Protected Species Mitigation and Monitoring Report

Marine Geophysical (Seismic) Survey
Eastern Tropical Pacific Ocean

Becel Mexico Guerrero Gap Survey
15 May 2022 – 30 June 2022

R/V *Marcus G. Langseth*

Prepared for:

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Acronyms and Abbreviations

ADCP – Acoustic doppler current profiler
BioOp – Biological Opinion (US)
BOEM – Bureau of Ocean Energy Management
BSS – Beaufort Sea States
BZ – Buffer Zones
DAQ – Data acquisition
dB - decibels
DSLR – Digital Single Lens Reflex
EA – Environmental Assessment (US)
EPU – Electronic Processing Unit
ESA – Endangered Species Act (US)
EEZ – Economic Exclusion Zone
EZ – Exclusion Zone
FONSI – Finding of No Significant Impact (US)
FWS – Fish and Wildlife Service (US)
GPS – Global Positioning System
HF – High Frequency
HZ - Hertz
IHA – Incidental Harassment Authorization (US)
ITS – Incidental Take Statement (US)
LDEO – Lamont-Doherty Earth Observatory (US)
LF – Low Frequency
MBES – Multibeam Echosounder
MMPA – Marine Mammal Protection Act (US)
NMFS – National Marine Fisheries Service (US)
NRP – Navigation Reference point
NSF – National Science Foundation (US)\
OBS – Ocean-bottom seismometers
OCS – Outer Continental Shelf
OEIS – Overseas Environmental Impact Statement (US)
PAM – Passive Acoustic Monitoring
PEIS – Programmatic Environmental Impact Statement (US)
PI – Principal Investigator
PTS – Permanent threshold shift
PSO – Protected Species Observer
RME – PAM sound card manufacturer company name (not an acronym)
RMS – Root mean square
RPS- PSO Provider company name (not an acronym)
R/V – Research vessel
SBP – Sub bottom Profiler
TOAD – Time of Arrival Distance
TVG – Transverse Gradiometer
US – United States
UTC – Coordinated Universal Time

1. EXECUTIVE SUMMARY

The R/V *Marcus G. Langseth* (*Langseth*), owned and operated by Columbia University's Lamont-Doherty Earth Observatory (LDEO), conducted a two-dimensional (2D) survey in the Eastern Tropical Pacific Ocean off the coast of western Mexico from 15 May to 30 June 2022 (referred to herein as "seismic survey"). The operational activities were conducted in support of research proposed by Principal Investigators (PIs) Drs. Anne Becel (LDEO), Donna Shillington (Northern Arizona University), Brian Boston (LDEO), and Adrian Arnulf (University of Texas), and researchers Victor Manuel Cruz-Atienza and Jorge Arturo Real Peres (National Autonomous University of Mexico).

The purpose of the research was to acquire data to quantify incoming plate hydration and examine the role of fluids on megathrust slip behavior in and around the Guerrero Gap of the Middle America Trench. The data would provide constraints on the properties and geometry of the subduction zone faults, including the abundance and distribution of fluids in both the incoming oceanic plate and within the subduction zone. The survey has broad implications for earthquake hazard assessment in the subduction zone off Mexico and would also provide prime constraints on Earth's water budget.

This report was prepared to meet the reporting requirements for the survey required under the US Marine Mammal Protection Act (MMPA) and the US Endangered Species Act (ESA). On 21 August 2021, L-DEO applied to the US National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) that would allow for the potential harassment of small numbers of protected marine mammals incidental to the seismic survey. On 18 August 2021, NSF submitted a formal ESA Section 7 consultation request to NMFS for the proposed activity. On 29 April 2022 NMFS issued the Biological Opinion (BiOp) and Incidental Take Statement (ITS) and the IHA on 02 May 2022. NMFS conveyed the authorizations to NSF on 02 May 2022. Pursuant to Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions", NSF prepared Draft and Final Environmental Analysis (EAs) for the activity and issued a Finding of No Significant Impact on 4 May 2022.

Mitigation measures were implemented to minimize potential impacts to marine mammals, endangered or threatened sea turtles and sea birds during the survey. These measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, and the designation of buffer zones (BZ) and exclusion zones (EZ) (where the presence of a protected species would trigger a mitigation action), ramp-up procedures, and mitigation actions (including delayed operations, power-downs, and shut-downs). Continuous protected species observation coverage during the survey was provided by RPS, the environmental consulting company contracted by L-DEO for the project. PSOs monitored and reported on the presence and behavior of protected species and directed the implementation of the mitigation measures as described in the regulatory documents issued for the survey.

PSO activities were consistent with the PSO standards identified in the Programmatic Environmental Impact Statement (PEIS) / Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the NSF or conducted by the U.S. Geological Survey and Record of Decision (referred to herein as the PEIS), to which the NSF Draft and Final EAs tiered. Five PSOs, one of which was designated as the Lead, were present on board the *Langseth* throughout the survey to conduct both visual and acoustic monitoring.

Throughout the survey, PSOs conducted visual observations for a total of 649 hours 20 minutes and acoustic monitoring for 629 hours three minutes. Visual and acoustic monitoring were conducted simultaneously for a total of 374 hours 25 minutes.

The acoustic source was active for a total of 553 hours 39 minutes, which occurred during 48% (311 hours 13 minutes) of the total visual effort and 88% (553 hours 39 minutes) of the total acoustic monitoring effort by the PSOs.

There was a total of 217 detections of protected species during the survey, including 211 visual detections, five acoustic detections, and one simultaneous visual and acoustic detection. Visual detections included 14 sightings of whales (two sightings of Bryde's whales, four sightings of minke

whales, one sighting of a fin whale, one sighting of a humpback whale, two sightings of sei whales, and four sightings of unidentifiable whales), 29 sightings of dolphins (four sightings of common dolphins, two sightings of striped dolphins, 10 sightings of spinner dolphins, two sightings of pantropical spotted dolphins, and 11 sightings of unidentifiable dolphins), and 168 sightings of sea turtles (12 sightings of green sea turtles, one sighting of a hawksbill sea turtle, 96 sightings of loggerhead sea turtles, 11 sightings of olive ridley sea turtles, and 48 sightings of unidentifiable shelled sea turtles). The five acoustic only detections and one simultaneous visual and acoustic detection all consisted of unidentifiable dolphins.

Protected species detections resulted in the implementation of 91 mitigation actions totaling 18 hours 36 minutes in duration. This total included 34 delays, 33 power-downs, 12 shut-downs, 11 power-downs followed by a shut-down, and one delay followed by a shut-down. There were also two vessel strike avoidance maneuvers implemented for whales.

NMFS issued an IHA and ITS authorizing 26,993 takes for 25 species and two species groups of marine mammals, including five species listed as endangered. Of this total, two individuals from two of these species were authorized for Level A takes (one Bryde's whale and one Kogia species), and the remaining individuals were authorized for Level B takes. For this report, Level A and Level B are used in the same definition as found in the MMPA and the NMFS issued BiOp description. Takes for endangered species totaled 30 individuals, all for Level B takes only, including eight humpback whales, two fin whales, three sei whales, five blue whales, and 12 sperm whales. There were also 416 Level B takes authorized for the threatened Guadalupe fur seal. There were no specific number of takes issued for ESA-listed sea turtles. Given the proposed activities, avoidance measures and unlikelihood of encounter, no effects to ESA-listed seabirds were anticipated from the proposed action and therefore no takes were requested or issued for seabird species.

During acoustic source operations, 26 marine mammals, including one Bryde's whale and 25 unidentifiable dolphins, were observed within the predicted 160 decibel radius (where there is a potential for a behavioral response) while the acoustic source was active, constituting potential Level B takes. There were 46 sea turtles, including three green sea turtles, one hawksbill sea turtle, 19 loggerhead sea turtles, two olive ridley sea turtles, and 21 unidentifiable shelled sea turtles, observed within the predicted 175 decibel radius (where there is a potential for a behavioral response) while the source was active. There were no protected species observed within the predicted radius at which there is a potential for auditory injury (based upon each species hearing range and how that overlaps with the frequencies produced by the sound source), constituting potential Level A takes/exposures.

A summary sheet of observation, detection, and operational totals for the seismic survey can be found in Appendix C.

2. INTRODUCTION

The following report details protected species monitoring and mitigation as well as seismic survey operations undertaken as part of the 2D marine geophysical survey on board the *Langseth* in the Eastern Tropical Pacific Ocean off the coast of Mexico over the Guerrero Gap from 15 May to 30 June 2022.

This document serves to meet the reporting requirements dictated in the IHA and ITS issued by NMFS on 02 May 2022and 29 April 2022, respectively. The IHA and ITS authorized takes of specific protected species, incidental to the marine seismic survey. NMFS has stated that seismic source received sound levels equal to or greater than 160 dB re 1 µPa root mean square (rms) (160 dB) could potentially disturb marine mammals, temporarily disrupting behavior, such that they could be considered non-lethal 'takes' (Level B harassment). In July 2016, NMFS released new technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing, which established new thresholds for permanent threshold shift (PTS) onset, Level A harassment (auditory injury), for marine mammal species. Predicted distances to Level A harassment vary based on species specific hearing groups – low frequency cetaceans, mid frequency cetaceans, high frequency (HF) cetaceans, phocid pinnipeds, otariid pinnipeds, and sea turtles – and how each group's hearing range overlaps with the frequencies produced by the sound source. For sea turtles, per the ESA, NMFS has stated that received sound levels equal to or greater than 175 dB represents the current best understanding of the threshold at which they exhibit behavioral responses.

NMFS requires that measures such as buffer zones (BZs), exclusion zones (EZs), delayed operations, ramp-ups, and shutdowns be implemented to mitigate for potentially adverse effects of the acoustic source sounds on protected species. The BZs and EZs were established from any element on the acoustic source array as areas where the presence of a protected species would trigger the implementation of a mitigation action (see section 3.1). For marine mammals, the occurrence of an individual detected approaching, entering, or within their designated EZ would trigger the implementation of a shut-down of the acoustic source. NMFS specified a 500-meter EZ for most marine mammals as it encompasses all zones within which auditory injury (Level A harassment) could occur on the basis of instantaneous exposure, provides additional protection from the potential for more severe behavioral reactions for marine mammals at relatively close range to the acoustic source, provides a consistent area for PSOs to conduct effective observational effort, and is a distance within which detection probabilities are reasonably high for most species under typical conditions. For sea turtles, the occurrence of an individual detected approaching, entering, or within the 500-meter and 150-meter EZ would trigger the implementation of a shut-down of the acoustic source, respectively. For protected sea birds, the detection of one foraging or diving within the 500-meter and 100-meter EZ would trigger a power-down and shut-down respectively.

2.1. PROJECT OVERVIEW AND LOCATION

The research activities involved a 2D multichannel seismic (MCS) and ocean bottom seismometer (OBS) survey in the Eastern Tropical Pacific Ocean off the coast of Mexico over the Guerrero Gap between approximately 14 to 18.5 degrees North and 99 to 105 degrees west. The majority of the survey lines occurred within the Exclusive Economic Zones (EEZ) of Mexico in water depths ranging between 100 and 5,600 meters (Figure 1).

The purpose of the research was to collect 2D MCS reflection and OBS refraction data in order to constrain plate boundary properties and the distribution of fluids in both the incoming Pacific oceanic plate and within the subduction zone in and around the Guerrero Gap of the Middle America Trench to better understand what the factors and processes that control the ability of a subduction zone to generate large earthquakes.

All operations for the survey were conducted solely by the *Langseth*. The vessel is 72 meters (235 feet) in length and utilizes a particularly quiet propulsion system to avoid interference with the seismic signals. *Langseth*' s cruising speed was approximately 10 to 11 knots during transits and varied between three and five knots during the seismic survey.

Operations for the OBS survey lines, including deployment and retrieval of the OBSs and data acquisition, were conducted between 16 May and 08 June 2022. Between 08 June and 09 June 2022, the vessel was positioned over four ocean bottom pressor gauges (OBPs) previously deployed by international researchers to allow data to be downloaded from the instruments on the sea floor. Seismic data acquisition of the main MCS survey lines was conducted from 10 June to 24 June 2022. From 26 June to 30 June 2022, MCS data was acquired along International Ocean Discovery Program (IODP) site survey lines located north-west of the main survey area. There was a total of 54 survey line sequences acquired totaling 3,973 kilometers. All of the OBS survey lines were acquired twice with MCS data.

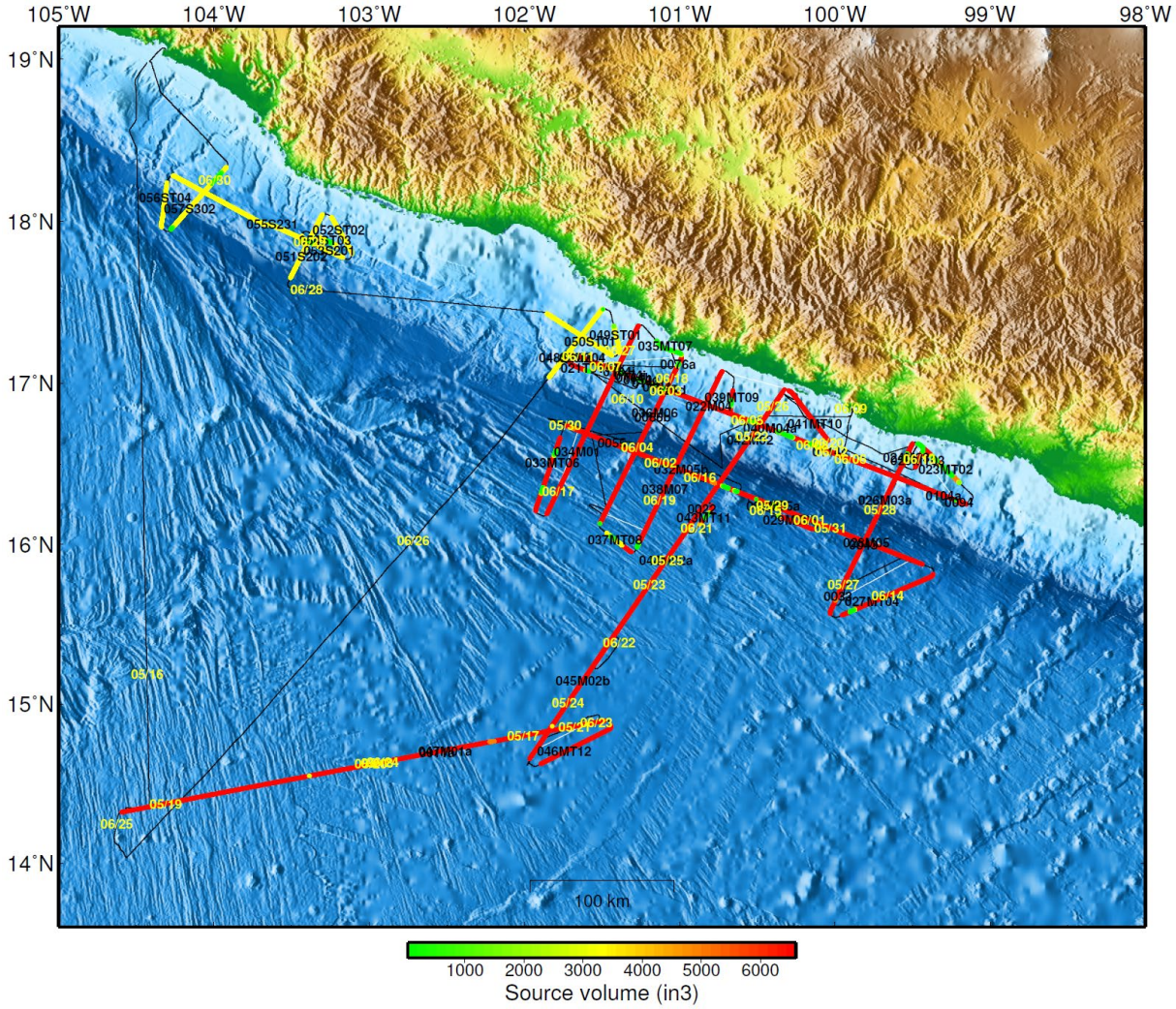


Figure 1. Location and survey points of the marine geophysical survey.

