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3D Marine Seismic Survey

PSO Report

Marine Seismic Survey

EPI Report No. E001642

Client	Schlumberger / WesternGeco LLC
Area	US Gulf of Mexico
Survey	3D OBN Seismic Survey

Project Name: Engagement 6, Multiclient (MC) 3D Survey
Dates: November 10, 2023 to July 18, 2024
Contractor: PXGEO

Source Vessels: PXGEO 2 and Sanco Spirit, REM Andes, Artemis Athene

QC Consultants: Neil Roper, Sam Dorado, Ana Lira, Claudia Portocarrero, Jordan Boliver, Chris Lacy, Alvaro Africano, Andrea Aguilar, Leif Burhans, Fernando Diaz.

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Author	Neil Roper, Sam Dorado, Sofia Sanchez, Chris Lacy
Prepared by	Neil Roper
QA Checked by	Neil Roper

1.0 Executive Summary

1.- EXECUTIVE SUMMARY

The Engagement 6, Multiclient (MC), 3D OBN seismic survey was conducted by PXGEO on behalf of WesternGeco LLC. The program was conducted in federal waters of the Gulf of Mexico (GOM) and located within the Walker Ridge block area. Protected species monitoring was conducted in accordance with Bureau of Ocean Energy Management (BOEM) and National Marine Fisheries Service (NMFS) standards, as well as Geophysical Survey Plan Approval Conditions for Lease Outer Continental Shelf (OCS) Permit L23-022. This report is the Final Protected Species Report for the Engagement 6, Multiclient 3D OBN Survey, undertaken by the Research Vessels PXGEO 2, Sanco Spirit, Artemis Athene, and REM Andes, where protected species monitoring and seismic survey operations took place from November 10, 2023, to July 18, 2024.

Schlumberger/WesternGeco took a best practice approach by adopting guidelines for the mitigation of protected species over the span of this project. The Client and Vessels operated under the regulatory guidelines jointly stipulated by the National Marine Fisheries Service (NMFS) Biological Opinion on the Federally Regulated Oil and Gas Program Activities in the Gulf of Mexico (BO), Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement, U.S. Environmental Protection Agency, as well as additional guidelines outlined in the Letter of Authorization (LOA) and the Environmental Management Plan (EMP).

Throughout the reporting timeframe, three trained visual Protected Species Observers (PSO)s and four Passive Acoustic Monitors (PAM)s contracted through EPI, remained on board the PXGEO 2 and Sanco Spirit to uphold the regulatory guidelines and reporting requirements. The PSOs/PAMs were certified by BOEM (Bureau of Ocean Energy Management) and had previous survey experience. Mitigation measures were implemented to minimize potential impacts to marine mammals and sea turtles throughout the duration of the survey. The mitigation protocols for this survey included the establishment of buffer zones (BZ) and exclusion zones (EZ) around the acoustic sound source to create a reasonable separation distance in regard to the animal, conducting visual and acoustic monitoring consistently for 24 hours, determining and implementing delays of the sound source initiation based on the animals' distance to their relevant buffer and exclusion zones, and executing shutdowns or strike avoidance maneuvers if necessary to ensure protection to all animals and to maintain regulatory compliance.

Across all source vessels there were 34 mitigation actions, thirteen turtle pauses and zero non-compliance issues for the duration of the project. All communication between the PSO/PAM team and the seismic crew was effective in ensuring that all airgun operations were conducted within compliance of the guidelines set forth for this project. See report overview in Tables 1, 2, and 3.

Table 1: Report Overview for PxGeo2 and Sanco Spirit

Report Overview
There were 176 survey days beginning 15 November 2023 to 18 July 2024.
Visual observation time totaled 3098:44 and Acoustic Monitoring time totalled 3147:07.
The total number of airgun sequences (172 test and 263 production lines) from the first production day to last was 435.
Airguns were active for a total of 2313:13 for the duration of this survey period.
There were 66 visual observations.
There were 68 acoustic detections.
There were 17 mitigation actions and one turtle pause required for this survey period.
There were 0 non-compliance issues.

Table 2. Report overview for Artemis Athene

REPORT OVERVIEW
There were 109 survey days beginning December 18,2024 to June 17, 2024
Visual observation time totaled 2251:05 and Acoustic Monitoring time totaled 2524:09.
The total number of airgun sequences (attempts at or full finish of line) from the first production day to last was 264.
Airguns were active for a total of 1757:15 for the duration of this survey period.
There were 60 visual observations.
There were 25 acoustic detections.
There were 9 mitigation actions required for this survey period.
There were 0 non-compliance issues.

Table 3. Report overview for REM Andes

REPORT OVERVIEW
There were 70 survey days from 6 May 2024 to 14 July 2024.
Visual observation time totalled 984 hours and 16 minutes, and acoustic monitoring time totalled 1288 hours and 53 minutes.
The total number of airgun sequences (attempts at or completion of line) from the first production day to last was 100.
Airguns were active for a total of 894 hours and 56 minutes for the duration of this survey period.
There were 33 visual observations.
There were 29 acoustic detections.
There were 18 mitigation actions required for this survey period.
There were no non-compliance issues.

2.0 Introduction

2.1. Project Information

The research vessels PXGEO 2, Sanco Spirit, Artemis Athene, and REM Andes undertook the Engagement 6, Multiclient (MC), 3D OBN seismic survey that was conducted by PXGEO on behalf of WesternGeco LLC. The survey took place in deep waters within the Walker Ridge block area US Gulf of Mexico.

The full fold, 3D seismic acquisition area was approximately 4,609.0 km2, with a greater working area of 10,378.4 km2 around it to allow for vessel line turns, equipment deployment and recovery, and source testing. Water depths during the program ranged from 1200 meters to 2,500 meters.

The objectives during this survey were to collect data to support: site characterization, development of a ground model, ensure the seabed is clear of any obstructions, and proper identification of buried archaeological features in compliance with the National Marine Fisheries Service (NMFS) Biological Opinion on the Federally Regulated Oil and Gas Program Activities in the Gulf of Mexico (BO), Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement, U.S. Environmental Protection Agency, as well as additional guidelines outlined in the Letter of Authorization (LOA) and the Environmental Management Plan (EMP).

Engagement 6 area is located approximately one hundred and fifty six nautical miles (~ 156 NM) south of Port Fourchon, in water depths ranging between approximately one thousand two hundred meters (~ 1,200 m) and approximately two thousand, five hundred meters (~ 2,500 m).

The survey utilizes a shooting methodology where nodes are rolled and source operations are conducted centrally within the active node patch. The working prospect Sx Area covers approximately 10,378.4 km2, with the Rx Area covering approximately 4,609.0 km2 kilometers in the center of the survey area.

2.2. Location Maps

The locations of the acquisition and working areas of Engagement 6 are shown in Figure 1., relative to the US coast in the Gulf of Mexico. Figure 2. shows the limits and distribution of the survey area. Figure 3. represents the shooting nodes design.

Figure 1. Location Map of survey area Engagement 6.

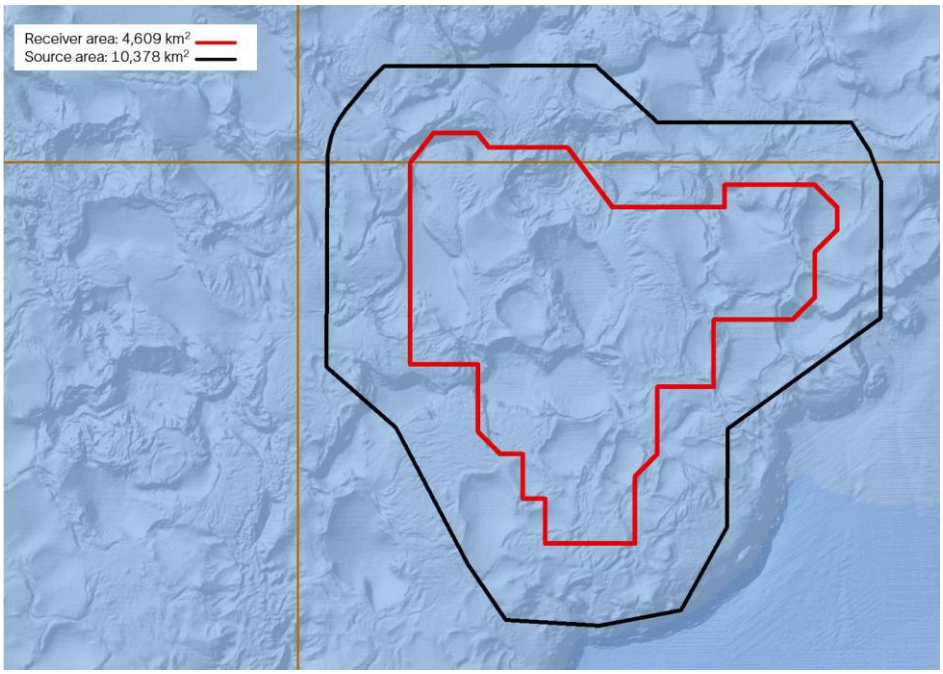

Figure 2. Engagement 6 area limits and distribution.

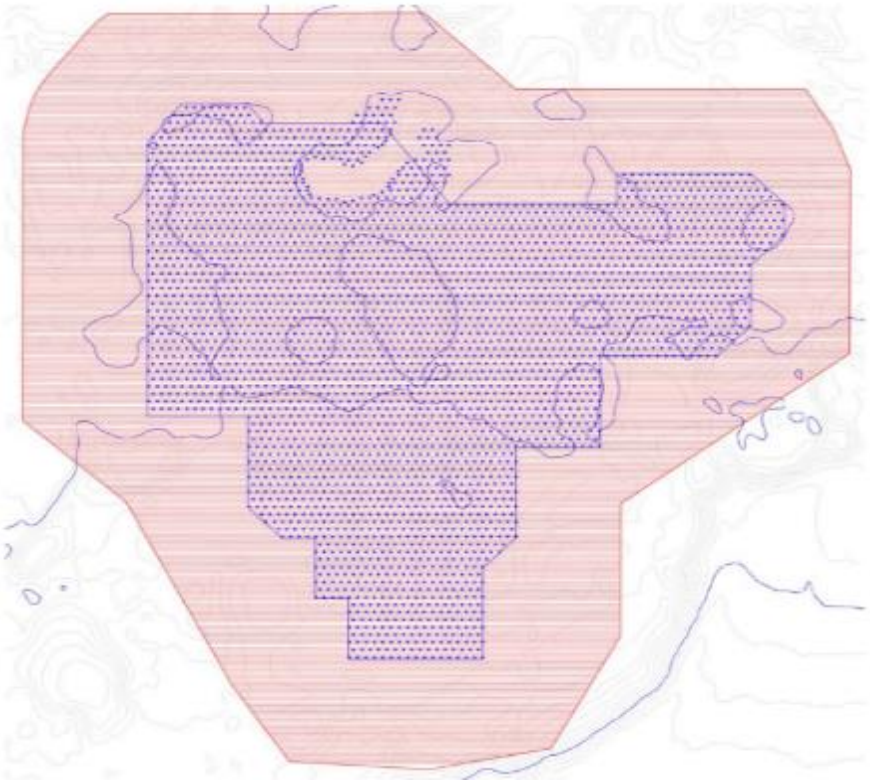

Figure 3. Shooting nodes design - Engagement 6.

2.3. Protected Species Occurrence

There were six species of marine mammals identified during this survey program as expected within the shallow waters during transits and the deep waters of the greater working and acquisition areas. These included five cetacean and three sea turtle species all covered by the BOEM permit L23-022 and NMFS BO guidelines to minimize the potential impacts from seismic operations. See table 4 for reference of the IUCN Red List (IUCN, 2020) status for each species.

Table 4: Reference of the IUCN Red List, status for each species

Species		IUCN Red List Status
Sperm whale	VU	Vulnerable
Rice's whale	EN	Endangered
Kogia spp.	LC	Least Concern
Beaked whale	EN	Endangered
Rough-toothed dolphin	LC	Least Concern
Bottlenose dolphin	LC	Least Concern
Clymene dolphin	LC	Least Concern
Atlantic spotted dolphin	LC	Least Concern
Pantropical spotted dolphin	LC	Least Concern
Spinner dolphin	DD	Data Deficient
Striped dolphin	LC	Least Concern
Fraser's dolphin	LC	Least Concern
Risso's dolphin	LC	Least Concern
Melon-headed whale	LC	Least Concern
Pygmy killer whale	DD	Data Deficient
False killer whale	DD	Data Deficient
Killer whale	DD	Data Deficient
Short-finned pilot whale	LC	Least Concern
Green sea turtle	TH	Threatened
Kemp's ridley sea turtle	EN	Endangered
Leatherback sea turtle	EN	Endangered
Hawkbill sea turtle	EN	Endangered

2.3.1. Marine Mammals

Twenty-one species of cetaceans, including whales and dolphins, are commonly found in the US waters of the Gulf of Mexico (GOM). In inshore waters such as bays, sounds, and estuaries, as well as coastal waters extending to the 20-meter isobath, common bottlenose dolphins (*Tursiops truncatus)* are prevalent. The continental shelf waters, ranging from 20 meters to 200 meters in depth, are primarily inhabited by bottlenose dolphins and Atlantic spotted dolphins (*Stenella frontalis*). The deeper oceanic waters, with depths exceeding 200 meters, are home to 20 different species, among them sperm whales (*Physeter macrocephalus*), dwarf and pygmy sperm whales (*Kogia spp.),* beaked whales *(Ziphiidae*), and several delphinids including short-finned pilot whales (*Globicephala macrorhynchus*) and Risso's dolphins (Grampus griseus). Smaller delphinids in these waters include pantropical spotted dolphins (*Stenella attenuata),* rough-toothed dolphins (*Steno bredanensis*), spinner dolphins (*Stenella longirostris),* striped dolphins (*Stenella coeruleoalba*), Clymene dolphins (*Stenella clymene*), and Fraser's dolphins (*Lagenodelphis hosei*).

Species such as false killer whales, pygmy killer whales, and melon-headed whales, collectively known as "blackfish," are observed relatively infrequently. These blackfish species are distributed throughout the deep waters of the northern GOM, with a majority of sightings occurring in the central and western regions of the GOM. Sperm whales are listed as "endangered" under the Endangered Species Act (ESA), and the GOM population is considered a strategic stock under the Marine Mammal Protection Act (MMPA). Rice's whales (*Balaenoptera ricei*), previously identified as Bryde's whales (*Balaenoptera edeni*), are the only resident baleen whales in the GOM, although other baleen whale species are occasionally observed. Rice's whales are primarily found in a small region of the northeastern GOM near De Soto Canyon along the continental slope. Due to their limited distribution and low numbers, Rice's whales are also classified as "endangered" under the ESA.

2.3.2. Marine Turtles

The Gulf of Mexico (GOM) is home to five species of sea turtles: Kemp's ridley (*Lepidochelys kempii),* loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), and leatherback *(Dermochelys coriacea*). In the GOM, loggerhead and green turtles are listed as "threatened," while Kemp's ridley, hawksbill, and leatherback turtles are classified as "endangered" under the Endangered Species Act (ESA).

Leatherback turtles are observed year-round in the GOM, with higher frequency of sightings in offshore waters, particularly east of the Mississippi River during winter and spring. Their density is greater in waters exceeding 50 meters, with peak concentrations in summer and fall, correlating with warmer sea surface temperatures. Temperature variations in temperature significantly influence their population estimates, peaking in the summer.
Green sea turtles predominantly inhabit the eastern and southeastern GOM across all seasons, extending to the western GOM in summer. Their highest densities are found in nearshore waters with warm temperatures. Kemp's ridley turtles are present throughout the GOM year-round, with peak densities at intermediate depths (<15 meters). Their density is higher in winter months, driven by sea surface temperature variations. Loggerhead turtles are widespread across coastal and shelf waters throughout the year, with the highest occurrences in nearshore waters of the eastern and central GOM. Their density peaks nearshore and at intermediate depths, declining sharply beyond 100 meters. Population density increases during winter and summer. Hawksbill turtles, though less frequently observed, are crucial to the GOM's foraging habitats, highlighting the GOM's diverse and dynamic marine ecosystem.

2.4. Local Activity

Jack St Malo platform SIMOPS Procedures will be enforced.
Other seismic acquisition surveys being conducted close to the survey area:
- Shell Stones – finished in January 2024 – Artemis Artic source vessel.
- 2Chevron Jack (orange/red) – finished end of Dec. 2023 – Fulmar Explorer source vessel

Figure 4. Adjacent survey areas.

There were few, if any, fishing vessels working in the prospect area for a short time. Commercial traffic was observed daily with the occurrence of tanker, bulk carrier, container, other cargo vessels, and cruise ships.

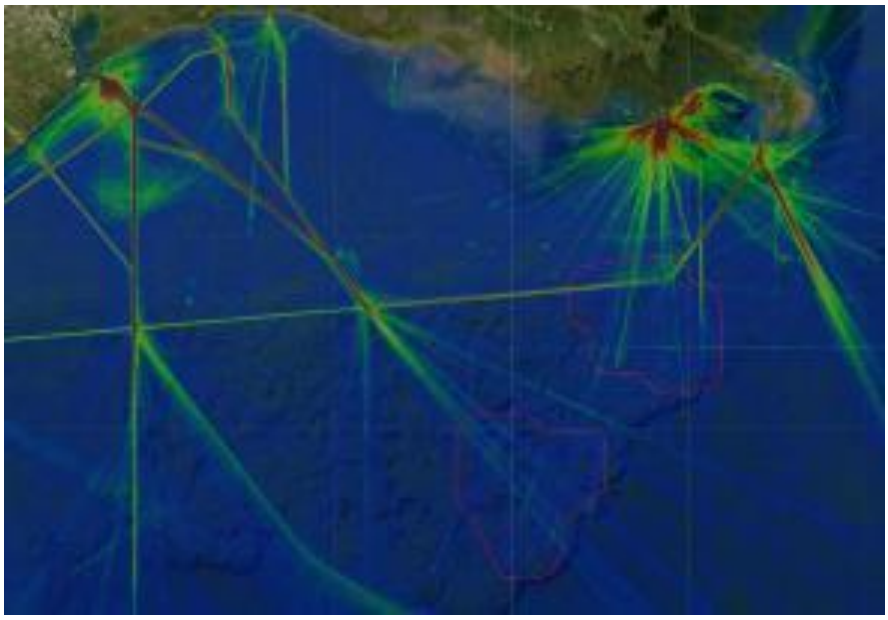

Figure 5. Shipping traffic

3.0 Vessels & Equipment

3.1. Vessels on the Survey

3.1.1. Source Vessels

PXGEO 2, Sanco Spirit, Artemis Athene, and Rem Andes were the source vessels for the project. The PXGEO 2 completed acquisition on 03 February 2024. The Sanco Spirit replaced the PXGEO and began testing on 17 of February 2024. All source vessels were equipped with triple source arrays of 5000 cu.in.

PXGEO 2

Classification: Source Vessel
IMO: 9620114
MMSI: 311001040
Flag: Bahamas
Call Sign: C6EY9
Length X Breadth: 100.1 x 25.64m

Figure 6. R/V PXGEO 2.

SANCO SPIRIT

Classification: Source Vessel
IMO: 9429936
MMSI: 236538000
Flag : Gibraltar
Call Sign: ZDJN3
Length X Breadth: 86 x 16m

Figure 7. R/V Sanco Spirit.

ARTEMIS ATHENE

Classification: Source Vessel
IMO: 8805626
MMSI: 257156000
Flag: Norway (NO)
Call Sign: LDIA3
Length X Breadth: 91.6 x 18m

Figure 8. R/V Artemis Athene.

R/V REM ANDES

Classification: Source Vessel
IMO: 9606699
MMSI: 311000913
Flag: Bahamas
Call Sign: C6EJ6
Length X Breadth: 87 x 18m

Figure 9. R/V REM Andes.

3.1.2. Node Vessels

Siddis Mariner, Havila Subsea, Chloe Candies were the dedicated node vessels for this project. The node vessels are equipped with dual ROV's with a minimum node inventory of 3000 MANTA nodes.

SIDDIS MARINER

Classification: Offshore Tug/Supply ship
IMO: 947518
MMSI: 259795000
Flag: Norway
Call Sign: LAIY3
Length X Breadth: 88m x 20m

Figure 10. Node Vessel Siddis Mariner.

HAVILA SUBSEA

Classification: Offshore Supply Ship
IMO: 9505508
MMSI: 259073000
Flag: Norway
Call Sign: LGSY3
Length X Breadth: 98m x 19,80m

Figure 11. Node Vessel Havila Subsea.

3.2. Seismic Equipment and Sound Emissions

The PXGEO 2 and Sanco Spirit towed a 3 source array (flip-flop-flap) Bolt 1900LL-X Bolt 1500LL source clusters with a total volume of 5000 cubic inches 270 meters astern of the vessel at a depth of 10 meters. The shot point interval was 16.66 meters. Each source was made up of two sub-arrays where each sub-array was equipped with 14 airguns, varying volume from 80m to 320 cu in.

3.2.1. Specifications

Survey Area

Area	10,378.4 km²
Average line length (km)	80 km
Number of sail lines	347
Heading (deg)	090
Reciprocal heading (deg)	270

Source Parameters

Source type	G-Guns
Number of source arrays	3 (flip-flop-flap)
Alternatively fired sources (flip-flop)	Yes
Source array separation	115 m
Shot point interval	16.6667 m
Shot point interval per source	50 m
Array volume per source	2,500/2,500 cu. In (2,570 / 2,570 Bolt)
Operating pressure	2,000 psi
Source depth	10 m
Number of sub arrays per source	2
Sub array separation	12 m
Number of airguns per sub array	14
Sub array length (m)	15 m
Gun synchronization	± 1.5 ms
Source control system	Gunlink 2500

Recording Parameters

Recording system	Manta
Recording format	ASCII
Recording length	60 secs
Sample rate	2 ms
Lo-cut recording filter	(-3dB) Out
Hi-cut recording filter	(-3dB) 216.5 Hz

3.2.1. **Towed Equipment Diagram**

The diagram shows the towing configuration and the configuration of the airgun arrays. The survey was conducted using a total of 84 airguns. At full power the three airgun sub-arrays operated at a pressure of 2,000 psi and a volume of 5,000 cubic inches. Individual airguns ranged in volume from 80 to 320 cubic inches. Soft starts were conducted under the agreed guidelines (20-minute minimum soft start) and Gunlink 2500 software was used to automatically increase power gradually. See figures 12 - 15 below for layout source display and string guns offset.

