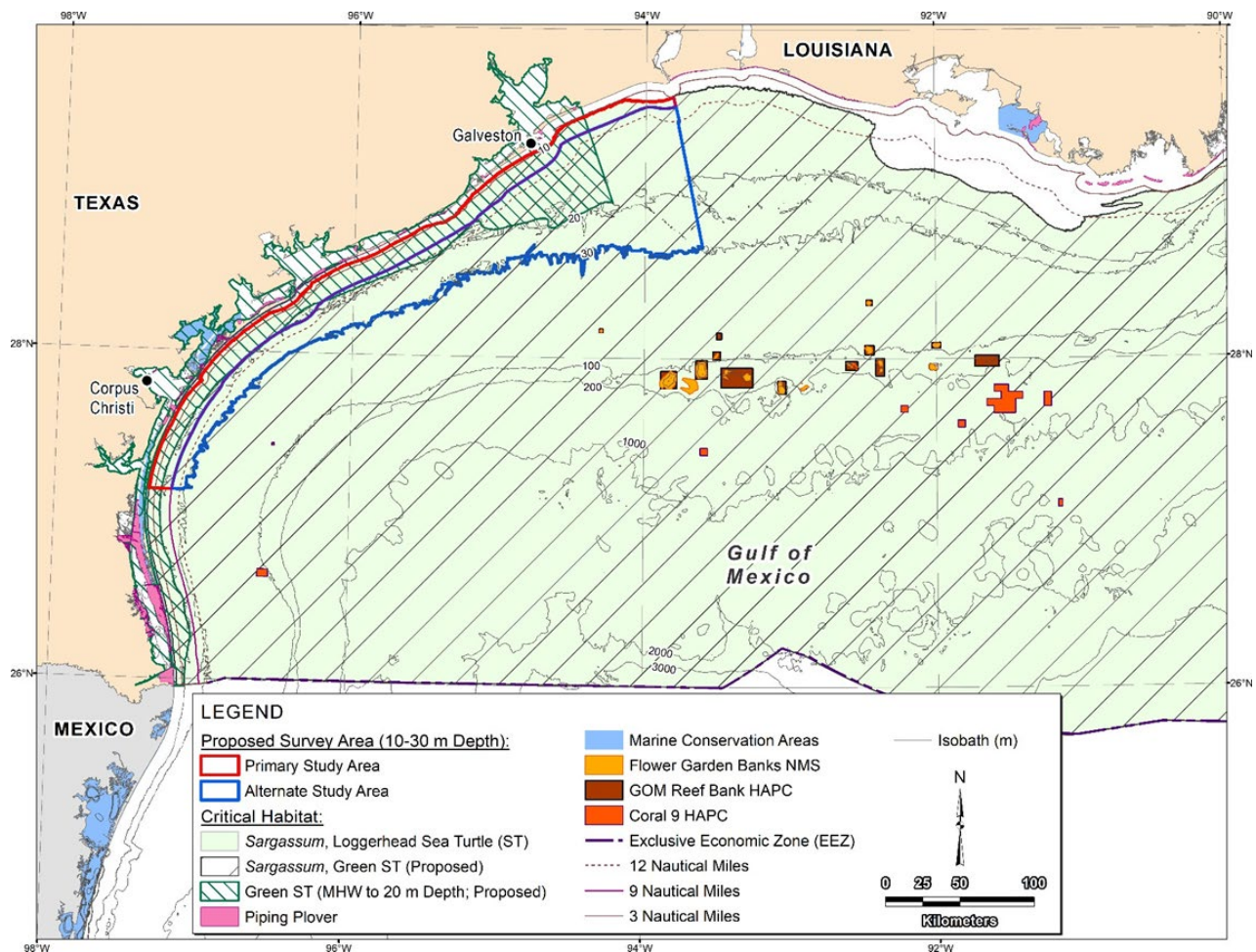
4.4 Gear Entanglement and Interaction

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. Air breathing animals that are entangled may be drowned and entanglements of marine mammals, sea turtles, and fish can cause injuries such as abrasions or lacerations. Additionally, it is possible a listed species could collide with the towed seismic equipment, leading to a range of consequences from startle to death. The gear is towed behind the vessel; therefore the extent of this stressor is the distance the vessel surveys.

5 ACTION AREA

Action area means “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action” (50 CFR §402.02). The action area is defined by the extent of the environmental changes the stressors cause on the physical environment (e.g., land, air or water, detailed in the previous section). The action area is located at approximately 27.1–29.6°N and 93.6–97.4°W, within Texas state waters and within the U.S. Exclusive Economic Zone (Figure 1). Water depths of the survey area are between 10 and 30 m (~32.8 to 98.4 ft). The closest approach to shore would be 1.3 km (~0.8 mi).

Figure 1. Primary study area shown in red along the Texas coast with a larger possible area that can be studied if necessary shown in blue



The action area also includes all areas where stressors from the proposed action will 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 two GI airguns is 78–123 km or ~48.5–76.4 mi (identical to OPR-2023-00050). This is less than approximately half the distance of trackline the research vessel would survey in one day.

6 SPECIES AND CRITICAL HABITAT IN THE ACTION AREA

The ESA and its implementing regulations (50 CFR Part 402) allows for three general determinations for listed species and critical habitat: 1) no effect, 2) may affect, not likely to adversely affect (NLAA), and 3) may affect, likely to adversely affect (LAA). Action agencies, prior to requesting ESA consultation, determine whether their proposed action may affect ESA-listed species or their designated or proposed critical habitat. Generally, a “no effect” determination means there is no plausible exposure or response to stressors generated by the proposed action for any ESA-listed species or designated or proposed critical habitat. A “no effect” determination does not require consultation. Any scenario where there is a plausible route of exposure to stressors generated by the action, no matter how unlikely, is considered “may affect.” For any action that “may affect” an ESA-listed species or its designated critical habitat, the action agency shall consult with the Services under section 7(a)(2) of the ESA. An action agency is also required to confer with the Services on any effects to proposed species or proposed critical habitat if those effects are likely to jeopardize the continued existence of the species or destroy or adversely modify the proposed critical habitat. However, action agencies may voluntarily confer with the Services for all proposed species or proposed critical habitat in the action area when the action may affect those proposed entities without rising to a level requiring us to confer.

This section identifies the ESA-listed species and designated critical habitat that occurs in 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
Green Sea Turtle (<i>Chelonia mydas</i>) – North Atlantic DPS	T – 81 Fed. Reg. 20057	63 Fed. Reg. 46693* and 88 Fed. Reg. 46572 (Proposed)	10/1991 – U.S. Atlantic
Hawksbill Sea Turtle (<i>Eretmochelys imbricata</i>)	E – 35 Fed. Reg. 8491	63 Fed. Reg. 46693*	57 Fed. Reg. 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of America
Kemp's Ridley Sea Turtle (<i>Lepidochelys kempii</i>)	E – 35 Fed. Reg. 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of America 09/2011
Olive Ridley Sea Turtle (<i>Lepidochelys olivacea</i>) – All Other Areas/Not Mexico's Pacific Coast Breeding Colonies	T – 43 Fed. Reg. 32800	-- --	-- --
Leatherback Sea Turtle (<i>Dermochelys coriacea</i>)	E – 35 Fed. Reg. 8491	44 Fed. Reg. 17710 and 77 Fed. Reg. 4170*	10/1991 – U.S. Caribbean, Atlantic, and Gulf of America
Loggerhead Sea Turtle (<i>Caretta caretta</i>) – Northwest Atlantic Ocean DPS	T – 76 Fed. Reg. 58868	79 Fed. Reg. 39855	74 Fed. Reg. 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of America 01/2009 – Northwest Atlantic
Giant Manta Ray (<i>Manta birostris</i>)	T – 83 Fed. Reg. 2916	-- --	10/2019 (Outline)
Oceanic Whitetip Shark (<i>Carcharhinus longimanus</i>)	T – 83 Fed. Reg. 4153	-- --	9/2018 (Outline)

Species	ESA Status	Critical Habitat	Recovery Plan
Nassau Grouper (<i>Epinephelus striatus</i>)	<u>T – 81 Fed. Reg. 42268</u>	<u>89 Fed. Reg. 126 (Final)</u>	<u>8/2018 (Outline)</u>
Queen conch (<i>Aliger gigas</i>)	<u>T – 89 Fed. Reg. 11208</u>	-- --	-- --

T=Threatened, E=Endangered, * = critical habitat not in action area

7 MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT

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

To assist in reaching a determination, we perform a two-step assessment that considers all of the stressors identified in Section 4 of this opinion and all of the species and critical habitats identified in the action area (Table 2) to understand the likelihood of the stressors having an effect on the ESA-listed species or their designated or proposed critical habitat. First, we consider whether it is likely that a listed species or critical habitat is exposed to a stressor or there is a reasonable expectation of the stressor and an individual or habitat co-occurring. If we conclude that exposure of a species or critical habitat to a stressor caused by the proposed action or activity is discountable, we must also conclude it is NLAA. However, if exposure is probable, the second step is to evaluate the probability of a response to the stressor. When all stressors of an action are found to be NLAA for a listed species or a critical habitat, we conclude informal consultation for that species or critical habitat. Likewise, if a stressor associated with this action is found to be NLAA for all listed species and all critical habitats, there is no need to continue analyzing the consequences of that stressor in the Analysis of Effects. Where the negative effects to any species or critical habitat or from any stressor to those species or critical habitat are found

to exceed the standards of insignificant or discountable, we must analyze those consequences in the Analysis of Effects.

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 and 7.3, we also identify the ESA-listed species and designated and proposed 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 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 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, PBFs for the Northwest Atlantic Ocean DPS of loggerhead sea turtle designated critical habitat, and proposed PBFs for the North Atlantic DPS of green sea turtle proposed 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 (23 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, the potential effects to ESA-listed species from vessel exhaust during the proposed action is not measurable. For these reasons, the stressor of exhaust on ESA-listed sea turtles, fishes, and the Northwest Atlantic Ocean DPS of loggerhead sea turtle designated critical habitat are insignificant.

Discharges into the water from the research vessel (e.g., wastewater, leakages of fuel or oil) are not anticipated and given typical amounts of unintended discharges, the effects of any spills to ESA-listed sea turtles, fishes, and designated critical habitat for the Northwest Atlantic Ocean

DPS of loggerhead sea turtles will be minimal, if they occur at all. The R/V *Brooks McCall* has not had a spill in over seven 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, the Northwest Atlantic Ocean DPS of loggerhead sea turtle designated critical habitat, and the proposed North Atlantic DPS of green sea turtle 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 has not been documented in the past and is extremely unlikely to occur, we expect that the effects from debris on ESA-listed sea turtles, fishes, the designated Northwest Atlantic Ocean DPS of loggerhead sea turtle critical habitat, and the proposed North Atlantic DPS of green sea turtle 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 North Atlantic DPS green, Northwest Atlantic Ocean DPS loggerhead, hawksbill, leatherback, Kemp's ridley, or olive ridley sea turtles; giant manta rays; oceanic white tip sharks, Nassau grouper; or queen conch in the action area.

7.1.2 Vessel Strike

Vessel strikes are always a possibility anytime a vessel of any size moves through water. The likelihood of a vessel strike generally depends on the density of vessels and the density of the species (Blondin et al. 2025). Measures, such as PSOs, further reduce that likelihood. We are not aware of any 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 because of vessel draft depth and increased density of sea turtles (Fuentes et al. 2021), we believe vessel strike to be extremely unlikely due to the project timing and general expected movement of sea turtles away from or parallel to the research vessel, as well as the relatively slow speed of the research vessel. Nassau grouper are reef fish and queen conch are benthic. Therefore, the risk of vessel strike is essentially limited to the vessel running aground, which has not occurred in the action area (<https://darrp.noaa.gov/what-we-do-resources/explore-cases?grounding>) and is extremely unlikely to occur. Additionally, we would expect ESA-listed elasmobranchs to swim away from the auditory and visual stimulus of the vessel. Elasmobranchs are able to detect particle motion with specialized cells and are able to move quickly to avoid vessel strike (Myrberg 2001; Popper and Hawkins 2016). 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 or grounding.

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 North Atlantic DPS green, Northwest Atlantic Ocean DPS loggerhead, hawksbill, leatherback, Kemp’s ridley, or olive ridley sea turtles; giant manta rays; oceanic white tip sharks, Nassau grouper; or queen conch.

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 some fishes. Visual and auditory disturbance may also affect the PBFs for loggerhead sea turtle designated critical habitat and green sea turtle proposed critical habitat, particularly important species in *Sargassum* habitat (i.e., copepods that make up the PBF for available prey for both critical habitats). 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, fishes, or queen conchs would be brief, and not likely to significantly impact any individual’s ability to feed, reproduce, or avoid predators. Elasmobranchs, like many animal species, may change their behavior in the presence of a startling sound (Myrberg 2001). Further, oceanic white tip sharks would not be expected to be found in waters adjacent to the Texas coast under 30 m in depth and giant manta rays would be expected to treat a vessel as a predator, dropping to the sea floor (Stewart et al. 2018; Andrzejczek et al. 2019; Pelletier et al. 2023). 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. 2007). The relatively slow traveling speed of the research vessel would also reduce underwater noise (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Grouper and queen conch are extremely unlikely to be near vessels and should not be visually disturbed. Grouper and conch also tend to be in shallower nearshore areas where there is active wave action and a generally noisier environment than in deeper or more offshore water so unlikely to have any measurable response to the vessel sound.

Regarding impacts on the PBFs for the loggerhead and green sea turtle designated and proposed critical habitats, 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 sea turtle designated critical habitat is insignificant. Therefore, we conclude that vessel noise and visual disturbance may affect, but is not likely to adversely affect North Atlantic DPS green, Northwest Atlantic Ocean DPS loggerhead, hawksbill, leatherback, Kemp's ridley, or olive ridley sea turtles; giant manta rays; oceanic white tip sharks, Nassau grouper; or queen conch.

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 elasmobranchs. It is not likely possible for either Nassau grouper or queen conch to be entangled because of their small size and because they inhabit areas that should not directly coincide with the vessels or research gear. 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. There are no known instances of entanglement and interaction between ESA-listed species and towed seismic survey equipment. 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 North Atlantic DPS green, Northwest Atlantic Ocean DPS loggerhead, hawksbill, leatherback, Kemp's ridley, or olive ridley sea turtles; giant manta rays; oceanic white tip sharks, Nassau grouper; or queen conch.

7.2 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 two 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 the Analysis of Effects section (Section 10).

7.3 Species Not Likely to be Adversely Affected

7.3.1 ESA-Listed Fish

ESA-listed elasmobranchs (giant manta ray and oceanic whitetip shark) and Nassau grouper considered in this opinion may be exposed to and be able to detect sound generated by the two GI airguns used in the seismic survey. Elasmobranchs use their inner ears and lateral line, which are capable of detecting relative motion between the body's surface and the surrounding water, to detect nearby (generally within two body lengths) sound sources (Popper et al. 2014). Grouper can detect sound via their inner ear bones, lateral lines, and swim bladders (Liem et al. 2001, Popper and Fay 2011). 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 these ESA-listed fish species. Furthermore, they are generally not considered especially sensitive to sound (Popper et al. 2005, Casper et al. 2012).

For elasmobranchs, behavioral changes have been documented in response to the presence of loud sounds (Mickle and Higgs 2022). 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 μ Pa in females, and 160 dB re 1 μ Pa 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). Grouper may be most sensitive to low frequency sounds ranging from 100-300 Hz at 90 dB re 1 μ Pa (Zhu et al. 2023). 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). Reef fishes, including grouper, have reduced anti-predator behavior to relatively quiet sound sources (Price et al. 2023). Pulsed sounds are not unlike the sound from airguns, and a review of sound effects on fishes concluded that the relative risk of exhibiting a behavioral response, injury, or mortality to impulsive sound sources was low (Popper et al. 2014).

The precise expected response of ESA-listed fish 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 fish exposed to the airguns, if any, would be a minor startle response or change in orientation to the sound source, none of which would be detectable outside of normal behavior or result in adverse effects to the individual. Therefore, the potential effect of the airgun noise on ESA-listed fish is

considered insignificant. We conclude that noise from the airguns may affect, but is not likely to adversely affect giant manta ray, oceanic whitetip shark, and Nassau grouper.

