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CEND23/16X Cruise Report: Monitoring Survey of Pisces Reef Complex cSAC/SCI

Jenkins, C. & Nelson, M.

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For further information please contact:

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough PE1 1JY
www.jncc.defra.gov.uk

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Summary

This report summarises the methods and data acquired during a survey of the Pisces Reef Complex candidate Special Area of Conservation (cSAC) and Site of Community Importance (SCI). The monitoring survey of the Pisces Reef Complex was carried out from 30th October – 4th November 2016, as part of a cruise that also visited Utopia Marine Conservation Zone (MCZ) on behalf of Natural England.

There were two key aims of the survey:

1. Acquire sentinel monitoring data to support the ongoing monitoring time-series for the Pisces Reef Complex.
2. Provide evidence on the structure, function and condition of the Annex I Reefs (both rocky and stony) against which the direction of change can be inferred over time.

A variety of data types were collected during the six-day survey including multibeam echosounder bathymetry and backscatter, chirper sub-bottom profiles, high resolution video and stills, and water samples to calibrate the camera frame mounted CTD.

Weather conditions were very good throughout the survey period with only minor data artefacts occurring in the sub-bottom data. Video transect locations were selected on vessel using multibeam echosounder and sub-bottom profiler data to target both areas of potentially exposed rocky reef and wider muddy habitat. 391km of multibeam and chirper data were acquired across the three Pisces Reef areas along with 63 video transects and 11 water samples. Due to the good weather, all of the survey objectives were completed with the vessel able to remain on site and work continuously, with no need to make use of the weather contingency sites.

Contents

1 Background and introduction

1.1 Survey project team

The monitoring survey at Pisces Reef Complex candidate Special Area of Conservation (cSAC) and Site of Community Importance (SCI) was carried out from 30th October– 4th November 2016, aboard the RV *Cefas Endeavour*. The survey team for the duration of the fieldwork included Cefas marine scientists, three marine scientists from the Joint Nature Conservation Committee (JNCC), two geophysicists, two hydrographers and a Passive Acoustic Monitoring (PAM) operator.

1.2 Site description – Pisces Reef Complex cSAC/SCI

The Pisces Reef Complex cSAC/SCI is located in the western Irish Sea, in the north-west mud basin. It is approximately midway between the Isle of Man and the coast of Northern Ireland. The area consists of an extensive mud plain through which three areas of Annex I bedrock and boulder-dominated stony reef protrude. The average seabed depth within the site boundary is approximately 100m with a maximum of 150m and a minimum of 70m at the peaks of the rocky reef outcrops. The deepest depths are within the scour pits which encircle the outcropping rocky reefs.

The three extruding reefs are composed of tertiary igneous rock and boulders, with the reef tops composed of silty bedrock, with a patchy veneer of muddy sediment due to sediment deposition from a localised scouring process. The reefs support a diverse animal community, including hydroids (e.g. *Diphasia nugra*), a range of sponges, including the cup sponge *Axinella infundibuliformi*, echinoderms, for example the cushion star *Porania pulvillus* and various crustaceans, for example the edible crab *Cancer pagurus* and squat lobster *Munida* *rugosa*. Additionally, the reef may provide shelter for juvenile fish, including blue whiting, bib, red gurnard and wrasse. In particular, the mosaic of bedrock and stony reef provide a myriad of ledges and habitat niches. Of note is the occurrence of the *Diphasia alata* hydroid community which is not currently included within the Marine Habitat Classification for Britain and Ireland, and is considered rare. The difference in species composition and abundance between the reefs and the surrounding mud plain highlights the importance of the reefs in providing a refuge for numerous species.

The site boundary for the Pisces Reef Complex cSAC/SCI has been defined using JNCC's marine SAC boundary definition guidelines. The boundary is made up of three separate polygons enclosing the minimum area necessary to ensure protection of the Annex I habitats (Figure 1). It does not include the areas of muddy sediment that lie between the reefs, however, the boundaries do encompass a number areas of burrowed mud between the exposed bedrock / boulders. The bedrock reef features were derived by collating survey data from various detailed acoustic and biological surveys. The areas of bedrock and stony reef that met the definition of Annex I Reef were delineated based on the interpretation of acoustic data, which showed a clear distinction between the hard and soft substrates. Seabed modelling using the Benthic Terrain Modeller (NOAA) was also carried out for all three areas. It should be noted that the data used for this analysis may have limitations in differentiating between exposed rock and rock with a shallow mud veneer.

As any bottom trawling that occurs in the area may pose a threat to the reef, the site boundary includes a margin to allow for mobile gear on the seabed being some distance from the location of a vessel at the sea surface. This 400m buffer has been applied individually to each of the reef features of the site.

Further detail can be found in the Pisces Reef Complex cSAC/SCI Conservation Objectives and Advice on Operations document (JNCC 2012b).

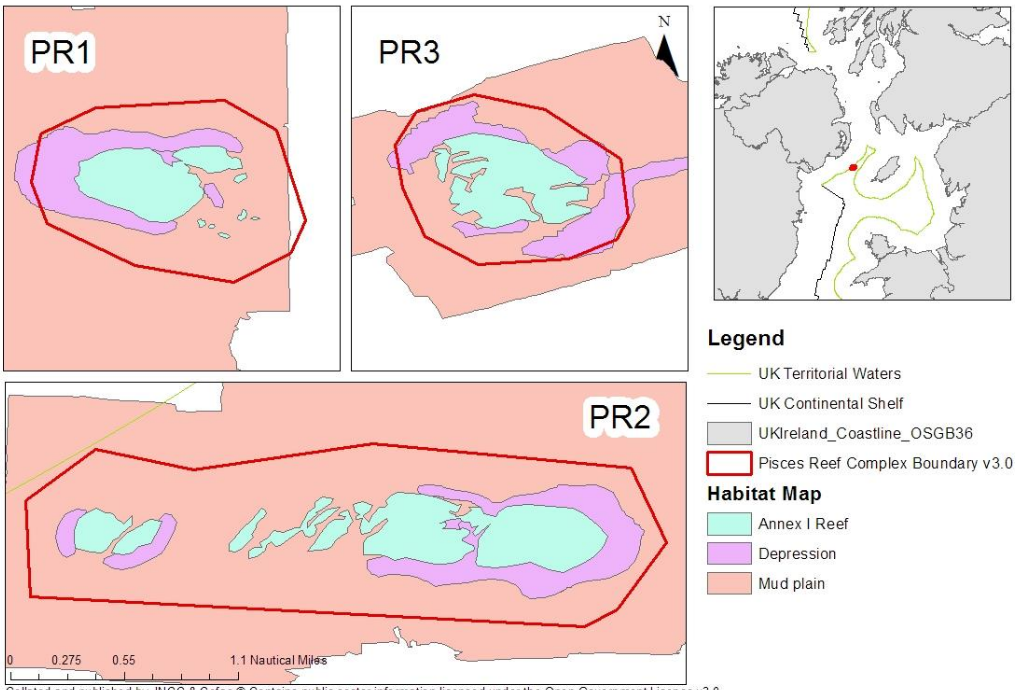

Figure 1. Original habitat map for Pisces Reef Complex cSAC/SCI (JNCC 2012a).

Several previous surveys have collected data from the area[1], and existing video tow positions are presented in Figure 2. A more recent habitat map was created in 2015 using opportunistic data collected from Pisces Reef Complex cSAC/SCI on a survey to Slieve na Griddle MCZ (Figure 2). This map does not, however, cover all three areas of Pisces Reef Complex cSAC/SCI (Barrio Froján 2015).

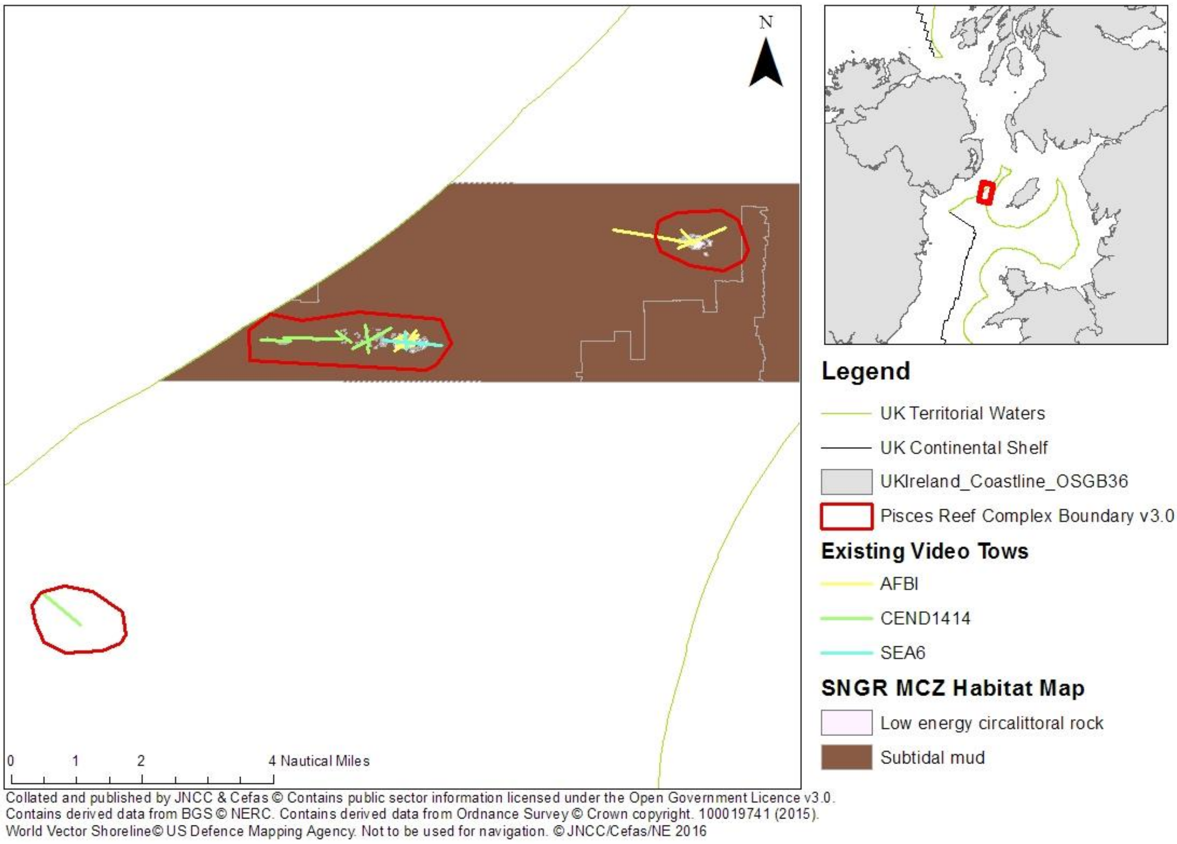

Figure 2. Existing video tow stations and habitat map covering Pisces Reef Complex cSAC/SCI created as part of the recent Slieve na Griddle MCZ verification surveys.

[1] JNCC Pisces Reef Complex cSAC/SCI Site Information Centre

2 Aims and objectives

2.1 Aim

The aim of the survey was to acquire sentinel (Type 1) monitoring (Kröger & Johnston 2016) data to contribute to the development of a monitoring time-series for Pisces Reef Complex cSAC/SCI.

The survey therefore gathered evidence on the structure, function and condition of Annex I Reefs (both rocky and stony reefs) against which the rate and direction of change can be inferred in the long term.

2.2 Objectives and priorities

The primary objectives of the survey are presented in Table 1, and have been developed based on the feature attributes defined in the Conservation Objectives for the site (JNCC 2012).

It is noted that the data from this survey will form part of a monitoring time series and that future repeat monitoring and evidence gathering will be required to fully investigate and understand the long-term variability in any parameters measured.

Table 1. Monitoring objectives for the CEND2316x survey of Pisces Reef Complex cSAC/SCI

<table>
<tr><th>Objective</th><th>Sub-objectives</th><th>Priority (1 highest)</th><th>Rationale</th></tr>
<tr><td rowspan="3">1. Collect acoustic and visual evidence to inform monitoring of the extent, distribution and physical structure of the features within the MPA.</td><td>1.1. Acquire full coverage MBES acoustic data across the site.</td><td>1</td><td rowspan="2">Produce an updated map of the site.
Groundtruthing will primarily be achieved through sub-objectives 2.1, 2.2 & 3.1 (with additional stations if needed).</td></tr>
<tr><td>1.2. Groundtruth the acquired acoustic data</td><td>1</td></tr>
<tr><td>1.3. Investigate the depth of sediment veneers across the site (in particular Area PR2, Figure 1) using sub-bottom acoustic method.</td><td>2</td><td>Determine whether buried reef areas are likely to constitute Annex I Reef in terms of habitat provision. Particularly relevant within Area PR2.</td></tr>
</table>

2. Collect acoustic and visual evidence to inform monitoring of the diversity and structure of biological communities, and typical species within the site.	**2.1.** Acquire quantitative photographic data on epifaunal communities across the reef features, stratifying effort by a) Areas PR2, PR1 & PR3, b) exposed rock & sediment veneer.	**1**	Supply data for Annex I Reef monitoring time-series, and characterise the different communities associated with rock and sediment veneers. Collect data to allow future identification of any differences in habitat condition between areas where buffered (PR1 & PR3) and non-buffered (PR2) fisheries management measures have been applied.
	2.2. Acquire qualitative photographic data on epifaunal communities across wider areas of sediment within the site boundary, including scour hollows.	**3**	Provide comparison to sediment veneer communities.
3. Acquire visual and environmental data to improve understanding of environmental conditions and sediment dynamics within the site.	**3.1.** Revisit camera transects surveyed in 2004 (SEA6), 2005 (AFBI/MESH), CEND1911 & CEND1414 to collect video/stills data.	**2**	Qualitative comparison to previously acquired photographic data, to investigate whether rock has been exposed/buried, and whether there is any evidence for mobility of sediment veneers.
	3.2. Acquire environmental data (conductivity, turbidity, temperature, salinity, chlorophyll) at camera stations.	**1**	Temperature, conductivity (salinity), pressure (depth), fluorescence (chlorophyll), light transmission (suspended load), dissolved oxygen will be collected for use in the evaluation of proposed supporting indicators for the determination of shallow sublittoral rock habitat status and to identify environmental variables that may be influential in any patterns observed in the epibenthic assemblages.

Objective 1.3 concerns the investigation of the depth of sediment veneers across the site. Existing data have shown areas of the Annex I Reef as being covered in a veneer of mud (JNCC 2012a). Determining whether buried reef areas are likely to constitute Annex I Reef in terms of habitat provision would provide vital contextual information for the site.

2.3 Acoustic data collection

The survey was undertaken aboard the RV *Cefas Endeavour*. Details of the vessel and the equipment used are provided in Appendix 1; details of equipment calibration are presented in Appendix 2. The planned survey operations and the equipment operation protocols are described below.

The following acoustic systems[2] were planned for use:

- Multibeam echosounder (MBES) run at 200kHz and 400kHz
- Chirper run at 11.2kHz.

The MBES and chirper system were monitored continuously throughout the survey operations. Acoustic and sub bottom lines were planned for areas PR1, PR2 and PR3. In all three areas MBES was collected for 100% coverage in both frequencies (200 and 400kHz), with each frequency being acquired perpendicular to the other. The chirper system was run simultaneous to the MBES and was acquired at a line spacing between 125-150m, dictated by the spacing required to acquire 20-30% overlap of the MBES swathe.

2.3.1 Multibeam echosounder (MBES)

MBES data (bathymetry and backscatter) were acquired continuously throughout survey operations to provide information about seabed depth, type and distinguish between hard and softer substrates.

2.3.2 Chirper acquisition and mitigation

The chirper system was operated by two technicians to allow 24hr operations and interpretation. JNCC guidelines for seismic surveys were used during the survey with respect to the sub-bottom profiler[3]; these require that deployments of the sub-bottom system are 'logged' in a noise register. Pre-shoot watches of 30 minutes were undertaken, by a trained Marine Mammal Observer, in daylight hours, and a Passive Acoustic Monitoring operator during night hours prior to the system being activated. A 'soft-start' of the chirper was initiated 20 minutes prior to the line, where the frequency of the source was incrementally increased over this period up to full power. Where marine mammals were detected within 500m of the vessel, during the 30 minute observation period, survey operations were delayed for 20 minutes from the time when the mammals left the 500m mitigation zone. Where line turns were known to be less than 40 minutes the source power was reduced to 10% of full power, but was kept firing throughout the turn (JNCC 2010).

2.3.3 Acoustic data formats

The formats in which the acoustic data were stored are shown in Table 2.

Table 2. Acoustic data formats

Kit	Data format(s)
Multibeam	.all .gsf .xyz .sd .wcd .TIF

[2] Details of the acoustic systems are presented in Appendix 1.
[3] http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Seismic%20Guidelines_Aug%202010.pdf

	.tid
Chirper	.segy .jpg summary images .sd

2.4 Groundtruthing stations

2.4.1 Visual groundtruthing

Placement of video tows followed the same protocol at all three Pisces Reef sites (PR1, PR2 and PR3; Figure 1). Processed MBES bathymetry, 200kHz (all sites) and 400kHz (PR1 and PR3) backscatter and sub-bottom profiler data were combined to construct a full coverage GIS layer of most likely surface substrate. Bathymetry and backscatter were gridded to 1m and 30cm, respectively. The class of the upper identified horizon (mud, reworked sediment (sediments laid down and then eroded again before being redeposited) or rock) and the thickness of the mud layer, were exported at 60-70cm intervals along the sub-bottom profiler track and imported into ArcGIS v10.1 as a point feature. Several topographic derivatives, including slope, bathymetric rugosity and bathymetric position index (BPI) were calculated from the bathymetry. Values of the raster layers were extracted at the point locations of the sub-bottom profiler track. A subset of 3000 values (1000 observations of each bottom class) was used to train two separate Conditional Inference Tree (CI) models, one on the bathymetry and derivative and the other on the backscatter. The splits identified by the models were used to reclassify the backscatter layer into soft and hard substrate. The layers of slope, bathymetry and a broad-scale BPI were used to further try to separate rock from the reworked sediments. Concave surfaces that were likely to accumulate sediment locally were identified using a fine scale BPI and reclassified as mud. Figure 4 illustrates the data used to identify potential rock and the different strata used to plan towed lines.

