



Marine Mammal Mitigation Report

Caithness to Moray Offshore High-Voltage Direct Current (HVDC) Cable
Installation Works 2018

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List of Abbreviations

Abbreviation	Description
AHTS	Anchor Handling Tug Supply
AUV	Autonomous Underwater Vehicle
BF	Beaufort Force Scale
CLV	Cable Lay Vessel
DAQ	Data Acquisition
dB	Decibel
DP	Dynamic Positioning
DPFPV	Dynamic Positioned Fall Pipe Vessel
EPS	European Protected Species
HVDC	High Voltage Direct Current
JNCC	Joint Nature Conservation Committee
kHz	Kilohertz
MBES	Multibeam Echo Sounder
MFE	Mass Flow Excavation
MMO	Marine Mammal Observer
NI	National Instruments
PAM	Passive Acoustic Monitoring
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SS	Scanning Sonar
USBL	Ultra Short Baseline
UTC	Coordinated Universal Time
UXO	Unexploded Ordnance

I. Executive Summary

ABB high voltage cables (ABB), on behalf of Scottish Hydro Electric Transmission (SHE Transmission), has installed a subsea cable between Noss Head, Caithness and Portgordon, Moray (see Figure A). A European Protected Species (EPS) risk assessment was undertaken prior to the work commencing (Natural Power report number 1156585), and an EPS licence (number MS EPS 01/2018/0 and MS EPS 01/2018/1) was awarded by Marine Scotland. Work under the current Licence was undertaken between the 20th February and the 31st August 2018.

Dedicated Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM) operators undertook mitigation monitoring for the various stages of operations as follows:

- Vibrocore sampling - 20th to 23rd February 2018;
 - Operations consisted of core sampling along the cable route.
- Cable Operations – 23rd February to 20th June 2018;
 - Operations consisted of four sections of work including cable pull-in operations, Mass Flow Excavation (MFE) works, fault finding and the cable repairs; with associated surveys during each stage of work.

Table 1 provides a summary of the mitigation undertaken across all phases of the work.

Table 1: Summary of mitigation undertaken during the Caithness to Moray Offshore HVDC Cable Installation Works

Item	Description
Duration of work under Licence	20 th February – 20 th June 2018
Duration of active operations	1473 hrs and 20 min
Total amount of visual monitoring	408 hrs and 39 min
Total amount of passive acoustic monitoring	80 hrs and 15 min
No. of pre-work searches	60
No. of sightings/detections during pre-work searches	4
No. delays due to marine mammal presence	3
Duration of delays caused by marine mammals	0 hrs and 34 min (<0.05% of all active operations)

II. Introduction

ABB High Voltage Cables (ABB) has installed High Voltage Direct Current (HVDC) and fibre optic cables between Caithness and Moray, Scotland, on behalf of Scottish Hydro Electric Transmission PLC (SHE Transmission). Although the initial construction programme predicted completion in 2017, a continuation of the works was required in 2018. Cable installation work (defined as all activities associated with cable installation; Cable pull in and mass flow excavation work at Portgordon; backfill; rock placement and surveys) was undertaken by ABB on behalf of SHE Transmission. EPS risk assessments were undertaken prior to the work commencing (Natural Power report number 1156585), and EPS licences (number MS EPS 01/2018/0 and MS EPS 01/2018/1) were awarded by Marine Scotland and Scottish Natural Heritage. All work was carried out in accordance with the conditions of the above licences.

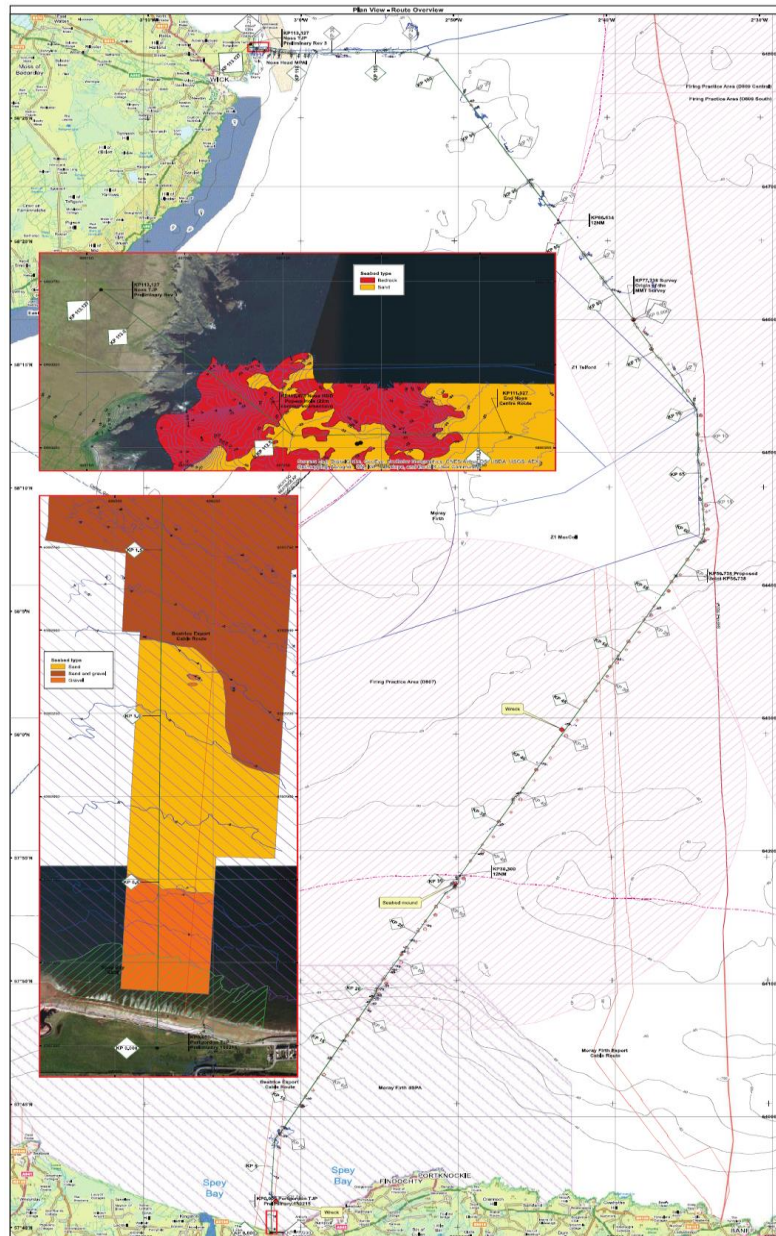


Figure A: Cable Route from Noss Head, Caithness to Portgordon, Moray

Cetaceans have been recorded within the Moray Firth all year round, with peak abundances for harbour porpoises from April to September. Bottlenose dolphins are resident within the Moray Firth year round and minke whales are present in the Moray Firth region from May until September. White-beaked dolphins and common dolphins are usually observed during the summer months. It is possible therefore, that all of these species could have been present within the Moray Firth during at least some part of the subsea cable installation works¹.

Table 2 lists a summary of marine mammal species which were identified in the EPS risk assessment as being common in the Moray Firth, and present on a year-round or seasonal basis¹.

Table 2: Marine mammals commonly recorded in the Moray Firth

Common Name	Scientific Name	Occurrence
Harbour porpoise	<i>Phocoena phocoena</i>	All year
Bottlenose dolphin	<i>Tursiops truncatus</i>	All year
Minke whale	<i>Balaenoptera acutorostrata</i>	Seasonal
White-beaked dolphin	<i>Lagenorhynchus albirostris</i>	Seasonal
Common dolphin	<i>Delphinus delphis</i>	Seasonal
Risso's dolphin	<i>Grampus griseus</i>	Seasonal
Humpback whale	<i>Megaptera novaengliae</i>	Occasional
Killer whale	<i>Orcinus orca</i>	Occasional
Long-finned pilot whale	<i>Globicephala melas</i>	Occasional
Grey seal	<i>Halichoerus grypus</i>	All year
Common seal	<i>Phoca vitulina</i>	All year

Source: EPS Risk Assessment (Natural Power report number 1156585)

The purpose of this report is to outline the mitigation measures taken to ensure no disturbance or injury has been caused to the EPS species present in the area under the conditions of the EPS licences (MS EPS 01/2018/0 and MS EPS 01/2018/1) issued by Marine Scotland. It will report the implementation of mitigation for the various activities and equipment employed, any marine mammal encounters, survey conditions and assess the compliance with the Licence conditions.

Dedicated Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM) operators undertook mitigation monitoring for the various stages of operations as listed below:

- Vibrocore sampling - 20th to 23rd February 2018;
- Cable pull in at Portgordon – 23rd February to 29th March 2018; and
- Cable repair works – 11th May to 20th June.

A number of different vessels have been involved during the cable installation work, and these are summarised in Table 3 below.

Table 3: Vessels used for cable installation activities

Vessel	Use
Cable Lay Vessel (CLV) - NKT Victoria	Cable laying activities
Utility Vessel – C-Fenna	Used for HDD pull in at Portgordon
Multi-Role Support Vessel – EDT Hercules	Cable repair works along the cable route
Multi-Role Support Vessel – MV Relume	MFE works at Portgordon and survey work along the cable route
Viewing Vessel – MV Coral Wind	Used as a mitigation viewing vessel for operations nearshore off Portgordon
Viewing Vessel – GV Rover Alpha	Viewing vessel for Vibrocore operations along the cable route

¹ Other species such as humpback whale (*Megaptera novaengliae*), killer whale (*Orcinus orca*) and long-finned pilot whale (*Globicephala melas*) occur on a more occasional basis and are covered by the EPS licence.

Vessel	Use
Coring Vessel - Voe Vanguard	Completed vibrocoring survey of the cable route
Survey Vessel – Marine Sensor *	Completed post operational survey of the nearshore seabed at Portgordon
Workboats* and Light workboats*	Used during the cable pull in at Portgordon to assist in positioning the floating cable
Guard vessels*	Used for protection of insufficiently protected cables during cable lay activities, including: each near shore section; as required along the offshore cable route until adequately protected; and at the offshore joint location

*No mitigation required for these vessels

III. Mitigation Methods

The following methods were applied to all activities carried out in association with subsea cable installation works between Noss Head, Caithness and Portgordon, Moray for the HVDC Link under the EPS licence (number MS EPS 01/2018/0 and 01/2018/1).

As per the EPS Licence (number MS EPS 01/2018/0 and 01/2018/1), marine mammal mitigation was carried out for all sections of the subsea cable installation following methods based on the 'JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys.' (JNCC, 2017).

A pre-work search period of at least 30 minutes duration was required prior to the operation of the Ultra Short Baseline (USBL) positioning system and beacons. During visual or acoustic pre-work searches, if a marine mammal was observed within the mitigation zone during the search, the start of the equipment activation (or soft start) was delayed until the animal had not been sighted within the mitigation zone for at least 20 minutes. As per the EPS licence, no additional mitigation was required prior to the use of other geophysical equipment if the USBL was in operation. If any marine mammals were detected once the equipment was in use, no action was required. A summary of all sighting made during the cable installation works is available in Appendix A.

In line with EPS Licence condition 6 (MS EPS 01/2018/0) and 7 (number MS EPS 01/2018/1) when operations were being conducted within 3 km of the Spey Bay coastline, concurrent visual and passive acoustic monitoring was conducted when sighting conditions allowed (i.e. during daylight hours and in suitable visibility). If daytime visibility became poor (< 1 km) or the sea state was not conducive to visual mitigation (\geq Beaufort Force (BF) 4), or during the hours of darkness, the pre-work monitoring was conducted using only PAM. The MMO and PAM operators worked in shifts to undertake pre-work visual and passive acoustic surveys and, where possible, to keep watch for marine mammals during transits to and from work sites.

The MMO/PAM operator maintained a look out during breaks in operations and advised the survey crew if marine mammals were detected within the mitigation zone when on watch during daylight hours. Use of the sound source could continue without a full pre-work monitoring period if the break in operations lasted less than 10 minutes and there were no marine mammals in the mitigation zone. If the break in operations lasted 10 minutes or more, a 30 minute pre-work monitoring period was required before operations could resume.

Where possible, soft-starts conducted over a 20 minute period were performed to engage 'full power' by increasing frequency over time or power for the MBES for testing or data acquisition. Soft-starts were not possible for other sound sources due to equipment limitations.

A nominated observer on board each vessel also kept watch for marine mammals during transits to and from the work site and the Scottish Marine Wildlife Watching Code was implemented as required.

Weather conditions are recorded during observations on the Effort forms. Weather can affect the ability to detect marine animals in a number of ways, with increasing sea state, wind force and decreasing visibility reducing the detection probability of marine animals (Forney, 2000) particularly those with inconspicuous surfacing behaviour such as the harbour porpoise (Palka, 1996).

Standard PAM Configurations

The PAM equipment mobilisation and deployment are dependent on vessel specification and are detailed for each viewing platform in the following sections. Information on the equipment and its sampling frequencies are detailed below.

The 12 mm diameter PAM cable is comprised of two sections; the deck cable and the tow cable. The PAM tow cable is 125 m in length and terminated with a 19 pin connector. The streamer consists of an array of 4 hydrophone elements, arranged in two pairs, which are assembled into a 6 m (35 mm diameter) polyurethane tube filled with hydrophone oil to minimise flow noise.

The mid-frequency pair of hydrophone elements, located at the head and the tail of the array have a low cut filter in the pre-amplifier to -3 dB at 100 Hz. These hydrophones have a flat frequency response from 100 Hz up to 15

kHz and a reasonable sensitivity up to 30 kHz. The high frequency pair of hydrophone elements, located in the centre of the array, these pre-amps have a low cut filter set at 2 kHz and the units have a good frequency response between 2 kHz and 150 kHz (Figure B). A depth sensor, built into the tail of the array, and the array is terminated with a tail rope which aids the stabilisation of the tow cable and the reduction of noise from oscillation of the array, whilst adding drag to assist in the initial stage of deployment.