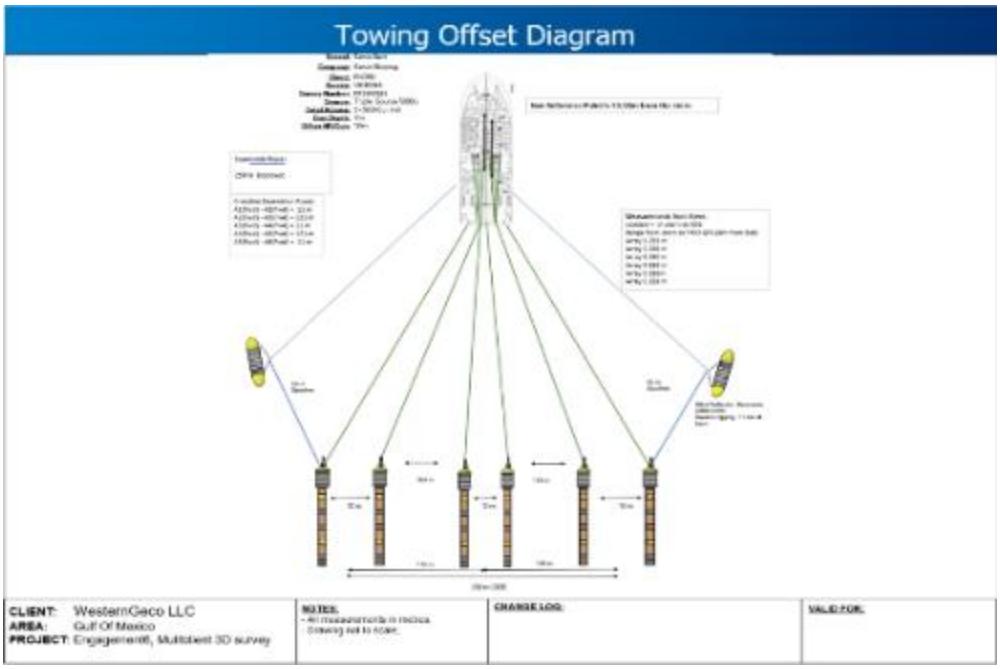

Figure 12. Engagement 6 layout towing display on the R/V Sanco Spirit.

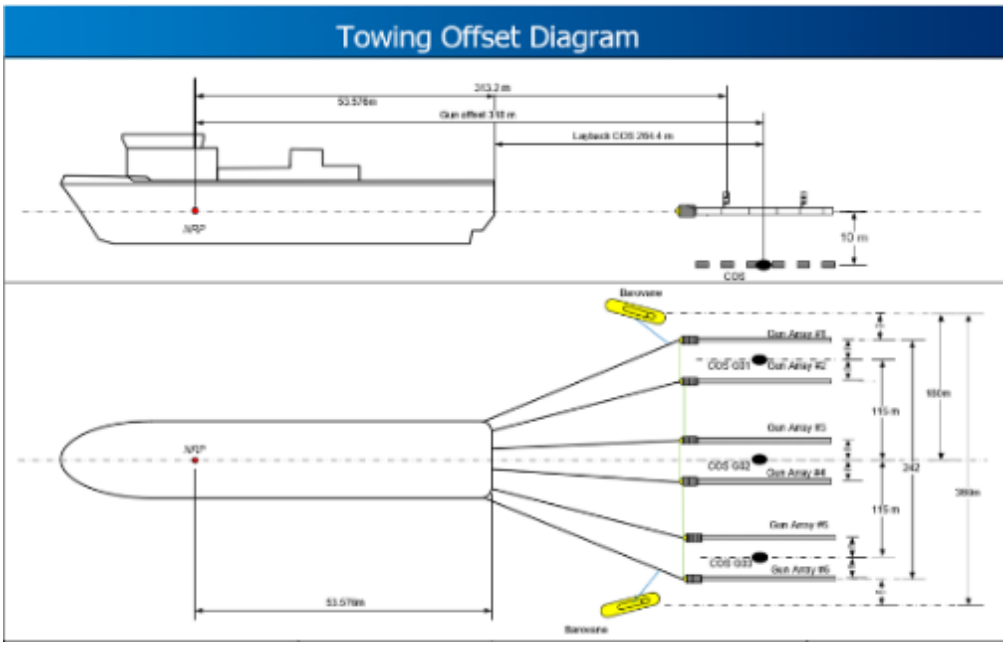

Figure 13. Engagement 6 layout towing display on the R/V Sanco Spirit.

3.2.2. **Source Layout**

Figure 14. Source Array layout display.Please find the attached PS

3.2.3. **Sub-Array Diagram**

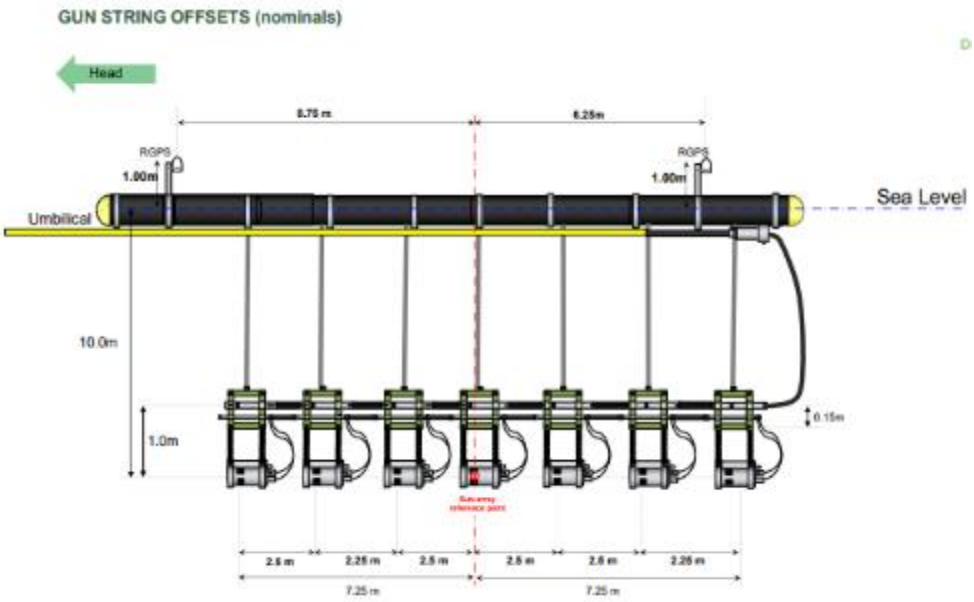

Figure 15. Gun string offsets.

4.0 Operations

4.1. Project Overview

The R/V PXGEO 2 departed from Freeport Bahamas on November 10, 2023, and commenced with the 3D OBN Seismic Survey Engagement 6 acquisition in Walker Ridge block, under the BOEM permit L23-022 on November 15, 2023, concluding operations on February 03, 2024. The R/V Sanco Spirit departed on February 13, 2024, replacing the R/V PXGEO 2, and began source testing in the prospect area on February 17, 2024. The R/V Artemis Athene completed source array configuration and deployment tests and commenced source operations in Walker Ridge lease area offshore January 7, 2024. The research vessel REM Andes departed Gulfport Mississippi May 6th 2024 and commenced with the Engagement 6, Multiclient (MC), 3D OBN seismic survey that was conducted by PXGEO on behalf of WesternGeco LLC on May 8th 2024. The survey took place in deep waters within the Walker Ridge block area US Gulf of Mexico. . The 3D OBN seismic survey was completed on July 18, 2024 and source operations on the Artemis Athene for this project concluded on June 16, 2024. The survey acquisition program was completed on July 18, 2024.

During this project, airgun tests, test lines, and equipment maintenance were conducted in addition to the standard acquisition of survey lines. Survey delays occurred due to technical issues, marine traffic and installations, currents affecting operations and gun separation, marine debris entanglement with gear, weather conditions, and protected species observations. Mitigation actions were applied based on regulatory guidelines from National Marine Fisheries Service (NMFS) Biological Opinion on the Federally Regulated Oil and Gas Program Activities in the Gulf of Mexico (BO), Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement, U.S. Environmental Protection Agency as well as additional guidelines outlined in the Letter of Authorization (LOA) and the Environmental Management Plan (EMP).

During this project, production sequences and source tests were all conducted in addition to the standard acquisition of survey lines and the required guidelines by R/V PXGEO 2, R/V Sanco Spirit, Artemis Athene, and REM Andes. See Tables 5, 6., and 7 below for number of production lines and source test events during the 176 survey days during this program.

Table 5. Number of production lines and source test events during the program

Research Vessel	Production sequences	Source tests	Survey days	Full Volume Tests
PXGEO 2	56	56	46	25
Sanco Spirit	207	116	130	63
PXGEO 2 / Sanco Spirit	263	172	176	88

Table 6. Number of production lines and source test events

Research Vessel	Production sequences	Source tests	Survey days	Full Volume tests
Artemis Athene	219	89	109	30

Table 7. Number of production lines and source test events

Research Vessel	Production sequences	Source tests	Survey days	Full Volume tests
REM Andes	108	98	69	24

Source events for source testing equaled a total of 359. Overall, 90 tests were carried out in daylight, 82 during the hours of darkness, two of these tests were followed immediately by a full production line.

4.1.1. Pre-searches

Seismic source activity was preceded by a pre-search under the BOEM and NMFS BO guidelines, where a 30 minute search period must be conducted prior to turning on the seismic source for any reason.
Pre-searches were broken into two separate categories.

- The pre-search during daylight was conducted simultaneously, visually by two PSOs and acoustically by one PAM operator.
- The pre- search during nighttime was conducted only acoustically by a PAM operator.

Table 8. Number of visual and acoustic pre-searches during source active events

Research Vessel	Total source events	Visual Pre-searches	Acoustic Pre-searches
PXGEO 2	116	63	116
Sanco Spirit	323	188	323
PXGEO 2 / Sanco Spirit	439	251	439
Artemis Athene	244	151	244
REM Andes	216	114	216
Project Total	**Total source events**	**Visual Pre-searches**	**Acoustic Pre-searches**
	899	516	899

4.1.2. Soft Starts

Soft starts for this survey were initiated by activating the smallest source element in the array first and then adding in the next largest, with the intent to warn marine mammals and sea turtles of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. Soft start activity continued in stages by doubling the active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration of the soft start was no less than 20 minutes.
All soft starts conformed to the current BOEM and NMFS BO guidelines. In total, 196 soft starts occurred during the hours of daylight, 155 soft starts occurring during the hours of darkness.

Table 9. Number of daytime and nighttime soft starts during the program

Research Vessel	Total Soft start	Soft start daylight	Soft start nighttime
PXGEO 2	81	37	44
Sanco Spirit	270	159	111
PXGEO 2 / Sanco Spirit	351	196	155
Artemis Athene	264	151	113
Rem Andes	118	71	47
Project Total	**Total Soft start**	**Soft start daylight**	**Soft start nighttime**
	733	418	315

4.1.3. Mitigation Source

A mitigation source is the continuous firing of the smallest source element at the same shot point interval as production shots. During this survey, a mitigation source was not utilized.

4.1.4. Source Silence

Except during the occasional source testing after the end of line, source arrays were immediately silenced after completion of survey lines. As per the BOEM and NMFS BO guidelines, during periods of source silence lasting less than 10 minutes (darkness, poor visibility or sea state >B4) and 30 minutes (daylight with good visibility or sea state <B4), no soft start was required to return to full volume if the PSOs and PAM Op were monitoring continuously throughout the silent period and no protected species were observed within the exclusion zone.

4.1.5. Record of Operations

All seismic source operations were recorded in the BOEM record of operations form, which includes the duration of the soft start, the time the source was disabled, and the length of the pre-firing watch. The seismic crew provided data on the duration of the soft start and the time spent shooting, which was verified against the PSOs logged gun use times recorded during daily protected species observation sessions. Please refer to Appendix-A for the record of operations throughout the 3D OBN Seismic survey.

5.0 Mitigation Measures

5.1. Protected Species Mitigation Action Procedures

In an effort to minimize the potential impacts of seismic operations on certain protected species, including marine mammals and sea turtles, the Bureau of Ocean Energy Management (BOEM), the National Marine Fisheries Service (NMFS), and the Bureau of Safety and Environmental Enforcement (BSEE), have outlined monitoring, mitigation, and reporting procedures that survey operators and permit holders are expected to implement during their seismic survey operations. Protected species monitoring, mitigation, and reporting procedures that are applicable to the 3D OBN Survey are contained in the following regulatory documents:

1. The Biological Opinion (BO) issued by the NMFS on March 13, 2020, where Protected Species Observer (PSO).

2. The survey permit issued by BOEM, permit L23-022.

PSOs shall establish and monitor applicable exclusion and buffer zones, depending on the species and source activity status, as shown in Table 6. These zones shall be based upon the radial distance from the edges of the airgun array. During use of the acoustic source (i.e., anytime the acoustic source is active, including ramp-up), occurrence of marine mammals within the relevant buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown of the acoustic source (when required).

Exclusion Zone (EZ) – a standard exclusion zone encompassing the area at and below the sea surface out from the edge of airgun array to a species specific distance.

Buffer Zone (BZ) – a species specific zone extending out from the edge of airgun array where delays to source activation are implemented during a pre-watch/clearance search.

Table 10. Established exclusion and buffer zones distances during this survey program

Species / Species Group	Separation Distance	Buffer Zone	Exclusion Zone
Rice's whale, beaked whale, Kogia species	500 m	1500 m	1500 m
Sperm whale	100 m	1500 m	1500 m
All other marine mammals	50 m	1000 m	500 m [1]
Sea turtles	50 m	1000 m	100 m [2]
ESA-listed fish (Gulf sturgeon, oceanic, white-tipped shark, giant manta ray)	50 m	N/A	N/A

1. Shut down is not required for dolphins of the following genera: *Steno, Tursiops, Stenella,* and *Lagenodelphis. (rough-toothed dolphin, bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, spinner dolphin, Clymene dolphin, striped dolphin, Fraser's dolphin)*
2. Turtles inside 100 m - implement 7 shot turtle pause to allow 200m from array upon resumption of source activity

5.1.1. Vessel Strike Mitigation

The PSOs maintained a continuous watch during daylight hours to ensure that the vessel maintained a safe distance from protected species while the vessel was in production or in transit. According to the National Marine Fisheries Service a safe distance for all whales, protected under federal law, is 100 yards or 91.44 meters to avoid disrupting

their natural behaviours and staying parallel to the whale's course and direction of travel to avoid cutting off its path or getting too close. A safe distance from small cetaceans and turtles is approximately 50 yards or 45.72 meters. There were no observations of vessel strikes for the duration of the project. When protected species approached the vessel, such as bow riding dolphins, abrupt changes in course were avoided as to not disturb the animals. The vessels operated at an average speed of 4.3 knots during operations and less than 10 knots during periods of transit, which allowed time for marine mammals and/or sea turtles to avoid the vessel's path (NOAA, 2008). Accordingly, support vessels on the project typically operated at speeds below 10 knots.

5.2. Acoustic Disturbance Mitigation

Visual monitoring of protected species is a standard procedure during seismic surveys in the Gulf of Mexico since 2002 (MMS, 2002). During the seismic operations and transiting phases of the project, the client and contractor adhered to the mitigation protocols as outlined in the NMFS Biological Opinion of 2020, the survey permit issued by BOEM, and the EMP.

The mitigation measures are as follows:

- **Pre-Clearance Search** – All seismic gun activity will be preceded by a 30-minute pre-clearance search by the PSOs (day) and PAM Operators (day and night) onboard.

- **Soft Start** – Airguns must always undergo a soft start process lasting a minimum of 20 minutes. Soft start and run in time until the start of a new line should be minimized. If this event happens, then a reason must be stated in the soft start logs by the seismic observers on board.

- **Shut Down** – In order to minimize acoustic disturbance, acoustic source must be shut down for line changes as well as infill intervals exceedingly more than 20 minutes.

- **Soft Start Delay** – Delay soft start if during the pre-clearance search a protected species is observed inside of its respective Buffer Zone (feeding, mating, and/or migrating, etc.). The soft start will be delayed until the protected species have been confirmed to have exited the Buffer Zone or after 15 minutes for small odontocetes or 30 minutes after other marine mammals or sea turtles were last sighted in the Buffer Zone.

- **Shut Down** –Turn off the airgun array if a protected species is sighted entering the exclusion zone. The exclusion zone of 1500-meter applies to sperm whale, Rice's whale, beaked whale, and Kogia species. All other marine mammals have a 500-meter exclusion zone during the survey. Sea turtles have an exclusion zone of 100-meters. During a soft start, a shutdown of any protected species applies to an animal in its exclusion zone. Shutdown is not required for the following dolphin genera: *Steno, Tursiops, Stenella* and *Lagenodelphis* during full volume firing. Sea turtles are also exempt from a shutdown during full volume firing. There are no shutdown exemptions during a soft start. The soft start may commence once the protected species are observed leaving the respective exclusion zone or 30 minutes post last visual or acoustic detection.

- **Source Silence**

    - In recognition of occasional short periods of silence, if the source is silenced, periods of silence not exceeding 30 minutes during the day (good visibility or sea state <B4) or 10 minutes at night (darkness, poor visibility or sea state >B4) in duration will not require soft start for the resumption of full power seismic operations if no protected species are detected inside the exclusion zone during the silent period.
    - If any protected species are observed in the exclusion zone during the short silent period, resumption of seismic survey operations must be preceded by a full soft start after the exclusion zone has been clear of protected species for a minimum of 30 minutes.
    - The silent period must be fully monitored with both visual and acoustic (PAM) during the day and acoustic (PAM) at night.

- **Source Testing**

- Source testing from silence should be preceded by a 30-minute visual pre-clearance search and soft start.
- Single airgun tests, or bubble tests, do not require a soft start, but must have a 30-minute pre-testing visual monitoring period if conducted from silence.
- If the full volume of the array is not required for testing, a proportional soft start (not less than 20 minutes) should be conducted up to the maximum output utilized for the test.
- In order to test for airgun leaks, a single airgun may be dropped and then added back in without requiring a soft start to be conducted.

Table 11. Summary of mitigation procedures

Source mitigation zone	1500 meters - All true whales 500 meters - Other marine mammals 100 meters - Sea turtles
Pre-watch period	30 minutes of consecutive monitoring 2 PSO's and 1 PAM operator during daylight 1 PAM operator during nighttime or reduced visibility
Soft start length	20 minutes
Soft start delays	15 minutes (Delphinid sp.) 30 minutes all other marine mammals and sea turtles
Shut down during full volume source	Any marine mammal detected in their exclusion zone (except for four delphinid genera)
Shutdown during Soft start	Any marine mammal detected in their exclusion zone with no exceptions
Turtle pause	7 turtle-pause shots allowed for turtles inside their exclusion zone
Vessel Strike Avoidance	500 meters – All true whales 100 meters – Sperm whale 50 meters – All other marine mammals
Applicable species	Marine mammals and sea turtles

6.0 Observations

6.1. Protected Species Observer Survey Methods

A team of three Protected Species Observers (PSOs), supplied by EPI, was on board each source vessel to undertake day-time visual watches, implement mitigations, conduct data collection and reporting in accordance with the BO and the survey permit. A team of four Passive Acoustic Monitoring (PAM) Operators conducted 24-hour PAM monitoring, implement mitigations, and conduct data collection and reporting, in accordance with the BO and the survey permit.

The PSO team conducted watches with two PSO's on watch at a time, from 30-minutes before sunrise to 30-minutes post sunset, every day there was survey operations. When the vessel was transiting or down for bad weather and no survey activities were planned for the day, the PSO team would conduct a vessel strike avoidance watch with a single PSO on shift. The PSO shifts allowed for a maximum of 2-hours on watch and minimum one-hour break (not on visual watch) for any individual PSO through the visual day. The PSO watch was a dedicated watch where no other duties outside of monitoring the relevant exclusion and buffer zones was performed.

The PSO teams used a range of optics and naked eye to scan the buffer and exclusion zones. These optics were handheld reticle binoculars with a 7X50 or 10X50 magnification or big eye binoculars at 25X150. Each individual PSO was also equipped with a DSLR camera with a minimum zoom lens of 300 mm.

The watch location varied for each individual PSO but was designed so the team could monitor the 360-degrees around the vessel and survey equipment. Watch locations on the Sanco Spirit included the bridge, starboard or port bridge wing outside, bow on the 02 deck, and the helicopter/stern deck. Locations on the PXGEO 2 included, bridge, starboard or port bridge wing outside, and helicopter deck/bow.

Table 12. Locations on board included, bridge, starboard or port bridge wing outside, and helicopter deck and bow

Watch Location	PXGEO 2 height of observation points	Sanco Spirit height of observation points
Bridge	16 meters	11 meters
Bridge Wing Outside	16 meters	11 meters
Helicopter deck	8 meters	8 meters
Bow	8 meters	8.5 meters
Watch Location	Artemis Athene height of observation points	REM Andes height of observation points
Bridge	12.1 meters	18.3 meters
Bridge Wing Outside	11.6 meters	18 meters
Helicopter deck	11.6 meters	9 meters
Bow	7.5 meters	NA

When marine fauna was observed, distance and bearing to the animal(s) from the observer's position were recorded, along with the species (or as much detail of the animal as possible), time, position, behavior, and other data required for the completion of the sighting form. Distances to sightings were determined using reticle binoculars, estimated by eye, and by reference to the known distances to seismic gear and guard vessels. Species identification was based on the observer's previous experience, aided, when possible, by photographic records of sightings and field guides.

Sightings, observer effort, operations, weather, and sea state data were recorded using EPI forms to comply with BOEM required guidelines for sightings, seismic operations, and observer effort.

- Sighting form: records time and location, number, species, behavior, and description of the animal. The closest approach to the source, and any required mitigation action are also recorded.
- Seismic operations form: recorded pre-watch search, soft start, and source activity timing records.
- Observer effort form: record of the time, vessel position, source activity, and a range of environmental conditions during PSO and PAM watches.

6.2. Marine Mammal Observer Monitoring Effort

6.2.1. Visual Monitoring Effort

The R/V PXGEO 2 departed from the Port of Galveston on November 10, 2023, for the prospect area with Lease permit L23-022 and commenced with acoustic operations for the 3D OBN Seismic Survey Engagement 6 in Walker Ridge block on November 15, 2023. The R/V PXGEO 2 concluded operations on February 03, 2024, and was replaced by the R/V Sanco Spirit sailing from Galveston port on February 13, 2024, beginning testing and acquisition in the prospect area on February 17, 2024, until July 18, 2024, when the survey program was completed.
Visual monitoring effort was maintained from port to port, during all source activity, when the source was inactive, while the vessel was in transit, and within the greater and working prospect areas. There was a total of 245 days where visual monitoring was performed. Visual monitoring days per vessel are found in Figure 16, and cumulative hours of visual effort by source activity on Figure 17.

The R/V Artemis Athene departed from the Port of Gulfport Mississippi on December 18, 2023, for the prospect area with Lease permit L23-022 and commenced with acoustic operations for the 3D OBN Seismic Survey Engagement 6 in Walker Ridge block on January 7, 2024 until July 18, 2024, when the survey program was completed.
Visual monitoring effort was maintained from port to port, during all source activity, when the source was inactive, while the vessel was in transit, and within the greater and working prospect areas. There was a total of 187 days where visual monitoring was performed. There were 122 days of monitoring where the source was active for some period. There were 65 days of monitoring where the source was silent. There were 118 days where there were periods of silence and source was active and 9 days of visual monitoring where the source was active and there were no silent periods. Visual monitoring days per source activity are found in Figure 16, and cumulative hours of visual effort by source activity on Figure 17.