7.3.2 ESA-Listed Sea Turtles

The ESA-listed leatherback, hawksbill, and olive ridley sea turtles may occur in the action area and may be affected by sound generated by the two GI airguns used in the seismic survey. Hawksbill and olive ridley sea turtles nest at low densities throughout the southern Gulf of America (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). Leatherbacks have only been documented nesting in Texas once recently, at Padre Island National Seashore in 2008 (National Park Service 2025). These sea turtles are rare in the northern Gulf of America or along the Texas Coast (Hart et al. 2014, SWOT 2022). For hawksbill and leatherback sea turtles, the DOE effects determination was may affect, likely to adversely affect. However, based on the best available science, it is extremely unlikely that the proposed seismic survey will overlap with these species. Similarly, the DOE effects determination for olive ridley sea turtles was no effect, but the best available science suggests they could be in the action area, but it is extremely unlikely that the proposed seismic survey will overlap with olive ridley sea turtles. The closest OBIS-SEAMAP record of a hawksbill sea 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). Olive ridley sea turtles generally stay out of the Caribbean and are therefore rare in Texas waters, with detections more common but still rare around Florida, Cuba, Puerto Rico, and Dominican Republic. However, the first stranding of an olive ridley sea turtle along the Texas Coast was observed in 2019 (Frandsen et al. 2020). Similarly, based on telemetry data compiled by SWOT (2022), leatherback sea turtle records were reported for waters off Louisiana, but not Texas and 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). Because of the low probability of occurrence of leatherback, hawksbill, and olive ridley sea 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 leatherback, hawksbill, or olive ridley sea turtles.

7.3.3 ESA-Listed Invertebrates

There is limited information about how invertebrates respond to seismic airguns. There is no information available specifically about the queen conch but information does exist for several other molluscs, which are closely related to the queen conch and can serve as a surrogate to better anticipate effects to queen conch. Squid (*Sepioteuthis australis*) were exposed to pulsed sound levels between 120 and 184 dB re one μPa and observed increases in alarm response, ink expression, and changes in swimming pattern (Fewtrell and McCauley 2012). Scallops and

mussels were exposed to pulsed sound in other studies. Mollusks generally do not show observable changes in behavior, so these studies were monitoring for changes in growth or fecundity. Giant scallop (*Placopecten magellanicus*) larvae experienced a 46% body abnormality rate when subjected to repeated loud noises (Jézéquel et al. 2023). Other studies of scallops found little to no observable changes in shell size, abductor muscle diameter, or gonad size (Przeslawski et al. 2016). However, these studies were intentionally exposing these mollusks to loud noises, whereas any exposure queen conch have to seismic survey noises will be of shorter duration and lower intensity. We do not anticipate that there will be any measurable response from queen conch as a result of exposure to the seismic airguns and, therefore, we conclude that DOE and UT's seismic survey may affect, but is not likely to adversely affect queen conch.

7.4 Critical Habitat Not Likely to be Adversely Affected

Here we consider critical habitat for Northwest Atlantic Ocean DPS loggerhead (79 Fed. Reg. 39856; Figure 1) and proposed critical habitat for the North Atlantic DPS green sea turtle (88 Fed. Reg. 46572; Figure 2). For Northwest Atlantic DPS loggerhead sea turtle critical habitat, there were five different units designated, but only the *Sargassum* unit is found in 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 inhabitation; 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. Proposed critical habitat for the North Atlantic DPS of green sea turtles is present in Texas from the Mexico border to and including Galveston Bay, all nearshore areas from mean high water line to 20 m depth. While four PBFs are proposed, only the benthic foraging/resting PBF and the surface-pelagic foraging and resting PBF are present in the action area. The benthic PBF provides underwater food and refugia resources of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and reproduction while the pelagic PBF is also focused on *Sargassum* habitat and overlaps with the PBF for Northwest Atlantic DPS of loggerhead sea turtle critical habitat.

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

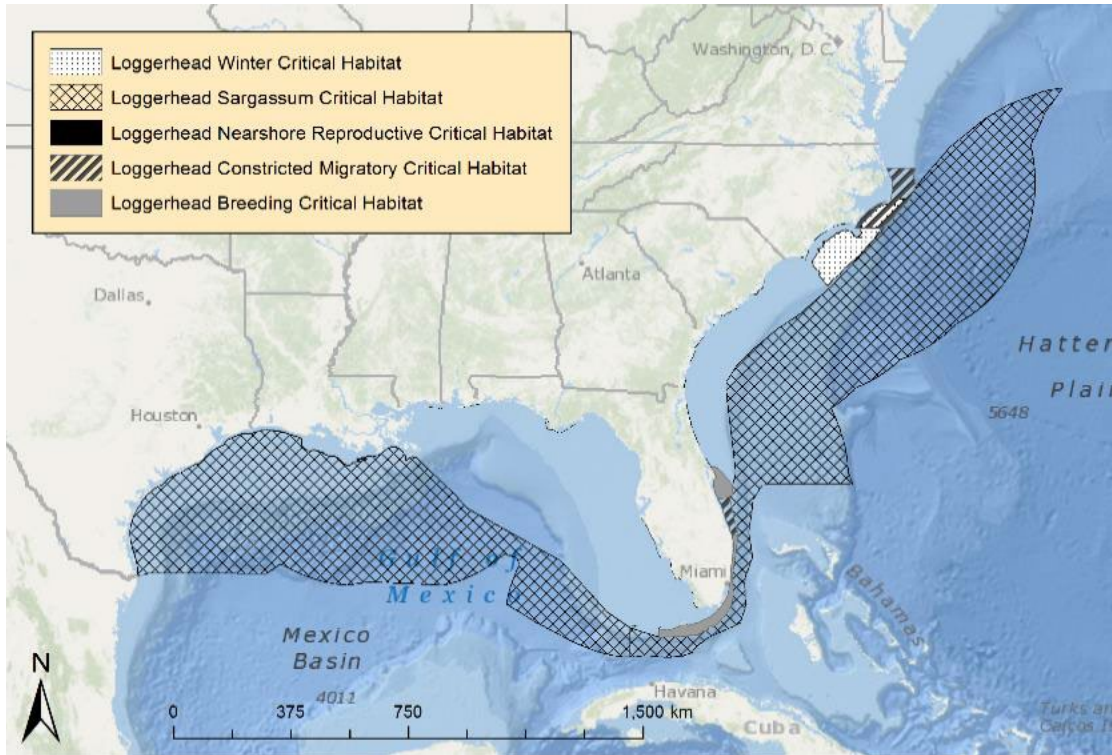
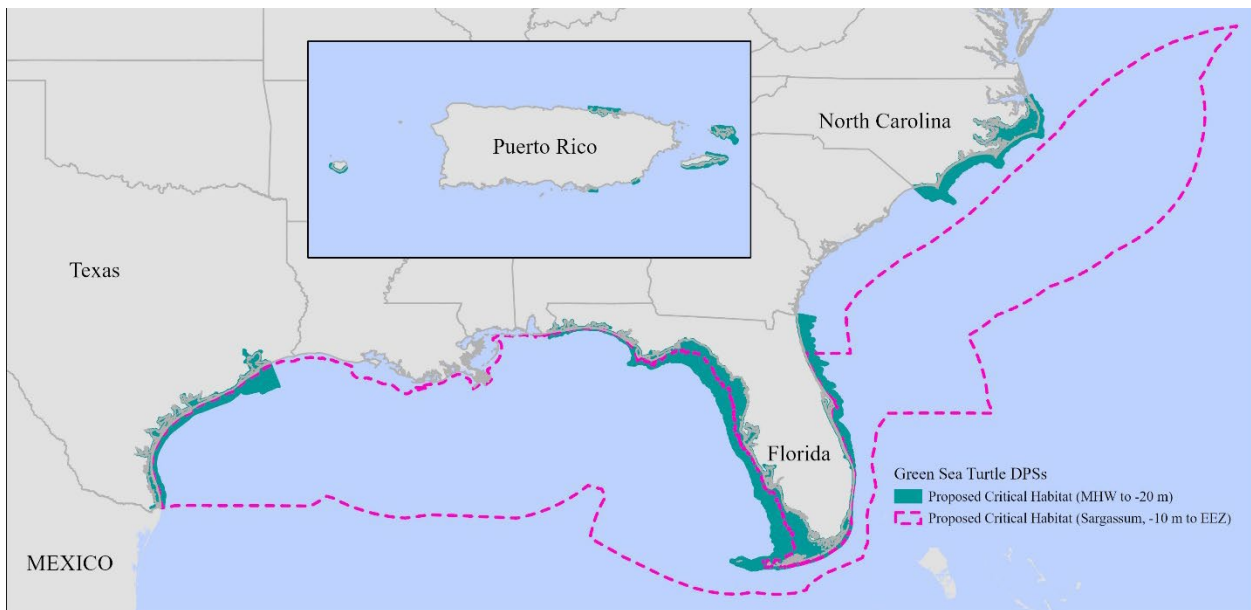


Figure 3. North Atlantic DPS of green sea turtle proposed critical habitat showing both the PBF for nearshore foraging and for *Sargassum* habitat



The proposed seismic survey may affect the designated PBF for *Sargassum* habitat and proposed PBF for benthic foraging and refuge. These areas support available prey and other material 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 in³ led to a decrease in zooplankton abundance by over 50% and a two 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 cm³ or 260 in³), 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 one h after exposure) in copepods exposed to the airgun noise compared to the control. Mortality one 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. The same would apply to benthic foraging habitat/vegetation. 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, copepods, *Sargassum*, or benthic vegetation 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. Effects to benthic habitat and copepods at greater distances from the sound source would be less and less detectable. Nonetheless, given that airguns primarily transmit sound downward, and airguns associated with the proposed action will be towed at depths of 3 m (9.8 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 (20 days of seismic acquisition), overlap a relatively small portion of *Sargassum* (50 km² or 19.3 mi²) habitat, and is not likely to have significant effects on zooplankton or benthic vegetation given the high turnover rate of zooplankton and distance from the sound source of benthos.

In summary, while the proposed seismic survey may temporarily alter food resources in proposed North Atlantic DPS green and designated Northwest Atlantic DPS loggerhead sea turtle *Sargassum* PBFs, 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. The refugia component of the PBFs would be temporarily lost, but only as long as the sound source was present. Because we also anticipate sea turtles moving away from the sound source, when sea turtles return to the area, there should be no lingering effects to the proposed green sea turtle PBF. Therefore, we find that the proposed action may affect, but is not likely to adversely affect designated loggerhead and proposed green sea turtle critical habitat.

8 SPECIES LIKELY TO BE ADVERSELY AFFECTED

The remainder of this opinion examines the North Atlantic DPS green sea turtle, Kemp's ridley sea turtle, and Northwest Atlantic DPS loggerhead sea turtle species likely to be adversely affected by the proposed action. The status is an assessment of the abundance, recent trends in abundance, survival rates, life stages present, limiting factors, and sub-lethal or indirect changes in population trends such as inter-breeding period, shifts in distribution or habitat use, and shifts in predator distribution that contribute to the extinction risk that the listed species face. The status of each species below is described in terms of life history, threats, population dynamics, and recovery planning.

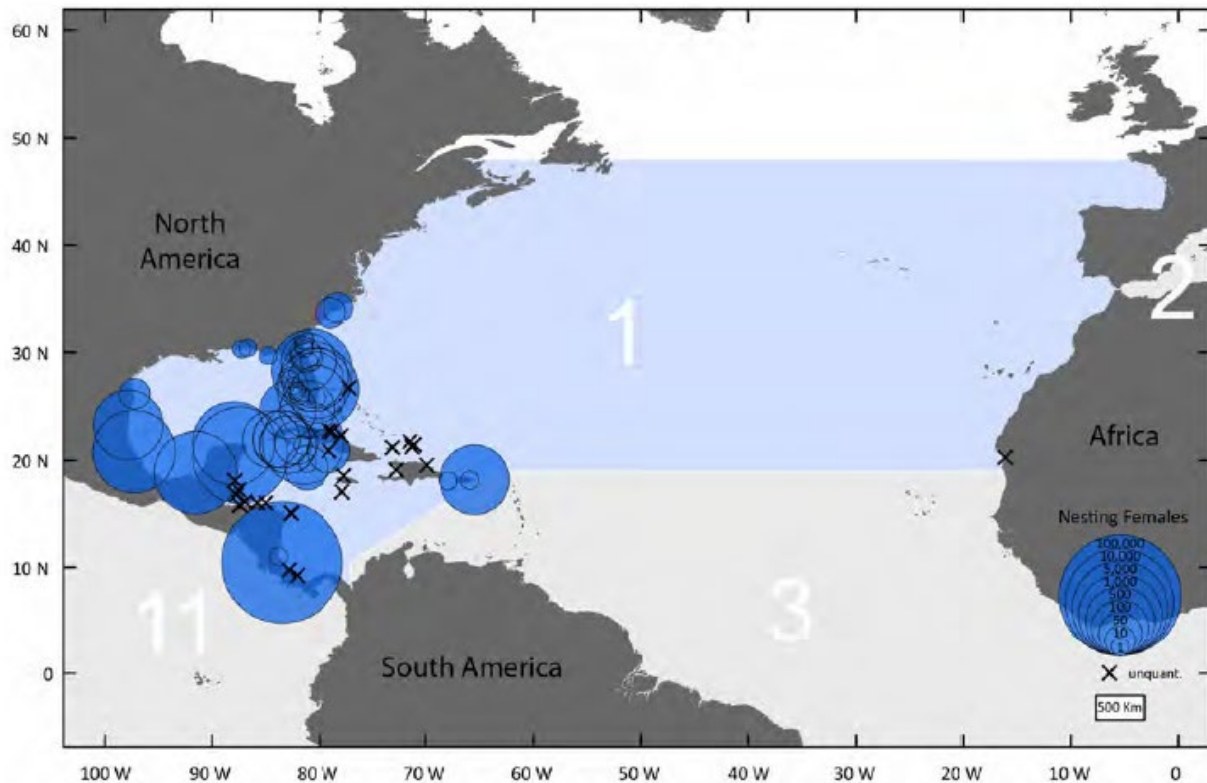
The information used in each of these sections is based on parameters considered in documents such as status reviews, recovery plans, and listing decisions and based on the best available scientific and commercial information. This section informs the description of the species' likelihood of both survival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

8.1 Green sea turtle – North Atlantic Distinct Population Segment

The green sea turtle was listed under the ESA on July 28, 1978 (43 Fed. Reg. 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 sea turtles as threatened or endangered under the ESA (81 Fed. Reg. 20057). The North Atlantic DPS of green sea turtle is listed as threatened. The North Atlantic DPS of green sea turtle is found in the North Atlantic Ocean and Gulf of America (Figure 3).

Figure 4. Map of geographic range of the North Atlantic distinct population segment of green sea turtle, with location and abundance of nesting females (Seminoff et al. 2015)



8.1.1 Life History

Green sea 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 sea 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 two 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 sea 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 sea turtles (NMFS and USFWS 2007). Green sea 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 sea 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 sea turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green sea turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges, and other invertebrate prey. Green sea 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 sea 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 America, green sea 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 America 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 sea 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 sea 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. 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 (NMFS and USFWS 2007). 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 sea 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 sea 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 sea 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 sea turtles (straight carapace length < 90 cm) from 1977 to 2002 (Witherington et al. 2006).

Differences in DNA of green sea 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 sea 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 four 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 America management unit might be appropriate (Shamblin et al. 2016). Although green sea turtles may nest in different regions, individuals from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range (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 sea turtles in St. Joseph Bay, Florida (northeastern Gulf of America; North Atlantic DPS) found approximately 4% of individuals came from nesting stocks in the South Atlantic DPS (Foley et al. 2007). On the Atlantic Coast of Florida (North Atlantic DPS), a study on the foraging grounds off Hutchinson Island found that approximately 5% of the green sea turtles sampled came from the South Atlantic DPS (Bass and Witzell 2000). All of the individuals in both studies were benthic juveniles. Available information on green sea turtle migratory behavior indicates that long distance dispersal is only seen for juvenile green sea turtles. This suggests that larger adult-sized green sea 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 sea turtles occur off Texas (northwestern Gulf of America).

8.1.3 Status

Once abundant in tropical and sub-tropical waters, green sea 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 sea turtles annually. Other threats include pollution, habitat loss through coastal development or stabilization, destruction of nesting habitat from storm events, artificial lighting, poaching, global changes in environmental conditions, 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 sea turtle appears to be somewhat resilient to future perturbations.

Historically, green sea 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 sea 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 sea turtle appears to be somewhat resilient to future perturbations.