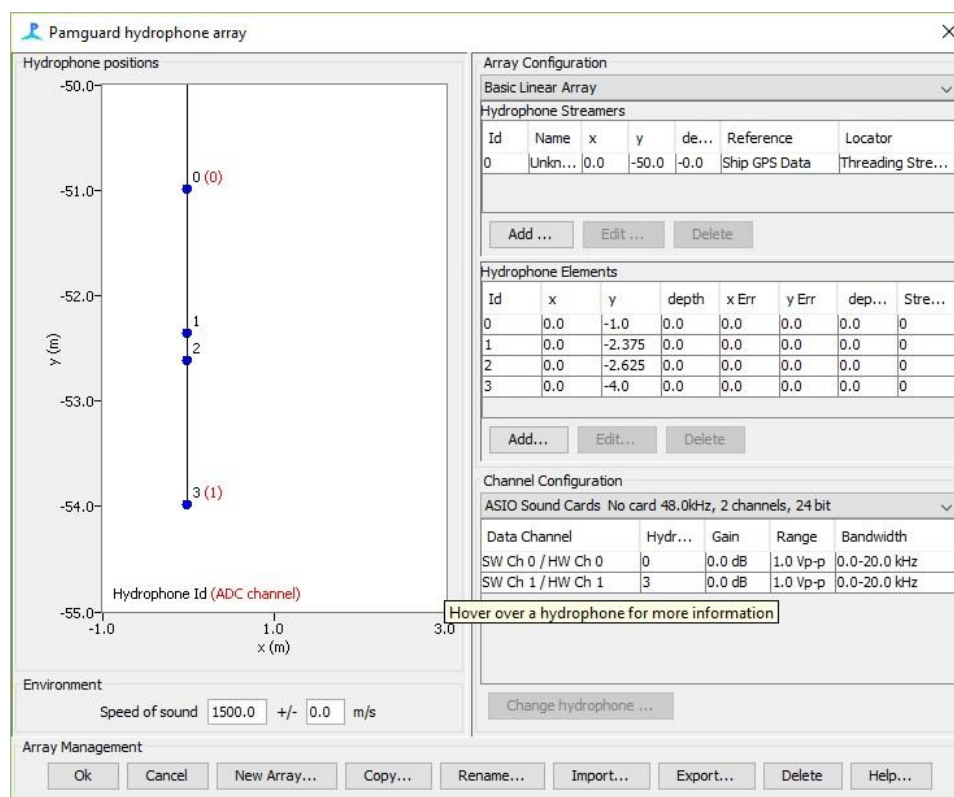


Figure B: Hydrophone array element spacing

The mid-frequency analogue signals were sampled at 96 kHz (allowing a maximum detection frequency of 48 kHz) by a MOTU sound card and streamed to a laptop. The high frequency analogue signal was passed through a balanced amplifier, which also provides 12V power to the array. This allowed further amplification if required and the sound to be filtered; the high frequency data was sampled by a National Instruments digital acquisition card at 360 kHz (allowing a maximum detection frequency of 180 kHz) and passed to a second laptop.

Laptops use the PAMGuard 1.15.05 software, configured with different Data Models, for “Low-Medium” frequency (0 kHz - 48 kHz) for the detection of vocalisations from animals such as Sperm whales and tonal vocalisations such as whistles and moans from small odontocetes (i.e. dolphins) or seals. The second laptop was used to detect “High” frequency (40kHz-180kHz) vocalising animals such as Harbour porpoises and Beaked whales. Both HF and MF models displayed spectrogram data which allowed the operator to make an assessment of noise levels as well as a backup to determining false positive detections from the detector modules. Below is a typical screenshot from the MF user interface (Figure C) showing the spectrogram upon which whistles and clicks are displayed; in this example the vertical blue lines show the vibrocore in operation.

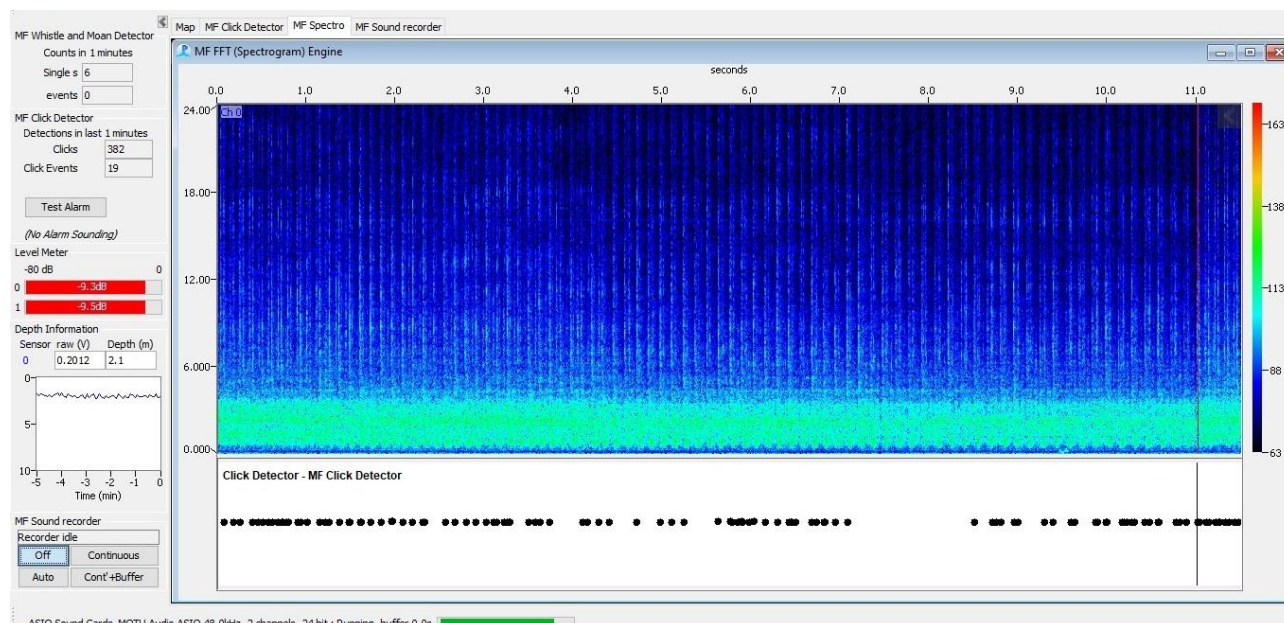


Figure C: Typical spectrogram view of PAMGuard software with vibrocoring represented by blue vertical lines

i. Rover Alpha Viewing Vessel

The vibrocore sampling works off the Moray coast utilised the survey vessel *Voe Vanguard*. The equipment used by the *Voe Vanguard* which required mitigation during the cable installation work included:

- USBL positioning system - Sonardyne Scout USBL acoustic system with user selectable frequencies between 33 and 35 kHz and a maximum source level of 193 dB; and
- Transponders/Beacons - Sonardyne Acoustic Transponder system with user selectable frequencies between 30 and 50 kHz and a maximum source level of 187 dB.

During the vibrocore sampling works space limitations meant that the MMO/PAM operator monitored operations from a separate viewing vessel to undertake pre-work searches prior to the use of the USBL positioning system and beacons.

a. Visual pre-work surveys

A dedicated MMO/PAM operator was aboard the viewing vessel and would monitor the 500 m mitigation zone around the source vessels to ensure that there were no marine mammals present before the sound source was activated. Visual watches were conducted by scanning the area with the naked eye. Reticule binoculars with at least 7 x 50 magnifications were used to confirm species identification. The MMO/PAM operator moved around the bridge to ensure the mitigation zone was monitored thoroughly.

The MMO/PAM operator were able to communicate with the survey team via the master on the viewing vessel, allowing source vessels crew to be kept informed of marine mammal sightings.

JNCC approved deck forms were used to record MMO effort and sightings, whilst the crew of the source vessels kept a record of operations. These data were transferred into an Excel spreadsheet each day.

b. Passive acoustic pre-work surveys

In accordance with JNCC guidelines, a proven PAM system capable of detecting vocalising marine mammals was used on the viewing vessel. A dedicated MMO/PAM operator ensured that all pre-work monitoring periods were monitored acoustically.

The PAM system consists of several components – an array of hydrophones, tow and deck cables, data processing system and specialised marine mammal detection software. The system was designed and built by Vanishing Point Ltd, which was shipped to Buckie with 100% back up, tools and spares.

The towed array was deployed to a length of 50m from the stern of the vessel using a Chinese finger and shackle secured to the stern rail on the *Rover Alpha*. The 50m deck cable was installed along the vessel's port side, terminated by a 19 pin connector at the tow cable end, whilst the dry-end was fitted with a splitter box, providing HF, MF and depth outputs.

Navigation data was collected from a standalone GPS while AIS data was collected via a VHF aerial and Digital receiver to enable accurate localisation of detections and positioning of the *Rover Alpha* in the 500 m mitigation zone of the *Voe Vanguard*. Noise cancelling, stereo headphones were used to monitor the raw acoustic signal.

ii. Coral Wind

The nearshore cable installation works off the Moray coast utilised multicat vessels due to the shallow water depths in that area. The equipment used by the *NKT Victoria* and the *C-Fenna* which required mitigation during the cable installation work included:

- USBL positioning system - Kongsberg HiPAP 500 system with user selectable frequencies between 21 and 30.5 kHz and a maximum source level of 207 dB. *TrackLink 1500* system with user selectable frequencies between 31 and 43.2 kHz
- Positioning Beacons - Kongsberg cNode Mini 34-180 Transponder with user selectable frequencies between 30 kHz and a maximum source level of 190 dB;

During the nearshore work which was conducted by the operations and multicat vessels, space limitations and co-working meant that the mitigation team monitored operations from a separate viewing vessel. A dedicated mitigation team were on board the viewing vessel during the nearshore cable installation works to undertake pre-work searches prior to the use of the USBL positioning system and beacons.

a. Visual pre-work surveys

A dedicated MMO was aboard the viewing vessel during daylight hours to monitor the 500 m mitigation zone around the source vessels to ensure that there were no marine mammals present before the sound source was activated. Visual watches were conducted by scanning the area with the naked eye. Reticule binoculars with at least 7 x 50 magnifications were used to confirm species identification. The MMO moved around the vessel to ensure the mitigation zone was monitored thoroughly.

The MMOs were able to communicate with the survey team via the master on the viewing vessel, allowing source vessels crew to be kept informed of marine mammal sightings.

JNCC approved deck forms were used to record MMO effort and sightings, whilst the crew of the source vessels kept a record of operations. These data were transferred into an Excel spreadsheet each day.

b. Passive acoustic pre-work surveys

In accordance with JNCC guidelines, a proven PAM system capable of detecting vocalising marine mammals was used on the viewing vessel. A dedicated PAM operator ensured that all pre-work monitoring periods were monitored acoustically.

PAM equipment (including back-ups of the key components) was provided by Vanishing Point Marine and consisted of a hydrophone cable, a deck cable, and data processing equipment positioned at the PAM station in the cabin. The hydrophone cable terminated in an oil-filled sensor streamer 5 m long and 3 cm in diameter. The sensor streamer contained two high frequency hydrophone elements positioned 30 cm apart and two medium frequency hydrophone elements.

The hydrophone cable was deployed whilst the mitigation viewing vessel was stationary. The tail rope of the hydrophone cable was attached to a weight that was lowered from the vessel to allow the hydrophone cable to be deployed vertically in the water column. At the deck end of the cable, a Kellum's grip was coupled to a secure point on the vessel to take the strain in the eventuality that the hydrophone cable detached from the weight (Figure B)



Figure B: PAM set-up on the deck of MV *Coral wind* showing how the hydrophone cable was deployed

The dry-end of the hydrophone cable connected to a 20 m deck cable that ran from the hydrophone cable reel on the deck (Figure B) to the data processing equipment in the cabin (Figure C).

The data processing equipment comprised an amplifier/conditioner unit, a National Instruments (NI) Data Acquisition (DAQ) card and a power supply contained within an instrument case (Figure C). The deck lead connected to the rear of an amplifier/conditioner unit. Connecting headphones to the headphone output on the unit allowed direct auditory monitoring in addition to running PAMGuard (open source passive acoustic monitoring software that can provide real-time localisations of vocalisations) for acoustic visualisation and detection.



Figure C: PAM monitoring station was within the wheelhouse of the MV *Coral Wind*

The output from the NI DAQ card was fed into a laptop via USB. PAMGuard was utilised as the primary user interface software during the survey. PAMGuard can provide visual interpretation of acoustic data in addition to automated detection and localisation of marine mammal vocalisations. The software includes real time spectrogram displays in addition to whistle and click detector algorithms.

Navigation data was collected from a standalone GPS while AIS data was collected via a VHF aerial and Digital receiver to enable accurate localisation of detections and positioning of the *Coral Wind* in the 500 m mitigation zone of the source vessel.

Audio data were monitored aurally, using the headphones, and visually, by watching the PAMGuard displays. Marine mammal detections could be recorded by means of the sound recorder module in PAMGuard. Recordings could then be reviewed to provide information such as numbers of whistles and clicks, duration, frequency bandwidth and, in some cases, species identification. In the event of an acoustic detection, the PAM operator also collected screenshots of the PAMGuard displays and completed a sightings/detection data form.

iii. NKT Victoria

Cable jointing activities were undertaken by the *NKT Victoria*. The equipment used for the cable lay included:

- USBL positioning system - Kongsberg HiPAP 500 system with user selectable frequencies between 21 and 30.5 kHz and a maximum source level of 207 dB. *TrackLink 1500* system with user selectable frequencies between 31 and 43.2 kHz
- Positioning Beacons - Kongsberg cNode Mini 34-180 Transponder with user selectable frequencies between 30 kHz and a maximum source level of 190 dB; and
- MBES - Teledyne Reson Seabat 7125; broadband/wideband system with user selectable frequencies between 200 and 400 kHz with a range of 100 m and a maximum source level of 221 dB.

