EPI Group
A Carbon Neutral Company

2D Marine Seismic Survey

ACCOBAMS MMO and PAM Report

Marine Seismic Survey

EPI Report No. E0479

Client	Hellenic Petroleum Group
Area	Ionian Block
Survey	
Regulatory Reference	73695/4484
Dates	10th February – 3rd March 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 10 February to 03 March 2022. The survey was performed in the Ionian Block, offshore of West Greece in the Ionian Sea.

The seismic data acquisition commenced on 10 February and was completed on 03 March 2022.

There were 25 soft-starts during daylight and dawn, and 25 soft-starts at night. Seismic operations were conducted over 22 days, during which 41 primary acquisition lines were completed, five (5) lines reshot, and five (5) source tests were performed.

Weather conditions recorded during the survey consisted of chiefly southerly winds Beaufort 1 to 7, sea states Beaufort 1 to 6 predominating, and low and medium 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 (4) dedicated MFOs and 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 MFO was on watch during all daylight hours throughout the survey and a 24-hour PAM watch was maintained. All the 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 246:39 hours of observer effort during the survey period.

Acoustic monitoring for marine mammals resulted in 425:11 hours of monitoring effort during the course of the survey.

There were five (5) visual sightings and no acoustic detections of marine mammals.

During the survey there were three (3) occasions where seismic operations were delayed/shutdown due to the presence of marine animals within the exclusion zone (EZ).

60.6% of monitoring effort took place while the acoustic source was active and 39.4 % took place while the acoustic source was inactive.

There were 25 combined visual and acoustic pre-watches during daylight and dawn and 52 acoustic pre-watches during night, using the PAM system.

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

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 mammal and sea turtle monitoring conducted during the 2D seismic survey in the Ionian Block of the Ionian Sea in Greek waters. Shearwater GeoServices carried out this survey on behalf of Hellenic Petroleum Group onboard the SW Cook from 10 February to 03 March 2022.
The survey was run following the conditions outlined in the consent, 73695/4484 (Appendix A), issued by the Greek Republic, Ministry of Environment & Energy and using the mitigation procedures outlined in Ionian Block Offshore Seismic Operations Environmental Action Plan (EAP). This indicated use of the ACCOBAMS and JNCC 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 Ionian Block off the coast of NW Greece, south of the island of Corfu, at the north-eastern edge of the Ionian Sea (Figure 1). The minimum distance between the boundaries of the Concession Area and the coasts of Corfu Island is approximately 6 km.
The survey area was located within Greek territorial waters in Western Greece, with water depths ranging from 100 metres to approximately 2,800 metres (Figure 1).
There are seven areas of interest for the conservation of marine/coastal habitats and species overlapping with the Ionian Block, including one NATURA 2000 protected area. These are shown in Table 1 and Figure 1.

Table 1 Areas of Interest overlapping with the Ionian Block

AREAS OF INTEREST SUMMARY	
NATURA 2000	Nisoi Paxoi kai Antipaxoi kai Evryteri Thalassia Periochi_GR2230004. Special Area of Conservation (SAC).
Other areas of interest	Ionian Archipielago. Important Marine Mammal Area (IMMA).
	Eastern Ionian Sea and Gulf of Corinth (Greece). ACCOBAMS Critical Cetacean Habitat (CCH)
	North East Ionian Sea. Candidate Important Marine Mammal Area (cIMMA).
	North East Ionian Sea Coast and Islands. Candidate Important Marine Mammal Area (cIMMA)
	Hellenic Trench. Ecologically or Biologically Significant Area (EBSA)
	Southern Adriatic and Northern Ionian Sea. Area of interest (Aol)

2.3. Location Map

3.5% of the total seismic survey length was within the “Ionian Archipielago” IMMA and ACCOBAMS “Eastern Ionian Sea and Gulf of Corinth (Greece)” CCH (refer to Figure 1).

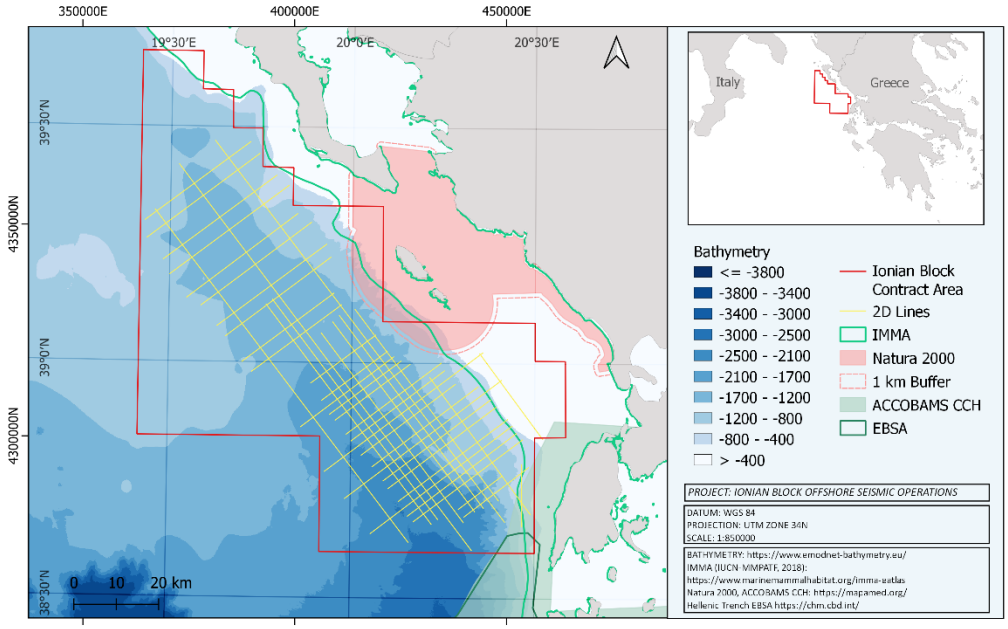

Figure 1 Location of the seismic survey

2.4. Protected Species Occurrence

Several species likely to be present in the survey area are shown along with their IUCN status (via IUCN red list) 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	Sperm whale	*Physeter macrocephalus*	Endangered
	Cuvier's beaked whale	*Ziphius cavirostris*	Data Deficient
	Long-finned pilot whale	*Globicephala melas*	Data Deficient
	Risso's dolphin	*Grampus griseus*	Endangered
	Bottlenose dolphin	*Turisops truncatus*	Vulnerable
	Short-beaked common dolphin	*Delphinus delphis*	Endangered
	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	Loggerhead turtle	*Caretta caretta*	Least Concern*
	Green turtle	*Chelonia mydas*	Endangered
	Leatherback turtle	*Dermochelys coriacea*	Vulnerable