2.1.1. Energy Source and Receiving Systems

The energy source utilized during the surveys consisted of four towed acoustic source sub-arrays, each with nine source elements (for a total of 36 source elements), deployed just aft of the vessel. The source array utilized Bolt 1500LL and Bolt 1900LLX elements ranging in size from 40 to 360 cubic inches (in^3), with an operating pressure of 1,950 pounds per square inch. The dominant frequency components ranged from two to 188 Hertz (Hz) and nominal source levels ranged from 258 dB re: 1 µPa (zero to peak) to 264 dB re: 1 µPa (peak-to-peak). The source elements were towed at a depth of 12 meters for the MCS and OBS survey lines, and at a depth of six meters for the IODP survey lines. For the OBS survey lines, the center of the source was situated 230 meters from the Navigation Reference point

(NRP), which was located on the PSO observation tower. This positioned the first elements on the arrays 193 meters from the stern of the vessel. For the MCS and IODP survey lines, the center of the source was 240 meters from the NRP, and the first elements were 203 meters from the stern.

The maximum source volume utilized during the seismic survey was 6600 in^3 with 36 active elements for the OBS and MCS survey lines and 3300 in^3 with 18 active elements for the IODP survey lines. During times when acoustic source arrays were brought on board for maintenance or repair, the total source volume was reduced to varying lower volumes depended on how many of the elements and arrays were disabled. The shot point interval was 400 meters for the OBS survey lines, 50 meters for the MCS survey lines, and 25 meters for the IODP survey lines. During acquisition the source elements emitted a brief (approximately 0.1 second) pulse of sound. During the intervening periods of operations, the source elements were silent.

The receiving system for the seismic survey consisted of one hydrophone streamer and OBSs. For the MCS survey lines the streamer was configured to a length of 15 kilometers and for the IODP survey lines the streamer was six kilometers. As the acoustic source array was towed along the track lines, the hydrophone streamer received the returning acoustic signal and transferred the data to the on-board processing system. The long streamer length allows for more accurate measurements of seismic velocities and provides a large amount of data redundancy for enhancing seismic images during data processing. The OBSs consisted of 33 short-period multi-component OBSs, including 15 from WHOI and 18 from Scripps (see Appendix F for OBS specifications). The OBSs receive and store the returning acoustic signals internally for later analysis.

Additional sound sources used in support of research efforts included a Kongsberg EM 122 multi-beam echosounder (MBES), Knudsen Chirp 3260 sub-bottom profiler (SBP), and a Teledyne RDI 75 kHz Ocean Surveyor acoustic Doppler current profiler (ADCP). The hull mounted MBES operated at frequencies between 10.5 and 13 (usually 12) kilohertz. Each ping consisted of eight (in water depths greater than 1,000 meters) or four (in water depths less than 1,000 meters) successive fan-shaped transmissions. The transmitting beam width was one or two degrees fore-aft and 150 degrees perpendicular to the ship's line of travel. The maximum source level was 242 dB re: 1 µPa (root mean square [rms]). The hull-mounted SBP beam was transmitted as a 27-degree cone, which was directed downward by a 3.5 kilohertz transducer. The nominal power output was 10 kilowatts; however, the actual maximum radiated power was three kilowatts or 222 dB re: 1 µPa m (rms). The ping duration was 64 seconds, and the interval was one second. The hull-mounted ADCP operated at a frequency of 75 kilohertz and a maximum source level of 224 dB re: 1 µPa m (rms) over a conically shaped 30-degree beam. The MBES and SBP operated simultaneously to provide information about near seafloor sedimentary features and to map the topography of the ocean floor. The ADCP was used to measure water current velocities

3. MITIGATION AND MONITORING METHODS

The PSO monitoring program on the *Langseth* was established to meet the standards set forth in the PEIS, EA, IHA, ITS, and BiOp requirements. Survey mitigation measures were designed to minimize potential impacts of the *Langseth*' s seismic activities on marine mammals, sea turtles, and other protected species of interest. The following monitoring protocols were implemented to meet these objectives.

- Visual observations were conducted to provide real-time sighting data, allowing for the implementation of mitigation procedures as necessary.
- A Passive Acoustic Monitoring system was operated 24 hours a day during seismic source operations to augment visual observations and provide additional marine mammal detection data.
- Effects of marine species exposed to sound levels constituting a take were observed and documented. The nature of the probable consequences was discussed when possible.

In addition to the mitigation objectives outlined in the project permit documents, PSOs collected and analyzed necessary data mandated by the IHA and ITS (see Appendix A and Appendix B).

3.1. MITIGATION METHODOLOGY

Mitigation actions were implemented for visual and acoustic detections of protected species, including marine mammals, sea turtles, and protected sea birds, as outlined in the EA, IHA, ITS, and BiOp. These actions included the establishment of BZs and EZs, and the implementation of delayed operations, power-downs (during which the source volume was reduced to a single active 40 cubic inch element), and shut-downs (during which the source was fully silenced) for protected species detected approaching, entering, or within their designated BZ and EZ.

Before the acoustic source could be activated from silence (day and night), two PSOs and one PAM operator conducted a 30-minute clearance survey of the BZs and EZs. In the event of a detection of protected species within their designated zones (Table 2) or as outlined in Table 1, a delay of source operations would be implemented. Source operations would not be cleared to begin until the protected species were observed exiting their designated zones. If the protected species were not observed exiting their designated zones (i.e., if they dove/submerged within the zone and were not re-sighted), operations would not be cleared to begin until a specific time following the final detection of the animals. For detections of small odontocetes, pinnipeds, sea turtles, or sea birds, this time was 15 minutes following last sighting. For detections of mysticetes and other large odontocetes (including sperm whales, pygmy sperm whales, dwarf sperm whales, beaked whales, killer whales, and Risso's dolphins) this time was 30 minutes following last sighting.

Once the acoustic source was active, the BZ from any element on the acoustic source arrays were established as areas in which the presence of a protected species would initiate an alert to the seismic operators that the animal was detected, and that the implementation of a mitigation action may soon be required. PSOs and the PAM operator would keep in frequent contact with each other and the seismic team, relaying information on the location and movement of the protected species, and the implementation of any needed mitigation actions.

The EZs from any active source element were established as areas in which the detection of a protected species would trigger a power-down or a shut-down of the acoustic source, depending on the species present. For marine mammals, the detection of one approaching, entering, or within their designated zone would trigger a shutdown of the source. For sea turtles, the detection of one approaching, entering, or within the 500-meter or 150-meter exclusion zones would trigger a power-down or a shut-down of the source, respectively. For protected sea birds, the detection of one foraging or diving within the 500-meter or 100-meter exclusion zone would trigger a power-down or a shut-down of the source, respectively.

Upon the implementation of a power-down or a shut-down for a detection of protected species, a ramp-up was required to resume source activity once the protected species were confirmed to have exited their respective exclusion zones. For both power-downs and shut-downs, if the protected species could not be confirmed to have exited their respective exclusion zones (i.e., if they submerged/dove within the zone and were not re-sighted), clearance for ramp-up would not be given until a specific time following the last sighting of the individuals within the zones. For detections of small odontocetes, pinnipeds, sea turtles, or sea birds, this time was 15 minutes following last sighting. For detections of mysticetes and other large odontocetes (including sperm whales, pygmy sperm whales, dwarf sperm whales, beaked whales, killer whales, and Risso's dolphins) this time was 30 minutes following last sighting.

The IHA and ITS also outlined additional mitigation actions for specific protected species while the acoustic source was active as outlined in Table 1. The shutdown requirement was waived for small dolphins in the genera *Tursiops, Delphinus, Stenella, Steno, Lagenodelphis, and Lissodelphis*. If PSOs could identify the dolphins sighted as one of these species, no mitigation action was required if they were observed approaching, entering, or within the 500-meter exclusion zone. If there was any uncertainty regarding the species identification, visual PSOs were to use their best professional judgment in making the decision to call for a shutdown.

Specific acoustic source operation procedures outlined in the IHA and ITS that were relevant to this specific survey included:

1. Ramp-ups could not be less than 20 minutes and were required to begin with the smallest volume element and continue in stages by doubling the number of active elements, with each stage approximately the same duration. The time between ramp-up completion and start of data acquisition had to be minimized.
2. Testing of individual elements or strings required a 30-minute clearance search period but no ramp-up. Testing of more than one element or string required both a 30-minute clearance search period and a ramp-up to the maximum volume being tested.
3. Brief periods (less than 30 minutes) of operational silence for reasons other than a protected species shut-down did not require a ramp-up to resume full volume source operations provided that: (1) PSOs maintained constant visual and/or acoustic observation, and (2) no visual or acoustic detections of protected species occurred within the applicable exclusion zone during that silent period. For any brief period of silence at night or in periods of poor visibility (e.g., BSS of four or greater), a ramp-up was required, but if constant observation was maintained, a pre-start clearance watch was not required. For any longer shut-down, both a pre-start clearance watches and a ramp-up were required.
4. Brief periods (less than 30 minutes) of reduced volume less than half of the maximum operating volume did not require a ramp-up to resume full volume if monitoring was continuous and no detections occurred within the EZs. Periods longer than 30 minutes and volumes reduced more than half required a ramp-up to resume full volume.
    a. For any longer shutdown, prestart clearance observation and ramp-up are required, but if the shutdown period was brief and constant observation was maintained, pre-start clearance watch is not required.

Table 3 describes the predicted 160 decibel radius (Level B harassment zone for marine mammals) and the predicted 175 decibel radius (harassment zone for sea turtles). Table 4 describes the predicted Level A harassment zones for each protected species hearing group per the NMFS guidelines, and the species that could occur in the survey area assigned to each group; as noted previously however, shutdowns would occur at each species designated EZs (e.g., 500m, 1500m, etc.).

Table 1: Specific detections of protected species and their required mitigation actions.

Detection of:	Mitigation Action Required
A large whale (defined as a sperm whale or any mysticete species) with a calf (defined as an animal less than two-thirds the body size of an adult and observed in close association with an adult) observed at any distance from the vessel.	Delayed operation of inactive source and shut-down of active source.
An aggregation of six or more large whales observed at any distance from the vessel.	Delayed operation of inactive source and shut-down of active source.
Any marine mammal species not authorized for take observed approaching, entering, or within the 160-decibel radius.	Delayed operation of inactive source and shut-down of active source.
Any marine mammal species for which the total authorized takes has been met observed approaching, entering, or within the 160-decibel radius.	Delayed operation of inactive source and shut-down of active source.
Any other protected species detected approaching, entering, or within their designated buffer zones.	Delayed operation of inactive source and a warning call that a mitigation action may soon be required for an active source.
Any other marine mammal species detected approaching, entering, or within their designated exclusion zones.	Delayed operation of inactive source and shut-down of active source.
Any ESA-listed sea bird species detected diving and/or foraging within their designated exclusion zones.	Delayed operation of inactive source and power-down and/or shut-down of active source (depending on which exclusion zone the individual was detected within – see Table 2).
Any dolphin species with a shut-down exemption detected approaching, entering, or within their designated exclusion zones.	None.

Table 2: Separation distances, and buffer and exclusion zone sizes for each species/species group expected to occur in the survey area.

Species/Species Groups	Separation Distances (meters)	Buffer Zones (meters)	Exclusion Zones (meters)
Beaked, pygmy & dwarf sperm whales	100	1500	1500
Sperm whales	100	1000[1]	500[1]
Mysticetes	50	1000[1]	500[1]
Killer whales, Risso's dolphins	50	1000	500
All Other Small Delphinids & Porpoises	50	1000	500[2]
Pinnipeds	50	1000	500
Sea turtles	50	175 decibel radius	500/150[3]
ESA Birds	None	500	500/100[3]

1 Sightings of an aggregation of six or more individuals, or and adult with a calf, have a BZ and EZ of any distance.
2 Except exempt species per the NMFS IHA
3 For these species, a power-down was implemented at the 500m EZ and a shutdown was implemented at the 150/100m EZ

Table 3: Predicted 160/175 Decibel Zones* Implemented during the survey.

Source	Volume (in^3)	Water Depth (m)	160 dB radius – Level B harassment zone for marine mammals	175 dB radius – harassment zone for sea turtles
1 element	40	> 1,000	431	77
		100-1,000	647	116
		< 100	1,041	170
36 elements	6600	> 1,000	6,733	1,864
		100-1,000	10,100	2,796
		< 100	25,494	4,123

*Distances are from any single element on the array

Table 4: Predicted Level A Harassment Zones* for each Marine Mammal Hearing Group Implemented during the survey.