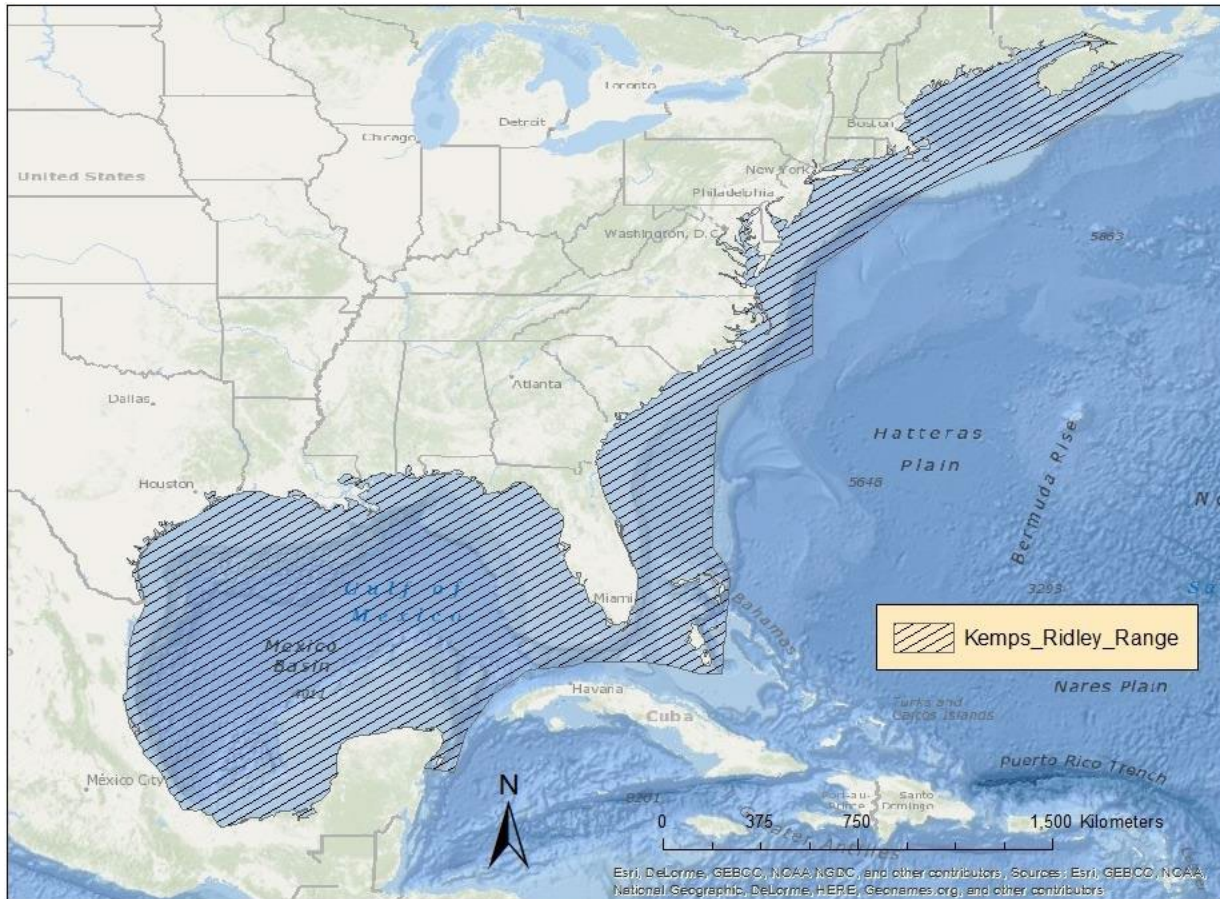
8.1.4 Status in the action area

Green sea turtles nest throughout the Gulf of America from May through September (Valverde and Holzwart 2017). In the Gulf of America, 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 sea turtles recorded animals in waters off Texas, as well as in the rest of the northern Gulf of America; however, most records were in the southern portion of the Gulf of America, 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 America, 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 sea turtle

The Kemp's ridley sea turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). Its range extends from the Gulf of America 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 sea turtles, possibly carried by oceanic currents, have been recorded as far north as Nova Scotia. The species was listed as endangered under the ESA in 1970.

Figure 5. Map identifying the range of the endangered Kemp's ridley sea turtle off the U.S. coast



8.2.1 Life History

Kemp's ridley sea 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 two 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 two years, although some animals nest annually. Nesting occurs from April through July in arribadas (large aggregations) mainly on beaches in the Gulf of America, 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 sea 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 two years before returning to nearshore coastal habitats. Juvenile Kemp’s ridley sea 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 sea turtles forage on swimming crabs, fish, jellyfish, mollusks, and tunicates (NMFS et al. 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 sea 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 three primary nesting beaches in Mexico (NMFS and USFWS 2015). The number of nests in Padre Island, Texas has increased over the past two decades, with one nest observed in 1985, four in 1995, 50 in 2005, 197 in 2009, and 119 in 2014 (NMFS and USFWS 2015). Gallaway et al. (2013) estimated the female abundance for age two 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 sea turtles was estimated to have been 248,307 in 2012 (Gallaway et al. 2013).

Kemp’s ridley sea turtle nesting population was exponentially increasing (NMFS et al. 2011b); 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 three 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 sea turtles is considered to be high (Frandsen et al. 2020). Additional analysis of the mitochondrial DNA taken from samples of Kemp’s ridley sea turtles at Padre Island, Texas, showed six distinct haplotypes, with one found at both Padre Island and Rancho Nuevo (Dutton et al. 2006). Additionally, the genetic diversity of immature Kemp’s ridley sea turtles foraging in the northern Gulf of America (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 sea 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 Status

Kemp's ridley sea 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 changes in environmental conditions, fisheries interactions, natural predation, and disease.

The Kemp's ridley sea 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.

8.2.4 Status in the action area

In the northern Gulf of America on the Texas coast, Kemp's ridley sea turtles primarily nest at Padre Island National Seashore, with a few hundred nesting attempts annually (Eckert and Eckert 2019; NMFS et al. 2011; 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. 2011; Seney and Landry Jr 2008; Shaver et al. 2016). According to the Turtle Island Restoration Network, in 2023, there were 256 Kemp's ridley sea 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 America is April–July (Valverde and Holzward 2017).

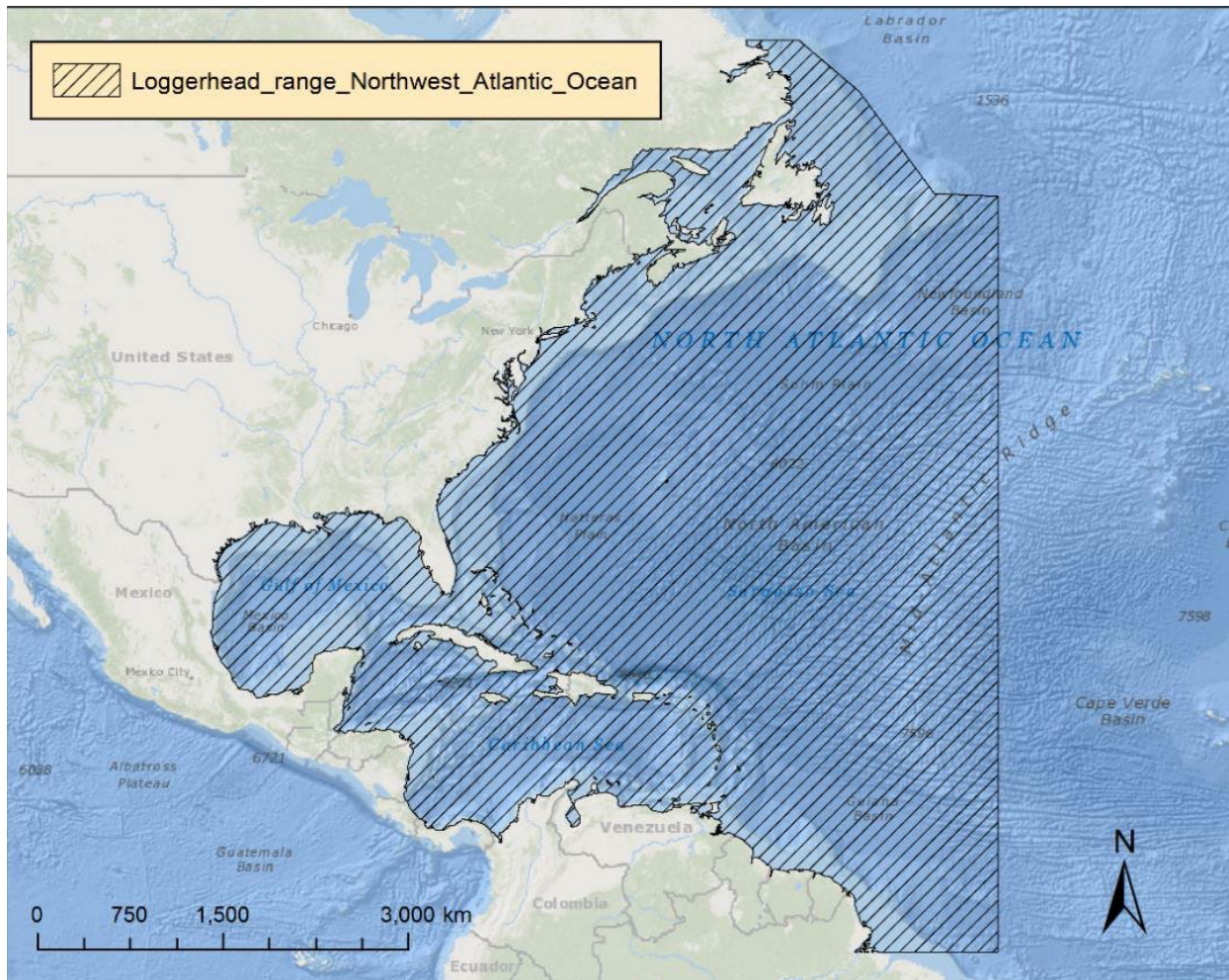
Satellite-tagged adult female Kemp's ridley sea turtles from Padre Island National Seashore and Rancho Nuevo showed post-nesting movements to foraging sites along the coast of the northern

Gulf of America, 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 Holzgart 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 America foraged near the proposed survey area off Texas, as well as most coastal waters along the northern and eastern Gulf of America. Based on telemetry data compiled by SWOT (2022), Kemp’s ridley sea turtle locations were reported along the entire northern coast of the Gulf of America, 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 sea turtles in the proposed survey area (Halpin et al. 2009).

8.3 Loggerhead sea turtle – Northwest Atlantic Ocean DPS

Loggerhead sea 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 Fed. Reg. 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead sea turtles, with the Northwest Atlantic Ocean DPS listed as threatened (75 Fed. Reg. 12598). The Northwest Atlantic Ocean DPS of loggerhead sea turtles is found along eastern North America, Central America, and northern South America (Figure 5).

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



8.3.1 Life History

Loggerhead sea 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 eight 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 2008). Loggerhead sea 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 sea 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 four 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 2008). Nesting occurs on beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the loggerhead sea 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 sea 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 America, 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 America, 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 sea 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 sea turtles. Neritic juvenile loggerhead sea 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 hard bottom habitats in coastal waters.

As post-hatchlings, loggerhead sea 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. 2009; 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 sea 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 sea 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 America (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 America. 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 America, comprise important inshore habitat. Along the shorelines of the Atlantic Ocean and Gulf of America, essentially all shelf waters are inhabited by loggerhead sea turtles (Conant et al. 2009).

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. 2009).

Offshore, adults primarily inhabit continental shelf waters, from New York through Florida, the Bahamas, Cuba, and the Gulf of America. 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.

8.3.2 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 and Southeast Fisheries Science Center 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 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 sea turtle is further categorized into five 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. 2009). 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 sea 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 sea turtle (NMFS and USFWS 2008). Aerial surveys of nests showed a 1.9% decline annually in nesting in South Carolina from 1980 through 2008. Data since that analysis are showing improved nesting numbers and a departure from the declining trend, with increases in nesting from 2009 through 2012.

The Peninsular Florida Recovery Unit is the largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead sea 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 2008). 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 three 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 sea turtles. The only available data for the nesting subpopulation on Key West comes

from a census conducted from 1995 through 2004 (excluding 2002), which suggests annual nesting of about 60 nesting females (NMFS and USFWS 2008). There was no detectable trend during this period (NMFS and USFWS 2008). The Gulf of Mexico Recovery Unit has between 100 and 999 nesting females annually. Analysis of a dataset from 1997 through 2008 of index nesting beaches in the northern Gulf of America shows a declining trend of 4.7% annually. The Greater Caribbean Recovery Unit supports over 1,000 nesting females per year (Zurita et al. 2003, Ehrhart et al. 2003, NMFS and USFWS 2008). Survey effort at nesting beaches has been inconsistent, and trends cannot be determined for this subpopulation (NMFS and USFWS 2008).

8.3.3 Status

Based on the currently available information, the overall nesting trend of the Northwest Atlantic DPS of loggerhead appears to be stable for over two 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).

8.3.4 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 2008). Post-nesting adult female loggerheads satellite-tagged in the Gulf of America 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, seven loggerhead sea turtle nests were recorded along the Texas Coast in 2023, but just four in 2024 (<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 America. There are numerous loggerhead sea turtle records in the OBIS-SEAMAP database for waters <20 m deep in the northern Gulf of America, 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 sea 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.

8.4 Changing Environmental Conditions Effects to Sea Turtle Status

There is a large and growing body of literature on past, present, and future impacts of global changes in environmental conditions, exacerbated and accelerated by human activities. Effects of changing environmental conditions 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 effects from changing environmental conditions (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 changing environmental conditions 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 the Gulf of America, consistent with the global trend of increasing sea surface temperature (Beazley et al. 2021). Large-scale changes in the earth's climate are in turn causing changes locally to the northwestern Gulf of America's climate and environment. Changes in the marine ecosystem caused by global changes in environmental conditions (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 America, 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. Based on climate, energetics, and habitat modeling, loggerhead sea 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 et al. 2006; Patel et al. 2021).

Increasing temperatures are likely to alter sea turtle sex ratios. Recent research has indicated sea turtle sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25 to 35°C (Ackerman 1997). Increasing temperatures could skew future sea turtle sex ratios toward higher numbers of females (NMFS and USFWS 2007; NMFS and USFWS 2015; NMFS and USFWS 2023).

In addition to increased ocean temperatures and changes in species' distribution, changing environmental conditions are 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 sea 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 sea turtle nests out to sea at the Archie Carr National Wildlife Refuge in 2017, and rescuers during Hurricane Harvey, also in 2017 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 changing environmental conditions within the action area. While it is difficult to accurately predict the consequences of changing environmental conditions to a particular species or habitat, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats, and may be exacerbated by additional threats in the action area.

9 ENVIRONMENTAL BASELINE

The *environmental baseline* refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and 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 impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that

are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

A number of human activities have contributed to the status of populations of ESA-listed sea turtles (North Atlantic DPS of green sea turtle, Kemp's ridley sea turtle, and Northwest Atlantic Ocean DPS of loggerhead sea 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 changing environmental conditions, 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 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 result 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 four km/h (2.6 kts); most vessels move much faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010b). 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. (2007) documented live and dead sea turtles with deep cuts and fractures indicative of a vessel strike, and suggested that green sea 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 two times above average based on statewide stranding numbers for the previous five 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 sea turtles (Stacy et al. 2020). Approximately 71% of stranded green sea turtles and 61% of Kemp's ridley sea turtles studied had documented vessel strike injuries (Stacy et al. 2020).

9.2 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. 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.

Fisheries-related injuries were the second-most documented injuries in sea turtles off Texas in 2019 (Stacy et al. 2020). Approximately 18% of green sea turtles and 22% of Kemp's ridley sea turtles studied had documented fishing-related injuries (Stacy et al. 2020). Revised TED regulations in 2014 were estimated to reduce shrimp trawl-related mortality by 94% for loggerheads (NMFS 2014c). In 2019, a final rule was published (84 Fed. Reg. 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 Fed. Reg. 20475).

9.3 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.

9.3.1 Marine Debris

Marine debris is a global 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. 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 sea turtles had anthropogenic debris, mainly pieces of plastic bags, present in digestive tract contents. Plotkin et al. (1993) attributed the deaths of three loggerhead sea turtles to debris ingestion, including one loggerhead sea turtle whose esophagus was perforated by a fishing hook, one loggerhead sea turtle whose stomach lining was perforated by a piece of glass, and one loggerhead sea 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 sea turtles.

9.3.2 Pollutants and Contaminants

Exposures to pollution and contaminants have the potential to cause adverse health effects in 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 America). 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) and anoxic (no oxygen) waters within which most marine life cannot survive (also called “dead zones”). In these zones and adjacent waters, pelagic marine life are displaced and many benthic organisms die (Rabalais and Turner 2001). In the northern Gulf of America, 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 mi² (~22,000 km²) and 8,776 mi² (~22,729 km²), 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 mi² (~11,259 km²).

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 America 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). 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-Quinónez 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 America and adjacent waters. Two studies have investigated heavy metals in Kemp's ridley, loggerhead, hawksbill, and green sea 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 sea 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. 1990; Orós et al. 2009). 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 sea 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 sea 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 America, 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 America, 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 America, 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 America, 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. 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).

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 America. 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. The Deepwater Horizon oil spill 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 sea turtles, loggerhead, hawksbill, and unidentified species) were killed (Deepwater Horizon Trustees 2016). Nearly 35,000 hatchling sea turtles (loggerhead, Kemp's ridley, and green sea turtles) were also injured by response activities. 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.