*IUCN Status for Mediterranean

3.0 Vessels & Equipment

3.1. Survey Information

The Concession Area covers 6,671 km2, excluding parts within the protected NATURA 2000 network. The survey included 41 primary lines with 1,616 km full fold acquisition. The acquisition lines and the boundaries of the Ionian Block are shown in Figure 1.
Duration of the lines averaged was 5 hours and 14 minutes with an average of 3 hours and 30 minutes line turns. The average speed of the vessel during seismic acquisition was 4.3 knots.

3.2. Vessels on the Survey

The seismic survey was undertaken from seismic vessel SW Cook (Figure 2), which was assisted by one chase/support vessel, the Platytera (Figure 3).

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

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

Figure 3 Playtera (Credit: MFO/PAM Team)

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 4.

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

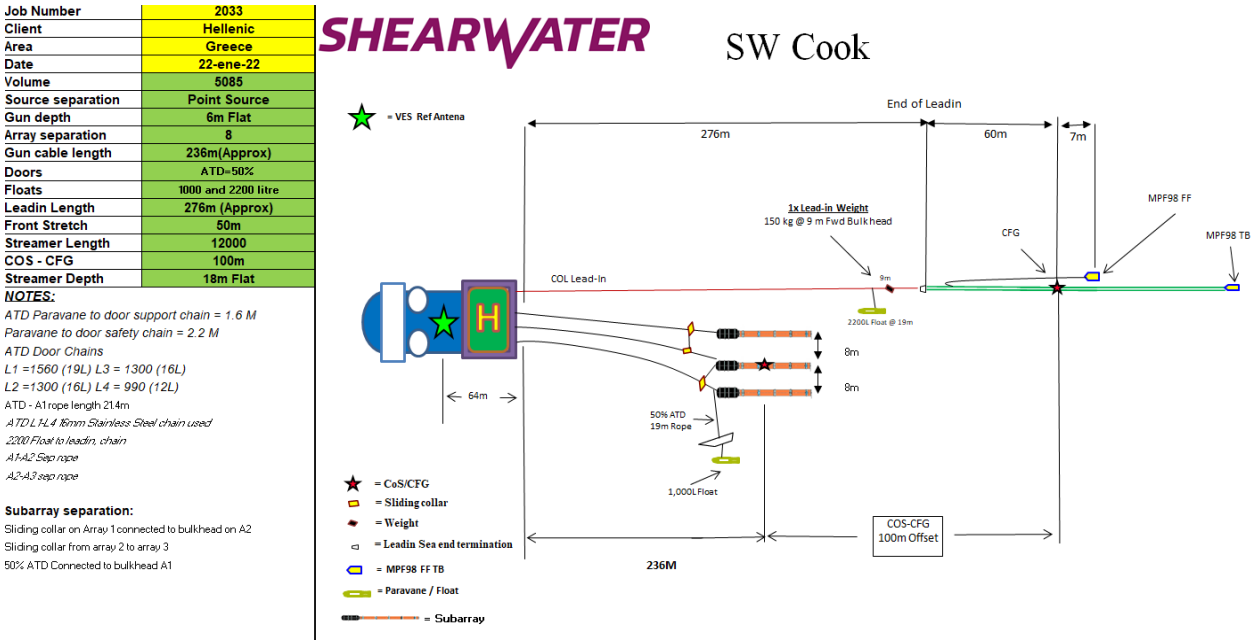

Figure 4 Source and streamer configuration (source: Shearwater)

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 73695/4484, the competent national regulator body, the Ministry of Environment and Energy, the General Directorate of Environmental Policy, and the Environmental Licensing Department, Section C (Appendix A). These recommendations were designed to minimize the risk of injury and disturbance to marine mammals and sea turtles from anthropogenic noise in the Concession Area of the Ionian Block in the Ionian Sea.
The EAP measures for the project were based on the Guidelines from the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS). For those operational aspects not covered by ACCOBAMS regulations, best practice guidance provided by the Joint Nature Conservation Committee (JNCC, 2017) was used.
Table 6 shows the mitigation requirements summary approved for the Ionian Block.

Table 6 Mitigation requirements summary

	MITIGATION PROCEDURES SUMMARY
Mitigation Team	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.
Species covered	Marine mammals (cetaceans and pinnipeds) and turtles.
Exclusion zone	750 m adopted by client instead of 500 m as per EAP and permit.
	Extended exclusion zone for Fin whales 1000 m.
	1500 m extended exclusion zone for sperm whales adopted by client and not included within the EAP or permit.
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.
	Distressed behaviour is observed anywhere in the monitoring area.
	Aggregations of vulnerable species (Cuvier's beaked whales, sperm whales and fin whales) anywhere in the monitoring area.
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	**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 to regain 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

A dedicated MFO conducted continuous visual monitoring during the daylight hours, from sunrise to sunset, as per shifts (local time) detailed in Table 7.

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

PERSONNEL	POSITION	SHIFTS (LT)
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	12:00-18:40
	MFO	06:00-08:00 10:00-11:00
Amber Beerman	PAM	18:40-00:00
	MFO	12:00-14:00 16:00-18:40

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 5).