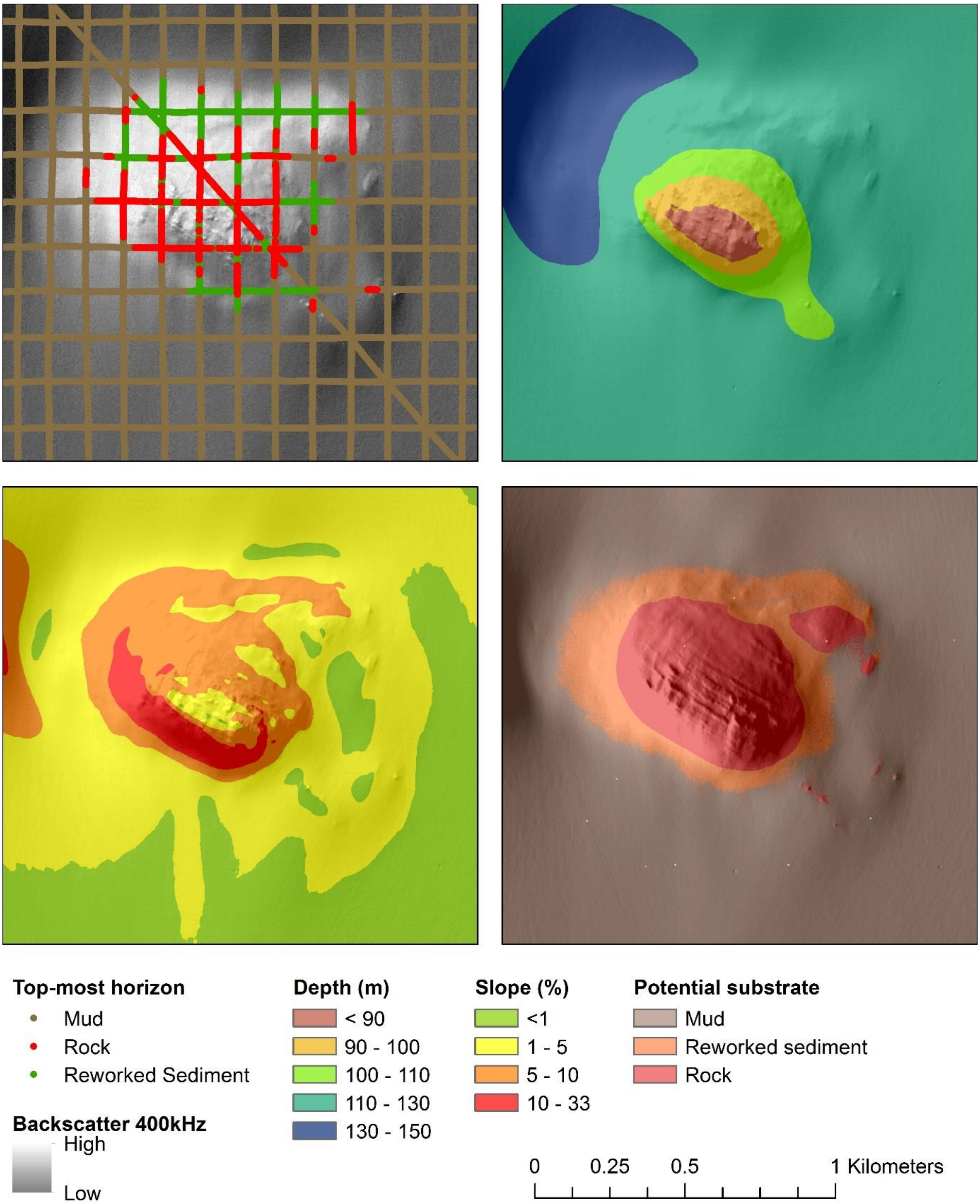

Figure 3. Illustration of acoustic data and different strata used in planning line placement at PR1.

A mixture of 200m and 100m lines were placed across and within strata of depth, slope and potential bottom type. The 200m lines were exploratory, aimed towards identifying the range of conditions covered by habitats, in order to improve accuracy for mapping the rock habitat. The 100m lines were placed within strata to provide descriptive data for characterisation of the habitat. Some camera tows, at PR2, were planned to be coincident with several locations previously investigated during the CEND1414 survey. Figure 4 presents the spatial distribution of video tows across Pisces Reef areas PR1, PR2 and PR3.

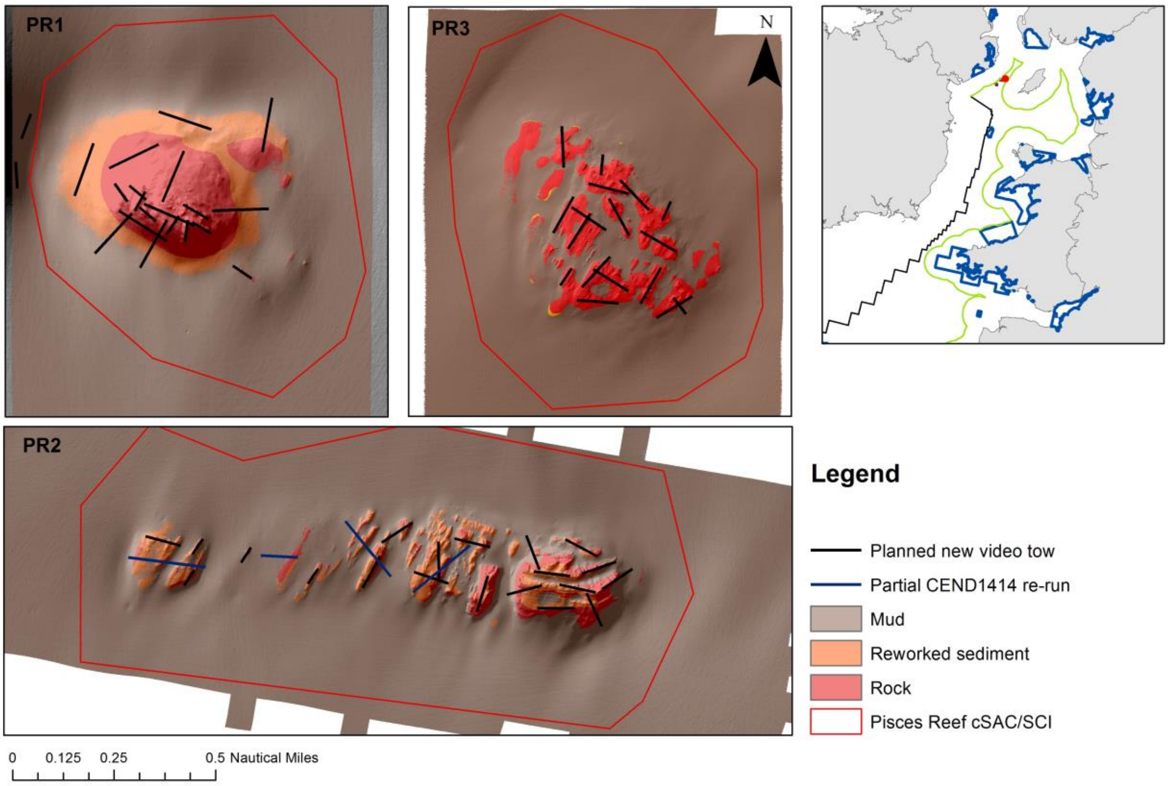

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Figure 4. Planned Video tows at Pisces Reef Complex cSAC/SCI overlaid on predictive strata

Visual groundtruthing was carried out using a drop frame equipped with laser scale, digital stills and HD video camera. The number of planned tows per Pisces Reef area are presented in Table 3. Tows were conducted at a speed of 0.3kts using the vessel’s dynamic positioning capability. Video footage with overlay of ship’s position were recorded during the tow, once the drop frame has reached the seabed. Still images were taken at 60 second intervals from a dedicated stills camera, together with opportunistic stills that would assist in completing the survey objectives. The drop frame was deployed from the side gantry and the Tower logging system was set up to record USBL position at five second intervals.

Table 3. Number of planned drop frame transects per Pisces Reef area.

Location	Number of stations
PR1	21
PR2	25
PR3	17

2.4.2 ESM2 logger

An ESM2 logger was mounted to the camera drop frame for continuous data acquisition during camera tows. The logger is a CTD system capable of measuring;

- Temperature
- Conductivity (salinity)
- Pressure (depth)
- Fluorescence (chlorophyll)
- Light transmission (suspended load)

2.4.3 Water sampling from Niskin sample bottle

Sea water samples were collected using a 10L Niskin sample bottle to validate data collected by the ESM2 logger. Each Niskin was subsampled by syphoning off water using a silicon rubber tubbing for dissolved oxygen, salinity, chlorophyll, and suspended load. All samples were collected in four replicates.

All samples collected will be analysed after the survey back at the Lowestoft Cefas laboratory with the exception of the dissolved oxygen. Dissolved oxygen analysis was performed within 24hrs of collection as the sample can degrade over a 1 to 4-week period depending on storage method.

Dissolved oxygen samples were collected first directly from the Niskin bottle and as soon as possible after collection as the water will rapidly equilibrate with the atmosphere once on deck. Water is carefully decanted into glass bottles of known volume to prevent bubble formation and the dissolved oxygen fixed by the addition of a known volume of manganous sulphate. A known volume of alkaline iodide is then added to convert the fixed oxygen into iodine. The iodine concentration is then measured by titrating against sodium thiosulphate. The dissolved oxygen concentration is directly proportional to the titration of thiosulphate and iodine (Winkler 1988).

Salinity samples were collected by syphoning off water into rinsed clean glass salinity bottles. The lip and opening of the bottle were wiped clean to prevent salt formation and potential loss of determinant. An insert is placed in the neck of the bottle to prevent evaporation and the bottle is then capped.

Chlorophyll samples were collected by syphoning off water into a high density polypropylene sample bottle and 250ml of sample is then filtered through a glass fibre filter. The filters are then folded in half and wrapped in foil and stored at -80°C.

Suspended load samples were collected by syphoning off water into high density polypropylene sample bottles and 750ml of water was then filtered through pre-weighed polycarbonate filters.

2.4.4 Groundtruth data formats

The formats in which the various types of groundtruth data were stored are shown in Table 4. Details of offsets are presented in Appendix 3.

Table 4. Groundtruth data formats.

Kit	Data format(s)
Video	.mdb Digilog MS Access database .jpg photographs stills .mp4 video .docx MS Word summary sheet
ESM2 logger	.xlsx MS Excel summary sheet

2.5 Positioning

GPS fixes were recorded using the Tower Navigation system on RV *Cefas Endeavour*. This records the positional coordinates of the gantry from which the sampling equipment is being deployed, automatically compensating for the offset between these gantries and the GPS antenna, as well as the corrected position provided by the HiPAP beacon, if used; details of offsets are presented in Appendix 3.

Positional fixes were made for the camera tows at five second intervals during the transect. This allowed accurate positional fixing of each still image to be applied retrospectively by time matching the still image to the nearest positional fix. The drop camera was always deployed from the side gantry of the vessel, so the fixes record the position of the side gantry. Improved accuracy of the positions assigned to the video footage and still images taken with the drop camera was achieved through use of the positional data generated using the HiPAP system.

Still images were time matched against fix records taken every five seconds using the HiPAP. Fix positions for the HIPAP were quality assured using GIS visualisation and removing erroneous fix positions. The information on water depth and ‘cable out’ were routinely recorded in the field metadata. Course over Ground for each tow was estimated from the uncorrected fix positions for the still images plotted in ArcGIS.

3 Cruise narrative

Survey equipment was mobilised to RV *Cefas Endeavour* on the 28th October in Liverpool, with Cefas, JNCC scientists, EGS processors and the Gardline PAM operator joining the vessel the next day, 29th October. The hired sub-bottom profile (SBP) chirper system was mounted on a frame and positioned within the moon tube on the starboard deck side for easy deployment and stability. The vessel sailed for site on the 29th October at 23:35 and commenced operations at 09:30 on the 30th October. The hull mounted MBES was calibrated over a known wreck during the transit to site in preparation for survey operations. The chirp system was simultaneously tested and the positioning assessed in comparison with the calibrated MBES bathymetry.

The remote data collection of MBES and SBP had been prioritised and were deployed to commence operations upon arrival at site at 18:00 on the 30th November 2016.

Weather conditions were good throughout the survey period and operations were not impacted by prevailing site conditions. After acoustic calibrations were completed over the wreck, the vessel transited to the northern most area of the Pisces Reef Complex cSAC/SCI (PR1). This entailed single pass operations for MBES and SBP, to gather 100% coverage across the area for bathymetry and backscatter. Line spacings were selected to ensure 20-30% beam overlap at the outer edges of the MBES swathe. This ensured that SBP data was collected roughly at a line spacing of 125-150m. Prior planning discussions had considered whether different frequencies of the EM2040 MBES would result in different penetrations of the seabed. Differences in sediment penetration between the two frequencies has the potential to influence future mapped products looking at determining rocky habitat extent. Data was, therefore, collected at 200kHz in an east to west orientation and at 400kHz in a north to south orientation for comparison purposes. All lines, at all three of the sites, were completed over the survey period.

Marine mammal observations were undertaken prior to any chirper operations according to JNCC marine mammal guidance for offshore surveys (JNCC 2010). These watches were carried out by trained marine mammal observers for at least 30 minutes, prior to the chirper being turned on. Where marine mammals were observed within 500 metres of the vessel during the 30-minute pre-shoot window, chirper operations were delayed until 20 minutes after the mammals had left the 500m mitigation area. Additional to the pre-shoot watch, visual or PAM, a 20-minute soft start was begun prior to commencement of operations. This soft start was achieved by incrementally increasing the power of the chirper system from its lowest setting up to operational power over the 20-minute time window.

Video and stills were collected across the three Pisces Reef areas (PR1-3) to gather evidence on the extent and condition of exposed rocky areas identified from the MBES and SBPs. As part of the wider environmental evidence gathering across the site the camera frame had been equipped with sensors capable of measuring temperature, depth, fluorescence and light transmissivity. This required water samples be taken at various points across the site to ensure data from the camera mounted sensor be calibrated to measured values. Four water samples were taken 2m from the seabed at two of the reef areas, PR1 and PR2, whilst three were taken at PR3 and all were processed by the on-board chemist. Camera tows were planned at lengths of either 120m or 250m dependent on their location within strata. Where strata where identified from depth, backscatter and slope thresholds. Sixty-three camera stations were planned and completed over the survey period.

The vessel was able to work continuously at the Pisces Reef Complex cSAC/SCI site with no need to make use of the weather contingency sites, with all the tasks identified in the survey plan completed.

Survey operations were concluded on the 4th November at 15:00 and the RV *Cefas Endeavour* continued for the Natural England-led Utopia MCZ site survey. Survey operations at the Utopia MCZ site commenced on the 6th November.

A summary of survey operation time is presented in Appendix 4 and Appendix 5 contains copies of Daily Progress Reports.

4 Results

A full record of all the survey line and sample metadata is provided in Appendix 6.

4.1 Acoustic line summaries

A total of 391km of MBES were collected across the three Pisces Reef areas. This allowed 100% coverage of the three sites PR1-3 at both 200kHz and 400kHz for bathymetry and backscatter (Figure 5, Figure 6 and Figure 7). SBP data was acquired simultaneously at a line spacing of 125-150m and accounted for 391km of acquired data (Figure 8). Figure 9 is a representation of the data acquired from the system and illustrates how the mud veneer and rocky habitat were differentiated.

4.1.1 Bathymetry and backscatter

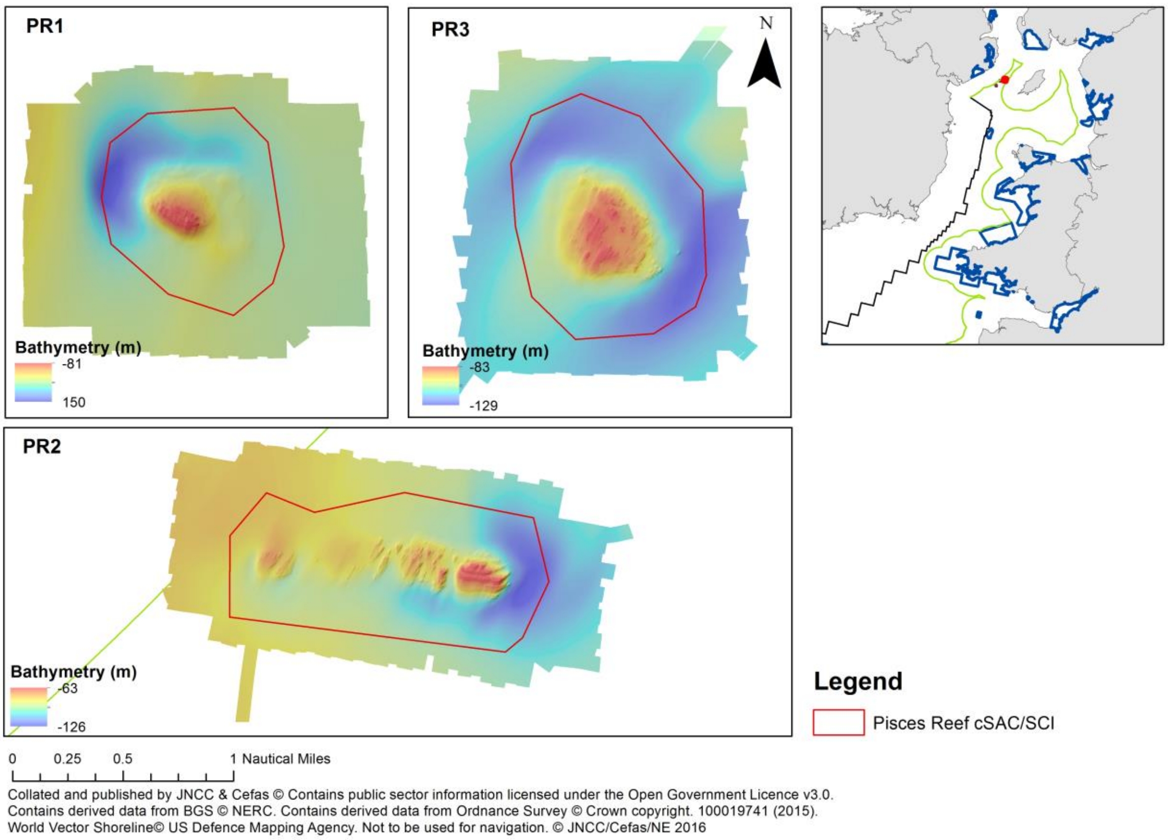

Figure 5. Initial combined bathymetric data for 200 and 400kHz for all three of the Pisces Reef Complex cSAC/SCI areas.