Green sea 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 sea turtles from the population. A total of four nests (580 eggs) were relocated during response efforts. Kemp's ridley sea 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. The estimated number of unrealized Kemp's ridley sea turtle nests is between 1,300 and 2,000, which translates to approximately 65,000–95,000 unrealized hatchlings (NMFS et al. 2011a). Loggerhead sea turtles made up 12.7% (60,800 animals) of the total sea turtle exposures (478,900 animals). A total of 14,300 loggerhead sea turtles died as a result of exposure to oil from the Deepwater Horizon event.

Despite natural weathering processes over the years since the Deepwater Horizon spill and response, oil persists in some habitats where it continues to expose and impact resources in the northern Gulf of America resulting in new environmental baseline conditions (BOEM 2016; Deepwater Horizon Trustees 2016). The true impacts of offshore megafauna populations and their habitats may never be fully quantified (Frasier 2020).

9.3.3 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. Within the action area, ESA-listed sea turtles may experience lethal or nonlethal injury, permanent or temporary noise-induced hearing loss, behavioral harassment and stress, or no apparent response.

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 one $\mu\text{Pa}^2/\text{Hz}$ at 1 m for fast-moving (greater than 37 km/h [20 kts]) supertankers to 140 dB re one $\mu\text{Pa}^2/\text{Hz}$ at 1 m for smaller vessels (NRC 2003). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels about two 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 2003). In the Gulf of America, shipping noise dominates the low frequency soundscape (Snyder and Orlin 2007). 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 two 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. 2012) 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. 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. 2014). The effective sound source level of a low-frequency airgun array, when viewed in the horizontal direction can be 235 dB re 1 μ Pa 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 μ Pa 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. There is little data on sea turtle response to aircraft. 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 sea 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.

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 2006). Seismic airgun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004). Seismic surveys dominated the northern Gulf of America 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 2003). 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 2003). Most of the sound energy is at frequencies below 500 Hz, which is within the hearing range of sea turtles (Dow Piniak et al. 2012; 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. Consequences to sea turtles are generally restricted to the duration of the use of the airguns and once the airguns are shut down, the lingering impacts of permanent threshold shift (PTS) or temporary threshold shift (TTS).

9.4 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. Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Wilcove et al. 1998; Raaymakers and Hilliard 2002; Raaymakers 2003; Terdalkar et al. 2005; Wambiji et al. 2007; Pughiuc 2010). Aquatic invasive species are introduced through many vectors including 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; Molnar et al. 2008; Keller and Perrings 2011). 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). 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.

9.5 Scientific Research Activities

Section 10(a)(1)(A) of the ESA allows issuance of permits authorizing take of ESA-listed species for the purposes of scientific research with the goal that any adverse effects of that

research lead to the ultimate recovery of the species. 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 Gulf of America, some of which extend into portions of the action area for the proposed action. 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 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.

10 ANALYSIS OF EFFECTS

The ESA section 7 regulations (50 CFR §402.02) define *effects of the action* as “all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.” To understand the effects of the action to listed species and critical habitats, we employ a stressor-exposure-response analysis. The stressors resulting from this action were identified in section 4 and the lone stressor associated with this action that is likely to adversely affect listed species are the sound fields produced by the two airguns. The following analysis is structured to separately assess the exposure of listed species and then critical habitat, followed by separate assessments of the responses of listed species and critical habitats to that exposure. To conclude this section, we summarize the combination of exposure and response for each species and each critical habitat.

10.1 Exposure Analysis

In this section, we consider the exposures to the various stressors that could cause an effect to ESA-listed species that are likely to co-occur with the action’s modifications to the environment in space and time, and identify the nature of that co-occurrence. We describe the timing and location of the stressors to identify the populations, life stages, or sexes of each listed species likely to be exposed. We also describe the duration, frequency, and intensity of stressors to quantify the number of exposures that are reasonably certain to occur. We then determine to which populations those exposed individuals belong and the proportion of the entire critical

habitat that is exposed. We ultimately quantify the likely exposure of ESA-listed species to sound from the airgun array.

Our exposure analysis relies on two 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. We evaluate the best available data and information in order to reduce the level of uncertainty in making our final exposure estimates.

10.1.1 Exposure Estimates of ESA-Listed Sea Turtles

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

The DOE and UT applied NMFS's acoustic thresholds (NOAA 2018) to determine the likely number of sea turtles exposed to the airgun array. 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 2024).

ESA-Listed Sea Turtle Hearing Abilities

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. 1999; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Below, specific studies of green, Kemp's ridley, and loggerhead sea turtle hearing are discussed.

Based upon auditory brainstem responses, green sea turtles have been measured to hear in the 50 Hz–1.6 kHz range (Dow et al. 2008; Piniak et al. 2016), with greatest response at 300 Hz (Bartol and Ketten 2006; Yudhana et al. 2010). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Other studies have similarly found greatest sensitivities between 200–400 Hz for the green sea turtle with a range of 100–500 Hz (Ridgway et al. 1969; Bartol and Ketten 2006; Piniak et al. 2016) and around 250 Hz or below for juveniles (Bartol et al. 1999).

There has been limited attention to specific hearing abilities of Kemp's ridley sea turtles, though like all turtles, they are also low frequency specialists (< 2,000 Hz; Dow Piniak et al. 2012,

Piniak et al. 2016). Kemp's ridley sea turtles can hear from 100–500 Hz, with a maximum sensitivity between 100–200 Hz at thresholds of 110 dB re 1 μ Pa (Bartol and Ketten 2006).

Loggerhead sea turtles, like the previous two, are also low frequency specialists. Underwater tones elicited behavioral responses to frequencies between 50–800 Hz and auditory evoked potential responses between 100–1,131 Hz in one adult loggerhead sea turtle (Martin et al. 2012). The lowest threshold recorded in this study was 98 dB re 1 μ Pa at 100 Hz. Bartol et al. (1999) reported effective hearing range for juvenile loggerhead sea turtles is from at least 250–750 Hz found post-hatchling loggerhead sea turtles responded to sounds in the range of 50–800 Hz while juveniles responded to sounds in the range of 50 Hz–1 kHz (Bartol and Ketten 2006; Lavender et al. 2014). Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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 2024). 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 America 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 life stages are present in the region, and that there is a likelihood of exposure to the proposed seismic survey. We estimate exposure of green, Kemp's ridley, and loggerhead sea turtles by relying on average sea turtle density, the linear transect distance, and ensonified area around the vessel during surveys, that is, the area within the 175 dB re 1 μ Pa (rms) isopleth is where sea turtles are likely to be adversely affected.

The habitat-based density models consisted of 40 km² hexagons (~3.9 km sides and ~7 km across) for each month across the entire Gulf of America. 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 mean monthly density for April was used given the anticipated survey period.

The densities of sea turtles during April 2025 are anticipated to be:

- Loggerhead sea turtles – 0.2479 per km²
- Green sea turtles – 0.0035 per km²
- Kemp’s ridley sea turtle – 0.3584 per km²

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 one or more occasions is estimated for the seismic survey area using expected seasonal density of animals in the area. Summing exposures along the total distance of trackline yields the total exposures for each species for the proposed action of the two GI airguns for the seismic survey. The seismic survey would consist of ~222 km (~138 mi) of trackline surveyed over the 20-day seismic survey. We calculate two different distances that are important, one for animals exposed in the entire action area and another for the radial distances from the airguns to the 175 dB re 1 μPa [rms] behavioral disturbance threshold for sea turtles is shown in Table 3.

Table 3. Predicted Distances to Received Sound Level of 175 dB re 1 μPa (rms) from two GI Airguns for Sea Turtles during the Proposed Seismic Survey

Source	Volume (in ³)	Water Depth (m)	Distance to 120 dB re 1 μPa (rms) Threshold (km)	Distance to 175 dB re 1 μPa (rms) Threshold (km)
2 GI airguns	210	< 100 m	78-123	0.284

The area expected to be ensonified on one day was determined by multiplying the number of line km possible in one day by two times the appropriate radius (Table 3). The lines would be acquired in a tightly spaced (18.5 m between lines) 7 km by 4 km grid of multiple transect lines with overlapping ensonification areas. This overlap was excluded from the daily ensonified area, and the resulting daily ensonified area for the action area (~1,042.85 – 2,513.15 km²) and the 175 dB isopleth (~34.5 km²) was multiplied by the number of days of seismic acquisition (20 days). This provides an estimate of the total area expected to be ensonified to the behavioral disturbance thresholds for sea turtles (Table 4).

Table 4. 175 dB re 1 μ Pa (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 μ Pa (rms)	2 GI Airguns	222	34.5	20	690
175 dB re 1 μ Pa (rms)	2 GI Airguns	222	1,042.85 – 2,513.15	20	20,857 – 50,263

* 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 5). Due to the high sound levels for PTS and TTS, the distances from the sound sources are only 1 to 2 m. Given the density of sea turtles in the action area and the conservation measures in place, we do not anticipate any sea turtles will get within 2 m of the sound source.

Table 5. 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

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, are likely to be exposed during the seismic survey activities. Given that the seismic survey will be conducted in the spring (likely April), we expect that most animals would be foraging or moving towards nesting beaches. All sea turtle species are expected to be feeding, traveling, or migrating in the action area but no females are expected to be nesting yet.

The ensonified action area will expose thousands of sea turtles to noise levels above background levels (Table 6). Green sea turtles, being relatively rare in this area in April, are likely to have between 73 and 176 individuals exposed to sound levels above background but only three individuals will be exposed to sound levels above 175 dB re 1 μ Pa (rms). Kemp’s ridley sea

turtles are the most common sea turtle in the action area at this time and the total number of individuals exposed to elevated sound levels will be between 7,475 and 18,014 individuals of all life stages. However, approximately 247 Kemp’s ridley sea turtles will be exposed to sound levels above 175 dB re 1 μ Pa (rms). Northwest Atlantic Ocean DPS loggerhead sea turtles are also a relatively common sea turtle in the action area at this time and the total number of individuals exposed to elevated sound levels will be between 5,170 and 12,460 individuals of all life stages. However, approximately 171 loggerhead sea turtles will be exposed to sound levels above 175 dB re 1 μ Pa (rms).

Table 6. 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)	Ensonified area to 175 dB re 1 μ Pa (rms)	Total Calculated Exposures	Calculated Exposures above 175 dB re 1 μ Pa (rms)
Green sea turtle – North Atlantic DPS	0.0035	20,857 – 50,263	690	73 – 176	2.4 (3)
Kemp’s Ridley sea turtle	0.3584	20,857 – 50,263	690	7,475 – 18,014	247.3 (247)
Loggerhead sea turtle – Northwest Atlantic Ocean DPS	0.2479	20,857 – 50,263	690	5,170 – 12,460	171.1 (171)

While it is important to understand the number of sea turtles likely to be exposed to noise levels above the baseline levels, most of those will not have any measurable response. In the next section, we will discuss how sea turtles exposed to sound levels above 175 dB re 1 μ Pa (rms) are likely to respond. Further, as noted earlier in this section, no sea turtles are expected to be found within 2 m of the sound source.

10.2 Response Analysis

Given the potential for exposure to stressors associated with the proposed action, in this section, we describe the range of responses ESA-listed species may display as a result of exposure to those stressors that are likely to adversely affect listed species and/or critical habitat. Our assessment considers the potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals.

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. This environmental change may also affect prey of ESA-listed sea turtles in the action area that would then affect the listed species.

10.2.1 Potential Response of Sea Turtles to Acoustic Sources

For species, we discuss responses in terms of physiological, physical, or behavioral effects to the species. These responses may rise to the level of take under the ESA. Take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (16 U.S.C. §1532(19)). NMFS has a definition for the term harass, which is to create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (NMFS Policy Directive 02-110-19). Harm is defined as an act that 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 (50 CFR §222.102).

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. 2000; 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. (2000) reported behavioral changes in sea turtles in response to seismic airgun arrays. These studies formed the basis for our 175 dB re 1 μ Pa (rms) threshold for determining when sea turtles will be harassed due to sound exposure because, at and above this level, loggerhead sea turtles were observed exhibiting avoidance behavior, increased swimming speed, and erratic behavior. Loggerhead sea turtles have also been observed moving towards the surface upon exposure to an airgun (Lenhardt 1994; Lenhardt et al. 1983). In contrast, loggerhead sea 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).

This observational evidence suggests that behavioral changes are only expected when sound levels rise above received sound levels of 175 dB re 1 μ Pa (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

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. 2012; 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 sea 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 μ Pa (rms), but data are lacking to evaluate this possibility. Therefore, we follow the best available evidence identifying an observable behavioral response as the point at which we would be able to measure a stress response.

10.2.2 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.

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. Fish or invertebrate mortality may occur from exposure to airguns, but will be limited to close-range exposure to high amplitudes (Falk and Lawrence 1973; Kostyuchenko 1973; Dalen and Knutsen 1986; Holliday et al. 1987; La Bella et al. 1996; Santulli et al. 1999; McCauley et al. 2000; Bjarti 2002; Hassel et al. 2003; McCauley et al. 2003; Buchanan et al. 2004; Popper et al. 2005).

Studies of sound-induced mortality of invertebrates 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. The greatest observed response to anthropogenic sounds is that prey species become more vulnerable to predation (Davies et al. 2024). 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 spatial ($\sim 50 \text{ km}^2$) and temporal (20 days) scale of the seismic survey in the Gulf of America, 2) downward transmission of sound from the airguns towed at a depth of 2 m (6.56 ft) relative to surface orientation of invertebrate prey, and 3) the energy of the seismic survey ($\sim 3,441 \text{ cm}^3$ [210 in^3] versus 2,458.1 or 4,260.6 cm^3 [$150\text{--}260 \text{ in}^3$]) proposed in this consultation, 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.

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; McCauley and Fewtrell 2008a). During airgun studies in which the received sound levels were not reported, McCauley and Fewtrell (2008a) 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 (McCauley and Fewtrell 2008a). 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 μ Pa) at close distances, with some cases of injury (McCauley et al. 2003). Effects from TTS were not found in whitefish at received levels of approximately 175 dB re 1 μ Pa²s, but pike did show 10–15 dB of hearing loss with recovery within one day (Popper et al. 2005). Caged pink snapper (*Pelates* spp.) have experienced PTS when exposed over 600 times to received sound levels of 165–209 dB re 1 μ Pa 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 μ Pa (Falk and Lawrence 1973).

Startle responses were observed in rockfish at received airgun levels of 200 dB re 1 μ Pa 0-to-peak and alarm responses at greater than 177 dB re 1 μ Pa 0-to-peak (Pearson et al. 1992). Fish also tightened schools and shifted their distribution downward. Normal position and behavior resumed 20–60 minutes after firing of the airgun ceased. A downward shift was also noted by Skalski et al. (1992) at received seismic sounds of 186–191 dB re 1 μ Pa 0-to-peak. Caged European sea bass (*Dichentrarchus labrax*) showed elevated stress levels when exposed to airguns, but levels returned to normal after three days (Skalski 1992). Whiting (*Merlangius merlangus*) exhibited a downward distributional shift upon exposure to 178 dB re 1 μ Pa 0-to-peak sound from airguns, but habituated to the sound after one h and returned to normal depth (sound environments of 185–192 dB re 1 μ Pa) despite airgun activity (Chapman and Hawkins 1969). 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). European sea bass also showed a startle response when the seismic survey vessel was as much as 2.5 km (1.55 mi) 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 (Skalski et al. 1992).

McCauley et al. (2000) 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 μ Pa (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 μ Pa 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 μ Pa 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 μ Pa 0-to-peak (Dalen and Knutsen 1986; Engås et al. 1996; Engås et al. 1993; Løkkeborg 1991; Løkkeborg and Soldal 1993; Turnpenney 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 Løkkeborg 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 μ Pa 0-to-peak (Turnpenney 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 all three sea turtle species considered here. 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 μ Pa (rms) by first ejecting ink and then moving rapidly away from the area (McCauley and Fewtrell 2008b; McCauley et al. 2000). 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 μ Pa (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 minutes. André et al. (2011) exposed four cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to two h of continuous sound from 50–400 Hz at 157 ± 5 dB re 1 μ Pa. 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 μ Pa, with peak levels at 175 dB re 1 μ Pa. 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 eight months post-exposure to airguns fired at 202–227 dB peak-to-peak pressure (Payne et al. 2013). However, feeding did increase for up to a month after exposure to the airguns (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 μ Pa (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, and rather may expect prey species to be more susceptible to predation, for ESA-listed sea turtles. 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 scientific and commercial data available, 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.

10.3 Summary of Effects

We expect up to three green sea turtles (North Atlantic DPS), 247 Kemp's ridley sea turtles, and 171 Northwest Atlantic Ocean DPS of loggerhead sea turtles to be exposed to the airgun array within the 175 dB re 1 μ Pa (rms) ensonified areas during the seismic survey and exhibit responses in the form of ESA behavioral harassment (see Table 6).