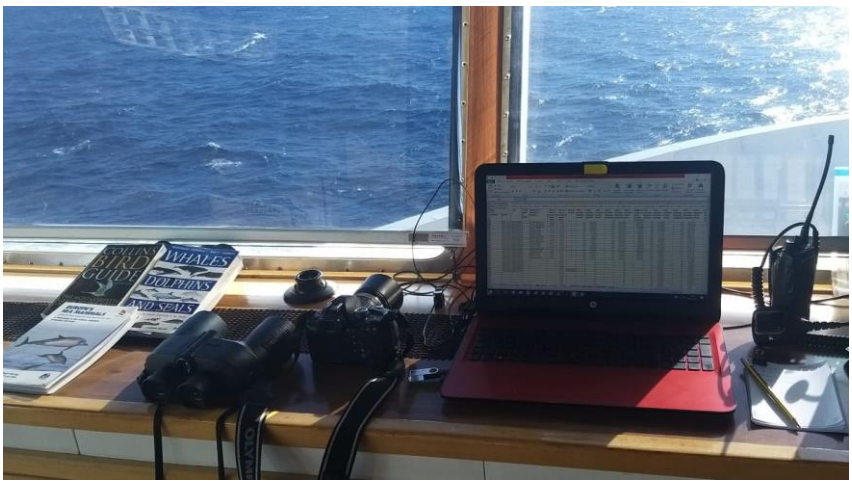

Figure 5 MFO monitoring station on the bridge of the SW Cook (Credit: MFO/PAM Team)

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 where 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 an acoustic monitoring 24 hours, in accordance with recommendations in the ACCOBAMS Guidelines and the requirements stipulated within the EAP. The PAM station was located within the instrument room, allowing ease of communication with the seismic observers (Figure 6).

Figure 6 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 attached to a deck cable connected to an acoustic monitoring station consisting of an acquisition unit, two high-frequency soundcards, a low-frequency sound card, and two (2) 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 7). 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 8).

The PAM equipment consisted of a spare deck cable and two spare hydrophone arrays, while the PAM station used two HF National Instruments Data Acquisition Cards (NIDAQs). Both NIDAQs were used to monitor to 125 kHz (sampling at 250 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.

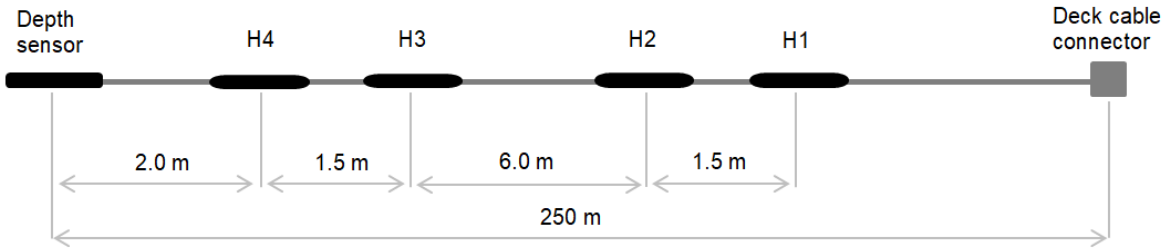

Figure 7 Standard four channel hydrophone array schematic highlighting technical specifications

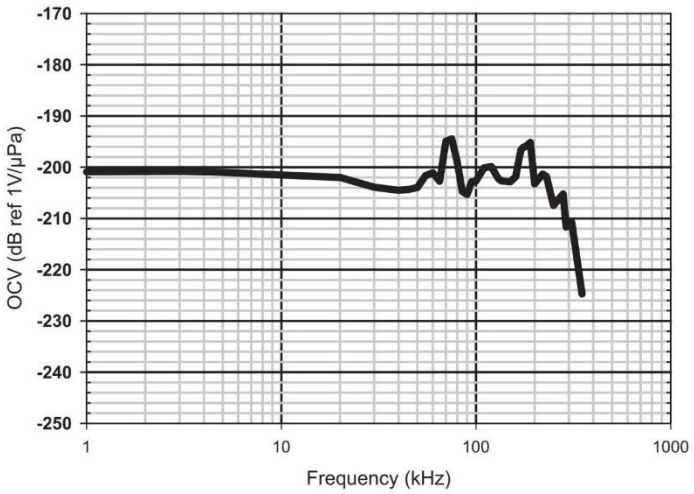

Figure 8 Frequency response curve of hydrophone elements

4.5.2. Passive Acoustic Monitoring Deployment

The hydrophone array cable was deployed from the streamer deck, 150 m astern of the vessel, ahead of the gun arrays and at a depth of approximately 18 m. 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 9 and 10 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 operation, a 'toolbox talk' was held for all relevant personnel, in adherence to Shearwater health, safety and environmental (HSE) policies.

During airgun maintenance, when 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 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 inhibited detection capability when the deployment was shortened to 30 m. This meant that the pre-watch of 2 hours could only commence once the array was deployed again, and the PAM cable was redeployed to the full 150 m. Therefore, once airguns were redeployed, the PAM deployment was returned to 150 m.

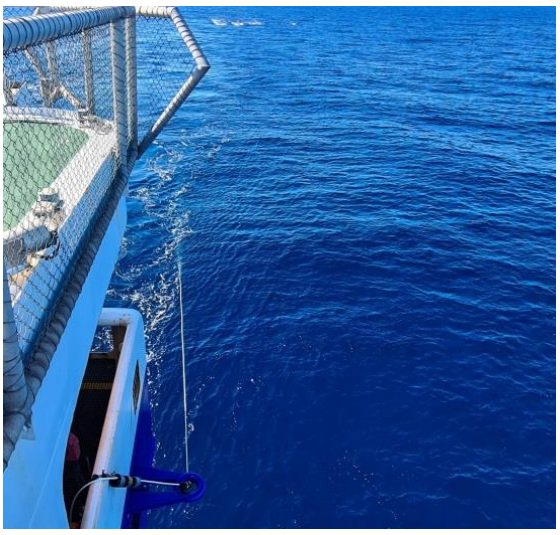

Figure 9 PAM hydrophone array cable deployment (Credit: MFO/PAM Team)

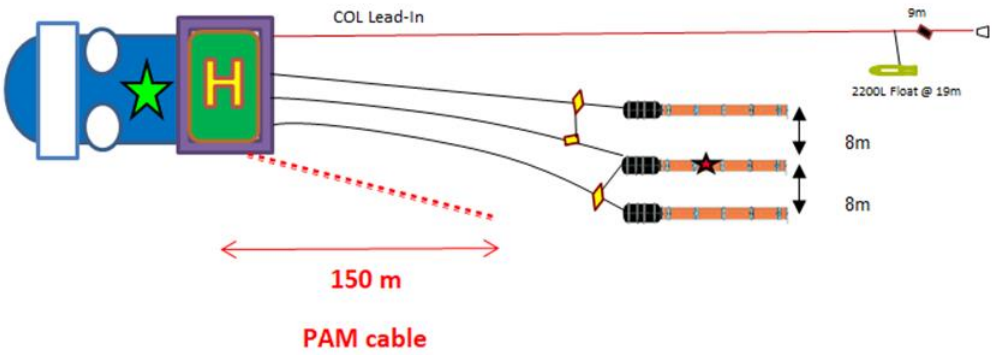

Figure 10 Location of PAM cable in relation to seismic gear

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 11). 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 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 11). Two Signal Conditioner channels were used to split signals from two hydrophones into high frequency NIDAQs.