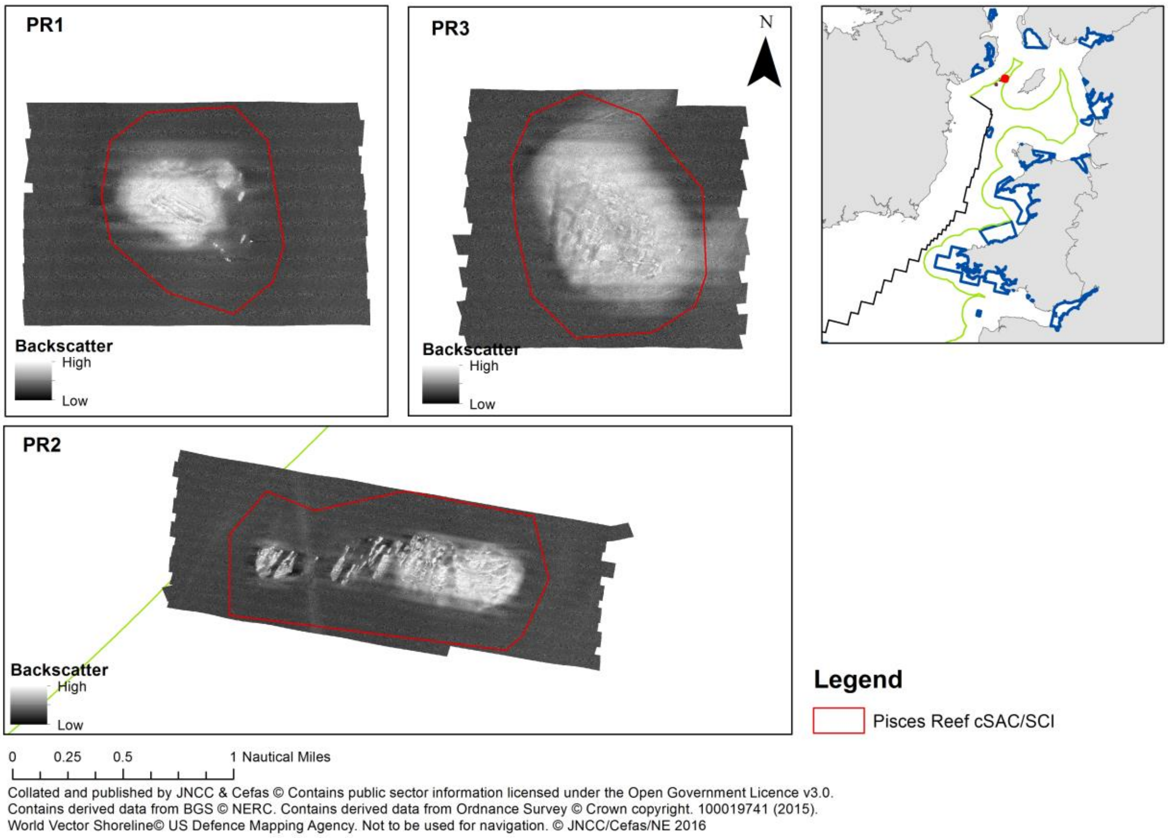

Figure 6. Initial backscatter data collected at 200kHz for all three of the Pisces Reef Complex cSAC/SCI areas.

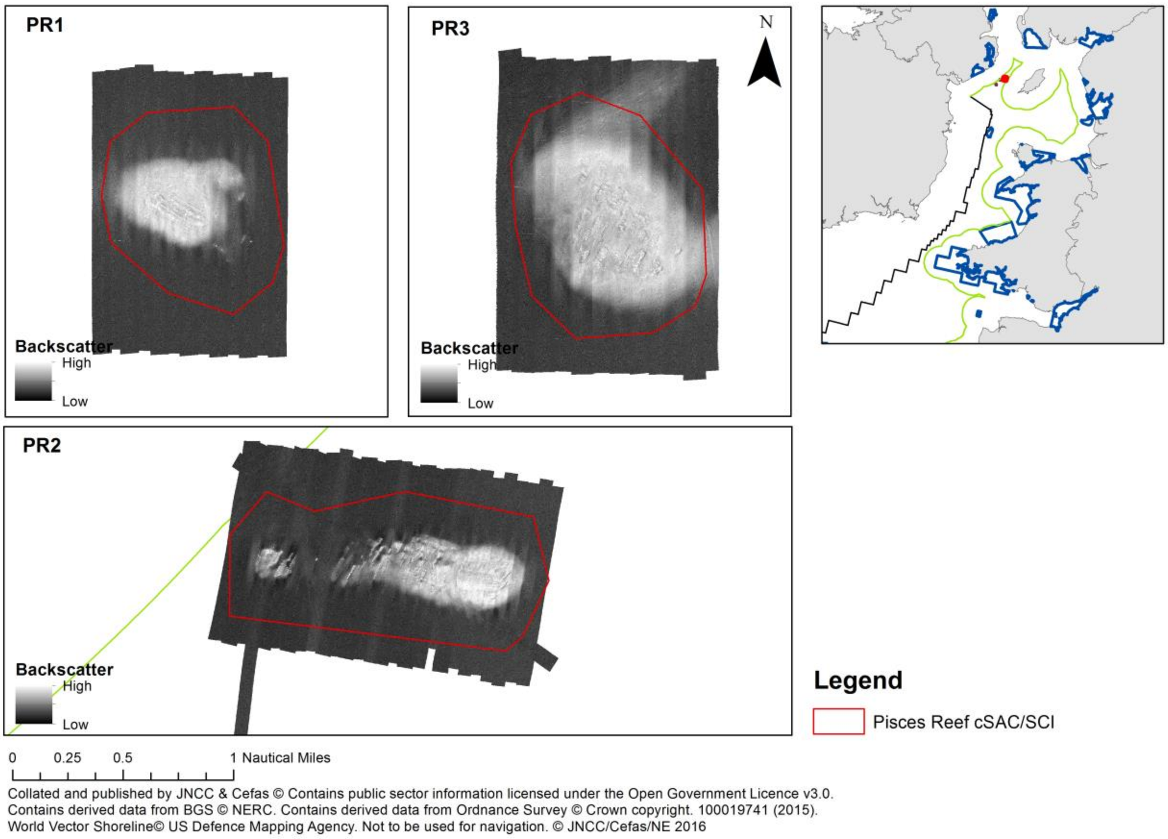

Figure 7. Initial backscatter data collected at 400kHz for all three of the Pisces Reef Complex cSAC/SCI areas.

4.1.2 Sub-bottom profiler (chirper)

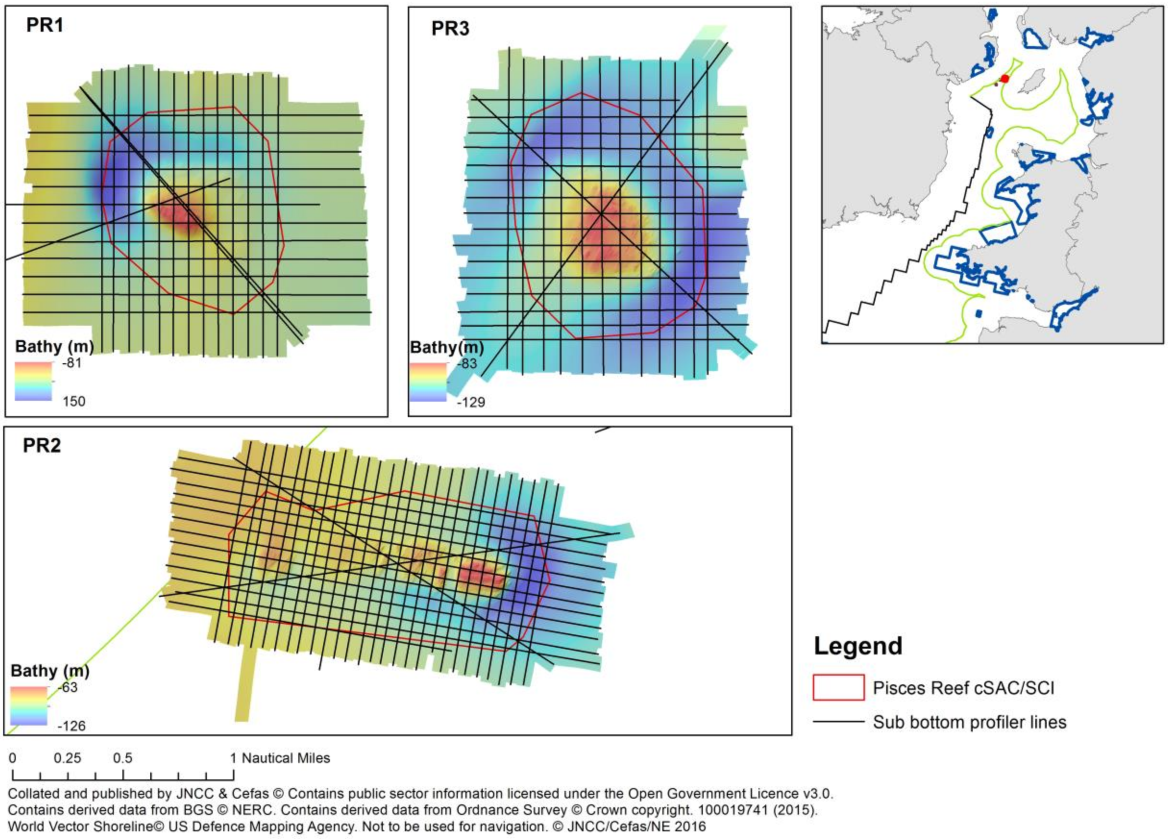

Figure 8. Acquired chirper lines at all three of the Pisces Reef Complex cSAC/SCI areas.

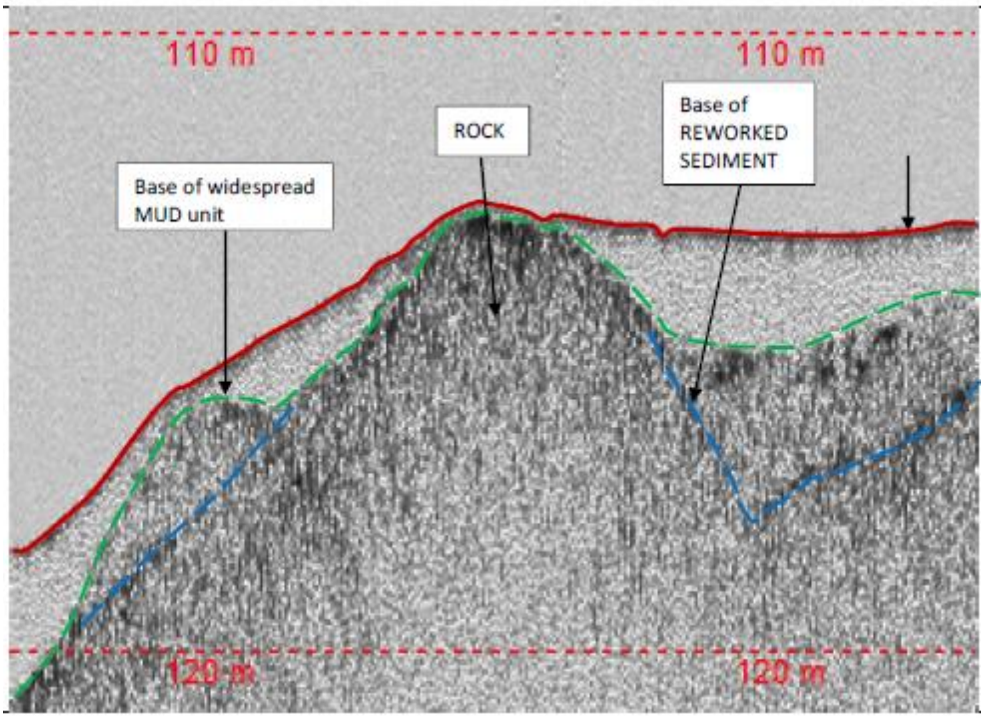

Figure 9. Example of acquired chirper data with demonstration of analysis differentiating mud and rock layers. Depth below surface shown in red and in metres.

4.2 Drop frame camera transect summaries

Drop frame camera transects were successfully recorded at 63 stations across the three Pisces Reef areas (Figure 10). On one occasion, at PR2_007, a camera tow was abandoned due to the presence of a school of fish obscuring the view and disturbing the soft sediments below. This tow was later revisited and successfully completed. Several habitats were identified from the video in real time. These varied from coarse, mud or mixed sediments through to low energy rock. Representative images of the various habitat types are presented in Appendix 7.

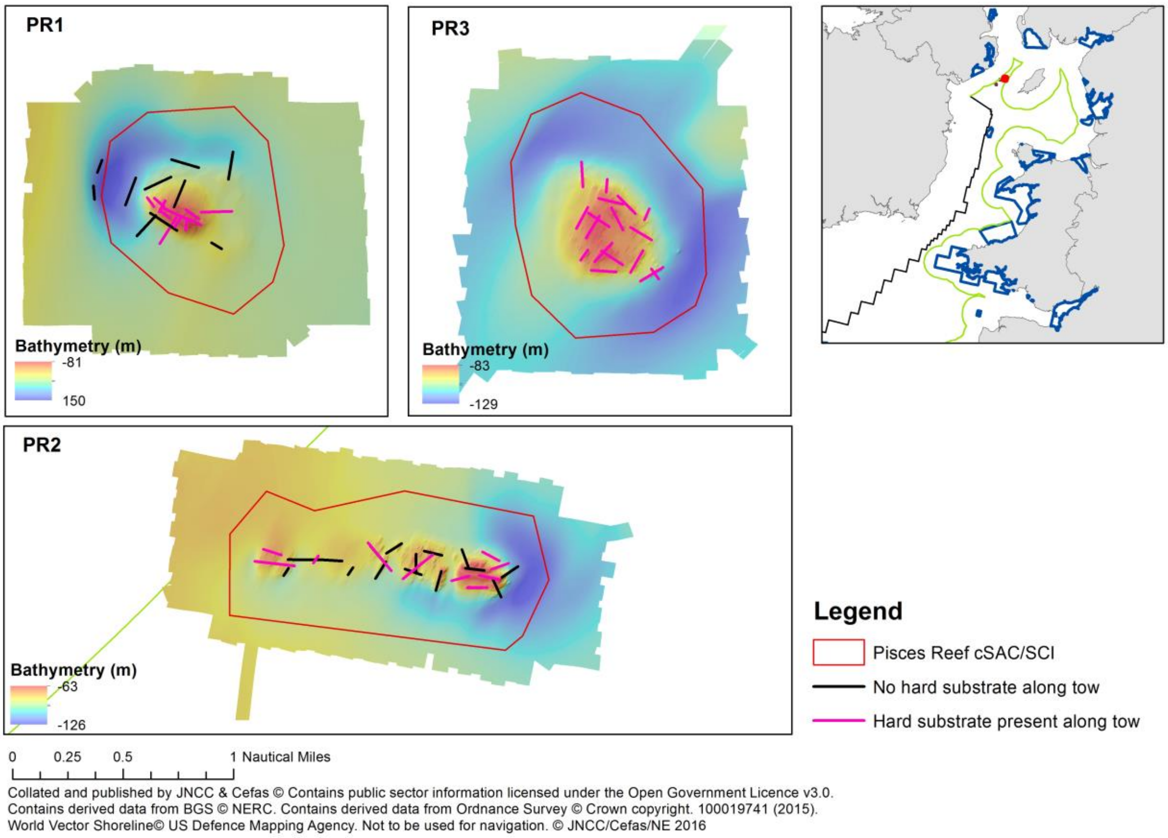

Figure 10. Completed video tows at the three Pisces Reef areas (PR1-3), showing tows where hard substrate was present and those where no hard substrate was seen.

4.3 ESM2 logger

Data was successfully collected by the ESM2 logger at all camera stations. Data analysis, calibration and interpretation will be carried out later. Figure 11 shows the sampling locations for Niskin water sampling.

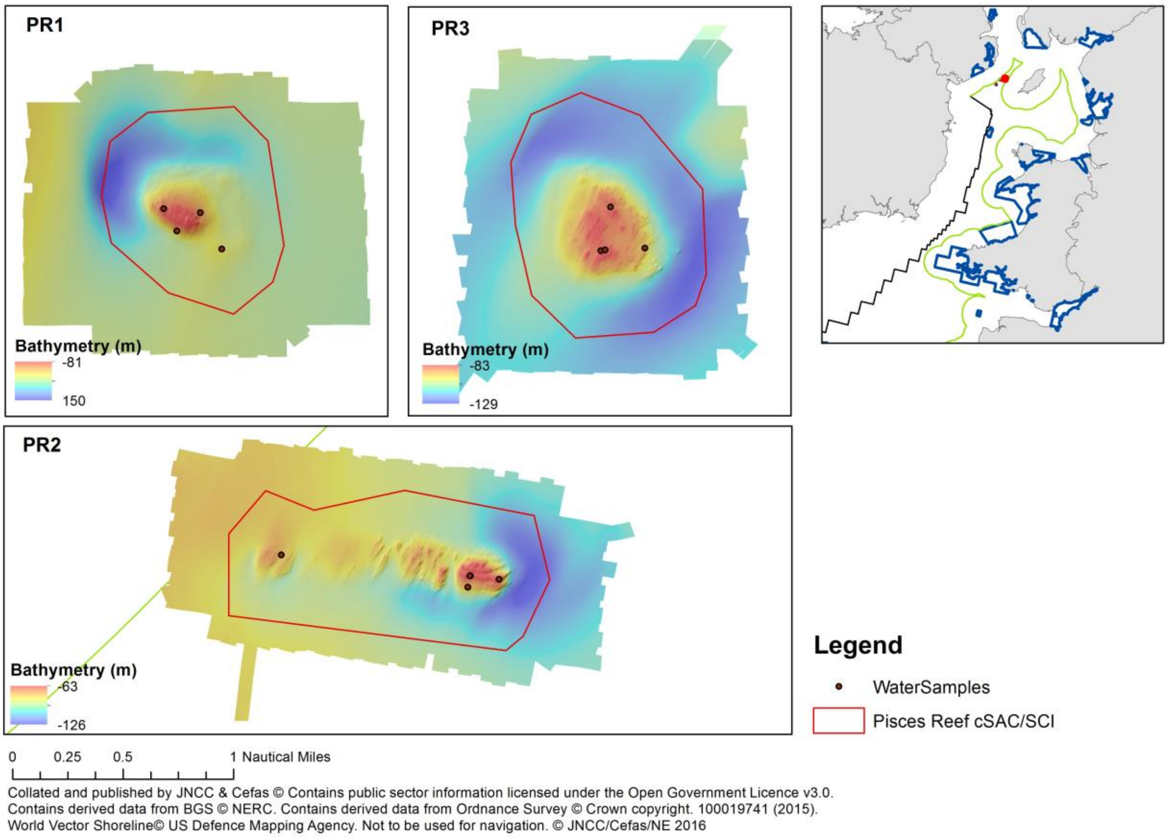

Figure 11. Locations of Niskin bottle water samples collected at the three Pisces Reef Complex cSAC/SCI areas.

