JNCC Report
No. 580

1515S Cruise Report: Monitoring survey of East of Gannet and Montrose Fields and Norwegian Boundary Sediment Plain Scottish Nature Conservation Marine Protected Areas

O'Connor, J.

January 2016

ISSN 0963 8901

For further information please contact:

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

This report should be cited as:

O'Connor, J. 2016. 1515S Cruise Report: Monitoring survey of East of Gannet and Montrose Fields and Norwegian Boundary Sediment Plain Scottish Nature Conservation Marine Protected Areas. *JNCC Report*, No. 580

Summary

The Joint Nature Conservation Committee (JNCC) and Marine Scotland Science (MSS) undertook an offshore seabed survey of East of Gannet and Montrose Fields (EGM) and Norwegian Boundary Sediment Plain (NSP) Scottish Nature Conservation Marine Protected Areas (NCMPAs) on the Marine Research Vessel Scotia (survey code 1515S) from 19 October 2015 to 2 November 2015.

The aim of the survey was to gather the initial dataset of a site monitoring time-series for the two NCMPAs. The data collected will be used to inform appropriate future monitoring at these sites to enable assessment of change (e.g. in distribution, extent and/or condition of features) and to contribute information on the habitats found at these sites for more general habitat-specific assessments.

Two hundred and seventy-six large Hamon grab (0.25m^2 surface area) samples from East of Gannet and Montrose Fields and Norwegian Boundary Sediment Plain NCMPAs (156 and 120 grab samples respectively) and 57 camera sledge transects at East of Gannet and Montrose Fields NCMPA were successfully completed.

Please note that observations made in this Cruise Report represent preliminary field observations. These observations have not been subject to Quality Assurance procedures. Please refer to the Final Report from this survey for Quality Assured evidence. This disclaimer should be included when referencing the Cruise Report.

Contents

1 Introduction

The Joint Nature Conservation Committee (JNCC) and Marine Scotland Science (MSS) undertook an offshore seabed survey of East of Gannet and Montrose Fields (EGM) and Norwegian Boundary Sediment Plain (NSP) Scottish Nature Conservation Marine Protected Areas (NCMPAs) (Figure 1) on the Marine Research Vessel (MRV) Scotia (survey code 1515S).

The survey departed Aberdeen on 19 October 2015 and arrived back into Aberdeen on 2 November 2015.

1.1 Scientific Staff

The survey team included scientists from MSS and JNCC.

The survey team were assigned to 12 hour shifts to allow for 24 hour operations.
Original content was created pre-GDPR and has been removed as contained personal information.
No scientific or technical content has been removed.