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.

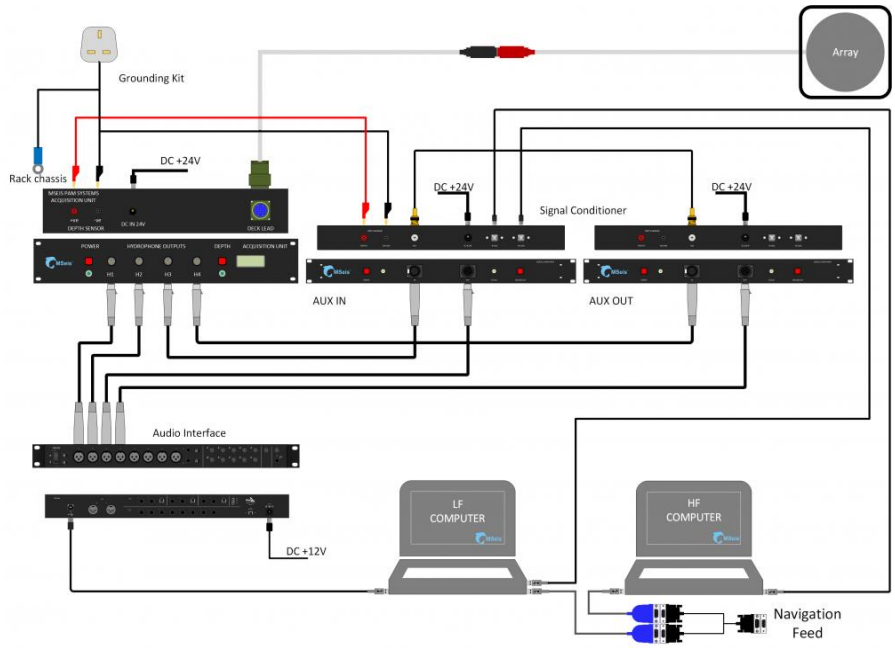

Figure 11 MSeis Night Hawk III Block Diagram Dual Setup with 4 channel LF and 2 channel HF using dual signal conditioners (Source: MSeis)

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 help with obtaining a positive ID and estimating group size.

4.7. Communication

Once on board at the beginning of the project, the 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.
The PAM Station was located in the instrument room (Figure 6) with the Seismic Crew (Observers and Navigators) allowing for face-to-face communications with the departments involved in the seismic operations.
The Mitigation Team communicated via UHF radio Channel four (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 as an alternate form of communication when the radio signal was poor due to interference.

5.0 Results

The following results are based on the data collected throughout the duration of this project onboard the survey vessel SW Cook, 10 February to 03 March 2022. All recorded data can be found in the survey Excel sheet, in Appendix C.

5.1. Operations Summary

From the first day of production on 10 February through 3 March 2022, when the project was completed, a total number of 52 active source sequences occurred, consisting of one (1) test line, 41 primary lines, five (5) re-runs lines and five (5) source tests.
Of the total active source sequences, 22 were initiated during daylight hours, 25 during hours of darkness, and five (5) during dawn. In total, 272 hours 35 minutes of active source were recorded throughout, comprising soft-starts, gun tests and production lines.
On two (2) occasions, the active source was stopped due to technical issues. This occurred once during soft-start and once during an acquisition line. Seismic operations were also stopped due to Client request on 21 February 2022 at 19:14 UTC and re-established on 25 February 2022 at 19:23 UTC.
Soft-starts were an average of 23 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 clear guidance; and therefore, a JNCC compliant approach was chosen. The shorter soft-start was specified in the EAP and this was adhered to as best possible.
The source was never active within the protected areas.
Two (2) Shutdowns due to presence of animals and one (1) delay was required. Further information can be found in Section 5.7.
Table 10 shows the operations summary and a sample of a recorded soft-start can be found in Table 11.

Table 10 Operations Summary

	OPERATIONS SUMMARY (10 February to 3 March 2022)	
SOURCE ACTIVITY TIME	Total Source Active (hh:mm)	272:35
	Total Soft-Start to SOL (hh:mm)	25:48
	Total Online Time (hh:mm)	240:44
	Total Source Test time (hh:mm)	02:29
	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)	46
	Total N° of Soft-Starts	50
	Total N° of Source Test	5
	Total N° of Source Test followed by a Line	0
	Total N° of Source Test during dawn/day	3
	Total N° of Source Tests during night	2
	Total Nº of Soft-Starts during dawn/day	25
	Total Nº of Soft-Starts during night	25
MITIGATION ACTION	Nº of mitigation actions initiated	3

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	12:46:47	1	105	2000
2	12:47:54	2	210	2000
3	12:48:50	3	315	2000
4	12:49:58	4	460	2000
5	12:50:55	5	605	2000
6	12:52:03	6	750	2000
7	12:52:59	7	945	2000
8	12:54:07	8	1140	2000
9	12:55:03	9	1335	2000
10	12:56:11	10	1530	2000
11	12:57:18	11	1725	2000
12	12:58:15	12	1920	2000
13	12:59:22	13	2115	2000
14	13:00:19	14	2310	2000
15	13:01:27	15	2505	2000
16	13:02:25	16	2785	2000
17	13:03:34	17	3065	2000
18	13:04:31	18	3345	2000
19	13:05:31	19	3635	2000
20	13:05:39	20	3925	2000
21	13:06:11	21	4215	2000
22	13:06:47	22	4505	2000
23	13:07:44	23	4795	2000

24	13:08:52	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 12). Weather conditions were recorded when visual monitoring was conducted during the daylight hours.