Source	Volume (in^3)	Low Frequency Cetaceans (m)	Mid Frequency Cetaceans (m)	High Frequency Cetaceans (m)	Otariid Pinnipeds/ Sea Otters (m)	Sea Turtles (m)
1 element	40	1.76	n/a	12.5	n/a	n/a
36 elements	6600	320	14	268	11	15
Distances are from any single element on the array The dolphin species in blue are the shut-down exemption species		• Humpback Whale • Minke Whale • Bryde's Whale • Fin Whale • Sei Whale • Blue Whale	• Sperm Whale • Cuvier's Beaked Whale • Longman's Beaked Whale • Mesoplodon spp. • Risso's Dolphin • Rough-toothed Dolphin • Common Bottlenose Dolphin • Pantropical Spotted Dolphin • Spinner Dolphin • Striped Dolphin • Short-beaked Common Dolphin • Fraser's Dolphin • Short-finned Pilot Whale • Killer Whale • False Killer Whale • Pygmy Killer Whale • Melon-headed Whale	• Pygmy Sperm Whale • Dwarf Sperm Whale	• Guadalupe Fur Seal • California Sea Lion	• Leatherback sea turtles • Loggerhead sea turtles • Green sea turtles • Olive ridley sea turtles • Hawksbill sea turtles

3.2. VISUAL MONITORING SURVEY METHODOLOGY

There were five experienced PSOs on board the *Langseth* during the seismic survey to conduct monitoring for protected species, record and report detections, and request mitigation actions in accordance with the PEIS, EA, IHA, ITS, and BiOp. The PSOs on board were NMFS approved and held certifications from a recognized Bureau of Ocean Energy Management (BOEM) course. Visual monitoring was primarily carried out from an observation tower (Figure 2) located 18.9 meters above the surface of the water, which allowed a 360-degree viewpoint around the vessel and acoustic source.

Figure 2. Protected Species Observer stern view of observation tower with mounted big-eye binoculars.

The PSO tower was equipped with Fujinon 7x50 and Steiner Marine 7x50 binoculars, as well as two mounted 25x150 Big-eye binoculars for visual monitoring. A D-300-2MS Night Optics USA, Inc. monocular and two Butler Creek PVS-7-night vision devices were also available for visual monitoring during reduced/restricted lighting conditions if needed. Inside the tarpaulin tent the PSOs were provided a laptop, a telephone for communication with the PAM station, bridge, and main lab, and a monitor that displayed pertinent information about the vessel including position; speed; heading; water depth; sea temperature, wind speed and direction, and air temperature. The monitor also displayed source activity information including survey line number, total number of active elements and volume. Environmental conditions along with vessel and acoustic source activity were recorded at least once an hour, and every time there was a change in one or more of the above variables. Most visual monitoring was held from the tower; however, during severe weather or when the ships exhaust was blowing on the tower, monitoring would be conducted from the bridge (approximately 12.8 meters above sea level) or the catwalk (approximately 12.3 meters above sea level).

Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA and ITS. Two PSOs visually monitored for protected species during daylight hours throughout the survey program, starting from vessel departure from port and ending upon vessel return to port. Visual monitoring during the transits between the ports and the survey area were conducted for vessel strike avoidance and to gather baseline data on the presence and abundance of protected species in the areas during periods of acoustic source silence. Throughout the survey program, visual monitoring was conducted each day from 30 minutes before sunrise until 30 minutes after sunset as required by the IHA and ITS. Observation times ranged between 11:34 to 02:02 Coordinated Universal Time (UTC) (06:34 to 21:02 local time). Scheduled watches were a maximum of four hours in duration followed by at least one hour of scheduled break time.

Visual observations were conducted around the entire area of the vessel and acoustic source, divided between the two PSOs on watch. The smaller monitoring area for each observer increased the probability

of protected species being sighted. PSOs searched for blows, fins, splashes or disturbances of the sea surface, large flocks of feeding sea birds, and other sighting cues indicating the possible presence of a protected species. Upon the visual detection of a protected species, PSOs would identify the animals' range to the vessel and acoustic source. Range estimations were made using reticle binoculars, the naked eye, and by relating the animal(s) to an object at a known distance, such as the acoustic source arrays and streamer head float. PSOs would also identify to species, if possible, upon initial detection to ensure that the proper mitigation measures were implemented, should any be required.

As required by the IHA (section 5(d)(iii)), PSOs recorded the following information for each protected species detection:

I. Date, time of first and last sighting, observers on duty during the detection, location of the observers, vessel information (e.g., position, speed, heading), water depth, and acoustic source activity (e.g., volume and number of active elements).
II. Species, detection cue, group size (including number of adults, juveniles, and calves), visual description (e.g., overall size, shape of the head, position and shape of the dorsal fin, shape of the flukes, height and direction of the blow), observed behaviors (e.g., porpoising, logging, diving, etc.), and the initial and final pace, heading, bearing, and direction of travel in relation to both the vessel and the source (e.g., towards, away, parallel, perpendicular, etc.).
III. Initial, closest, and final distance to the vessel and the source, time when entering and exiting the exclusion zones, type of mitigation action implemented, total time of the mitigation action, description of other vessels in the area, and any avoidance maneuvers conducted.

During or immediately after each sighting event, the PSOs recorded the detection details per the requirements of the IHA and ITS in a detection datasheet. Each sighting event was linked to an entry on an effort datasheet where specific environmental conditions (e.g., Beaufort Sea state, wind force, swell height, visibility, and glare) and vessel activity were logged.

Species identifications were made whenever the distance from the observer, length of the sighting, and visual observation conditions allowed. Whenever possible during detections, photographs were taken with Canon EOS 80D cameras that had 300-millimeter lenses. Marine mammal identification manuals (*Whales, Dolphins and Other Marine Mammal of the World; Guide to Marine Mammals of the world; Readers Digest Whales, Dolphins, and Porpoises; Seabirds of the world; Sibley Guide to Birds*) were consulted, and photos were examined to confirm identifications were consulted, and photos were examined to confirm identifications.

3.3. PASSIVE ACOUSTIC MONITORING SURVEY METHODOLOGY

Passive Acoustic Monitoring (PAM) was used to augment visual monitoring efforts in the detection, identification, and locating of marine mammals. PAM was very important during periods of time when visual monitoring was not effective (periods of darkness or low visibility). Acoustic monitoring was conducted continuously during all seismic operations and to the maximum extent possible during periods of acoustic source silence. When the acoustic source was activated from any period of silence, acoustic monitoring was conducted for at least 30 minutes prior to the activation of the source for the pre-clearance survey. PAM shifts were a maximum of four hours in duration followed by at least one hour of scheduled break time.

In accordance with the NMFS issued IHA and ITS, in the event of an issue with PAM equipment, acoustic source activity could continue for 30 minutes without acoustic monitoring while the PAM operator diagnosed the issue. If the diagnosis indicated that the PAM system needed maintenance, operations could continue for an additional five hours without acoustic monitoring, during daylight hours only, provided that: (1) the sea state was less than or equal to a BSS 4; (2) with the exception of delphinids (other than killer whales), no marine mammals were acoustically detected in the applicable exclusion zones in the previous two hours; (3) active acoustic source operations without acoustic monitoring did not exceed a cumulative total of five hours within any 24 hour period; and (4) NMFS was notified via email as soon as practicable of the time and location in which operations occurred without an active PAM system.

The PAM system was located in the main science lab which allowed ample space, quick communication with the PSOs and seismic technicians, and access to the vessel's instrumentation screens. Information about the vessel (e.g., position, heading, and speed), water depth, source activity (e.g., line number, total source volume, number of active elements), and the PAM system (e.g., cable deployments/retrievals, changes to the system, background noise score, hydrophone depth) were recorded at least once an hour, and whenever any of the parameters changed.

Acoustic monitoring for marine mammals was conducted aurally, utilizing Sennheiser headphones, and visually with the *Pamguard* software program. Low frequency (LF) to mid-frequency delphinid whistles, clicks, and burst pulses, as well as sperm whale clicks and baleen whale vocalizations, could be visualized in *Pamguard's* spectrogram modules. Sperm whale, beaked whale, Kogia species, and delphinid clicks could also be visualized in LF and HF click detector modules. Settings adjustments to amplitude range, amplitude triggers, and spectral content filters, among others, could be made in *Pamguard*'s spectrogram and click detector modules to maximize the distinction between cetacean vocalizations and ambient signal. The map module within *Pamguard* could be utilized to attempt localizing the position and range of vocalizing marine mammals. Sound recordings could be made using the HF and LF sound recording modules when potential marine mammal vocalizations were detected, or when the operator noted unknown or unusual sound sources.

As required by the IHA (section 5(d)(iv)), PAM operators recorded the following information during acoustic detections of protected species:

I. Date, time of first and last detection, operator on duty, linked to a visual sighting, vessel information (e.g., position, speed, heading), water depth, and acoustic source activity (e.g., volume and number of active elements).
II. Species (if determinable), group size, methods/modules on which vocalizations were detected during the event, and vocalization characteristics (e.g., signal type, frequency and amplitude range, inter-click interval, patterns, etc.)
III. Determinable bearings (to the hydrophones, vessel, and source) estimated and/or attempted localizations, and any ranges determined, type and time of any implemented mitigation actions and any resulting production loss.

3.3.1. Passive Acoustic Monitoring Parameters

A PAM system designed to detect most species of marine mammals was installed on board the *Langseth*. The system was developed by *Seiche Measurements Limited* and consisted of the following main components: a 255 meter hydrophone cable (configured as a separate 230 meter steel-reinforced tow cable and detachable 25 meter hydrophone array); a 100 meter deck cable; a rack-mounted electronic processing unit (EPU) that incorporated a buffer unit, RME Fireface 800 unit and computer; two desktop monitors; a keyboard and mouse; acoustic analysis software package; and headphones for aural monitoring. A complete spare system of all components was also present on board in the event that any of the main system components became damaged or inoperable. The diagram in Figure 3 is a simplified depiction of the PAM system installed on the *Langseth*, and further PAM system specifications can be found in Appendix D.

The hydrophone cable contained six hydrophone elements and a depth gauge molded into a 25-meter section of the cable. The six-element linear hydrophone array allowed the system to sample a large range of marine mammal vocalization frequencies. The hydrophone pair closest to the end by the depth gauge were used for low frequencies between 10 hertz and 24 hertz, the middle hydrophone pair was used for mid frequencies between 200 hertz and 200 kilohertz, and the forward hydrophone pair closest to the connector to the tow cable was used for high frequencies between two kilohertz and 200 kilohertz.

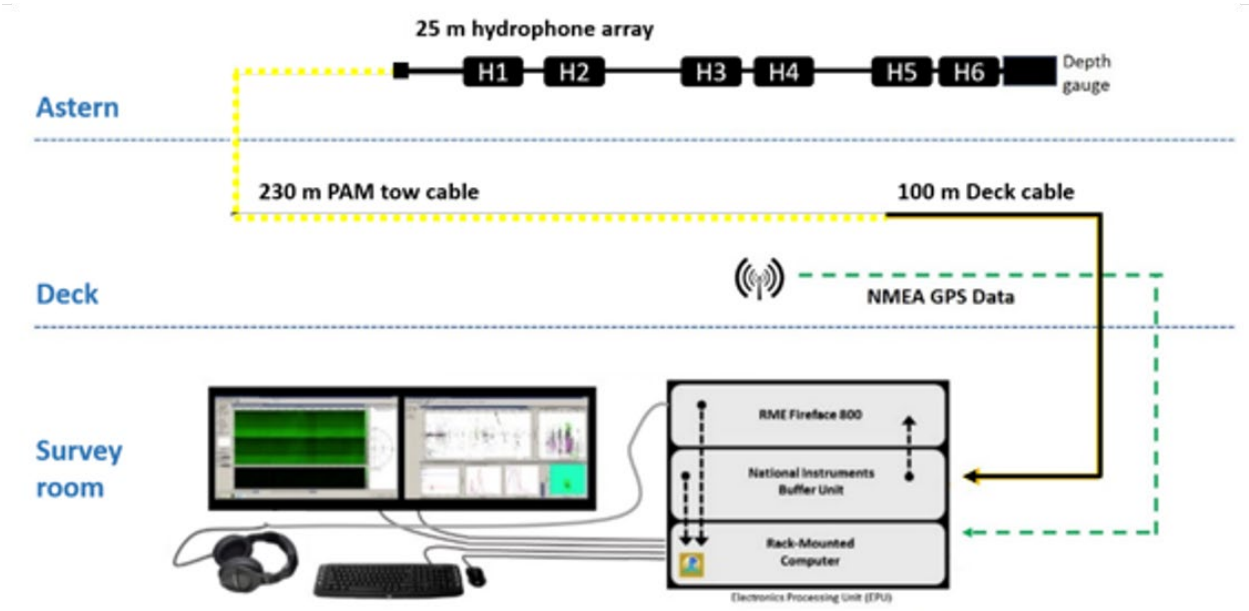


Figure 3: Simplified pathway of data through the PAM system on board the *Langseth*.

The deck cable interfaced between the hydrophone cable deployed astern of the vessel and the electronics processing unit (EPU) located in the main science lab. The rack-mounted EPU was set up with the two pre-installed, wall-mounted monitors supplied by the *Langseth*, a keyboard, a mouse, and headphones. The EPU contained a buffer unit with Universal Serial Base (USB) output, an RME Fireface 800 ADC unit with firewire output, and a rack-mounted computer. A Global Positioning System (GPS) feed of GNGGA strings was supplied from the ship's Seapath navigation system and routed to the computer, reading data every five seconds. Data from the hydrophone cable's depth transducer was routed through the buffer unit to the computer, via USB connection. *Pamguard Beta* version 1.15.11 was the software version utilized for the survey until 22 May 2022, at which time version 1.15.17 was installed and utilized for the remainder of the survey.

Raw feed from the two high frequency hydrophone elements was digitized in the buffer unit using an analogue-digital National Instruments data acquisition (DAQ) soundcard at a sampling rate of 500 kilohertz. The output was filtered for HF content and visualized using the *Pamguard* software, which used the difference between the time that a signal arrived at each of the two hydrophones to calculate and display the bearing to the source of the signal. A scrolling bearing/time module displayed the filtered data in real time, allowing for the detection and directional mapping of click trains. Additional components of the HF click detector system in *Pamguard* included: an amplitude/time display that registered click intensity data in real time, as well as click waveform, click spectrum, and Wigner plot displays, providing the PAM operator immediate review of individual click characteristics in the identification process.

Raw feed from the two low frequency and two mid frequency hydrophone elements was routed from the buffer unit to the RME Fireface 800 unit, where it was digitized at a sampling rate of 48 kilohertz. The relatively low frequency (LF) output was further processed within *Pamguard* by applying Engine Noise Fast Fourier Transform (FFT) filters, including click suppression and spectral noise removal filters (e.g., median filter, average subtraction, Gaussian kernel smoothing and thresholding). Filtered LF content was visualized in two spectrograms, one displaying a channel feed at frequency ranges of zero to 24 kilohertz, and another displaying a channel feed at a frequency range of zero to three kilohertz. LF click detector modules allowed for review of individual click characteristics as well as the detection and tracking of click trains.