4.4 Marine mammal observations

Three trained members of the survey team (undertook marine mammal observations and passive acoustic monitoring, following JNCC guidance (JNCC 2010), prior to commencement of chirper firing.

A broadband (10Hz to 180kHz) passive acoustic monitoring system (PAM) was used over four days, night hours only, of the Pisces Reef Complex cSAC/SCI habitat identification survey to mitigate the effects of the use of the chirper sub-bottom profiling system. The PAM system was towed 75m behind the vessel from the stern gantry for all pre-shoot watches prior to the initiation of the soft start of the Chirp system, to check if any cetaceans were within a 500m mitigation zone. Two soft starts were delayed due to the presence of dolphins, even though the animals were subsequently judged to be outside the mitigation zone, the PAM operator took a precautionary approach as distance and bearing information to the dolphins was not calculable. When the PAM operator was satisfied that the animals were outside the mitigation zone, an ‘all clear’ for soft start operations was given. The PAM system was used for a total of 24 hours and 32 minutes of operations of the four days of acoustic survey on the Pisces Reef Complex cSAC/SCI.

The Marine mammal observations report can be found in Appendix 9.

5 Quality control (QC)

5.1 Bathymetry and backscatter

For the MBES, a patch test and calibration were carried out during the transit to the survey site. For details of the calibration see Appendix 1. Following the calibration, all offsets were applied to the data and the resulting data showed all data from the different lines to be perfectly aligned. Further checks were undertaken during the remainder of the survey where perpendicular survey lines were situated over seabed features. Good alignment was observed in all cases.

5.2 Sub-bottom profiling

The chirper was most affected by the speed over ground and metocean conditions. The outputs from the chirper were monitored as soon as it started firing before the start of each line. Vessel speed was adjusted to ensure high quality output; this was typically at 4-5kts.

5.3 Seabed imagery

Camera stills were examined after each tow. Occasionally photographs were blurry. This was typically because either the drop frame moved when the photograph was taken, or the concentration of suspended matter in the water column was too high. Video files were viewed directly after each tow to confirm video data were recorded.

5.4 ESM2 logger

To validate the data derived from the CTD sensor, water samples were collected by Niskin bottle and are to be analysed post-survey, with the exception of dissolved oxygen.

6 Human activity

Multibeam echo-sounder data did not identify areas of human activity.

7 H&S events

A safety induction to the vessel for scientific staff was carried out at 19:00 on 29th October 2016. A toolbox talk was held at 08:00 followed by a muster station drill at 08:30. During the drill all staff were familiarised with lifeboat deployment and relevant safety equipment.

On the morning of the 2nd October a near-miss relating to equipment was reported to the vessels Master and Scientist in Charge (SiC). This was investigated on board and appropriate action was taken to avoid a repeat incident. No personnel were injured and no kit was damaged as a result of this near miss. Cefas, JNCC and P&O continued to pass details through the appropriate H&S system onshore.

8 References

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Appendix 1. Vessel and equipment used

RV Cefas Endeavour

Port of registry	Lowestoft
Length OA	73.00 m (excluding stern roller)
Length extreme	73.916 m
Breadth (MLD)	15.80 m
Depth (MLD)	8.20 m
Design draft	5.00 m
Deep draught	5.50 m
LBP	66.50 m
Gross tonnage	2983 tonnes
Net register tonnage	894 tonnes
Net lightship	2436 tonnes
Deadweight @ 5.00 m	784 tonnes
Deadweight @ 5.50 m	1244 tonnes
Displacement @ 5.00 m	3210 tonnes
Displacement @ 5.50 m	3680 tonnes
Builder	Ferguson Shipbuilders Limited, Port Glasgow
Commissioned	2003
Communications	In port BT Tel. Cellphone Voice/Fax/Data Radio TELEX Inmarsat C Fleet 77 (Inmarsat F) and VSAT (eutelsat) internet access
Endurance	42 days
Complement	En suite accommodation for 16 crew and 19 scientists with dedicated hospital facility
Propulsion System	AC/DC Diesel Electric 3 x diesel electric AC generators, individually raft mounted 2x tandem electric DC motors Single screw
Power generation	3240 Kw
Power propulsion	2230 Kw
Thrusters	Bow thruster (flush mounted azimuthing) Stern thruster (tunnel)
Trial speed	14.4 knots
Bollard pull	29 tonnes
Call sign	VQHF3
Official number	906938
MMSI	235005270
Lloyds/IMO number	9251107

Side Gantry	7.5 tonne articulated side A-frame
Stern Gantry	25 tonne stern A-frame
Winches	3x cranes 35 tM, heave compensated 2x trawl winches 2x drum winches, (1 double) Double barrel survey winch with motion compensation and slip rings Double barrel survey winch with slip rings Double barrel towing winch with slip rings Side-scan sonar winch with slip rings 3x Gilson winches (one fitted to stern A-frame)
Transducers/Sea tube	Drop keel to deploy transducers outside the hull boundary layer in addition to hull mounted transducers 1.2 m diameter sea tube/moon-pool
Acoustic equipment	Kongsberg Simrad: HiPAP 500 positioning sonar EK60, 38/120 kHz scientific sounder EA 600, 50/200 kHz scientific sounder Scanmar net mensuration system SH80 high frequency omni-directional sonar EM3002 swathe bathymetry sounder Hull mounted Scanmar fishing computer transducers
Boats	2x 8 m rigid work and rescue boats with suite of navigational equipment deployed on heave-compensated davits
Laboratories	8 networked laboratories designed for optimum flexibility of purpose 4 serviced deck locations for containerised laboratories
Special features	Dynamic positioning system Intering anti-roll system Local Area Network with scientific data management system Ship-wide general information system CCTV
Class	LRS 100A1+LMC UMS SCM CCS ICC IP ES(2) DP(CM) ICE class 2

STR SeaSpyder "Telemetry" drop camera system

Telemetry operation over coaxial cable
18 mega pixels underwater digital stills camera
High power camera flash
20W high intensity LED lights x 4
Dual scaling Subsea lasers x 4 (spaced at 17cm)
250kHz precision altimeter
Combined compass & depth
STR in-house software

Positioning software-Tower

Vessel offsets are defined from the pitch roll centre of the vessel – the Common Reference Point (CRP) used by the Tower CEMAP software to calculate offsets.

Niskin water bottle

A 10 litre Niskin water bottle was used to collect the water samples. Water was collected for the purposes of calibrating the ESM2 logger and was processed as described previously.

Multibeam echosounder (bathymetry and backscatter)

A Simrad EM2040 operated at 300kHz was used.

Hardware On-line	**Remarks**
Kongsberg EM2040	Head serial 220
Seapath 330 plus MRU-5	Serial MRU-5 2043 Serial Seapath S/N10580
C-Nav 3050 GPS	C-NAVC2 (GPS + GLONASS)
Thales 3011 GPS	Fugro Seastar differential corrections
MAHRS Gyro	SN 040644
SAIV SD204	CTD casts SN 718
Reson SVP24	Mounted on blade next to sonar heads
Druck PTX 1830	Vessel draft sensor
Software (including version)	**Remarks**
Kongsberg SIS V4.1.3	-
Caris HIPS V7.1 SP2 Hotfix 1-5	-
IVS3D Fledermaus GT v7.3.2a	-

Sub-bottom profiler (chirper)

An EdgeTech 2000 FS Combined Sidescan and Sub-Bottom System (100/400kHz or 300/600kHz SSS and DW-216: 2-16kHz SBP) was hired from STR. This system was stripped down from its original mounting and reconfigured onto a new mounting bracket for deployment through the *RV Cefas Endeavour* moon tube. The sidescan transducer were removed from the system as they were not required for the objectives of this survey. This allowed the chirper system to be deployed and recovery very easily and run at survey speeds between 4 and 5kts.

This system has an internal receiver and does not require a towed hydrophone. The received signal is processed and stored in industry-standard (SEGY) format. Screen shots (in JPEG format) can be provided for real-time interpretation.
Operating parameters used during this cruise were:

Source frequency: 11.2kHz
Shot interval: 250 milliseconds (~0.5 metres)
Survey speed: 4-5 knots

Appendix 2. Equipment calibration

GPS positions and corrections

GPS fixes were recorded using the Tower Navigation system on RV *Cefas Endeavour*. This records the latitude/longitude position of the side gantry from which the sampling equipment was deployed, automatically compensating for the offset between these gantries and the GPS antenna. Fixes for grab samples were taken at the instant the grab contacted the seabed. The mini-Hamon grab and drop camera systems were always deployed from the side gantry and appended with a beacon for HiPAP. This data is data is checked post deployment for inconsistencies. Where large errors are recorded the ships side gantry position is used preferentially, though an offset of up to 10m can be observed in strong tides. The side gantry position was used for recording day grab positions. In the case of the drop camera, this could be accounted for by comparing the logged position of the side gantry steer point with position calculated by the ships High Precision Acoustic Positioning (HiPAP) system. Where large differences were observed between the position logged using the side gantry steer point and the HiPAP position, the HiPAP position was considered to be most accurate.

GPS positional fixes were taken, for both the side gantry steer point and the position derived from HiPAP, continuously at five second intervals throughout the tow. This allowed the position of the camera system above the seabed to be cross referenced with the time at which the still image was captured to accurately determine the position of each still image acquired during the drop camera transect.

Calibration patch test report, Kongsberg EM2040 multibeam

A patch test took place on the afternoon of Saturday 30th October 2016 west of the Isle of Man, during transit from Liverpool to the main survey site. A charted wreck close to the planned transit plan was chosen. The blade was deployed to 3.2m. Three parallel lines were surveyed at constant speed, in each direction. This provided sufficient data to calibrate pitch, roll and yaw offsets. Lines were not run for latency as 1PPS (Pulse Per Second) is being used.

On completion of data collection, all survey data were loaded in Caris HIPS. The Caris HIPS calibration tool was used to determine offsets and were applied to in the Caris vessel configuration file (Endeavour_EM2040.hvf).

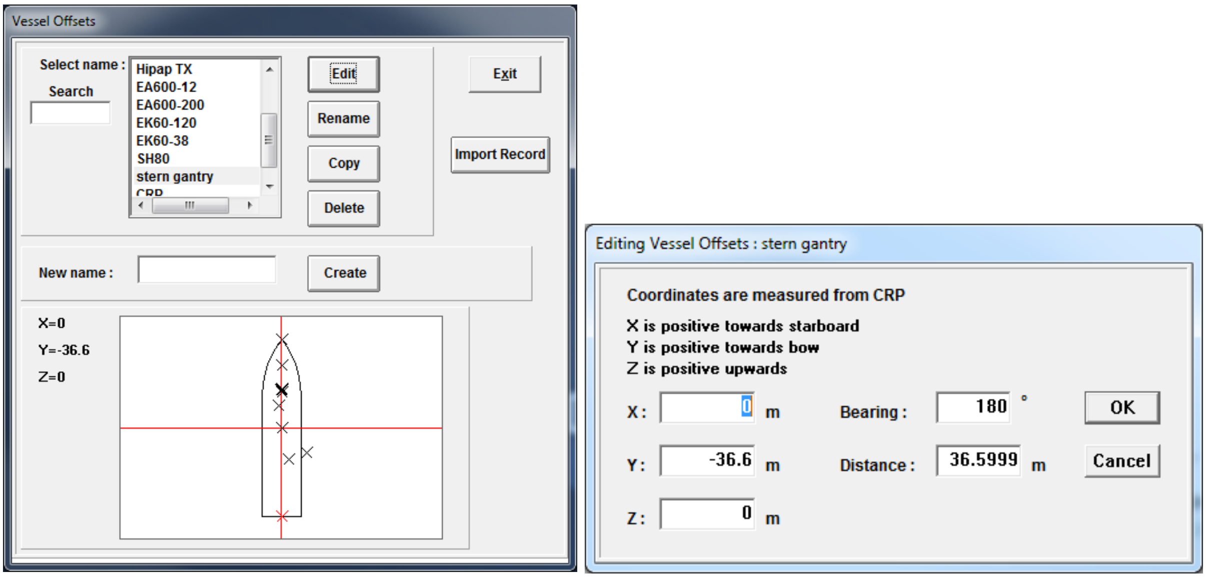
The following correction factors were obtained from the patch test:
Pitch correction: -1.0 degrees
Roll Correction: +0.10 degrees
Yaw: -3.7 degrees

Following the calibration, all offsets were applied to the data and the resulting data showed all data from the different lines to be perfectly aligned. Further checks were undertaken during the remainder of the survey where perpendicular survey lines were situated over seabed features. Good alignment was observed in all cases.

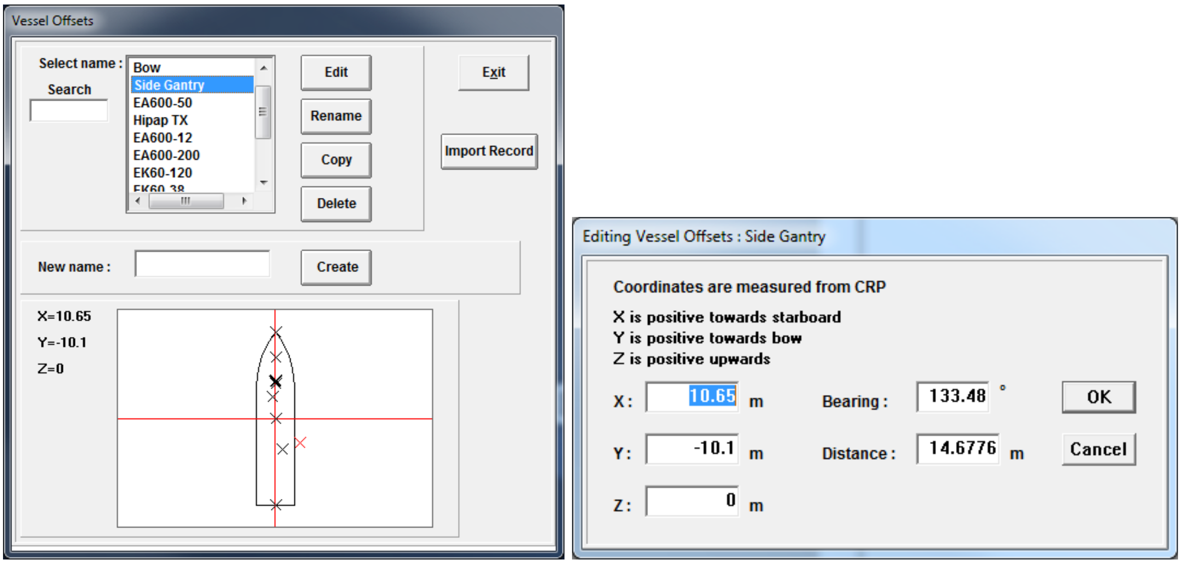
Appendix 3. Offsets

The following vessel offsets were used to calculate the true positions of equipment deployed from the RV *Cefas Endeavour*.

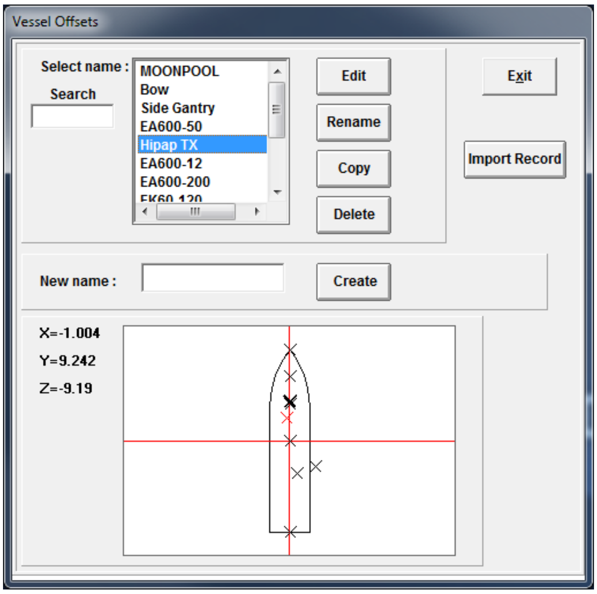
Stern gantry

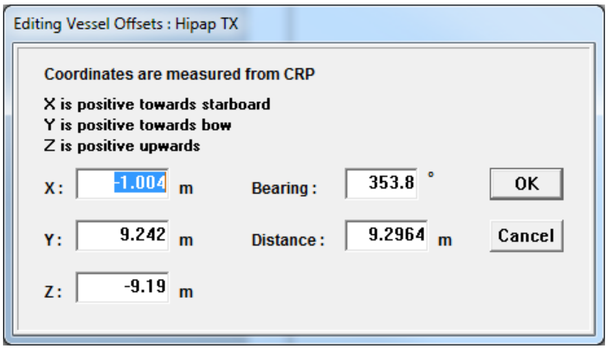


Side gantry



HiPAP


Vessel Offsets
Select name :
Search
MOONPOOL
Bow
Side Gantry
EA600-50
Hipap TX
EA600-12
EA600-200
Edit
Rename
Copy
Delete
Exit
Import Record
New name :
Create
X=-1.004
Y=9.242
Z=-9.19


Editing Vessel Offsets : Hipap TX
Coordinates are measured from CRP
X is positive towards starboard
Y is positive towards bow
Z is positive upwards
X : -1.004 m
Y : 9.242 m
Z : -9.19 m
Bearing : 353.8 °
Distance : 9.2964 m
OK
Cancel

Appendix 4. Summary of survey operation time

Table 5. Breakdown of survey operations.