The sea state was predominantly Beaufort 3 during visual monitoring (36.3%) and the swell height was predominantly low (<2 m, 92.1%), which was conducive to effective monitoring for marine mammals.

Wind speeds between Beaufort force 1 and 7 were recorded with the most dominant wind speed being Beaufort force 4 (29.8%). Wind direction was predominantly from the south (20.9%).

With only a few periods of rain (light 3.1% and medium 1.2%), visibility was good (>5 km) for 98.5% of the monitoring time.

The sun glare oscillated during the daytime with a predominantly strong glare forward (36.7%).

Weather conditions on watch were good for 60% (Figure 13) of monitoring time with a sea state less than Beaufort 4, swell less than 2 m, and visibility greater than 5 km.

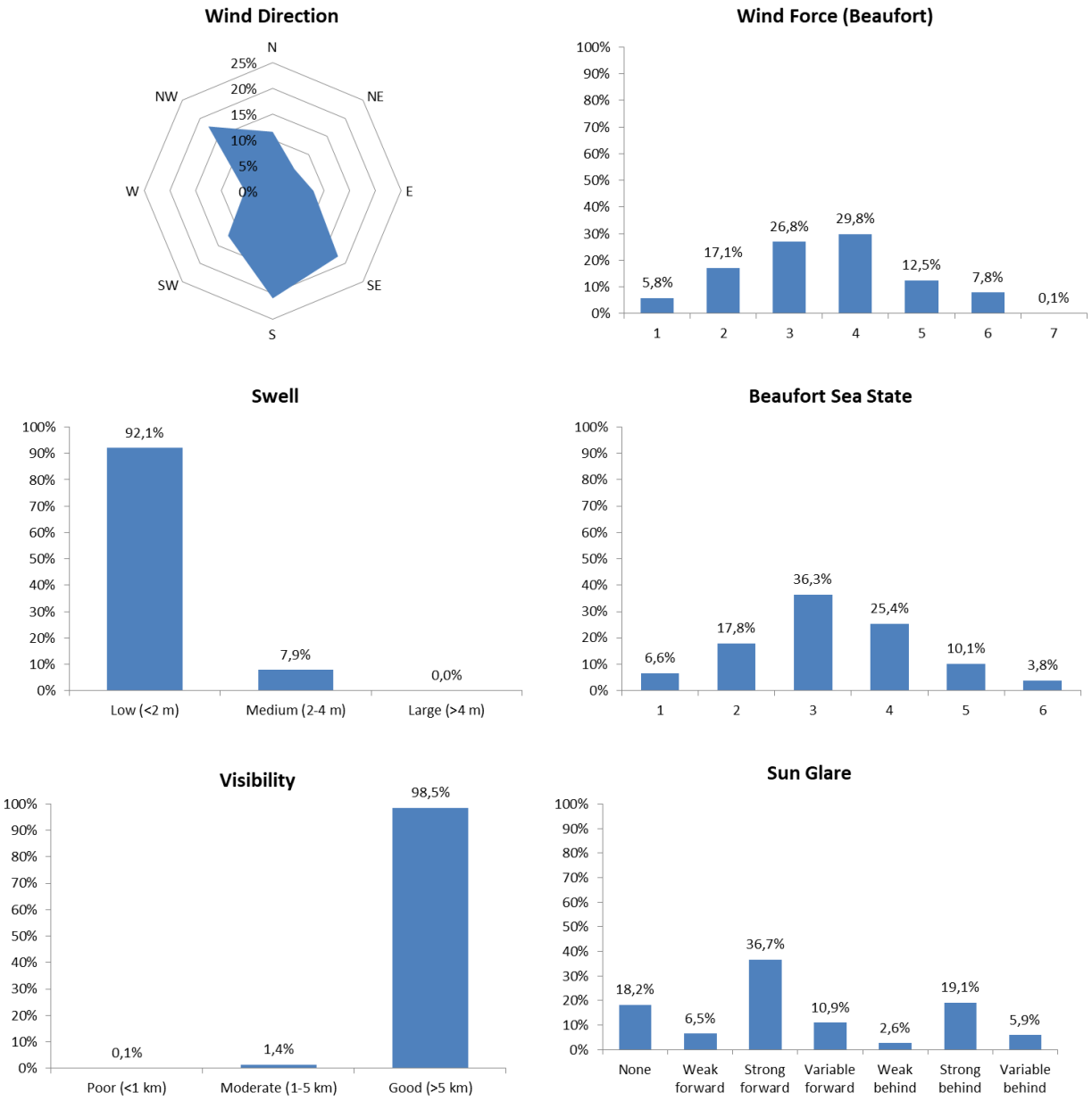

Figure 12 Weather conditions during visual monitoring

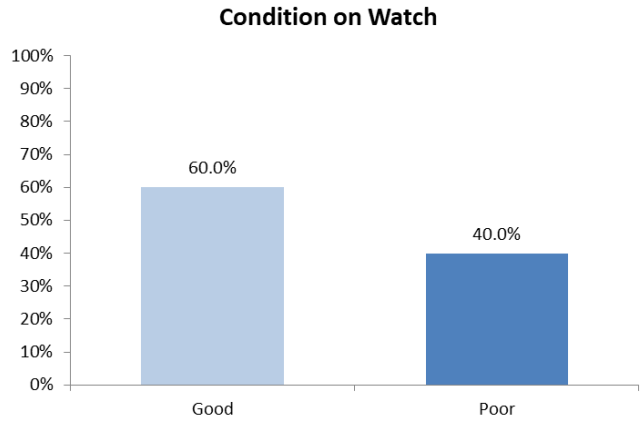

Figure 13 Weather conditions on watch

5.3. Visual and Acoustic Monitoring Effort

A total of 246:39 hours of dedicated marine animal watches were carried out by the MFOs and 425:11 hours of dedicated marine mammal acoustic monitoring was carried out by the PAM operator between 10 February and 03 March 2022. Out of the total 671:50 hours of monitoring effort, 406:56 hours (60.6%) were completed while the acoustic sources were active and 264:54 hours (39.4%) were completed while the acoustic sources were silent (Figure 14).