A map module on the LF system interfaced with GPS data provided by the vessel to display the vessel location and could be used to determine range and bearing estimates based on clicks tracked in the click detector module. *Pamguard* contained a function for calculating the range to vocalizing marine mammals

based upon the least squares fit test. This method is most effective with animals that are relatively stationary in comparison to the moving vessel, such as sperm whales. The mathematical function estimated the range to vocalizing marine mammals by calculating the most likely crossing of a series of bearing lines generated from tracked clicks or whistles and plotted on a map display. The bearings of detected whistles and moans were calculated using a Time-of-Arrival-Distance (TOAD) method (where the signal time delay between the arrival of a signal on each hydrophone was compared), and presented on a radar display, along with amplitude information for the detected signal as a proxy for range.

Additional modules displayed on the LF monitor included a LF sound recorder and clip generator. The clip generator module within *Pamguard* could be used to generate short sound clips in response to either an automatic detection or the operator manually selecting a portion of the spectrogram display. This module was useful in the event that the whistle-and-moan detector falsely triggered and identified a non-biological sound (i.e., echosounder) or if it missed detecting tonal signatures that the operator determined to be vocalizations.

3.3.2. Hydrophone Deployment

The hydrophone cable was deployed from a hydraulic winch on the port stern of the vessel's aft deck where the acoustic source arrays were deployed. Two deck cables, a main and a spare, were installed along the deck-head running from the winch to the main science lab. A Chinese finger attached to the tow cable approximately 125 meters ahead of the connector to the hydrophone array was secured to the port side boom via lifting rope. This reduced the tension on the cable remaining on the winch and served as a method to pull the cable further to port and away from the source arrays. This deployment method placed the trailing end of the hydrophone cable approximately 125 meters from the port stern of the vessel, and approximately 68 meters and 78 meters forward of the first elements on the acoustic source arrays (Figure 4). Two pieces of chain of seven kilograms each were attached and secured to the tow cable to increase tow depth and to decrease the chance of entanglement with the source arrays' umbilicals. The tow depth of the hydrophones varied between 8.4 and 33 meters and averaged 17.7 meters throughout the seismic survey.

A more detailed description of the hydrophone deployment method can be found in Appendix E.

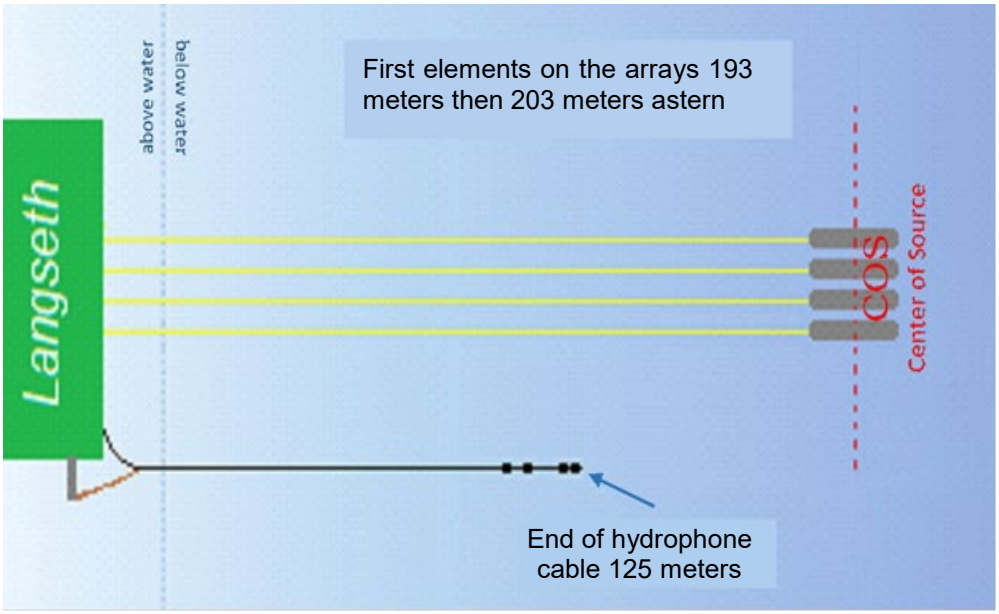


Figure 4. Location of the PAM cable in relation to the seismic gear during the survey.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

4.1.1. General survey parameters

The Guerrero Gap seismic survey began on 15 May 2022 when the *Langseth* departed the anchorage in Manzanillo, Mexico. OBS operations were conducted between 16 May and 08 June 2022, after which the vessel briefly went to anchorage in Acapulco, Mexico for crew change and provision supplies. From 08 to 09 June 2022 the vessel downloaded data from four OBP sites within the survey area, and then acquisition of the MCS survey lines was conducted from 10 to 24 June 2022. From 26 to 30 June 2022 the vessel acquired the IODP survey lines, and then the survey concluded on 30 June 2022 when the vessel arrived at port in Manzanillo, Mexico (Table 5).

Table 5: Survey parameters

Survey Parameter	Date	Time (UTC)	Location
Mobilization	15 May 2022	00:25	Manzanillo, Mexico
Start OBS operations	16 May 2022	04:53	Survey area
First source activity	17 May 2022	05:43	Survey area
End OBS operations	08 June 2022	12:49	Survey area
Start OBP sites	08 June 2022	17:26	Survey area
Arrive at anchorage	08 June 2022	20:27	Acapulco, Mexico
Depart anchorage	09 June 2022	02:08	Acapulco, Mexico
End OBP sites	09 June 2022	09:33	Survey area
Start MCS survey lines	10 June 2022	09:07	Survey area
End MCS survey lines	24 June 2022	22:43	Survey area
Start IODP survey lines	26 June 2022	12:01	Survey area
End IODP survey lines	30 June 2022	01:47	Survey area
Demobilization	30 June 2022	14:25	Manzanillo, Mexico

During the seismic survey, data was acquired continuously according to the survey plan, with source operations only suspended when operationally necessary, as outlined in Table 6.

Table 6: Suspension of source operations during the survey.

Date	Time Source Silenced	Date	Time Source Re-activated	Reason for Interruption in Acquisition
18 May 2022	02:43	18 May 2022	03:23	Compressor failure
18 May 2022	19:42	22 May 2022	05:05	Retrieve and re-deploy OBSs on next survey line
22 May 2022	15:05	26 May 2022	19:48	Retrieve and re-deploy OBSs on next survey line
27 May 2022	10:48	28 May 2022	23:37	Retrieve and re-deploy OBSs on next survey line
31 May 2022	06:39	02 June 2022	21:22	Retrieve and re-deploy OBSs on next survey line
03 June 2022	10:16	05 June 2022	12:19	Retrieve and re-deploy OBSs on next survey line
07 June 2022	00:40	10 June 2022	06:59	Retrieve OBSs, download data from OBP sites, transit to and from anchorage, deploy streamer
10 June 2022	12:26	10 June 2022	21:04	Streamer power issues
11 June 2022	21:38	11 June 2022	21:44	Compressor failure
12 June 2022	18:58	12 June 2022	20:52	Silent for line change in shallow water
14 June 2022	21:08	15 June 2022	01:17	Source maintenance and vessel circling around for re-shoots
15 June 2022	16:03	15 June 2022	20:41	Source maintenance and vessel circling around for re-shoots
17 June 2022	15:43	17 June 2022	18:22	Source arrays retrieved during line change to adjust streamer
21 June 2022	19:47	22 June 2022	00:06	Compressor failure

Date	Time Source Silenced	Date	Time Source Re-activated	Reason for Interruption in Acquisition
24 June 2022	22:43	26 June 2022	11:38	End MCS survey lines, retrieve all gear for transit to ODP survey lines then re-deploye streamer and source arrays.
27 June 2022	07:36	28 June 2022	01:02	Silent for transit between IODP sites, all gear remained deployed

4.1.2. MBES, SBP, and ADCP operations

The multi-beam echosounder (MBES), sub-bottom profiler (SBP), and the acoustic Doppler current profiler (ADCP) systems were active throughout the majority of the seismic survey while the vessel was within the survey area for a total of 769 hours 29 minutes. The sound sources were active for the first time on 16 May 2022 at 16:54 (MBES), 16:58 (SBP), and 16:59 UTC (ADCP). The MBES, SBP, and ADCP were disabled and re-enabled multiple times throughout the survey for OBS retrieval operations, long transits within the survey area, and transits two and from the survey area. All three sound sources were disabled for the final time for the survey at 05:17 UTC on 30 June 2022 before the vessel began transit back to dock.

4.1.3. Acoustic source operations

The acoustic source was active for a total of 553 hours 39 minutes throughout the seismic survey. This total included: 22 hours 43 minutes of ramp-up, 483 hours 14 minutes of operations on a survey line (409 hours 22 minutes at full volume and 73 hours 52 minutes at reduced volumes), 37 hours 10 minutes of operations not on a survey line (29 hours 31 minutes at full volume and seven hours 39 minutes of reduced volumes), and 29 minutes of source testing. Table 7 summarizes the acoustic source operations over the course of the seismic survey.

The acoustic source was ramped-up 72 times, including 18 times to commence source operations from a period of operational silence, 31 times to resume full volume operations from a mitigation power-down, and 23 times to resume full volume operations from a mitigation shut-down. Sixty-six ramp-ups were conducted during daylight hours and six ramp-ups were conducted during hours of darkness. All ramp-ups were cleared by both visual and acoustic monitoring. Ramp-ups averaged 21 minutes in duration and were conducted using an automated controller program, which added source elements sequentially to achieve the full source volume over the required period.

There were 10 hours three minutes of operations with only a single 40 in^3 source element conducted for protected species mitigation power-downs.

There was one occasion of source testing totaling 29 minutes consisting of a full volume source test preceded by a ramp-up after equipment maintenance.

Table 7. Total acoustic source operations during the seismic survey.

Acoustic Source Operation	Number	Duration
Source Tests	1	00:29
Ramp-up	72	22:43
Day-time ramp-ups	66	20:56
Night-time ramp-ups	6	01:47
Full (6600 in^3)/Reduced Volume on a Survey Line[1]		483:14
Full (6600 in^3)/Reduced Volume not on a Survey Line[2]		37:10
Single Source Element (40 in^3)		10:03
Total Time Acoustic Source Was Active		**553:39**

1. **On a Survey Line:** 409:22 (full volume), 73:52 (reduced volume)
2. **Not on a Survey Line:** 29:31 (full volume), 07:39 (reduced volume)

The geospatial data for source operations are provided as a shapefile attachment to this report. The volume of the acoustic source was changed (reduced or increased) on multiple occasions during active source operations, mainly due to issues with individual source elements and maintenance of the acoustic source arrays. A list of these volume changes and the reasons can be found in Appendix G.

4.1.4. Interactions with Other Vessels

In addition to visually monitoring for protected species, PSOs also observed and documented interactions with other marine vessel traffic. Such interactions included but were not limited to another vessel or another vessels' towed gear/equipment interacting with the *Langseth's* towed gear/equipment, and the *Langseth* having to deviate from planned survey operations (i.e., diverge from the survey line, increase/decrease speed) because of another vessel.

There was one instance where the *Langseth* had such an interaction with another vessel. On 21 May 2022, the *Langseth* delayed starting transit to the next OBS deployment site due to shipping vessel traffic, with the closest vessel passing approximately two kilometers ahead of the *Langseth*.

4.2. VISUAL MONITORING SURVEY SUMMARY

Visual monitoring was conducted by two PSOs during all daylight hours, beginning 30 minutes before sunrise and ending 30 minutes after sunset each day, initiating when the vessel left anchorage at the beginning of the program and terminating upon the vessels return to dock at the end of the program (Table 8). This included times when the vessel was in transit and deploying and retrieving equipment. Visual monitoring during transit was conducted for vessel strike avoidance, and visual monitoring during times with no source operations was conducted to collect baseline data about protected species abundance in the survey areas.

Table 8: Initiation and termination of visual monitoring during the survey.

Visual Monitoring	Date	Time (UTC)
Initiation for the survey	15 May 2022	00:39
Termination for the survey	30 June 2022	14:25

Visual monitoring on the *Langseth* was conducted over a period of 47 days for a total of 649 hours 20 minutes. Of the overall total visual monitoring effort, 48% (311 hours 13 minutes) was undertaken while the acoustic source was active, and 52% (338 hours seven minutes) was undertaken while the acoustic source was silent. Visual monitoring while the acoustic source was silent was mainly conducted during the transits to and from the survey sites, and during equipment deployment, recovery, and maintenance. Table 9 details visual monitoring with acoustic source operations on the *Langseth* throughout the seismic survey.

Table 9. Total visual monitoring effort during the survey.

Visual Monitoring Effort	Duration (hh:mm)	% of Overall Effort
Total monitoring while acoustic source active	311:13	48
Total monitoring while acoustic source silent	338:07	52
Total monitoring effort	**649:20**	

Visual observations on the *Langseth* were preferentially conducted from the PSO tower, which provided a 360-degree view of the water around the vessel and the acoustic source. Visual watches were conducted from other locations, including the catwalk and bridge if monitoring conditions could not be undertaken from the tower, such as during rough weather and sea conditions which made the tower unsafe, or when the vessel was heading directly into the wind, blowing the engine exhaust onto the tower. PSOs conducted visual monitoring from the tower (79%) more often than any other location (Table 10) during the survey. Monitoring was conducted simultaneously from the bridge and catwalk when the ships exhaust was blowing on the tower but monitoring conditions were otherwise favorable. Monitoring was conducted simultaneously from the tower and catwalk when the ships exhaust was only blowing on part of the tower.

Table 10: Total visual monitoring effort from observation locations during the survey.

Observation Location During Visual Effort	Duration (hh:mm)	% of Overall Effort
Tower	509:45	79
Bridge	95:30	15
Catwalk	44:05	7

4.3. ACOUSTIC MONITORING SURVEY SUMMARY

Acoustic monitoring was conducted continuously throughout acoustic source operations and to the maximum extent possible while the acoustic source was silent (Table 11). Brief periods of source activity without acoustic monitoring were conducted for any needed assessments, adjustments, or maintenance to the PAM system. Periods without source activity or acoustic monitoring occurred when the PAM hydrophone cable was secured on board the vessel during transits, during deployment and recovery of the seismic gear, and during times when operations were suspended due to rough weather and sea conditions.

Table 11: Initiation and termination of acoustic monitoring watches during survey.

Acoustic Monitoring	Date	Time (UTC)
Initiation for the survey	17 May 2022	03:30
Termination for the survey	30 June 2022	01:49

Acoustic monitoring was conducted on 35 days for a total of 629 hours three minutes. Of the overall total acoustic monitoring effort, 88% (553 hours 39 minutes) was undertaken while the acoustic source was active, and 12% (75 hours 24 minutes) was undertaken while the acoustic source was silent. Acoustic monitoring while the acoustic source was silent was mainly conducted during the brief periods of time between recovery/deployment of the seismic gear and recovery/deployment of the PAM cable. Table 12 details acoustic monitoring with acoustic source operations.

Table 12. Total Passive Acoustic Monitoring (PAM) effort during the survey.