One dedicated, experienced, and certified MMO/PAM operator was on board the *NKT Victoria* throughout the cable jointing works. Pre-work searches were conducted visually when conditions were suitable ($BF \geq 4$ and good visibility) or using PAM when conditions were unsuitable for visual searches ($BF \geq 4$ and/or low visibility and during the hours of darkness).

a. Visual pre-work surveys

Visual pre-work searches were made from the bridge of the *NKT Victoria* when conditions were suitable, prior to beginning operations using either USBL positioning systems, beacons and/or MBES. This location provided the highest point of elevation on board the vessel at 20 m above sea level, as well as providing 360° views. The area was surveyed primarily using the naked eye, with binoculars being used to confirm presence and identify species. Ranges to sightings were determined using a range finder stick (Heinemann 1981) or reticule binoculars. Where possible in the event of sightings, photos were taken (SLR Nikon D3300 camera with a 70-300 mm zoom len) to aid the identification of the species seen. Along with the pre-work searches, the MMO carried out visual watches during daylight hours to record and monitor marine mammals detected. Continuous visual watches were carried out during transit between port and site during daylight hours.

b. Passive acoustic pre-work surveys

A Vanishing Point Marine hardware system was used for PAM and PAMGuard software was used. The PAM equipment was located on the port side of the vessel adjacent to the ROV hanger.

Acoustic pre-work searches were conducted when conditions were unsuitable for visual pre-work searches, prior to beginning operations. The passive acoustic pre-work surveys were undertaken from the *NKT Victoria* using a weighted static hydrophone. A data acquisition unit was set-up with a laptop for signal processing (Figure D), and two channels were monitored by the PAM operator. The weighted vertical hydrophone array, consisting of two hydrophones and a tow cable was deployed to 22 m whilst the vessel was stationary.

Audio data were monitored aurally, using the headphones, and visually, by watching the PAMGuard displays. Marine mammal detections could be recorded by means of the sound recorder module in PAMGuard. Recordings could then be reviewed to provide information such as numbers of whistles and clicks, duration, frequency bandwidth and, in some cases, species identification. In the event of an acoustic detection, the PAM operator also collected screenshots of the PAMGuard displays and completed a sightings/detection data form.

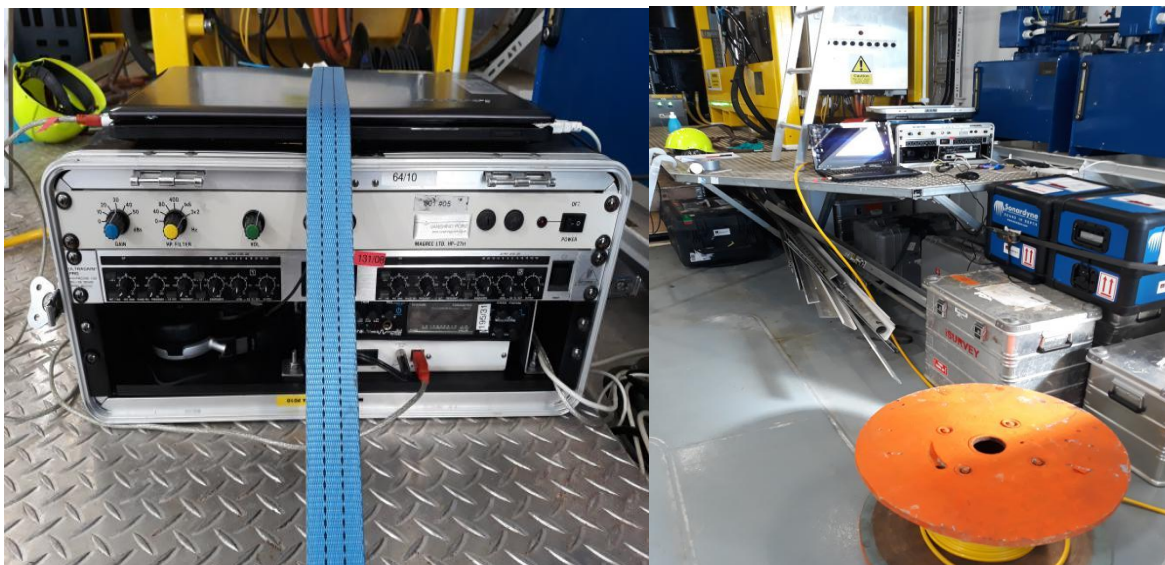


Figure D: Acquisition unit and laptop (left); Deck cable coiled on the spool (right).

iv. MV Relume

MFE operations were undertaken by the *MV Relume*. The equipment used for the MFE works included:

- USBL positioning system - Kongsberg HiPAP 501 system with user selectable frequencies between 21 and 31 kHz and a maximum source level of 206 dB;
- Transponder Beacons - Kongsberg cNode Mini Transponder with frequency of 21 – 31 kHz and a maximum source level of 190 dB; and
- Transponder Beacons - MST 319 Transponder with frequency of 30 kHz and a maximum source level of 190 dB.

A mitigation team of up to three dedicated, experienced, and certified JNCC MMO/PAM operators were on board the *MV Relume* during the MFE and survey works due to its location within the nearshore Portgordon area. Pre-work searches were conducted visually when conditions were suitable or using PAM when conditions were unsuitable for visual searches (increased sea states/low visibility and during the hours of darkness).

a. Visual pre-work surveys

Visual pre-work searches were primarily conducted from the bridge, and from the vessel's front deck situated just below and aft of the bridge (19.5m & 18.0m above sea level respectively) of the *MV Relume* when conditions were suitable, prior to beginning operations using the USBL positioning systems and beacons. These locations provided the highest point of elevation on board the vessel, as well as providing 360° views. The area was surveyed primarily using the naked eye, with binoculars being used to confirm presence and identify species. Ranges to sightings were determined using a range finder stick (Heinemann 1981) or reticule binoculars. Where possible in the event of sightings, photos were taken (either with a SLR Canon 1300D camera and a Canon 100D both with 75-300 mm zoom lens) to aid the identification of the species seen. Along with the pre-work searches, the MMO carried out visual watches during daylight hours to record and monitor marine mammals detected. Continuous visual watches were carried out during transit between port and site during daylight hours.

b. Passive acoustic pre-work surveys

A Vanishing Point Marine hardware system was used for PAM and PAMGuard software was used. The PAM data acquisition unit, along with one laptop, has been set up on a desk in a room on the work deck level (see Figure E). The deck cable was rigged up to the higher mezzanine deck for ease of use. A vertical hydrophone array was being used for this survey. The array consists of 2 hydrophone elements and has a weight attached at the end for optimal detection results. Acoustic pre-work searches were conducted when conditions were unsuitable for visual pre-work searches, prior to activation of the sound source.



Figure E: PAM monitoring station

The distance from the hydrophone deployment point to the data acquisition unit was minimal. The deck cable has been rigged up to the higher mezzanine deck for ease of use (Figure F).



Figure F: Hydrophone cable deployment area showing where the cable has been coiled and secured

The hydrophone cable, fed from the deck below, is coiled and stored ready for a quick deployment. 12.5m of cable, plus the fluid-filled hydrophone section, is required for deployment from the rail to which it is attached with a Chinese finger knot.

Deployment is straightforward and a member of crew will be around to help deploy and retrieve. Once given the all clear from the bridge, the hydrophone is deployed over the port side of the vessel for the pre-work search. Once the pre-work search had been completed, the cable is retrieved and stored away neatly for the following deployment.

v. EDT Hercules

Cable removal works were undertaken by the *EDT Hercules*. The equipment used for the works included:

- USBL positioning system - Kongsberg HiPAP 501 system with user selectable frequencies between 21 and 31 kHz and a maximum source level of 207 dB; and
- Transponder Beacons - Kongsberg cNode Mini 34-180 Transponder with frequency of 30 kHz and a maximum source level of 190 dB.

A dedicated, experienced, and certified JNCC mitigation team were on board the *EDT Hercules* throughout the cable repair works with two operators onboard for the works within 3 km of Portgordon and a solo MMO/PAM operator at all other times. Pre-work searches were conducted visually and acoustically when conditions were suitable or using PAM when conditions were unsuitable for visual searches (increased sea states/low visibility and during the hours of darkness).

a. Visual pre-work surveys

Visual pre-work searches were made from the bridge of the *EDT Hercules* when conditions were suitable, prior to beginning operations using either the USBL positioning systems and/or beacons which were used each time the ROV was launched. This location provided the highest point of elevation on board the vessel at 15 m above sea level, as well as providing 360° views. The area was surveyed primarily using the naked eye, with binoculars being used to confirm presence and identify species. Along with the pre-work searches, the MMO carried out visual watches during daylight hours to record and monitor marine mammals detected. Continuous visual watches were carried out during transit between port and site during daylight hours.

b. Passive acoustic pre-work surveys

A Vanishing Point Marine hardware system was used for PAM and PAMGuard software was used. The PAM system used two laptops to maximise processing power, screen area and add redundancy. The data acquisition unit and laptops were secured to the survey desk (Figure G), the deck cable run through the bulkhead and out to the port side attached to the PAM cable to overboard. Only a short cable run was required for the deck cable, the remainder was coiled and secured on deck. The unprocessed acoustic signal is monitored by headphones.



Figure G: PAM monitoring station

During these works, PAM operations were only conducted when the vessel was stationary, thus a vertical hydrophone array was used. This array comprised 4 hydrophone elements in a protective filament and was used with a cable length of 125 m. The PAM cable was fed out from a side vent on the vessel (Figure 2.2); this angled the cable away from the side of the vessel. The hydrophone section was lowered in to the water until it was 5m below water line (this was measured and marked prior to deployment) this was then secured with a Chinese finger to deck and laid back on deck ready for deployment with the remainder of the 125m cable coiled back on the drum and securely fastened. A weight was attached to the end of hydrophone array to assist sinking.

1. Chapter 1 – Vibrocore Survey

Geotechnical survey work (vibrocore sampling) was carried out by the *Voe Vanguard* between the 20th and 23rd February 2018.

1.1. Vibrocore Sampling

The *Voe Vanguard* used a Feritech FT550 vibrocorer to collect the samples. To accurately position the vibrocore, a Sonardyne Scout USBL (Ultra Short Baseline) acoustic system was used, which consists of two main acoustic components. A Beacon or transponder (Figure 1.1.1, left) was attached to the vibrocore frame which was interrogated acoustically by a pole mounted USBL transceiver (Figure 1.1.1, right) mounted over the side of the *Voe Vanguard* to provide a range and bearing to the vibrocore on the seabed, relative to the ships GPS.

A dedicated MMO/PAM operator was stationed onboard the viewing vessel (*Rover Alpha*) during vibrocore sampling works.



Figure 1.1.1: USBL system components – Beacon (left) and pole mounted Transceiver head (right)

1.1.1. Mitigation methods

Pre-work searches were carried out as described in Mitigation Methods section III. This included visual and passive acoustic searches conducted between the 20th and 23rd February 2018 prior to the use of the USBL positioning system.

1.1.2. Vibrocore sampling work undertaken

13 sites were sampled by the vibrocore and 42 cores collected along the length of the route between KP 19 and KP 63. At each location 3 vibrocore samples were taken. Prior to operations commencing, a pre-job briefing held with the contractor onboard the *Voe Vanguard* while alongside in Buckie to confirm the requirements for mitigation.

1.1.3. Results

1.1.3.1. Survey summary

The viewing vessel mobilised from Buckie harbour, Moray. The PAM equipment was set up and tested on February 19th. The first pre-work monitoring was completed on the 20th prior to use of the USBL positioning system

from the *Voe Vanguard*, whilst the final pre-work search for the nearshore boulder clearance work was completed on the 22nd February.

Whilst the transit speed of the mitigation vessel *GV Rover Alpha* was too high to deploy PAM, many of the sites were within a few metres of each other therefore a watch was maintained between sampling stations.

A total of 42 operations were undertaken during this phase of work. A further operation was planned but not started after the completion of a pre-work search.