On 21 February 2022, the operations were stopped due to Client request and re-established on 25 February 2022. Acoustic monitoring was discontinued at 05:15 UTC on 22 February 2022 and resumed at 17:12 UTC on 25 February 2022. The visual monitoring continued during this period and when weather conditions were favourable.

On 24 February 2022, visual monitoring was discontinued for three (3) hours 25 minutes due to bad weather conditions. No seismic operations took place during this period.

On 28 February 2022, the PAM cable was tangled in the streamer lead-in. Acoustic monitoring was discontinued for 35 minutes and recommenced immediately upon deployment of the PAM cable after the cable was disentangled.

On 02 March 2022, due to source recovery of array 3 and re-deployment, the PAM cable was brought on board to avoid entanglement. Acoustic monitoring was discontinued for One (1) hour 46 minutes hours and recommenced immediately on deployment of the PAM cable after the airgun array was re-deployed.

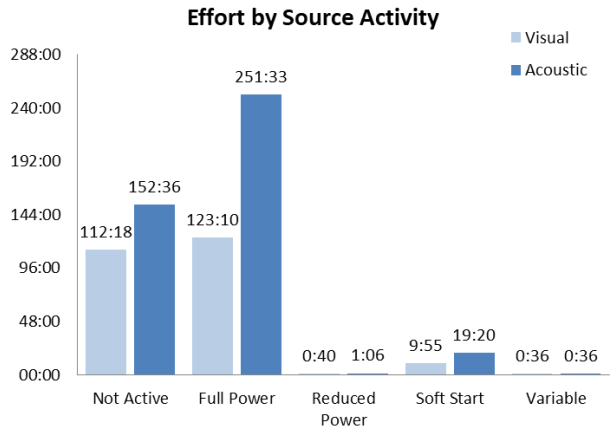

Figure 14 Time in hh:mm of visual and acoustic effort by source activity

From the first day of the 2D seismic survey on 10 February through 03 March 2022, when the project was completed, a total number of 77 pre-watches were conducted; 25 combined visual and acoustic pre-watches during

the day/dawn/dusk and 52 acoustic pre-watches during the night (Figure 15). All pre-watches were conducted in deep waters (> 200 m) with 120 minutes duration each.
On three (3) occasions, the visual pre-watch was shorter than the required time as the pre-watch began before dawn and daylight.

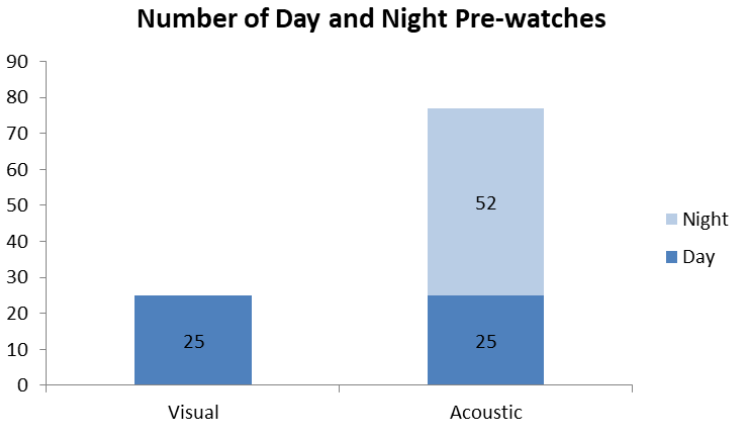

Figure 15 Number of day and night pre-watches

Table 12 Marine mammal mitigation effort summary

EFFORT MONITORING SUMMARY (10th February to 3rd March 2022)		
MONITORING EFFORT	Total visual observation (hrs/min)	246:39
	Total acoustic monitoring (hrs/min)	425:11
	Total monitoring (hrs/min)	671:50
MONITORING EFFORT & SOURCE ACTIVITY	Total effort whilst source was inactive	264:54
	Total effort whilst source was active	406:56
PRE-WATCH EFFORT	Nº of day/dawn/dusk Pre-watch periods	25
	Nº of night Pre-watch periods	52
	Total Nº of Pre-watches	77
	Nº of Pre-watches in shallow waters	0
	Nº of Pre-watches in deep waters	77
SIGHTINGS & DETECTIONS	Nº of cetaceans sightings	5
	Nº of seals sightings	0
	Nº of turtle sightings	0
	Nº of acoustic detections	0
MITIGATION ACTION	Nº of mitigation actions initiated	3
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 91 m and over 2759 m, allowing for the possibility of encountering both deep-water and shallow-water species.
In total, there were five marine mammal sightings, comprising three different species. These included two positive species identification of cetaceans, Cuvier's Beaked Whale (Ziphius cavirostris) and Sperm whale (Physeter macrocephalus). Furthermore, a group of dolphins could not be identified due to the distance from the vessel.
All species were 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 16 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	Duration of Mitigation Action (hh:mm)
1	Cuvier's Beaked Whale	*Ziphius cavirostris*	4	39° 04.11' N	20° 01.26' E	09:41	Full Power	5227	Shutdown of Active Source	01:38
2	Cuvier's Beaked Whale	*Ziphius cavirostris*	3	39° 03.04' N	20° 03.86' E	10:20	Not Active	1215	None Required	N/A
3	Unidentified dolphin	-	4	39° 03.04' N	20° 03.86' E	10:20	Not Active	1215	None Required	N/A
4	Cuvier's Beaked Whale	*Ziphius cavirostris*	3	39° 02.84' N	20° 08.37' E	11:19	Not Active	3167	Delay Soft-start	03:15
5	Sperm Whale	*Physeter macrocephalus*	1	39° 15.25' N	19° 55.98' E	05:40	Full Power	949	Shutdown of Active Source	02:32

