EPI Group
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2D Marine Seismic Survey

ACCOBAMS MMO and PAM Report

Marine Seismic Survey

EPI Report No. E0479

Client	Hellenic Petroleum Kyparissiakos Gulf Exploration and Production of Hydrocarbons Single Member S.A
Area	Kyparissiakos Gulf
Survey	Block 10
Regulatory Reference	56786/3725
Dates	20th January to 4th February 2022
Contractor	Shearwater Geoservices
Vessel	SW Cook
Marine Fauna Observers & Passive Acoustic Monitors	Patrick Lyne, Manuel Garcia Sandra Villar, Amber Beerman

EPI Group - The Energy People

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1.0 Executive Summary

This report covers the Marine Fauna Observer (MFO) and Passive Acoustic Monitoring (PAM) mitigation undertaken during the 2D Seismic Survey on the SW Cook from 20th January to 4th February 2022. The survey was performed in Exploration Block 10, offshore of West Greece in the Ionian Sea.

The seismic data acquisition commenced on 21stJanuary and was completed on 4th February 2022.

There were 16 soft-starts during daylight, 22 at night and four (4) during dusk or dawn. Seismic operations were conducted over 15 days, during which 30 primary acquisition lines were completed, 6 lines reshot, and 6 source tests were performed.

Weather conditions recorded during the survey consisted of chiefly northerly winds Beaufort 1 to 8, sea states Beaufort 2 to 4 predominating, and low swell heights.

The survey applied the ACCOBAMS Guidelines to address the impact of anthropogenic noise on cetaceans in the ACCOBAMS area.

A team of four dedicated Marine Fauna Observers (MFOs) and Passive Acoustic Monitoring (PAM) operators were present on board to implement mitigation measures as required.

Acoustic or visual pre-watches were implemented before the start of all operations.

A dedicated Marine Fauna Observer was on watch during all daylight hours during the survey, and a 24-hour Passive Acoustic Monitoring watch was maintained. All survey operations were in deep water and preceded by an MFO and PAM pre-watch period of 120 minutes.

Visual monitoring for marine animals resulted in 171:09 hours of observer effort during the survey period.

Acoustic monitoring for marine mammals resulted in 345:03 hours of monitoring effort during the course of the survey.

There were four (4) visual sightings and no acoustic detections of marine mammals.

61.4 % of monitoring effort took place while the acoustic source was active, and 38.6 % took place while not active.

There were 19 combined visual and acoustic pre-watches during daylight and 22 during night, using the PAM system.

During the survey there were no incidences where seismic operations were delayed/shutdown due to the presence of marine animals within the exclusion zone (EZ).

There were no instances of non-compliance with the guidelines during operations.

The communication with the Seismic Operators and the mitigation team was professional, efficient, and effective.

2.0 Introduction

2.1. Project Information

This report details the procedures and results of marine mammals and sea turtle monitoring conducted during the 2D seismic survey in Block 10 of the Ionian Sea in Greek waters. Shearwater Geoservices carried out this survey on behalf of Hellenic Petroleum Group onboard the SW Cook from 21st January to 4th February 2022.
The survey was run following the conditions outlined in the consent, 56786/3725 (Appendix A), issued by the Greek Republic, Ministry of Environment & Energy and using the mitigation procedures outlined in the Environmental Action Plan (EAP) for the geophysical research program in the sea area of Kyparissiakos bay "Block 10." This indicated use of the ACCOBAMS Guidelines to address the impact of anthropogenic noise on cetaceans in the ACCOBAMS area.

2.2. Survey Area

The marine seismic survey area covered Hellenic's Block 10 in the Kyparissiakos Gulf (Ionian Sea) of Western Peloponnese, Figure 1. The minimum distance between the boundaries of the Concession Area and the coasts of Peloponnese and Zakynthos Island is approximately 6 km and 17 km.
The survey area was located within Greek territorial waters in Western Greece, with water depths ranging from 200 metres to approximately 3400 metres, Figure 1.
There are five areas of interest in the survey area or immediately adjacent to it, including three NATURA 2000 protected areas. These are shown in Table 1 and Figure 1.

Table 1 Areas of Interest within the survey area

AREAS OF INTEREST SUMMARY	
NATURA 2000	Nisides Stamfani kai Arpyia (Strofades) kai Thalassia Zoni / GR2210004.
	Thalassia Periochi Kolpou Kyparissia: Akr. Katakolo - Kyparissia / GR2330008.
	Thalassia Periochi Notias Messinia / GR2550010.
Other areas of interest	Hellenic Trench. Important Marine Mammal Area (IMMA)
	North East Ionian Sea. Candidate Important Marine Mammal Area (CIMMA)

2.3. Location Map

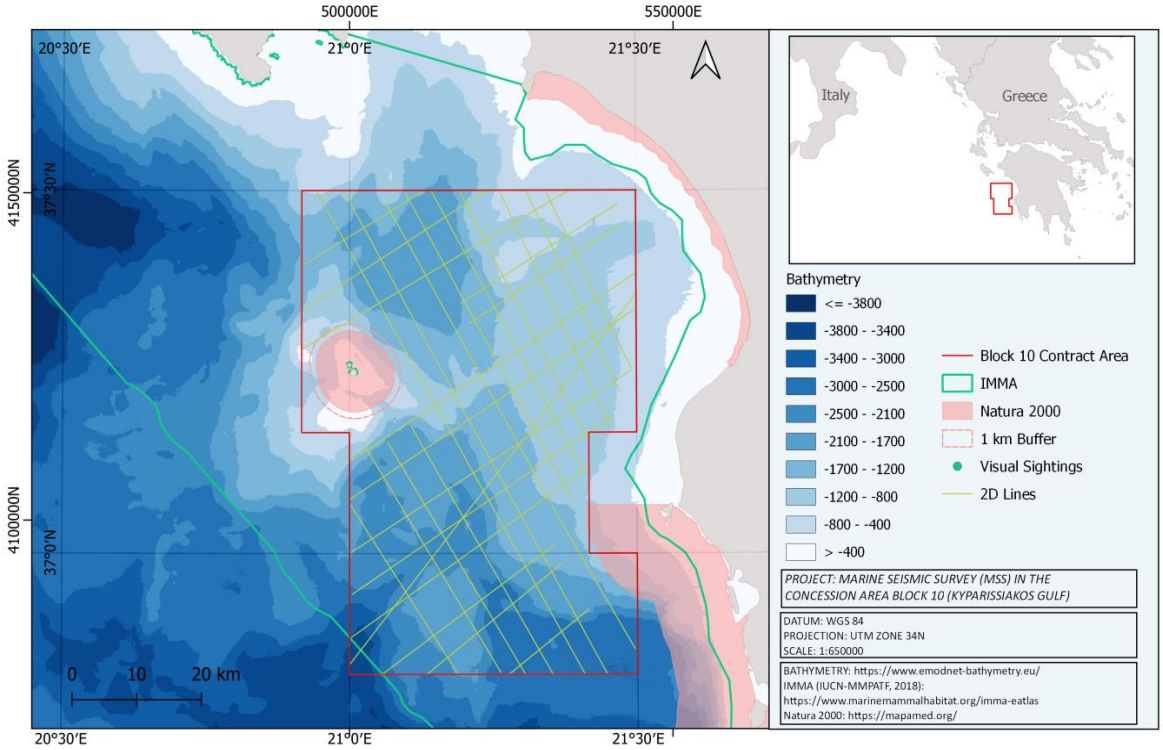

Figure 1 Location of the seismic survey

2.4. Protected Species Occurrence

Several species are likely to be present in the survey area, which are shown along with their IUCN status (via IUCN red list). This information can be found in Tables 2 and 3.