Acoustic Monitoring Effort	Duration (hh:mm)	% of Overall Effort
Total nighttime monitoring	260:03	59
Total day time monitoring	369:00	41
Total monitoring while the acoustic source was active	553:39	88
Total monitoring while the acoustic source was silent	75:24	12
Total acoustic monitoring	**629:03**	

Acoustic monitoring was suspended seven times throughout the survey program. Acoustic monitoring downtime totaled 425 hours 10 minutes, all of which was due to seismic gear deployment, retrieval, and maintenance operations. Each instance of acoustic monitoring downtime is recorded in Appendix I. There was no acoustic monitoring downtime while the acoustic source was still active.

4.4. SIMULTANEOUS VISUAL AND ACOUSTIC MONITORING SUMMARY

Simultaneous visual and acoustic monitoring was conducted to the maximum extent possible for a total of 374 hours 25 minutes. Of the overall simultaneous monitoring effort, 83% (311 hours 13 minutes) was conducted while the acoustic source was active (Table 13). Additional visual monitoring conducted during transit periods was not accompanied by acoustic monitoring as the increased vessel speed would causes the hydrophone cable to migrate to the water surface, out of the ideal tow position, where increased background noise would impair acoustic detection capabilities.

Table 13: Simultaneous visual and acoustic monitoring effort during the survey.

Simultaneous Visual and Acoustic Monitoring	Duration (hh:mm)	% of Overall Downtime
Source Active	311:13	83
Source Silent	63:12	17
Overall Total	**374:25**	

4.5. ENVIRONMENTAL CONDITIONS

Environmental conditions can have an impact on the probability of detecting protected species. The environmental conditions present during visual observations undertaken during the survey program were generally considered to be good to excellent. The majority of the moderate to poor observation conditions were due to the three hurricanes that passed by and through the survey area during the program.

Visibility was classified as 'excellent' if it extended greater than 10 kilometers and "very good" if it was between seven and 10 kilometers. 75.90% and 12.22% of monitoring effort on the *Langseth* was undertaken at 'excellent' and 'very good' visibility levels respectively (Table 14). The entire predicted harassment zone radii, BZs, and EZs were not visible on multiple occasions, mainly due to precipitation and reduced lighting before sunrise and after sunset and during night-time visual monitoring. During these times, it is possible that protected species were not detected within these zones.

Table 14. Visibility during the survey (kilometers).

Total	<0.05	0.05-0.1	0.1-0.3	0.3-0.5	0.5-1	1-2	2-5	5-7	7-10	>10
Duration (hh:mm)	00:00	01:28	00:56	08:35	18:22	11:59	15:22	20:27	79:21	492:50

Reduced visibility was mainly attributed to periods of rain and fog, and the brief periods of reduced lighting before sunrise and after sunset. Precipitation was recorded during visual monitoring on the *Langseth* for a total of 12 hours two minutes. The majority of the precipitation recorded was light rain (5.21%) (Table 15).

Table 15. Precipitation during the survey.

Total	None	Heavy Rain	Moderate Rain	Light Rain	Heavy Fog	Moderate Fog	Thin Fog	Haze
Duration (hh:mm)	577:05	05:25	11:12	33:48	00:00	01:39	01:45	18:26

The Beaufort Sea state recorded during visual monitoring ranged from level one to level six. The majority of visual observations on the *Langseth* were undertaken in conditions where the Beaufort state was level two (46.65%) or level three (27.78%), which were considered good conditions for the detection of protected species (Table 16).

Table 16. Beaufort Sea State during the survey.

Total	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9
Duration (hh:mm)	00:00	13:48	302:54	180:24	92:57	53:48	05:29	00:00	00:00	00:00

Wind speeds recorded visual monitoring ranged between one and 38 knots. The majority of visual monitoring on the *Langseth* occurred during recorded wind speeds between 10 and 15 knots (33.19%) and less than 10 knots (48.16%) (Table 17).

Table 17. Wind speed during the survey.

Total	<10	10-15	16-20	21-25	26-30	>30

Duration (hh:mm)	312:43	215:31	67:37	36:21	14:13	02:55

Swell heights during visual observations were generally low, with swells of less than two meters recorded for the majority of visual observations on both vessels (90%) (Table 18).

Table 18. Swell Height during the survey.

Total	<2m	2-4m	>4m
Duration (hh:mm)	582:28	66:52	00:00

The majority of visual monitoring effort on both vessels was conducted while mild glare (32.64%) was present (Table 19). During times of moderate to severe glare, it is possible that the detections of protected species was hindered.

Table 19. Glare during the survey.

Total	None	Mild	Moderate	Severe
Duration (hh:mm)	160:00	211:58	120:35	156:47

5. MONITORING AND DETECTION RESULTS

5.1. VISUAL DETECTIONS

Visual monitoring efforts during the survey program resulted in a total of 212 visual detections of protected species totaling 773 individuals (summarized in Appendix J). This total included 14 detections of whales, 29 detections of dolphins, and 168 detections of sea turtles. One detection of unidentifiable dolphins was simultaneous with an acoustic detection of the six individuals. Table 20 lists the total number of detections and total number of animals recorded for each protected species observed during the survey. Photographs taken of visual detections can be found in Appendix L.

Maps of the detections of the protected species are shown in Figure 5 and Figure 6.

Table 20. Number of visual detection records collected for each protected species during the survey.

Species	Total Number of Detection Records	Total Number of Animals
Bryde's whale	2	2
Common minke whale	4	4
Fin whale	1	1
Humpback whale	1	1
Sei whale	2	2
Unidentifiable whale	4	5
Whales	**14**	**15**
Common dolphin	4	117
Striped dolphin	2	6
Spinner dolphin	10	293
Pantropical spotted dolphin	2	13
Unidentifiable dolphin	12	129
Dolphins	**29**	**558**
Green sea turtle	12	13
Hawksbill sea turtle	1	1
Loggerhead sea turtle	96	126
Olive ridley sea turtle	11	12
Unidentifiable shelled sea turtle	48	48
Sea Turtles	**168**	**200**
Total	**212**	**773**

Figure 5: All protected species detections during the survey.

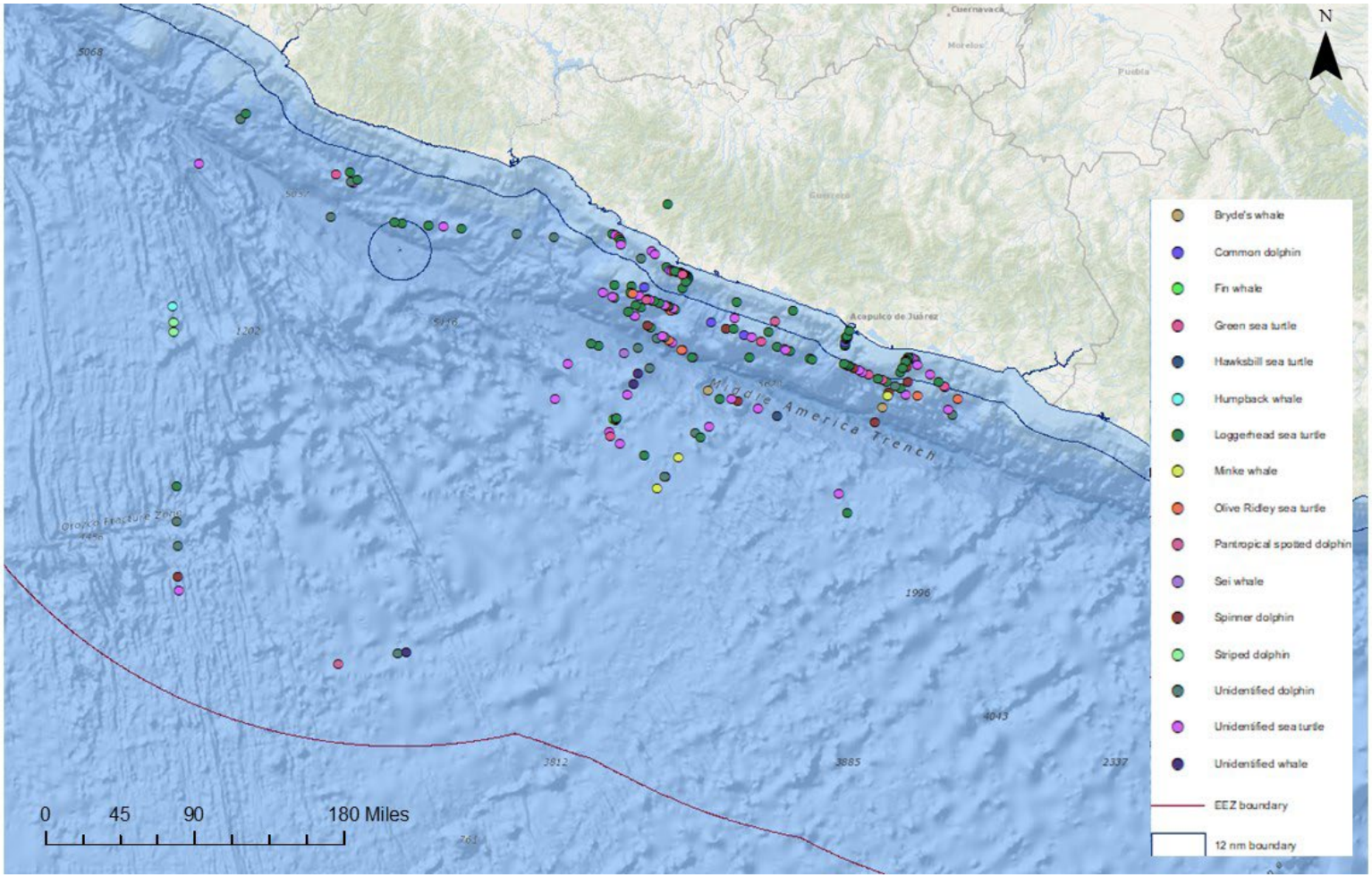
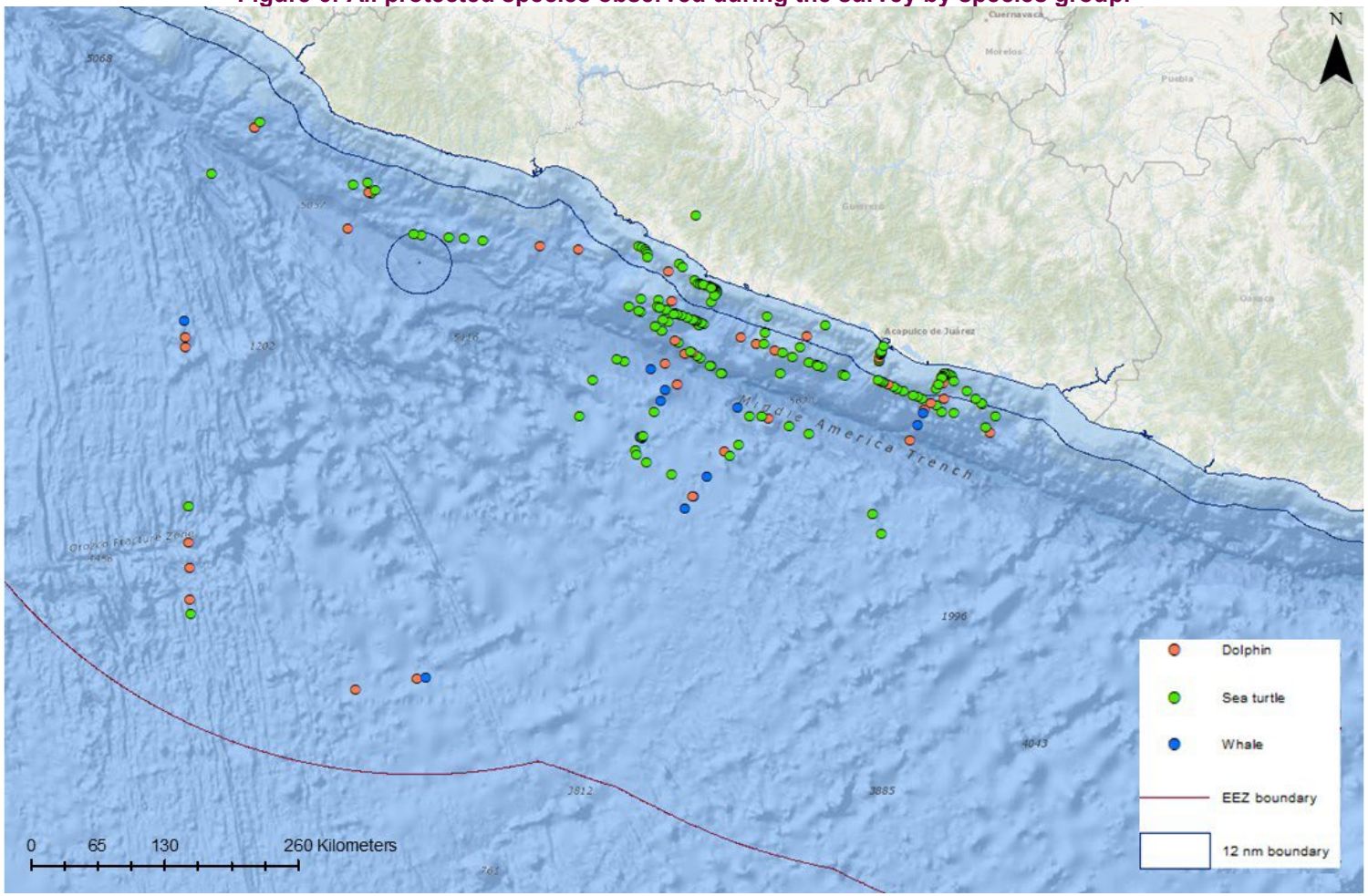


Figure 6: All protected species observed during the survey by species group.



Of the 212 visual detections, 72 detections occurred while the acoustic source was deployed and active, 50 detections occurred while the acoustic source was deployed but silent, and 90 detections occurred while the acoustic source was not deployed. Table 21 lists the number of each species detected during each different source activity described above as well as the species average closest approach to the source during those times. Detections occurred in water depths ranging between 107 and 5.257 meters, with the majority of detections in the shallower waters consisting of sea turtles.