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 sea turtle, Kemp's ridley sea turtle, and Northwest Atlantic Ocean DPS of loggerhead sea turtle). Harassment is not expected to have more than short-term effects on individual ESA-listed sea turtles, but is expected to increase the likelihood of injury while being harassed.

11 CUMULATIVE EFFECTS

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

We assessed the action area of this consultation for any non-Federal activities that are reasonably certain to occur. The past and ongoing impact of existing actions, such as vessel traffic or pollution, was described in the Environmental Baseline. During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to

occur in the action area. We did not find any information about non-Federal actions that would occur in the action area.

12 INTEGRATION AND SYNTHESIS

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

Jeopardize the continued existence of means “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR §402.02). *Recovery*, used in that definition, means “improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act” (50 CFR §402.02).

In this opinion, the Integration and Synthesis is the final step in our jeopardy analysis. In this section, we add the effects of the action (Section 10) to the environmental baseline (Section 9) and the cumulative effects (Section 11), taking into account the status of the species and recovery planning (Section 8), to formulate the agency’s biological opinion as to whether the action agency can insure its proposed action is not likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

12.1 Jeopardy Analysis

The jeopardy analysis assesses the proposed action’s effects to ESA-listed species’ survival and recovery. The following sections summarize the relevant information in this opinion for each individual species considered.

12.1.1 Green Sea turtle – North Atlantic DPS

Adult, juvenile, and post-hatchling North Atlantic DPS of green sea 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 sea turtles worldwide exist at a fraction of their historical abundance, as a result of over-exploitation for food and other products. Historically, green sea 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 sea turtle appears to be somewhat resilient to future perturbations. Despite this, the available data indicate an increasing trend in nesting. There is no reliable estimate of population growth rate of the North Atlantic DPS as a whole, but estimates have been developed at a localized level. Apparent increases in nester abundance for the North Atlantic DPS of green sea turtle in recent years are encouraging, but must be viewed cautiously, as the datasets represent a fraction of green sea turtle generation, up to approximately 50 years.

No reduction in numbers is anticipated as part of the proposed action. The three anticipated takes of North Atlantic DPS green sea turtles will be non-lethal.

We do not anticipate the non-lethal take of three individuals to affect reproduction of North Atlantic DPS of green sea turtles, particularly in light of the currently increasing trend in nesting. The extent of response we anticipate is temporary in duration and behavioral in nature (e.g., temporary displacement and stress). While harassment increases the likelihood of injury to these three individuals, it is unlikely that reproduction (particularly reproductive intervals of the respective individuals) is affected. The best data available (see Section 10.2) does not suggest there are likely effects to reproduction.

We do anticipate that North Atlantic DPS green sea turtles will move away from the sound source, but this will be temporary and will not affect the distribution of North Atlantic DPS of green sea turtles in the Gulf of America.

The Recovery Plan for the U.S. Atlantic population of green sea 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 sea turtle populations are expected, we do not anticipate that the proposed seismic survey will impede any recovery objectives for North Atlantic DPS of green sea turtles. In conclusion, we believe the effects associated with the proposed action are not expected to appreciably reduce the likelihood of both the survival and recovery of North Atlantic DPS of green sea turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

12.1.2 Kemp's Ridley Sea turtle

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

turtles face many of the same threats as other sea turtle species. In 2002, Rancho Nuevo, Mexico, 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, possibly due to forced submergence, appear to be the main threats to the species. The Deepwater Horizon oil spill event caused exposures to oil in the oceanic environment which has resulted in large losses of individuals across various age classes, and likely had a population-level effect on the species. Long-term ramifications of Deepwater Horizon's oil spill are the reduced number of individuals noted above, leading to a reduction in numbers of nests (fewer nesters) and associated hatchling production. The oil spill event also impaired the availability of prey resources (e.g., Gallaway et al. 2016a; Gallaway et al. 2016b; Plotkin 2016). While we are aware of those losses, 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 abundance 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 an average of 7,000 females between 2013 and 2022 (Caillouet and Gallaway 2024). The number of nests in Padre Island, Texas has increased over the past two decades, with a peak of 219 in 2017 (204 nests in 2024; NPS 2024).

No reduction in numbers is anticipated as part of the proposed action. We anticipate 247 Kemp's ridley (of any life stage or sex) are likely to experience nonlethal harassment that increases the likelihood of injury occurring.

We do not anticipate the non-lethal take of 247 individuals to measurably affect reproduction of Kemp's ridley sea turtles, particularly in light of the recent increase in nesting and currently stable number of nests over the last decade. The extent of response we anticipate is temporary in duration and behavioral in nature (e.g., temporary displacement and stress). While harassment increases the likelihood of injury, it is unlikely that reproduction (particularly reproductive intervals of the respective individuals) is affected. The best data available (see Section 10.2) does not suggest there are likely effects to reproduction.

We do anticipate that Kemp's ridley sea turtles will move away from the sound source, but this will be temporary and will not affect the distribution of Kemp's ridley sea turtles in the Gulf of America.

The Bi-National (U.S. and Mexico) Recovery Plan for populations of Kemp's ridley sea turtle lists recovery objectives for the species (NMFS et al. 2011). 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 sea turtle populations are expected, we do not anticipate the seismic survey will impede any recovery objectives for Kemp's ridley sea turtles.

In conclusion, we believe the non-lethal effects associated with the proposed action will not appreciably reduce the likelihood of both the survival and recovery of Kemp's ridley sea turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

12.1.3 Loggerhead Sea turtle – Northwest Atlantic Ocean DPS

Adult, juvenile, and post-hatchling Northwest Atlantic Ocean DPS of loggerhead sea 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 sea turtle population trend as being stable (NMFS 2017). While it is difficult to enumerate sea turtles, nest counts are a helpful metric for understanding trends in reproduction. The total number of annual U.S. nest counts for the Northwest Atlantic Ocean DPS of loggerhead sea turtles is over 110,000 and either stable or slightly increasing (NMFS and USFWS 2023).

No reduction in numbers is anticipated as part of the proposed action. The 171 anticipated takes of Northwest Atlantic Ocean DPS loggerhead sea turtles (of any life stage or sex) will be non-lethal.

We do not anticipate the non-lethal take of 171 individuals to measurably affect reproduction of Northwest Atlantic Ocean DPS of loggerhead sea turtles, particularly in light of the currently stable or increasing trend in nesting. The extent of response we anticipate is temporary in duration and behavioral in nature (e.g., temporary displacement and stress). While harassment increases the likelihood of injury, it is unlikely that reproduction (particularly reproductive intervals of the respective individuals) is affected. The best data available (see Section 10.2) does not suggest there are likely effects to reproduction.

We do anticipate that Northwest Atlantic Ocean DPS loggerhead sea turtles will move away from the sound source, but this will be temporary and will not affect the distribution of Northwest Atlantic Ocean DPS of loggerhead sea turtles in the Gulf of America.

The Recovery Plan for the Northwest Atlantic population of loggerhead sea turtle lists recovery objectives for the species (NMFS and USFWS 2008). 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 sea 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 sea 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 sea turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

13 CONCLUSION

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

Section 7.1 of this opinion determined the likelihood of exposure was discountable or a response would be insignificant and, therefore, the effects of this action may affect, but are not likely to adversely affect leatherback, hawksbill, and olive ridley sea turtles; oceanic white tip sharks, giant manta ray, Nassau grouper, and queen conch. Similarly, section 7.2 of this opinion determined the effects of the proposed action may affect, but are not likely to adversely affect Northwest Atlantic Ocean DPS loggerhead sea turtle designated critical habitat or North Atlantic DPS green sea turtle proposed critical habitat.

14 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR §222.102). NMFS has defined the term "harass" in policy (PD 02-110-19) as to create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding,

feeding or sheltering. “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR §402.02). Section 7(b)(4) and section 7(o)(2) of the ESA, as well as in regulation at 50 CFR §402.14(i)(5) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

14.1 Amount or Extent of Take

In the opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Table 7. 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 Sea turtle – North Atlantic DPS	3
Kemp’s Ridley Sea turtle	247
Loggerhead Sea turtle – Northwest Atlantic Ocean DPS	171

DPS=distinct population segment

14.2 Reasonable and Prudent Measures

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

1. The DOE must coordinate with UT to monitor and report the exposure and response of ESA-listed species from seismic survey activities, as well as the effectiveness of conservation measures for the incidental taking of sea turtles (North Atlantic DPS of green sea turtles, Kemp’s ridley sea turtles, and Northwest Atlantic Ocean DPS of loggerhead sea turtles).

14.3 Terms and Conditions

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

The following terms and conditions implement RPM #1:

1. A copy of the 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 America Seismic Survey Report”. The report should also demonstrate how conservation measures were implemented during the seismic survey, 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 sea turtles, Kemp’s ridley sea turtles, and Northwest Atlantic Ocean DPS of loggerhead sea 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 within 24 hours. The subject line of the e-mail should include “DOE Gulf of America Seismic Survey: Dead/Injured ESA-listed Species Report”.

15 CONSERVATION RECOMMENDATIONS

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

At this time, NMFS has no recommendations for appropriate measures that would avoid or minimize effects to threatened and endangered species associated with this action.

16 REINITIATION NOTICE

This concludes formal consultation on the DOE Gulf of America Seismic Survey. Consistent with 50 CFR §402.16(a), reinitiation of consultation is required and shall be requested by the Federal agency, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

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

17 REFERENCES

- Ackerman, R.A. 1997. The nest environment and the embryonic development of sea turtles. Pages 83-106 in P.L. Lutz and J.A. Musick, editors. *The Biology of Sea Turtles*. CRC Press, Boca Raton.
- 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.
- André, M., M. Solé, M. Lenoir, M. Durfort, C. Quero, A. Mas, A. Lombarte, M. Van der Schaar, M. López-Bejar, M. Morell, and S. Zaugg. 2011. Low-frequency sounds induce acoustic trauma in cephalopods. *Frontiers in Ecology and the Environment*, 9(9):489-493.
- Andrzejaczek, S., Gleiss, A.C., Pattiaratchi, C.B. & Meekan, M.G. 2019. Patterns and drivers of vertical movements of the large fishes of the epipelagic. *Reviews in Fish Biology and Fisheries* 29: 335-354. DOI:10.1007/s11160-019-09555-1.
- Aspirault, A. 2019. Impact of boat sound on the feeding and growth behavior of planktonic species. Dissertation. University of Quebec at Rimouski.
- 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 Y. Swimmer and R. Brill, editors. *Sea turtle and pelagic fish sensory biology: developing techniques to reduce sea turtle bycatch in longline fisheries*. 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.L. Lenhardt. 1999. 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.
- 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., 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. and B.E. Witherington. 2003. *Loggerhead Sea Turtles*. Smithsonian Books, Washington, D.C.
- 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.
- 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.
- 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 and 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).
- Caillouet, C.W. and B.J. Gallaway. 2024. Demographic criteria for downlisting and delisting Kemp's ridley sea turtle based on numbers of females nesting in a season need revision. *Marine Turtle Newsletter* 167:1-6.
- 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 and 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.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.
- Chaloupka, M., K.A. Bjorndal, G.H. Balazs, A.B. Bolten, L.M. Ehrhart, C.J. Limpus, H. Sumanuma, 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.

- 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.
- 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.
- 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.
- 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. 1990. 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.
- Davidson, 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. Sjurson, 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.
- Davies H.L., K.D. Cox, K.A. Murchy, H.M. Shafer, A. Looby, and F. Juanes. 2024. Marine and freshwater sounds impact invertebrate behavior and physiology: a meta-analysis. *Global Change Biology* 30:e17593. doi/10.1111/gcb.17593
- 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 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.
- 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 and 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. 2024. Draft environmental assessment for marine geophysical surveys in the northwestern Gulf of Mexico, 2025. 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.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. 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, Virginia.
- 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 Conference on Acoustic Communication by Animals, Corvallis, Oregon.
- 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.
- 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 interesting leatherback sea turtles using 3d animated computational fluid dynamics and finite volume heat transfer. *Ecological Modelling* 320:231-240.

- 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.
- 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. WIDECASST Technical Report.
- 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. Bolten and B. Witherington, editors. *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, 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.
- 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.
- 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.
- Fewtrell, J.L. and R.D. McCauley. 2012. Impact of air gun noise on the behaviour of marine fish and squid. *Marine Pollution Bulletin*, 64(5):984-993.
- 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* 144:2719-2727.
- 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.
- 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., 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.
- 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.
- 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.
- 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).
- 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.
- 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.
- 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 Commission (IWC) Seismic Workshop, St. Kitts, 24-25 May 2006. 7p.
- 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.
- Griffiths S.P., K. Kesner-Reyes, C. Garilao, L.M. Duffy, M.H. Román. 2019. Ecological Assessment of the Sustainable Impacts of Fisheries (EASI-Fish): a flexible vulnerability assessment approach to quantify the cumulative impacts of fishing in data-limited settings. *Marine Ecology Progress Series* 625:89-113.
- 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. Gonzalez, and F. Rocha. 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.
- 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, 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.
- 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.
- 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.
- 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.
- Hawkes, L.A., A.C. Broderick, H. Godfrey, B. Godley, and M.J. Witt. 2014. The impacts of climate change on marine turtle reproduction 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., 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):2647-56.

- Hazel, J. and E. Gyuris. 2006. Vessel-related mortality of sea turtles in Queensland, Australia. *Wildlife Research* 33(2):149-154.
- Hazel, J., I.R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research* 3(2):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.
- 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. 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.
- 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.
- 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.
- IPCC. 2023. Summary for policymakers, Geneva, Switzerland.
- 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., 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.
- 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.
- Jézéquel, Y., P. Jandial, S.F. Cones, S. Ferguson, N. Aoki, Y. Girdhar, and T.A. Mooney. 2023. Short-term habituation of the longfin squid (*Doryteuthis pealeii*) to pile driving sound. *ICES Journal of Marine Science* 173:112934. <https://doi.org/10.1016/j.marpolbul.2021.112934>
- Johnson, S.A. and L.M. Ehrhart. 1996. Reproductive ecology of the Florida green turtle: clutch frequency. *Journal of Herpetology* 30:407-410.
- 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. Frogli, 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.
- 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.
- Lewis, 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-Quinónez, C., A. Zavala-Norzagaray, T.L. Espinosa-Carreón, 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.
- Liem, K.F., W.E. Bemis, W.F.J. Walker, and L. Grande. 2001. Functional anatomy of the vertebrates: an evolutionary perspective. USA, Brooks/Cole- Thomson Learning, 703 p.
- 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.
- 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.
- López, P. and J. Martín. 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 et al., 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.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: 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, and A.N. Popper. 2003. High intensity anthropogenic sound damages fish ears. *Journal of the Acoustical Society of America* 113:5.
- McCauley, R.D., R.D. Day, K.M. Swadlow, 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. and J. Fewtrell. 2008a. Experiments and observations of fish exposed to seismic survey pulses. *Bioacoustics* 17:205-207.
- McCauley, R.D. and J. Fewtrell. 2008b. Marine invertebrates, intense anthropogenic noise, and squid response to seismic survey pulses. *Bioacoustics* 17:315-318.
- 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, 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.
- 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.
- Mickle, M.F. and D.M. Higgs. 2022. Towards a new understanding of elasmobranch hearing. *Marine Biology* 169:1-12.
- 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.
- 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*, 50p.

- 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.
- 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. Pages 31-46 in: *The Behavior and Sensory Biology of Elasmobranch Fishes: an Anthology in Memory of Donald Richard Nelson*.
- 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.
- 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.
- 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.
- National Marine Fisheries Service, U.S. Fish and Wildlife Service, and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland 156 pp. + appendices.
- National Park Service. 2025. Leatherback Sea Turtle webpage for Padre Island National Seashore.
<https://www.nps.gov/pais/learn/nature/leatherback.htm#:~:text=Only%20one%20leatherback%20nest%20has,during%20the%201920s%20and%201930s>. Retrieved February 25, 2025.
- 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 and USFWS. 2007. Green sea turtle (*Chelonia mydas*) 5-year review : Summary and evaluation.
- 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 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, and USFWS. 2008. 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, USFWS, and Semarnat. 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. 2001. Stock assessments of loggerhead and leatherback sea turtles: 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. 2006a. 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. 2006b. Biological opinion on the funding and permitting of seismic surveys by the National Science Foundation and National Marine Fisheries Service in the eastern tropical Pacific Ocean from March to April 2006. National Marine Fisheries Service, Silver Spring, Maryland. 76p.
- 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. 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. 2019. Guidance on the Endangered Species Act Term "Harass". Policy Directive 02-110-19. <https://www.fisheries.noaa.gov/s3/2023-05/02-110-19-renewal-kdr.pdf>
- 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.
- 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.
- NPS. 2024. Daily sea turtle nest counts on the Texas Coast. May 28, 2024 (accessed March 3, 2025). <https://seaturtles.org/turtle-count-texas-coast/>

- NRC. 1990. Decline of the sea turtles: causes and prevention. National Academy Press, 030904247X, Washington, D.C.
- NRC. 2003. 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 acoustic 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.
- Ogren, L.H. 1989. Distribution of juvenile and subadult Kemp's ridley sea turtles: Preliminary results from 1984-1987 surveys. Pages 116-123 in C.W. Caillouet Jr. and A.M. Landry, Jr., editors. First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A&M University, Sea Grant College, Galveston, Texas.
- O'hara, J. and J.R. Wilcox. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. *Copeia* (2):564-567.
- 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.
- Parry, G.D., S. Heislors, 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 Freshwater Resources Institute, Report No. 50.
- 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.
- Payne, J.F. J. Coady, and D. White. 2009. Potential effects of seismic airgun discharges on monkfish eggs (*Lophius americanus*) and larvae., St. John's, Newfoundland.
- 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.
- 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.
- Pelletier, N.A., A.M. Knochel, J.D. Stewart, N. Froman, T.R. Smith, G. Marshall, K. Abernathy, J. Hawkins, and G.M. Stevens. 2023. Insight into manta ray behaviour using animal-borne Crittercams. *Behaviour* 160:1205-1243.
- 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.
- 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 Directed Fisheries Research, Lowestoft, Endland.
- 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.