Table 2 Marine Mammals in the survey area

SPECIES GROUP	SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	IUCN STATUS (Mediterranean)
Baleen whales	Fin whale	*Balaenoptera physalus*	Endangered
Toothed whales and dolphins	Bottlenose dolphin	*Turisops truncates*	Vulnerable
	Risso's dolphin	*Grampus griseus*	Endangered
	Short-beaked common dolphin	*Delphinus delphis*	Endangered
	Long-finned pilot whale	*Globicephala melas*	Data Deficient
	Sperm whale	*Physeter macrocephalus*	Endangered
	Cuvier's beaked whale	*Ziphius cavirostris*	Data Deficient
	Striped dolphin	*Stenella coeruleoalba*	Least Concern
Pinnipeds	Monk seal	*Monachus monachus*	Critical Endangered

Table 3 Turtles in the survey area

SPECIES GROUP	SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	IUCN STATUS (Global)
Turtles	Leatherback turtle	*Dermochelys coriacea*	Vulnerable
	Green turtle	*Chelonia mydas*	Endangered
	Loggerhead turtle	*Caretta caretta*	Least Concern*

*IUCN Status for Mediterranean

3.0 Vessels & Equipment

3.1. Survey Information

The Concession Area covers 3,225 km2, excluding parts within the protected NATURA 2000 network. The survey included 27 primary lines with 1,210 km full fold acquisition. The acquisition lines and the boundaries of the Block 10 can be found in Figure 1.
Duration of the lines averaged was 5 hours and 52 minutes with an average of 4 hours and 58 minutes line turns. The average speed of the vessel during seismic acquisition was 4.2 knots.

3.2. Vessels on the Survey

The seismic survey was undertaken from seismic vessel SW Cook (Figure 2), which was assisted by two chase/support vessels EDT Argonaut (Figure 3), until 26th January, and then replaced by the Platytera (Figure 4).

3.2.1. Source Vessel

SW COOK SPECIFICATIONS	
CALL SIGN	5BPC2
TYPE	2D SEISMIC Vessel
LENGTH	88.80 m
BEAM	19 m
DRAFT	6.6 m (max)
GR	6599 tons

Figure 2 SW Cook (Credit: marinetraffic.com)

3.2.2. Support Vessels

EDT ARGONAUT SPECIFICATIONS	
CALL SIGN	P3ES7
TYPE	SUPPORT Vessel
LENGTH	41.65 m
BEAM	9.20 m
DRAFT	3.67 m (max)
GR	387 tons

Figure 3 EDT Argonaut (Credit: Patrick Lyne)

PLATYTERA SPECIFICATIONS	
CALL SIGN	SVA7933
TYPE	TUG Vessel
LENGTH	40 m
BEAM	11.8 m
DRAFT	3.80 m (max)
GR	499 tons

Figure 4 Playtera (Credit: Patrick Lyne)

3.3. Survey Equipment

Details of the 2D equipment and configuration used to acquire data during the survey can be found in Tables 4 and 5 and Figure 5.

Table 4 Survey equipment specifications

SOURCE	
Source type	BOLT 150LL
Number of arrays (source)/sub-arrays	3 arrays, one source
Number of source elements	24
Operation pressure (psi)	2,000
Volume (per source) (in^3)	5085
Source depth (m)	6
Shot point interval (m)	25
STREAMER	
Streamer type	Q-Marine Thermogel – Schlumberger
Number of streamers	1
Streamer length (per streamer) (m)	12,000
Streamer depth (m)	18

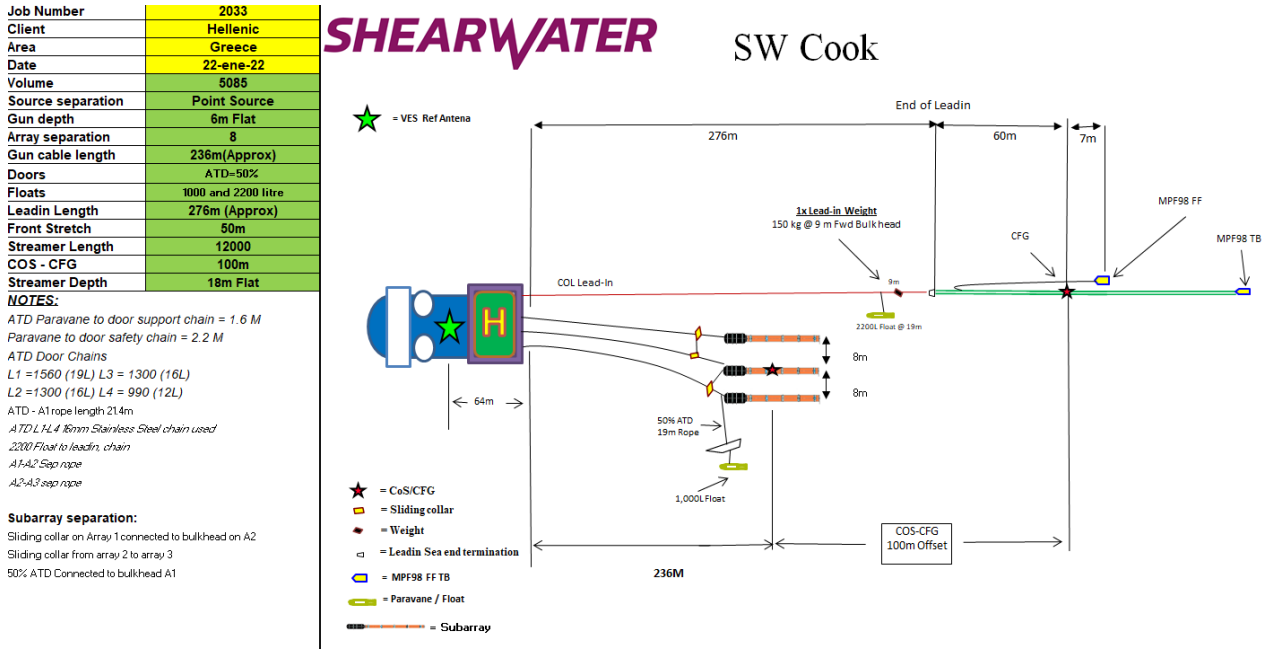

Figure 5 Source and streamer configuration (source: Shearwater)

Table 5 Source Specification

GUN VOLUME in Cu.in		Array 1	Array 2	Array 3
Pos 1	2 x	290	290	290
Pos 2	2 x	195	195	195
Pos 3	1	280	280	280
Pos 4	1	195	195	195
Pos 5	1	145	145	145
Pos 6	1	105	105	105
Total Vol	**5085**	**1695**	**1695**	**1695**

4.0 Mitigation Measures

4.1. Mitigation Requirements

The survey followed the Environmental Action Plan (EAP) recommendations, approved by the Directorate of Environmental Licensing in the Greek Ministry of Environment and Energy under license reference number 56786/372 by the competent national regulator body, Ministry of Environment and Energy, General Directorate of Environmental Policy, Environmental Licensing Department, Section C (Appendix A). These were designed to minimize the risk of injury and disturbance to marine mammals and sea turtles from anthropogenic noise in the concession area of Block 10 in Gulf of Kyparissiakos.
The EAP measures for the project were based on the Guidelines from Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) and Joint Nature Conservation Committee (JNCC, 2017).
Table 6 shows the mitigation requirements summary approved for Block-10.