Detections that occurred while the source was active included one sighting of a Bryde's whale, one sighting of spinner dolphins, two sightings of unidentifiable dolphins, seven sightings of green sea turtles, one sighting of a hawksbill sea turtle, 28 sightings of loggerhead sea turtles, two sightings of olive ridley sea turtles, and 30 detections of unidentifiable shelled sea turtles. The Bryde's whale had a closest observed distance of 513 meters to active source, the spinner dolphins had a closest observed distance of 250 meters to the active source, and the unidentifiable dolphins had closest observed distances of 788 and 900 meters to the active source. Sea turtles had closest observed distances between 70 and 508 meters to the active source, averaging 237 meters. The species with the closest observed distances were loggerhead sea turtles and unidentifiable shelled sea turtles. For the whale and dolphins, the source volume at the closest observed distance was 6,600 cubic inches. For the sea turtles, the majority of the closest distances observed occurred while only a single 40 cubic inch element was active, mainly after a mitigation power-down. Thirty of these detections occurred where the source was initially active but lastly silent, mainly after a mitigation shut-down. For these detections, the closest observed distance to the elements after they were silent ranged between 30 and 1,089 meters, averaging 258 meters, with the closest distances occurring for sea turtles.

Detections that occurred while the acoustic source was deployed but silent included two detections of spinner dolphins, two detections of unidentifiable dolphins (including the simultaneous visual and acoustic detection), two detections of green sea turtles, 31 detections of loggerhead sea turtles, four detections of olive ridley sea turtles, and nine detections of unidentifiable shelled sea turtles. The dolphins had closest observed distances between 600 and 1,172 meters to the silent elements, averaging 866 meters. The sea turtles had closest observed distances between 50 and 351 meters to the silent elements, averaging 202 meters. The closest observed distances were for loggerhead sea turtles.

Detections while the source was not deployed (i.e., during transits and OBS deployment/retrieval operations) included one detection of a Bryde's whale, four detections of common minke whales, one detection of a fin whale, one detection of a humpback whale, two detections of sei whales, four detections of unidentifiable whales, four detections of common dolphins, two detections of striped dolphins, seven detections of spinner dolphins, eight detections of unidentifiable dolphins, three detections of green sea turtles, 37 detections of loggerhead sea turtles, five detections of olive ridley sea turtles, and nine detections of unidentifiable shelled sea turtles. As the seismic source was secured onboard the vessel during these detections, no distances to the elements were recorded.

While the source was active, the one Bryde's whale detected had a closest observed distance of 350 meters to the vessel. For the 13 whale detections that occurred while the source was not deployed, the closest distances of the whales to the vessel ranged between five and 2,614 meters, averaging 753 meters. The closest observed distance was for a Bryde's whale at five meters from the vessel. This whale was observed for over an hour circling around and diving under the vessel while the vessel was stationary during an OBS retrieval operation. While the source was active, dolphins had closest observed distances to the vessel ranging between 15 and 700 meters, averaging 432 meters. While the source was deployed but silent, dolphins had closest observed distances to the vessel ranging between 690 and 980 meters, averaging 818 meters. While the source was not deployed, dolphins had closest observed distances to the vessel ranging between one and 2,614 meters, averaging 361 meters. The closest observed distances of the dolphins to the vessel were during the few detections where individuals were observed bow-riding. While the source was active, sea turtles had closest observed distances to the vessel ranging between 10 and 360 meters, averaging 90 meters. While the source was deployed but silent, sea turtles had closest observed distances to the vessel ranging between five and 250 meters, averaging 54 meters. While the source was not deployed, sea turtles had closest observed distances to the vessel ranging between one and 421 meters, averaging 73 meters. The closest observed distances were for loggerhead

sea turtles and unidentifiable shelled sea turtles.

Table 21. Average closest approach of protected species to the acoustic source at during the survey.

Species Detected	Regulated Source Active		Regulated Source Inactive	
	Number of detections	Mean closest observed approach to source (meters)	Number of detections	Mean closest observed approach to source (meters)
Bryde's whale	1	513	-	-
Spinner dolphin	1	250	2	847
Unidentifiable dolphin	2	844	2	886
Green sea turtle	7	211	2	274
Hawksbill sea turtle	1	100	-	-
Loggerhead sea turtle	28	225	31	182
Olive Ridley sea turtle	2	196	4	231
Unidentifiable Shelled Sea Turtle	30	261	9	243

While the source was active, the one Bryde's whale was initially observed crossing ahead of the vessel and lastly observed crossing astern of the vessel traveling at a moderate and then a vigorous pace. For the 13 whale detections while the source was not deployed, the whales were mainly observed traveling at moderate or vigorous paces, initially on an undetermined heading and lastly away from the vessel. While the source was active, dolphins were mainly observed traveling at moderate or vigorous paces either on an undetermined heading or crossing ahead of the vessel. While the source was deployed but silent or not deployed, dolphins were mainly observed traveling at a moderate or vigorous pace at variable initial headings but lastly heading away from the vessel. There were no significant differences in pace or directions of travel for sea turtles if the source was active, silent, or not deployed. The majority of the sea turtles sighted were observed traveling at sedate or moderate paces either in the opposite direction as the vessel or away from the vessel.

Whales detected during the survey program were observed blowing, surfacing, and diving. Dolphins detected during the survey program were observed surfacing, porpoising, jumping, diving, bow-riding, and the individuals in one detection were also observed milling and feeding. Sea turtles detected during the survey program were observed resting at the surface of the water, swimming at and below the surface of the water, and diving. There were also 12 detections of loggerhead sea turtles that included a pair of individuals observed mating.

Of the total 212 visual detections, 78 occurred within Mexican territorial seas (12 nautical miles). This total included one sighting of common dolphins, three sightings of spinner dolphins, one sighting of pantropical spotted dolphins, one sighting of unidentifiable dolphins, four sightings of green sea turtles, 50 sightings of loggerhead sea turtles, two sightings of olive ridley sea turtles, and 16 sightings of unidentifiable shelled sea turtles. The remaining 133 sightings occurred outside of territorial seas.

Three of the visual detections consisted of deceased individuals, including one detection of a spinner dolphin, one detection of a loggerhead sea turtle, and one detection of an unidentifiable shelled sea turtle. The deceased spinner dolphin and deceased loggerhead sea turtle had small signs of predation, bloating, and bleaching from the sun. The deceased unidentifiable shelled sea turtle had heavy signs of predation, with the flippers and head being reduced to only bone visible. There was no visible apparent cause of death for any of these individuals. PSOs also noted that several of the loggerhead sea turtles sighted had variable amounts of visible dark red algae covering the back half of their upper carapace.

5.1.1. Other Wildlife

Observations of other wildlife included 12 species of birds, six species of fish, and three species of marine invertebrates. There were also two sightings of a yellow-bellied snake. There were no sightings of ESA-listed seabirds during the survey program. A complete list of birds and other marine wildlife observed and identified, in addition to the approximate number of individuals observed and the number of days on which they were observed, can be found in Appendix N. No impacts to any other wildlife species as a result of research activities.

5.2. ACOUSTIC DETECTIONS

There were six acoustic detections of protected species during the survey program, including one that was simultaneous with a visual detection, all of which consisted of unidentifiable dolphins. The detections included between one and eight individuals and occurred in water depths between 2,308 and 3,661 meters. Four of the detections occurred during hours of darkness with no ongoing visual monitoring. Two of the detections occurred while the seismic source was active at full volume, three of the detections occurred while the vessel was in transit between IODP sites with the gear deployed but silent, and one detection (the simultaneous detection) occurred while the source was silent from a mitigation shut-down for a previous visual sighting. All acoustic detections consisted of high frequency click trains, with only one detection also including a single audible low frequency whistle. Only two of the detections had click trains that were able to be tracked within the Pamguard software, with estimated tracked distances of 52 and 80 meters to the active and silent source, respectively. The dolphins in the other four detections were estimated to likely be within 500 meters of the hydrophones and source due to the high frequency vocalizations.

For the simultaneous detection, the dolphins were initially detected acoustically with click trains trailing astern of the hydrophones. The dolphins were only acoustically detected for approximately 20 seconds, and then shortly after the dolphins were visually sighted 800 meters astern traveling at a vigorous pace away from the vessel. Visual observers were unable to determine the species of the dolphins.

Details of the acoustic detections can be found in Appendix K, and screenshots of the acoustic detections can be found in Appendix M.

6. MITIGATION ACTION SUMMARY

There were 91 mitigation actions implemented due to visual protected species being observed approaching, entering, or within their designated exclusion zones. This included 34 ramp-up delays totaling five hours 34 minutes, 33 power-downs totaling six hours 53 minutes, 12 shut-downs totaling two hours 52 minutes, and 12 multiple mitigation actions for the same detection totaling three hours 17 minutes (Table 22). The multiple mitigation actions included 12 power-downs followed by shutdowns totaling two hours 52 minutes and one delay followed by a shut-down totaling 17 minutes. Twenty-four of the delays were from silence totaling three hours 17 minutes, and 10 of the delays were from power-downs totaling two hours 17 minutes. There was one shut-down totaling six minutes of mitigation downtime and 15 minutes of silence (due to an additional delay by the seismic operators) for a Bryde's whale, and all other delays, power-downs, and shut-downs were implemented for sea turtles. The majority of the mitigation actions were implemented for loggerhead sea turtles (49.28%) and unidentifiable shelled sea turtles (33.96%). The two vessel strike avoidance maneuvers were implemented for one Bryde's whale and one common minke whale, both consisting of the vessel remaining stationary while on site during OBS retrieval operations until the whales had exited their separation zones.

Table 23 summarizes the mitigation actions by species, and Table 24 summarizes each detection that resulted in a mitigation action.

There were no mitigation actions for ESA-listed sea birds during this survey.

Table 22. Number and duration of mitigation actions implemented.

Mitigation Action	All Species		Whales		Sea turtles	
	Number	Mitigation Downtime	Number	Mitigation Downtime	Number	Mitigation Downtime
Ramp-up Delays	34	05:34	-	-	34	05:34
Power-down	33	06:53	-	-	33	06:53
Shut-down	12	02:52	1	00:06	11	02:46
Multiple mitigation actions	12	03:17	-	-	12	03:17
Avoidance Maneuver	2	-	2	-	-	-
Total Mitigation	**93**	**18:36**	**3**	**00:06**	**90**	**18:30**

Table 23: Mitigation actions and downtime by species.

Species	Number of Delayed Operations	Number of Power-downs	Number of Shut-downs	Number of Multiple Mitigation Actions	Duration of Mitigation action (h:mm)	Percentage of Mitigation Downtime	Duration of Silence Between Shut-down and Ramp-up
Bryde's whale	-	-	1	-	00:06	0.54	00:15
Green sea turtle	4	3	-	1	01:47	9.59	-
Hawksbill sea turtle	-	-	-	1	00:18	1.61	00:17
Loggerhead sea turtle	21	12	6	6	09:10	49.28	03:55
Olive ridley sea turtle	3	1	-	1	00:56	5.02	00:15
Unidentifiable shelled sea turtle	6	17	5	3	06:19	33.96	06:20

Table 24: Summary of each mitigation action implemented.

Date	Visual or Acoustic Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Silence Between Shut-down and Ramp-up	Comment
2022-05-22	14	Loggerhead sea turtle	1	Soft start/ramp-up	238	shut-down	0:30	0:30	Detection occurred in Mexican territorial seas, one minute into a night-time ramp-up.
2022-05-26	22	Unidentifiable shelled sea turtle	1	Full volume	232	shut-down	0:15	0:19	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-05-30	33	Bryde's whale	1	Full volume	513	shut-down	0:06	00:15	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-02	43	Loggerhead sea turtle	1	Source silent	-	delay	0:04	-	Detection occurred in Mexican territorial seas.
2022-06-02	44	Loggerhead sea turtle	3	Source silent	-	delay	0:16	-	Detection occurred in Mexican territorial seas.
2022-06-02	46	Loggerhead sea turtle	2	Source silent	-	delay	0:06	-	Detection occurred in Mexican territorial seas.
2022-06-02	47	Loggerhead sea turtle	2	Source silent	-	delay	0:07	-	Detection occurred in Mexican territorial seas.
2022-06-02	48	Loggerhead sea turtle	1	Source silent	-	delay	0:13	-	Detection occurred in Mexican territorial seas.
2022-06-02	49	Loggerhead sea turtle	1	Source silent	-	delay	0:12	-	Detection occurred in Mexican territorial seas.
2022-06-02	50	Loggerhead sea turtle	1	Source silent	-	delay	0:04	-	Detection occurred in Mexican territorial seas.
2022-06-02	51	Loggerhead sea turtle	2	Source silent	-	delay	0:04	-	Detection occurred in Mexican territorial seas.
2022-06-02	52	Loggerhead sea turtle	1	Source silent	-	delay	0:06	-	Detection occurred in Mexican territorial seas.
2022-06-02	53	Loggerhead sea turtle	1	Source silent	-	delay	0:09	-	Detection occurred in Mexican territorial seas.
2022-06-02	54	Loggerhead sea turtle	1	Source silent	-	delay	0:16	-	Detection occurred in Mexican territorial seas.

Date	Visual or Acoustic Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Silence Between Shut-down and Ramp-up	Comment
2022-06-02	55	Loggerhead sea turtle	1	Soft start/ramp-up	221	power-down and shut-down	0:15	0:15	Detection occurred in Mexican territorial seas. Seismic operators initially implemented power-down at PSO request, but then implemented a shut-down at their discretion.
2022-06-05	69	Unidentifiable shelled sea turtle	1	Full volume	250	power-down	0:06	-	Ramp-up delayed by seismic operators for an additonal 16 minutes.
2022-06-05	70	Unidentifiable shelled sea turtle	1	Full volume	295	shut-down	0:15	0:16	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	71	Loggerhead sea turtle	1	Full volume	256	shut-down	0:15	0:16	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	72	Unidentifiable Shelled Sea Turtle	1	Soft start/ramp-up	274	shut-down	0:06	0:23	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	73	Green sea turtle	1	Source silent	-	delay	0:01	-	Source was silent from previous detections shut-down.
2022-06-06	74	Olive ridley sea turtle	1	Source silent	-	delay	0:15	-	Source was silent from previous detections shut-down.
2022-06-06	75	Unidentifiable shelled sea turtle	1	Full volume	254	shut-down	0:15	0:15	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	76	Loggerhead sea turtle	1	Soft start/ramp-up	265	shut-down	0:09	0:48	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	77	Loggerhead sea turtle	1	Source silent	-	delay	0:03	-	Source was silent from previous detections shut-down.
2022-06-06	78	Olive ridley sea turtle	1	Source silent	-	delay	0:06	-	Source was silent from previous detections shut-down.