1.1.3.2. Weather conditions

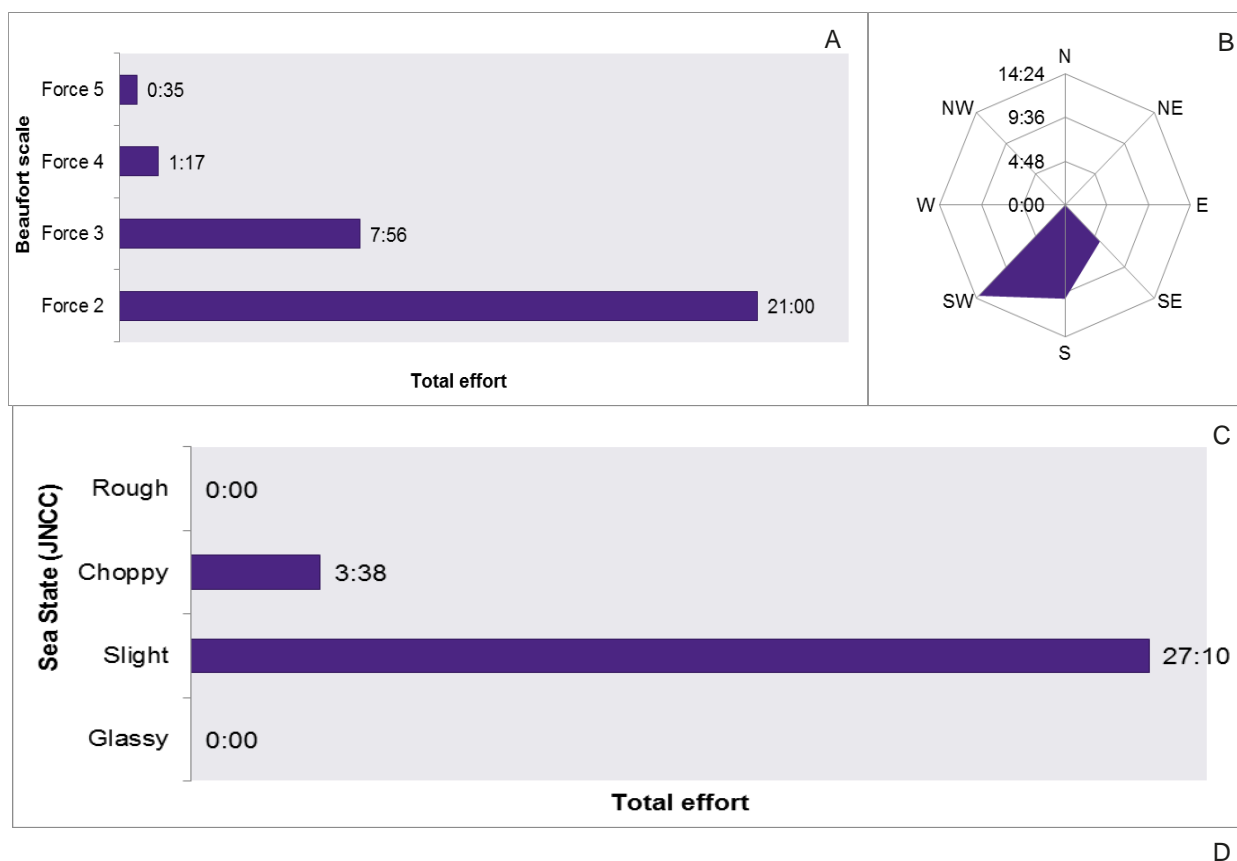
Wind speed and direction, sea state, swell height, visibility, sun glare and precipitation were recorded during on effort and are summarised below. A total of 9 hours and 57 minutes of visual effort were conducted during daylight hours when visibility and sun glare conditions were recorded and all other factors over the 30 hours and 48 minutes of acoustic monitoring.

Wind speed ranged from BF 2 to 5 (Figure 1.1.A) during visual monitoring. The majority of visual effort (68%) took place during BF 2 winds followed by BF 3 (26%). The wind direction was predominantly from the southwest (46%) and from the south 33% of all visual monitoring time (Figure 1.1.1B).

Slight sea state conditions were recorded during 88% of the visual survey effort (Figure 1.1.1C). Choppy sea conditions were the second most common sea state encountered by the MMO and accounted for the remaining 12% of the effort. During the nearshore boulder clearance work the swell remained low (< 2 m) throughout.

Visibility can change as a result of time of day or precipitation. Good visibility (> 5 km) accounted for all of the MMO effort. There were 17 minutes of light rain (1%) recorded during effort.

Sun glare was experienced at times during the survey although there was most often no glare (45%). The levels of sun glare that were experienced during the survey can be seen in Figure 1.1.1D.



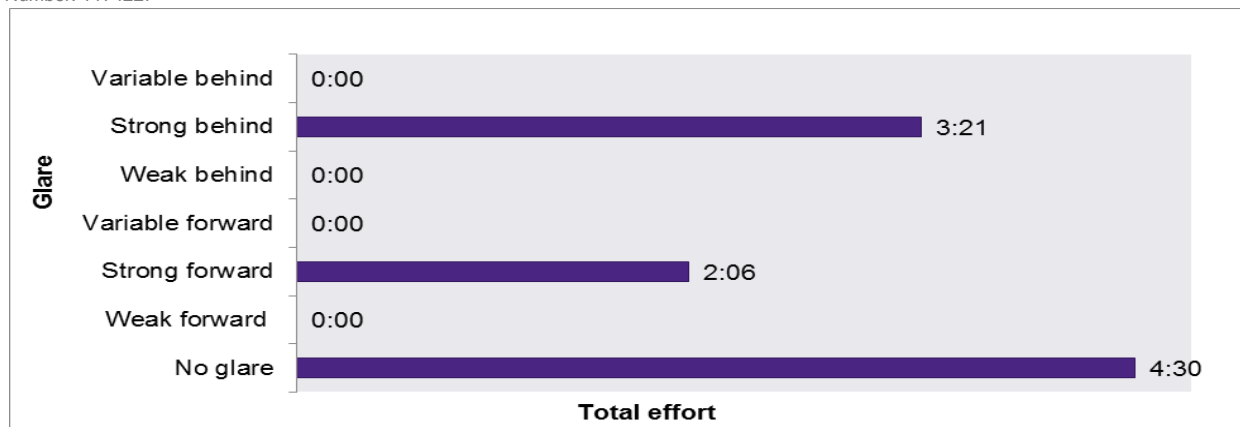


Figure 1.1.2: Environmental conditions during the course of observations in hh:mm, A) wind speed (Beaufort), B) wind direction C) sea state and D) sun glare.

1.1.3.3. Marine mammal observations

During the vibrocore survey work there were no visual sightings or acoustic detections of marine species.

1.1.3.4. Mitigation

A total of 42 sample stations were completed, with four 30 minute pre-work monitoring periods to be conducted first. A further operation was planned but abandoned following the pre-work search.

Of the pre-work monitoring periods, four were conducted acoustically and one was conducted both visually and acoustically due to the PAM equipment being stationed on the bridge with the use of wireless headphones.

During the survey, 9 hours and 57 minutes of visual monitoring and 30 hours and 48 minutes of acoustic monitoring were conducted. Of the mitigation monitoring, 81% of effort was carried out during operations (in case of breaks in activity), 19% of monitoring was carried out when there was no active source (i.e. pre-work searches and transits) (Figure 1.1.3).

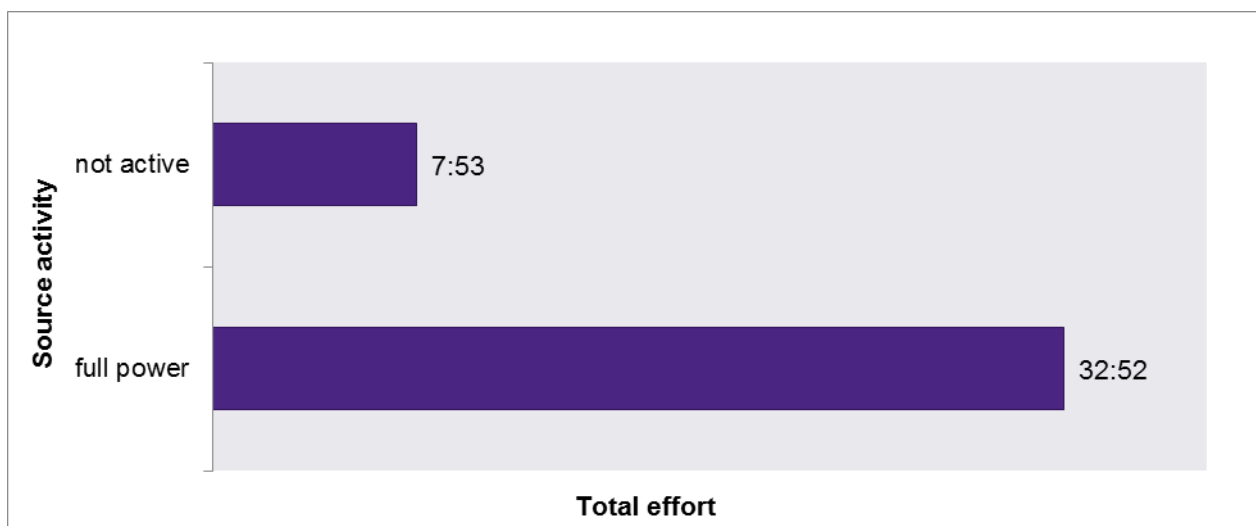


Figure 1.1.3: Combined visual and acoustic monitoring throughout operations (hh:mm)

Mitigation action

No mitigation action was required due to the lack of presence of marine mammals.

Compliance

There were multiple technical challenges with the survey work, and this meant that on occasion there were delays between samples during which the USBL was in continual operation. The survey crew were advised that

unnecessary noise emissions should be avoided where possible and that the USBL transponder should be shut down if extended delays were predicted.

2. Chapter 2 – Cable Operations

Cable operations started on the 23rd February and finished on the 20th June 2018 after the completion of the post cable repair survey. Four separate activities were carried out during this period:

- The cable pull-in performed by the *NKT Victoria* and *C Fenna* working with an additional viewing vessel (*MV Coral wind*) including pre and post pull-in surveys;
- MFE work and cable de-burial performed by the *MV Relume* with onboard mitigation team;
- Fault finding investigations undertaken by the *EDT Hercules* with a mitigation team onboard; and
- Cable jointing works conducted by the *NKT Victoria* with a MMO/PAM Operator onboard.

2.1. Cable Pull-in Operations

The Cable Lay Vessel (CLV) *NKT Victoria* undertook cable pull-in operations and associated surveys between the 23rd February and the 4th April 2018 with the assistance of the Utility Vessel *C Fenna*.

The work consisted of HVDC and fibre optic cable pull-in at Portgordon to the omega joint performed by the two vessels, working with an additional viewing vessel (*MV Coral wind*) to permit concurrent visual and PAM monitoring when within 3 km of Spey Bay (as per the licence). This included mitigation for pre and post cable pull-in surveys.

A dedicated mitigation team was situated on the viewing vessel *MV Coral wind* throughout the full duration of the works and performed all mitigation requirements. They undertook pre-work searches visually and passive acoustically as per the marine mammal protection plan and kept watch for marine mammals during transit to and from the work site.

2.1.1. Mitigation methods

Pre-work searches were conducted as outlined in the Mitigation Methods section i. Pre-work searches were conducted prior to the use of any of the USBL and beacons and after breaks in operations.

The MMO carried out continuous watches, even during operations, in daylight hours, and completed the relevant recording forms. Pre-watches were undertaken as required using PAM within the 3 km of Spay Bay and during periods of darkness, low visibility, or increased sea states.

2.1.2. Cable pull-in work undertaken

The *NKT Victoria* left port in Emden, Germany on the 21st February and transited to the Moray Firth. On arrival in the Moray Firth equipment calibrations were carried out on the 23rd February and the pre cable pull-in surveys commenced on the 27st February. From the 27st February to the 2nd March a survey of the cable route and trench was undertaken to check for obstructions and the cable position using the MBES and ROV. From the 9th March the cables were pulled-in at Portgordon and jointed in the nearshore and the Omega joint location. The pull-in operations were completed on the 6th April following a post pull-in survey.

Geophysical equipment used during cable pull-in work was as follows; USBL positioning systems and positioning transponders, Scanning Sonar, and a MBES for surveying the cable route. As per the EPS Licence, no mitigation was required for the MBES and SS only prior to the use of the USBL and beacons.

2.1.3. Results

2.1.3.1. Survey summary

The MMO and PAM Operators carried out a total of 46 hours and 50 minutes of monitoring for marine mammals. There were 23 hours and 31 minutes of visual monitoring and 23 hours and 19 minutes of dedicated acoustic monitoring. This included nine pre-work searches, totalling nine hours and five minutes.

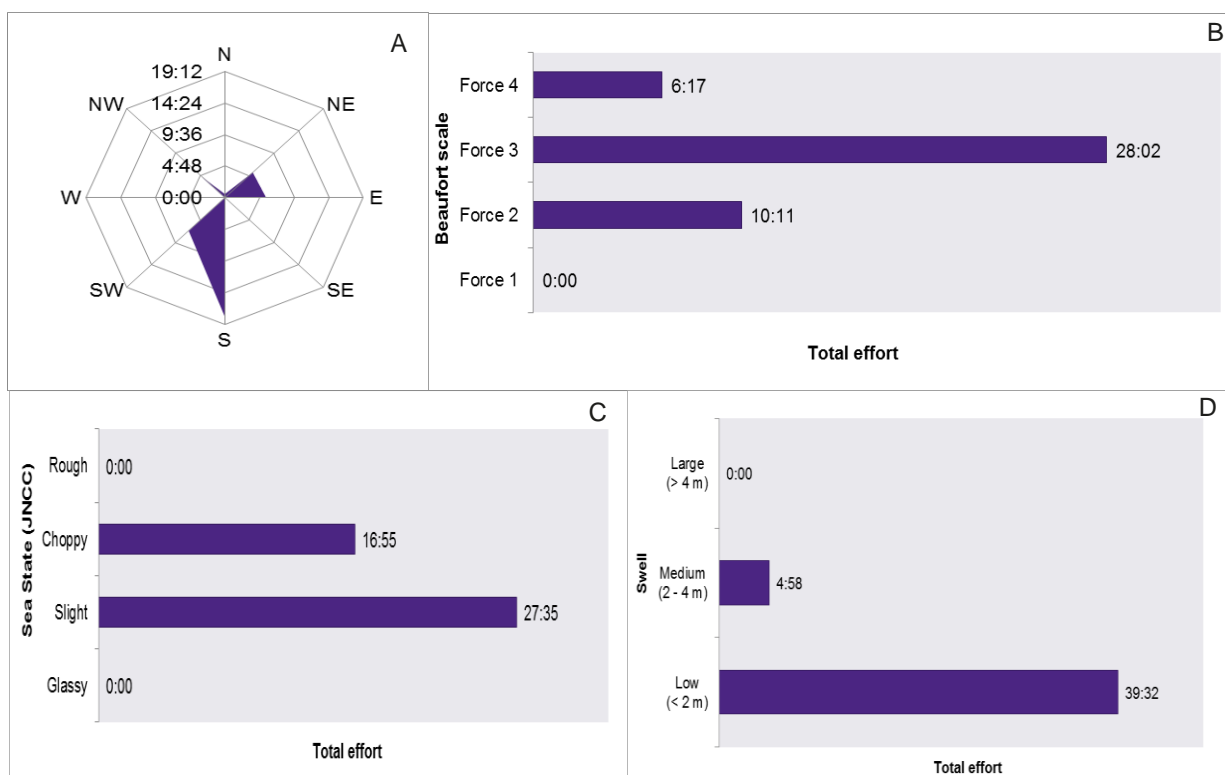
2.1.3.2. Weather conditions

Wind speed and direction, sea state, swell height, visibility, sun glare and precipitation were recorded during daylight hours when the MMO and PAM operators were on effort and are summarised below. Full survey conditions were not recorded during PAM watches during hours of darkness.