Table 6 Mitigation requirements summary

MITIGATION PROCEDURES SUMMARY	
MFO & PAM	Yes.
Species covered	Marine mammals and turtles.
Exclusion zone	750 m.
	Extended exclusion zone for sperm whales 1500 m.
Pre-watch period	30 minutes in shallow waters (< 200 m).
	120 minutes in deep waters (> 200 m) due to the presence of deep diving species.
Soft-start length	Minimum 20 min.
	Maximum 40 min from soft-start to start acquisition line.
Soft-start	At least one soft-start should be recorded.
Soft-start delays	30 minutes after last sighting.
	Extended to 120 minutes after last sighting of Cuvier´s beaked whales and Sperm whales.
Shutdown during production	Immediate shutdown is required if marine mammals or turtles are detected in the EZ.
	Distress behaviour is observed.
	Aggregations of Cuvier´s beaked whales or Sperm whales anywhere.
Airgun Testing	Pre-watch must be carried out before any gun testing.
	If testing a single gun, no soft-start required.
	If testing multiple guns, a soft-start (20 min) is required. Guns should be tested in order of volume, smallest first.
	Test no longer than 20 min.
Operation suspended	Less than 10 min, ask MFO/PAM for clearance.
	More than 10 min, a new pre-watch must be undertaken.
Line Turns	Longer than 40 minutes, firing is to be terminated at the end of the survey line.

Additional requirements	**NIGHT VISUAL MONITORING**. In order to increase the potential of detecting marine animals during the hours of darkness, mitigation personnel should be equipped with thermal imaging technology devices to detect marine animals.
	TWO VISUAL OBSERVERS. At least two dedicated Visual Observers should be on continuous watch at the same time during all seismic operations.
	24 hours PAM OPERATOR. At least one operator should be on watch and shifts should be organized to allow 24/24h operation, unless automatic detection/alerting systems with proven effectiveness are available.
	NO SEISMIC ACQUISITION IN PROTECTED AREAS. The seismic vessel could enter Natura areas to perform turning manoeuvres, however no seismic survey activities will take place within the NATURA 2000 protected areas and a buffer of 1000 m around them.
	TURTLE GUARD. Due to presence of sea turtles in the survey area, a turtle protection system (Turtle Guard) should be installed on the towed equipment to prevent any accidents.
	SEABIRDS. To mitigate the impact on the seabirds, the external lighting should be limited. Furthermore, all injure seabirds must be assisted with regaining consciousness and released back into the environment following the appropriate instructions.

4.2. Monitoring Methodology

4.3. Marine Fauna Mitigation Team

Certified and experienced MFOs and PAM operators were present on board the SW Cook throughout the seismic survey.
The MFOs and PAM operators' role was to monitor if seismic operations were conducted in accordance with the permit, EAP, and Guidelines to minimize the risk of injury and disturbance to marine mammals and sea turtles from anthropogenic noise.

4.4. Visual Monitoring

One dedicated MFO conducted continuous visual monitoring during the daylight hours, from sunrise to sunset, as per shifts detailed in Table 7.

Table 7 Marine Fauna Observers and PAM Operators aboard the SW Cook

PERSONNEL	POSITION	SHIFTS
Patrick Lyne	PAM	00:00-06:00
	MFO	08:00-10:00
		11:00-12:00
Sandra Villar	PAM	06:00-12:00
	MFO	14:00-16:00
		17:00-18:00
Manuel Garcia	PAM	12:00-18:00
	MFO	06:00-08:00
		10:00-11:00
Amber Beerman	PAM	18:00-00:00
	MFO	12:00-14:00
		16:00-17:00

The main platform of observation was on the bridge, which allowed 360 degrees of visibility at 14.5 m elevation above sea level, and where the MFO station was located (Figure 6).

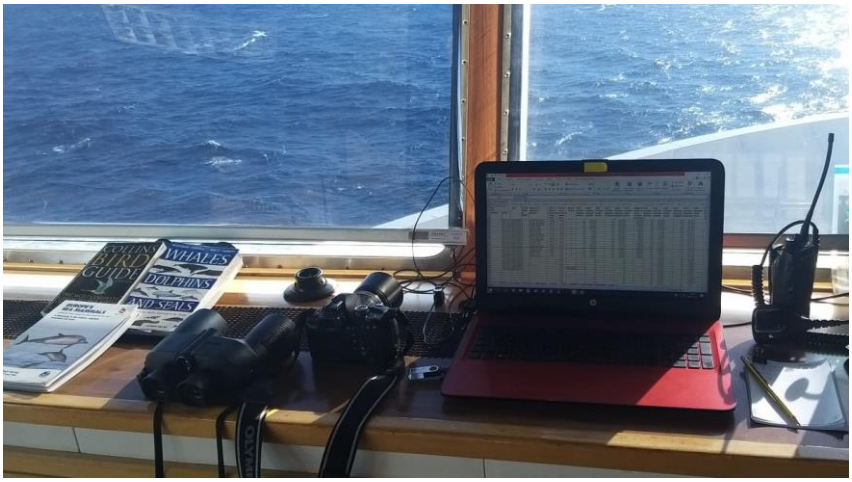

Figure 6 MFO monitoring station on the bridge of the SW Cook (Credit: MFO/PAM Team)

When and if required for tracking sighted animals, both D-deck (13.2 m) and Heli-deck (10.5 m) could be used, enabling a better view of the bow and the gun-arrays, respectively.

Combined use of the naked eye with binoculars was used to monitor the sea surface visually. The distance was estimated using a range-finder stick and reticulated binoculars (Table 8). Several field guides were available to assist MFOs in species identification when necessary.
MFO effort, sightings and operations of seismic activity were recorded following ACCOBAMS template forms (Appendix B) to monitor compliance with the permit, Environmental Action Plan and the ACCOBAMS guidelines.

Table 8 MFO equipment

MFO EQUIPTMENT	
CAMERA	Canon EOS 1100D (Lens Tamron AF 70-300 mm F/4-5.6)
	Olympus E-510 (Lens 40-150 mm 1:4-5.6)
	Canon 750 D (Lens 55-250 mm F/4-22)
	Sony CYBERSHOT DSC-HX400V (Lens 24-1200 mm)
BINOCULARS	Bushnell Marine 7x50 with compass and Reticules
	Bushnell Marine 7x50 with compass and Reticules
	Nikon Prostaff 3S 10x42
	Nikon Monarch 7 10x42

4.5. Passive Acoustic Monitoring

During the survey, experienced PAM Operators maintained a PAM watch 24 hours, in accordance with recommendations in the ACCOBAMS Guidelines and the requirements stipulated within the EAP. The PAM monitoring station was located within the instrument room, allowing ease of communication with the seismic observers (Figure 7).

Figure 7 PAM moitoring station in the instrument room of the SW Cook (Credit: MFO/PAM Team)

4.5.1. Passive Acoustic Monitoring System

The PAM System was provided by MSeis (Night Hawk III) and was installed before the survey operations. The system consisted of a standard towed four-channel hydrophone array cable with a detachable depth sensor. The hydrophone array cable was via deck cable connected to an acoustic monitoring station consisting of an acquisition unit, two high-frequency soundcards, a low-frequency sound card, and two laptop computers for low frequency (LF) and high frequency (HF) monitoring.

The standard towed four-channel hydrophone array cable comprised four identical omni-directional broadband elements with a frequency response of 4 Hz to 180 kHz +/-3 dB, with integrated pre-amplifiers (PA2) and a detachable depth sensor (4-20 mA current loop) (Figure 8). The hydrophone array cable was 250 m and terminated in an SD16 dry-end connector. Effective sensitivity of all hydrophone elements in the array was typically -201 dBV re.1µPa (Figure 9).