- 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.
- 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.
- 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.
- Popper, A.N. and A. Hawkins. 2016. The effects of noise on aquatic life II, volume 875. Springer.
- Popper, A.N. and R.R. Fay. 2011. Rethinking sound detection by fishes. *Hearing Research* 273:25-36.
- 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.
- 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. Tavalga. 2014. Sound exposure guidelines for fishes and sea turtles: a technical report. Springer and ASA Press, Cham, Switzerland.
- 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, N.W., Y. Liu, K. Chen, C. Tang, C. Chen, M. Cheng, and C.K. Wen. 2023. Acute noise is harmful on the anti-predator behavior of commercially important juvenile coral reef fishes. *Behavioral Processes* 210:104908.
- Prosnier, L., E. Rojas, and V. Médoc. 2022. A freshwater zooplankton in the face to boat noise pollution. *bioRxiv*:2022.11.20.517267.
- Przeslawski, R., L. Hurt, A. Forrest, and A. Carroll. 2016. Potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin. Fisheries Research and Development Corporation, Canberra, p.60.
- 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 Geophysical 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.
- 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, *Chelonia mydas*. Proceedings of the National Academies of Science 64.
- 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. Page 117 in J.I. Richardson and T.H. Richardson, editors. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA.
- 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 review of the green turtle (*Chelonia mydas*) under the Endangered 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.
- 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* 488:111-120.
- 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.
- 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. *Journal of Ocean Technology* 9(1):71-90.
- Skalski, J.R., W.H. Pearson, and C.I. Malme. 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.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.
- 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.
- 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 interesting 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.
- 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. 2020 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.
- Stewart, J.D., Jaine, F.R.A., Armstrong, A.J., Armstrong, A.O., Bennett, M.B., Burgess, K.B., Couturier, L.I.E., Croll, D.A., Cronin, M.R., Deakos, M.H., Dudgeon, C.L., Fernando, D., Froman, N., Germanov, E.S., Hall, M.A., Hinojosa-Alvarez, S., Hosegood, J.E., Kashiwagi, T., Laglbauer, B.J.L. & Stevens, G.M.W. (2018). Research priorities to support effective manta and devil ray conservation. *Frontiers in Marine Science* 5:314. DOI:10.3389/fmars.2018.00314.
- 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.
- SWOT. 2022. Printed maps of sea turtle biogeography. State of the World Sea Turtles, editor.
- TDOT (Texas Department of Transportation). 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. and J.A. Raga. 2008. Occurrence of Kemp's ridley sea turtle (*Lepidochelys kempii*) in the Mediterranean. *Marine Biodiversity Records* 1:e58.
- 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.
- 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.
- 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. Pages 1189-1351 in *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*.
- 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., 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.
- 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.
- 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.E. 2002. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a gulf stream front. *Marine Biology* 140(4):843-853.
- 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., M. Bresette, and R. Herren. 2006. *Chelonia mydas*—green turtle. *Chelonian Research Monographs* 3:90-104.
- 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.
- 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., J. Din, S. Abdullah, and R.B.R. Hassan. 2010. Turtle hearing capability based on abr signal assessment. *Telkomnika* 8:187- 194.
- Zhu, X., X. Zhang, M. Chen, and X. Xu. 2023. Characteristics of auditory brainstem response in wild yellow grouper *Epinephelus awoara*. *Frontiers in Marine Science* 10:1135310.

- 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. 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.
- Zwinnenberg, 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.

If you have any questions regarding this biological opinion, please contact Dr. Jason Kahn, Consultation Biologist, at (301) 427-8464 or jason.kahn@noaa.gov, or me at (240) 723-6321 or tanya.dobrzynski@noaa.gov.

Sincerely,

Chief, ESA Interagency Cooperation Division
Office of Protected Resources

APPENDIX E: INCIDENTAL HARASSMENT AUTHORIZATION



INCIDENTAL HARASSMENT AUTHORIZATION

The University of Texas at Austin (UT) 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 the date of issuance.
2. This IHA is valid only for geophysical survey activity in coastal waters off Texas in the NW Gulf of Mexico, as specified in UT's IHA application.
3. General Conditions
 - (a) A copy of this IHA must be in the possession of UT, the vessel operator, the lead protected species observer (PSO), and any other relevant designees of UT operating under the authority of this IHA.
 - (b) The species and/or stocks authorized for taking are listed in Table 1. Authorized take, by Level B harassment only, is limited to the species and/or stocks and numbers listed in Table 1.
 - (c) The taking by Level A harassment, serious injury or death of any of the species listed in Table 1 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized numbers listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.
 - (d) During use of the acoustic source, if any marine mammal species or stock not listed in Table 1 appear within or enter the Level B harassment zone (Table 2) the acoustic source must be shut down.
 - (e) UT must ensure that relevant vessel personnel and the PSO team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocols, operational procedures, and IHA requirements are clearly understood.
4. Mitigation Requirements
 - a. UT must use independent, dedicated, trained visual PSOs, meaning that the PSOs must be employed by a third-party observer provider, must not have tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including



brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course.

- b. At least one visual PSO must have a minimum of 90 days at-sea experience working in those roles, respectively, during a shallow penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience.
- c. Visual Observation
 - i. During survey operations (e.g., any day on which use of the airgun array is planned to occur and whenever the airgun array is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during ramp-up of the airgun array. To the maximum extent practicable, two PSOs must be on duty at all times during daylight hours.
 - ii. Visual monitoring of the pre-start clearance zone and, to the extent practicable, the Level B harassment zone (Table 2) must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the airgun array ceases or until 30 minutes past sunset.
 - iii. Visual PSOs must coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and must conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
 - iv. During good conditions (e.g., daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs must conduct observations when the airgun array is not operating for comparison of sighting rates and behavior with and without use of the airgun array and between acquisition periods, to the maximum extent practicable.
 - v. Visual PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period.
- d. Pre-start clearance and Ramp-up
 - i. A ramp-up procedure must be followed at all times as part of the activation of the airgun array, except as described under 4(d)(viii).
 - ii. The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO. The notification time should not be less than 60 minutes prior to the planned ramp-up in order to allow the PSOs time to monitor the shutdown and buffer zone for 30 minutes prior to the initiation of ramp-up.

- iii. Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in.
 - iv. One of the PSOs conducting the pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSOs to proceed.
 - v. 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.
 - vi. Ramp-up must 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 zone or until an additional time period has elapsed with no further sightings (15 minutes for small delphinids belonging to the genera of *Steno*, *Stenella*, or *Tursiops*, and 30 minutes for all other species).
 - vii. Ramp-up must begin by activating one GI airgun for no less than 5 minutes and then activating the second airgun. The operator must provide information to the PSO documenting that appropriate procedures were followed.
 - viii. If the airgun array is shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described for shutdown (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant observation and no detections of marine mammals have occurred within the pre-start clearance zone. For any longer shutdown, pre-start clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (e.g., BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-start clearance watch is not required.
 - ix. Testing of the airgun array involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-start clearance watch.
- e. Shutdown requirements
- i. Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the airgun array.
 - ii. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the airgun array to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch.
 - iii. 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).

f. Vessel strike avoidance

- i. Vessel operators and crew must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammals. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (separation distances stated below). Visual observers monitoring the vessel strike avoidance zone may be third-party observers (i.e., PSOs) or crew members, but crew members responsible for these duties must be provided sufficient training to 1) distinguish marine mammals from other phenomena and 2) broadly to identify a marine mammal to taxonomic group (i.e., as a large whale, or other marine mammal).
- ii. Vessel speeds must be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.
- iii. The vessel must maintain a minimum separation distance of 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 is 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.
- iv. The vessel must maintain a minimum separation distance of 100 m from sperm whales.
- v. The vessel must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an understanding that at times this may not be possible (e.g., for animals that approach the vessel).
- vi. When marine mammals are sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

5. Monitoring Requirements

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

- i. Reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups).
 - ii. Global Positioning Unit (GPS) (plus backup).
 - iii. Digital single-lens reflex cameras of appropriate quality that capture photographs and video (plus backup).
 - iv. Compass (plus backup)
 - v. Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups).
 - vi. Any other tools necessary to adequately perform necessary PSO tasks.
- b. Protected Species Observers Qualifications
- i. PSOs must have successfully completed an acceptable PSO training course.
 - ii. NMFS must review and approve PSO resumes.
 - iii. One visual PSO with experience as shown in 4(b) shall be designated as the lead for the PSO team. The lead must coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. (Note that the responsibility of coordinating duty schedules and roles may instead be assigned to a shore-based, third-party monitoring coordinator.) To the maximum extent practicable, the lead PSO must devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.
 - iv. PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.
 - v. PSOs must have successfully attained a bachelor's degree 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.
 - vi. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must be submitted to NMFS and must include written justification. Requests must be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine

mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

c. Data Collection

- i. PSOs must use standardized electronic data collection forms. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of animals to the airgun array and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the airgun array. If required mitigation was not implemented, PSOs should record a description of the circumstances.
- ii. At a minimum, the following information must be recorded:
 1. Vessel name, vessel size and type, maximum speed capability of vessel;
 2. Dates (MM/DD/YYYY) of departures and returns to port with port name;
 3. PSO names and affiliations, PSO ID (initials or other identifier);
 4. Date (MM/DD/YYYY) and participants of PSO briefings (as discussed in General Requirement);
 5. Visual monitoring equipment used (description);
 6. PSO location on vessel and height (meters) of observation location above water surface;
 7. Watch status (description);
 8. Dates (MM/DD/YYYY) and times (Greenwich Mean Time/UTC) of survey on/off effort and times (GMC/UTC) corresponding with PSO on/off effort;
 9. Vessel location (decimal degrees) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
 10. Vessel location (decimal degrees) at 30-second intervals if obtainable from data collection software, otherwise at a practical regular interval;
 11. Vessel heading (compass heading) and speed (knots) at beginning and end of visual PSO duty shifts and upon any change;
 12. Water depths (meters) (if obtainable from data collection software);

13. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
 14. Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (description) (e.g., vessel traffic, equipment malfunctions); and
 15. Vessel/survey activity information (and changes thereof) (description), such as airgun array power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).
- iii. Upon visual observation of any marine mammals, the following information must be recorded:
1. Sighting ID (numeric);
 2. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
 3. Location of PSO/observer (description);
 4. Vessel activity at the time of the sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other);
 5. PSO who sighted the animal/ID;
 6. Time/date of sighting (GMT/UTC, MM/DD/YYYY);
 7. Initial detection method (description);
 8. Sighting cue (description);
 9. Vessel location at time of sighting (decimal degrees);
 10. Water depth (meters);
 11. Direction of vessel's travel (compass direction);
 12. Speed (knots) of the vessel from which the observation was made;
 13. Direction of animal's travel relative to the vessel (description, compass heading);
 14. Bearing to sighting (degrees);

15. Identification of the animal (*e.g.*, genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;
16. Species reliability (an indicator of confidence in identification)
(1=unsure/possible, 2=probable, 3=definite/sure, 9=unknown/not recorded);
17. Estimated distance to the animal (meters) and method of estimating distance;
18. Estimated number of animals (high/low/best) (numeric);
19. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
20. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
21. Detailed behavior observations (*e.g.*, number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);
22. Animal's closest point of approach (CPA) (meters) and/or closest distance from any element of the airgun array;
23. Description of any actions implemented in response to the sighting (*e.g.*, delays, shutdown, ramp-up) and time and location of the action.
24. Photos (Yes/No);
25. Photo Frame Numbers (list of numbers); and
26. Conditions at a time of sighting (*e.g.*, visibility, BSS)

6. Reporting

- (a) 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. A final report must be submitted within 30 days following resolution of any comments on the draft report. If no comments are received from NMFS within 30 calendar days of receipt of the draft report, the report shall be considered final. The draft report must include the following:
 - (i) Summary of all activities conducted and sightings of marine mammals near the activities;
 - (ii) Summary of all data required to be collected (see condition 5(c));

- (iii) Full documentation of methods, results, and interpretation pertaining to all monitoring;
 - (iv) Summary of dates and locations of survey operations (including (1) the number of days on which the airgun array was active and (2) the percentage of time and total time the array was active during daylight vs. nighttime hours (including dawn and dusk)) and all marine mammal sightings (dates, times, locations, activities, associated survey activities);
 - (v) Geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa);
 - (vi) GIS files in ESRI shapefile format and UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates must be referenced to the WGS84 geographic coordinate system; and
 - (vii) Raw observational data.
- (b) Reporting Injured or Dead Marine Mammals
- (i) Discovery of Injured or Dead Marine Mammal – In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, UT must report the incident to the Office of Protected Resources (OPR) (PR.ITP.MonitoringReports@noaa.gov) as soon as feasible. The report must include the following information:
 1. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
 2. Species identification (if known) or description of the animal(s) involved;
 3. Condition of the animal(s) (including carcass condition if the animal is dead);
 4. Observed behaviors of the animal(s), if alive;
 5. If available, photographs or video footage of the animal(s); and
 6. General circumstances under which the animal was discovered.
 - (ii) Vessel Strike – In the event of a ship strike of a marine mammal by any vessel involved in the activities covered by the authorization, UT must report the incident to 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 incident;
2. Species identification (if known) or description of the animal(s) involved;
3. Vessel's speed during and leading up to the incident;
4. Vessel's course/heading and what operations were being conducted (if applicable);
5. Status of all sound sources in use;
6. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;
7. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;
8. Estimated size and length of animal that was struck;
9. Description of the behavior of the marine mammal immediately preceding and following the strike;
10. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;
11. Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and
12. To the extent practicable, photographs or video footage of the animal(s).

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

8. Renewals

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

- (a) A request for renewal is received no later than 60 days prior to the needed Renewal IHA effective date (the Renewal IHA expiration date cannot extend beyond one year from expiration of this IHA).
- (b) The request for renewal must include the following:
 - (i) An explanation that the activities to be conducted under the requested Renewal IHA are identical to the activities analyzed for this IHA, are a subset of the activities, or include changes so minor that the changes do not affect the previous analyses, mitigation and monitoring requirements, or take estimates (with the exception of reducing the type or amount of take).
 - (ii) A preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.
- (c) Upon review of the request for Renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures will remain the same and appropriate, and the findings made in support of this IHA remain valid.

For Kimberly Damon-Randall,
Director, Office of Protected Resources,
National Marine Fisheries Service.

Table 1. Authorized take numbers, by species

Species	Authorized Take by Level B Harassment
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	26
Bottlenose dolphin (<i>Tursiops truncatus</i>)	1,309
Rough-toothed dolphin (<i>Steno bredanensis</i>)	14

Table 2. Modeled Radial Distances (m) to Isoleths Corresponding to Level A and Level B Harassment Thresholds.

Airgun configuration	Level A harassment zone (m)	Level B harassment zone (m)
	HF cetaceans	
2 airgun array (210 in ³)	1.5	1,750

APPENDIX F: REQUEST FOR IHA REISSUANCE

October 8, 2025

National Marine Fisheries Service

Permits and Conservation Division,
Office of Protected Resources
1315 East-West Hwy, F/PR1
Room 13805
Silver Spring, MD 20910

To whom it may concern:

The University of Texas at Austin, Bureau of Economic Geology, hereby, requests reissuance of the IHA (incidental harassment authorization) issued by the National Marine Fisheries Service on January 13, 2025. As summarized further below, none of the planned geophysical survey activity described in the IHA Application has taken place and it is not expected to take place before the IHA expires. In accordance with instructions on the 2025 IHA for a renewal application, please, see the following justifications (below) for a reissuance.