Action	Total	Remark
Multibeam echosounder EM2040		391 kilometres (Combination of 200kHz and 400kHz)
Chirper		391 kilometres
Video tows		65 tows
Water sample (Niskin bottle & data logger)		11 water samples taken 2m from seabed

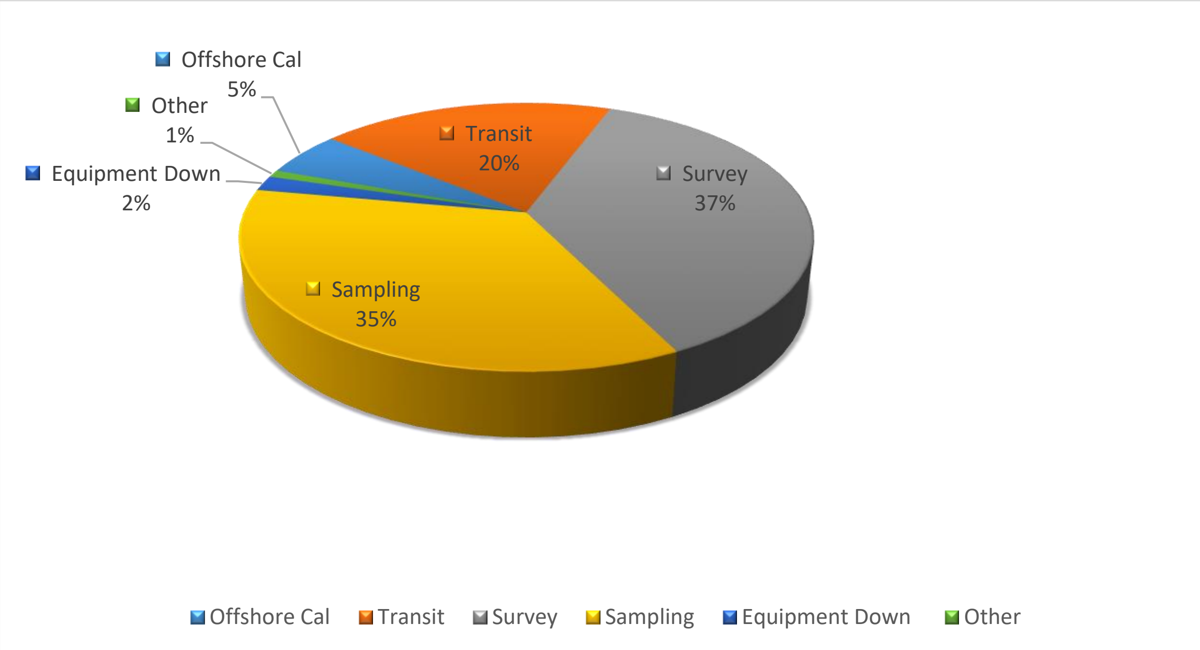


Figure 12. Summary of operations.

Appendix 5. Copy of daily progress reports

Original content was created pre-GDPR and has been removed as it contained personal information.
No scientific or technical content has been removed.

Appendix 6. Survey metadata

Table 6. Survey metadata output for survey CEND2316X. Station no. is a sequential event number for the survey, so changes each time a new gear is used or a new location is sampled. Station code is used to identify the location of the sampling station. CTD = CTD Micrologger, MB2 = Simrad EM2040 multibeam echosounder, DC = Drop Camera, SBP = Sub-bottom Profiler, NWB = Niskin Water Bottle, SOL = Start of Line, EOL = End of Line, OBS, Flu, Optode. Latitude and longitude for DC was taken from HiPAP; CTD and NWB were taken from side gantry; whilst MBES and SBP were recorded from the central reference point.

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
30/10/2016	1	CTD_01	CTD	125	A1	09:48	54.23297	-5.04229	NA
30/10/2016	2	Cal1	MB2	NA	A1	10:27	54.22660	-5.03863	SOL
30/10/2016	2	Cal1	MB2	NA	A1	10:31	54.21931	-5.03819	EOL
30/10/2016	2	Cal3	MB2	NA	A1	10:41	54.21836	-5.04008	SOL
30/10/2016	2	Cal3	MB2	NA	A1	10:42	54.22393	-5.04065	EOL
30/10/2016	2	Cal3	MB2	NA	A1	10:58	54.22546	-5.04069	SOL
30/10/2016	2	Cal3	MB2	NA	A1	11:03	54.21946	-5.04023	EOL
30/10/2016	2	Cal_4130	MB2	NA	A1	11:16	54.21933	-5.04216	SOL
30/10/2016	2	Cal_4130	MB2	NA	A1	11:19	54.22264	-5.04243	EOL
30/10/2016	2	Cal1	MB2	NA	A1	11:32	54.22650	-5.03873	SOL
30/10/2016	2	Cal1	MB2	NA	A1	11:40	54.21960	-5.03821	EOL
30/10/2016	3	SE_NW	MB2	NA	A1	13:28	54.22384	-5.04389	SOL
30/10/2016	3	SE_NW	MB2	NA	A1	13:33	54.22014	-5.03718	EOL
30/10/2016	3	SW_NE	MB2 & SBP	NA	A1	14:03	54.21900	-5.04400	SOL
30/10/2016	3	SW_NE	MB2 & SBP	NA	A1	14:07	54.22367	-5.03684	EOL
30/10/2016	3	SW_NE	MB2 & SBP	NA	A1	14:19	54.22455	-5.03511	SOL
30/10/2016	3	SW_NE	MB2 & SBP	NA	A1	14:25	54.21845	-5.04521	EOL
30/10/2016	3	EW_1	MB2	NA	A1	14:35	54.22024	-5.04468	SOL
30/10/2016	3	EW_1	MB2	NA	A1	14:39	54.22028	-5.03506	EOL
30/10/2016	3	EW_2	MB2 & SBP	NA	A1	14:48	54.22178	-5.03574	SOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
30/10/2016	3	EW_2	MB2 & SBP	NA	A1	14:52	54.22148	-5.04434	EOL
30/10/2016	3	EW_2	MB2 & SBP	NA	A1	15:07	54.22171	-5.04564	SOL
30/10/2016	3	EW_2	MB2 & SBP	NA	A1	15:11	54.22169	-5.03581	EOL
30/10/2016	3	SE_NW	MB2 & SBP	NA	A1	15:23	54.22009	-5.03755	SOL
30/10/2016	3	SE_NW	MB2 & SBP	NA	A1	15:30	54.22398	-5.04422	EOL
30/10/2016	3	NS_2	MB2 & SBP	NA	A1	15:41	54.22480	-5.03996	SOL
30/10/2016	3	NS_2	MB2 & SBP	NA	A1	15:45	54.22037	-5.03994	EOL
30/10/2016	3	NS_2	MB2 & SBP	NA	A1	15:58	54.21955	-5.03986	SOL
30/10/2016	3	NS_2	MB2 & SBP	NA	A1	16:02	54.22426	-5.04007	EOL
30/10/2016	3	EW_3	MB2	NA	A1	16:19	54.22228	-5.04554	SOL
30/10/2016	3	EW_3	MB2	NA	A1	16:23	54.22261	-5.03748	EOL
30/10/2016	3	EW_3	MB2	NA	A1	16:35	54.22253	-5.03606	SOL
30/10/2016	3	EW_3	MB2	NA	A1	16:39	54.22241	-5.04510	EOL
30/10/2016	3	Cal_4130	MB2	NA	A1	16:54	54.22383	-5.04135	SOL
30/10/2016	3	Cal_4130	MB2	NA	A1	16:57	54.21956	-5.04131	EOL
30/10/2016	4	CTD_02	CTD	119	A1	17:52	54.18644	-5.13848	NA
30/10/2016	5	PR1EW30	MB2 & SBP	NA	A1	19:42	54.18693	-5.18669	SOL
30/10/2016	5	PR1EW30	MB2 & SBP	NA	A1	19:58	54.18767	-5.14403	EOL
30/10/2016	5	PR1EW36	MB2 & SBP	NA	A1	20:08	54.18627	-5.14989	SOL
30/10/2016	5	PR1EW36	MB2 & SBP	NA	A1	20:26	54.18551	-5.19146	EOL
30/10/2016	5	PR1EW42	MB2 & SBP	NA	A1	20:37	54.18417	-5.18790	SOL
30/10/2016	5	PR1EW42	MB2 & SBP	NA	A1	20:53	54.18496	-5.14386	EOL
30/10/2016	5	PR1EW48	MB2 & SBP	NA	A1	21:04	54.18367	-5.14357	SOL
30/10/2016	5	PR1EW48	MB2 & SBP	NA	A1	21:21	54.18274	-5.18753	EOL
30/10/2016	5	PR1EW54	MB2 & SBP	NA	A1	21:32	54.18153	-5.18785	SOL
30/10/2016	5	PR1EW54	MB2 & SBP	NA	A1	21:52	54.18223	-5.14374	EOL
30/10/2016	5	PR1EW60	MB2 & SBP	NA	A1	22:07	54.18096	-5.14334	SOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
30/10/2016	5	PR1EW60	MB2 & SBP	NA	A1	22:30	54.18014	-5.18763	EOL
30/10/2016	5	PR1EW66	MB2 & SBP	NA	A1	23:06	54.17957	-5.14357	EOL
30/10/2016	5	PR1EW72	MB2 & SBP	NA	A1	23:19	54.17826	-5.14280	SOL
30/10/2016	5	PR1EW72	MB2 & SBP	NA	A1	23:41	54.17745	-5.18741	EOL
30/10/2016	5	PR1EW66	MB2 & SBP	NA	A1	23:44	54.17881	-5.18760	SOL
31/10/2016	5	PR1EW24	MB2 & SBP	NA	A1	00:01	54.18822	-5.18788	SOL
31/10/2016	5	PR1EW24	MB2 & SBP	NA	A1	00:22	54.18903	-5.14494	EOL
31/10/2016	5	PR1EW18	MB2 & SBP	NA	A1	00:33	54.19032	-5.14478	SOL
31/10/2016	5	PR1EW18	MB2 & SBP	NA	A1	00:54	54.18959	-5.18740	EOL
31/10/2016	5	PR1EW12	MB2 & SBP	NA	A1	01:04	54.19099	-5.18749	SOL
31/10/2016	5	PR1EW12	MB2 & SBP	NA	A1	01:23	54.19174	-5.14476	EOL
31/10/2016	5	PR1EW06	MB2 & SBP	NA	A1	01:34	54.19307	-5.14479	SOL
31/10/2016	5	PR1EW06	MB2 & SBP	NA	A1	01:53	54.19229	-5.18741	EOL
31/10/2016	5	PR1NS68	MB2 & SBP	NA	A1	02:35	54.19593	-5.17834	SOL
31/10/2016	5	PR1NS68	MB2 & SBP	NA	A1	02:53	54.17467	-5.17718	EOL
31/10/2016	5	PR1NS64	MB2 & SBP	NA	A1	03:03	54.17472	-5.17577	SOL
31/10/2016	5	PR1NS64	MB2 & SBP	NA	A1	03:20	54.19577	-5.17670	EOL
31/10/2016	5	PR1NS59	MB2 & SBP	NA	A1	03:31	54.19629	-5.17491	SOL
31/10/2016	5	PR1NS59	MB2 & SBP	NA	A1	03:49	54.17476	-5.17370	EOL
31/10/2016	5	PR1NS54	MB2 & SBP	NA	A1	04:01	54.17469	-5.17192	SOL
31/10/2016	5	PR1NS54	MB2 & SBP	NA	A1	04:18	54.19624	-5.17296	EOL
31/10/2016	5	PR1NS49	MB2 & SBP	NA	A1	04:28	54.19607	-5.17106	SOL
31/10/2016	5	PR1NS49	MB2 & SBP	NA	A1	04:44	54.17475	-5.16981	EOL
31/10/2016	5	PR1NS44	MB2 & SBP	NA	A1	04:55	54.17456	-5.16806	SOL
31/10/2016	5	PR1NS44	MB2 & SBP	NA	A1	05:11	54.19577	-5.16903	EOL
31/10/2016	5	PR1NS39	MB2 & SBP	NA	A1	05:21	54.19595	-5.16723	SOL
31/10/2016	5	PR1NS39	MB2 & SBP	NA	A1	05:37	54.17477	-5.16606	EOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
31/10/2016	5	PR1NS34	MB2 & SBP	NA	A1	05:49	54.17454	-5.16414	SOL
31/10/2016	5	PR1NS34	MB2 & SBP	NA	A1	06:06	54.19591	-5.16526	EOL
31/10/2016	5	PR1NS29	MB2 & SBP	NA	A1	06:15	54.19599	-5.16350	SOL
31/10/2016	5	PR1NS29	MB2 & SBP	NA	A1	06:28	54.17471	-5.16223	EOL
31/10/2016	5	PR1NS24	MB2 & SBP	NA	A1	06:38	54.17457	-5.16038	SOL
31/10/2016	5	PR1NS24	MB2 & SBP	NA	A1	06:52	54.19576	-5.16146	EOL
31/10/2016	5	PR1NS19	MB2 & SBP	NA	A1	07:01	54.19593	-5.15955	SOL
31/10/2016	5	PR1NS19	MB2 & SBP	NA	A1	07:13	54.17470	-5.15843	EOL
31/10/2016	5	PR1NS14	MB2 & SBP	NA	A1	07:22	54.17460	-5.15652	SOL
31/10/2016	5	PR1NS14	MB2 & SBP	NA	A1	07:37	54.19590	-5.15767	EOL
31/10/2016	5	PR1NS9	MB2 & SBP	NA	A1	07:44	54.19590	-5.15562	SOL
31/10/2016	5	PR1NS9	MB2 & SBP	NA	A1	07:57	54.17480	-5.15470	EOL
31/10/2016	5	PR1X	MB2 & SBP	NA	A1	08:04	54.17576	-5.15144	SOL
31/10/2016	5	PR1X	MB2 & SBP	NA	A1	08:22	54.19370	-5.17984	EOL
31/10/2016	5	PR1X	MB2 & SBP	NA	A1	08:31	54.19455	-5.18106	SOL
31/10/2016	5	PR1X	MB2 & SBP	NA	A1	08:48	54.17636	-5.15159	EOL
31/10/2016	6	PR2EW8	MB2 & SBP	NA	A1	09:29	54.16407	-5.21986	SOL
31/10/2016	6	PR2EW8	MB2 & SBP	NA	A1	10:02	54.16998	-5.28968	EOL
31/10/2016	6	PR2EW13	MB2 & SBP	NA	A1	10:17	54.16892	-5.29092	SOL
31/10/2016	6	PR2EW13	MB2 & SBP	NA	A1	10:52	54.16304	-5.22076	EOL
31/10/2016	6	PR2EW18	MB2 & SBP	NA	A1	11:07	54.16190	-5.22082	SOL
31/10/2016	6	PR2EW18	MB2 & SBP	NA	A1	11:39	54.16763	-5.28974	EOL
31/10/2016	6	PR2EW23	MB2 & SBP	NA	A1	11:54	54.16659	-5.29030	SOL
31/10/2016	6	PR2EW23	MB2 & SBP	NA	A1	12:28	54.16074	-5.22081	EOL
31/10/2016	6	PR2EW28	MB2 & SBP	NA	A1	12:38	54.15956	-5.22093	SOL
31/10/2016	6	PR2EW28	MB2 & SBP	NA	A1	13:10	54.16501	-5.29694	EOL
31/10/2016	6	PR2EW33	MB2 & SBP	NA	A1	13:22	54.16439	-5.29036	SOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
31/10/2016	6	PR2EW33	MB2 & SBP	NA	A1	13:56	54.15845	-5.22096	EOL
31/10/2016	6	PR2EW38	MB2 & SBP	NA	A1	14:06	54.15719	-5.22119	SOL
31/10/2016	6	PR2EW38	MB2 & SBP	NA	A1	14:39	54.16319	-5.29048	EOL
31/10/2016	6	PR2EW43	MB2 & SBP	NA	A1	14:49	54.16207	-5.29057	SOL
31/10/2016	6	PR2EW43	MB2 & SBP	NA	A1	15:23	54.15631	-5.22127	EOL
31/10/2016	6	PR2EW48	MB2 & SBP	NA	A1	15:33	54.15516	-5.22118	SOL
31/10/2016	6	PR2EW48	MB2 & SBP	NA	A1	16:04	54.16092	-5.29030	EOL
31/10/2016	6	PR2EW53	MB2 & SBP	NA	A1	16:18	54.15987	-5.29116	SOL
31/10/2016	6	PR2EW53	MB2 & SBP	NA	A1	16:49	54.15390	-5.29010	EOL
31/10/2016	6	PR2EW58	MB2 & SBP	NA	A1	16:59	54.15274	-5.22144	SOL
31/10/2016	6	PR2EW58	MB2 & SBP	NA	A1	17:30	54.15862	-5.29020	EOL
31/10/2016	6	PR2EW63	MB2 & SBP	NA	A1	17:43	54.15735	-5.28948	SOL
31/10/2016	6	PR2EW63	MB2 & SBP	NA	A1	18:13	54.15182	-5.22123	EOL
31/10/2016	7	CTD_03	CTD	124	A1	18:29	54.15799	-5.23158	NA
31/10/2016	8	PR2EW68	MB2 & SBP	NA	A1	20:08	54.15260	-5.24499	SOL
31/10/2016	8	PR2EW68	MB2 & SBP	NA	A1	20:27	54.15640	-5.29047	EOL
31/10/2016	8	PR2X	MB2 & SBP	NA	A1	20:39	54.15686	-5.29208	SOL
31/10/2016	8	PR2X	MB2 & SBP	NA	A1	21:08	54.16420	-5.21861	EOL
31/10/2016	8	PR2NS125	MB2 & SBP	NA	A1	21:28	54.16904	-5.23446	SOL
31/10/2016	8	PR2NS125	MB2 & SBP	NA	A1	21:42	54.15008	-5.23901	EOL
31/10/2016	8	PR2NS100	MB2 & SBP	NA	A1	21:59	54.15246	-5.24808	SOL
31/10/2016	8	PR2NS100	MB2 & SBP	NA	A1	22:15	54.16969	-5.24390	EOL
31/10/2016	8	PR2NS75	MB2 & SBP	NA	A1	22:28	54.17055	-5.25318	SOL
31/10/2016	8	PR2NS75	MB2 & SBP	NA	A1	22:42	54.15138	-5.25794	EOL
31/10/2016	8	PR2NS50	MB2 & SBP	NA	A1	22:57	54.15191	-5.26756	SOL
31/10/2016	8	PR2NS50	MB2 & SBP	NA	A1	23:18	54.17115	-5.26289	EOL
31/10/2016	8	PR2NS25	MB2 & SBP	NA	A1	23:33	54.17148	-5.27234	SOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
31/10/2016	8	PR2NS25	MB2 & SBP	NA	A1	23:46	54.15234	-5.27716	EOL
01/11/2016	9	PR3EW4	MB2 & SBP	NA	A1	00:58	54.09759	-5.31645	SOL
01/11/2016	9	PR3EW4	MB2 & SBP	NA	A1	01:09	54.09714	-5.34113	EOL
01/11/2016	9	PR3EW9	MB2 & SBP	NA	A1	01:21	54.09589	-5.34146	SOL
01/11/2016	9	PR3EW9	MB2 & SBP	NA	A1	01:34	54.09659	-5.30846	EOL
01/11/2016	9	PR3EW14	MB2 & SBP	NA	A1	01:45	54.09535	-5.30871	SOL
01/11/2016	9	PR3EW14	MB2 & SBP	NA	A1	01:58	54.09482	-5.34129	EOL
01/11/2016	9	PR3EW19	MB2 & SBP	NA	A1	02:11	54.09382	-5.34181	SOL
01/11/2016	9	PR3EW19	MB2 & SBP	NA	A1	02:25	54.09427	-5.30839	EOL
01/11/2016	9	PR3EW24	MB2 & SBP	NA	A1	02:35	54.09304	-5.30889	SOL
01/11/2016	9	PR3EW24	MB2 & SBP	NA	A1	02:48	54.09257	-5.34140	EOL
01/11/2016	9	PR3EW29	MB2 & SBP	NA	A1	02:59	54.09152	-5.34158	SOL
01/11/2016	9	PR3EW29	MB2 & SBP	NA	A1	03:12	54.09212	-5.30862	EOL
01/11/2016	9	PR3EW34	MB2 & SBP	NA	A1	03:21	54.09095	-5.30844	SOL
01/11/2016	9	PR3EW34	MB2 & SBP	NA	A1	03:34	54.09031	-5.34126	EOL
01/11/2016	9	PR3EW39	MB2 & SBP	NA	A1	03:45	54.08921	-5.34154	SOL
01/11/2016	9	PR3EW39	MB2 & SBP	NA	A1	03:59	54.08979	-5.30922	EOL
01/11/2016	9	PR3EW44	MB2 & SBP	NA	A1	04:07	54.08876	-5.30769	SOL
01/11/2016	9	PR3EW44	MB2 & SBP	NA	A1	04:21	54.08813	-5.34033	EOL
01/11/2016	9	PR3EW49	MB2 & SBP	NA	A1	04:32	54.08693	-5.34272	SOL
01/11/2016	9	PR3EW49	MB2 & SBP	NA	A1	04:46	54.08762	-5.30789	EOL
01/11/2016	9	PR3EW54	MB2 & SBP	NA	A1	04:55	54.08650	-5.30788	SOL
01/11/2016	9	PR3EW54	MB2 & SBP	NA	A1	05:09	54.08586	-5.34080	EOL
01/11/2016	9	PR3EW59	MB2 & SBP	NA	A1	05:19	54.08470	-5.34195	SOL
01/11/2016	9	PR3EW59	MB2 & SBP	NA	A1	05:33	54.08531	-5.30863	EOL
01/11/2016	9	PR3EW64	MB2 & SBP	NA	A1	05:43	54.08424	-5.30754	SOL
01/11/2016	9	PR3EW64	MB2 & SBP	NA	A1	05:57	54.08360	-5.34084	EOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
01/11/2016	9	PR3EW69	MB2 & SBP	NA	A1	06:09	54.08229	-5.34186	SOL
01/11/2016	9	PR3EW69	MB2 & SBP	NA	A1	06:20	54.08314	-5.30890	EOL
01/11/2016	9	PR3EW74	MB2 & SBP	NA	A1	06:29	54.08209	-5.30737	SOL
01/11/2016	9	PR3EW74	MB2 & SBP	NA	A1	06:42	54.08134	-5.34140	EOL
01/11/2016	9	PR3EW78	MB2 & SBP	NA	A1	06:53	54.08039	-5.34114	SOL
01/11/2016	9	PR3EW78	MB2 & SBP	NA	A1	07:05	54.08103	-5.30845	EOL
01/11/2016	9	PR3X	MB2 & SBP	NA	A1	07:13	54.08007	-5.30686	SOL
01/11/2016	9	PR3X	MB2 & SBP	NA	A1	07:31	54.09745	-5.34091	EOL
01/11/2016	9	PR3NS65	MB2 & SBP	NA	A1	07:45	54.10089	-5.33685	SOL
01/11/2016	9	PR3NS65	MB2 & SBP	NA	A1	07:58	54.07850	-5.33585	EOL
01/11/2016	9	PR3NS60	MB2 & SBP	NA	A1	08:06	54.07807	-5.33398	SOL
01/11/2016	9	PR3NS60	MB2 & SBP	NA	A1	08:23	54.10010	-5.33508	EOL
01/11/2016	9	PR3NS54	MB2 & SBP	NA	A1	08:32	54.10032	-5.33267	SOL
01/11/2016	9	PR3NS54	MB2 & SBP	NA	A1	08:46	54.07846	-5.33149	EOL
01/11/2016	9	PR3NS48	MB2 & SBP	NA	A1	08:54	54.07822	-5.32945	SOL
01/11/2016	9	PR3NS48	MB2 & SBP	NA	A1	09:10	54.10004	-5.33056	EOL
01/11/2016	9	PR3NS42	MB2 & SBP	NA	A1	09:19	54.10032	-5.32817	SOL
01/11/2016	9	PR3NS42	MB2 & SBP	NA	A1	09:34	54.07837	-5.32689	EOL
01/11/2016	9	PR3NS36	MB2 & SBP	NA	A1	09:40	54.07823	-5.32436	SOL
01/11/2016	9	PR3NS36	MB2 & SBP	NA	A1	09:55	54.10031	-5.32605	EOL
01/11/2016	9	PR3NS30	MB2 & SBP	NA	A1	10:04	54.10042	-5.32371	SOL
01/11/2016	9	PR3NS30	MB2 & SBP	NA	A1	10:18	54.07853	-5.32236	EOL
01/11/2016	9	PR3NS24	MB2 & SBP	NA	A1	10:30	54.07827	-5.31984	SOL
01/11/2016	9	PR3NS24	MB2 & SBP	NA	A1	10:46	54.10012	-5.32116	EOL
01/11/2016	9	PR3NS18	MB2 & SBP	NA	A1	10:56	54.10050	-5.31884	SOL
01/11/2016	9	PR3NS18	MB2 & SBP	NA	A1	11:11	54.07856	-5.31774	EOL
01/11/2016	9	PR3NS13	MB2 & SBP	NA	A1	11:21	54.07826	-5.31588	SOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
01/11/2016	9	PR3NS13	MB2 & SBP	NA	A1	11:37	54.10019	-5.31709	EOL
01/11/2016	9	PR3NS7	MB2 & SBP	NA	A1	11:48	54.10046	-5.31501	SOL
01/11/2016	9	PR3NS7	MB2 & SBP	NA	A1	12:03	54.07829	-5.31359	EOL
01/11/2016	9	PR3NS3	MB2 & SBP	NA	A1	12:11	54.07853	-5.31202	SOL
01/11/2016	9	PR3NS3	MB2 & SBP	NA	A1	12:11	54.10037	-5.31328	EOL
01/11/2016	9	PR3XNESW	MB2 & SBP	NA	A1	12:42	54.10170	-5.31096	SOL
01/11/2016	9	PR3XNESW	MB2 & SBP	NA	A1	13:03	54.07790	-5.33887	EOL
01/11/2016	10	TRANPR3PR2	MB2 & SBP	NA	A1	13:11	54.07649	-5.34275	SOL
01/11/2016	10	TRANPR3PR2	MB2 & SBP	NA	A1	14:45	54.16824	-5.23736	EOL
01/11/2016	10	PR2NS140	MB2 & SBP	NA	A1	15:07	54.16860	-5.22868	SOL
01/11/2016	10	PR2NS140	MB2 & SBP	NA	A1	15:20	54.14965	-5.23327	EOL
01/11/2016	10	PR2NS135	MB2 & SBP	NA	A1	15:28	54.14962	-5.23534	SOL
01/11/2016	10	PR2NS135	MB2 & SBP	NA	A1	15:42	54.16885	-5.23051	EOL
01/11/2016	10	PR2NS130	MB2 & SBP	NA	A1	15:51	54.16892	-5.23247	SOL
01/11/2016	10	PR2NS130	MB2 & SBP	NA	A1	16:05	54.14960	-5.23722	EOL
01/11/2016	10	PR2NS120	MB2 & SBP	NA	A1	16:13	54.15026	-5.24078	SOL
01/11/2016	10	PR2NS120	MB2 & SBP	NA	A1	16:27	54.16937	-5.23619	EOL
01/11/2016	10	PR2NS115	MB2 & SBP	NA	A1	16:36	54.16932	-5.23814	SOL
01/11/2016	10	PR2NS115	MB2 & SBP	NA	A1	16:49	54.15046	-5.24273	EOL
01/11/2016	11	PR2NS110	MB2 & SBP	NA	A1	16:59	54.15066	-5.24463	SOL
01/11/2016	11	PR2NS110	MB2 & SBP	NA	A1	17:13	54.16963	-5.24007	EOL
01/11/2016	12	TRANPR2PR1	MB2 & SBP	NA	A1	17:21	54.17360	-5.22299	SOL
01/11/2016	12	TRANPR2PR1	MB2 & SBP	NA	A1	17:50	54.18802	-5.16150	EOL
01/11/2016	13	PR1_004	DC & CTD, OBS, Flu, Optode	114	A1	18:52	54.18793	-5.16165	SOL
01/11/2016	13	PR1_004	DC & CTD, OBS, Flu, Optode	124	A1	19:17	54.19000	-5.16116	EOL
01/11/2016	14	PR1_010	DC & CTD, OBS, Flu, Optode	124	A1	19:44	54.18874	-5.16550	SOL
01/11/2016	14	PR1_010	DC & CTD, OBS, Flu, Optode	133	A1	20:10	54.18927	-5.16903	EOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
01/11/2016	15	PR1_013	DC & CTD, OBS, Flu, Optode	118	A1	20:34	54.18797	-5.16904	SOL
01/11/2016	15	PR1_013	DC & CTD, OBS, Flu, Optode	124	A1	21:00	54.18698	-5.17234	EOL
01/11/2016	16	PR1_012	DC & CTD, OBS, Flu, Optode	140	A1	21:17	54.18782	-5.17355	SOL
01/11/2016	16	PR1_012	DC & CTD, OBS, Flu, Optode	144	A1	21:43	54.18575	-5.17476	EOL
01/11/2016	17	PR1_005	DC & CTD, OBS, Flu, Optode	133	A1	22:18	54.18610	-5.17877	SOL
01/11/2016	17	PR1_005	DC & CTD, OBS, Flu, Optode	134	A1	22:31	54.18711	-5.17894	EOL
01/11/2016	18	PR1_006	DC & CTD, OBS, Flu, Optode	139	A1	22:54	54.18814	-5.17848	SOL
01/11/2016	18	PR1_006	DC & CTD, OBS, Flu, Optode	140	A1	23:05	54.18907	-5.17797	EOL
01/11/2016	19	PR1_002	DC & CTD, OBS, Flu, Optode	108	A1	23:34	54.18502	-5.17084	SOL
01/11/2016	19	PR1_002	DC & CTD, OBS, Flu, Optode	133	A1	23:59	54.18344	-5.17319	EOL
02/11/2016	20	PR1_007	DC & CTD, OBS, Flu, Optode	114	A1	00:26	54.18520	-5.17154	SOL
02/11/2016	20	PR1_007	DC & CTD, OBS, Flu, Optode	102	A1	00:55	54.18395	-5.16807	EOL
02/11/2016	21	PR1_007	NWB	100	A1	01:17	54.18390	-5.16806	NA
02/11/2016	22	PR1_001	DC & CTD, OBS, Flu, Optode	88	A1	01:49	54.18493	-5.16819	SOL
02/11/2016	22	PR1_001	DC & CTD, OBS, Flu, Optode	123	A1	02:17	54.18293	-5.17019	EOL
02/11/2016	23	PR1_011	NWB	91	A1	02:47	54.18556	-5.16983	NA
02/11/2016	24	PR1_011	DC & CTD, OBS, Flu, Optode	91	A1	03:19	54.18557	-5.16984	SOL
02/11/2016	24	PR1_011	DC & CTD, OBS, Flu, Optode	81	A1	03:48	54.18469	-5.16622	EOL
02/11/2016	25	PR1_003	DC & CTD, OBS, Flu, Optode	89	A1	04:42	54.18570	-5.16852	SOL
02/11/2016	25	PR1_003	DC & CTD, OBS, Flu, Optode	112	A1	05:08	54.18772	-5.16721	EOL
02/11/2016	26	PR1_009	NWB	95	A1	05:32	54.18534	-5.16511	NA
02/11/2016	27	PR1_009	DC & CTD, OBS, Flu, Optode	95	A1	06:01	54.18539	-5.16503	SOL
02/11/2016	27	PR1_009	DC & CTD, OBS, Flu, Optode	114	A1	06:29	54.18553	-5.16108	EOL
02/11/2016	28	PR1_008	NWB	108	A1	06:44	54.18265	-5.16223	NA
02/11/2016	29	PR1_008	DC & CTD, OBS, Flu, Optode	108	A1	07:07	54.18268	-5.16227	SOL
02/11/2016	29	PR1_008	DC & CTD, OBS, Flu, Optode	108	A1	07:18	54.18310	-5.16358	EOL
02/11/2016	30	PR2_008	NWB	65	A1	08:13	54.15941	-5.23770	NA