The PAM equipment consisted of a spare deck cable and two spare hydrophone arrays, while the PAM station used two HF National Instruments (NI) DAQs (Data Acquisition Cards), while both were used to monitor to 125 kHz one could be used to 250 kHz (sampling at 500 kHz). Localisation is not necessary for high-frequency cetaceans. It can be assumed that high-frequency calls are within a short distance of the array with harbour porpoise vocalisations, for example, at (120-130 kHz) generally assumed to be within 300 m of a hydrophone. The low to mid-frequency vocalisations were processed through a Behringer Uphoria UMC404HD sound card with a sampling rate of 192 kHz that allowed processing of vocalisations up to 96 kHz. A spare Tascam US-16x08 was available with a sampling rate of 96 kHz and was not used. The equipment was supplied with various other tools and spares, including spare depth sensors.

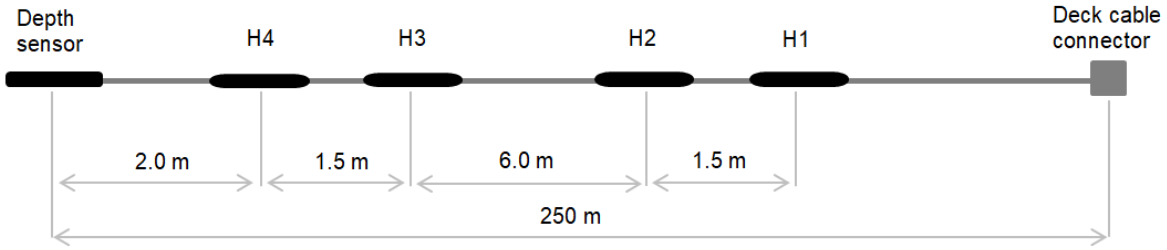

Figure 8 Standard four channel hydrophone array schematic highlighting technical specifications

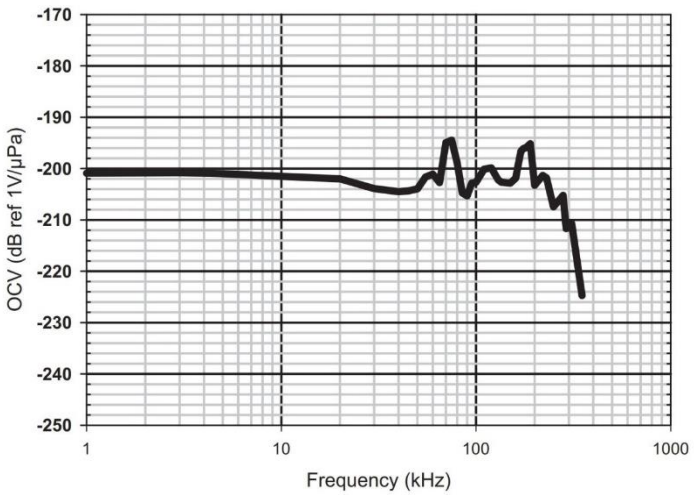

Figure 9 Frequency response curve of hydrophone elements

4.5.2. Passive Acoustic Monitoring Deployment

The hydrophone array cable was deployed from the gun deck, at 150 m astern of the vessel, ahead of the gun arrays; at a depth of approximately 18m. Weights (10 kg) were attached to the array cable at 20 m (6 kg) and 80 m (4 kg) ahead of the hydrophones (Table 9). The array cable was routed into the water through a hydraulic winch at the starboard side. See Figures 10 and 11 for the deployment configuration and location of the PAM cable in relation to the seismic gear.

Prior to the first PAM cable deployment and recovery operations, a 'toolbox talk' was held for all relevant personnel, in adherence to Shearwater HSE policies.

During airgun maintenance, when the array 1 and 2 were retrieved, the PAM cable deployment was shortened to 70 m to avoid entanglement and shortened to 50 m for a brief period to allow the airgun string to pass for five (5) to 10 minutes. When airgun string 3 needed repair or maintenance it was impossible to maintain a PAM watch as the noise on the gun string meant detection was completely impossible when the deployment was shortened to 30 m. This meant that the pre-watch of two (2) hours could only be commenced once the array had been deployed again, and the PAM cable was then redeployed to the full 150 m. Once airguns were redeployed the PAM deployment was returned to 150 m.

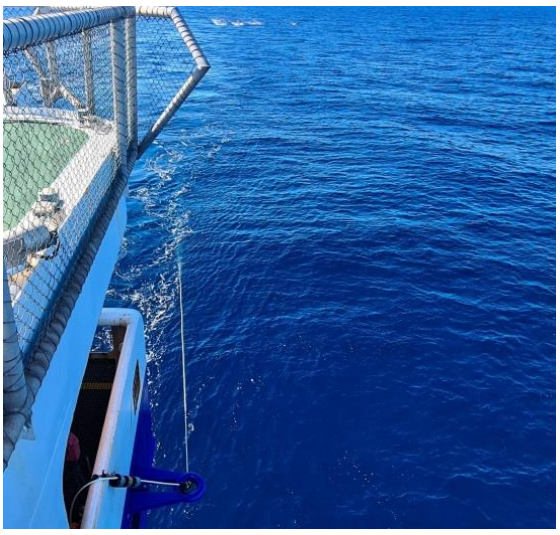

Figure 10 PAM hydrophone array cable deployment (Credit: MFO/PAM Team)

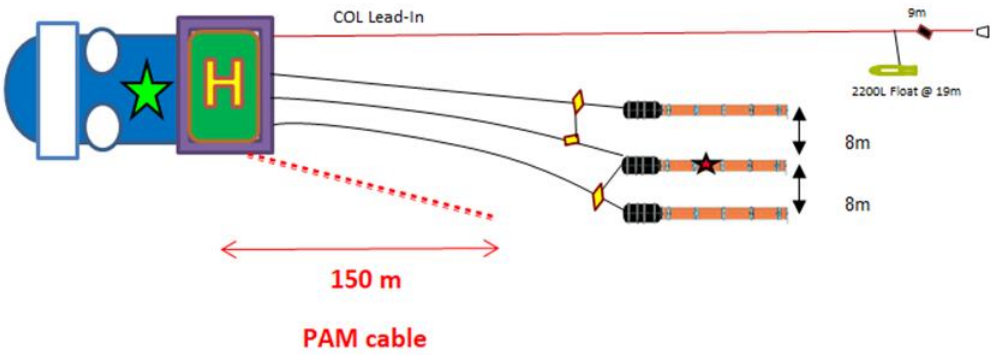

Figure 11 Location of PAM cable in relation to seismic gear

Table 9 Deployment of the PAM cable on SW Cook

Hydrophone separation	1.5 – 6.0 – 1.5 m
PAM cable length	150 m
Depth	16-20 m
Deployment technique	Approximately 6 kg of chain was added to the cable 20 m from the hydrophones and further 4 kg approximately 80 m from the hydrophones. This allowed for a deeper deployment to keep the cable away from airguns and streamer. PAM was deployed from the port side with airguns deployed diagonally over the PAM cable.

4.5.3. PAM Hardware and Sofware Configuration

The open-source PAM software program PAMGuard (version 2.01.05 Beta) was used for acoustic monitoring. PAMGuard enables real-time detection and localisation of cetacean vocalisations. The software can be configured to meet any specific project requirements by adding and setting various modules, allowing visualization of the hydrophones' raw and/or filtered signal, implementing whistle/moan and click detectors, mapping functions, tracking localizing animals and recording signals.

The PAM system was configured to monitor low/mid-frequency signals (moans, whistles and clicks) to 96 kHz on one laptop and high-frequency vocalisations (dolphin echolocation clicks) to 125 kHz on a second laptop.

Analogue audio signals from the towed hydrophone cable were transmitted through the deck cable to the acquisition unit (with a built-in pre-amplifier) in the instrument room. The acquisition unit fed the four channels to a Behringer sound card (audio interface) which digitised the received analogue audio signals and sampled at 192 kHz (Figure 12). The Behringer sound card was connected to an LF/MF laptop, where the signals were visually monitored in PAMGuard.