1. The reasons for the reissuance request are multiple logistical delays in the geophysical survey activities covered by the current IHA.
 - a. Marine vessel availability is currently in doubt during the remaining effective dates of the 2025 IHA.
 - b. We do not yet have a permit from the Texas General Land Office to acquire geophysical data in Texas state waters.
 - c. The FONSI (finding of no significant impact) has not yet been issued by the Dept. of Energy's National Energy Technology Laboratory NEPA office. Without the FONSI, the geophysical acquisition activity covered by the current IHA does not have permission from DOE to proceed.
 - d. The federal government is currently shut down, and it is unclear when the government will re-open. Until the government re-opens, no FONSI will be issued.
2. The activities to be conducted under the reissued IHA are identical to the activities analyzed for the current 2025 IHA, and therefore there are no changes to the analyses, mitigation and monitoring requirements, or take estimates of the current, 2025 IHA.
3. To date, no activities have occurred under the 2025 IHA.

Please, advise whether or not more information is needed in support of this renewal application.

Respectfully,

Ramón Treviño
Program Manager
Gulf Coast Carbon Center
Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin

APPENDIX G: EFH CONSULTATION

15 October 2024

Ms. 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, 2025

Dear Ms. Fay:

The University of Texas (UT), 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 study the geologic environments beneath the Gulf of Mexico for secure, long-term, large-scale carbon dioxide (CO₂) storage and enhanced hydrocarbon recovery. The proposed project would take place in early 2025 (January to April) for a period of approximately 23 days, with ~20 days of seismic acquisition using up to 2 generator-injector (GI) airguns as the energy source.

The surveys are proposed to occur within Texas state waters, within 9 nautical miles (n. mi.) from shore; however, the primary study area is no closer to shore than the 10-meter (m) isobath or ~1.3 kilometers (km) [closest point of approach or CPA is Port Aransas]. If no suitable sites (i.e., lease areas) are available within Texas state waters, the surveys would occur on the outer continental shelf (OCS) but within the 30-m isobath or between 13.3 and up to 115 km from shore (alternative study area). The actual surveys (or survey area) would occur in a limited area (~50 km²) anywhere within the proposed study area depicted in Figure 1, although a site within the primary study area is preferred. All activities would occur within the U.S. Exclusive Economic Zone (EEZ), between ~27.1–29.6°N and ~93.6–97.4°W (Figure 1).

Up to two 105 cubic inch (in³) GI-airguns would be towed 10-20 m behind the source vessel as the energy source, at a depth of ~3 m; the total possible discharge volume would be ~210 in³. 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 4,440 km of seismic acquisition are proposed.

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 Fishery Management Plan (FMP). FMPs for the Gulf of Mexico have been developed for Coastal Migratory Pelagics (such as mackerel and cobia), reef fish, coral, red drum, spiny lobster, stone crab, and shrimp. EFH has been designated in the Gulf of Mexico for several species (Figure 1) and overlaps with the survey area for Coastal Migratory Pelagics/Reef Fish/Shrimp, as well as Atlantic Highly-Mobile Species. Although there are several Habitat Areas of Particular Concern (HAPC), including Coral HAPCs, in the northern Gulf of Mexico, none are near the proposed survey area. The closest HAPC to the study area is Southern Bank, a Coral Amendment 9 HAPC – it is located 34 km east of the alternate study area and 50 km from the primary study area (Figure 2).

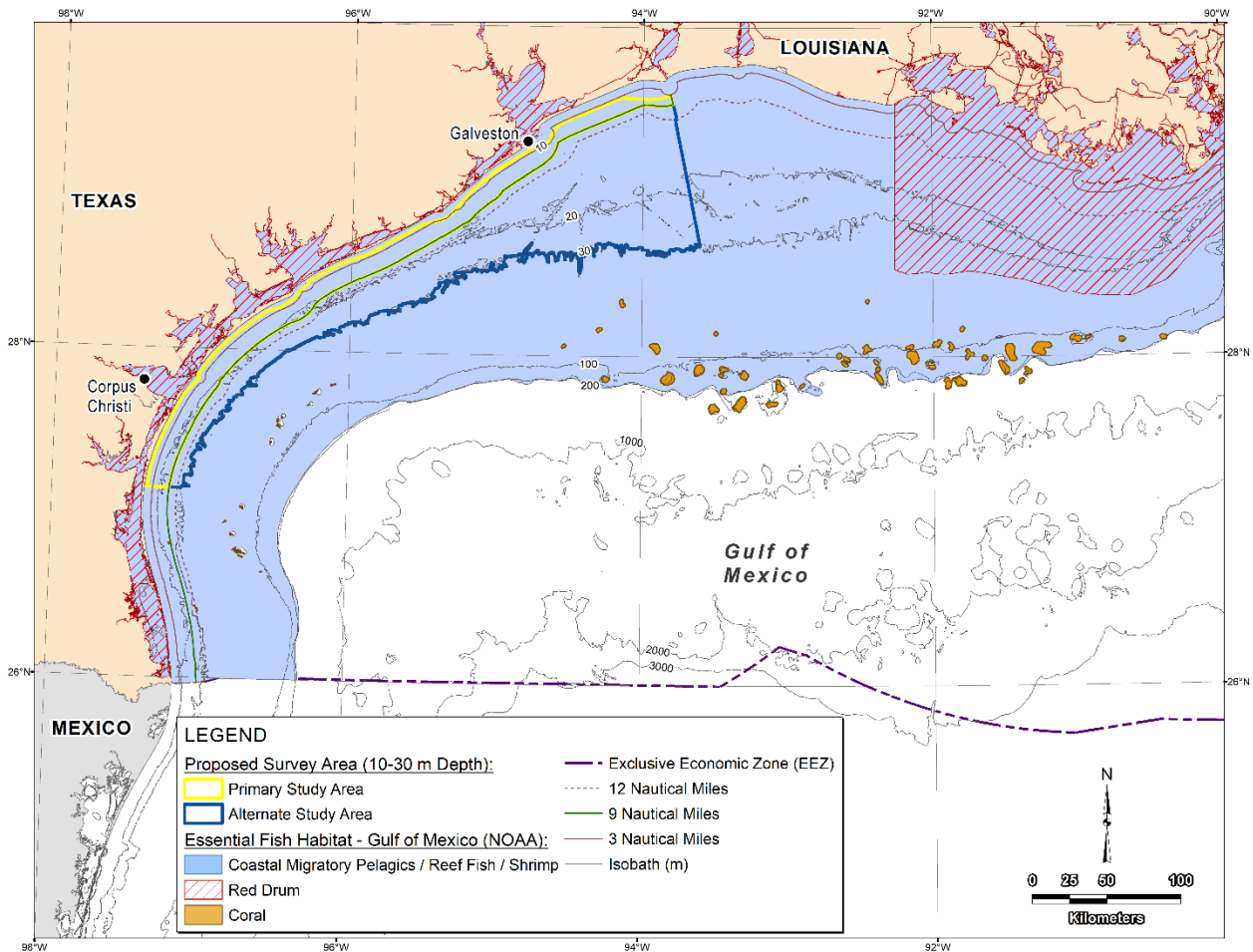


Figure 1. Proposed study area and Essential Fish Habitat (EFH) in the northern Gulf of Mexico. The seismic tracklines could occur anywhere within the primary or alternate study area but would only cover an area approximately 50 km². Not shown is EFH for Atlantic Highly-Mobile Species, as it overlaps with the Coastal Migratory Pelagics/Reef fish/Shrimp EFH.

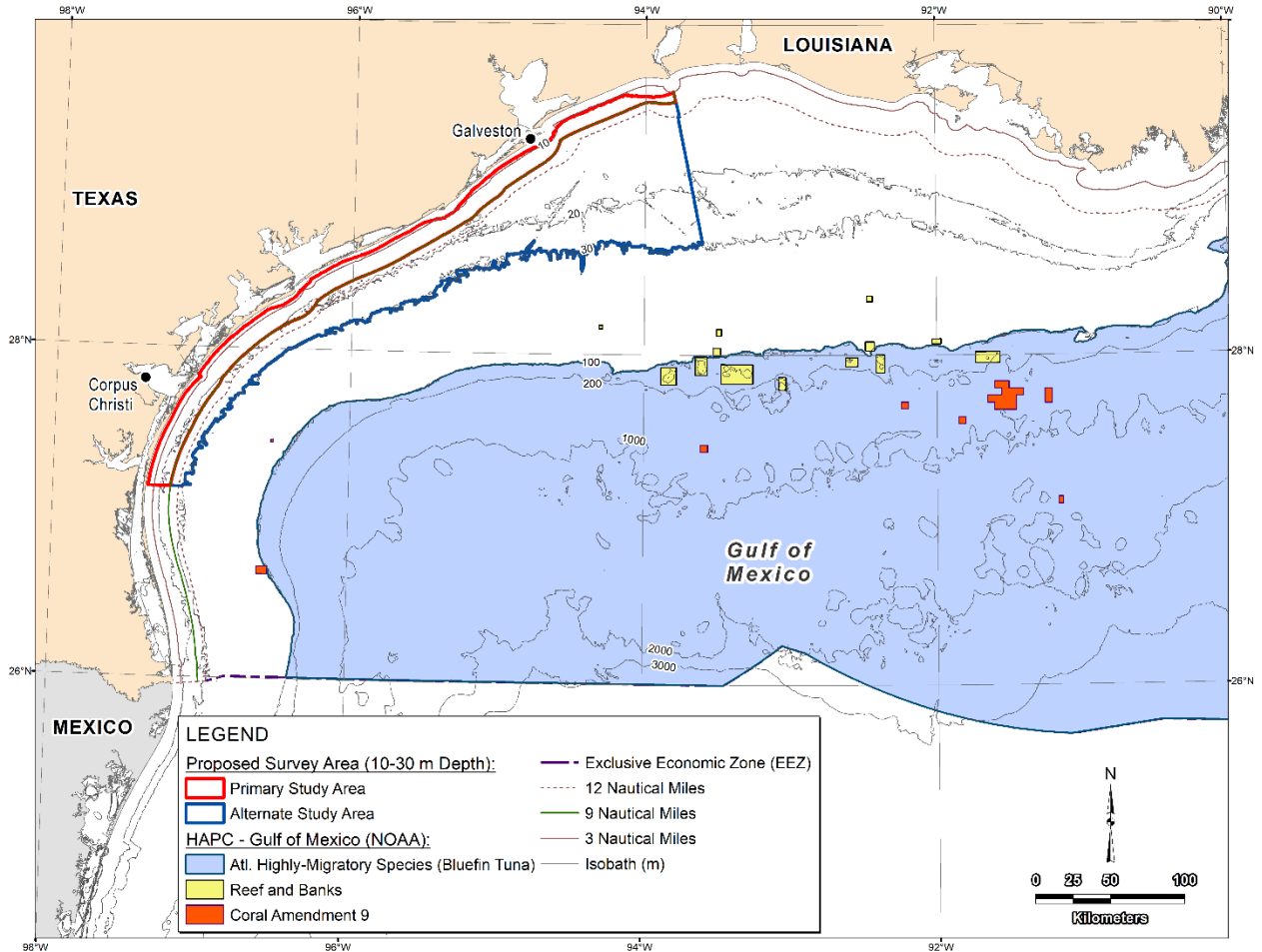


FIGURE 2. Habitat Areas of Particular Concern (HAPC) in the northwestern Gulf of Mexico. Atl. = Atlantic.

Effects Determination

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 (~20 days of seismic acquisition). Proposed monitoring and mitigation measures for the surveys include: monitoring by Protected Species Observers (PSO) for marine mammals and sea turtles near the vessel, and observing for potential impacts of acoustic sources on fish; (2) PSO data and documentation; and (3) mitigation during operations (delayed start up, shut downs for sea turtles within an exclusion zone (EZ) and marine mammal species without take authorization, ramp up procedures, vessel strike avoidance).

For a similar low-energy survey carried out by UT in the northern GoM during 2024, the EZ for marine mammals was replaced by NMFS with a 200-m clearance zone prior to start up, as shut-downs were not required for cetaceans entering the EZ, unless the cetaceans were species for which take was not authorized or for which take numbers were exceeded. For sea turtles, a 100-m

clearance zone and 100-m EZ were used. 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,

A handwritten signature in blue ink that reads "Johnna Sholtis". The signature is written in a cursive style with a prominent initial "J".

Johnna Sholtis, Ph.D.
NEPA Compliance Officer
Department of Energy – National Energy Technology Laboratory
626 Cochran Mill Road, Pittsburgh, PA 15236
Email: Johnna.Sholtis@netl.doe.gov

cc: David Dale, NOAA Fisheries, Southeast Regional Office, EFH Coordinator

From: charrish stevens - NOAA Federal <charrish.stevens@noaa.gov>

Sent: Thursday, October 17, 2024 12:09 PM

To: Sholtis, Johnna <Johnna.Sholtis@netl.doe.gov>; _NMFS ser HCDconsultations <nmfs.ser.hcdconsultations@noaa.gov>

Cc: Rusty Swafford - NOAA Federal <rusty.swafford@noaa.gov>

Subject: Re: [EXTERNAL] Re: Essential Fish Habitat Consultation Request for Marine Geophysical Surveys in the Northwestern Gulf of Mexico, Early 2025

Dear Ms. Johanna Sholtis,

The National Marine Fisheries Service Habitat Conservation Division has received your letter dated October 15, 2024, requesting Essential Fish Habitat Coordination on the following proposed Marine Geographical Surveys in the Northwestern Gulf of Mexico approximately nine nautical miles from the shore of the Texas gulf coast.

We have reviewed the proposed project details in the letter you provided under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act. We concur with the “minimal Adverse Effect” determination and have no objections to the issuance of this permit. We appreciate your coordination with our office on this project. If you have any additional questions or require additional information, please feel free to contact me via email.

Thank you for your coordination,

Charrish Stevens

Fishery Biologist

Habitat Conservation Division

NOAA National Marine Fisheries Service
4700 Ave U, Galveston, TX 77551

Currently Teleworking contact at

Mobile Number: 713-715-9613

Office Ph: (409) 766-3699

Fax: (409) 766-3575

Email: charrish.stevens@noaa.gov

APPENDIX H: CZMA DETERMINATION LETTER

October 17, 2024

Ms. Leslie Koza, Federal Consistency Coordinator
Texas Coastal Management Program
Coastal Resources Division
Texas General Land Office
1700 North Congress Avenue
Austin, Texas 78701-1495

Re: Coastal Zone Management Act (CZMA) Consistency Determination

Dear Ms. Koza:

This document provides the Texas General Land Office (GLO), which administers the Texas Coastal Management Program (CMP), with the Department of Energy's (DOE) Consistency Determination under the Coastal Zone Management Act (CZMA) Section 15 CFR Part 930, subpart C, for a research proposal entitled, "Partnership for Offshore Carbon Storage Resources and Technology Development in the Gulf of Mexico (GoMCarb)." As the Proposed Action involves a federal entity (DOE) funding researchers from the University of Texas (UT), DOE considered this activity under Subpart C of the CZMA (16 USC §1451, et seq.). In accordance with CZMA Subpart C, DOE considered whether the Proposed Action would have any effect on coastal uses or resources of the State of Texas.

Pursuant to the National Environmental Policy Act, as amended, DOE prepared a Draft Environmental Assessment (Draft EA) to evaluate the potential impacts on the human and natural environment associated with the proposed activities, including to species protected under the Marine Mammal Protection Act (MMPA) and endangered and threatened species listed under the Endangered Species Act (ESA). Based on the conclusions from the Draft EA, entitled "Draft Environmental Assessment for Marine Geophysical Surveys by University of Texas in the Northwestern Gulf of Mexico, 2025" (Attachment 1), DOE has determined that the proposed activities would not have a significant adverse impact on the environment.

Consultations

DOE has initiated consultation with the National Marine Fisheries Service under Section 7 of the ESA. Separately, an Incidental Harassment Authorization (IHA) under the MMPA is being sought for the surveys by UT, which would conduct the surveys. DOE will also consult on Essential Fish Habitat (EFH) pursuant to the Magnuson Stevens Act. The proposed activities are not related to ocean mining, oil and gas exploration, development, production, or lease sales, and therefore are not subject to Bureau of Ocean Energy Management regulatory jurisdiction pursuant to the Outer Continental Shelf Lands Act.

Proposed Research Activity

The research proposal was received by DOE in response to a funding opportunity announcement and was selected to receive cost-share funding. The proposed research activities that include seismic surveys would be led by academic researchers Dr. Susan Hovorka, Dr. Tip Meckel and Mr. Ramón Treviño from UT. The purpose of the proposed seismic surveys would be to study the geologic environments beneath the Gulf of Mexico for secure, long-term, large-scale carbon dioxide (CO₂) storage. To achieve the project's goals, the researchers would conduct seismic surveys utilizing up to two GI-airguns. The proposed research is not related to ocean mining, oil

and gas exploration, development, production, or lease sales. The proposed study would take place in early 2025 (between January and April) for a period of approximately 23 days, with ~20 days of seismic acquisition.