The wind direction was mainly from the south (41%) and southwest (16%) (Figure 2.1.1 A); wind speed ranged mainly from BF 2 to 4 (Figure 2.1.1 B) during visual monitoring. The majority of visual effort (36%) took place during BF 3 winds followed by BF 2 (23%).

Slight sea state conditions predominated being recorded during 62% of the visual survey effort (Figure 2.1.1 C). Choppy sea conditions accounted for the rest of the sea state encountered by the MMO and accounted for 38% of the visual effort. During the operations the swell (Figure 2.1.1 D) was mainly low (< 2 m) 89% of the time with occasional medium (2-4m) periods (11%).

Visibility changed as a result of time of day or precipitation. Good visibility (> 5 km) accounted for 93% of the MMO effort (Figure 2.1.1 E). Poor visibility (< 1 km) was experienced for 6% of the survey. Periods of Moderate visibility (1- 5 km) accounted for only 18 minutes of the effort.



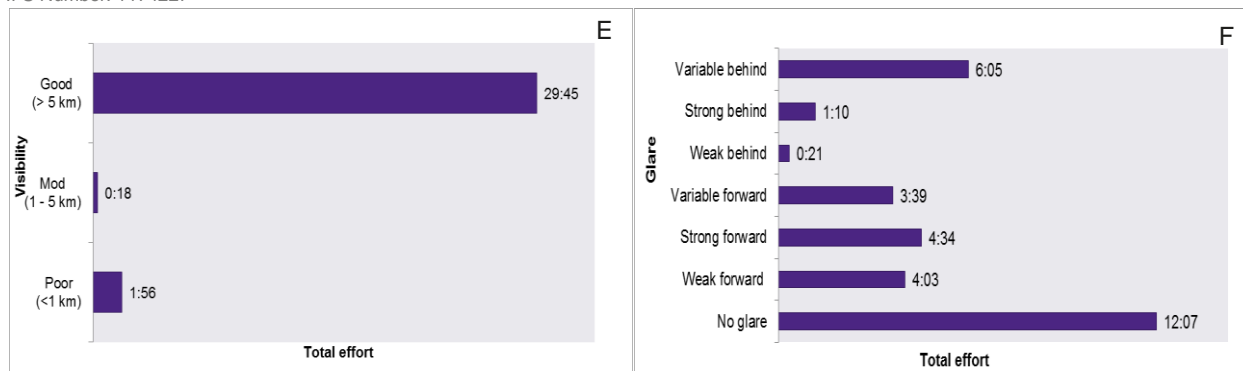


Figure 2.1.1: Environmental conditions during the course of observations in hh:mm, A) wind direction, B) wind speed (Beaufort), C) sea state, D) swell, E) visibility and F) sun glare.

Precipitation was recorded during visual survey effort; the majority of effort (87 %) was during periods with no precipitation. Snow accounted for 13% of effort with no rain recorded. Sun glare was experienced at times during the survey (Figure 2.1.1 F) although there was no glare for 38% of observations. The majority of the time the glare was from ahead (forward) of the vessel (38%) and the rest of the time (24%) it was from behind.

2.1.3.3. Marine mammal observations

During the cable lay operations the MMO/PAM operator recorded observations of all marine mammals during dedicated watches and any incidental sightings which occurred (e.g. those made by vessel crew/during transits).

Visual sightings

Both of the sightings made during observations were of grey seals and occurred prior to operations with no active source.

Acoustic detections

There were no acoustic detections of marine mammals made during the 23 hours and 19 minutes of acoustic monitoring that took place during the cable lay operations.

As previously stated, underwater seal vocalisation is relatively uncommon, in comparison to other marine mammals. Thus, it was not expected to obtain an acoustic detection coinciding with the visual sighting, despite the proximity to the hydrophone.

2.1.3.4. Mitigation

A total of 11 equipment start-up operations were completed during the works, with 10 requiring a 30 minute pre-work monitoring period to be conducted first.

Of the pre-work monitoring periods, seven were during daylight hours and were conducted with concurrent visual and acoustic monitoring; two were during the night and were conducted acoustically. One additional pre-work search was conducted outside the 3 km from Spay Bay and performed with only a visual watch.

Of the mitigation monitoring, 50% of the effort was carried out during operations (in case of breaks in activity), 50% of monitoring was carried out when there was no active source (i.e. pre-work searches and transits) (Figure 2.1.2).

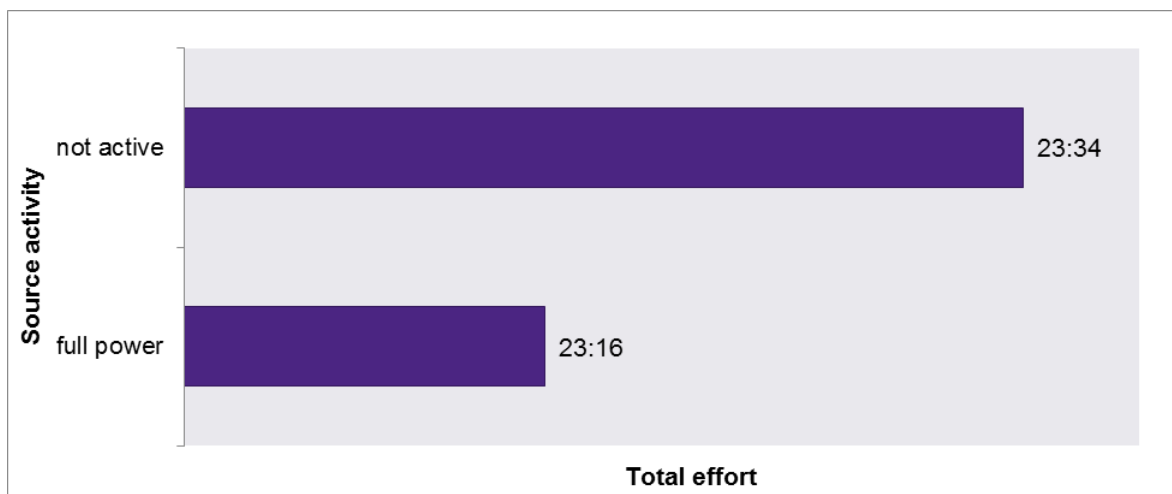


Figure 2.1.2: Combined visual and acoustic monitoring throughout operations (hh:mm)

Mitigation action

There was one sighting of a grey seal during a pre-work search at 09:34 UTC on the 4th March 2018. The *C Fenna* was advised of the seals presence and that a 20 minute delay would be required. On completion of the delay and search the all clear was give but due to operational reasons the vessel was not ready to start operations. The search continued for another 20 minutes until the *C Fenna* activated is USBL for ROV testing. As such no direct delay was caused by the seal entering the mitigation zone.

Compliance

During this campaign when, on the 27th February 2018 a visual pre-work search was completed by bridge personnel on the *NKT Victoria* as opposed to the mitigation team.

This situation arose due to poor weather conditions, it was decided that the *NKT Victoria* would head offshore to conduct a survey of a part of the installed cable. The mitigation team were called out on the *Coral Wind* at 08:23 UTC, however the decision was made at 09:20 UTC by the skipper of the *Coral Wind* to abort the approach to the *NKT Victoria* due to high swell's and a potential to exceed safe working conditions in maintaining contact with the *NKT Victoria*.

The *NKT Victoria* was advised that the *Coral Wind* could not stay out to do the pre-work search due to the conditions. The Captain on the *NKT Victoria*, who had received a briefing from the project Environmental Advisors on the MMO/PAM procedures (specifically in order to undertake transit watches to comply with the Scottish Marine Wildlife Watching Code), took the decision to undertake a visual watch to ensure no animals were around the vessel prior to undertaking the survey work. This pre-work search was undertaken from 09:38 UTC – 10:08 UTC. No animals were sighted in this time.

2.2. MFE Work and Cable De-burial

The *MV Relume* undertook Phase II of the MFE and cable de-burial works and associated surveys between the 12th of May and the 11th June 2018. During that time a port call was made at Aberdeen harbour between 13th and 16th May 2018.

A dedicated mitigation team was on board the *MV Relume* throughout the full duration of the works and performed onboard mitigation. They undertook pre-work searches visually and passive acoustically as per the Marine Mammal Protection Plan (Natural Power report number 1084113) and kept watch for marine mammals during transit to and from the work site.

Between the 16th May and 2nd June the operations took place within 3 km of Spey bay and as such additional personnel were present due to the extended duration of daylight and requirement for concurrent PAM and visual monitoring in this area.

2.2.1. Mitigation methods

Pre-work searches were conducted as outlined in the Mitigation Methods section III. Pre-work searches were conducted prior to the use of any of the geophysical equipment and after breaks in operations.

The mitigation team carried out continuous watches, even during operations, in daylight hours, and completed the relevant recording forms. Pre-watches were undertaken as required using PAM during periods of darkness, low visibility, or increased sea states, and concurrently with visual for works in the nearshore area.

2.2.2. MFE and cable de-burial work undertaken

The *MV Relume* left port in Aberdeen on the 11th May and transited to the Moray Firth. The operations undertaken from the *MV Relume* between 11th and 13th May included conducting visual and MBES surveys of various sections of the cable route and searching for faults on the cable. The MFE works at Portgordon commenced on the 16th May and continued with de-burial and trenching across the cable route until the 11th June.

The types of geophysical survey equipment used during this phase of the work are listed in Section III. The USBL systems were always activated prior to the use of the beacon on the ROV or MFE pipe. It was not possible to soft start the USBL system or beacons. As per the EPS Licence, no mitigation was required for the MBES and SS only prior to the use of the USBL and beacons.

2.2.3. Results

2.2.3.1. Survey summary

The mitigation team carried out a total of 209 hours and 12 minutes of monitoring for marine mammals. There were 22 hours and 35 minutes of dedicated marine mammal acoustic monitoring and 186 hours and 37 minutes of visual monitoring carried out between 11th of May and the 11th of June 2019. This included 39 pre-work searches (including 14 concurrent visual and acoustic watches), totalling 20 hours in duration.

2.2.3.2. Weather conditions

Wind speed and direction, sea state, swell height, visibility, sun glare and precipitation were recorded during daylight hours when the MMO/PAM operator was on effort and are summarised below. A total of 196 hours and 42 minutes of visual effort were conducted during daylight hours. Survey conditions were not recorded during PAM watches during hours of darkness.

The wind direction was mainly from the northeast (32%), north (17%) and east (15%) (Figure 2.2.1A). Wind speed ranged mainly from BF 1 to 6 (Figure 2.2.1B) during visual monitoring. The majority of visual effort (27%) took place during BF 3 winds followed by BF 4 (26%) and BF 2 (25%).

Slight sea state conditions predominated being recorded during 70% of the visual survey effort (Figure 2.2.1C). Choppy and Glassy sea conditions were the second most common sea state encountered by the MMO and accounted for 15% each of the visual effort. During the operations the swell was mainly low (< 2 m) 96% of the time with occasional medium (2-4m) periods (4%).

Visibility changed as a result of time of day or precipitation. Good visibility (> 5 km) accounted for 91% of the MMO effort (Figure 2.2.1D). Moderate visibility (1 - 5 km) was experienced for 7% of the survey. Periods of poor visibility (< 1 km) accounted for only 2% of the effort.

Precipitation was recorded during visual survey effort (Figure 2.2.1 E); the majority of effort (96%) was during periods with no precipitation. Light rain and moderate rain accounted for 2% of effort with being recorded for 2% each of effort. Sun glare was experienced at times during the survey (Figure 2.2.1F) although there was no glare for 34% of observations. The majority of the time the glare was from ahead of the vessel (36%) and the rest of the time (29%) it was from behind of the vessel.