A low/mid-frequency spectrogram was configured with a frequency range of 0-48 kHz (a 0-96 kHz spectrogram was also set up and available). A whistle and moan detector was configured to detect low/mid-frequency dolphin whistles. Also, a click detector was incorporated to detect clicks (partial clicks from dolphins), and displayed on a second monitor. The trigger threshold was set to 10 dB for this click detector.

To help to detect low frequency pulses and clicks (sperm whales), another low-frequency spectrogram was configured to a frequency range of 0-5 kHz; this had a 10 kHz sampled decimated source.

The low/mid-frequency configuration also included GPS input and mapping functions, including localisation. The low/mid-frequency configuration also displayed the depth transducer output.

A dual setup was configured for a two-channel HF input (H3 and H4) to the HF laptop (Figure 12). Two Signal Conditioner channels were used to split signals from two hydrophones into high frequency DAQs. The internal National Instruments DAQ sampled high frequency at 500 kHz but the combined signal was sampled twice down to 250 kHz.

This configuration allowed the deduction of bearings to marine mammal vocalizations obtained through the whistle/moan and click detectors. Bearing overlays in the map display could then be used to estimate the distance to the animals. In addition, distances could also be evaluated from relative amplitude and frequency content (as a proxy for distance), along with waveform characteristics and spectral energy for species identification.

A high-frequency spectrogram was configured with a 0-125 kHz frequency range. Also, a click detector was incorporated to detect clicks. The trigger threshold was set to 8 dB for this click detector. The HF laptop was also used for headphone monitoring.

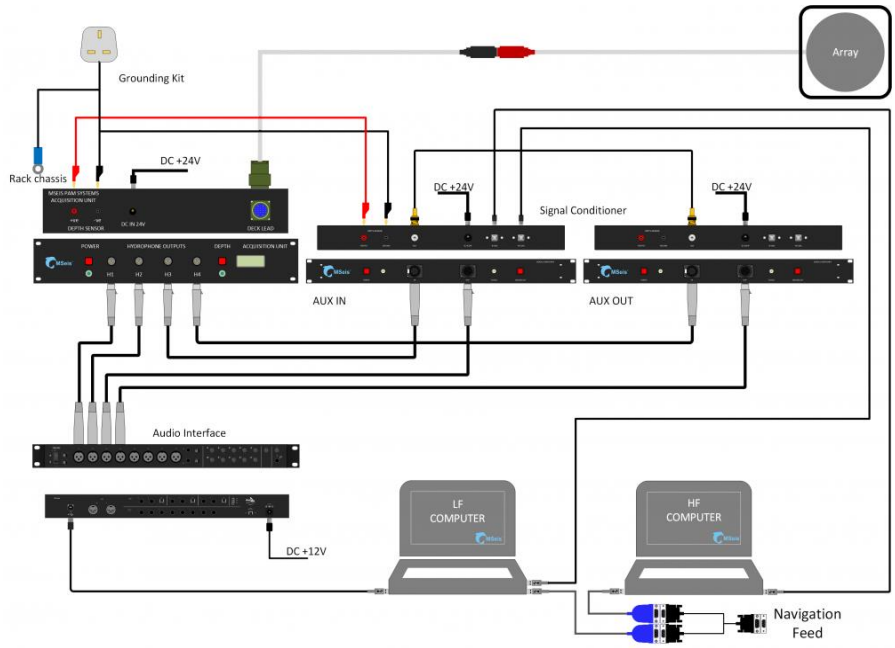

Figure 12 MSeis Night Hawk III Block Diagram Dual Setup with 4 channel LF and 2 channel HF using dual signal conditioners (Source: MSeis)

4.6. Data Collection and Recording Forms

Throughout the 2D seismic survey, ACCOBAMS template forms were used for recording data collection into the main data sheets (Appendix C), "MMO-Effort", "PAM-Effort", "Operations" and "Sightings/Acoustic Detections"; filled out according to ACCOBAMS Guide for Marine mammal recording form (Appendix B).
Cumulative totals and statistics of the data were compiled throughout the survey. Daily reports on visual and acoustic monitoring effort were submitted along with any sightings, including marine wildlife activity to the Client Representative and Party Manager.
All sighting data were tabulated and summarised. Sightings and detections were plotted onto a distribution map using QGIS 3.16.15. Visual sightings were numbered from 001 and onwards and acoustic detections from 501 and onwards.
When possible, photographs were taken of sightings to allow for analysis after the sighting was made to help with obtaining a positive ID and to estimate group size.

4.7. Communication

Once onboard, at the beginning of the project, Mitigation Team (MFOs/PAMOs) delivered two presentations to both day and night shifts, where the key mitigation procedures were introduced, protocols of communications were agreed upon, and any points of contention were resolved with the Seismic Crew, Party Manager and Client Representative.
PAM Station was located in the instrument room (Figure 7) with the Seismic Crew (Observers and Navigators), with face to face communications with the departments involved in the seismic operations.
The Mitigation Team communicated via UHF radio Channel #4 and the PAM operator informed the MFO on the bridge of seismic operations and timings, requested clearance to commence soft-start and relayed information to the Seismic Crew as necessary.
In case of a sighting, the MFO immediately reported this to the PAM Operator via UHF radio, who immediately informed the Seismic Crew. A telephone close to the PAM station could be used when the radio signal was poor due to interference.

5.0 Results

The following results are based on the data collected during the duration of this project onboard the survey vessel SW Cook, from January 20th to 4th February 2022. All raw data can be located in the survey Excel sheet, in Appendix C.

5.1. Operations Summary

From the first day of production on 21st January until 4th February 2022, when the project was completed, a total number of 42 active source sequences occurred, consisting of two (2) test lines, 30 primary lines, six (6) re-runs lines and four (4) bubble tests.
Of the total active source sequences, 16 were initiated during daylight hours, 22 during hours of darkness, two (2) during dawn and two (2) during dusk. In total, 217:20 hours of active source were recorded throughout, comprising soft-starts, gun tests and production lines.
On six (6) occasions, the active source was stopped due to technical issues. This occurred on three (3) soft-starts and during three (3) acquisition lines. Soft-starts were terminated due to the fact the entire procedure to Start of Line was going to take over 40 minutes. These were restarted later when the Start of Line could be reached within the 40 minutes.
Soft-starts were an average of 22 minutes, with an average of 12 minutes between the end of soft-start and the start of line on full power. Due to difficulties in getting soft-starts to a precise time, a period of 20 to 25 minutes was chosen for the soft-start, with a total period of 40 minutes between the start of soft-start and the start of line allowed. This is an area in which the ACCOBAMS guidelines do not give guidance, and therefore, a JNCC-compliant approach was chosen as a best practice approach. The shorter soft-start was specified in the EAP, and this was adhered to as best possible.
The source was not active within the protected areas.
No delays or shutdowns were required during the survey in Block-10 due to animal presence.

Table 10 shows the operations summary and sample of a recorded soft-start can be found in Table 11.