The surveys are proposed to occur within Texas state waters, within 9 n.mi. from shore; however, the primary study area is no closer to shore than the 10-m isobath or ~1.3 km (closest point of approach or CPA is Port Aransas). If no suitable sites (i.e., lease areas) are available within Texas state waters, the surveys would occur on the outer continental shelf (OCS) but within the 30-m isobath or between 13.3 and up to 115 km from shore (alterative study area). The actual surveys (or survey area) would occur in a limited area (~50 km²) anywhere within the proposed study area depicted in Figure 1 (Attachment 1), although a site within the primary study area is preferred. All activities would occur within the U.S. Exclusive Economic Zone (EEZ), between ~27.1–29.6°N and ~93.6–97.4°W (Figure1). The water depth at the site could be as shallow as 10 m and no deeper than 30 m.

The seismic surveys would involve one source vessel, likely the TDI-Brooks owned R/V *Brooks McCall*. The proposed energy source for the surveys was considered by the researchers during planning efforts and tailored to use the least amount of energy to meet the research goals for this particular survey site. Up to two 105 in³ GI-airguns would be towed 10-20 m behind the source vessel as the energy source, at a depth of ~3 m; the total possible discharge volume would be ~210 in³. 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 array is 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 4440 km of seismic acquisition are proposed.

The Proposed Action includes an extensive monitoring and mitigation program to minimize potential impacts on the environment. Mitigation efforts include pre-cruise planning activities and operational activities (Attachment 1, Chapters 2 and 4). Pre-cruise planning mitigation activities included consideration of energy source optimization/minimization; survey timing (i.e., environmental conditions: seasonal presence of animals and weather); and determination of mitigation zones.

The operational mitigation program would further minimize potential impacts to marine species that may be present during the conduct of the proposed research to a level of insignificance. As detailed in Attachment 1 (Chapters 2 and 4) the surveys would include operational monitoring and mitigation measures, such as, but not limited to: visual observations; enforcement of exclusion zones; pre-clearance and ramp ups, shutdown of the airguns; monitoring and reporting. The fact that the GI airgun(s) direct the majority of the energy downward and less energy laterally, would also be an inherent mitigation measure.

For a similar low-energy seismic survey by UT off the coast of Texas in 2024, the National Marine Fisheries Service (NMFS) required a 200-m clearance zone for marine mammals prior to start up, instead of a 100-m exclusion zone (EZ), as shut downs were not required for cetaceans entering the EZ. However, shut downs were to be implemented for cetacean species for which take was not authorized or for which take numbers were exceeded. For sea turtles, a 100-m clearance zone and 100-m EZ were required.

Potential Effects to Texas Coastal Resources

During preparation of the Draft EA and in accordance with the CZMA (16 USC §1451, *et seq.*), DOE considered whether the proposed activity would have any effect on coastal uses or resources

of the State of Texas. The proposed activities would occur either in state waters or on the OCS, with the closest point of approach to land being 1.3 km. Potential impacts of the seismic surveys on the environment, if any, would be primarily a result of the operation of the airgun(s). The increased underwater noise may result in avoidance behavior by marine mammals, sea turtles, seabirds, and fish, and other forms of disturbance. At most, effects on marine mammals may be interpreted as falling within the MMPA definition of “Level B Harassment” for those species managed by the NMFS. No long-term or significant effects would be anticipated on individual marine mammals, sea turtles, seabirds, fish, the populations to which they belong, or their habitats as a result of this proposed action.

Mitigation measures proposed in the Draft EA for the surveys would reduce potential risks to marine species (Attachment 1, Sections 2.1.3 and 4.1.1.4). Given the proposed activities, including the short duration of the surveys, temporary nature of potential impacts to marine species, including mitigation measures, significant impacts on marine species off the coast of Texas are not anticipated.

The proposed marine geophysical surveys would not interfere with commercial or recreational fisheries activities. The marine seismic surveys would not preclude fisheries from operating within or around the survey area. A safe distance, however, would need to be kept between the source vessel and other vessels to avoid entanglement with the towed seismic equipment (Attachment 1, Section 4.1.2.4). The vessel operator would use vessel-based radio broadcasts and issue Notice to Mariners to alert mariners, including fishers, of survey activities. During the proposed seismic surveys, disturbance to fish species would be short-term, and fish would return to their pre-disturbance behavior once the seismic activity ceased (Attachment 1, Section 4.1.4). Given the proposed activities, impacts would not be anticipated to be significant or likely to adversely affect (including ESA-listed) marine invertebrates or marine fish (see Attachment 1, Section 4.1.2.4), and their fisheries, including commercial and recreational fisheries. In addition, although the proposed activities may affect Essential Fish Habitat (EFH), no adverse effects on EFH are expected. The proposed activities would have no effect on Habitat Area of Particular Concern (HAPC) as these are located at least 34 km from the proposed surveys.

Other human activities in the area around the survey vessel could include scuba diving and dolphin watching. Potential conflicts with SCUBA divers would be avoided through Notice to Mariners and communication with dive operators during the surveys. There are also numerous shipwrecks in the survey area. Airgun sounds would have no effects on solid structures. No adverse impacts to SCUBA diving activities or cultural resources, including shipwrecks, are anticipated. Given the short and temporary duration of the surveys, it would be unlikely that the dolphin watching industry would be affected by the proposed activities.

No activities would occur on land. Access to Texas beaches and fisheries in state waters would not be impeded by the offshore marine-based proposed activities.

Coastal Management Program Objectives and Policies

Projects must comply with the following key elements of Texas’ CMP, which are addressed in more detail below.

Pursuant to §26.15, *Policy for Major Actions*, it is the policy of GLO that prior to taking a major action, the agencies having jurisdiction over the activity shall meet and coordinate their major actions relating to the activity. DOE is consulting with the NMFS and has, to the greatest extent practicable, considered the cumulative and secondary adverse effects. Although DOE has determined that the proposed project may affect the coastal natural resources areas (CNRA), Waters

of the Gulf of Mexico, by emitting temporary and intermittent impulsive sounds into the water column, adverse effects on CNRA are not anticipated. Rather, the proposed project is likely to have minor, temporary effects on marine species, such as marine mammals and sea turtles, in the waters surrounding the surveys. Potential impacts from the proposed marine geophysical surveys on the marine environment are described in detail in the Draft EA (Attachment 1, Chapter 3). The proposed marine geophysical surveys include a monitoring and mitigation plan that would reduce any potential impacts on the marine environment, such as on marine mammals and sea turtles (Attachment 1, Sections 2.1.3 and 4.1.1.4). Cumulative adverse effects to CNRA would be minimized. Therefore, the proposed activities are consistent to the maximum extent practicable with the guidelines and policies of §26.15, *Policy for Major Actions*.

Pursuant to §26.16, *Policies for Construction of Electric Generating and Transmission Facilities*, it is the policy of GLO that construction of electric generating facilities and electric transmission lines in the coastal zone comply with regulations as outlined in the policy. The proposed research activities would not involve construction of electric generating and transmission facilities. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.16, *Policies for Construction of Electric Generating and Transmission Facilities*,

Pursuant to §26.17, *Policies for Construction, Operation, and Maintenance of Oil and Gas Exploration and Production Facilities*, it is the policy of GLO that construction, operation, and maintenance of oil and gas exploration and production facilities comply with regulations as outlined in the policy. The proposed activities do not involve construction, operation, or maintenance of oil and gas exploration or production facilities; therefore, no further action is required regarding the consistency of the proposed activities with the floating structure policy outlined in of §26.17, *Policies for Construction, Operation, and Maintenance of Oil and Gas Exploration and Production Facilities*.

Pursuant to §26.18, *Policies for Discharges of Wastewater and Disposal of Waste from Oil and Gas Exploration and Production Activities*, it is the policy of GLO that discharges of wastewater and disposal of waste from oil and gas exploration and production activities comply with regulations as outlined in the policy. The proposed activities do not involve discharges of wastewater and disposal of waste from oil and gas exploration and production activities. Therefore, no further action is required regarding the consistency of the proposed activities with the floating structure policy outlined in §26.18, *Policies for Discharges of Wastewater and Disposal of Waste from Oil and Gas Exploration and Production Activities*.

Pursuant to §26.20, *Policies for Prevention, Response and Remediation of Oil Spills*, the GLO regulations shall provide for measures to prevent coastal oil spills and to ensure adequate response and removal actions, and a natural resource damage assessment must be conducted. The seismic source vessel for the proposed surveys will not be transporting oil. However, it does have a Shipboard Oil Pollution Emergency Plan (SOPEPE). Therefore, no further action is required regarding the consistency of the proposed activities with the floating structure policy outlined in §26.20, *Policies for Prevention, Response and Remediation of Oil Spills*.

Pursuant to §26.21, *Policies for Discharge of Municipal and Industrial Wastewater to Coastal Water*, it is the policy of GLO that discharges shall comply with water-quality-based effluent limits, that discharges that increase pollutant loadings to coastal waters shall not impair designated uses of coast waters and shall not significantly degrade coastal water quality unless necessary for important economic or social development, and that no wastewater outfalls shall be located where they will not adversely affect critical areas. The proposed marine geophysical surveys would

follow all international and federal regulatory requirements for vessel discharges, and no wastewater outfalls are proposed as part of the project. The proposed marine geophysical surveys would not be anticipated to affect water quality (Attachment 1, Chapter 3). Any project-related wastes would be disposed of in accordance with international, U.S. state, and federal requirements. The proposed activities would not degrade water quality and are therefore consistent with §26.21, *Policies for Discharge of Municipal and Industrial Wastewater to Coastal Water*.

Pursuant to §26.22, *Policies for Nonpoint Source (NPS) Water Pollution*, it is the policy of GLO that state agencies and subdivisions with authority to manage NPS pollution shall cooperate in the development and implementation of a coordinated program to reduce NPS pollution in order to restore and protect coastal waters. The proposed marine geophysical surveys would follow all international and federal regulatory requirements for vessel discharges. The proposed marine geophysical surveys would not be anticipated to affect water quality (Attachment 1, Chapter 3). Any project-related wastes would be disposed of in accordance with international, U.S. state, and federal requirements. Thus, the proposed activities would not degrade water quality and are therefore consistent with §26.22, *Policies for Nonpoint Source (NPS) Water Pollution*.

Pursuant to §26.23, *Policies for Development in Critical Areas*, it is the policy of GLO that dredging and construction of structures in, or the discharge of dredged or fill material into, critical areas shall comply with the regulations. The proposed activities do not include dredging or construction. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.23, *Policies for Development in Critical Areas*.

Pursuant to §26.24, *Policies for Construction of Waterfront Facilities and Other Structures on Submerged Land*, it is the policy of GLO that the development on submerged lands shall comply with the regulations. The proposed activities do not include any construction activities. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.24, *Policies for Construction of Waterfront Facilities and Other Structures on Submerged Land*.

Pursuant to §26.25, *Policies for Dredging and Dredged Material and Placement*, it is the policy of GLO that dredging and dredged material and placement shall comply with the regulations. The proposed activities do not include any dredging. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.25, *Policies for Dredging and Dredged Material and Placement*.

Pursuant to §26.26, *Policies for Construction in the Beach/Dune System*, it is the policy of GLO that construction in critical dune areas or areas adjacent to or on Gulf beaches shall comply with the regulations. The proposed activities do not include any construction. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.26, *Policies for Construction in the Beach/Dune System*.

Pursuant to §26.27, *Policies for Development in Coastal Hazard Areas*, it is the policy of GLO that development in special hazard areas shall comply with the regulations. The proposed activities do not include any development or construction. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.27, *Policies for Development in Coastal Hazard Areas*.

Pursuant to §26.28, *Policies for Development Within Coastal Barrier Resource System Units and Otherwise Protected Areas in Coastal Barriers*, it is the policy of GLO that development of new infrastructure or major repair of existing infrastructure within or supporting development within

Coastal Barrier Resource System Units and Otherwise Protected Areas shall comply with the regulations. The proposed activities do not include any development or construction. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.28, *Policies for Development Within Coastal Barrier Resource System Units and Otherwise Protected Areas in Coastal Barriers*.

Pursuant to §26.29, *Policies for Development in State Parks, Wildlife Management Areas or Preserves*, it is the policy of GLO that development by a person other than the Parks and Wildlife Department that requires the use or taking of any public land in such areas shall comply with the Texas Parks and Wildlife Code, Chapter 26. The proposed activities do not include any development or construction in State Parks, Wildlife Management Areas or Preserves or elsewhere. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.29, *Policies for Development in State Parks, Wildlife Management Areas or Preserves*.

Pursuant to §26.30, *Policies for Alteration of Coastal Historic Areas*, it is the policy of GLO that development affecting a coastal historic area shall avoid and otherwise minimize alteration or disturbance of the site unless the sites excavation will promote historical, archaeological, educational, or scientific understanding. The proposed activities do not include alteration of coastal historic areas. Although shipwrecks do occur within the proposed survey area (see Attachment 1, Figure 4), pulses from the airgun(s) would not impact these structures; therefore, the proposed activities are consistent with §26.30, *Policies for Alteration of Coastal Historic Areas*.

Pursuant to §26.31, *Policies for Transportation Projects*, it is the policy of GLO that transportation construction projects and maintenance programs within the coastal zone shall comply with the regulations. The proposed activities do not include transportation construction projects or maintenance programs. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.31, *Policies for Transportation Projects*.

Pursuant to §26.32, *Policies for Emission of Air Pollutants*, the Clean Air Act must be followed to protect and enhance air quality in the coastal areas so as to protect CNRAs and promote the public health, safety, and welfare. Project vessel emissions would result from the proposed activity; however, these short-term emissions would not result in any exceedance of Federal Clean Air standards. Emissions would be expected to have a negligible impact on the air quality within the proposed survey area. To reduce impacts on air quality, the source vessel would use low-sulfur fuel and minimize fuel consumption (e.g., speed optimization) resulting in overall lower emissions. The proposed activities would not degrade air quality and are therefore consistent with §26.32, *Policies for Emission of Air Pollutants*.

Pursuant to §26.33, *Policies for Appropriations of Water*, it is the policy of GLO that impoundments and diversion of state water within 200 stream miles of the coast, to commence from the mouth of the river thence inland, shall comply with regulations. The proposed activities do not involve impoundment and diversion of state water. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.33, *Policies for Appropriations of Water*.

Pursuant to §26.34, *Policies for Levee and Flood Control Projects*, it is the policy of GLO that drainage, reclamation, channelization, levee construction or modification, or flood-or floodwater-control infrastructure projects shall be designed, constructed, and maintained to avoid the impoundment and draining of coastal wetlands to the greatest extent practicable. If impoundment or draining of coastal wetlands cannot be avoided, adverse effects to the wetlands shall be mitigated

in accordance with regulations. The proposed activities do not include levee and flood control projects. Therefore, no further action is required regarding the consistency of the proposed activities with the policies outlined in §26.34, *Policies for Levee and Flood Control Projects*.

Conclusion

DOE reviewed the Texas CMP and determined that the proposed activity is consistent to the maximum extent practicable with the CMP. Furthermore, after review and consideration, DOE anticipates that the Proposed Action, which would involve marine geophysical research activities, including the temporary use of airgun(s) would have no significant adverse effects on the State of Texas coastal uses or associated resources. DOE has considered Texas' CMP, including the key elements found in the Coastal Area Management Act, and concludes that the Proposed Action would be consistent with the enforceable policies of Texas' federally approved CMP.

DOE would be appreciative if GLO could inform the agency of its perspective on the Consistency Determination at the earliest possible convenience. The States' response should be sent via mail or **email** to:

Dr. Johnna Sholtis, NEPA Compliance Officer
U.S. Department of Energy
National Energy Technology Laboratory
626 Cochran Mill Road
Pittsburgh, PA 15236
412-386-9395
Email: Johnna.Sholtis@netl.doe.gov

Sincerely,



Johnna Sholtis
NEPA Compliance Officer

Attachment 1: DOE/EA-2267D: Draft Environmental Assessment for Marine Geophysical Surveys by University of Texas in the Northwestern Gulf of Mexico, 2025



TEXAS GENERAL LAND OFFICE
COMMISSIONER DAWN BUCKINGHAM, M.D.

December 31, 2024

U.S. Department of Energy
National Energy Technology Laboratory
626 Cochran Mill Road
Pittsburgh, PA 15236
ATTN: Johnna Sholtis

**Re: DOE/EA-2267D: Draft Environmental Assessment for Marine Geophysical
Surveys by University of Texas in the Northwestern Gulf of Mexico
CMP#: 25-1038-F2**

Dear Ms. Sholtis:

The project referenced above has been reviewed for consistency with the Texas Coastal Management Program (CMP) pursuant to 31 Texas Administrative Code §30.20. It has been determined that the project, as proposed, is consistent with the CMP goals and enforceable 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
Federal Consistency Coordinator
Texas General Land Office