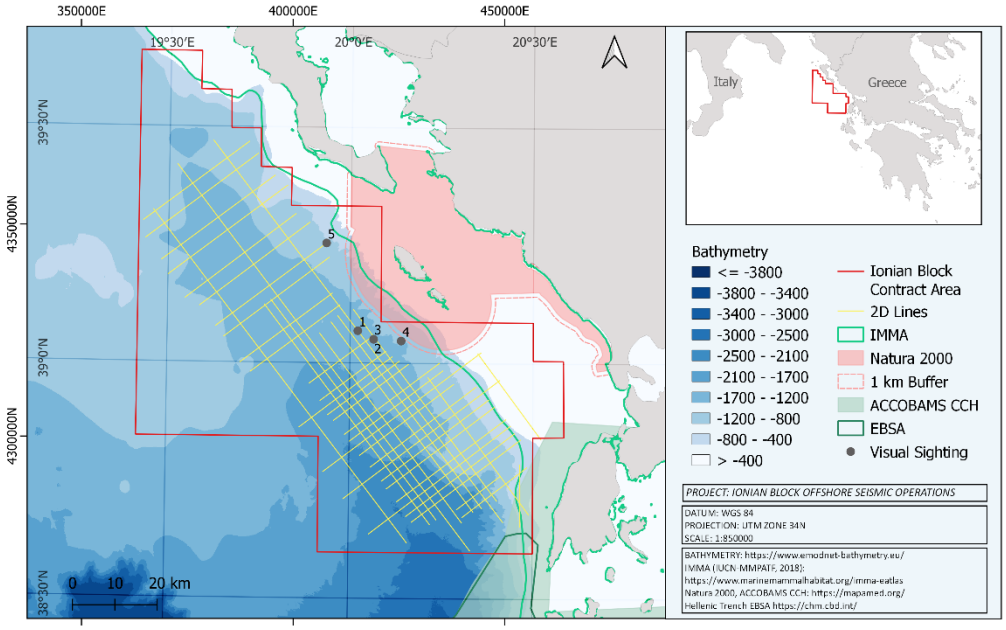

Figure 16 Survey location of sightings during visual watches from the SW Cook during the survey

Sighting 1: Cuvier's Beaked whale, *Ziphius cavirostris*

On 11 February 2022 at 09:41 UTC, a pod of beaked whales was seen logging on the surface with low blows of one (1) m and only backs visible for about two (2) m on the surface. The distance to the animals was approximately 6000 m with a bearing 350° off the bow and 130° from north. The animals were an aggregation of beaked whales and on the trackline of the vessel; therefore, a shutdown was required per the ACCOBAMS guidelines. These guidelines require a shutdown specifically for aggregations of beaked whales and sperm whales anywhere in the mitigation area. At approximately 09:46 UTC, the animals dove and were not seen again. The shutdown was already requested and was actioned at 09:46 UTC in compliance with ACCOBAMS. No photos were taken and the animals were not detected acoustically.

Sighting 2: Cuvier's Beaked whale, *Ziphius cavirostris*

On 11 February 2022 at 10:20 UTC, at a bearing 30° off the bow and 170° from north, activity was seen at 1000 m. Cuvier's beaked whales with a brown colouration and dorsal fin set two thirds of the way back along a six (6) to seven (7) m body (Figure 17). At least two Cuvier's beaked whales were seen with unidentified dolphins. One animal appeared smaller and was a possible juvenile or calf. Initially, animals appeared to be travelling to the east but possibly changed direction. No shutdown was required as this was still within the required delay period from the previous shutdown and with ample time to start of pre-watch (over 120 minutes) before the next line. It is probable, as the vessel was travelling towards the initial sighting, that these represent the same animals and suggests little movement between the sighting at 09:41 UTC and the potential subsequent sighting at 10:20 UTC. The vessel covered approximately four (4) km between these two sightings. The animals were not detected acoustically.

Figure 17: Cuvier's Beaked whales surfacing (Photo credit: Patrick Lyne)

Sighting 3: Unidentified dolphins

On 11 February 2022 at 10:20 UTC, a small pod of four (4) unidentified dolphins together with the Cuvier's Beaked whales (Sighting 2) was sighted at approximately 1000 m from the vessel with a bearing of 170° from true north. The animals surfaced a few times and were travelling slowly to the north. The animals were last spotted at 10:20 UTC. The sighting was during line change; no mitigation action was required. The animals were not detected acoustically.

Sighting 4: Cuvier's Beaked whale, *Ziphius cavirostris*

On 11 February 2022 at 11:19 UTC, an aggregation of three (3) Cuvier's Beaked whales was sighted at approximately 3000 m from the vessel with a bearing of 180° from true north. The animals were travelling slowly to the north. The animals were last spotted at 11:23 UTC and were probably the same group as sightings 1 and 2. The sighting was during line change; delay of soft-start was required and enacted. No photographs were taken due to the distance and the animals were not detected acoustically.

Sighting 5: Sperm whale (*Physeter macrocephalus*)

On 1 March 2022 at 05:40 UTC, a low blow was first spotted (Figure 18) which was positively confirmed to be a sperm whale at 05:44 UTC. The source was operating at full power and a shutdown of operations was carried out at 05:44 UTC. The animal was at a bearing 90° from north and 95° from the bow on the starboard side, at an approximate distance of 900 m from the vessel and 923.5 m from the center of the source (within the Exclusion Zone). The sperm whale moved away rapidly and after a short dive, the animal reappeared at the same bearing at 1000 m. The whale was blowing for a while and was last sighted when fluking into a dive at 06:12 UTC. The animal was not detected acoustically.

Figure 18: Sperm whale blow (Photo credit: MFO/PAM Team)

5.5. Acoustic Detections

There were no acoustic detections of marine mammals.
The PAM cable was deployed and operational during the five sightings; however, animals were not detected.

5.5.1. Sonar Signal

A sonar signal was detected in PAMGuard on both the low/mid-frequency and high-frequency monitoring stations. The signal was recorded almost continually from 19 to 22 February 2022. The sonar had a signal duration of approximately 5 seconds, with most energy between 3.5 and 4.25 kHz, typically repeated every 101 seconds (Figure 19). Sonar was additionally detected on 26 February; this sonar was a lower frequency signal below 2 kHz (Figure 20). For further information see Appendix E.