Table 10 Operations Summary

	OPERATIONS SUMMARY (21th January to 4th February 2022)	
SOURCE ACTIVITY TIME	Total Source Active (hh:mm)	217:20
	Total Soft-Start to SOL (hh:mm)	13:31
	Total Online Time (hh:mm)	202:33
	Total Source Test time (hh:mm)	01:16
	Minimum Soft-Start Time (hh:mm)	00:20
	Maximum Soft-Start Time (hh:mm)	00:25
SOURCE ACTIVITY NUMBER	Total N° of Lines (including re-runs)	36
	Total N° of Soft-Starts	38
	Total N° of Source Test	6
	Total N° of Source Test followed by a Line	0
	Total N° of Source Test during dawn/day	2
	Total N° of Source Tests during dusk/night	4
	Total Nº of Soft-Starts during dawn/day	16
	Total Nº of Soft-Starts during dusk/night	20

MITIGATION ACTION	Nº of mitigation actions initiated	0
NON-COMPLIANCE	Nº of incidences of non-compliance	0

Table 11 Outline of the soft-start procedure

STEP	TIME	NUMBER OF GUNS	VOLUME (CU. IN.)	PRESSURE (PSI)
1	14:30:40	1	105	2000
2	14:31:27	2	210	2000
3	14:32:31	3	315	2000
4	14:33:24	4	460	2000
5	14:34:27	5	605	2000
6	14:35:20	6	750	2000
7	14:36:23	7	945	2000
8	14:37:11	8	1140	2000
9	14:38:16	9	1335	2000
10	14:39:09	10	1530	2000
11	14:40:13	11	1725	2000
12	14:41:17	12	1920	2000
13	14:42:10	13	2115	2000
14	14:43:13	14	2310	2000
15	14:44:06	15	2505	2000
16	14:45:10	16	2785	2000
17	14:46:02	17	3065	2000
18	14:47:07	18	3345	2000
19	14:48:01	19	3635	2000
20	14:49:05	20	3925	2000
21	14:50:10	21	4215	2000
22	14:51:03	22	4505	2000
23	14:52:08	23	4795	2000
24	14:52:26	24	5085	2000

5.2. Weather Conditions

The weather can affect the probability of detecting marine animals, with increasing sea state, swell height and wind speeds, and decreasing visibility, reducing the probability of visually detecting marine mammals (Forney, 2000). This is particularly true of species with inconspicuous surfacing behaviour (Palka, 1996).

As environmental conditions heavily influence the likelihood of observing marine mammals, several weather-related variables were recorded during MFO watches. These variables and the percentage of time spent observing during different states are illustrated below (Figure 13). Weather conditions were recorded when the visual monitoring was conducted during the daylight hours.

The Sea state was predominantly Beaufort 3 during visual monitoring (21.8%), and the Swell height was predominantly low (<2m, 82.2%), conducive to effective monitoring for marine mammals.

Wind speed between Beaufort force 1 and 8 were recorded with the most dominant wind speed, Beaufort force 4 (25.2%). Beaufort force 4 or less (conditions best suited for visually detecting marine mammals) was recorded 59.9% of the time. Wind direction was predominantly from the North (44.9%).

With only a few periods of rain (light 2.4% and medium 1.4%), visibility was good (>5km) for 96.7% of the time spent on monitoring.

The sun glare oscillated during the daytime; with a predominantly strong glare forward (46.6%).

Weather conditions on watch were good for 59.14% (Figure 14) of monitoring time with sea state less than Beaufort 4, Swell less than 2 m and visibility greater than 5 km.

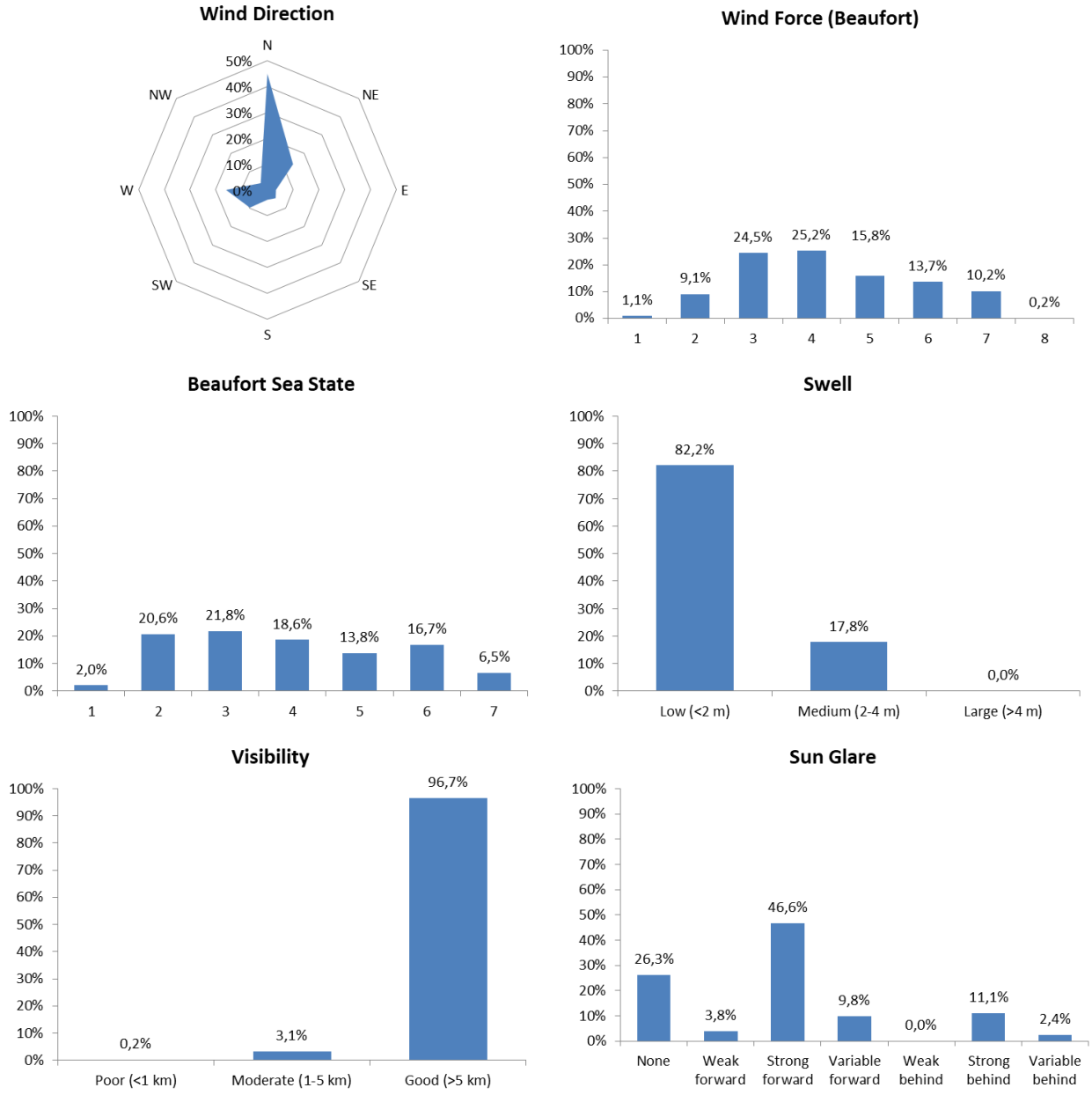

Figure 13 Weather conditions during visual monitoring

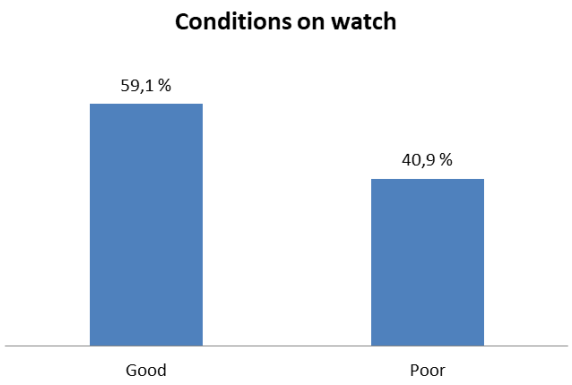

Figure 14 Weather conditions on watch

5.3. Visual and Acoustic Monitoring Effort

A total of 171:09 hours of dedicated marine animal watches were carried out by the MFOs and 345:03 hours of dedicated marine mammal acoustic monitoring by the PAM Operators between 20th January and 4th February 2022. Out of the total 516:12 hours of the monitoring effort, 316:45 hours (61.4 %) were completed whilst the acoustic sources were active and 199:27 hours (38.6 %) were completed whilst the acoustic sources were silent (Figure 15).
On 27th January 2022, due to source recovery of array 3 and re-deployment, PAM was brought on board to avoid entanglement. Acoustic monitoring was discontinued for 03:45 hours and recommenced immediately on deployment of PAM cable after the airgun array was re-deployed.