The REM Andes departed from the Port of Gulfport Mississippi on May 6, 2024, for the prospect area with Lease permit L23-022 and commenced with acoustic operations for the 3D OBN Seismic Survey Engagement 6 in Walker Ridge block on May 8, 2024 until July 18, 2024, when the survey program was completed. There was a total of 70 days where visual monitoring was performed. Visual monitoring days per vessel are found in Figure 16, and in visual effort by source activity on Figure 17.
PSOs on the REM Andes conducted a total of 984 hours and 16 minutes of visual monitoring, consisting of 531 hours and 58 minutes while the source was deployed and active, and 452 hours and 18 minutes when the source was not deployed or deployed but silent. The visual effort is summarized in the Figure 17.

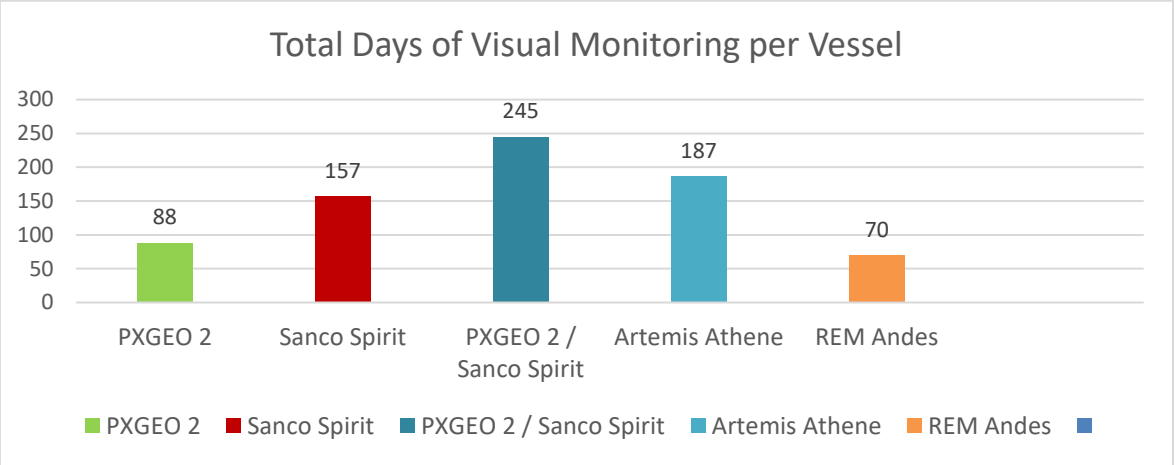

Figure 16. Visual monitoring days per vessel.

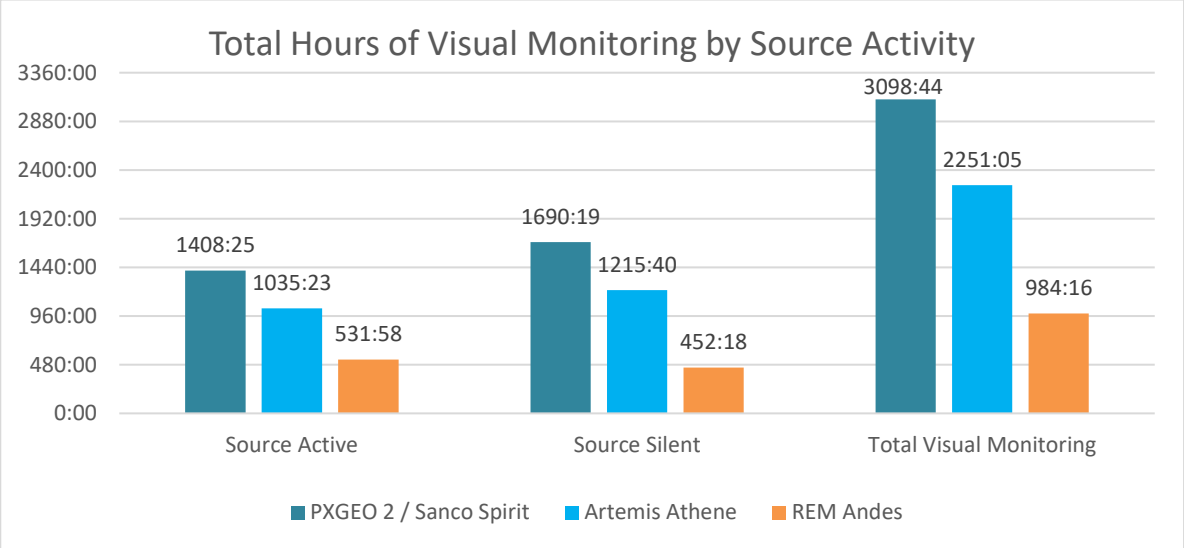

Figure 17. R/V PXGEO 2, the R/V Sanco Spirit, the Artemis Athene, and the REM Andes visual effort by source activity.

Seismic crew supplied all information regarding soft starts and source operating times as requested and ensured that PSO's and PAM Ops were notified well in advance to conduct pre-watches. All seismic source operations were recorded in the BOEM record of operations form, including the duration of soft start, full volume production and testing, the time the source was disabled, and the length of pre-firing watch. See Figure 18 and 19 for visual monitoring effort by source activity for each vessel.

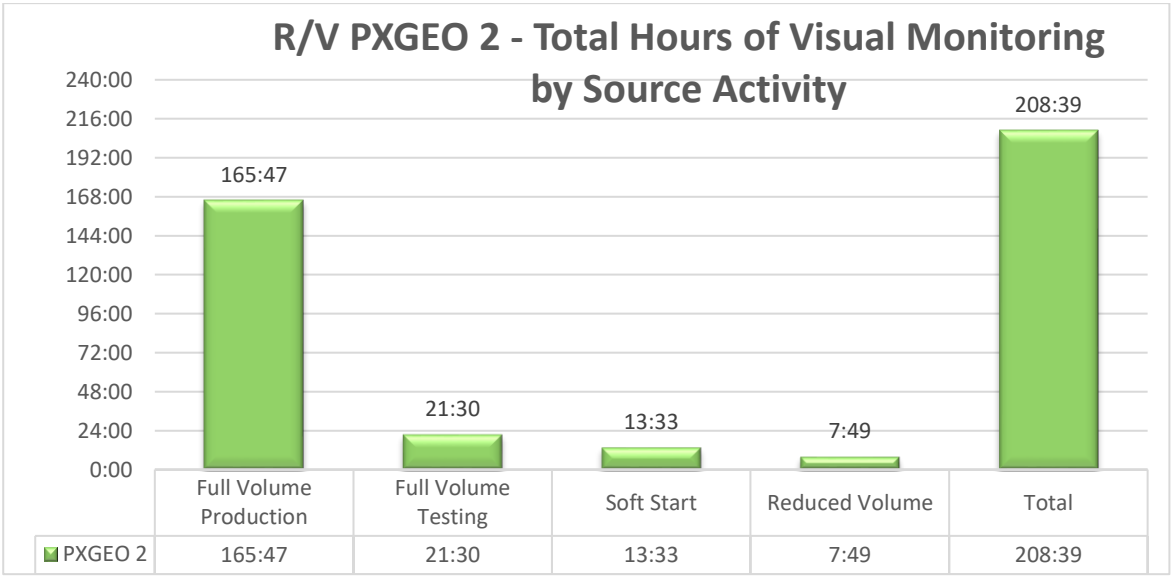

Figure 18. R/V PXGEO 2 distribution of visual monitoring hours by source activity.

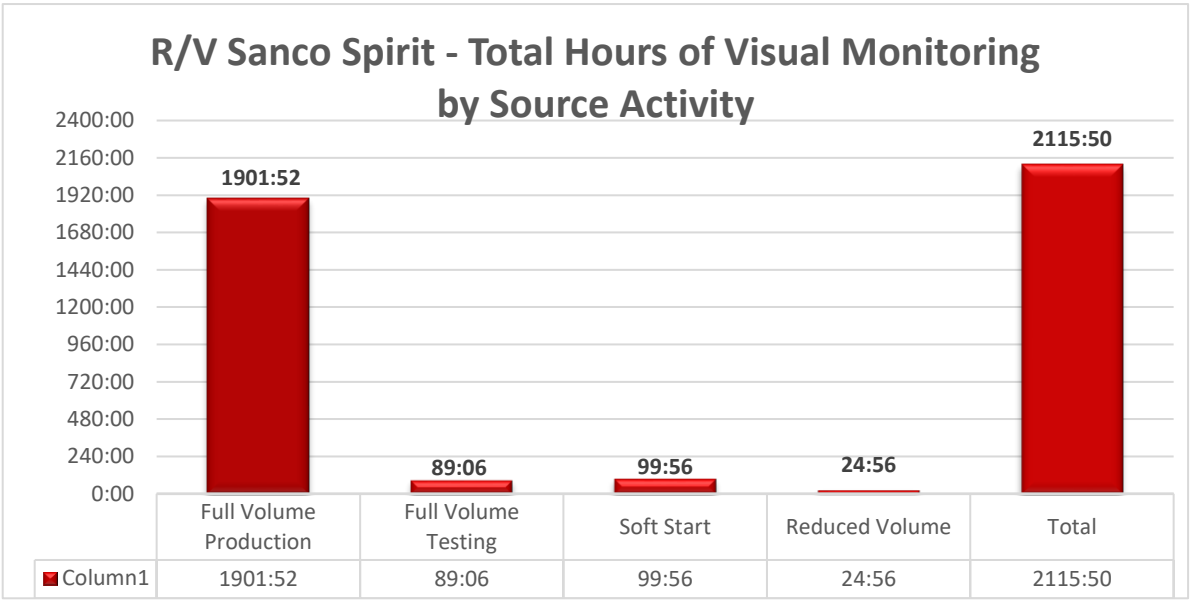

Figure 19. R/V Sanco Spirit distribution of visual monitoring hours by source activity.

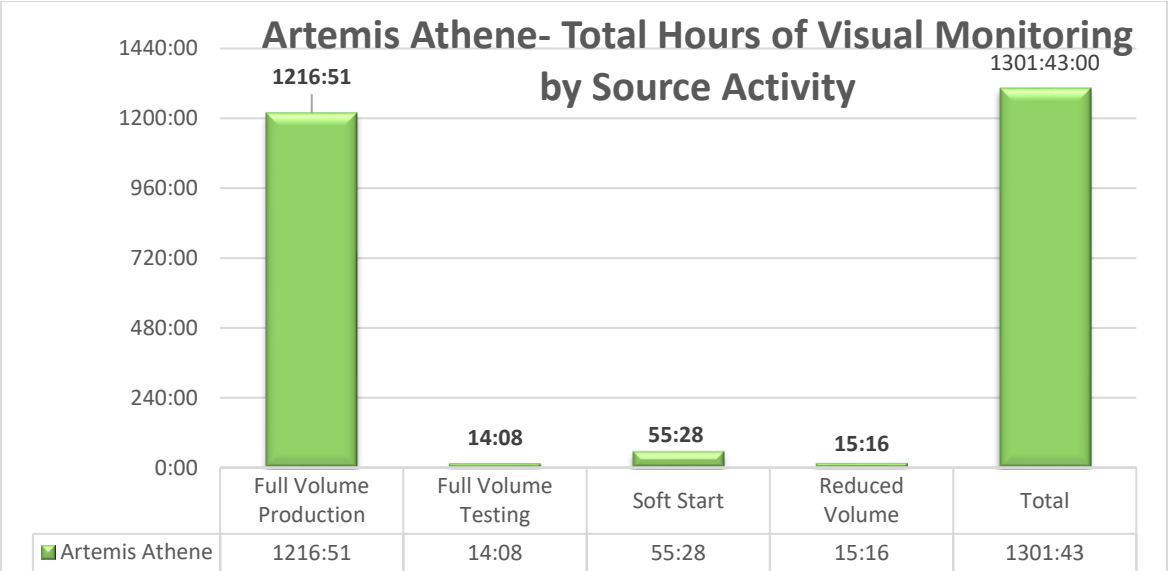

Figure 20. Artemis Athene distribution of visual monitoring hours by source activity.

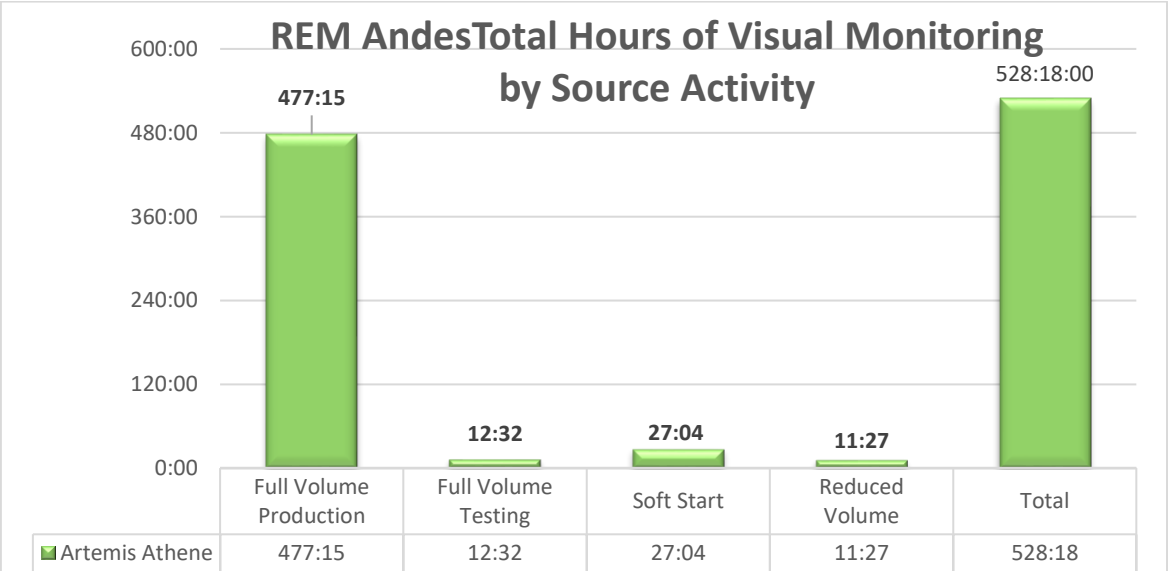

Figure 21. Artemis Athene distribution of visual monitoring hours by source activity.

6.3. Protected Species Distribution & Occurrence

Table 13: Protected species sightings distribution according to source activity

M/V PXGEO 2			
Source activity at detection	Number of whale observations	Number of dolphin observations	Number of turtle observations
Silent	1	16	1
Soft start	0	0	0
Full volume	0	1	0
Total	1	17	1
R/V Sanco Spirit			
Source activity at detection	Number of whale observations	Number of dolphin observations	Number of turtle observations
Silent	3	31	2
Soft start	1	2	0
Full volume	2	4	2
Total	6	37	4
Artemis Athene			
Source activity at detection	Number of whale observations	Number of dolphin observations	Number of turtle observations
Silent	11	35	4
Soft start	0	0	0
Reduced volume	0	0	1
Full volume	2	7	10
Total	13	42	15
REM Andes			
Source activity at detection	Number of whale observations	Number of dolphin observations	Number of turtle observations
Silent	2	15	8
Soft start	0	0	1
Full volume	1	3	2
Total	3	18	11
Project totals			
Source activity	Whale observations	Dolphin observations	Turtle Observations
Silent	17	97	13
Soft Start	1	2	1
Reduced Volume	0	0	1
Full Volume	5	15	14
Project Total	23	114	31

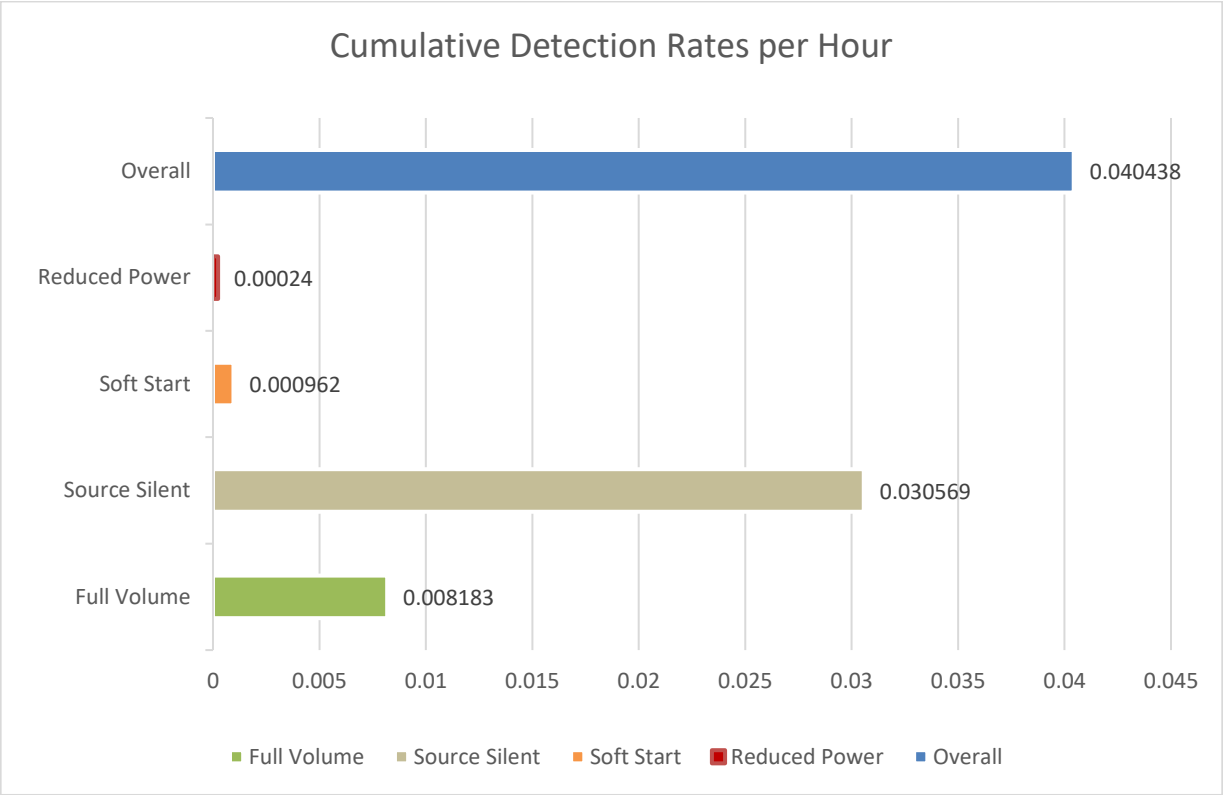

Figure 22. Cumulative Detection rates per source activity

Table 14. Protected Species proximity and source status

Closest Average Approach to source		
Vessel	**Source Active**	**Source Silent**
PXGeo 2	(1) 2000m	(18) 598.61m
Sanco Spirit	(18) 1,017.72m	(36) 523.8m
Artemis Athene	(15) 378.33m	(51) 642.078m
REM Andes	(8) 754m	(25) 468m
Project total	(42) 775.35m	(130) 569.83

Table 15: Visual sightings occurrences

R/V PXGEO 2		
Species	Number of observations	Total number of individuals
Unidentified dolphin (Delphinidae sp.)	5	36
Bottlenose dolphin (*Tursiops truncatus)*	8	70
Rough-toothed dolphin *(Steno bredanensis*)	2	30
Pantropical spotted dolphin (*Stenella attenuata*)	1	8
Short-finned pilot whale (*Globicephala macrorhynchus)*	1	8
Sperm whale (*Physeter macrocephalus*)	1	3
Leatherback sea turtle (*Dermochelys coriacea)*	1	1
Total	19	156
R/V Sanco Spirit		
Species	Number of observations	Total number of individuals
Unidentified dolphin (*Delphinidae* sp.)	13	70
Bottlenose dolphin (*Tursiops truncatus)*	19	222
Rough-toothed dolphin *(Steno bredanensis*)	2	20
Pantropical spotted dolphin (Stenella attenuata)	1	20
Short-finned pilot whale (*Globicephala macrorhynchus)*	2	23
Sperm whale (*Physeter macrocephalus*)	6	9
Leatherback sea turtle (*Dermochelys coriacea)*	2	2
Hawksbill sea turtle (*Eretmochelys imbricata*)	1	1
Green sea turtle (Chelonia mydas)	1	1
Total	47	368
Artemis Athene		
Species	Number of observations	Total number of individuals
Unidentified dolphin (*Delphinidae* sp.)	18	45
Bottlenose dolphin (*Tursiops truncatus)*		
Pantropical spotted dolphin (Stenella attenuata)	2	5
Sperm whale (*Physeter macrocephalus*)	4	4
False Killer Whale (Pseudora crassidens)	1	6
Total	25	60
REM Andes		
Species	Number of observations	Total number of individuals
Unidentified Unidentified dolphin (*Delphinidae* sp.)	4	7
Bottlenose dolphin (*Tursiops truncatus)*	5	85
Pantropical spotted dolphin *(Stenella attenuata)*	6	110
Spinner Dolphin (*Stenella longirostris)*	2	18
Short-finned pilot whale (*Globicephala macrorhynchus)*	1	5
Sperm whale (*Physeter macrocephalus*)	3	7
Unidentified Sea Turtle (*Chleonid)*	2	2
Leatherback sea turtle (*Dermochelys coriacea)*	1	1
Hawksbill sea turtle (*Eretmochelys imbricata*)	1	1
Green sea turtle (Chelonia mydas)	6	6
Loggerhead sea turtle (*Caretta caretta*)	1	1
Total	32	243
Total All Vessels	**123**	**827**

6.4. Protected Species sightings distribution.

Protected species sightings occurred during transit to the prospect area, inside the survey working and greater area, on the transit to port, and during weather patterns.