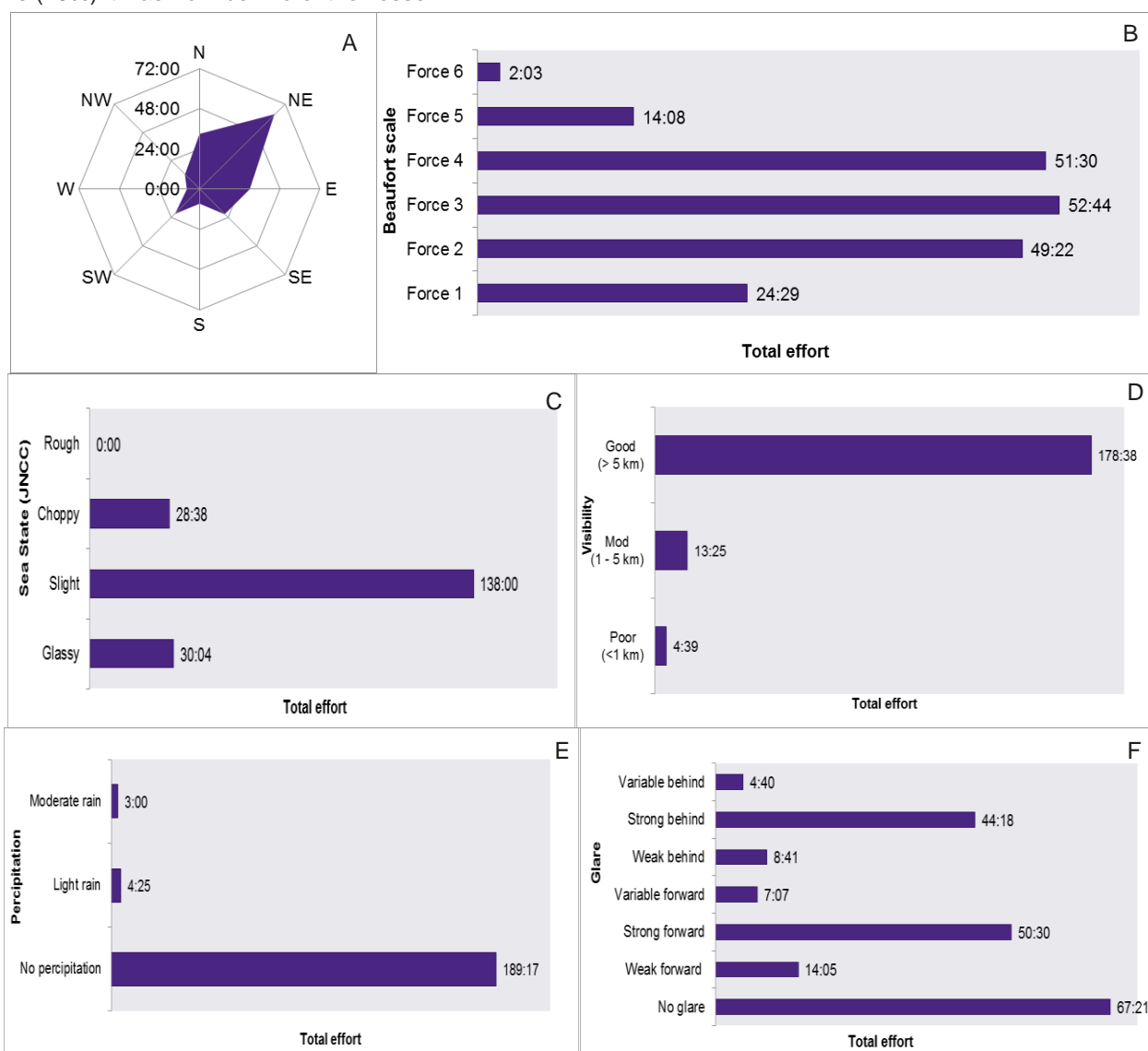


Figure 2.2.1: Environmental conditions during the course of observations in hh:mm, A) wind direction, B) wind speed (Beaufort), C) sea state, D) visibility, E) precipitation and F) sun glare.

2.2.3.3. Marine mammal observations

During the MFE operations the MMO/PAM operators recorded observations of all marine mammals during dedicated watches and any incidental sightings which occurred (e.g. those made by vessel crew/during transits).

Visual sightings

A total of 41 marine mammal sightings and one detection were recorded, details of which are given below and in Appendix A1. A summary of the sightings split into species is in table 2.2.1 below.

Three of the sightings occurred when equipment was in operation, and in total 25 animals entered the 500 meter mitigation zone, two of which occurred during a pre-work search. Of the 41 sightings, 29 were identified to species level and comprised of four sighting of harbour porpoises, eight of bottlenose dolphins (Figure 2.2.2), seven of minke whales, nine of grey seals (Figure 2.2.3) and two of common seals. All sightings were of species considered likely to be seen during the works.

Table 2.2.1: Marine mammal visual sightings summary table

Species	Number of Sightings	Total No. of Individuals
Harbour Porpoise	4	5
Bottlenose dolphins	8	53
Minke whale	7	7
Grey seal	9	10
Common Seal	2	2
Unidentified dolphin	2	10
Unidentified seals	9	10
Total	41	97



Figure 2.2.2: Sighting No. 01 - Bottlenose dolphin, *Tursiops truncatus* on 11/05/2018



Figure 2.2.3: Sighting No. 31 - Grey seal *Halichoerus grypus* seen on 01/06/2018

Acoustic detections

There was one acoustic detection of marine mammals made during the 22 hours and 35 minutes of acoustic monitoring that took place during the MFE and repair operations. This was the only time an acoustic detection was made during combined visual and acoustic watch. The detection was identified as a dolphin species, and as visual searches were also in effect, the dolphins could be confirmed as bottlenose dolphins (Figure 2.2.4).

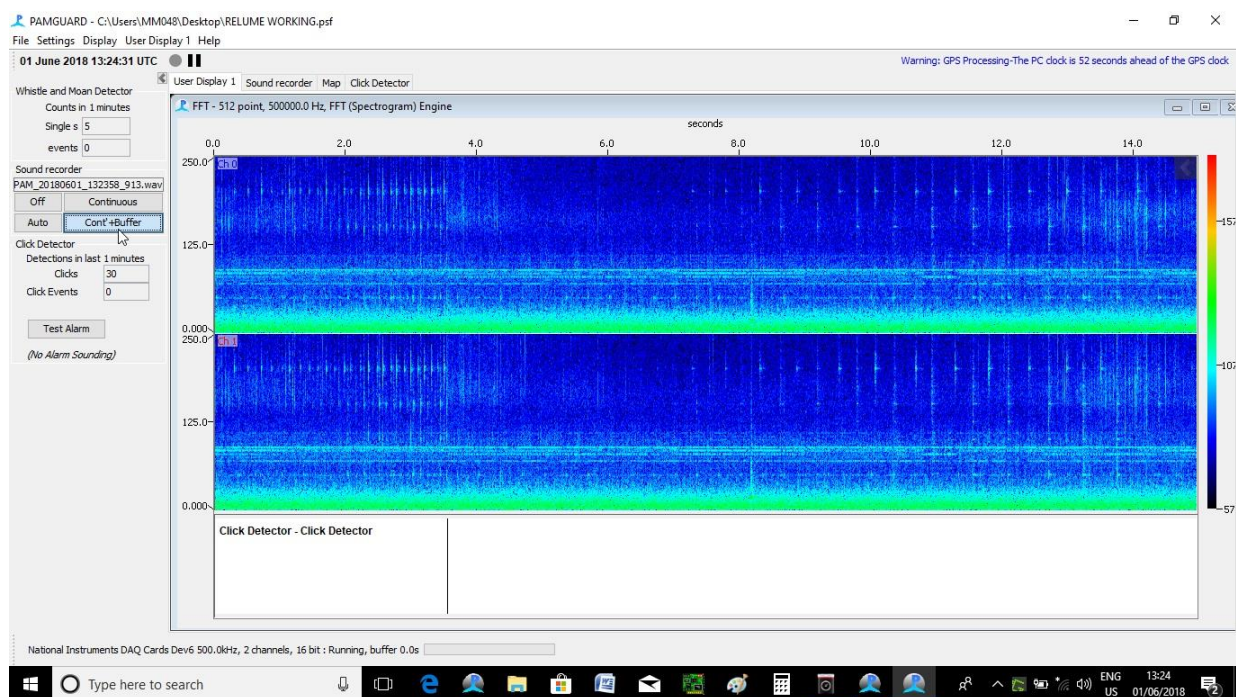


Figure 2.2.4: Sighting No. 30 - Bottlenose dolphin, *Tursiops truncatus* clicks on spectrogram on 01/06/2018

2.2.3.4. Mitigation

A total of 39 equipment start-up operations were completed during the work, with 38 requiring a 30 minute pre-work monitoring period, totalling 20 hours of combined visual and acoustic effort.

Of the pre-work monitoring periods, 12 were carried out visually, 12 were conducted only acoustically, and there were 14 combined visual and acoustic pre-work searches.

Of the mitigation monitoring (Figure 2.2.5), 31% of the effort was carried out during operations (in case of breaks in activity), 69% of monitoring was carried out when there was no active source (i.e. pre-work searches and transits).

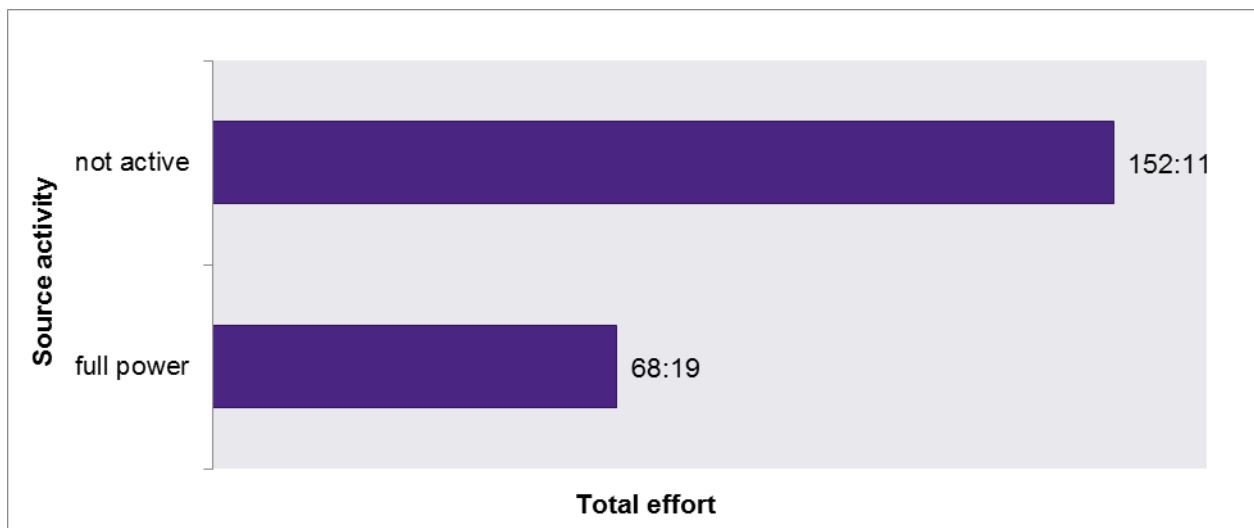


Figure 2.2.5: Combined visual and acoustic monitoring throughout operations (hh:mm)

Mitigation action

Mitigation action was required on two occasions following the detection of marine mammals within the mitigation zone during pre-work monitoring.

- On 25/05/2018 a harbour seal within the mitigation zone resulted in a 20 minute delay to the start of operations.
- On 30/05/2018 a grey seal within the mitigation zone resulted in a 14 minute delay to the start of operations.

Compliance

On 31/05/2018 at 03:50 UTC, the bridge supervisor informed the MMO on watch that the USBL was off. At 05:38 UTC the MMO noticed that the USBL was interrogating. The bridge supervisor informed the MMO that the USBL was interrogated by mistake due to an accidental activation, and that the time of activation was unknown. The USBL was then switched off immediately.

On 04/06/2018 at 11:44 UTC it was noticed that the USBL was still interrogating and that no tool was in the water at that time. The survey crew were advised that unnecessary noise emissions should be avoided where possible and that the USBL transponder should be shut down if extended delays were predicted.

2.3. Fault Finding Investigations

The *EDT Hercules* undertook fault finding investigations and associated surveys between the 26th May and the 05th June 2018. The vessel mobilised from the port of Montrose, Scotland on the 22nd May 2018 prior to transit to site in the Moray Firth; the PAM equipment was mobilised on the same day. The vessel sailed for site on the 25th May and commenced works on arrival on the 26th May.

The scope of work was to locate a fault in the cable and de-bury and cut ready for another vessel to complete the repair. One dedicated MMO/PAM Operator was on board while the vessel was working outside 3 km from Portgordon. Between the 4th and 6th June the operations took place within 3 km of Spey bay and as such an additional MMO/PAM operator was present. This ensured the license conditions which required concurrent visual and acoustic monitoring were able to be met.

2.3.1. Mitigation methods

Pre-work searches were conducted as outlined in the Mitigation Methods section III. Pre-work searches were conducted prior to the use of any of the USBL and beacons and after breaks in operations.

The MMO carried out continuous watches, even during operations, in daylight hours, and completed the relevant recording forms. Pre-watches were undertaken as required using PAM within the 3 km of Spey Bay and during periods of darkness, low visibility, or increased sea states.

2.3.2. Fault finding work undertaken

The *EDT Hercules* left port in Montrose on the 22nd May and arrived on site on the 26th May after conducting DP trials and testing to start operations. The initial cable surveys with the MBES were completed on the 26th May and the cable de-burial and cutting commenced on the 27th May. This work continued until the 6th June when the post as left surveys and UXO surveys commenced. The survey continued with a trip in to Aberdeen between the 3rd and 4th June and completed on the 6th of June when the vessel transited to port for de-mobilisation.

Geophysical equipment used during cable pull-in work was as follows; USBL positioning systems and positioning transponders, Scanning Sonar, and a MBES for surveying the cable route. As per the EPS Licence, no mitigation was required for the MBES and SS only prior to the use of the USBL and beacons.

2.3.3. Results

2.3.3.1. Survey summary

The MMO and PAM Operators carried out a total of 73 hours and three minutes of monitoring for marine mammals. There were 70 hours and 43 minutes of visual monitoring and two hours and 20 minutes of dedicated acoustic monitoring. This included seven pre-work searches, totalling four hours.

2.3.3.2. Weather conditions

Wind speed and direction, sea state, swell height, visibility, sun glare and precipitation were recorded during daylight hours when the MMO and PAM operators were on effort and are summarised below. Full survey conditions were not recorded during PAM watches during hours of darkness.

The wind direction was mainly from the east (30%) and northeast (29%) (Figure 2.3.1 A); wind speed ranged mainly from BF 1 to 5 (Figure 2.3.1 B) during visual monitoring. The majority of visual effort (33%) took place during BF 2 winds followed by BF 4 (25%) and BF 3 (24%).