Date	Visual or Acoustic Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Silence Between Shut-down and Ramp-up	Comment
2022-06-06	79	Loggerhead sea turtle	1	Source silent	-	delay	0:15	-	Source was silent from previous detections shut-down.
2022-06-06	80	Unidentifiable shelled sea turtle	1	Source silent	-	delay	0:15	-	Source was silent from previous detections shut-down.
2022-06-06	81	Loggerhead sea turtle	1	Full volume	264	shut-down	0:15	0:15	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	82	Loggerhead sea turtle	1	Full volume	307	shut-down	0:15	0:15	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	83	Unidentifiable shelled sea turtle	1	Full volume	245	power-down	0:02	-	Detection began during a ramp-up.
2022-06-06	84	Unidentifiable shelled sea turtle	1	Single element	269	delay	0:15	-	Source powered-down from previous detection.
2022-06-06	85	Unidentifiable shelled sea turtle	1	Full volume	284	shut-down	0:15	0:15	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-06	86	Olive Ridley sea turtle	1	Full volume	150	power-down and shut-down	0:16	0:15	Seismic operators initially implemented power-down at PSO request, but then implemented a shut-down at their discretion.
2022-06-11	140	Loggerhead sea turtle	1	Full volume	306	shut-down	0:16	0:17	PSOs requested power-down but seismic operators implemented shut-down instead.
2022-06-11	141	Unidentifiable shelled sea turtle	1	Full volume	265	power-down	0:15	-	None.
2022-06-11	142	Loggerhead sea turtle	2	Soft start/ramp-up	70	power-down and shut-down	0:10	0:07	None.
2022-06-11	143	Loggerhead sea turtle	1	Full volume	232	power-down	0:15	-	None.
2022-06-11	144	Loggerhead sea turtle	1	Soft start/ramp-up	170	power-down and shut-down	0:20	0:19	None.
2022-06-12	145	Olive ridley sea turtle	1	Reduced volume	242	power-down	0:15	-	Occurred while source was at reduced volume on a line change.

Date	Visual or Acoustic Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Silence Between Shut-down and Ramp-up	Comment
2022-06-12	146	Unidentifiable shelled sea turtle	1	Full volume	275	power-down	0:05	-	None.
2022-06-12	147	Green sea turtle	1	Single element	222	delay	0:16	-	Source powered-down from previous detection.
2022-06-12	148	Loggerhead sea turtle	1	Soft start/ramp-up	189	power-down	0:16	-	Detection occurred in Mexican territorial seas.
2022-06-12	149	Unidentifiable shelled sea turtle	1	Full volume	303	power-down	0:16	-	Detection occurred in Mexican territorial seas.
2022-06-12	150	Loggerhead sea turtle	1	Full volume	324	power-down	0:05	-	Detection occurred in Mexican territorial seas.
2022-06-12	151	Loggerhead sea turtle	1	Single element	150	delay	0:11	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-12	152	Unidentifiable shelled sea turtle	1	Single element	250	delay	0:08	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-12	154	Loggerhead sea turtle	2	Source silent	-	delay	0:05	-	Detection occurred in Mexican territorial seas.
2022-06-12	155	Loggerhead sea turtle	4	Source silent	-	delay	0:12	-	Detection occurred in Mexican territorial seas.
2022-06-12	156	Loggerhead sea turtle	5	Source silent	-	delay	0:06	-	Detection occurred in Mexican territorial seas.
2022-06-12	157	Unidentifiable shelled sea turtle	1	Source silent	-	delay	0:02	-	Detection occurred in Mexican territorial seas.
2022-06-12	158	Unidentifiable shelled sea turtle	1	Source silent	-	delay	0:01	-	Detection occurred in Mexican territorial seas.
2022-06-12	159	Olive ridley sea turtle	1	Source silent	-	delay	0:04	-	Detection occurred in Mexican territorial seas.
2022-06-12	160	Loggerhead sea turtle	1	Source silent	-	delay	0:15	-	Detection occurred in Mexican territorial seas.
2022-06-12	161	Loggerhead sea turtle	1	Full volume	130	power-down and shut-down	0:19	0:21	Detection occurred in Mexican territorial seas.
2022-06-13	163	Unidentifiable shelled sea turtle	1	Full volume	257	power-down	0:15	-	Detection occurred in Mexican territorial seas.
2022-06-13	164	Loggerhead sea turtle	1	Full volume	214	power-down	0:16	-	None.

Date	Visual or Acoustic Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Silence Between Shut-down and Ramp-up	Comment
2022-06-14	165	Hawksbill sea turtle	1	Full volume	100	power-down and shut-down	0:18	0:17	Turtle was next to a small fishing buoy.
2022-06-14	166	Unidentifiable shelled sea turtle	1	Full volume	150	power-down and shut-down	0:16	4:22	Ramp-up greatly delayed by seismic operators while vessel circled around to re-shoot that line section.
2022-06-15	167	Unidentifiable shelled sea turtle	1	Full volume	295	power-down	0:15	-	None.
2022-06-16	168	Unidentifiable shelled sea turtle	1	Full volume	273	power-down	0:15	-	None.
2022-06-16	169	Unidentifiable shelled sea turtle	1	Full volume	257	power-down	0:15	-	None.
2022-06-17	173	Loggerhead sea turtle	2	Reduced volume	223	power-down	0:08	-	Detection occurred in Mexican territorial seas.
2022-06-17	174	Loggerhead sea turtle	1	Single element	241	delay	0:16	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-17	176	Unidentifiable shelled sea turtle	1	Soft start/ramp-up	286	power-down	0:05	-	Detection occurred in Mexican territorial seas.
2022-06-17	177	Unidentifiable shelled sea turtle	1	Single element	256	delay	0:13	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-17	178	Green sea turtle	2	Single element	250	delay	0:12	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-17	179	Loggerhead sea turtle	1	Single element	296	delay	0:15	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-17	180	Loggerhead sea turtle	1	Full volume	405	power-down	0:03	-	Detection occurred in Mexican territorial seas.
2022-06-17	181	Green sea turtle	1	Single element	238	delay	0:16	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-18	182	Unidentifiable shelled sea turtle	1	Full volume	180	power-down	0:15	-	None.

Date	Visual or Acoustic Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Silence Between Shut-down and Ramp-up	Comment
2022-06-18	183	Green sea turtle	1	Soft start/ramp-up	186	power-down	0:16	-	None.
2022-06-18	184	Unidentifiable shelled sea turtle	1	Reduced volume	360	power-down	0:06	-	None.
2022-06-18	185	Loggerhead sea turtle	1	Full volume	203	power-down	0:15	-	None.
2022-06-19	186	Loggerhead sea turtle	1	Full volume	237	power-down	0:16	-	Detection occurred in Mexican territorial seas.
2022-06-19	187	Unidentifiable shelled sea turtle	1	Full volume	331	power-down	0:15	-	None.
2022-06-19	188	Loggerhead sea turtle	2	Full volume	192	power-down and shut-down	0:18	0:17	None.
2022-06-19	189	Unidentifiable shelled sea turtle	1	Full volume	165	power-down and shut-down	0:16	0:15	None.
2022-06-19	190	Unidentifiable shelled sea turtle	1	Full volume	236	power-down	0:15	-	None.
2022-06-21	192	Unidentifiable shelled sea turtle	1	Full volume	395	power-down	0:17	-	None.
2022-06-26	193	Loggerhead sea turtle	1	Reduced volume	191	power-down	0:17	-	Detection occurred in Mexican territorial seas. Source was at reduced volume on IODP survey line.
2022-06-26	194	Unidentifiable shelled sea turtle	1	Soft start/ramp-up	216	power-down	0:16	-	Detection occurred in Mexican territorial seas.
2022-06-26	195	Green sea turtle	1	Soft start/ramp-up	202	power-down	0:15	-	Detection occurred in Mexican territorial seas.
2022-06-26	196	Loggerhead sea turtle	1	Single element	235	delay	0:15	-	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-26	197	Loggerhead sea turtle	2	Single element	150	delay and shut-down	0:17	0:15	Detection occurred in Mexican territorial seas. Source powered-down from previous detection.
2022-06-26	198	Unidentifiable shelled sea turtle	1	Soft start/ramp-up	176	power-down and shut-down	0:17	0:15	Detection occurred in Mexican territorial seas.
2022-06-28	206	Green sea turtle	1	Reduced volume	228	power-down	0:16	-	Source was at reduced volume on IODP survey line.
2022-06-28	207	Loggerhead sea turtle	2	Reduced volume	220	power-down	0:06	-	Source was at reduced volume on IODP survey line.

Date	Visual or Acoustic Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Active Source (m)	Mitigation Action	Total Duration of Mitigation Event	Total Duration of Silence Between Shut-down and Ramp-up	Comment
2022-06-28	208	Loggerhead sea turtle	2	Reduced volume	175	power-down	0:07	-	Source was at reduced volume on IODP survey line.
2022-06-29	209	Unidentifiable shelled sea turtle	1	Reduced volume	231	power-down	0:17	-	Source was at reduced volume on IODP survey line.
2022-06-29	210	Green sea turtle	1	Reduced volume	150	power-down and shut-down	0:15	-	Source was at reduced volume on IODP survey line.
2022-06-30	212	Loggerhead sea turtle	2	Reduced volume	183	power-down	0:17	-	Source was at reduced volume on IODP survey line.

6.1. PROTECTED SPECIES KNOWN TO HAVE BEEN EXPOSED TO 160 DECIBELS OR GREATER OF RECEIVED SOUND LEVELS

Numerous protected species are known to occur within the survey area, including several species listed as endangered or threatened under the ESA. These species included: humpback whale, blue whale, fin whale, sei whale, and sperm whale, Guadalupe fur seal, leatherback sea turtle, hawksbill sea turtle, olive ridley sea turtle, loggerhead sea turtle, green sea turtle, and California least tern.

NMFS granted an IHA and ITS for the marine seismic survey authorizing a total of 26,993 from 27 species or species groups, including five species of whales and one species of pinnipeds listed as endangered or threatened. Of this total, two individuals from two species/groups were authorized for Level A harassment takes (exposure to sound pressure levels where there is a potential for auditory injury based upon each species hearing range). A total of 26,991 individuals from all 27 species/groups were authorized for Level B harassment takes (exposure to sound pressure levels equal to or greater than 160 dB re: 1 µPa (rms) where there is potential for behavioral changes), including 446 takes for endangered/threatened species. While no specific number of takes were issued for sea turtle species, behavioral harassment was expected to occur in the 175-decibel zone. Given the proposed activities, avoidance measures and unlikelihood of encounter, no effects to the California least tern were anticipated from the proposed action and therefore no takes were requested or issued.

During acoustic source operations, 26 marine mammals, including one Bryde's whale and 25 unidentifiable dolphins, were observed within the predicted 160 decibel radius while the acoustic source was active, constituting potential Level B takes. There were 46 sea turtles, including three green sea turtles, one hawksbill sea turtle, 19 loggerhead sea turtles, two olive ridley sea turtles, and 21 unidentifiable shelled sea turtles, observed within the predicted 175-decibel radius while the source was active. There were no protected species observed within the predicted radius at which there is a potential for auditory injury, constituting potential Level A takes/exposures. Table 25 details the authorized and potential Level A and Level B takes/exposures. While the vessel was operating within Mexican territorial seas (12 nautical miles from the coast), there were five unidentifiable dolphins, one green sea turtle, eight loggerhead sea turtles, and three unidentifiable shelled sea turtles observed within the predicted harassment zones. However, as NMFS cannot authorize takes within another country's territorial waters, these totals are not included in the table below.

The number of potential takes may be an underestimation and, therefore, may be a minimum estimate of the number of protected species potentially exposed to received sound levels within the predicted harassment zones, including Level A and B. It is possible that the estimated numbers of animals recorded were underestimates due to some individuals not being visually sighted or having moved away before they were observed, or some individuals not vocalizing and therefore not detected acoustically.

Additionally, weather conditions have a large impact on the ability to visually detect protected species, particularly smaller or unobtrusive species such as sea turtles and beaked whales. Visual monitoring was conducted for 311 hours 13 minutes while the acoustic source was active. Of this time, 15% (45 hours 11 minutes) was undertaken while swell heights were between two and four meters, and 33% (101 hours 42 minutes) was undertaken while the Beaufort Sea state was a level four or greater, which were considered moderate to poor conditions for visually sighting protected species. In addition, there were several occasions when the entire predicted radii and zones were not entirely visible, mainly due to reduced lighting in the dawn/dusk hours and precipitation. Fifteen percent of visual monitoring efforts (48 hours 45 minutes) while the source was active were undertaken during recorded precipitation, mainly light and moderate rain.

Table 26 describes the behavior of all animals, including unidentified species, which were visually observed within the predicted harassment zones, including Level A and B. There were no highly distinctive behavioral reactions observed in relation to the vessel or acoustic source during the seismic survey.

Table 25. Number of authorized and potential Level A and B Takes/Harassment/Exposures within Mexican territorial waters during the survey.

Species	IHA Authorized Level A Takes/ Exposures	Potential Level A Takes/ Exposures/ PTS During the Program	IHA Authorized Level B Takes/ Exposures	Potential Level B Takes/ Exposures/ TTS During the Program	Total IHA Authorized Takes/ Exposures	Total Potential Takes/ Exposures During the Program
Humpback Whale	-	-	8	-	8	-
Minke Whale	-	-	2	-	2	-
Bryde's Whale	1	-	27	1	28	1
Fin Whale	-	-	2	-	2	-
Sei Whale	-	-	3	-	3	-
Blue Whale	-	-	5	-	5	-
Sperm Whale	-	-	12	-	12	-
Cuvier's Beaked Whale	-	-	69	-	69	-
Longman's Beaked Whale	-	-	3	-	3	-
Mesoplodon spp.	-	-	23	-	23	-
Kogia spp.	1	-	33	-	34	-
Risso's Dolphin	-	-	328	-	328	-
Rough-toothed Dolphin	-	-	597	-	597	-
Common Bottlenose Dolphin	-	-	2274	-	2274	-
Pantropical Spotted Dolphin	-	-	7988	-	7988	-
Spinner Dolphin (whitebelly)	-	-	121	-	121	-
Spinner Dolphin (eastern)	-	-	8189	-	8189	-
Striped Dolphin	-	-	2212	-	2212	-
Short-beaked Common Dolphin	-	-	2818	-	2818	-
Fraser's Dolphin	-	-	858	-	858	-
Short-finned Pilot Whale	-	-	244	-	244	-
Killer Whale	-	-	25	-	25	-
False Killer Whale	-	-	118	-	118	-
Pygmy Killer Whale	-	-	116	-	116	-
Melon-headed Whale	-	-	135	-	135	-
Unidentifiabe dolphin	-	-	-	25	-	25
Guadalupe Fur Seal	-	-	416	-	416	-
California Sea Lion	-	-	365	-	365	-
Green sea turtle	-	-	-	3	-	3
Hawksbill sea turtle	-	-	-	1	-	1
Leatherback sea turtle	-	-	-		-	-
Loggerhead sea turtle	-	-	-	19	-	19
Olive Ridley sea turtle	-	-	-	2	-	2
Unidentifiable Shelled Sea Turtle	-	-	-	21	-	21

Table 26: Behavior of species visually observed to be exposed to sound pressure levels of 160 dB or greater.