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
02/11/2016	31	PR2_008	DC & CTD, OBS, Flu, Optode	66	A1	08:37	54.15941	-5.23770	SOL
02/11/2016	31	PR2_008	DC & CTD, OBS, Flu, Optode	68	A1	08:59	54.15975	-5.24079	EOL
02/11/2016	32	PR2_005	NWB	67	A1	09:16	54.15966	-5.24234	NA
02/11/2016	32	PR2_005	NWB	67	A2	09:22	54.15966	-5.24232	NA
02/11/2016	32	PR2_005	NWB	67	A3	09:39	54.15964	-5.24239	NA
02/11/2016	33	PR2_005	DC & CTD, OBS, Flu, Optode	68	A1	09:52	54.15962	-5.24245	SOL
02/11/2016	33	PR2_005	DC & CTD, OBS, Flu, Optode	98	A1	10:12	54.15915	-5.24524	EOL
02/11/2016	34	PR2_006	DC & CTD, OBS, Flu, Optode	99	A1	10:42	54.16197	-5.24041	SOL
02/11/2016	34	PR2_006	DC & CTD, OBS, Flu, Optode	96	A1	11:03	54.16119	-5.23769	EOL
02/11/2016	35	PR2_004	DC & CTD, OBS, Flu, Optode	78	A1	11:28	54.16035	-5.23888	SOL
02/11/2016	35	PR2_004	DC & CTD, OBS, Flu, Optode	108	A1	11:48	54.16095	-5.23616	EOL
02/11/2016	36	PR2_009	DC & CTD, OBS, Flu, Optode	75	A1	12:15	54.15962	-5.23715	SOL
02/11/2016	36	PR2_009	DC & CTD, OBS, Flu, Optode	118	A1	12:37	54.16068	-5.23462	EOL
02/11/2016	37	PR2_001	DC & CTD, OBS, Flu, Optode	70	A1	13:02	54.15935	-5.23856	SOL
02/11/2016	37	PR2_001	DC & CTD, OBS, Flu, Optode	107	A1	13:23	54.15775	-5.23717	EOL
02/11/2016	38	PR2_007	DC & CTD, OBS, Flu, Optode	81	A1	13:49	54.15859	-5.23977	SOL
02/11/2016	38	PR2_007	DC & CTD, OBS, Flu, Optode	83	A1	14:09	54.15852	-5.24267	EOL
02/11/2016	39	PR2_010	DC & CTD, OBS, Flu, Optode	67	A1	14:34	54.16020	-5.24004	SOL
02/11/2016	39	PR2_010	DC & CTD, OBS, Flu, Optode	71	A1	14:56	54.16037	-5.24311	EOL
02/11/2016	40	PR2_003	DC & CTD, OBS, Flu, Optode	73	A1	15:13	54.16052	-5.24266	SOL
02/11/2016	40	PR2_003	DC & CTD, OBS, Flu, Optode	96	A1	15:34	54.16213	-5.24375	EOL
02/11/2016	41	PR2_002	DC & CTD, OBS, Flu, Optode	74	A1	16:02	54.16000	-5.24694	SOL
02/11/2016	41	PR2_002	DC & CTD, OBS, Flu, Optode	97	A1	16:25	54.15818	-5.24775	EOL
02/11/2016	42	PR2_012	DC & CTD, OBS, Flu, Optode	78	A1	17:37	54.16151	-5.24694	SOL
02/11/2016	42	PR2_012	DC & CTD, OBS, Flu, Optode	79	A1	17:58	54.16187	-5.24983	EOL
02/11/2016	43	PR2_011	DC & CTD, OBS, Flu, Optode	78	A1	18:16	54.16155	-5.25111	SOL
02/11/2016	43	PR2_011	DC & CTD, OBS, Flu, Optode	80	A1	18:38	54.15973	-5.25103	EOL