Slight sea state conditions predominated being recorded during 91% of the visual survey effort (Figure 2.3.1 C). Glassy sea conditions accounted for the rest of the sea state encountered by the MMO and accounted for 9% of the visual effort. During the operations the swell was low (< 2 m) throughout.

Visibility changed as a result of time of day or precipitation. Good visibility (> 5 km) accounted for 83% of the MMO effort (Figure 2.3.1 D). Poor visibility (< 1 km) was experienced for 12% of the survey. Periods of Moderate visibility (1- 5 km) accounted for 5% of the effort. There was no precipitation during the survey effort.

Sun glare was experienced at times during the survey (Figure 2.3.1 E) although there was no glare for 26% of

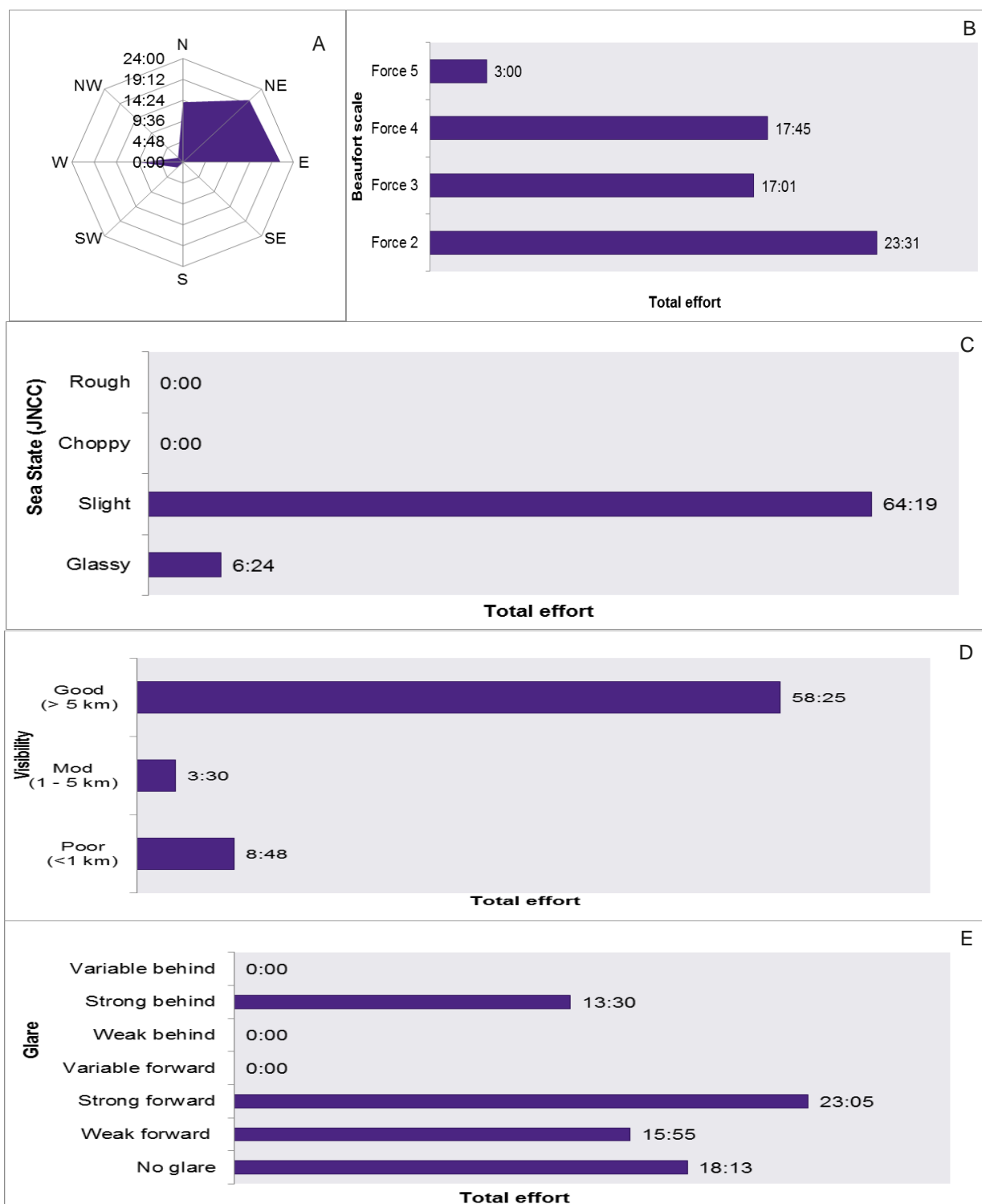


Figure 2.3.1: Environmental conditions during the course of observations in hh:mm, A) wind direction, B) wind speed (Beaufort), C) sea state, D) visibility and E) sun glare.

observations. The majority of the time the glare was from ahead (forward) of the vessel (55%) and the rest of the time (19%) it was from behind.

2.3.3.3. Marine mammal observations

During the operations, the MMO/PAM operator recorded observations of all marine mammals during dedicated watches and any incidental sightings which occurred (e.g. those made by vessel crew/during transits).

Visual sightings

There were six sightings made during observations, four were of grey seals and two of bottlenose dolphins (Figure 2.3.2 & 2.3.3). Four of the sightings occurred during operations and the other two were sighted when there was no active source.



Figure 2.3.2: Sighting No. 05 - Bottlenose dolphin, *Tursiops truncatus* on 02/06/2018



Figure 2.3.3: Sighting No. 06 - Bottlenose dolphin, *Tursiops truncatus* on 06/06/2018

Acoustic detections

There were no acoustic detections of marine mammals made during the two hours and 20 minutes of acoustic monitoring that took place during the operations.

2.3.3.4. Mitigation

A total of seven equipment start-up operations were completed during the works, all requiring a 30 minute pre-work monitoring period to be conducted first.

Of the pre-work monitoring periods, five were during daylight hours and were conducted with visual observations only; one was concurrent visual and acoustic monitoring due to taking place with in the 3 km of Portgordon and one was during the night and was therefore conducted acoustically.

Of the mitigation monitoring, 75% of the effort was carried out during operations (in case of breaks in activity), 20% of monitoring was carried out when there was no active source (i.e. pre-work searches and transits) and 5% of the effort was conducted with a variable source power during DP trial and testing (Figure 2.3.4).

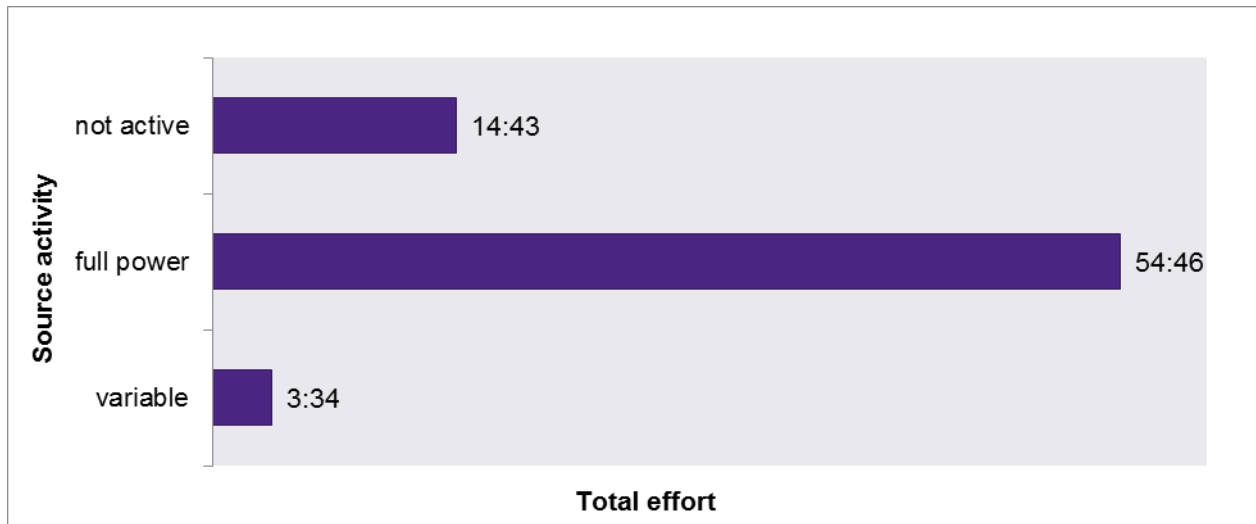


Figure 2.3.4: Combined visual and acoustic monitoring throughout operations (hh:mm)

Mitigation action

No mitigation action was required during the fault finding investigations.

Compliance

There was no compliance issues recorded during the fault finding investigations. Good communication between the surveyors and the MMO/PAM operator ensured that pre-work searches were completed prior to operations commencing.

2.4. Cable repair works

The *NKT Victoria* undertook cable repair works between the 8th and 19th of June 2018. A dedicated MMO/PAM operator was on board the *NKT Victoria* throughout the works. They undertook pre-work searches visually and passive acoustically and kept watch for marine mammals during transit to and from the work site.

2.4.1. Mitigation methods

Pre-work searches were conducted as outlined in section III (Mitigation Methods). Pre-work searches were conducted prior to the use of any of the geophysical equipment. Mitigation was under taken prior to the use of the USBL and beacons which are audible to marine mammals; there was no need to undertake an additional pre-work search prior to starting the MBES (as per the EPS licence).

The MMO carried out visual pre-work searches in daylight hours, and completed the relevant recording forms. Pre-work searches were undertaken as required using PAM during periods of darkness, low visibility, or increased sea states.

2.4.2. Cable repair works undertaken

The *NKT Victoria* transited from Karlskrona, Sweden on the 5th June and arrived on site in the Moray Firth on the 8th June when operations began. Surveys of the cable were conducted and recovery of the cut cable sections was started on the 10th June. New sections of the cable were then jointed and laid over the next few days and the as laid survey was carried out on the 19th June prior to staff demobilisation and vessel transit back to Sweden.

As stated in the EPS risk assessment, once the USBL system was in operation no additional mitigation was required prior to the use of other geophysical equipment. As the USBL was needed to monitor the positioning of the vessel, operations commenced with the USBL system.

It was not possible to soft start the USBL system or the transponders.

2.4.3. Results

2.4.3.1. Survey summary

The MMO/PAM Operator carried out a total of 107 hours and 46 minutes of visual monitoring for marine mammals. No passive acoustic monitoring was required during the operations. This included one pre-work search, totalling 39 minutes. The USBL was left interrogating (emitting noise) throughout the works due to the need to keep the ROV operational for the duration of the work.

2.4.3.2. Weather conditions

Wind speed and direction, sea state, swell height, visibility, sun glare and precipitation were recorded during daylight hours when the MMO/PAM operator was on effort and are summarised below.

The wind direction was mainly from the southwest (32%) and northeast (28%) (Figure 2.4.1 A); wind speed ranged mainly from BF 1 to 9 during monitoring (Figure 2.4.1 B). The majority of visual effort (28%) took place during BF 3 winds followed by BF 4 (22%).

Slight sea state conditions predominated and were recorded during 80% of the survey effort (Figure 2.4.1 C). Choppy sea conditions were recorded for the rest of the observation effort and accounted for 20% of the effort. During the cable repair works the swell was mainly low (< 2 m) 99% of the time with occasional medium (2-4m) periods totalling one hour and six minutes (1%).

Visibility changed as a result of time of day or precipitation. Visibility was Good (> 5 km) for the majority of the MMO effort (99%) and poor for 51 minutes of observations. Precipitation was recorded during survey effort (Figure

2.4.1 D); the majority of effort (95%) was during periods with no precipitation and Light rain accounted for 5% of effort.

Sun glare was experienced at times during the survey (Figure 2.4.1 E) although there was most often no glare (64%). The majority of the time the glare was from behind the vessel (20%) and the rest of the time (16%) it was from ahead (forward).