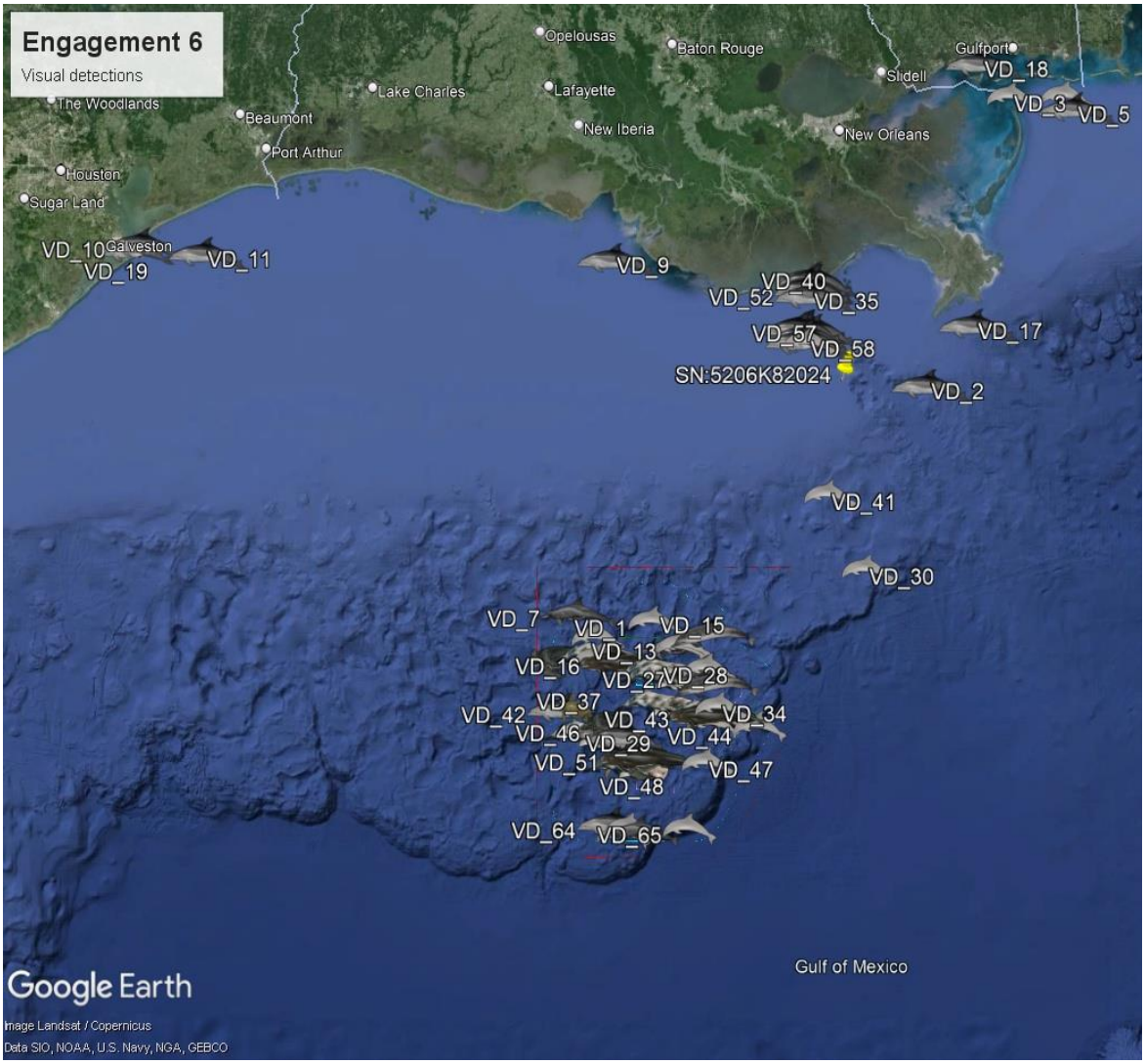

Figure 23. PXGeo2 and Sanco Spirit Distribution of visual sightings on Google Earth Pro.

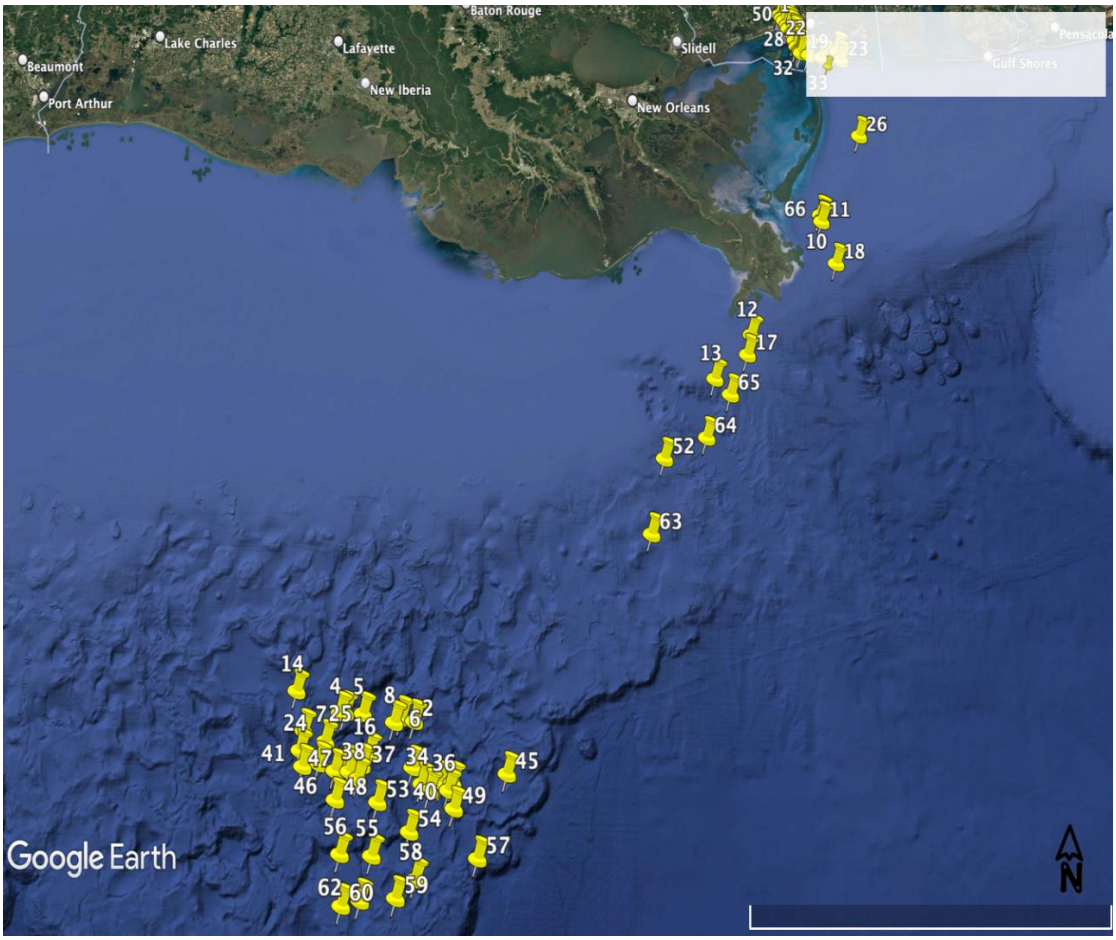

Figure 24. Artemis Athene Distribution of visual sightings on Google Earth Pro.

Figure 25. REM Andes Distribution of visual sightings on Google Earth Pro.

6.5. Descriptions of Protected Species Encountered

6.5.1. Rice's Whale

In accordance with the new language in the BOEM permit, operators or their recognized representatives must notify BOEM or BSEE as appropriate of their intention to transit through the Rice's Whale Area (100 to 400 meter isobaths from 87.5° W to 27.5° N, as described in the species' status review plus an additional 10 km around that area) as shown in Figure 21 below.

For this survey the Rice's Whale Area should not be a consideration as the survey area and transit path in and out of the survey area does not approach the Rice's Whale Area.

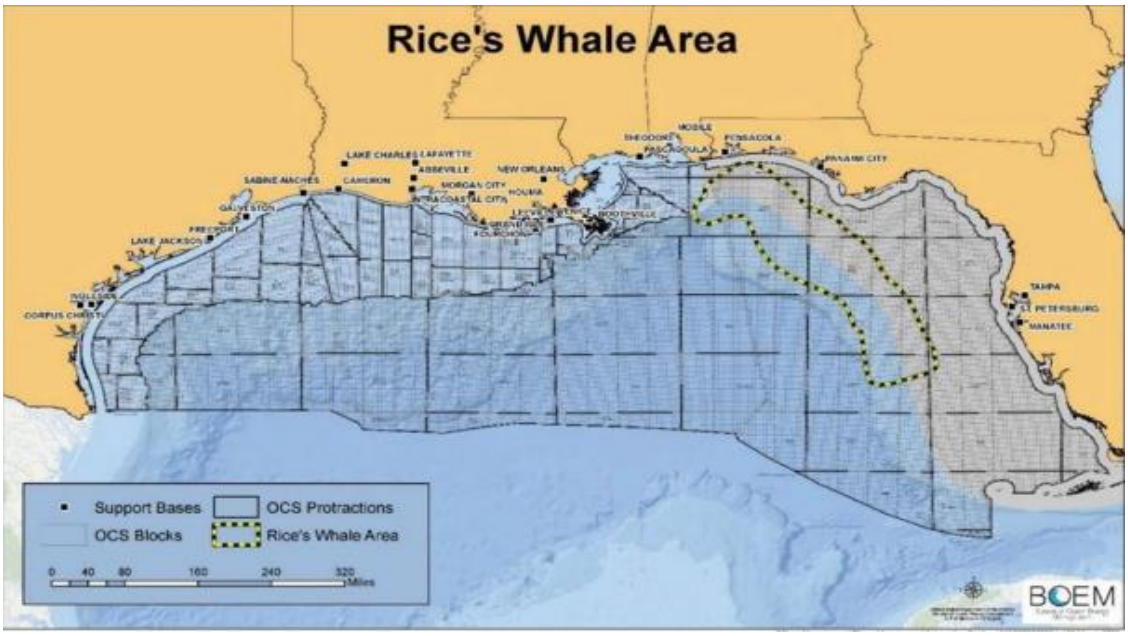

Figure26. Rice's whale distribution area as described in Permit L23-002

6.5.2. Sperm Whale

Sperm whales, *Physeter macrocephalus*, are the most common large whales found throughout the Northern Gulf of Mexico, primarily at the continental shelf and slope, in waters deeper than 200 m, and along the 1000 m isobaths. Sperm whales likely travel in response to geographical and temporal variations in the abundance of medium- and large-sized pelagic squids, their primary prey. Species traits: Huge and squared head with narrow underslung lower jaw. Large and triangular flukes with smooth edges and deep notch. Dark gray-brown color with some lighter blotches and scarring around head. Single, smooth low dorsal hump.

6.5.3. Short-finned Pilot Whale

Short-finned pilot whales, *Globicephala macrorhynchus,* are long-lived, slow to reproduce, and highly social. They have a worldwide distribution in both coastal and pelagic waters in temperate and tropical regions of the Indian, Atlantic, and Pacific Oceans. Species traits: Long and robust dark gray body with deep tail stock. Bulbous head with prominent melon and slight beak. Curved and pointed flippers.

6.5.4. Common Bottlenose Dolphin

Bottlenose dolphins, *Tursiops truncatus*, live in temperate and tropical waters worldwide. Distribution is generally limited to surface water temperatures of 10° to 32°C. Variations in water temperature, movements of food fish, and feeding habits may account for the seasonal movements of some dolphins to and from certain areas. Some coastal dolphins in higher latitudes show a clear tendency toward seasonal migrations, traveling farther south in the winter. Species traits: Robust body and head, shorth thick beak. Gray body with lighter sides and belly.

6.5.5. Pantropical Spotted Dolphin

Pantropical spotted dolphins, *Stenella attenuata*, can be found in all tropical and subtropical oceans worldwide. The depleted northeastern offshore spotted stock inhabits the eastern tropical Pacific Ocean, far at sea. Coastal spotted dolphins are found within 100 miles of the coast. Species traits: Slender body with long, narrow and white tipped beak. Small and pointed flippers. Dark and body with light gray sides and belly.

6.5.6. Rough-toothed Dolphin

Rough-toothed dolphins, *Steno bredanensis*, are distributed worldwide in the Atlantic, Pacific and Indian Oceans, generally in warm temperate, subtropical, or tropical waters. They are commonly reported in a wide range of water depths, from shallow, nearshore waters to oceanic waters. Species traits: Robust body, cone shaped head and sloping forehead. Large and pointed flippers. Dark body with lighter sides and white belly. White lips.

6.5.7. Leatherback Sea Turtle

The leatherback turtle*, Dermochelys coriacea*, has the widest global distribution of any reptile, with nesting mainly on tropical or subtropical beaches. Once prevalent in every ocean except the Arctic and Antarctic, the leatherback population is rapidly declining in many parts of the world. Leatherbacks are highly migratory, some swimming over 10,000 miles a year between nesting and foraging grounds. They are also accomplished divers with the deepest recorded dive reaching nearly 4,000 feet—deeper than most marine mammals. Species traits: Black and huge body with white spots. Lacks shell scutes. Head and body scales covered by leathery skin. Carapace is divided into seven ridges. Short, blunt head.

6.5.8. Green Sea Turtle

The green sea turtle, *Chelonia mydas*, is the second largest of seven sea turtle species and has a wide geographical distribution. Highly migratory by nature, migrated through climatically varying habitats to reach suitable foraging and nesting grounds. Species traits: Largest of all the hard-shelled sea turtles, with a comparatively small head. Dark brown, grey, or olive colored shell, much lighter, yellow-to-white underside.

6.5.9. Hawksbill Sea Turtle

The Hawksbill sea turtle, *Eretmochelys imbricata,* as a highly migratory species has a global distribution that is largely limited to tropical and subtropical marine and estuary ecosystems. Along the East Coast of the United States, hawksbill sea turtle range from Virginia to Florida. Like other young sea turtles, they are assumed to be completely pelagic, remaining at sea until they mature. Species traits: Shield shaped carapace covered with thick, overlapping scutes. Carapace with black, brown, and amber streaks, head scales dark brown with yellow margin. Nuchal scute not touching the first costal. Snout beak.

6.6. Protected Species Relevant Photographs

Figure 26. VS#14 Sperm whale *(Physeter macrocephalus).*

Figure 27. VS# 2 Bottlenose dolphin (Tursiops truncatus).

Figure 25. VS#12 Rough tooted dolphin (*Steno bredanensis*).

Figure 28. VS#15 Pantropical spotted dolphin (Stenella attenuata).

Figure 29. VS#16 Short-finned Pilot whale (Globicephala macrorhynchus).

Figure 30. VS#18 Bottlenose dolphin (Tursiops truncatus).

Figure 31. VS#21 Rough-tooted dolphin (Steno bredanensis).

Figure 32. VS#25 Sperm whale (Physeter macrocephalus).

Figure 33. VS#28 Pantropical spotted dolphin (Stenella attenuata).

Figure 34. VS#36 Bottlenose dolphin (Tursiops truncatus).

Figure 35. VS#37 Green sea turtle (Chelonia mydas).

Figure 36. VS#38 Sperm whale (Physeter macrocephalus).

Figure 37. VS#39 Bottlenose dolphin (Tursiops truncatus).

Figure 38. VS#50 Hawksbill sea turtle (Eretmochelys imbricata).

Figure 39. VS#51 Short-finned Pilot whale (Globicephala macrorhynchus).

Figure 40. VS#57 Bottlenose dolphin (Tursiops truncatus).

Figure 41. VS#59 Bottlenose dolphin (Tursiops truncatus).

Figure 42. VS#62 Bottlenose dolphin (Tursiops truncatus).

7.0 PAM

7.1. Passive Acoustic Survey Methods

Passive Acoustic Monitoring (PAM), designed to detect most species of marine mammals, was installed on the R/V Sanco Spirit. The systems were developed by Seiche Measurements Limited and consisted of the following main components - a 6 channel 25-meter hydrophone array, a 230-meter tow cable, subsea connector, a 100-meter deck cable, a buffer box, an audio interface, a National Instruments data-acquisition card (DAQ), and a Measurement Computing analogue-digital convertor (ADC) for processing the signal from the array depth sensor. A computer, running PAMGuard sound analyzation software, creates a variety of displays of the processed sound, the depth readout from depth sensor, and GPS data of the position and movement of the vessel with overlays of the exclusion and buffer zones. A full spare system was also present on board, in the event the main system components became damaged or inoperable. Figure 41 is a simplified description of the PAM system installed on the Sanco Spirit.

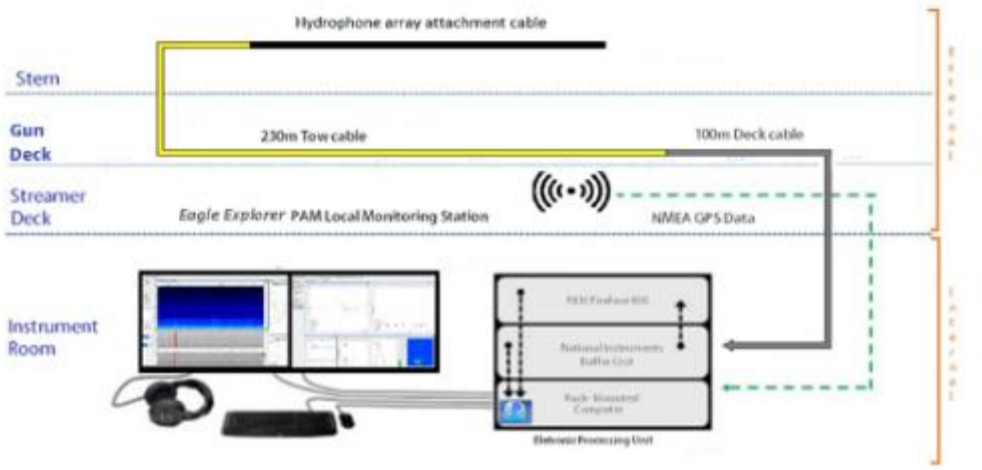

Figure 41. Simplified pathway of data through the PAM system on board the R/V Sanco Spirit.

The 6-channel hydrophone array allows PAMs to view displays of processed and analyzed sound signals in two designations, by grouping the hydrophones into pairs for low, mid, and high frequency analyzation. Four hydrophones utilized for low-mid frequency (MF) analyzation target a frequency range between 0.2 kHz and ~24-48 kHz, targeting broad frequency sperm whale clicks and delphinid calls. The hydrophones used for high frequency analyzation target a frequency range of 2-200 kHz and are processed by the National Instruments USB 6251 DAQ, before being displayed on two scrolling click detector displays. Click detector shows two scrolling time displays, one with a scale for bearing and the other a scale for amplitude, and targets HF echolocation clicks of delphinid species and clicks of beaked whales. PAMGuard software can localize, or approximate distance of HF clicks, and LF and MF signals on a map display, with buffer and exclusion zone overlays relative to the source.

Raw feed from the two designated HF hydrophone elements was digitized in the buffer unit using an analog-digital National Instruments data acquisition (DAQ) soundcard at a sampling rate of 500 kHz. The output was filtered for HF content and visualized using the PAMGuard software. 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 were 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.

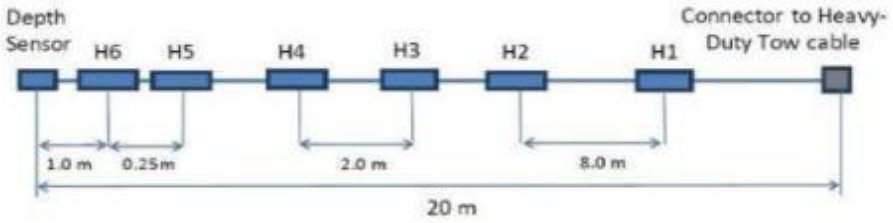

Figure 42. Schematic diagram of the hydrophone array cable indicating position and separation of hydrophone elements.

Pam observations can begin at least 30 minutes before source activation, often extending to an hour or more, following deployment of the PAM hydrophone array and tow cables. The 230-meter tow cable portion of the array is wound on a hydraulic winch, located on the streamer deck at the vessel's stern. The 25-meter 6 hydrophone array is connected via a subsea connection to the tow cable and remains connected and coiled on deck when not deployed. PAM deployment begins with a toolbox by PAM and Sanco source mechanics, followed by crew carefully lowering the array portion of the cable over the rail at the stern of the vessel into the water.

Figure 43. Deck cable connected to the tow cable spooled into the winch onboard the Sanco Spirit.

The tow cable and 6-channel hydrophone array on the Sanco Spirit are deployed from a winch on the streamer deck. The winch is located at the center stern of the vessel, approximately 4 meters from the stern rail and 6.6 meters above the water's surface. The cable and hydrophone array are deployed over the stern rail to approximately 150 meters astern of the vessel. To prevent an acute point of tension and chaffing on the tow cable, a braided rope arrangement was positioned at the 150 meter mark and secured to a winch on deck after deployment. Pam deployment setup for each vessel is shown in Figures 44 and 45. Subsequently, the tow cable is connected to a 100 meter deck cable, the acquisition unit and audio interface are powered on the buffer unit, PAMGuard signal processing starts, and acoustic observations begin.

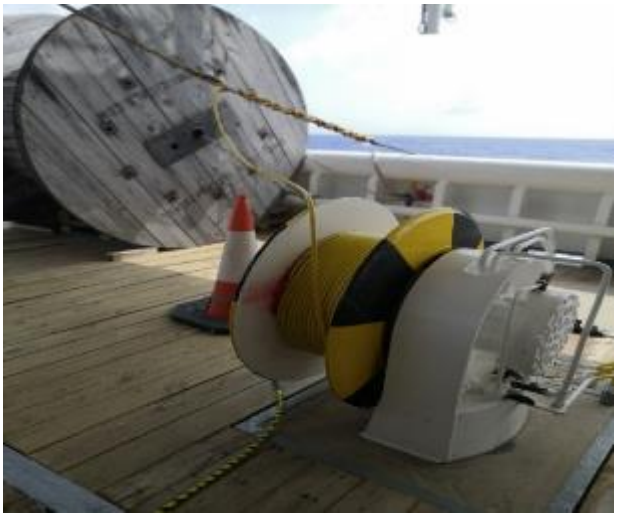

Figure 44. R/V Sanco Spirit PAM deployment setup.

Figure 45. R/V PXGEO 2 PAM deployment setup.

The PAM station onboard the Artemis Athene was set up in the Instrument room (Figure 43). The main and the spare deck leads are both routed under the floor of the Instrument Room and Server Room (Figure 44 & 45).

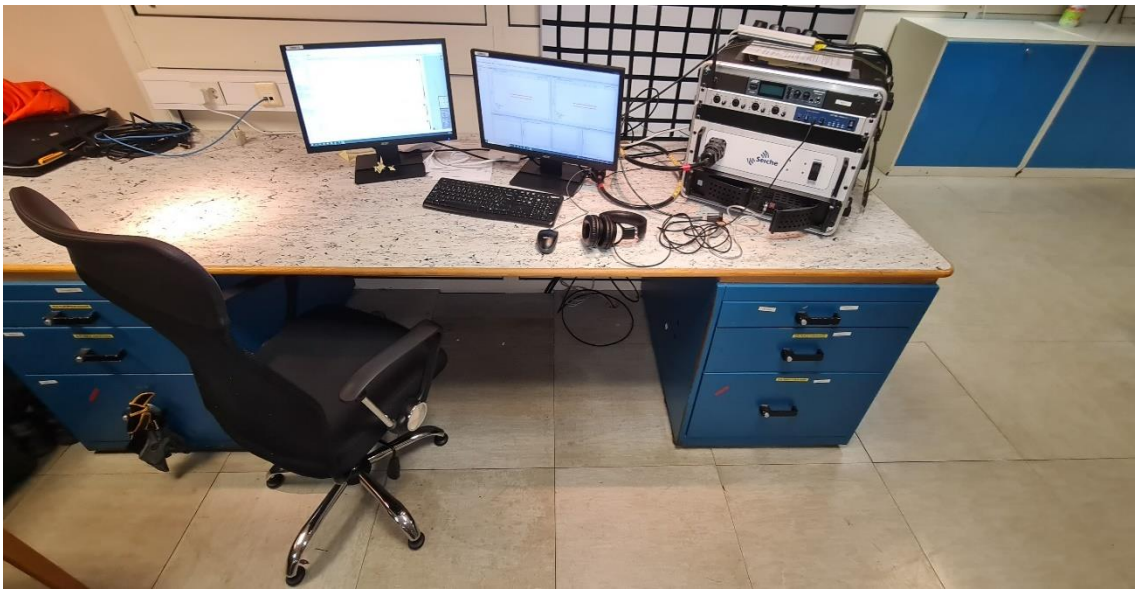

Figure 43. PAM station on the Artemis Athene

Figure 44. Main & spare deck cables under PAM desk.