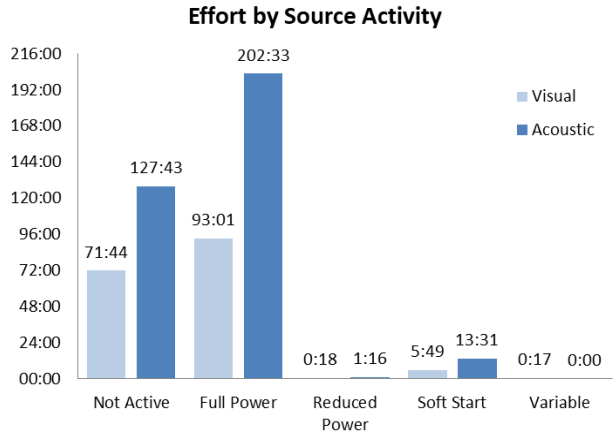

Figure 15 Time in hh:mm of visual and acoustic effort by source activity

From the first day of the 2D seismic survey on the 21st January until 4th February 2022, when the project was completed, a total number of 41 pre-watches were conducted. There were 19 combined visual and acoustic pre-watches during the day/dawn/dusk and 22 acoustic pre-watches during the night (Figure 16). A total of 41 pre-watches were conducted in deep waters (> 200 m) with 120 minutes duration each.

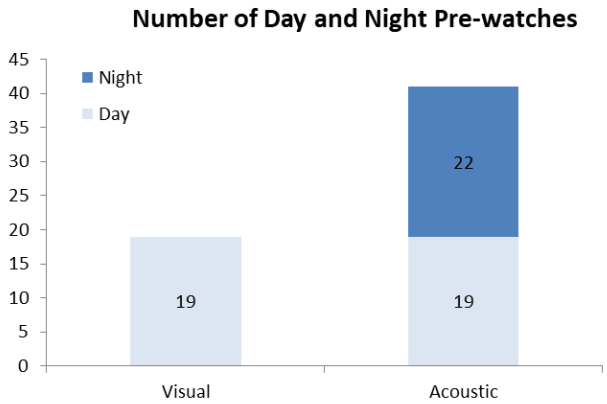

Figure 16 Number of day and night pre-watches

Table 12 Marine mammal mitigation effort summary

EFFORT MONITORING SUMMARY (20th January to 4th February 2022)		
MONITORING EFFORT	Total visual observation (hrs/min)	171:09
	Total acoustic monitoring (hrs/min)	345:03
	Total monitoring (hrs/min)	516:12
MONITORING EFFORT & SOURCE ACTIVITY	Total effort whilst source was inactive	316:45
	Total effort whilst source was active	199:27
PRE-WATCH EFFORT	Nº of day/dawn/dusk Pre-watch periods	19
	Nº of night Pre-watch periods	22
	Total Nº of Pre-watches	41
	Nº of Pre-watches in shallow waters	0
	Nº of Pre-watches in deep waters	41
SIGHTINGS & DETECTIONS	Nº of cetaceans sightings	4
	Nº of seals sightings	0
	Nº of turtle sightings	0
	Nº of acoustic detections	0
MITIGATION ACTION	Nº of mitigation actions initiated	0
NON-COMPLIANCE	Nº of incidences of non-compliance	0

5.4. Visual Sightings

The survey was conducted in the Ionian Sea, West coast of Greece, where depths varied between 200 m and over 3400 m, allowing for the possibility of encountering both deep-water and shallow-water species.
In total, there were four marine mammal sightings, comprising three different species. These included two positive species identification of cetaceans, Striped dolphin (*Stenella coeruleoalba*) and Sperm whale (*Physeter macrocephalus*). Furthermore, a cetacean could not be identified due to the distance from the vessel.
All species had been recorded previously in the area. Species identification was also confirmed by reference to a field guide (Svensson et al. 1999).
Table 13 provides a selection of the data collected during each sighting, including species, range to source and source status at the time of the sightings. Figure 17 shows the location of all visual sightings. More details are included in the ACCOBAMS recording form.

Table 13 List of the sightings recorded by the MFO during the survey

No.	Common Name	Species	Latitude (DDM)	Longitude (DDM)	Time (UTC)	Source Activity at Initial Detection	Closest Approach to Source (m)	Mitigation Action
1	Striped dolphin	*Stenella coeruleoalba*	36° 59,21 N	20° 56,89 E	11:55	Not Active	Source not in the water	None required
2	Unidentified whale	-	37° 03,20 N	20° 52,67 E	13:17	Not Active	Source not in the water	None required
3	Sperm whale	*Physeter macrocephalus*	37°27.64'N	21°17.95'E	13:01	Full power	6000	None required
4	Sperm whale	*Physeter macrocephalus*	37°29.79'N	21°22.53'E	14:02	Full 9ower	3000	None required

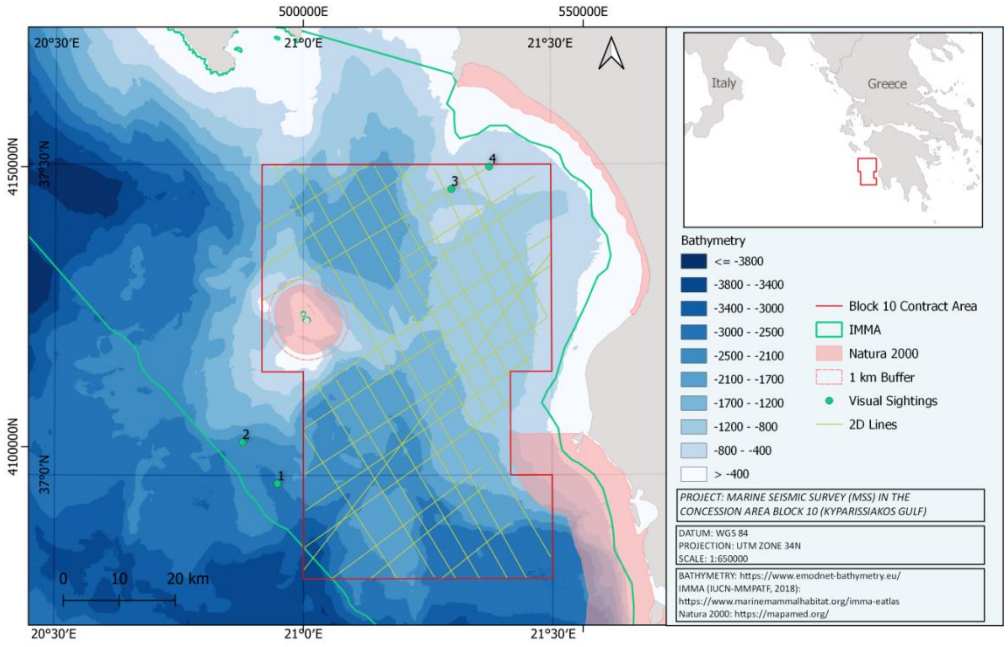

Figure 17 Survey location of sightings during visual watches from the SW Cook during the survey

Sighting #1: Striped dolphin, *Stenella coeruleoalba*

On January 20th 2022, at 11:55 UTC, a pod of 20 Striped dolphins (*Stenella coeruleoalba*) was sighted at approximately 800 m from the vessel with a bearing of 310° from true North (Figure 18). The dolphins were porpoising/travelling fast, crossing ahead of the vessel in a westerly direction. After crossing, the animals changed direction and started to swim parallel in opposite direction to the vessel on the port side. Around 12:00 UTC, the dolphins entered the EZ. The animals surfaced in various directions at the port beam. At 12:03 UTC, the animals left the EZ and started to move away from the vessel in a westerly direction. The sighting was made during standby; the source was not yet in the water; therefore, no mitigation action was required. The animals were last spotted at 12:05 UTC.