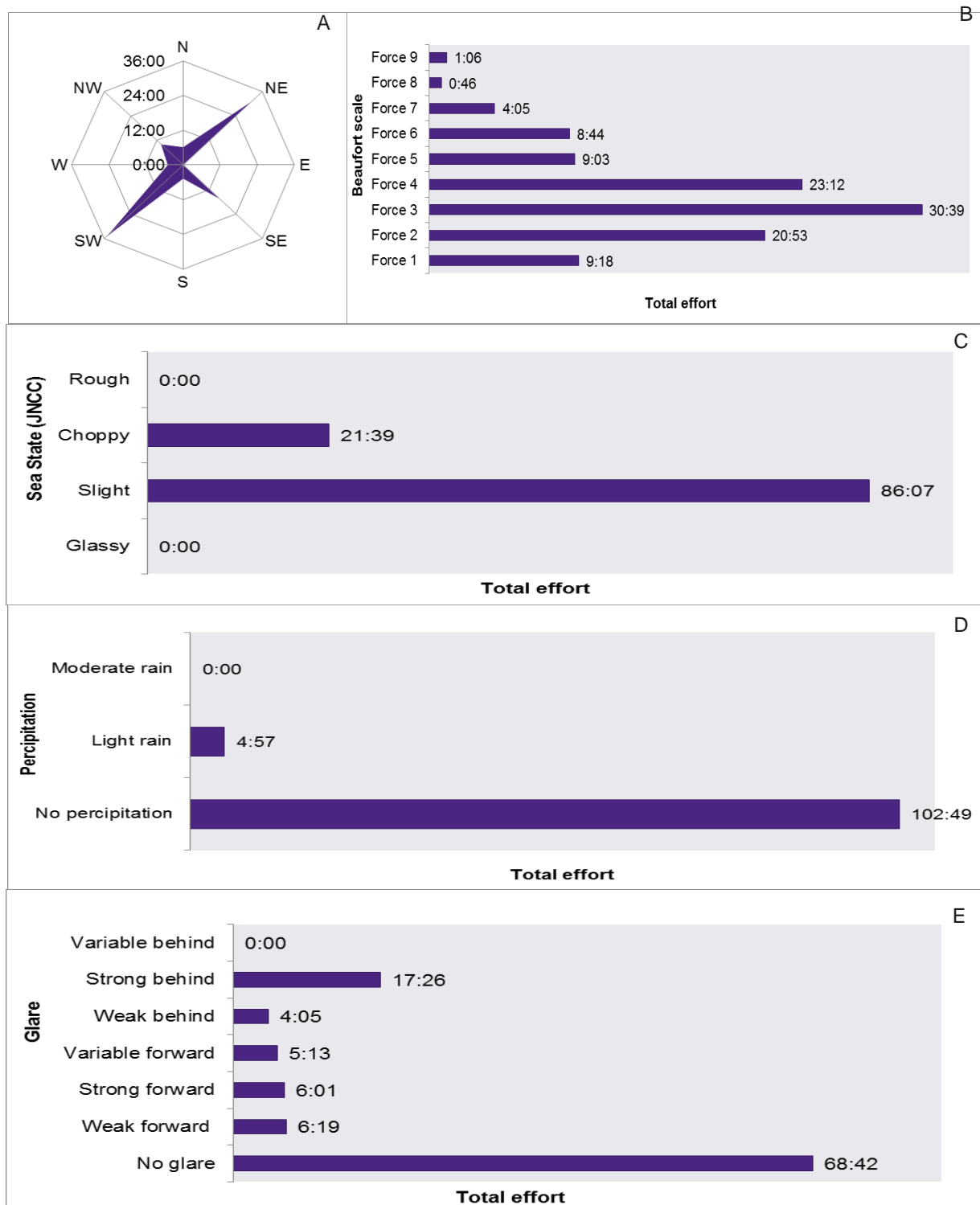


Figure 2.4.1: Environmental conditions during the course of observations in hh:mm, A) wind direction, B) wind speed (Beaufort), C) sea state, D) precipitation and E) sun glare.

2.4.3.3. Marine mammal observations

During the cable repair work the MMO/PAM operator recorded observations of all marine mammals during dedicated watches and any incidental sightings which occurred (e.g. those made by vessel crew/during transits).

Visual sightings

A total of 23 marine mammal sightings occurred during the works and details are given below and in Appendix A1. A summary of the sightings split into species is in table 2.4.1 below.

Of the sightings 18 occurred when equipment was in operation and in six sightings animals entered the 500 meter mitigation zone. Of the 23 sightings, 11 were identified to species level and comprised of seven of minke whales (Figure 2.4.2), three of humpback whales and one of common seals. All sightings were of species considered likely to be seen during the works.

Table 2.4.1: Marine mammal visual sightings summary table

Species	Number of Sightings	Total No. of Individuals
Minke whale	7	7
Humpback whale	3	3
Common Seal	1	1
Unidentified dolphin	4	13
Unidentified seals	3	5
Unidentified marine mammal	5	5
Total	23	34



Figure 2.4.2: Sighting No. 04 Northern minke whale, *Balaenoptera acutorostrata* on 08/06/2018

Acoustic detections

There were no acoustic detections of marine mammals made during the operations.

2.4.3.4. Mitigation

There was one equipment activation requiring a 30 minute pre-work monitoring period to be conducted first due to the USBL being kept on during throughout all the works.

The pre-work monitoring period was during daylight hours and was conducted visually; no acoustic monitoring periods were required.

Of the monitoring, 13% of monitoring was carried out when there was no active source (i.e. pre-work searches and transits) the rest of the effort (87%) was carried out during operations (in case of breaks in activity) (Figure 2.4.3).

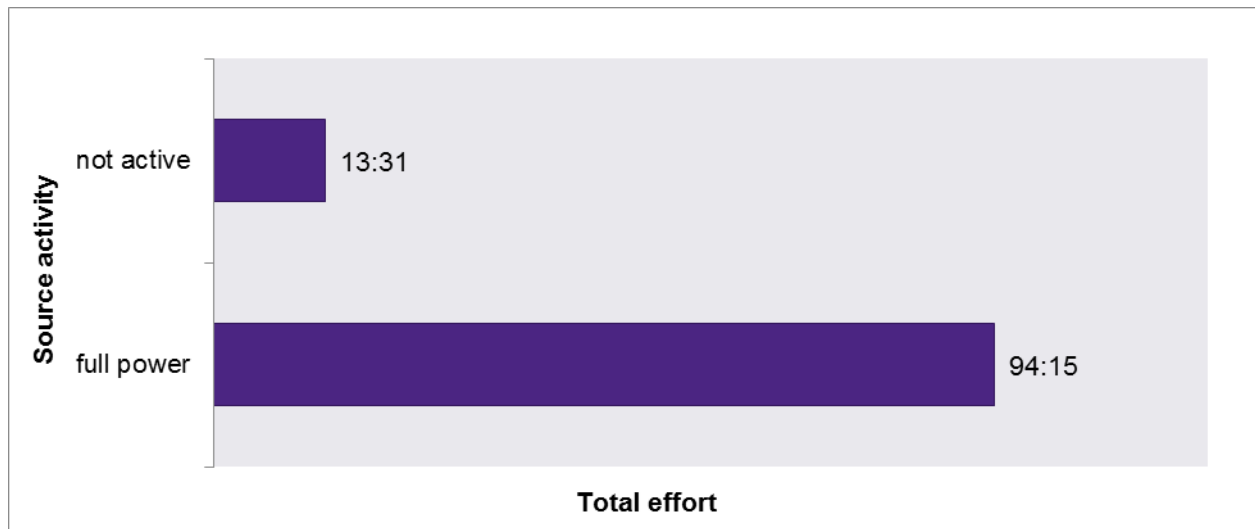


Figure 2.4.3: Total visual and acoustic monitoring throughout operations (hh:mm)

Mitigation action

No mitigation action was required during the cable repair works.

Compliance

There was no compliance issues recorded during the cable repair works. Good communication between the surveyors and the MMO/PAM operator ensured that pre-work searches were completed prior to operations commencing.

3. Chapter 3 – Discussion

References

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Appendices

A. Sightings and Detections of Marine Mammals during the Cable Installation Works

A.1. Cable Operations

Sighting number	Detection number	Date	Time at start of encounter	Species	Closest distance of animals from noise source (metres)	Noise source status when animals first detected	Did the animals enter the mitigation zone?	Action taken
<i>Cable Pull-in Operations – 23/02/2018 to 06/04/2018</i>								
001		04/03/18	09:34	Grey Seal	60	No operations	Yes	Delay to start
002		09/03/18	07:03	Grey Seal	200	No operations	Yes	None required
<i>MFE & Cable De-burial – 12/05/2017 to 11/06/2018</i>								
001		11/05/18	18:22	Bottlenose dolphin	600	No operations	No	None required
002		12/05/18	11:50	Harbour Porpoise	200	No operations	Yes	None required
003		12/05/18	14:39	Harbour Porpoise	1000	No operations	No	None required
004		12/05/18	14:39	Harbour Porpoise	200	No operations	Yes	None required
005		16/05/18	14:20	Bottlenose dolphin	200	No operations	Yes	None required
006		18/05/18	04:25	Common seal	400	No operations	Yes	None required
007		18/05/18	08:32	Grey Seal	300	No operations	Yes	None required
008		19/05/18	14:23	Grey seal	800	No operations	No	None required
009		19/05/18	15:30	Unidentified seal	400	No operations	Yes	None required

Sighting number	Detection number	Date	Time at start of encounter	Species	Closest distance of animals from noise source (metres)	Noise source status when animals first detected	Did the animals enter the mitigation zone?	Action taken
010		20/05/18	05:14	Grey Seal	100	No operations	Yes	None required
011		20/05/18	05:19	Harbour Porpoise	200	No operations	Yes	None required
012		20/05/18	10:40	Bottlenose dolphins	600	No operations	No	None required
013		20/05/18	19:12	Unidentified seal	600	No operations	No	None required
014		20/05/18	19:23	Unidentified seal	2000	No operations	No	None required
015		21/05/18	04:06	Unidentified seal	200	No operations	Yes	None required
016		21/05/18	04:30	Unidentified seal	400	No operations	Yes	None required
017		21/05/18	07:16	Grey Seal	500	No operations	Yes	None required
018		21/05/18	16:15	Probable grey seal	600	No operations	No	None required
019		21/05/18	19:04	Bottlenose dolphin	700	No operations	No	None required
020		23/05/18	05:53	Grey Seal	250	No operations	Yes	None required
021		23/05/18	01:10	Unidentified dolphins	800	No operations	No	None required
022		24/05/18	14:20	Grey seal	500	No operations	Yes	None required
023		24/05/18	15:54	Probable bottlenose dolphin	2500	No operations	No	None required
024		25/05/18	17:40	Common seal	60	No operations	Yes	Delay to start
025		26/05/18	10:00	Bottlenose dolphins	60	No operations	Yes	None required
026		27/05/18	04:00	Bottlenose dolphins	1200	Full power	No	None required

Sighting number	Detection number	Date	Time at start of encounter	Species	Closest distance of animals from noise source (metres)	Noise source status when animals first detected	Did the animals enter the mitigation zone?	Action taken
027		30/05/18	15:40	Grey seal	500	No operations	Yes	Delay to start
028		30/05/18	19:38	Unidentified seal	700	No operations	No	None required
029		01/06/18	10:57	Bottlenose dolphins	500	Full power	Yes	None required
030	501	01/06/18	13:18	Bottlenose dolphins	50	No operations	Yes	None required
031		01/06/18	20:11	Grey seal	100	No operations	Yes	None required
032		02/06/18	11:23	Minke Whale	150	No operations	Yes	None required
033		02/06/18	11:28	Minke Whale	100	No operations	Yes	None required
034		02/06/18	11:41	Minke whale	200	No operations	Yes	None required
035		02/06/18	11:49	Minke Whale	150	No operations	Yes	None required
036		02/06/18	14:14	Minke Whale	2000	No operations	No	None required
037		02/06/18	15:16	Minke Whale	2000	No operations	No	None required
038		02/06/18	16:18	Grey seal	150	No operations	Yes	None required
039		03/06/18	16:05	Minke Whale	1000	No operations	No	None required
040		03/06/18	18:04	Unidentified seal	200	No operations	Yes	None required
041		06/06/18	20:11	Unidentified seal	200	Full power	Yes	None required
Cable Repair Surveys– 25/05/2017 to 05/06/2018								
001		31/05/18	07:54	Grey seal	700	No operations	No	None required

Sighting number	Detection number	Date	Time at start of encounter	Species	Closest distance of animals from noise source (metres)	Noise source status when animals first detected	Did the animals enter the mitigation zone?	Action taken
002		31/05/18	14:25	Grey seal	180	Full power	Yes	None required
003		02/06/18	10:08	Grey seal	800	Full power	No	None required
004		02/06/18	11:45	Grey seal	700	Full power	No	None required
005		02/06/18	16:10	Bottlenose dolphins	100	Full power	Yes	None required
006		05/06/18	17:20	Bottlenose dolphins	20	No operations	Yes	None required
Cable Repair Works– 07/06/2017 to 19/06/2018								
001		07/06/18	13:22	Unidentified dolphins	100	No source	Yes	None required
002		07/06/18	13:49	Probable common dolphins	3000	No source	No	None required
003		07/06/18	14:22	Unidentified dolphins	2500	No source	No	None required
004		08/06/18	10:50	Minke Whale	1500	No source	No	None required
005		08/06/18	12:25	Minke Whale	300	No source	Yes	None required
006		09/06/18	7:59	Unidentified seal	100	Full power	Yes	None required
007		10/06/18	7:12	Minke Whale	80	Full power	Yes	None required
008		11/06/18	6:15	Unidentified seal	700	Full power	No	None required
009		11/06/18	8:15	Probable minke whale	1600	Full power	No	None required
010		11/06/18	11:00	Probable humpback whale	100	Full power	Yes	None required

Sighting number	Detection number	Date	Time at start of encounter	Species	Closest distance of animals from noise source (metres)	Noise source status when animals first detected	Did the animals enter the mitigation zone?	Action taken
011		11/06/18	15:11	Probable humpback whale	2500	Full power	No	None required
012		11/06/18	15:51	Minke Whale	2000	Full power	No	None required
013		12/06/18	15:30	Humpback whale	700	Full power	No	None required
014		13/06/18	15:27	Minke Whale	1500	Full power	No	None required
015		14/06/18	8:23	Unidentified marine mammal	1300	Full power	No	None required
016		15/06/18	10:17	Minke Whale	1500	Full power	No	None required
017		15/06/18	15:48	Unidentified marine mammal	2000	Full power	No	None required
018		15/06/18	16:48	Unidentified marine mammal	2500	Full power	No	None required
019		16/06/18	11:14	Unidentified marine mammal	700	Full power	No	None required
020		16/06/18	15:23	Unidentified marine mammal	2000	Full power	No	None required
021		17/06/18	10:17	Unidentified seal	1300	Full power	No	None required
022		17/06/18	10:59	Unidentified dolphins	1700	Full power	No	None required
023		18/06/18	10:15	Probable common seal	400	Full power	Yes	None required

B. MMOs/PAM Operators

Operations	Nearshore	Offshore
Coring Works 20 th to 23 rd February 2018		Nick Duthie
Cable Operations 23 rd February to 20 th June 2018	Anna Sweeney Nick Duthie Heather Fowle Jon Kenny Patrick Lyne James Davie Stephen Comerford Simon Keith Jane Griffiths Tina Hopewell	Catherine O'Sullivan Hannah Finch-Saunders Gareth MacGlennon Tom Joyce Moira Moore Ana Santos

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