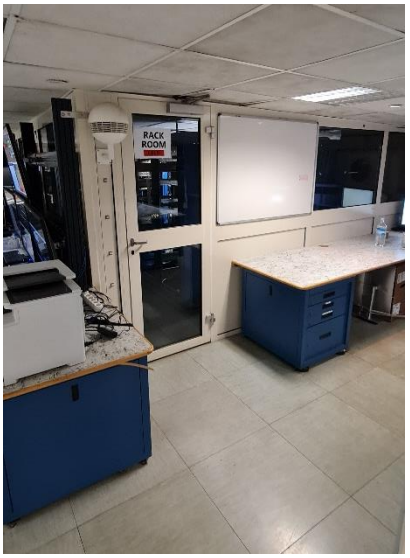

Figure 45. Figure 5. Server Room inside Instrument Room.

The deck cable exits out of the aft wall of the server room. The cables are then routed along the cable trays to the stern of the streamer deck where the tow cables are set up on winches.

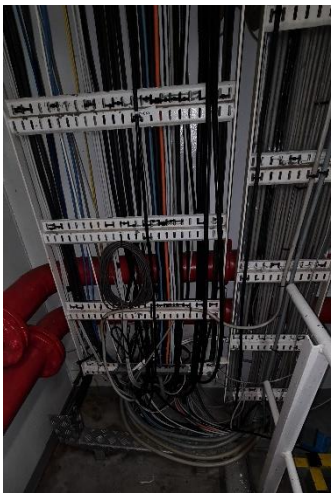

Figure 46. Aft wall of server room with cable tray.

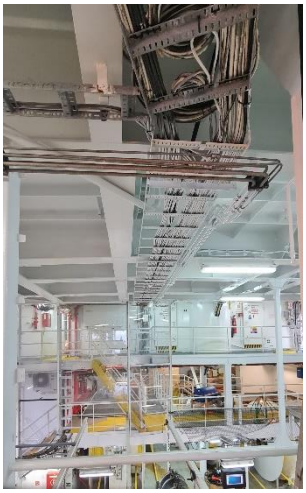

Figure 47. Aft wall of server room with cable tray.

Routing the deck cables though the cable trays between the instrument room and the opening of the gun deck can be easily done as the ceiling is quite low. Routing the deck cables through the cable trays over the opening in the streamer deck was achieved using a rope to pull the cables through. Once the cables were routed to the back of the streamer deck past the opening in the deck, scaffolding was required to continue routing the deck cables through the cable trays to the winches with the tow cables as it entailed working at heights (Figure 8 & 9).

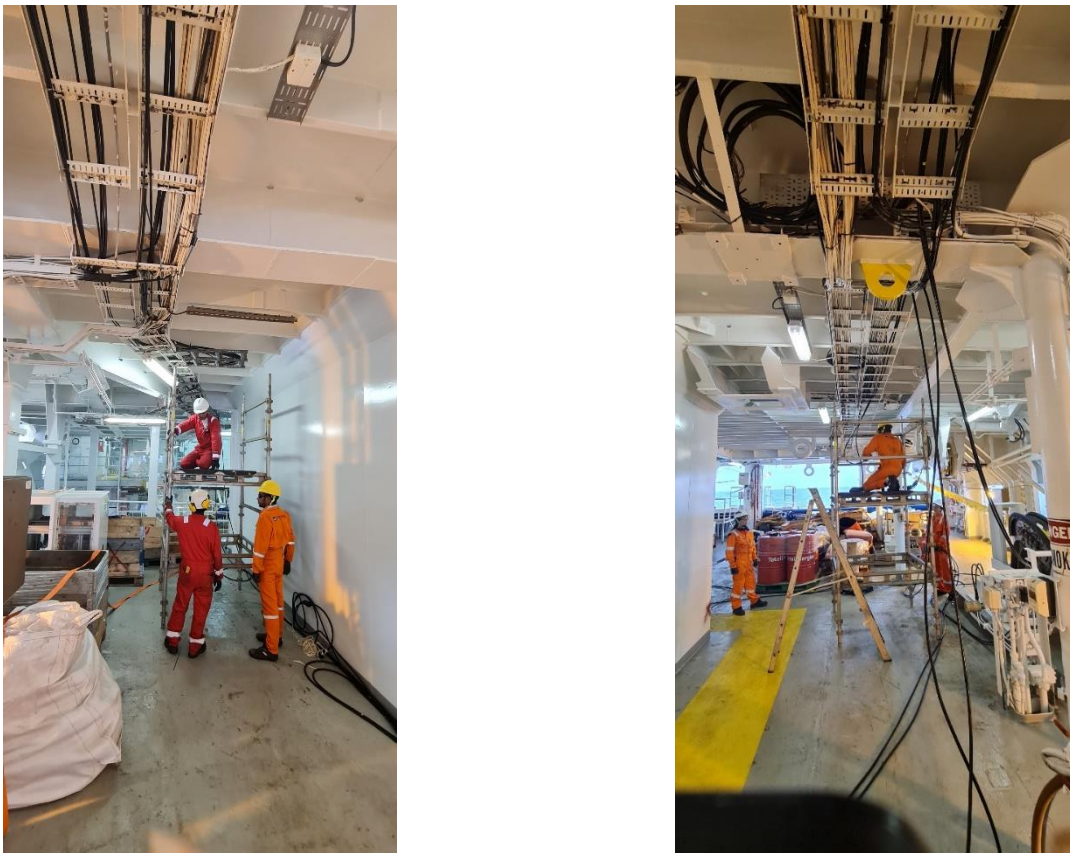

Figure 48. Working at heights scaffolding.

At the stern of the streamer deck, both sets of tow + array cables are spooled onto mechanical winches on the port and starboard sides for easy deployment/retrieval (Figures 2-3). The starboard side cable was used as the main system until May 05 2024. Afterwards the port side cable was used as the main system.

Figure 49. Port winch utilized for spare PAM cable

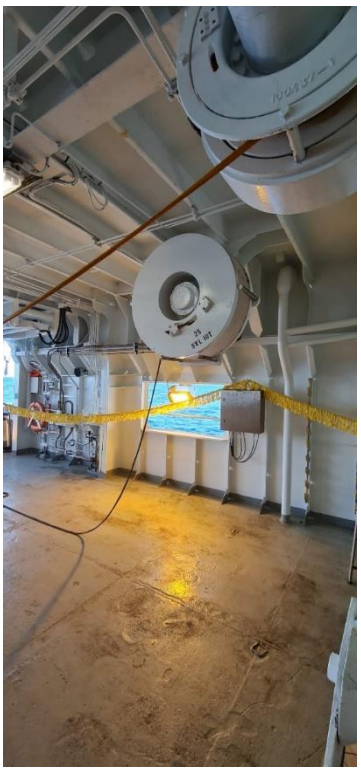

Figure 50. Starboard winch utilized for main PAM cable.

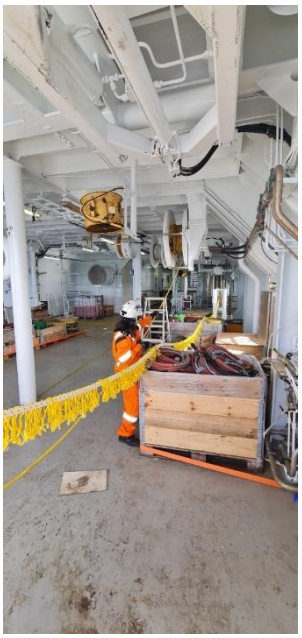

Figure 51. Starboard side main PAM cable being spooled onto winch.

Two sets of weights are added to the tow cable to sink it below the water line and below the depths of the gun strings (10 meters). The first set of weights are zip tied and taped approximately 10 meters from the ITT connector at the end of the tow cable. The additional set of weights were attached approximately 15 meters from the end of the tow cable

Figure 52. Starboard side main PAM cable being spooled onto winch.

A set of Chinese fingers is attached 145 meters from the end of the tow cable (ITT connector) which will be the tow point for the tow cable (Figure 53).

Figure 53. Chinese fingers being attached to tow cable.

Deployment Procedure

This hydrophone deployment procedure is a draft document and may be altered at any time to reflect changes in the deployment over time. The deployment requires the PAM operator and one to two additional people to complete.

The PAM cable is deployed directly off the stern of the Artemis Athene from the streamer deck. When deploying, the 25 meters of hydrophone cable are deployed off the stern by hand. The PAM Operator or mechanic then opens the local hydraulic valves to activate and run the winch to deploy the cable to the desired tow length, which for the project is 145 meters of tow cable added to the 25 meter length of hydrophone cable.

Figure 54. PAM cable deployed off the stern.

The PAM cable is deployed and retrieved from the streamer deck but the tow point and tension is off the gun deck of the Artemis Athene. A ten meter rope with a G-link is temporarily attached to the back of the streamer deck near the PAM cable deployment point (Figure 16). The other end of the rope is securely attached to the back of the Gun Deck. At approximately 145 meters a set of Chinese fingers with a G-link is attached to the tow cable. Once the cable is deployed up to the Chinese fingers the G-link is attached to the rope/G-link (Figure 17) and the remaining 12-15 meters of PAM cable are deployed which transfers the tension from the PAM cable and winch to the rope attached to the Gun Deck (Figure 18-20).

Figure 55. tension rope with G-link in stored position off Streamer deck.

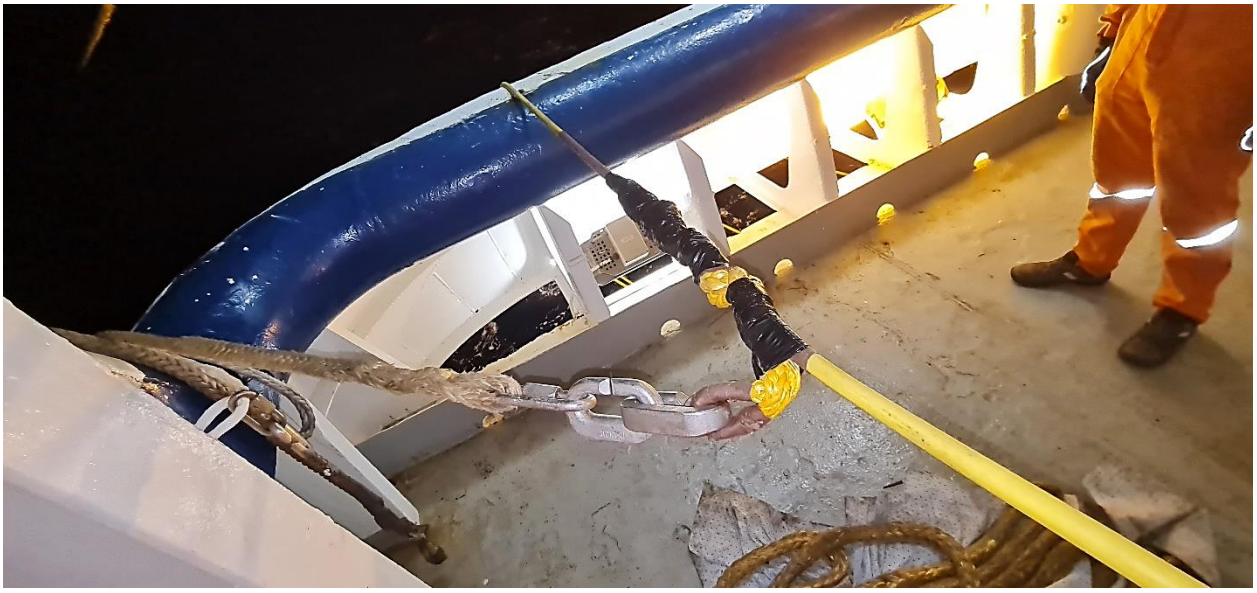

Figure 56. Chinese fingers with G-link attached to tension rope on Streamer Deck.

Figure 57. Tension rope attachment on Gun Deck

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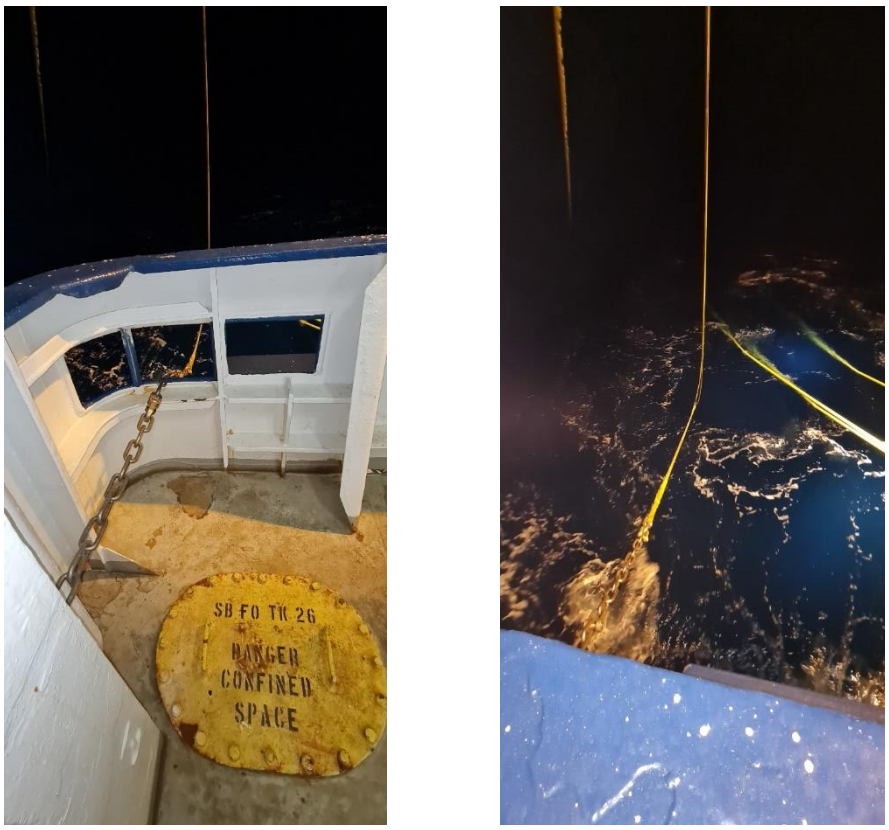


Figure 58. Tension rope attached to PAM cable off Gun Deck.

During retrieval, the deck cable is disconnected, and the PAM cable is first spooled back onto the winch up to where the Chinese fingers are attached. The tension rope is detached from the tow cable via the G-Links and the rope is attached back to the Streamer deck stow point for next deployment (Figure 21). The remaining tow cable is then spooled back onto the winch. Then the array cable is manually retrieved and coiled on deck. The connectors are then wrapped with tape and collars to prevent any moisture from getting in them.

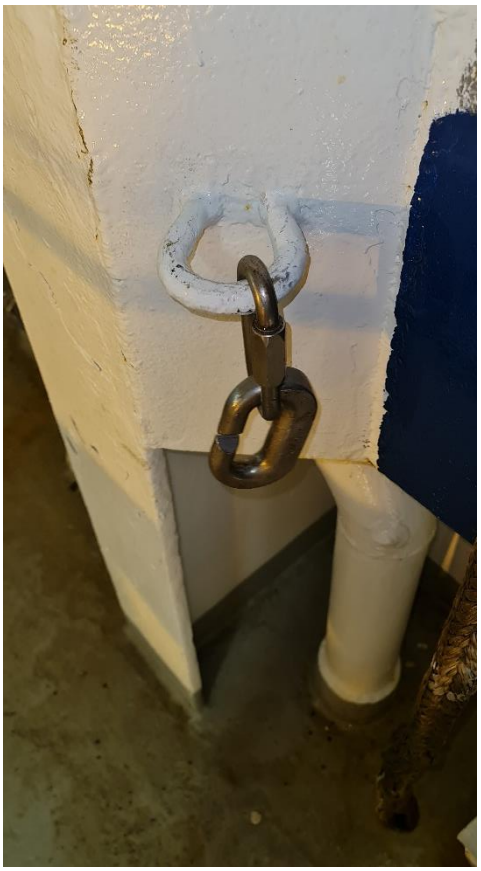


Figure 59. Tension rope attachment point on Streamer Deck.

Pre-Deployment/Recovery Tasks

Deployment

- Ensure that the PAM electronics unit is powered down (this also includes the Fireface and buffer units).
- Ensure local hydraulics are turned on.
- Ensure the deck cable is disconnected from the hydrophone tow cable.
- Remove the tape from the covered connectors.
- Ensure the hydrophone cable is deployed to port of the paravane/door lead-in rope **NOT** to starboard of the rope lead-in or cable retrieval will have to be done by hand (**Figure 22 & 23**).
- Deploy the 25 – 30 meters of array cable by hand.
- PAM operators will deploy the tow cable via the winch up to the point where the Chinese fingers are attached on the tow cable (Approx. 145 meters from ITT connector).
- Attach the tension rope to the Chinese fingers via the G-links.
- Continue deploying PAM cable via the winch until the tow rope is under tension and PAM tow cable has some slack.
- Close the local hydraulics controls.
- Connect the deck cable to the tow cable.
- Power up PAM electronics in the instrument room.

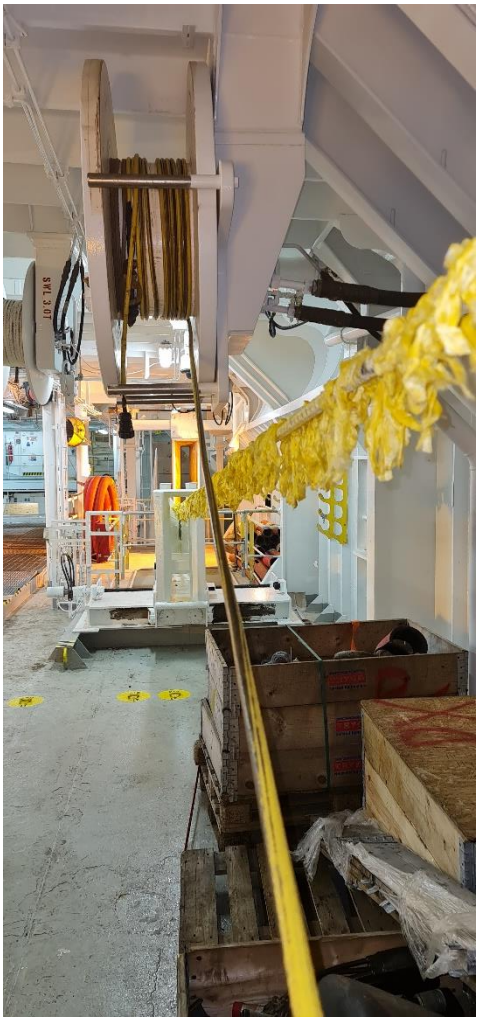


Figure 60. Correct cable deployment.

Figure 61. Incorrect cable deployment.

Retrieval

- Power down electronics on the PAM desk.
- Ensure the deck cable is disconnected from the tow + hydrophone cable.
- Cover the connectors with tape to prevent moisture intrusion and corrosion.
- Ensure local hydraulics are open.
- Retrieve the tow cable via the winch up to the Chinese fingers/tow rope point.
- Disconnect G-links between tow rope and Chinese fingers
- Connect tow rope to stow point on streamer deck (Figure 21).
- Retrieve the remaining 145 meters of tow PAM cable with the winch.
- Retrieve the remaining 25-30 meters of hydrophone array cable manually and coil it on deck.
- close the local hydraulics controls.

The R/V Artemis Athene's towed cable and six-channel hydrophone array are deployed from a winch on the streamer deck. There are two winches located one to starboard and one to port at the stern of the vessel, approximately 4 meters from the stern rail and approximately 11 meters above the water surface. The tow cable and hydrophones array are installed on each winch. The tow cable and hydrophone array go over the railing at the stern of the vessel and a Chinese finger is tied to a rope between the streamer deck and the gun deck to prevent an acute point of tension on the cable.
The tow cable is deployed at a distance of 170 meters astern of the vessel. On the Artemis Athene, the towed cable passes over the stern railing. A 100 meter deck cable is connected to the tow cable on the winch after the tow cable is deployed and assembled.

The PAM station on board the REM Andes was set up in the Instrument Room. The main and the spare deck leads were both routed above the panels on the ceiling of the Instrument Room and Server Room.

Figure 62. PAM Station in instrument room.

The deck cable exits out of the aft wall of the server room. The cables were then routed along the cable trays on both Port and STBD sides to the stern of the guns deck where the tow cables were then coiled up on the deck.

Figure 63. Opening of the Gun deck.

Routing the deck cables through the cable trays between the instrument room and the opening of the gun deck could be easily done as the ceiling was quite low. Routing the deck cables through the cable trays over the opening in the guns deck was achieved using a rope to pull the cables through. Once the cables were routed to the back of the gun deck and past the opening in the deck, a stepladder was required to continue routing the deck cables through the cable trays in port and starboard side to the tow cables.

Figure 64. Routing of the Deck cable.

The port side cable was the main one and the starboard side spare cable was ready to use during the initial testing of the gun strings.
In this first deployment for gun testing, a set of Chinese fingers was attached 75 meters from the end of the tow cable (ITT connector) which was the tow point for the tow cable. When in full operations of the gun strings the Chinese fingers were attached at 175 meters from the end of the tow cable.

Figure 65. Routing of the Deck cable.

Figure 66. Tow cable in the back of gun deck.

Deployment

- Ensure that the PAM electronics unit was powered down (this also includes the Fireface and buffer units).
- Ensure the deck cable was disconnected from the hydrophone tow cable.

- Cover the connectors with tape to prevent moisture intrusion and corrosion.
- PAM operators deployed the tow cable manually up to the point where the Chinese fingers were attached on the tow cable (Approx. 75 meters from ITT connector).
- Continue slowly deploying PAM cable manually until the tow rope was under tension and PAM tow cable had some slack.
- Connect the deck cable to the tow cable.
- Power up PAM electronics in the instrument room.

Retrieval

- Power down electronics on the PAM desk.
- Ensure the deck cable was disconnected from the tow + hydrophone cable.
- Cover the connectors with tape to prevent moisture intrusion and corrosion.
- Retrieve the tow cable manually up to the Chinese fingers/tow rope point.
- Connect tow rope to stow point on the streamer deck.
- Retrieve the remaining 25 meters of hydrophone array cable manually and coil it on the deck.
- Always ensure the deck cable is disconnected from the tow cable before manually recovering or operating the winch.

Demobilization

The Engagement 6 was immediately followed up by Engagement 5, therefore the PAM system remained installed.

HSE

Normal working deck PPE was required (hard hat, boots, gloves, eye protection, and coveralls). The operation carried a relatively low risk. Hazards include working close to the side of the vessel, trip hazards, pinch points at the winch, and working at heights during mobilization and demobilization.

A Job Safety Analysis (JSA) has been completed for this task. The JSA also required further review of any additional modification.