Figure 18 Striped dolphins (Stenella coeruleoalba), (Credit: MFO/PAM Team)

Sighting #2: Unidentified whale (Possible beaked whale)

On January 20th 2022, at 13:17 UTC, an unidentified whale (possible Beaked whale) was sighted at 10° and 1500 m from the vessel with a bearing of 350° from true North. The animal was resting on the surface before dive. The sighting was made during standby, the source was not yet in the water; therefore no mitigation actions were required. The animal was last spotted at 13:18 UTC. No Photos were taken.

Sighting #3: Sperm whale (*Physeter macrocephalus*)

On January 31st 2022, at 13:01 UTC, a bushy and angled blow of a sperm whale (*Physeter macrocephalus*) was observed twice at 6000 m and 10° starboard side of the vessel (70° true North). The last blow was spotted at 13:03 UTC. The seismic source was on full power. No mitigation action was required. No photographs were taken due to the distance. The animal was not detected acoustically.

Sighting #4: Sperm whale (*Physeter macrocephalus*)

On January 31st 2022, at 14:02 UTC, a bushy and angled blow was observed. The sperm whale (*Physeter macrocephalus*) surfaced several times at 3000 m and 50° port side of the vessel (from 340° true North) (Figure 19). The animal was probably the same as sighting #3. The animal was travelling in a northeast direction away from the vessel. At 14:16 UTC, the animal was last sighted when it tail fluked on diving. The seismic source was at full power on the line; no mitigation action was required. The animal was not detected acoustically.

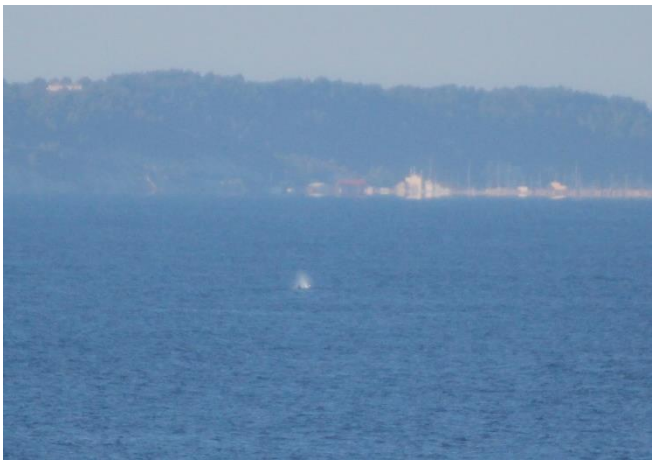

Figure 19 Blow sperm whale (Physeter macrocephalus), (Credit: MFO/PAM Team)

5.5. Acoustic Detections

There were no acoustic detections of marine mammals.
Of the four sightings, PAM had not yet been deployed during the first two sightings and was only operational for the sperm whales sightings. However, the sperm whales were not detected while at the surface, which would be considered normal as typically sperm whales echolocate at depth. Additionally, PAM did not detect the animal after it submerged.

5.6. Birds and Further Marine Fauna Monitoring

Three species of seabird and one species of land bird were recorded during this survey. The species seen are summarised in Table 14, and photographs of birds observed are included in Appendix D.
All species had been recorded previously in the area. Species identification was also confirmed by using a field guide (Svensson et al. 1999).

Table 14 Birds sighted during the survey

COMMON NAME	SCIENTIFIC NAME
Cory´s Shearwater	*Calonectris diomedea*
Kestrel	*Falco tinnunculus*
Mediterranean gull	*Larus melanocephalus*
Yellow-legged Gull	*Larus michahellis*

5.7. Mitigations Incidences

During the survey, no mitigation actions due to the presence of marine mammals or sea turtles within their respective exclusion zones were necessary.

5.8. Compliance

For the entire duration of the 2D seismic survey, the seismic crew were diligently performing with all mitigation requirements, and the procedures were in full compliance with the EAP approved by the regulator.

- No source was active, including soft-starts, within the Natura 2000 protected areas.
- Good communication was maintained between the MFO/PAM team and seismic crew throughout the survey to ensure that all guidelines were implemented effectively concerning the protection of marine mammals and sea turtles within the exclusion zones.
- Turtle guards (Figure 20), a structure welded to the underside of tail buoy designs, aims to exclude sea turtles from becoming fatally entrapped in gaps at the front of the tail buoy undercarriage. In the event of turtle entrapment in seismic equipment, the Contractor's appropriately trained staff must intervene immediately to remove the trapped animal, weather permitting.

Figure 20 Turtle guard SW Cook (Credit: MFO/PAM Team)

- There was 24-hour acoustic monitoring as required.
- As per approved EAP Mitigation Measures and compliance with the ACCOBAMS Guidelines, in order to avoid any inconsistency with measures addressed and prior to the commencement of the survey, the following point regarding mitigation procedures was confirmed.

- One (1) MFO was conducting visual monitoring at the time, and one (1) MFO was 'floating on stand-by', assisting the MFO on watch during critical events such as a sighting. Also in charge of retrieving/deploying the PAM cable when Seismic Crew needed to pick-up the gears, avoid entanglements, and attend the meetings or meal breaks, always available with a UHF radio. Meanwhile, one (1) was performing the PAM role and the other was resting.
- Visual monitoring during the night period was not conducted for two reasons: the number of personnel and no night-vision gears were available. Emphasis was put on PAM 24-hour monitoring as typically sperm whales can be easily detected by PAM.
- The EAP established 20 minutes as the maximum and minimum time for the soft-start duration. This was found technically non-possible to achieve. In addition, no duration from soft-start to start of an acquisition line was defined in the EAP. A JNCC standard, of minimum 20 minutes soft-start and 40 minutes for the period from soft-start commencement and the start of acquisition line, was applied as a best practice approach.

All of these amendments were agreed by all parties (Client, Shearwater and EPI) before starting the operations and the regulator was informed and approved them to the mitigation team.

6.0 Conclusions & Recommendations

6.1. Recommendations

The following recommendations are made to improve the current committed performance in applying the mitigation requirements.

- In general, we recommend having a clear and summarized 'Brief document' with the main mitigation features.
- An English version of the documents, particularly the permit, which is the standard for the working language on board and in the offshore industry worldwide as well.
- As best practice, we would also like to suggest that for visual/acoustic detections of single individuals of deep-diving species, such as beaked whales or sperm whales, to be treated the same per aggregations regarding mitigation actions (soft-start delay or acquisition shutdown).

6.2. Acknowledgements

The MFO/PAM team would like to thank Shearwater GeoServices and the crew of SW Cook for their kind and highly professional collaboration during this survey.
They would also like to thank the seismic crew for their full cooperation and assistance with the PAM equipment, their help was gratefully appreciated.

6.3. References

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Towing layout modified for Port Arrays & Adjustments made on 21-01-2022. SW Cook, Shearwater.

Appendices

The following list of appendices includes standard forms associated with the JNCC. They are included on the final report media.

Appendix A **56786/3725_Block 10-PERMIT**

Appendix B **GUIDE FOR MARINE MAMMAL RECORDING FORMS_ACCOBAMS**

Appendix C **ACCOBAMS EXCEL RECORDING FORM INCLUDING DATA**

Appendix D **BIRD PHOTOS**