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
02/11/2016	44	PR2_013	DC & CTD, OBS, Flu, Optode	87	A1	19:17	54.16010	-5.25281	SOL
02/11/2016	44	PR2_013	DC & CTD, OBS, Flu, Optode	88	A1	19:36	54.15963	-5.25019	EOL
02/11/2016	45	PR2_015	DC & CTD, OBS, Flu, Optode	82	A1	19:59	54.16073	-5.25597	SOL
02/11/2016	45	PR2_015	DC & CTD, OBS, Flu, Optode	94	A1	20:22	54.15912	-5.25752	EOL
02/11/2016	46	PR2_016	DC & CTD, OBS, Flu, Optode	86	A1	20:42	54.16220	-5.25852	SOL
02/11/2016	46	PR2_016	DC & CTD, OBS, Flu, Optode	84	A1	21:05	54.16072	-5.25626	EOL
02/11/2016	47	PR2_014	DC & CTD, OBS, Flu, Optode	87	A1	21:28	54.16252	-5.25353	SOL
02/11/2016	47	PR2_014	DC & CTD, OBS, Flu, Optode	89	A1	21:49	54.16153	-5.25592	EOL
02/11/2016	48	PR2_018	DC & CTD, OBS, Flu, Optode	88	A1	22:08	54.16009	-5.26124	SOL
02/11/2016	48	PR2_018	DC & CTD, OBS, Flu, Optode	89	A1	22:19	54.15940	-5.26197	EOL
02/11/2016	49	PR2_017	DC & CTD, OBS, Flu, Optode	85	A1	22:34	54.16067	-5.26304	SOL
02/11/2016	49	PR2_017	DC & CTD, OBS, Flu, Optode	89	A1	22:56	54.16072	-5.26602	EOL
02/11/2016	50	PR2_020	DC & CTD, OBS, Flu, Optode	87	A1	23:16	54.16072	-5.26602	SOL
02/11/2016	50	PR2_020	DC & CTD, OBS, Flu, Optode	85	A1	23:27	54.16066	-5.27175	EOL
02/11/2016	51	PR2_021	DC & CTD, OBS, Flu, Optode	86	A1	23:42	54.15985	-5.27162	SOL
02/11/2016	51	PR2_021	DC & CTD, OBS, Flu, Optode	88	A1	23:52	54.15911	-5.27237	EOL
03/11/2016	52	PR2_019	NWB	80	A1	00:13	54.16105	-5.27275	NA
03/11/2016	53	PR2_019	DC & CTD, OBS, Flu, Optode	80	A1	00:28	54.16106	-5.27282	SOL
03/11/2016	53	PR2_019	DC & CTD, OBS, Flu, Optode	87	A1	00:50	54.16155	-5.27577	EOL
03/11/2016	54	PR2_007	NWB	83	A1	01:31	54.15856	-5.24265	NA
03/11/2016	55	PR2_007	DC & CTD, OBS, Flu, Optode	84	A1	01:45	54.15856	-5.24257	SOL
03/11/2016	55	PR2_007	DC & CTD, OBS, Flu, Optode	81	A1	02:07	54.15860	-5.23947	EOL
03/11/2016	56	PR3_012	NWB	88	A1	03:11	54.08996	-5.32419	NA
03/11/2016	57	PR3_012	DC & CTD, OBS, Flu, Optode	88	A1	03:26	54.08992	-5.32409	SOL
03/11/2016	57	PR3_012	DC & CTD, OBS, Flu, Optode	90	A1	03:46	54.08839	-5.32262	EOL
03/11/2016	58	PR3_002	NWB	85	A1	04:30	54.08687	-5.32516	NA
03/11/2016	58	PR3_002	NWB	85	A2	04:37	54.08688	-5.32516	NA

Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
03/11/2016	58	PR3_002	NWB	85	A3	04:44	54.08694	-5.32464	NA
03/11/2016	59	PR3_002	DC & CTD, OBS, Flu, Optode	84	A1	05:03	54.08685	-5.32509	SOL
03/11/2016	59	PR3_002	DC & CTD, OBS, Flu, Optode	93	A1	05:24	54.08595	-5.32251	EOL
03/11/2016	60	PR3_015	NWB	93	A1	05:40	54.08716	-5.31992	NA
03/11/2016	61	PR3_015	DC & CTD, OBS, Flu, Optode	93	A1	06:01	54.08699	-5.32018	SOL
03/11/2016	61	PR3_015	DC & CTD, OBS, Flu, Optode	102	A1	06:22	54.08543	-5.32158	EOL
03/11/2016	62	PR3_011	DC & CTD, OBS, Flu, Optode	109	A1	06:36	54.08486	-5.32034	SOL
03/11/2016	62	PR3_011	DC & CTD, OBS, Flu, Optode	105	A1	06:58	54.08586	-5.31773	EOL
03/11/2016	63	PR3_001	DC & CTD, OBS, Flu, Optode	102	A1	07:11	54.08574	-5.31911	SOL
03/11/2016	63	PR3_001	DC & CTD, OBS, Flu, Optode	116	A1	07:21	54.08504	-5.31820	EOL
03/11/2016	64	PR3_008	DC & CTD, OBS, Flu, Optode	97	A1	08:12	54.08776	-5.31919	SOL
03/11/2016	64	PR3_008	DC & CTD, OBS, Flu, Optode	91	A1	08:32	54.08858	-5.32174	EOL
03/11/2016	65	PR3_007	DC & CTD, OBS, Flu, Optode	97	A1	08:50	54.08914	-5.32010	SOL
03/11/2016	65	PR3_007	DC & CTD, OBS, Flu, Optode	106	A1	09:00	54.08993	-5.31958	EOL
03/11/2016	66	PR3_016	DC & CTD, OBS, Flu, Optode	93	A1	09:20	54.08955	-5.32121	SOL
03/11/2016	66	PR3_016	DC & CTD, OBS, Flu, Optode	92	A1	09:40	54.09075	-5.32336	EOL
03/11/2016	67	PR3_004	DC & CTD, OBS, Flu, Optode	90	A1	09:58	54.09098	-5.32478	SOL
03/11/2016	67	PR3_004	DC & CTD, OBS, Flu, Optode	104	A1	10:08	54.09188	-5.32469	EOL
03/11/2016	68	PR3_005	DC & CTD, OBS, Flu, Optode	93	A1	10:32	54.09053	-5.32563	SOL
03/11/2016	68	PR3_005	DC & CTD, OBS, Flu, Optode	94	A1	10:52	54.09018	-5.32272	EOL
03/11/2016	69	PR3_010	DC & CTD, OBS, Flu, Optode	103	A1	11:16	54.08543	-5.32326	SOL
03/11/2016	69	PR3_010	DC & CTD, OBS, Flu, Optode	99	A1	11:36	54.08550	-5.32625	EOL
03/11/2016	70	PR3_006	DC & CTD, OBS, Flu, Optode	101	A1	11:55	54.08617	-5.32754	SOL
03/11/2016	70	PR3_006	DC & CTD, OBS, Flu, Optode	90	A1	12:07	54.08691	-5.32672	EOL
03/11/2016	71	PR3_014	DC & CTD, OBS, Flu, Optode	92	A1	12:28	54.08611	-5.32587	SOL
03/11/2016	71	PR3_014	DC & CTD, OBS, Flu, Optode	90	A1	12:50	54.08745	-5.32388	EOL
03/11/2016	72	PR3_009	DC & CTD, OBS, Flu, Optode	93	A1	13:09	54.08774	-5.32697	SOL

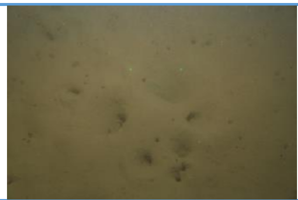
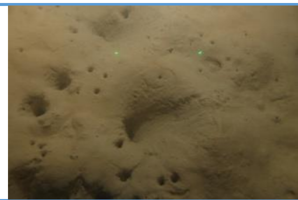
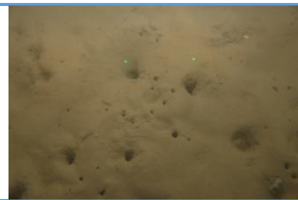
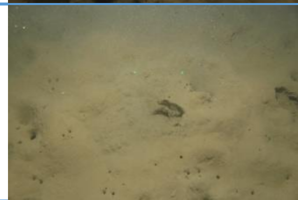
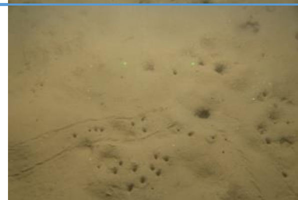
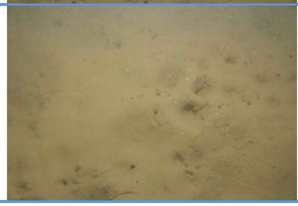
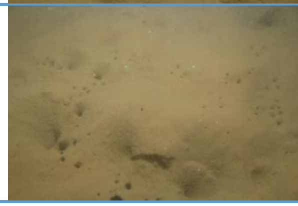
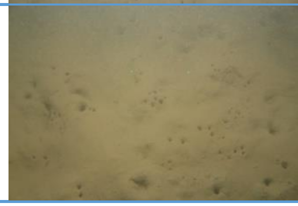
Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
03/11/2016	72	PR3_009	DC & CTD, OBS, Flu, Optode	88	A1	13:31	54.08931	-5.32548	EOL
03/11/2016	73	PR3_003	DC & CTD, OBS, Flu, Optode	91	A1	13:54	54.08949	-5.32681	SOL
03/11/2016	73	PR3_003	DC & CTD, OBS, Flu, Optode	91	A1	14:15	54.08857	-5.32428	EOL
03/11/2016	74	PR3_013	DC & CTD, OBS, Flu, Optode	92	A1	14:38	54.08989	-5.32688	SOL
03/11/2016	74	PR3_013	DC & CTD, OBS, Flu, Optode	96	A1	14:59	54.08838	-5.32817	EOL
03/11/2016	75	PR3_017	DC & CTD, OBS, Flu, Optode	100	A1	15:22	54.09130	-5.32755	SOL
03/11/2016	75	PR3_017	DC & CTD, OBS, Flu, Optode	113	A1	15:43	54.09304	-5.32781	EOL
03/11/2016	76	PR1_019	DC & CTD, OBS, Flu, Optode	100	A1	17:39	54.18569	-5.17110	SOL
03/11/2016	76	PR1_019	DC & CTD, OBS, Flu, Optode	111	A1	17:49	54.18635	-5.17200	EOL
03/11/2016	77	PR1_020	DC & CTD, OBS, Flu, Optode	96	A1	18:08	54.18532	-5.17040	SOL
03/11/2016	77	PR1_020	DC & CTD, OBS, Flu, Optode	91	A1	18:20	54.18616	-5.16969	EOL
03/11/2016	78	PR1_018	DC & CTD, OBS, Flu, Optode	88	A1	18:34	54.18573	-5.16985	SOL
03/11/2016	78	PR1_018	DC & CTD, OBS, Flu, Optode	101	A1	18:46	54.18633	-5.17108	EOL
03/11/2016	79	PR1_016	DC & CTD, OBS, Flu, Optode	91	A1	19:09	54.18489	-5.16907	SOL
03/11/2016	79	PR1_016	DC & CTD, OBS, Flu, Optode	93	A1	19:19	54.18540	-5.17026	EOL
03/11/2016	80	PR1_015	DC & CTD, OBS, Flu, Optode	84	A1	19:36	54.18504	-5.16748	SOL
03/11/2016	80	PR1_015	DC & CTD, OBS, Flu, Optode	99	A1	19:47	54.18422	-5.16831	EOL
03/11/2016	81	PR1_021	DC & CTD, OBS, Flu, Optode	83	A1	20:00	54.18492	-5.16683	SOL
03/11/2016	81	PR1_021	DC & CTD, OBS, Flu, Optode	96	A1	20:11	54.18400	-5.16694	EOL
03/11/2016	82	PR1_014	DC & CTD, OBS, Flu, Optode	82	A1	20:28	54.18482	-5.16640	SOL
03/11/2016	82	PR1_014	DC & CTD, OBS, Flu, Optode	92	A1	20:39	54.18441	-5.16499	EOL
03/11/2016	83	PR1_017	DC & CTD, OBS, Flu, Optode	88	A1	20:54	54.18555	-5.16699	SOL
03/11/2016	83	PR1_017	DC & CTD, OBS, Flu, Optode	88	A1	21:09	54.18486	-5.16528	EOL
03/11/2016	84	PR2_023	DC & CTD, OBS, Flu, Optode	95	A1	22:05	54.16038	-5.27707	SOL
03/11/2016	84	PR2_023	DC & CTD, OBS, Flu, Optode	91	A1	22:50	54.16006	-5.27065	EOL
03/11/2016	85	PR2_022	DC & CTD, OBS, Flu, Optode	90	A1	23:16	54.16039	-5.26760	SOL
03/11/2016	85	PR2_022	DC & CTD, OBS, Flu, Optode	88	A1	23:25	54.16108	-5.26689	EOL

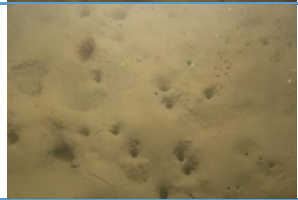
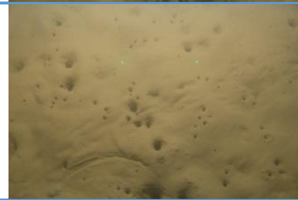
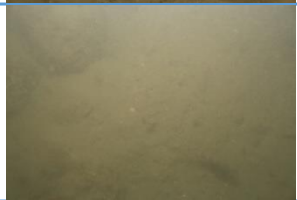
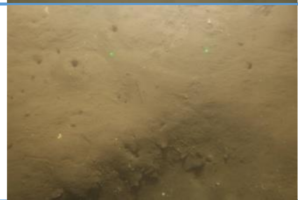
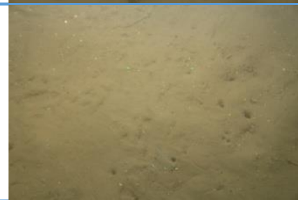
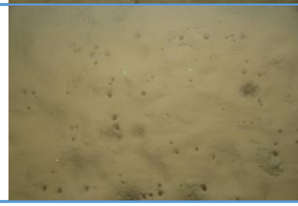
Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
03/11/2016	86	PR2_024	DC & CTD, OBS, Flu, Optode	90	A1	23:49	54.16248	-5.25892	SOL
04/11/2016	86	PR2_024	DC & CTD, OBS, Flu, Optode	100	A1	00:28	54.15991	-5.25502	EOL
04/11/2016	87	PR2_025	DC & CTD, OBS, Flu, Optode	97	A1	00:49	54.15917	-5.25312	SOL
04/11/2016	87	PR2_025	DC & CTD, OBS, Flu, Optode	83	A1	01:32	54.16154	-5.24844	EOL
04/11/2016	88	CTD_04	CTD	98	A1	01:59	54.15616	-5.24746	NA
04/11/2016	88	CTD_04	CTD	98	A2	02:32	54.14680	-5.24314	NA
04/11/2016	89	PR2NS105	MB2 & SBP	NA	A1	04:09	54.16990	-5.24153	SOL
04/11/2016	89	PR2NS105	MB2 & SBP	NA	A1	04:25	54.15066	-5.24663	EOL
04/11/2016	89	PR2NS95	MB2 & SBP	NA	A1	04:34	54.15073	-5.25055	SOL
04/11/2016	89	PR2NS95	MB2 & SBP	NA	A1	04:49	54.16971	-5.24570	EOL
04/11/2016	89	PR2NS90	MB2 & SBP	NA	A1	04:59	54.16990	-5.24768	SOL
04/11/2016	89	PR2NS90	MB2 & SBP	NA	A1	05:13	54.15098	-5.25234	EOL
04/11/2016	89	PR2NS85	MB2 & SBP	NA	A1	05:23	54.15108	-5.25426	SOL
04/11/2016	89	PR2NS85	MB2 & SBP	NA	A1	05:38	54.16993	-5.24958	EOL
04/11/2016	89	PR2NS80	MB2 & SBP	NA	A1	05:47	54.17015	-5.25157	SOL
04/11/2016	89	PR2NS80	MB2 & SBP	NA	A1	06:01	54.15122	-5.25631	EOL
04/11/2016	89	PR2NS60	MB2 & SBP	NA	A1	06:57	54.15157	-5.26379	SOL
04/11/2016	89	PR2NS60	MB2 & SBP	NA	A1	07:12	54.17049	-5.25912	EOL
04/11/2016	89	PR2NS55	MB2 & SBP	NA	A1	07:20	54.17062	-5.26084	SOL
04/11/2016	89	PR2NS55	MB2 & SBP	NA	A1	07:34	54.15046	-5.26604	EOL
04/11/2016	89	PR2NS45	MB2 & SBP	NA	A1	07:41	54.15194	-5.26969	SOL
04/11/2016	89	PR2NS45	MB2 & SBP	NA	A1	07:57	54.17082	-5.26483	EOL
04/11/2016	89	PR2NS40	MB2 & SBP	NA	A1	08:05	54.17100	-5.26630	SOL
04/11/2016	89	PR2NS40	MB2 & SBP	NA	A1	08:19	54.15210	-5.27131	EOL
04/11/2016	89	PR2NS35	MB2 & SBP	NA	A1	08:28	54.15213	-5.27330	SOL
04/11/2016	89	PR2NS35	MB2 & SBP	NA	A1	08:44	54.17112	-5.26866	EOL
04/11/2016	89	PR2NS30	MB2 & SBP	NA	A1	08:52	54.17139	-5.26992	SOL

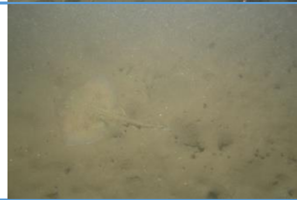
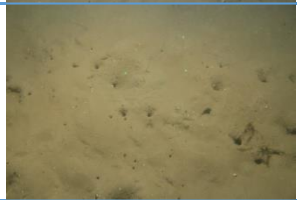
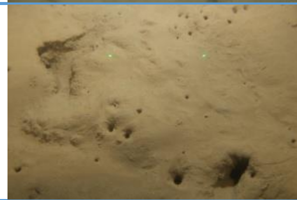
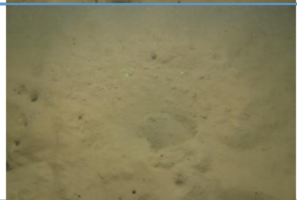
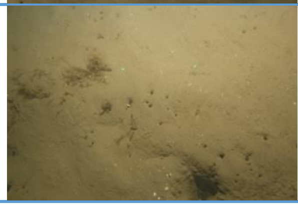
Date	Station no.	Station code	Gear code	Water depth (m)	Attempt	Time	Latitude	Longitude	SOL/EOL
04/11/2016	89	PR2NS30	MB2 & SBP	NA	A1	09:05	54.15238	-5.27530	EOL
04/11/2016	89	PR2NS20	MB2 & SBP	NA	A1	09:16	54.15247	-5.27917	SOL
04/11/2016	89	PR2NS20	MB2 & SBP	NA	A1	09:31	54.17137	-5.27441	EOL
04/11/2016	89	PR2NS15	MB2 & SBP	NA	A1	09:40	54.17157	-5.27570	SOL
04/11/2016	89	PR2NS15	MB2 & SBP	NA	A1	09:53	54.15263	-5.28079	EOL
04/11/2016	89	PR2NS10	MB2 & SBP	NA	A1	10:02	54.15273	-5.28301	SOL
04/11/2016	89	PR2NS10	MB2 & SBP	NA	A1	10:16	54.17167	-5.27816	EOL
04/11/2016	89	PR2Xa	MB2 & SBP	NA	A1	10:28	54.17010	-5.28093	SOL
04/11/2016	89	PR2Xa	MB2 & SBP	NA	A1	10:51	54.15165	-5.22854	EOL