7.2. Acoustic Monitoring Effort

The R/V PXGEO 2 arrived at the prospect area, located in Walker Ridge block, and commenced with acoustic operations for the 3D OBN Seismic Survey Engagement 6 project on November 15, 2023, concluding operations on February 3, 2024. The R/V Sanco Spirit replaced the R/V PXGEO 2 and began acoustic operations in the prospect area on February 17, 2024. The survey program was completed on July 18, 2024.

The R/V Artemis Athene arrived at the prospect area, located in Walker Ridge block, and commenced with acoustic operations for the 3D OBN Seismic Survey Engagement 6 project on December 18, 2023, concluding operations on July 14, 2024. The R/V Artemis Athene began acoustic operations in the prospect area on January 7, 2024. The survey program was completed on July 18, 2024.

The REM Andes arrived at the prospect area located in Walker Ridge block, and commenced with acoustic observations on May 8th 2024 and concluded acoustic observations for the project on
July 14th 2024.

Acoustic monitoring efforts were conducted before, during, and after all source activities, including periods when the source was inactive, within both the working and greater prospect areas. This included conducting the one-hour acoustic post-watch requirement per the survey Letter of Authorization.

There were 235 days where acoustic monitoring was performed. See R/V PXGEO 2 and the R/V Sanco Spirit acoustic effort days and distribution of hours by source activity in **Error! Reference source not found.**, respectively.

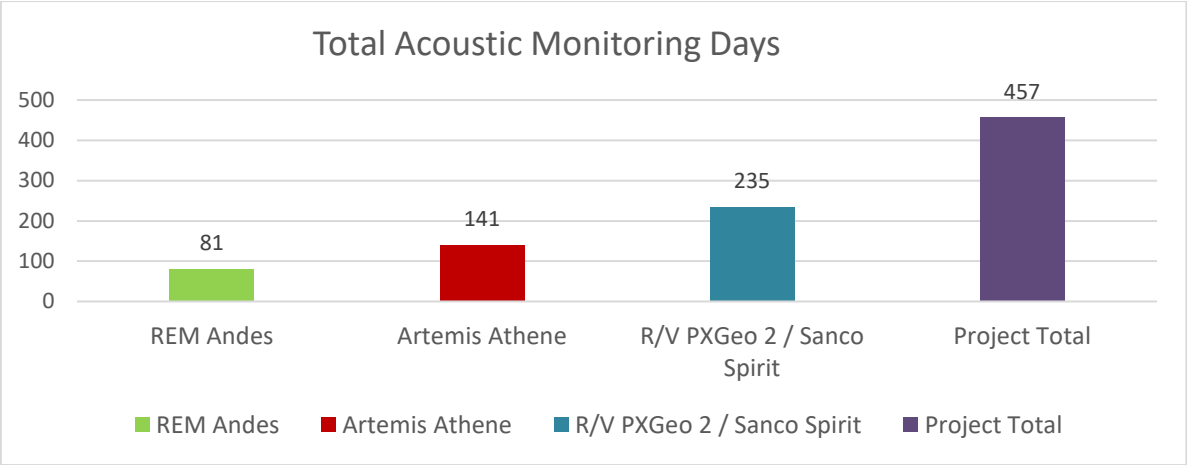


Figure 67. Acoustic monitoring days by vessel.

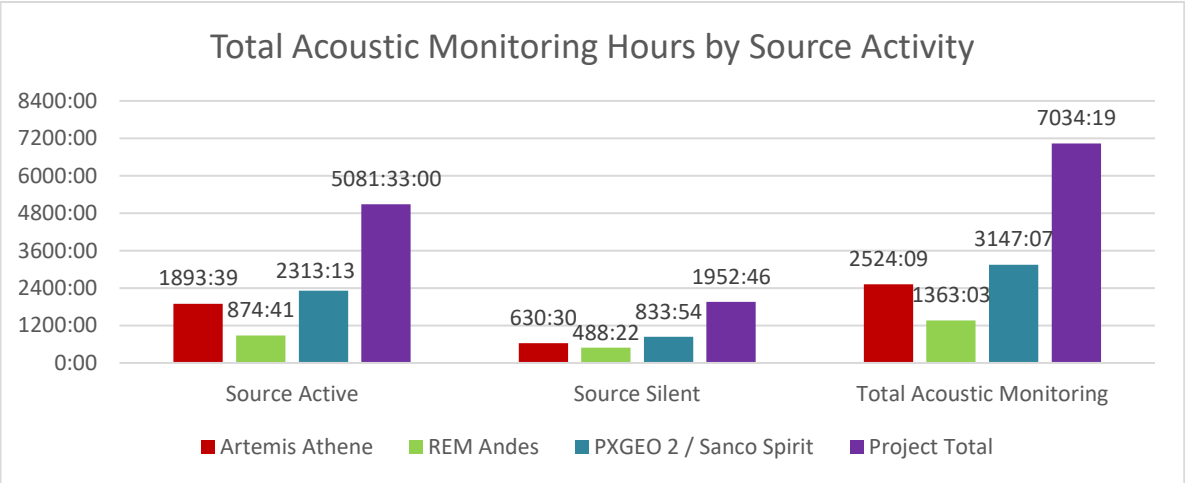
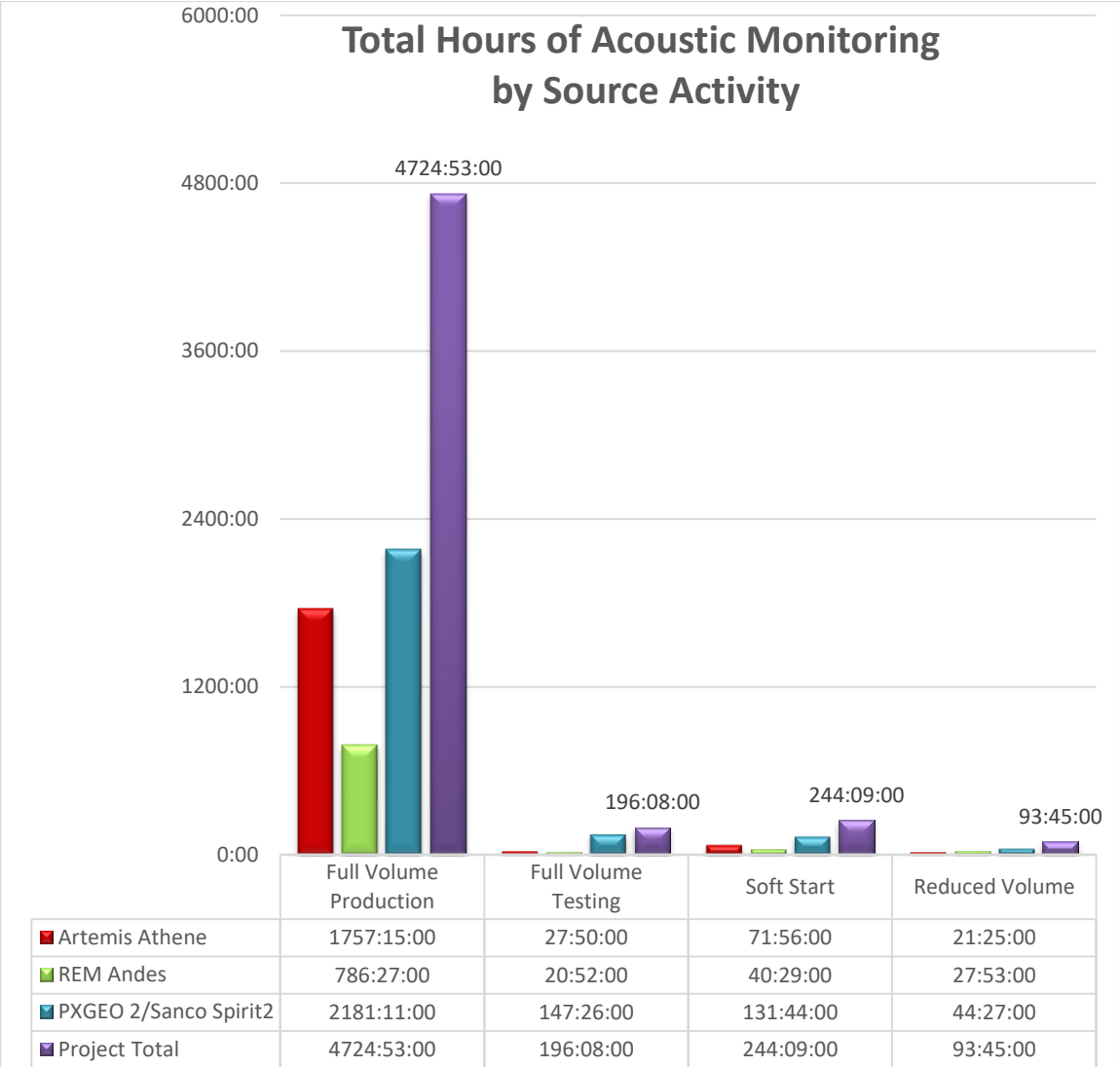


Figure 66. Acoustic monitoring effort by source activity.



	Full Volume Production	Full Volume Testing	Soft Start	Reduced Volume
Artemis Athene	1757:15:00	27:50:00	71:56:00	21:25:00
REM Andes	786:27:00	20:52:00	40:29:00	27:53:00
PXGEO 2/Sanco Spirit2	2181:11:00	147:26:00	131:44:00	44:27:00
Project Total	4724:53:00	196:08:00	244:09:00	93:45:00

Figure 68. R/V PXGEO 2 distribution of acoustic monitoring hours by source activity.

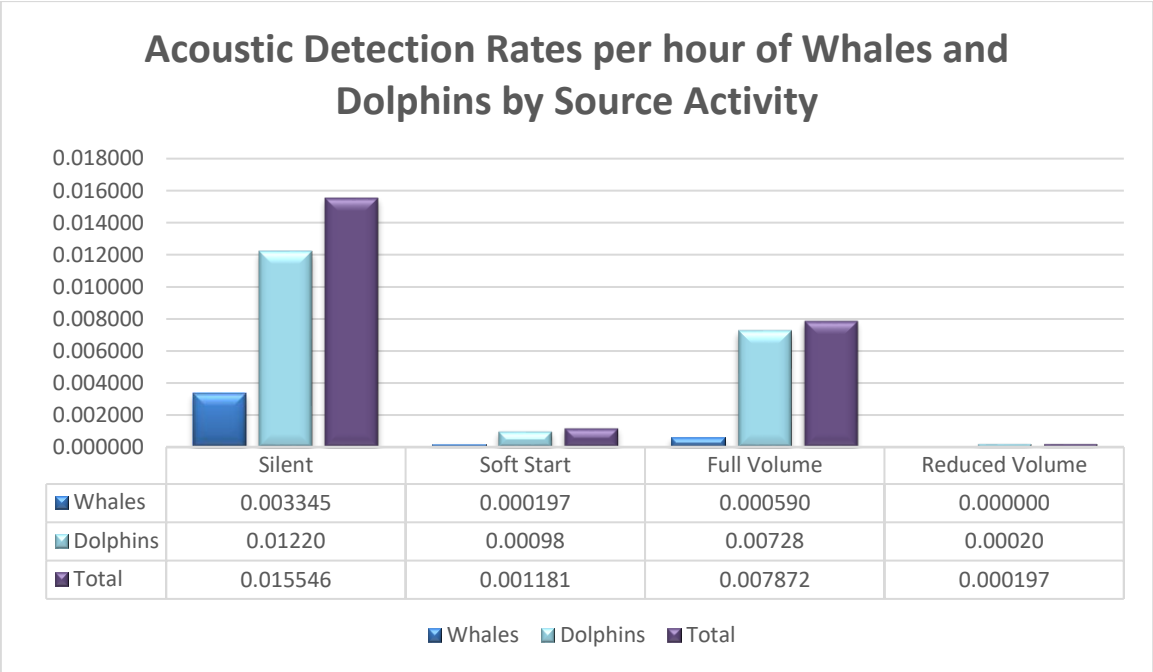


Figure 69. Acoustic Detection Rates per hour of Whales and Dolphins by Source Activity

7.3. Protected Species Distribution & Occurrence

Table 16: Acoustic detections by source activity.

R/V PXGEO & 2 R/V Sanco Spirit		
Source activity at detection	Number of whale detections	Number of dolphin detections
Silent	4	38
Soft start	0	4
Full volume	0	22
Reduced Volume Testing	0	1
Total	4	65
Artemis Athene		
Source activity at detection	Number of whale detections	Number of dolphin detections
Silent	3	13
Soft start	0	0
Full volume	2	8
Total	5	21
REM Andes		
Source activity at detection	Number of whale detections	Number of dolphin detections
Silent	10	11
Soft start	1	1
Full volume	1	7
Total	12	19
Project Totals		
Silent	17	62
Soft start	1	5
Full volume	3	37
Reduced Volume Testing	0	1
Total	21	114

Table 17: Summary of acoustic detections by vessel

M/V PXGEO 2 & R/V Sanco Spirit		
Species	Number of detections	Total number of individuals
Unidentified dolphin (*Delphinidae* sp.)	64	121
Bottlenose dolphin (*Tursiops truncatus)*	1	5
Sperm whale (*Physeter macrocephalus*)	4	8
Total PXGEO 2 / Sanco Spirit	69	134
Artemis Athene		
Species	Number of detections	Total number of individuals
Unidentified dolphin (*Delphinidae* sp.)	20	48
False killer whale (*Pseudorca crassidens*)	1	6
Pantropical spotted dolphin (*Stenella attenuata)*	2	5
Sperm whale (*Physeter macrocephalus*)	3	4
Total	26	63
	REM ANDES	
Species	Number of detections	Total number of individuals
Unidentified dolphin (*Delphinidae* sp.)	17	28
Pantropical spotted dolphin (*Stenella attenuata)*	3	3
Sperm whale (*Physeter macrocephalus*)	12	24
Total	32	55
Project Total	126	254

7.4. Acoustic Detections of Protected Species Distribution

Distribution of acoustic detections during all source activity within Engagement 6 prospect area.

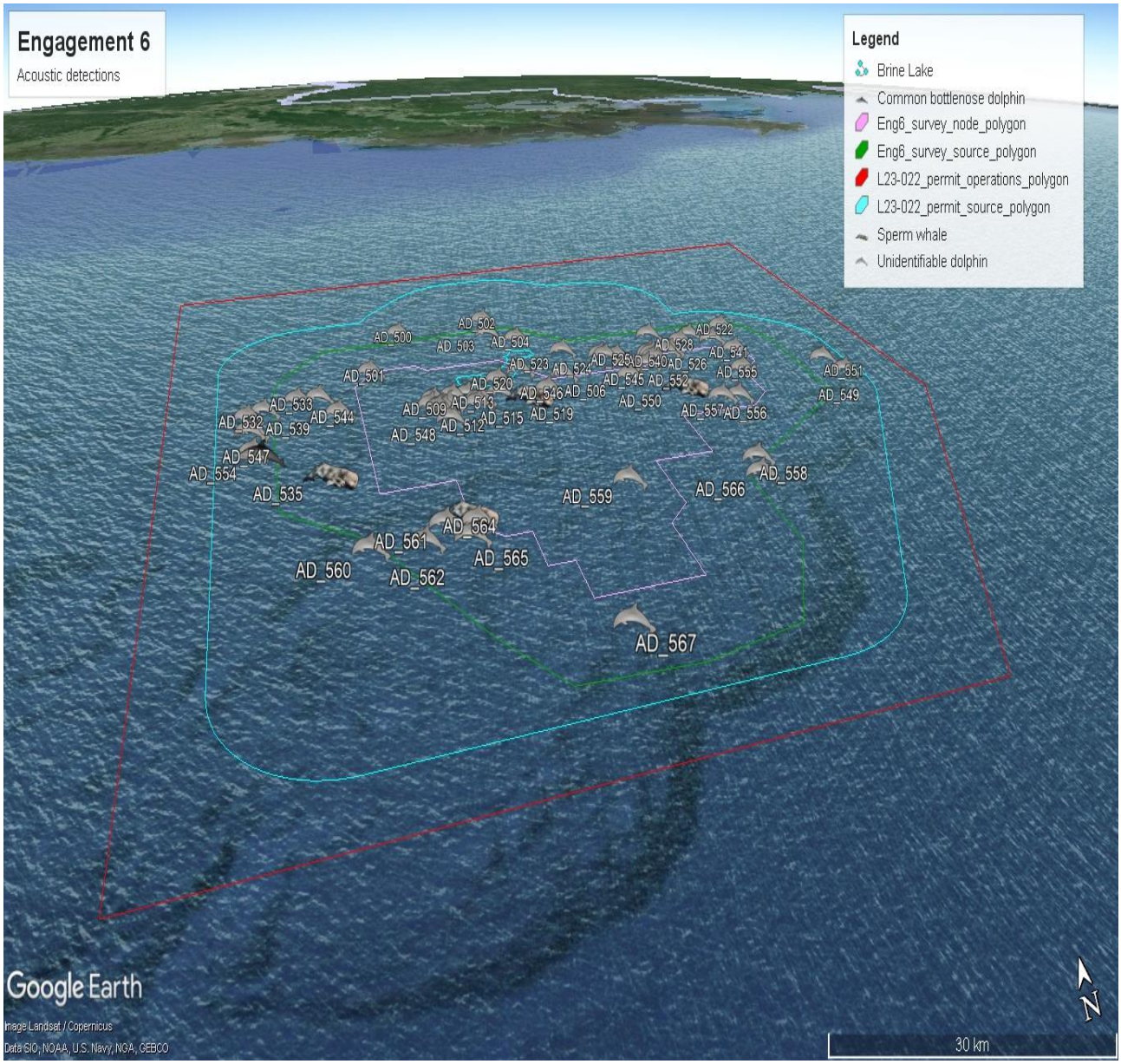


Figure 70. PXGeo2/ Sanco Spirit Distribution of acoustic detections on Google Earth Pro.

Figure 71. REM Andes Distribution of acoustic detections on Google Earth Pro.

Figure 72. Artemis Athene Distribution of acoustic detections on Google Earth Pro.

7.5. Protected Species Occurrence

Acoustic monitoring for marine mammals was conducted aurally and visually, utilizing PAMGuard software installed on the PAM system. Low 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. Odontocete clicks could also be visualized in low frequency (LF) and high frequency (HF) click detector modules. Settings adjustments to amplitude range, amplitude triggers, and spectral content filters, among others, could be made in PAMGuard's spectrogram. Click detector modules were utilized 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 were 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.

7.5.1. Sperm Whale

Sperm whale clicks can be detected acoustically from a large distance due to high source levels and a centroid frequency between 5 and 15 kHz. As such, the occurrence of these clicks can be used to identify individuals and estimate sperm whale abundance via distance sampling. The sperm whale (*Physeter macrocephalus*), the largest toothed whale, dedicates more than a third of its mass to sound production and has the most intense echolocation system ranging into mid-frequencies (100 Hz to 32 kHz, transmitting at a maximum source level of 232 dB re 1 µPa that allows its signals to project up to 10 km).

There were four acoustic sperm whale detections: two detections occurred on March 3 and 12, one on April 20, and one on June 12, 2024. These four detections were correlated both visually and acoustically.

All correlated detections had a similar distance range as acoustic detection (AD) #51 and correlated visual sighting (VS)#38, described in the following acoustic detection narrative: At 21:07 UTC, sperm whale clicks were observed on the mid frequency spectrogram. Broad range click trains were observed on the LF click detector at a bearing of 45/315 degrees relative to the hydrophone array. These clicks were manually tracked and localized approximately 600 meters from the sound source. Multiple click trains were observed from the original bearing of 45/315 degrees down to 60/300 degrees. At 21:12 UTC, simultaneous click trains were then observed on the LF click detector at approximate bearings of 60/300 and 20/340 degrees, indicating two animals present. Dominant frequencies of the clicks were between 4-12 kHz and amplitude range of 75-80 dB re 1 micro Pascal. The click trains became shorter and shorter until the last set of clicks was observed at 21:25 UTC with a final relative bearing of 140/220. The observers had visually detected the sperm whale at 21:04 UTC and determined the animal was within the exclusion zone and called for a shutdown at 21:06 UTC, and this was the last visual detection of the animals. The guns were silenced at 21:06 UTC, therefore there was no source active at the time of acoustic detection and mitigation actions had already been initiated.

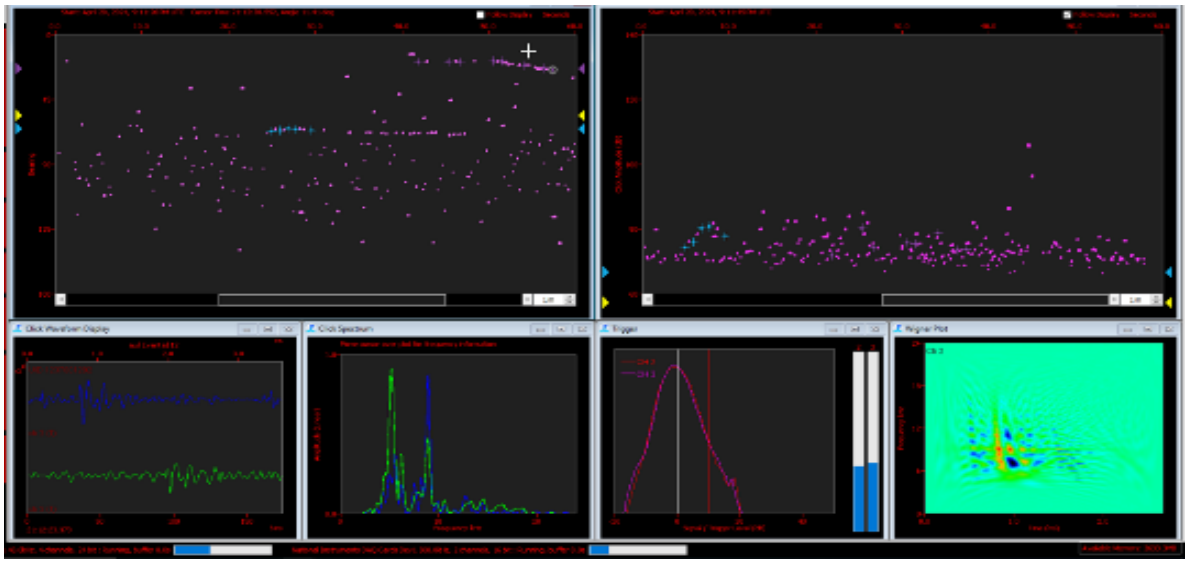


Figure 73: Acoustic detection #51 (550). Sperm whale clicks on PAMGuard's HF Click Detector.