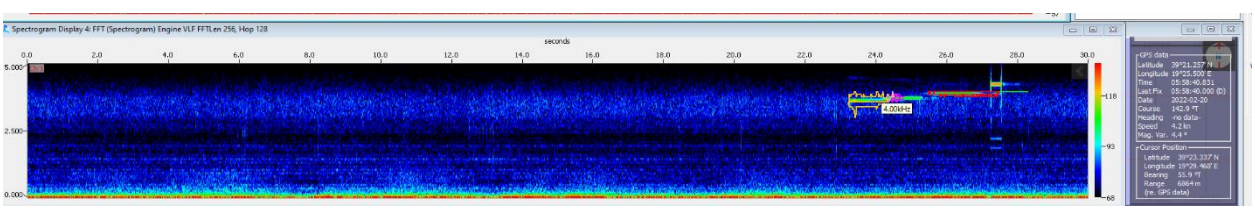

Figure 19: Sonar signal detection 19-22 February

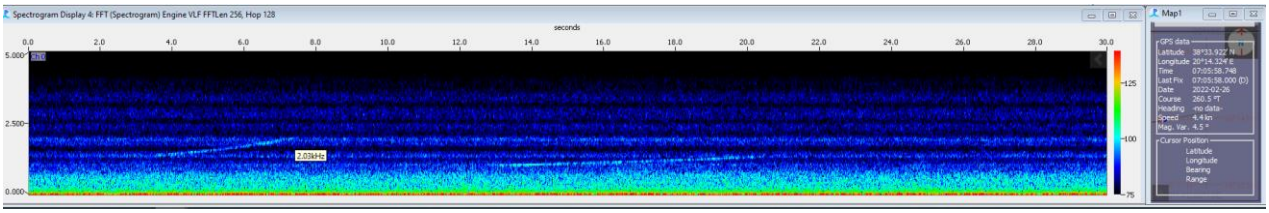

Figure 20: Sonar signal detection 26 February

5.6. Birds and Further Marine Fauna Monitoring

Five (5) species of seabird and five (5) species of land bird were recorded during this survey. The species observed are summarised in Table 14 and photographs of birds observed are included in Appendix D.
All species were previously recorded 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
	Common house martin	*Delichon urbicum*
	Cory´s Shearwater	*Calonectris diomedea*
	Mediterranean gull	*Larus melanocephalus*
	Northern pintail	*Anas acuta*
	Rock Dove	*Columba livia*
	Scopoli's shearwater	*Calonectris diomedea diomedea*
	Unidentified Passeridae	-
	White wagtail	*Motacilla alba*
	Yelkouan shearwater	*Puffinus yelkouan*
	Yellow-legged Gull	*Larus michahellis*

On 11 February 2022 at 11:20 UTC, an ocean sunfish (*Mola mola*) was sighted at approximately 200 m from the vessel with a bearing of 140° from true north (coordinates: 39°02.98' N/ 20°08.24' E). A photograph is included in Appendix D.

5.7. Mitigations Incidences

During the survey, three (3) mitigation actions due to the presence of marine mammals or sea turtles within their respective exclusion zones were necessary.
On 11 February 2022 at 09:46 UTC, the Acquisition Line HE22GR811033A102 was shut down due to the presence of a pod of beaked whales (sighting 1). ACCOBAMS guidelines, resolution 7.13 par (q), require a shutdown specifically for aggregations of beaked whales and sperm whales anywhere in the mitigation area.
On 11 February 2022 at 11:23 UTC, the Acquisition Line HE22GR811013A103 was delayed due to the presence of a pod of beaked whales (sighting 4). This sighting was likely the same pod sighted previously (sighting 1), so 11:23 UTC was considered last sighting of the animals.
On 01 March 2022 at 05:44 UTC, the Acquisition Line HE22GR811007A138 was shut down due to the presence of a sperm whale (sighting 5) inside the mitigation zone (1500 m). As mentioned before in Section 3 Mitigation requirements, an extended mitigation zone for sperm whales was adopted by the Client and not included within the EAP or permit.
During all the mitigation actions undertaken, the communication with seismic crew was quick and efficient, and the mitigation actions were applied immediately after the request.

5.8. Compliance

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

- The seismic survey was carried out during winter season to minimize impacts on marine mammal breeding season.
- The average speed of the vessel was 4.3 kts, which complied with the recommendation of the working group IWC-IUCN-ACCOBAMS to reduce speed to 10 knots maximum in order to minimize the strike risk with marine fauna.
- A total of 50 soft-starts were carried out before starting an acquisition line or gun-array test in accordance with procedures described.
- A 750 m radius, from the centre of the noise source (Exclusion Zone), extended to 1000 m for fin whales and 1500 m for sperm whales, were established.
- Aggregations of vulnerable species (Cuvier's beaked whales, sperm whales, and fin whales) anywhere in the monitoring area were established.
- 120 min of visual and/or acoustic pre-watches were performed before any firing of guns, including soft-starts, acquisition lines, tests, and resuming operations after unexpected breaks.
- Soft-start duration was a minimum of 20 minutes.
- Soft-start duration and time from soft-start to SOL was less than 40 minutes as required.
- No source was active (including soft-starts and line turns) within the 1000 m safety buffer zone from 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 21), 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 21 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.

The mitigation team was informed that the number of the dedicated visual observers on continuous watch, concurrently, during seismic operations in the Ionian block could be one (1) instead (2), as ACCOBAMS guidelines addresses. Before starting operations, the Client confirmed this amendment taking into consideration results obtain from previous campaign in Kyparissiakos Gulf and overall MMO/PAM effort. In any case, while conducting the survey, there was no incontinency with guidelines and mitigation measures applied.

One (1) MFO was conducting visual monitoring during daylight hours throughout the project and one (1) MFO was 'floating or on standby.' The standby MFO assisted the MFO on watch during critical events, such as a sighting. They were also in charge of retrieving/deploying the PAM cable, when required, to avoid entanglements and attend meetings or meal breaks. The standby MFO was always available with a UHF radio. Meanwhile, one other team member fulfilled the PAM role while another was resting

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 summarised 'brief document' with the mitigation features.
- An official translated English version of the documents, particularly the permit, should be available as this is the standard for the working language on board and in the offshore industry worldwide.
- As best practice, we would also like to suggest that visual/acoustic detections of single individuals of deep-diving species, such as beaked whales, sperm whales, or fin whales, be treated the same as 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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Appendices

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

Appendix A **73695/4484 IONIAN BLOCK PERMIT**

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

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

Appendix D **BIRD and FURTHER MARINE FAUNA PHOTOS**

Appendix E **SONAR SIGNAL DETECTION**