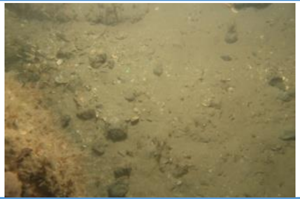
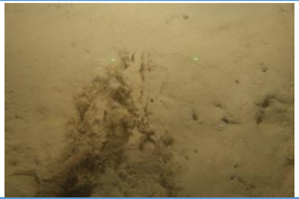
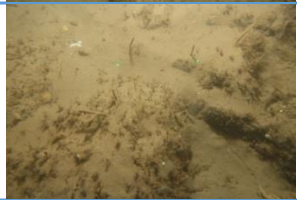
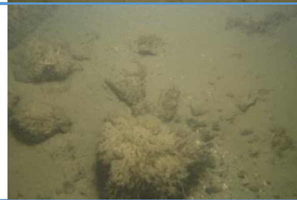
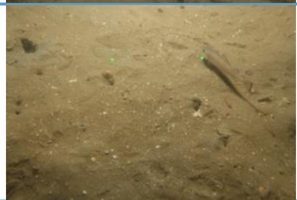
Appendix 7. Habitat types

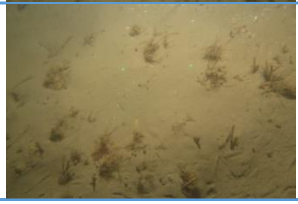
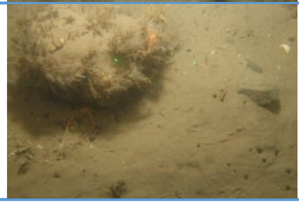
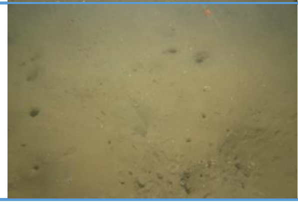
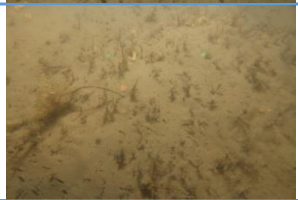
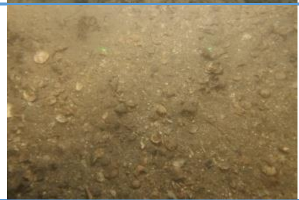
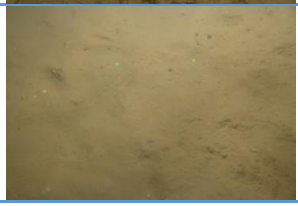
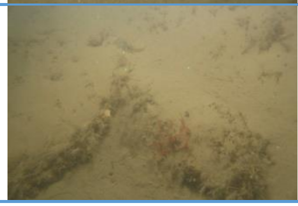
Table 7. Habitat types observed during each drop camera deployment on CEND2316X. Note: hard substrate presence analysis is preliminary and may change following detailed analysis.

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PR1				
PSCS_CEND2316X_PR1_004_STN_013_A1				No
PSCS_CEND2316X_PR1_010_STN_014_A1				No
PSCS_CEND2316X_PR1_013_STN_015_A1				No
PSCS_CEND2316X_PR1_012_STN_016_A1				No

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR1_005_STN_017_A1				No
PSCS_CEND2316X_PR1_006_STN_018_A1				No
PSCS_CEND2316X_PR1_002_STN_019_A1				No
PSCS_CEND2316X_PR1_007_STN_020_A1				No (boulders before SOL)
PSCS_CEND2316X_PR1_001_STN_022_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR1_011_STN_024_A1				Yes
PSCS_CEND2316X_PR1_003_STN_025_A1				No
PSCS_CEND2316X_PR1_009_STN_027_A1				Yes
PSCS_CEND2316X_PR1_008_STN_029_A1				No
PSCS_CEND2316X_PR1_019_STN_076_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR1_020_STN_077_A1				Yes
PSCS_CEND2316X_PR1_018_STN_078_A1				Yes
PSCS_CEND2316X_PR1_016_STN_079_A1				Yes
PSCS_CEND2316X_PR1_015_STN_080_A1				Yes
PSCS_CEND2316X_PR1_021_STN_081_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR1_014_STN_082_A1				Yes
PSCS_CEND2316X_PR1_017_STN_083_A1				Yes
PR2				
PSCS_CEND2316X_PR2_008_STN_031_A1				Yes
PSCS_CEND2316X_PR2_005_STN_033_A1				Yes
PSCS_CEND2316X_PR2_006_STN_034_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
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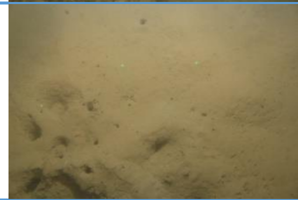
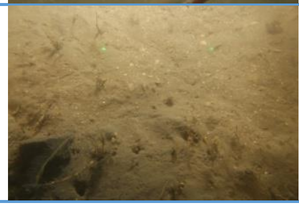
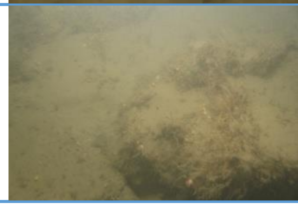
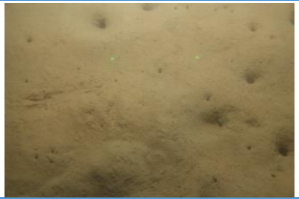
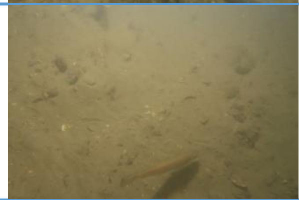
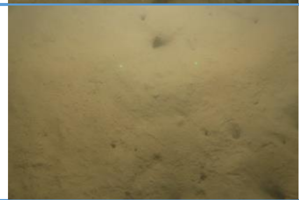
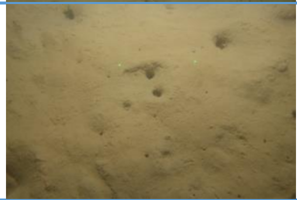
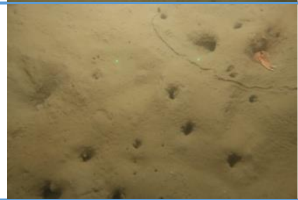
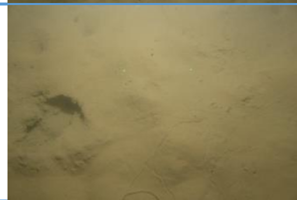
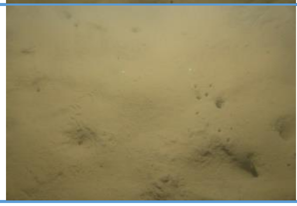
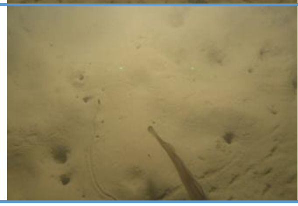
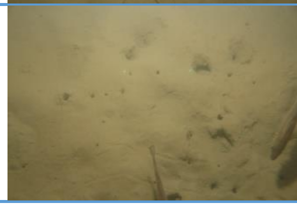
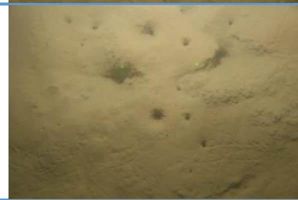
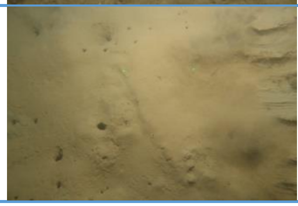
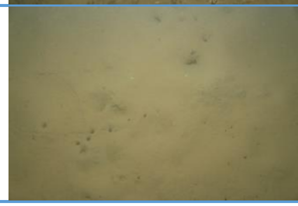
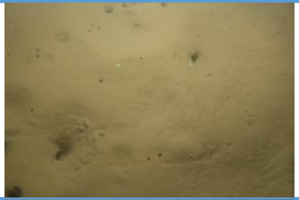
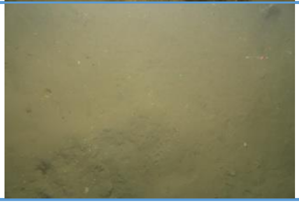
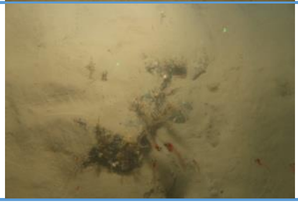
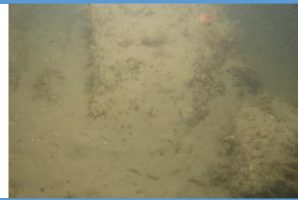
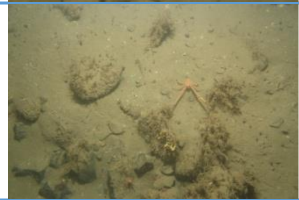
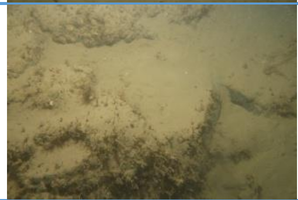
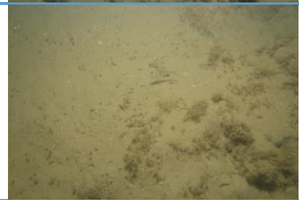
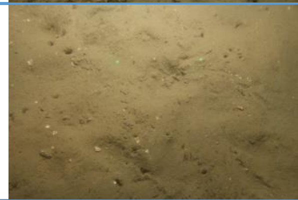
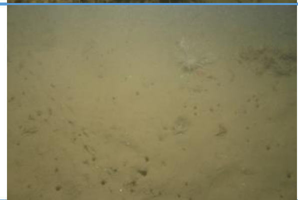
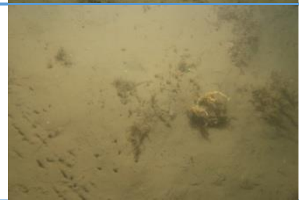
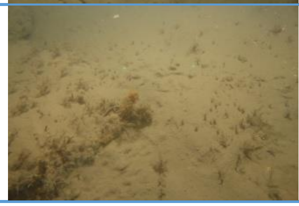
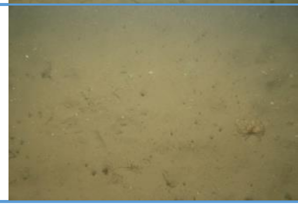
PSCS_CEND2316X_PR2_009_STN_036_A1				No
PSCS_CEND2316X_PR2_001_STN_037_A1				No
PSCS_CEND2316X_PR2_007_STN_038_A1				No
PSCS_CEND2316X_PR2_010_STN_039_A1				No

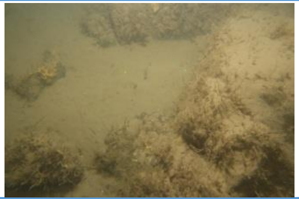
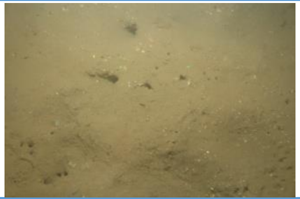
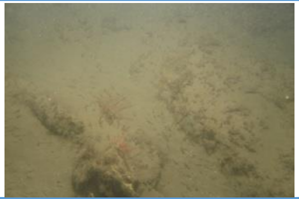
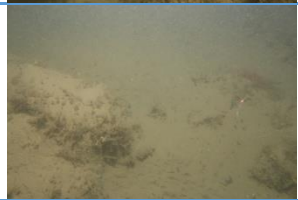
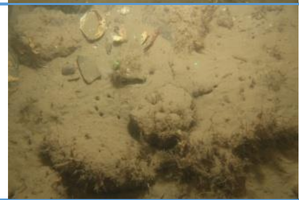
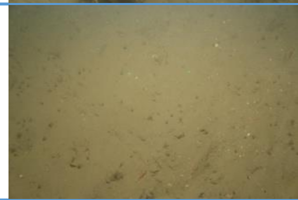
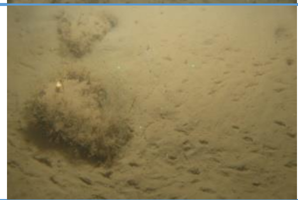
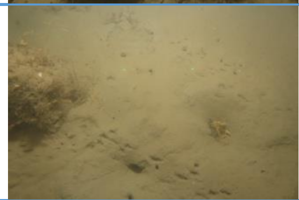
Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR2_003_STN_040_A1				No
PSCS_CEND2316X_PR2_002_STN_041_A1				No
PSCS_CEND2316X_PR2_012_STN_042_A1				No
PSCS_CEND2316X_PR2_011_STN_043_A1				No
PSCS_CEND2316X_PR2_013_STN_044_A1				No

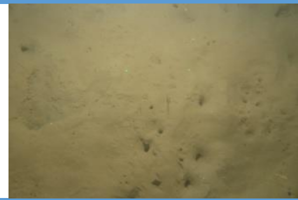
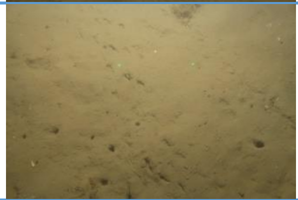
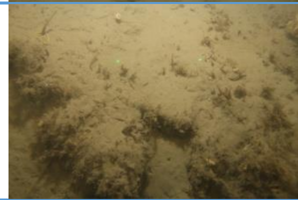
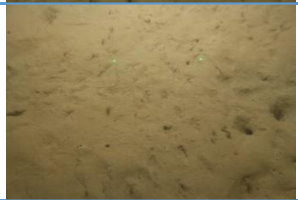
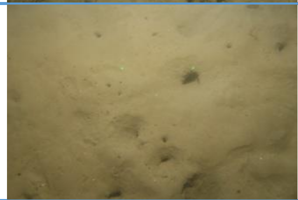
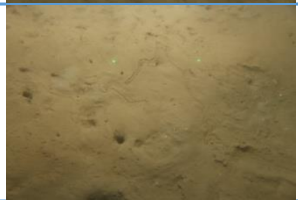
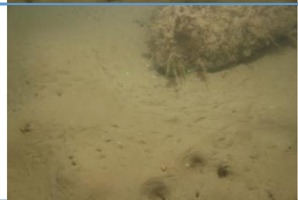
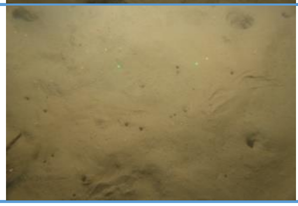
Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR2_015_STN_045_A1				No
PSCS_CEND2316X_PR2_016_STN_046_A1				No
PSCS_CEND2316X_PR2_014_STN_047_A1				No
PSCS_CEND2316X_PR2_018_STN_048_A1				No
PSCS_CEND2316X_PR2_017_STN_049_A1				No

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR2_020_STN_050_A1				No
PSCS_CEND2316X_PR2_021_STN_051_A1				No
PSCS_CEND2316X_PR2_019_STN_053_A1				Yes
PSCS_CEND2316X_PR2_007_STN_055_A1				Yes
PSCS_CEND2316X_PR2_023_STN_084_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR2_022_STN_085_A1				Yes
PSCS_CEND2316X_PR2_024_STN_086_A1				Yes
PSCS_CEND2316X_PR2_025_STN_087_A1				Yes
PR3				
PSCS_CEND2316X_PR3_012_STN_057_A1				Yes
PSCS_CEND2316X_PR3_002_STN_059_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR3_015_STN_061_A1				Yes
PSCS_CEND2316X_PR3_011_STN_062_A1				Yes
PSCS_CEND2316X_PR3_001_STN_063_A1				Yes
PSCS_CEND2316X_PR3_008_STN_064_A1				Yes
PSCS_CEND2316X_PR3_007_STN_065_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR3_016_STN_066_A1				Yes
PSCS_CEND2316X_PR3_004_STN_067_A1				Yes
PSCS_CEND2316X_PR3_005_STN_068_A1				Yes
PSCS_CEND2316X_PR3_010_STN_069_A1				Yes
PSCS_CEND2316X_PR3_006_STN_070_A1				Yes

Station code/filename	Representative sample 1	Representative sample 2	Representative sample 3	Hard substrate present
PSCS_CEND2316X_PR3_014_STN_071_A1				Yes
PSCS_CEND2316X_PR3_009_STN_072_A1				Yes
PSCS_CEND2316X_PR3_003_STN_073_A1				Yes
PSCS_CEND2316X_PR3_013_STN_074_A1				Yes
PSCS_CEND2316X_PR3_017_STN_075_A1				Yes

Appendix 8. Marine mammal observations report

The full Marine Mammal Observation and Passive Acoustic Monitoring Report is provided as a supplemental download.

Gardline: Survey Report for Centre for Environment, Fisheries and Aquaculture Science
Project: CEND23/16X Pisces Reef Complex cSAC/SCI Monitoring Survey
Description: Marine Mammal Observation and Passive Acoustic Monitoring Report
Survey Dates: 29-October-2016 to 09-November-2016
Project Number: 10897
Report Status: Final

Cefas

JNCC
Joint Nature Conservation Committee

JNCC/Cefas Partnership Report Series. *CEND23/16X Cruise Report: Monitoring Survey of Pisces Reef Complex cSAC/SCI*, **No. 18**. Jenkins, C. & Nelson, M. June 2017.
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