7.5.2. Bottlenose dolphin

One correlated visual and acoustic detection of bottlenose dolphin, VS#42 / AD#55 (554), ocurred on May 09, 2024, at 18:40 UTC. Delphinid vocalizations were detected while the vessel was conducting a line change with its acoustic source silent. Initial detection took place via Pamguard's high frequency Click Detector module from a bearing of 120/240 degrees relative to the array, indicating the vocalizing dolphins were aft of the hydrophone array. At 18:46 UTC, peak intensity for the detection event was measured at 123.57 dB re 1 µPa, suggesting a probable time of closest approach. Multiple concurrent click bearings indicated the presence of at least five vocalizing individuals. Attempts at localization led the operator to conclude that animals were likely present within the 500m exclusion zone, and a delay in source activation was implemented accordingly. Clicks were also visible on the upper margins of the mid/frequency Spectrogram module since 18:42 UTC. Whistles were audible to the operator between 18:42 UTC and 18:55 UTC, registering sinusoidal signatures, up/sweeping within a frequency range of 8.3 and 19.7 kilohertz. Dolphins disappeared at 18:55 UTC and reappeared for a final no audible whistle in mid/frequency Spectogram at 19:09 UTC. At this time dolphins were visible for the PSOs on watch on the vessel's bow, resulting in a correlated detection with VD#42, where the dolphins were identified as bottlenose dolphin. At the beginning of the detection the vessel slowed down the speed. The initial planned soft start was at 19:29 UTC, and after the applicable 30 minutes mitigation downtime, clearance was given at 19:39 UTC, and soft start started at 19:41 UTC, resulting in a 10-minute delay of clearance for soft start of the acoustic source.

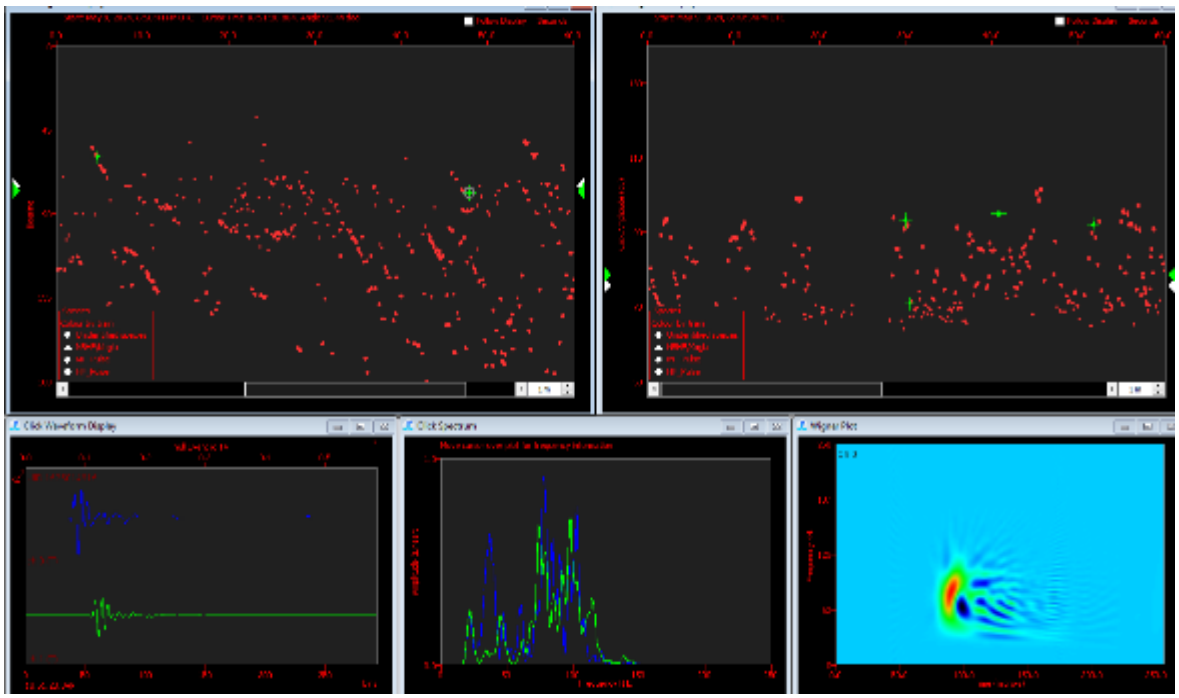


Figure 74: AD#55 _Bottlenose dolphin. Click trains on PAMGuard's HF Click Detector.

7.5.3. **Unidentified dolphin**

Several acoustic detections consisted of unidentifiable delphinids with variety in frequencies and distances, including one detection inside the exclusion zone, AD 62 (561) as follows: On June 11, 2024, at 05:44 UTC, where several organized click trains of unidentified delphinids were observed on the HF click detector module at an initial bearing of 100/260 degrees (left/right ambiguity) from the source array. Immediately following, convex, up, and down-sweeps ranging from 10 -23 kHz were observed on the LF spectrogram. Multiple overlapping whistle signatures indicated the presence of at least three vocalizing individuals. Click trains averaged 2-10 seconds and analyzed clicks ranged in amplitude from 870-110 dB, with peak frequencies between 40-80 kHz. At 05:51 UTC, peak intensity for the detection event was measured with frequencies over 100kHz and click amplitudes at 110 dB re 1 µPa. The click train was localized within the exclusion zone, at approximately 150 m from the source array. Low frequency whistles became intermittent, weak in intensity, and were last observed at 05:53 UTC. The pod remained in the area until 05:55 UTC with the last click train observed at a bearing of 160/200 degrees. The vessel was on a line and at full source volume throughout the detection. No mitigation actions were necessary.

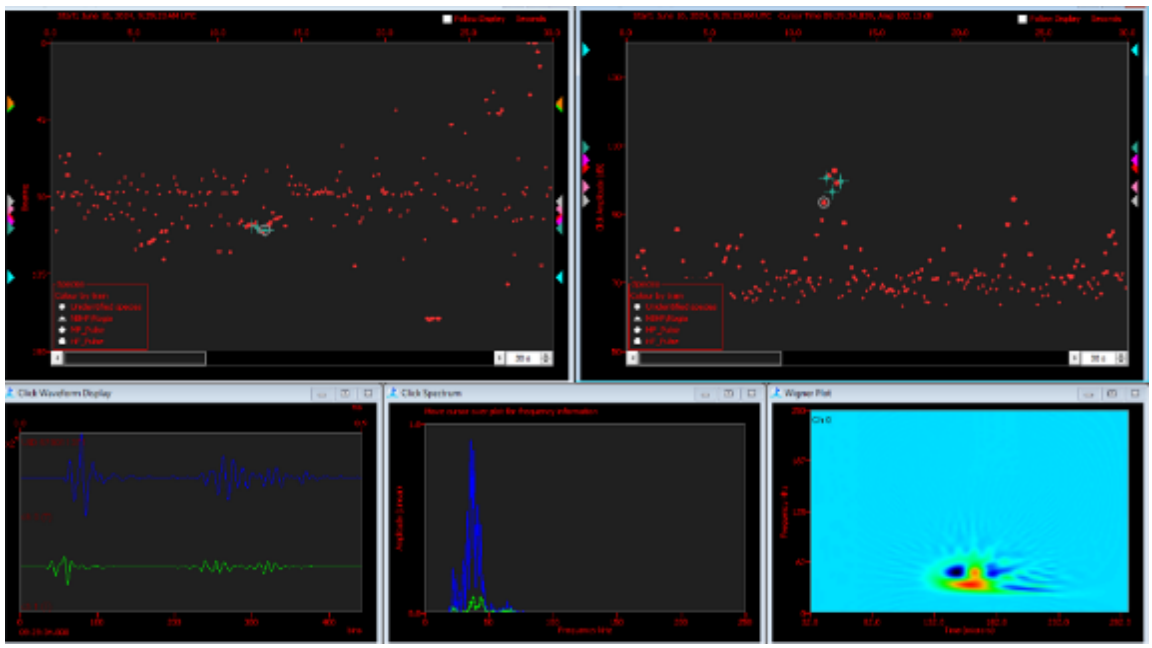


Figure 75: AD #62_Unidentifiable dolphin. Click trains on PAMGuard's HF Click Detector.

8.0 Mitigation Actions Applied

8.1. Protected Species Mitigation Actions

The mitigation procedures in place for this survey were as follows:

- **Delay** – Applicable during the pre-clearance search periods conducted prior to initiating the sound source from silence, where detections of a protected species inside it's applicable BZ result in a delay to activating the source.

- **Shut Down** – The source array must be shut down if a protected species is observed entering its exclusion zone when the array is active. An exclusion zone of 1500 meters applies to sperm whale, Rice's whale, beaked whale, and Kogia species. All other marine mammals have a 500-meter exclusion zone and sea turtles have an exclusion zone of 100 meters. During a soft start, the source array must be shut down if any protected species enters its respective exclusion zone. Shutdown is not required for the following dolphin genera: *Steno, Tursiops, Stenella* and *Lagenodelphis,* during full volume firing. Additionally, sea turtles are exempt from shutdown requirements during full volume firing. There are no shutdown species exemptions during soft start operations.

- **Turtle pause** – A voluntary 7-shot turtle pause is implemented for any turtles within 100 meters of the source array such that the turtle is allowed to float past the array while the source is inactive, and it is a distance greater than 100 meters from the array upon resumption of source activity.

Sanco Spirit implemented a total of 17 mitigation actions and one voluntary turtle pause due to protected species being observed within their respective exclusion and buffer zones. These actions included 13 delays to the initiation of the sound source, during the pre-search period, prior to soft start, and four shutdowns (two of which occurred during soft start), and one turtle pause for a leatherback sea turtle. There were two correlated detections that required mitigation actions.

Artemis Athene implemented a total of 12 mitigation actions and 10 voluntary turtle pauses due to protected species being observed within their respective exclusion and buffer zones. These actions included 10 delays to the initiation of the sound source, during the pre-search period prior to soft start, and two shutdowns for sperm whales (both of which occurred while the source was at full power).

REM Andes implemented a total of 6 mitigation actions and one voluntary turtle pause due to protected species being observed within their respective exclusion and buffer zones. These actions included 13 delays to the initiation of the sound source, during the pre-search period, prior to soft start, and four shutdowns (two of which occurred during soft start), and one turtle pause for a leatherback sea turtle. There were two correlated detections that required mitigation actions. Refer to Tables 18 and 19 for details.

Table 18. Visual Observer Mitigations

VISUAL DELAYS TO SOFT START				
	Number		Duration	
		Project Total		Project Total
Sanco Spirit Initiated from Visual Observation		5		01:31
Artemis Athene Initiated from Visual Observation		2		00:29
REM Andes Initiated from Visual Observation		1		00:55
Total Number of Delays to Soft Start		8		02:55
VISUAL SHUT-DOWN PROCEDURES				
	Number		**Duration**	
		Project Total		Project Total
Sanco Spirit Initiated from Visual Observation		3		01:57
Artemis Athene Initiated from Visual Observation		2		03:55
REM Andes Initiated from Visual Observation		4		01:36
Total Number of Shut-Downs		9		07:28

Table 19: PAM Mitigations

PAM DELAYS TO SOFT START				
	Number		Duration	
		Project Total		Project Total
Sanco Spirit Initiated from PAM Observation		8		06:05
Artemis Athene Initiated from PAM Observation		8		05:22
REM Andes Initiated from PAM Observation		7		06:34
Total Number of Delays to Soft Start		23		18:01
PAM SHUT-DOWN PROCEDURES				
	Number		**Duration**	
		Project Total		Project Total
Sanco Spirit Initiated from PAM Observation		1		00:34
Artemis Athene Initiated from PAM Observation		0		00:00
REM Andes Initiated from PAM Observation		3		02:06
Total Number of Shut-Downs		4		02:40

**Duration of soft start delay is difference between time vessel could have begun soft start had area been clear, and time Visual observer or PAM operator cleared vessel to begin soft start*

**Duration of shutdown is entire time period animal was observed inside mitigation zone plus required waiting period following last detection inside zone.*

Table 20. PXGEO visual and acoustic detections with mitigation actions applied

PXGEO 2							
Detection Number	**Common Name**	**Species**	**Time (UTC)**	**Source Activity at Initial Detection**	**Closest Approach to Source (m)**	**Mitigation Action**	**Duration of Mitigation Action (HH:MM)**
There were no mitigation actions on the PXGEO 2 for this project.							

Table 21. Sanco Spirit visual and acoustic detections with mitigation actions applied

Sanco Spirit							
Detection Number	**Common Name**	**Species**	**Time (UTC)**	**Source Activity at Initial Detection**	**Closest Approach to Source (m)**	**Mitigation Action**	**Duration of Mitigation Action (HH:MM)**
VISUAL							
VS_20	Unidentified dolphin	Delphinidae	12:53	Silent	200	Delay	**00:15**
VS_26	Unidentified dolphin	Delphinidae	17:29	Soft start	400	Shutdown	**00:34**
VS_37	Green sea turtle	Chelonia *mydas*	17:23	Silent	100	Delay	**00:30**
VS_38 / AD_550	Sperm whale	Physeter *macrocephalus*	21:04	Full volume	1000	Shutdown	**00:49**
VS_43	Short-finned pilot whale	Globicephala *macroryhncus*	22:44	Full volume	150	Shutdown	**00:34**
VS_46	Leatherback sea turtle	Globicephala *macroryhncus*	19:37	Full Volume	100	Pause	**00:01**
VS_50	Hawksbill sea turtle	Eretmochelys *imbricata*	15:27	Silent	60	Delay	**00:20**
VS_51	Short-finned pilot whale	Globicephala *macroryhncus*	00:34	Silent	350	Delay	**00:05**
VS_65	Unidentified dolphin	Delphinidae	16:21	Silent	60	Delay	**00:21**
ACOUSTIC							
AD_508	Unidentified dolphin	Delphinidae	05:41	Silent	Within 500m	Delay	**00:14**
AD_513	Unidentified dolphin	Delphinidae	08:37	Silent	Within 500m	Delay	**00:31**
AD_517	Unidentified dolphin	Delphinidae	09:44	Silent	Within 500m	Delay	**00:50**
AD_518	Unidentified dolphin	Delphinidae	05:40	Silent	Within 500m	Delay	**02:54**
AD_521	Unidentified dolphin	Delphinidae	17:29	Soft start	Within 500m	Shutdown	**00:34**
AD_522	Unidentified dolphin	Delphinidae	02:13	Silent	Within 500m	Delay	**00:22**
AD_542	Unidentified dolphin	Delphinidae	01:00	Silent	Within 1000m	Delay	**00:27**
AD_554 / VD_42	Bottlenose dolphin	Tursiops *truncatus*	18:40	Silent	Within 200m	Delay	**00:12**
AD560	Unidentified dolphin	Delphinidae	09:36	Silent	142	Delay	**00:35**

Table 22. R/V Artemis Athene visual and acoustic detections with mitigation actions applied

R/V Artemis Athene							
Detection Number	**Common Name**	**Species**	**Time (UTC)**	**Source Activity at Initial Detection**	**Closest Approach to Source (m)**	**Mitigation Action**	**Duration of Mitigation Action (HH:MM)**
Visual							
VD# 24	Pantropical spotted dolphin	Stenella *attenuata*	18:03	Silent	5	Delay	00:05
VD# 35	Unidentified sea turtle	Cheloniidae	14:11	Full power	50	Pause	00:01
VD# 37	Leatherback sea turtle	Dermochelys *coriacea*	16:17	Full power	100	Pause	00:01
VD# 40	Sperm Whale	Physeter *macrocephalus*	22:34	Full Power	650	Shutdown	01:48
VD# 41	Unidentified sea turtle	Cheloniidae	16:42	Silent	100	Delay	00:24
VD# 42	Unidentified sea turtle	Cheloniidae	20:13	Full Power	100	Pause	00:01
VD# 43	Unidentified sea turtle	Cheloniidae	17:52	Full Power	100	Pause	00:01
VD# 45	Unidentified sea turtle	Cheloniidae	20:56	Full Power	100	Pause	00:02
VD# 49	Sperm Whale	Physeter *macrocephalus*	21:12	Full Power	1300	Shutdown	02:07
VD# 54	Unidentified sea turtle	Cheloniidae	15:14	Full Power	40	Pause	00:02
VD# 55	Unidentified sea turtle	Cheloniidae	14:43	Full Power	510	Pause	00:02
VD# 56	Unidentified sea turtle	Cheloniidae	17:13	Full Power	520	Pause	00:02
VD# 58	Unidentified sea turtle	Cheloniidae	17:45	Reduced Power	100	Pause	00:02
VD# 59	Unidentified sea turtle	Cheloniidae	17:15	Full Power	100	Pause	00:02
ACOUSTIC							
AD# 1	Unidentified dolphin	Unidentified Odontoceti	03:57	Silent	500	Delay	00:00
AD# 2	Unidentified dolphin	Unidentified Odontoceti	13:54	Silent	350	Delay	00:17
AD# 4	Unidentified dolphin	Unidentified Odontoceti	18:16	Silent	500	Delay	00:16
AD# 10	Unidentified dolphin	Unidentified Odontoceti	06:12	Silent	500	Delay	00:44
AD# 16	Unidentified dolphin	Unidentified Odontoceti	1:03	Silent	500	Delay	00:39
AD#17	Sperm Whale	Physeter *macrocephalus*	15:08	Silent	120	Delay	00:28
AD# 18	Sperm whale	Physeter *macrocephalus*	19:55	Silent	490	Delay	01:38
AD# 24	*False killer whale*	Pseudorca *crassidens*	14:40	Silent	73	Delay	01:20

Table 23. *REM Andes* visual and acoustic detections with mitigation actions applied

REM Andes							
Detection Number	**Common Name**	**Species**	**Time (UTC)**	**Source Activity at Initial Detection**	**Closest Approach to Source (m)**	**Mitigation Action**	**Duration of Mitigation Action (HH:MM)**
Visual							
VD# 8	Sperm Whale	Physeter *macrocephalus*	12:06	Full power	1200	Shutdown	00:00
VD# 10	Short-finned pilot whale	Globicephala *macroryhncus*	12:19	Soft Start	450	Shutdown	00:32
VD# 12	Pantropical spotted dolphin	Stenella *attenuata*	19:47	Full Power	300	Shutdown	00:33
VD# 13	Green sea turtle	Chelonia *mydas*	14:17	Full Power	80	Pause	00:02
VD# 15	Pantropical spotted dolphin	Stenella *attenuata*	13:32	Silent	400	Delay	00:55
VD# 22	Unidentified sea turtle	Cheloniidae	19:43	Soft Start	80	Shutdown	00:31
VD# 31	Loggerhead sea turtle	Cheloniidae	22:22	Full Power	290	Pause	00:01
ACOUSTIC							
AD# 503	Unidentified dolphin	Unidentified Odontoceti	04:46	Silent	500	Delay	02:12
AD# 506	Sperm Whale	Physeter *macrocephalus*	12:18	Silent	350	Delay	00:00 *see VD# 8
AD# 509	Sperm Whale	Physeter *macrocephalus*	19:44	Full Power	500	Shutdown	00:30
AD# 512	Unidentified dolphin	Unidentified Odontoceti	07:39	Silent	500	Delay	00:30
AD# 517	Sperm Whale	Physeter *macrocephalus*	11:48	Silent	500	Delay	00:58
AD# 518	Pantropical spotted dolphin	Stenella *attenuata*	13:32	Silent	120	Delay	00:55
AD# 520	Sperm whale	Physeter *macrocephalus*	13:58	Silent	490	Delay	00:55
AD# 521	Sperm whale	Physeter *macrocephalus*	16:32	Soft Start	73	Shutdown	01:03
AD# 522	Sperm whale	Physeter *macrocephalus*	18:24	Silent	73	Delay	01:04
AD# 525	Unidentified dolphin	Unidentified Odontoceti	01:50	Soft Start	73	Shutdown	00:33

9.0 Other Wildlife

9.1. Other Wildlife Occurrence

Throughout the observation period, a wide range of wildlife was recorded. Incidental observations highlighted various species including; brown booby (*Sula leucogaster*), masked booby (*S. dactylatra*), brown pelican (*Pelecanus occidentalis*), laughing gull (*Leucophaeus atricilla*), royal tern (*Thalasseus maximus*), cattle egrets (*Bubulcus ibis*) and magnificent frigatebirds (*Fregata magnificens*) and several unidentified species. Additionally, several fish species were also sighted such as oceanic manta rays (*Mobula birostris*), flying fish (Family Exocoetidae), mahi-mahi (*Coryphaena hippurus*), alongside unidentified fish species.

Other Wildlife Observed	
Species	Species
American oystercatcher (*Haematopus palliates*)	Masked booby (*Sula dactylatra*)
American pelican (Pel*ecanus erythrorhynchos*)	Northern gannet (*Morus bassanus)*
Baltimore oriole (*Icterus galbula*)	Oceanic manta rays (*Mobula birostris*),
Bank swallow (Riparia riparia)	Osprey (*Pandion haliaetus*)
Barn swallow (*Hirundo rustica*)	Peregrine falcon (*Falco peregrinus*)
Black-crowned night heron (*Nycticorax nycticorax*)	Pomarine jaeger (*Stercorarius pomarinus*)
Brown headed cowbird (*Molothrus ater*),	Purple gallinule (Porphyrio martinica)
Brown booby (*Sula leucogaster)*	Red-footed booby (*Sula sula)*
Brown pelican (*Pelecanus occidentalis*)	Roseate spoonbill (Platalea ajaja)
Cattle egret (*Bubulcus ibis*)	Royal tern (*Thalasseus maximus)*
Cliff swallow (Petrochelidon pyrrhonota)	Sanderling (*Calidris alba*)
Common loon (Gavia immer)	Sanwich tern (Thalasseus sandvicensis)
Common nighthawk (*Choreiled minor*)	White pelican (Pelecanus erythrorhynchos)
Double-crested cormorant (*Phalacrocorax auritus*)	White-winged dove (Zenaida asiatica)
Eurasian collared-dove (*Steptopelia decaocto*)	Yellow-billed cuckoo (*Coccyzus americanus)*
Great blue heron (*Ardea herodias)*	Yellow-crowned night-heron (*Nyctanassa violacea*)
Great egrets (*Ardea alba*)	Yellow-throated warbler (*Dendrocia dominica)*
Green heron (Butorides virescens)	Blackfin tuna (*Thunnus atlanticus*)
Herring gull (*Larus argentatus*)	*Escombridae sp*
Laughing gulls (*Leucophaeus atricilla)*	*Flying fish sp*
Least tern (*Sterna antillarum*)	Mahi mahi (*Coryphaena hippurus)*
Little blue heron (*Egretta caerulea*)	Portuguese man o' war (*Physalia physalis*)
Magnificent frigate bird (*Fregata magnificens*)	Ommastrephidae squid
Magnolia warbler (*Setophaga magnolia)*	

9.1.1. **Birds**

Figure 76. Brown booby (Sula leucogaster).

Figure 77. Brown pelican (Pelecanus occidentalis).

Figure 78. Yellow-rumped warbler (Setophaga coronata).

Figure 79. Great Blue heron (Ardea herodias).

Figure 80. Little Blue herons (Egretta caerulea).

Figure 81. Herring gull (Larus argentatus).

Figure 82. Common loon (Gavia immer).

Figure 83. Laughing gull (Leucophaeus atricilla).

Figure 84. Sandwich tern (Thalasseus sandvicensis).

Figure 85. Yellow-throated warbler (Setophaga dominica).

Figure 86. Magnificent frigatebird (Fregata magnificens).