Species	Detection No.	No. Of Animals	CPA Active Source (meters)	Source Volume (in^3) at CPA	Initial Behavior	Initial Direction in Relation to Vessel	Subsequent and Final Behaviors	Final Direction in Relation to Vessel	Detection Occurred within Territorial Seas
Unidentifiable shelled sea turtle	22	1	232	6600	Diving	unknown	Diving	unknown	no
Bryde's whale	33	1	513	6600	Fast travel	crossing ahead of vessel	Fast travel, Surfacing, Blowing	crossing astern of vessel	no

Species	Detection No.	No. Of Animals	CPA Active Source (meters)	Source Volume (in^3) at CPA	Initial Behavior	Initial Direction in Relation to Vessel	Subsequent and Final Behaviors	Final Direction in Relation to Vessel	Detection Occurred within Territorial Seas
Loggerhead sea turtle	55	1	221	40	Resting at surface / Logging	away from vessel	Resting at surface / Logging, Diving	away from vessel	yes
Unidentifiable dolphin	68	20	1467	1780	Porpoising	towards vessel	Porpoising, Fast travel, Breaching / Jumping / Acrobatic behaviour	away from vessel	no
Unidentifiable shelled sea turtle	69	1	250	40	Resting at surface / Logging	away from vessel	Resting at surface / Logging	away from vessel	no
Unidentifiable shelled sea turtle	70	1	295	6600	Diving	towards vessel	Diving, Fast travel	towards vessel	no
Loggerhead sea turtle	71	1	256	6600	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Fast travel, Diving	parallel in opposite direction as vessel	no
Unidentifiable shelled sea turtle	72	1	274	580	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface	parallel in opposite direction as vessel	no
Unidentifiable shelled sea turtle	75	1	254	6600	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Diving, Fast travel	parallel in opposite direction as vessel	no
Loggerhead sea turtle	76	1	265	4440	Stationary	parallel in same direction as vessel	Stationary	parallel in same direction as vessel	no
Loggerhead sea turtle	81	1	264	6600	Resting at surface / Logging	parallel in opposite direction as vessel	Resting at surface / Logging, Diving	parallel in opposite direction as vessel	no
Loggerhead sea turtle	82	1	307	6600	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Surfacing, Diving	parallel in opposite direction as vessel	no
Unidentifiable shelled sea turtle	83	1	245	40	Swimming below surface	unknown	Swimming below surface	unknown	no
Unidentifiable shelled sea turtle	85	1	284	6600	Swimming below surface	unknown	Swimming below surface	unknown	no
Olive ridley sea turtle	86	1	150	40	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Surfacing	unknown	no
Loggerhead sea turtle	140	1	306	6600	Resting at surface / Logging	parallel in same direction as vessel	Resting at surface / Logging, Swimming, Diving	unknown	no

Species	Detection No.	No. Of Animals	CPA Active Source (meters)	Source Volume (in^3) at CPA	Initial Behavior	Initial Direction in Relation to Vessel	Subsequent and Final Behaviors	Final Direction in Relation to Vessel	Detection Occurred within Territorial Seas
Unidentifiable shelled sea turtle	141	1	265	40	Resting at surface / Logging	unknown	Resting at surface / Logging, Diving	unknown	no
Loggerhead sea turtle	142	2	70	40	Mating	other	Mating	unknown	no
Loggerhead sea turtle	143	1	232	40	Swimming below surface	away from vessel	Swimming below surface	parallel in opposite direction as vessel	no
Loggerhead sea turtle	144	1	170	40	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Surfacing	parallel in opposite direction as vessel	no
Olive ridley sea turtle	145	1	242	40	Resting at surface / Logging	stationary	Resting at surface / Logging, Swimming below surface	unknown	no
Unidentifiable shelled sea turtle	146	1	275	40	Swimming below surface	parallel in same direction as vessel	Swimming below surface, Fast travel	away from vessel	no
Loggerhead sea turtle	148	1	189	40	Swimming below surface	parallel in same direction as vessel	Swimming below surface, Surfacing, Fast travel	parallel in opposite direction as vessel	yes
Unidentifiable shelled sea turtle	149	1	303	40	Swimming	parallel in opposite direction as vessel	Swimming, Swimming below surface	parallel in opposite direction as vessel	yes
Loggerhead sea turtle	150	1	324	40	Fast travel	parallel in opposite direction as vessel	Fast travel, Surfacing, Diving	parallel in opposite direction as vessel	yes
Loggerhead sea turtle	151	1	150	40	Resting at surface / Logging	parallel in same direction as vessel	Resting at surface / Logging, Diving	parallel in same direction as vessel	yes
Loggerhead sea turtle	161	1	130	40	Resting at surface / Logging	stationary	Resting at surface / Logging, Diving	away from vessel	yes
Unidentifiable shelled sea turtle	163	1	257	40	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Surfacing, Diving	away from vessel	yes
Loggerhead sea turtle	164	1	214	40	Resting at surface / Logging	stationary	Resting at surface / Logging, Diving	parallel in same direction as vessel	no
Hawksbill sea turtle	165	1	100	40	Swimming	parallel in same direction as vessel	Swimming, Diving	parallel in same direction as vessel	no
Unidentifiable shelled sea turtle	166	1	150	6600	Stationary	stationary	Stationary	Stationary	no

Species	Detection No.	No. Of Animals	CPA Active Source (meters)	Source Volume (in^3) at CPA	Initial Behavior	Initial Direction in Relation to Vessel	Subsequent and Final Behaviors	Final Direction in Relation to Vessel	Detection Occurred within Territorial Seas
Unidentifiable shelled sea turtle	167	1	295	6600	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface	parallel in opposite direction as vessel	no
Unidentifiable shelled sea turtle	168	1	273	40	Resting at surface / Logging	stationary	Resting at surface / Logging	Stationary	no
Unidentifiable shelled sea turtle	169	1	257	6600	Swimming	parallel in opposite direction as vessel	Swimming	parallel in opposite direction as vessel	no
Unidentifiable dolphin	170	5	900	6600	Breaching / Jumping / Acrobatic behaviour	unknown	Breaching / Jumping / Acrobatic behaviour, Fast travel	unknown	yes
Loggerhead sea turtle	173	2	223	3300	Mating	other	Mating	unknown	yes
Unidentifiable shelled sea turtle	176	1	286	40	Diving	parallel in opposite direction as vessel	Diving	parallel in opposite direction as vessel	yes
Loggerhead sea turtle	180	1	405	6600	Surfacing	towards vessel	Surfacing	towards vessel	yes
Unidentifiable Shelled Sea Turtle	182	1	180	6600	Resting at surface / Logging	stationary	Resting at surface / Logging,Diving	unknown	no
Green sea turtle	183	1	186	40	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Diving	away from vessel	no
Unidentifiable Shelled Sea Turtle	184	1	360	40	Resting at surface / Logging	stationary	Resting at surface / Logging	stationary	no
Loggerhead sea turtle	185	1	203	40	Swimming	away from vessel	Swimming, Diving	away from vessel	no
Loggerhead sea turtle	186	1	237	40	Swimming below surface	away from vessel	Swimming below surface, Surfacing, Swimming, Diving	away from vessel	yes
Unidentifiable Shelled Sea Turtle	187	1	331	40	Swimming	parallel in opposite direction as vessel	Swimming, Surfacing, Diving	parallel in opposite direction as vessel	no
Loggerhead sea turtle	188	2	192	40	Other(Describe in Detection Description)	variable	Other, Diving, Swimming	parallel in opposite direction as vessel	no
Unidentifiable Shelled Sea Turtle	189	1	165	40	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Surfacing	parallel in opposite direction as vessel	no

Species	Detection No.	No. Of Animals	CPA Active Source (meters)	Source Volume (in^3) at CPA	Initial Behavior	Initial Direction in Relation to Vessel	Subsequent and Final Behaviors	Final Direction in Relation to Vessel	Detection Occurred within Territorial Seas
Unidentifiable Shelled Sea Turtle	190	1	236	40	Swimming below surface	parallel in opposite direction as vessel	Swimming below surface, Surfacing	parallel in opposite direction as vessel	no
Unidentifiable Shelled Sea Turtle	192	1	395	40	Resting at surface / Logging	parallel in opposite direction as vessel	Resting at surface / Logging, Swimming below surface, Diving	away from vessel	no
Loggerhead sea turtle	193	1	191	40	Surfacing	away from vessel	Surfacing, Swimming, Swimming below surface, Diving	away from vessel	yes
Green sea turtle	195	1	202	40	Swimming below surface	away from vessel	Swimming below surface, Fast travel, Surfacing, Diving	away from vessel	yes
Unidentifiable Shelled Sea Turtle	204	1	508	3300	Resting at surface / Logging	parallel in opposite direction as vessel	Resting at surface / Logging, Swimming, Diving	parallel in opposite direction as vessel	no
Unidentifiable dolphin	205	5	788	3300	Surfacing	crossing ahead of vessel	Surfacing	crossing ahead of vessel	no
Green sea turtle	206	1	228	40	Other(Describe in Detection Description)	stationary	Other, Swimming below surface, Surfacing	parallel in same direction as vessel	no
Loggerhead sea turtle	207	2	220	40	Mating	other	Mating	other	no
Loggerhead sea turtle	208	2	175	40	Mating	other	Mating	other	no
Unidentifiable Shelled Sea Turtle	209	1	231	3300	Swimming	towards vessel	Swimming	towards vessel	no
Green sea turtle	210	1	150	40	Swimming	parallel in opposite direction as vessel	Swimming, Surfacing	away from vessel	no
Loggerhead sea turtle	212	2	183	40	Mating	away from vessel	Mating	away from vessel	no

6.2. IMPLEMENTATION AND EFFECTIVENESS OF THE BIOLOGICAL OPINION'S ITS AND IHA

In order to minimize the potential impacts to marine mammals, sea turtles, and protected sea birds during the seismic survey, LDEO and PSOs were prepared to implement mitigation measures whenever these protected species were detected approaching, entering, or within their designated exclusion zones as outlined in the IHA, ITS, BiOp and Final EA. There were 91 mitigation actions implemented for protected species, including 34 delays, 33 power-downs, 12 shut-downs, 11 power-downs followed by shut-downs for the same detection, and one delay followed by a shut-down for the same detection. The confirmation of the implementation of each term and condition of the project permit documents are described in this report.

As noted in Section 3.1, there were several additional mitigation measures for certain detections of protected species as well as mitigation exemption for seven species of delphinids in US EEZ. There were no instances during the survey where these extra mitigation measures or exemptions were implemented.

In the event that an injured or dead protected species was discovered, the incident was to be reported to the NMFS Office of Protected Resources (OPR), and the NMFS West Coast Regional Stranding Coordinator as soon as possible. The report would include a detailed description of the incident (time, date, location, species identification, description of the animal, condition of the animal/carcass, observed behaviors if the animal was alive, and general circumstances under which the animal was discovered), including pictures when possible. There were three sightings of dead or injured protected species during the seismic survey all reports were submitted by RPS to LDEO (appendix Q), including one spinner dolphin, one loggerhead sea turtle, and one unidentifiable shelled sea turtle. Both the spinner dolphin and the loggerhead sea turtle carcasses were mostly intact with extensive sun bleaching and some signs of predation. The unidentifiable shelled sea turtle carcass however showed heavy signs of predation with the flippers and head down to bone. There was no visible apparent cause of death for any of these deceased animals.

To prevent the occurrence of the vessel striking a marine mammal during transits, PSOs and vessel crew members maintained a vigilant watch for marine mammals, and the vessel was prepared to slow down, stop, or alter course as appropriate to avoid striking a protected species. The vessel speed had to be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans were observed near the vessel. The vessel had to maintain the minimum separation distances as described in Table 2 in Section 3.1. If a marine mammal was sighted during transits, the vessel was to act as necessary to avoid violating the relevant separation distances (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal left the area). If marine mammals were sighted within the relevant separation distances, the vessel was required to reduce speed, shift the engines to neutral, and not engage the engines until the animals were clear of the area. These requirements did not apply in any case where compliance would create an imminent and serious threat to a person or vessel, or if the vessel was restricted in maneuverability due to towed equipment. There were two instances during the survey where avoidance maneuvers were implemented for protected species detections. Both instances were for whales (one Bryde's whale and one common minke whale) that entered the separation zone while the vessel was mostly stationary (less than one knot) while on location during OBS retrieval operations awaiting the instrument to surface, and the vessel remained in position/location until the whales had exited the separation zone. For the Bryde's whale, there was a miscommunication between the PSOs and the bridge officer towards the end of the detection where the vessel began a slow transit (increasing speed to three knots) before the PSOs had cleared the whale from the separation zone; however, there was no physical interaction between the vessel and the whale due to this issue.

In the event of a ship strike of a marine mammal, the incident was to be reported to NMFS OPR and to the West Coast Regional Stranding Coordinator as soon as feasible.

The report would include a detailed description of the incident (date, time, location, species identification, description of the animal(s) involved, vessel speed leading up to the incident, vessel's course/heading and what operations were being conducted, status of all sound sources in use, description of avoidance measures taken if any, environmental conditions, description of the animals behavior preceding and

following the strike, and estimated fate of the animal), including pictures when possible. There were no instances of the vessel striking a protected species during the seismic survey.

In the event of a live stranding (or near-shore atypical milling) event of marine mammals within 50 kilometers of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return the animals to the water, LDEO would be advised by NMFS OPR (or designee) of the need to implement shutdown procedures for all active acoustic sources operating within 50 kilometers of the stranding. The shutdown procedures would be implemented until all of the live animals had left the area, or until the marine mammals died or were euthanized. NMFS OPR (or designee) did not contact LDEO for the need to implement shutdown procedures in response to a stranding event.

PAM was conducted for acoustic source operations during the survey and the majority of monitoring was undertaken while the source was active. Vessel speeds greater than six knots can result in high levels of background noise, which made it impractical to conduct acoustic monitoring while the vessel was in transit both within and outside of the survey area while visual monitoring was ongoing for baseline data collection purposes. There were six acoustic detections of protected species during the survey program, all consisting of unidentifiable dolphins. These detections including two while the source was active at full volume on a survey line, one while the source was silent from a mitigation shut-down for a previous visual detection (which was simultaneous with a visual sighting of the dolphins), and three while the source was deployed but silent while the vessel was in transit between survey lines.

PSOs likely did not detect all animals present; however, it is highly unlikely that the actual number of animals present during survey operations reached anywhere near the fully authorized levels for all species. The combination of conservative predicted mitigation zones combined with conservative take estimation by NMFS (*i.e.,* the precautionary approach), appears for most species to have resulted in an overestimation of take and of overall impact on marine species from the activity. The monitoring and mitigation measures required by the IHAs and ITSs appear to have been an effective means to protect the marine species encountered during survey operations.

7. LITERATURE CITED

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