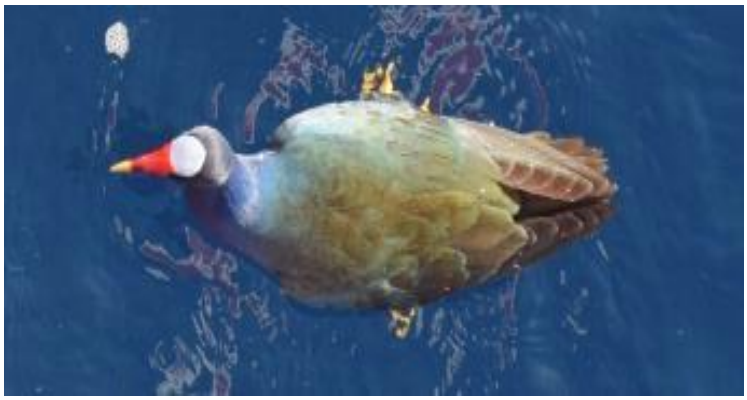


Figure 87. Purple gallinule (Porphyrio martinica).

Figure 88. Cattle egret (Ardea ibis)

Figure 89. Black-crowned Night heron (Nycticorax nycticorax).

Figure 90. Baltimore Oriole (Icterus galbula).

Figure 91. Masked booby (Sula dactylatra).

Figure 92. Peregrine falcon (Falco peregrinus).

Figure 93. Sanderling (Calidris alba).

Figure 94. Royal tern (Thalasseus maximus).

9.1.2. **Fish**

Figure 95. Blackfin tuna (Thunnus atlanticus).

Figure 96. Giant oceanic manta ray (Mobula birostris).

9.1.3. **Invertebrates**

Figure 97. Ommastrephidae squid.

Figure 98. Portuguese man o' war (Physalia physalis).

10.0 Weather Conditions

10.1. Weather Conditions

Environmental conditions can impact the probability of detecting protected species in a survey area. The weather conditions varied throughout the project duration, but all remained within the typical range for the Gulf of Mexico considering the time of year. The project lasted a total of 245 days, with environmental conditions during visual observations ranging from favorable to moderate.

Visibility was measured in kilometers and categorized as poor (< 1 km), moderate (1 – 5 km) good (>5km). The sea state was described as glassy (mirror-like), slight (no or few white caps), choppy (many white caps), rough (big waves, foam, spray). Sea state was measured by the Beaufort sea state scale on the REM Andes. Swell height was categorized as low (<2 m), medium (2 - 4m), large (>4 m). Glare by classified as none, slight, moderate or severe. The majority of monitoring efforts was conducted in conditions where visibility extended greater than 5 kilometers. The duration of monitoring conducted in each category classification is provided below.

10.1.1. Visibility

The visibility ranged from poor to moderate and good during the duration of this project. Figure 27.

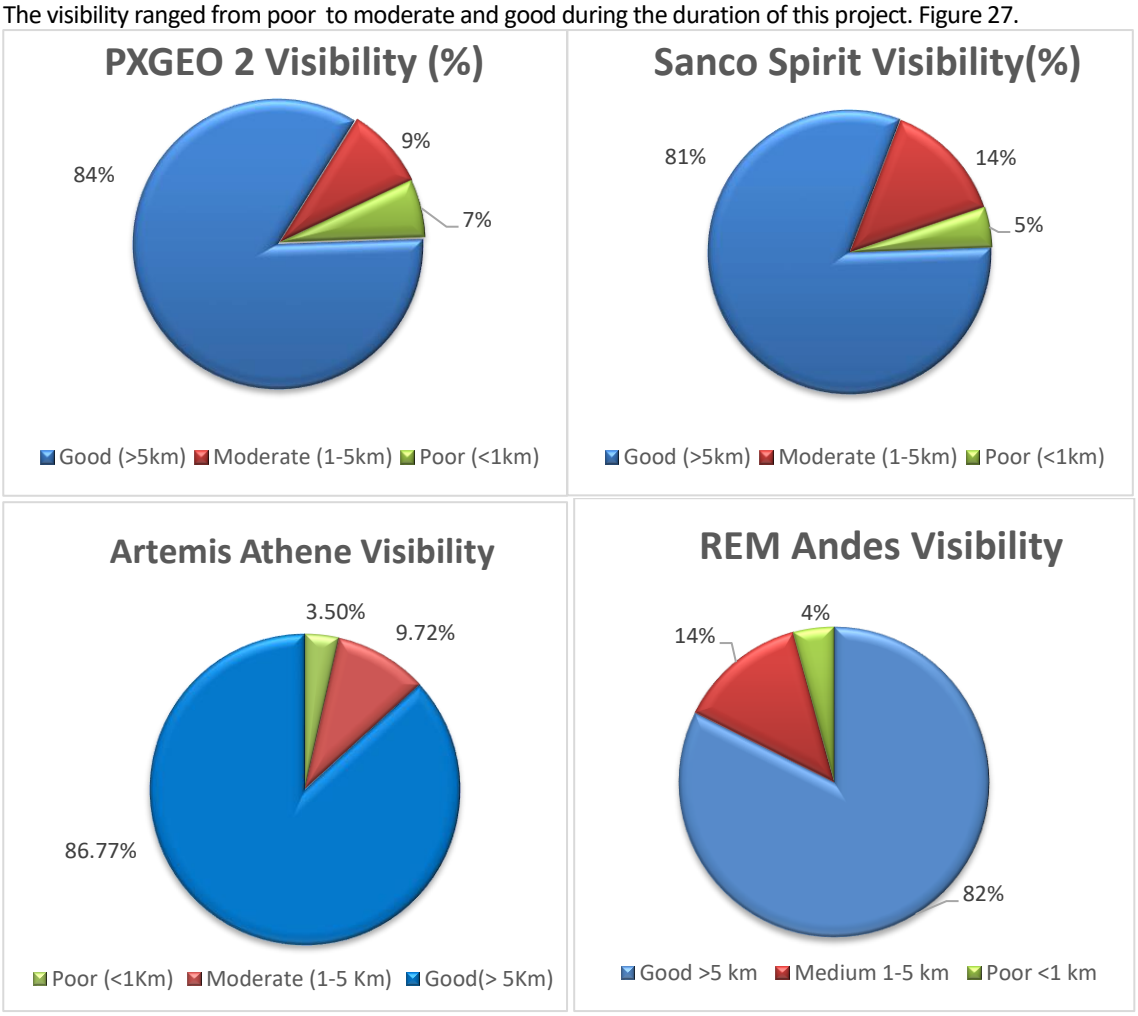


Figure 99. visibility chart, across all vessels during Engagement 6 survey.

10.1.2. **Sea state**

Sea state varies from glassy, slight, choppy and rough during the project. Figure 28.

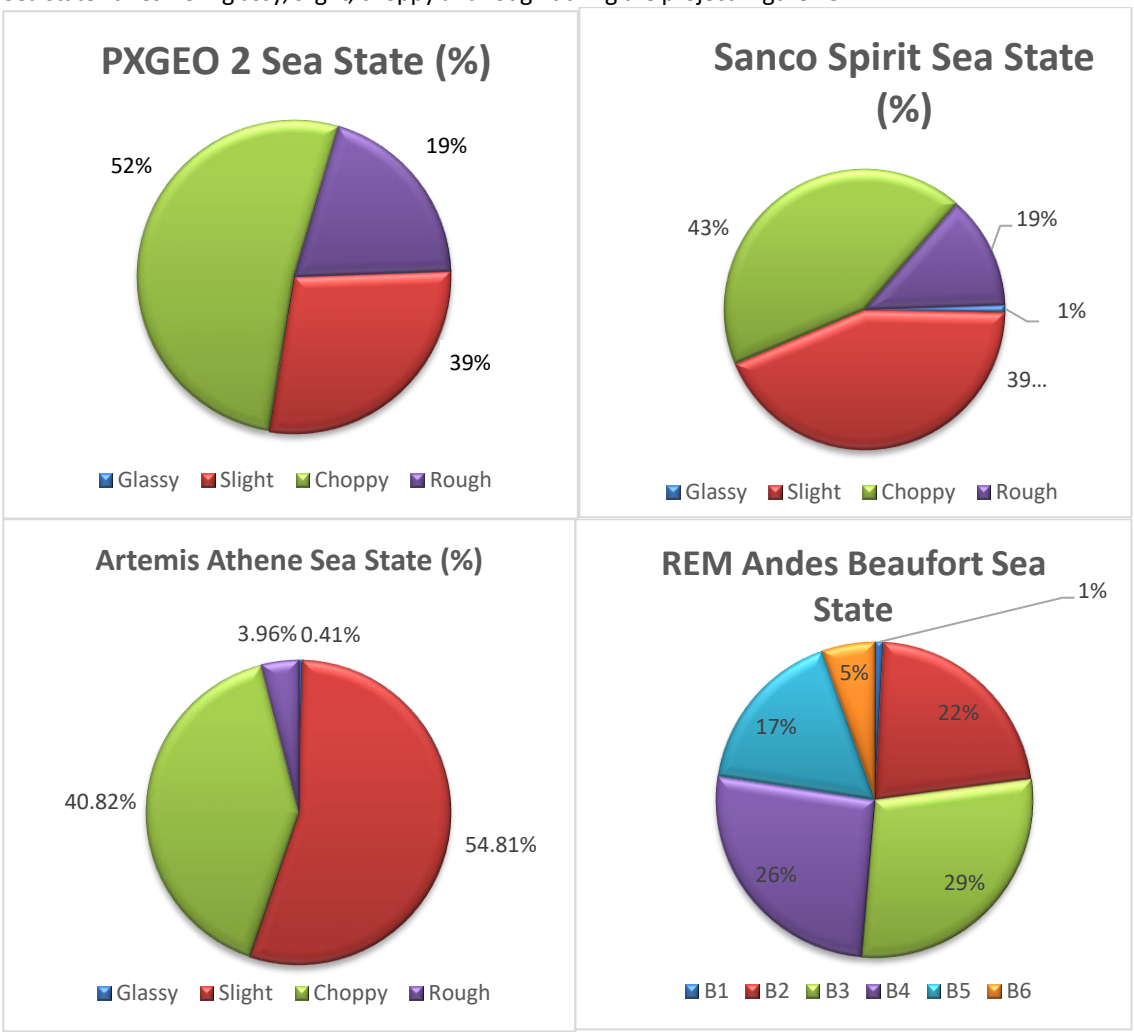


Figure 100. Sea state chart, across all vessels during Engagement 6 survey.

10.1.3. **Swell Height**

Swell height was categorized as low (<2 m), medium (2 - 4m), large (>4 m). Figure 29.

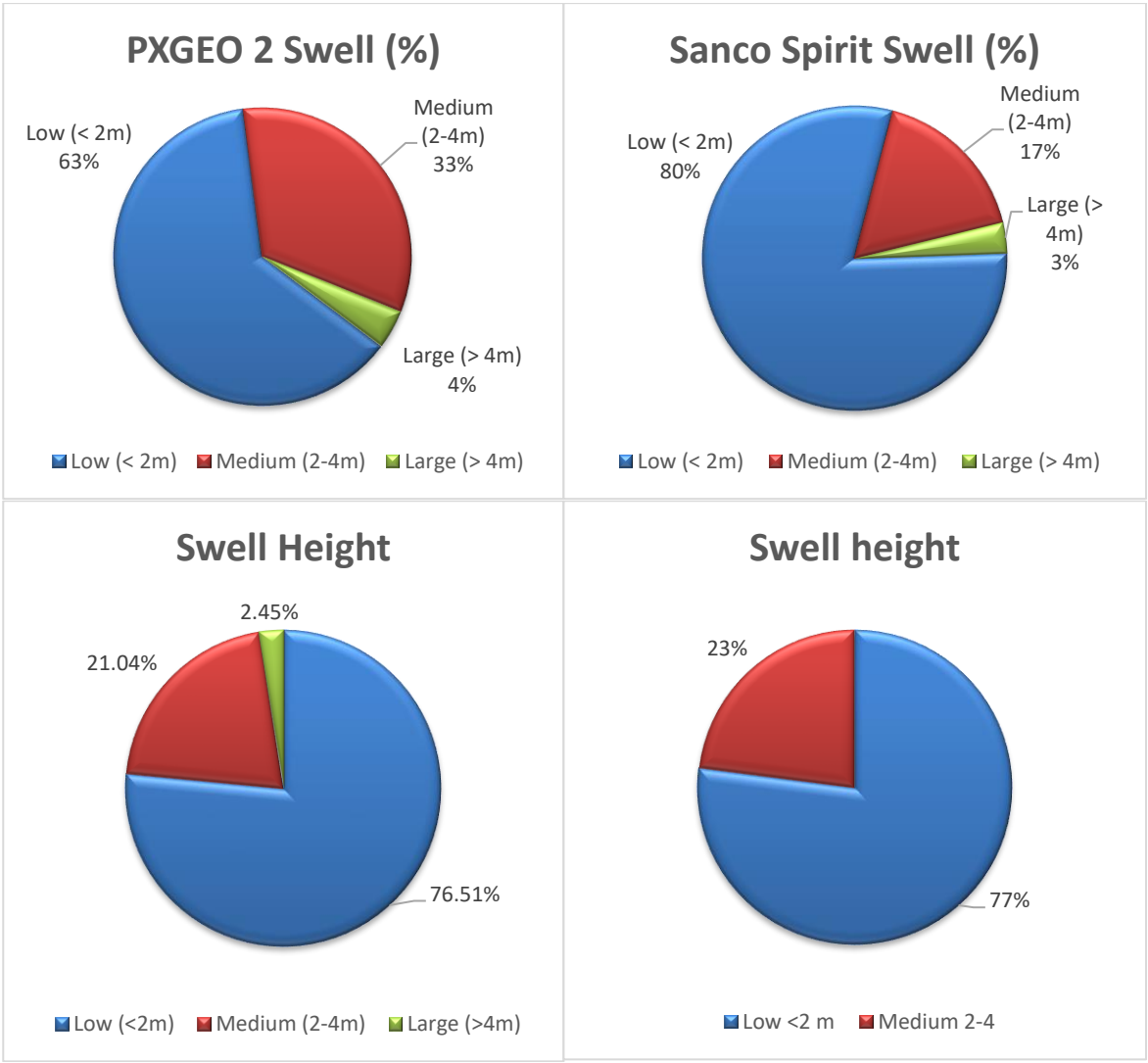


Figure 101: Swell height percentage, across all vessels during Engagement 6 survey. during Engagement 6 survey.

10.1.4. **Glare**

Glare by classified as none, slight, moderate or severe. Figure 30.

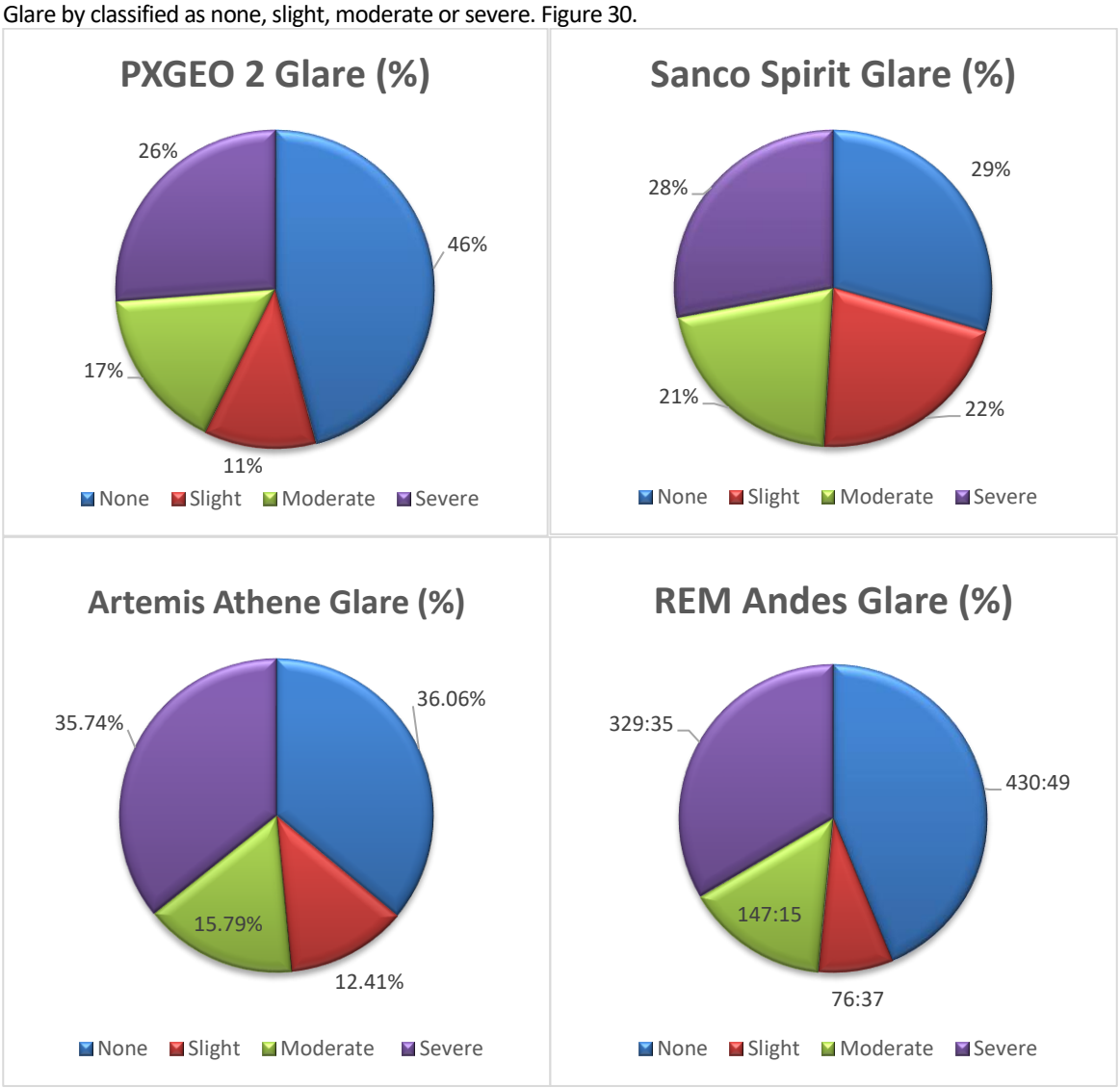


Figure 102. Glare percentage, across all vessels during Engagement 6 survey. during Engagement 6 survey.

The weather conditions varied for the duration of the project, but all remained within the typical range for the Gulf of Mexico when the time of year was considered. The project spanned seven months including winter, spring and summer seasons.

During the reporting period, average wind speeds were around 15 knots, primarily blowing from the southeast. Sea conditions were most often classified as 'slight,' with few white caps observed. Visibility was generally good, extending over 5 kilometers, indicating favorable weather for visual monitoring. In December, wind speed averaged 15 knots, ranging from 2 to 34 knots. Sea conditions were mostly slight, and visibility was generally good. In January, the average wind speed rose to 17 knots, with a range from 1 to 52 knots, while sea states remained slight and visibility good. February recorded an average wind speed of 15 knots, ranging from 1 to 44 knots, with similar slight sea conditions and good visibility. In March, wind speed averaged 16 knots, ranging from 3 to 41 knots, while April recorded an average of 16 knots and a range of 1 to 40 knots. Both months continued to feature mostly slight sea states and good visibility. By May, wind speed averaged 14 knots, ranging from 2 to 29 knots, with conditions remaining slight and visibility good. June saw a decrease in average wind speed to 12 knots, ranging from 1 to 31 knots, still maintaining slight seas and good visibility.

11.0 Conclusions & Recommendations

11.1. Compliance with Guidelines

All seismic operations, including pre-watches and soft starts, complied fully with current BOEM / NMFS BO and required guidelines, survey consent (permit) requirements, and project recommendations. The survey was considered successful at minimizing the risk of disturbance and injury to marine mammals from seismic survey activity.

There were no non-compliance events recorded.

- Marine mammal monitoring was undertaken by trained and experienced dedicated PSO's and PAM Operator who did not have any other duties.
- There were no instances of vessel strikes with marine fauna.
- There were no observations of protected species becoming entangled as a result of seismic operations.

11.2. Conclusions

The R/V PXGEO 2 departed from Freeport Bahamas on November 10, 2023, and commenced with the 3D OBN Seismic Survey Engagement 6 acquisition in Walker Ridge block, under the BOEM permit L23-022 on November 15, 2023, concluding operations on February 03, 2024. The R/V Sanco Spirit departed on February 13, 2024, replacing the R/V PXGEO 2, and began source testing in the prospect area on February 17, 2024. The R/V Artemis Athene completed source array configuration and deployment tests and commenced source operations in Walker Ridge lease area offshore January 7, 2024. The research vessel REM Andes departed Gulfport Mississippi May 6th 2024 and commenced with the Engagement 6, Multiclient (MC), 3D OBN seismic survey that was conducted by PXGEO on behalf of WesternGeco LLC on May 8th 2024. The survey took place in deep waters within the Walker Ridge block area US Gulf of Mexico. . The 3D OBN seismic survey was completed on July 18, 2024 and source operations on the Artemis Athene for this project concluded on June 16, 2024. The survey acquisition program was completed on July 18, 2024.

The Biological Opinion (BO) issued by the NMFS on March 13, 2020, survey permit issued by BOEM (L23-022), consent guidelines and project requirements were complied with. The seismic survey was successfully completed within the dates of its validity.

There were 168 visual sightings and 126 acoustic detections of protected species made during the Engagement 6 survey. A total of 44 mitigation actions, 13 turtle pauses, were necessary when marine mammals were observed/detected within the 500 m mitigation zone during pre-watch or while the vessel was running a survey line. There were 31 delays of initiation of the sound source during the pre-search prior to soft start. There were 13 shutdowns, four of them during soft start. There was one turtle pause implemented for a leatherback sea turtle. Three of the mitigation actions included a correlated sperm whale detection within the exclusion zone requiring a shutdown and delays of the initiation of the source applied for a pantropical spotted dolphin, bottlenose dolphin, and a false killer whale. The project total mitigation downtime was divided in delay to initiation of the sound source and shutdown after activation, resulting in a delay of 20:56 (HH:00) and 10:08 (HH:MM) respectively.

Weather conditions were generally favorable for observing marine fauna throughout the survey. However, there were regular periods of poor weather which hampered sighting effectiveness, such as rough weather conditions due to hurricane Beryl and smaller local storms.

There was full co-operation from the personnel of both vessels for the implementation of BOEM and NMFS BO guidelines, and all pre-watches and soft starts were correctly executed.

Shipping traffic was light and had no impact on survey operations.

There were no observations of injuries or mortalities to marine mammals, sea turtles, seabirds, or other protected species.

11.3. Recommendations

There are no major recommendations for the period this report covers. A diligent and positive interaction between the seismic crew and the environmental team was always kept.

11.4. Acknowledgements

There was full co-operation from the R/V PXGEO 2 and R/V Sanco Spirit seismic and maritime personnel for the implementation of all the regulatory requirements during the survey.

The communications between the seismic navigators and the PSO/PAM team were very good and professional. The hand-held radios supplied by the vessel for communication between the PSO's and the instrument room were excellent.

Special recognition of the seismic crew for their assistance with the installation, deployment and recovery of the PAM system.

11.5. References

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Appendices

The following list of appendices includes standard forms associated with the BOEM and NMFS BO. They are included on the final report media.

Appendix A	**Record of Operations**
Appendix B	**Location & Effort**
Appendix C	**Record of Sightings**