1.2 Survey location

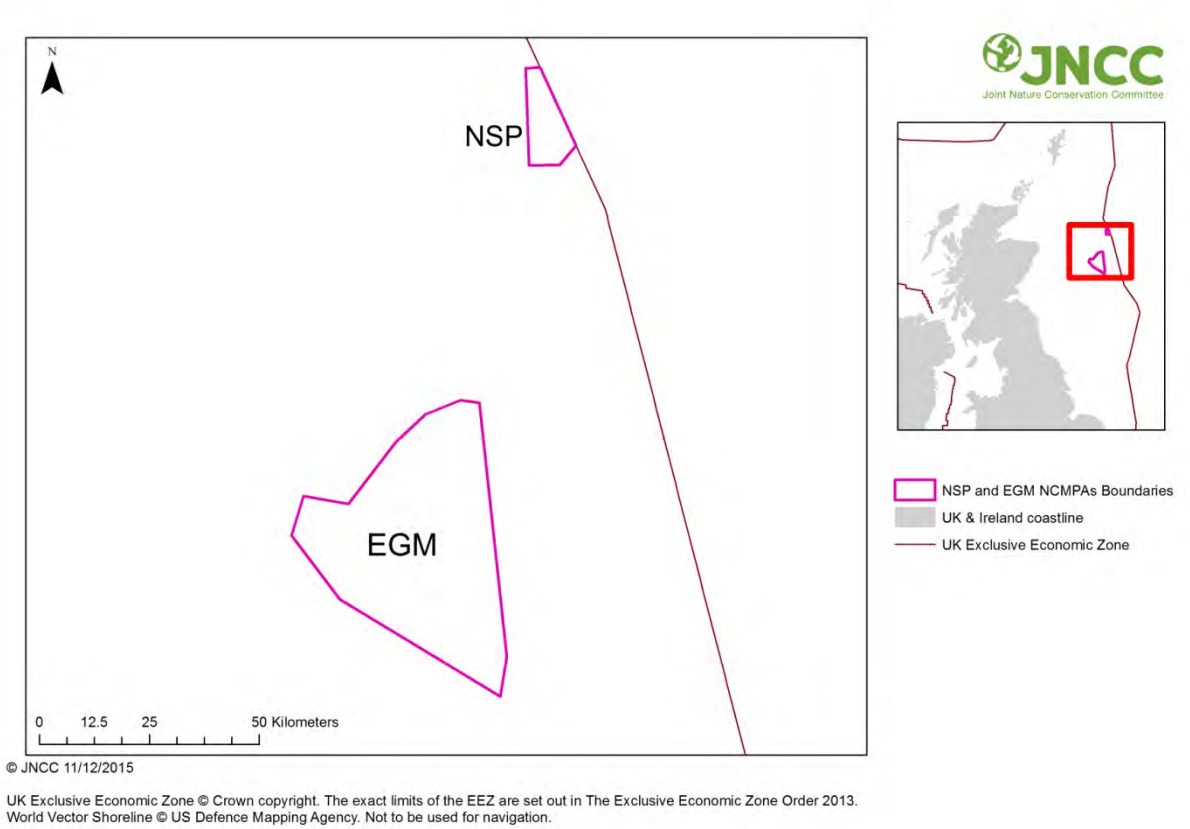


Figure 1. 1515S survey location and boundaries of EGM and NSP NCMPAs.

1.3 East of Gannet and Montrose Fields NCMPA

East of Gannet and Montrose Fields NCMPA (hereafter EGM) lies within a relatively shallow sediment plain in the Northern North Sea. **The protected features of EGM are *Arctica islandica* aggregations (including offshore subtidal sands and gravels as their supporting habitat) and offshore deep sea muds**.

Evidence available prior to the 1515S survey suggests that EGM is comprised mainly of sand and gravel habitats that support a range of benthic species, including *A. islandica* (the ocean quahog) which is considered Threatened and/or Declining in the Greater North Sea by the OSPAR Commission (OSPAR 2009). EGM is also aligned to coincide with the best estimate of the extent of an area of offshore deep sea muds, which is one of the few examples of Atlantic-influenced offshore deep sea mud habitats on the continental shelf in the region. EGM is the only MPA designated in the northern North Sea region for the protection of offshore deep sea muds. The deep sea muds are predicted to occur in a 2-7 km wide band from the south east to the north west of the MPA, though note that there is limited evidence of the composition and diversity of the biological communities present in this habitat.

Site area: 1,839km^2
Site depth range: The site ranges in depth between **80m** below sea level and **100m** below sea level.

Site boundary description: The MPA boundary reflects the entirety of the predicted extent of a patch of offshore deep sea muds which has been verified by existing British Geological Survey (BGS) and Marine Scotland Science survey data along the southern and western boundary, and sand and gravel habitats considered appropriate to harbour *A. islandica* aggregations.

The **Conservation Objectives** for the protected features of EGM are:
Subject to natural change, **conserve** the ***A. islandica* aggregations** in favourable condition, such that:

- the quality and extent of its habitat is stable or increasing; and
- the population structure allows numbers to be maintained or increased.

Subject to natural change, **conserve** the **offshore deep sea muds** in favourable condition, such that:

- its extent is stable or increasing; and
- its structures and functions, its quality, and the composition of its characteristic biological communities are such as to ensure that it is in a condition which is healthy and not deteriorating.

According to the JNCC Site Information Centre, there was no direct evidence available of damage to the protected features within EGM before the 1515S survey (see link below), though oil and gas infrastructure is present within the site (see Figure 3). Fishing (pelagic and demersal) and shipping also occur.

For further information please refer to the EGM Site Information Centre:

- http://jncc.defra.gov.uk/page-6478

1.3.1 Existing Information used to Inform Survey Planning

The environmental data available for survey planning and the infrastructure present within the EGM at the time of the 1515S survey are represented in Figures 2 and 3 below respectively.

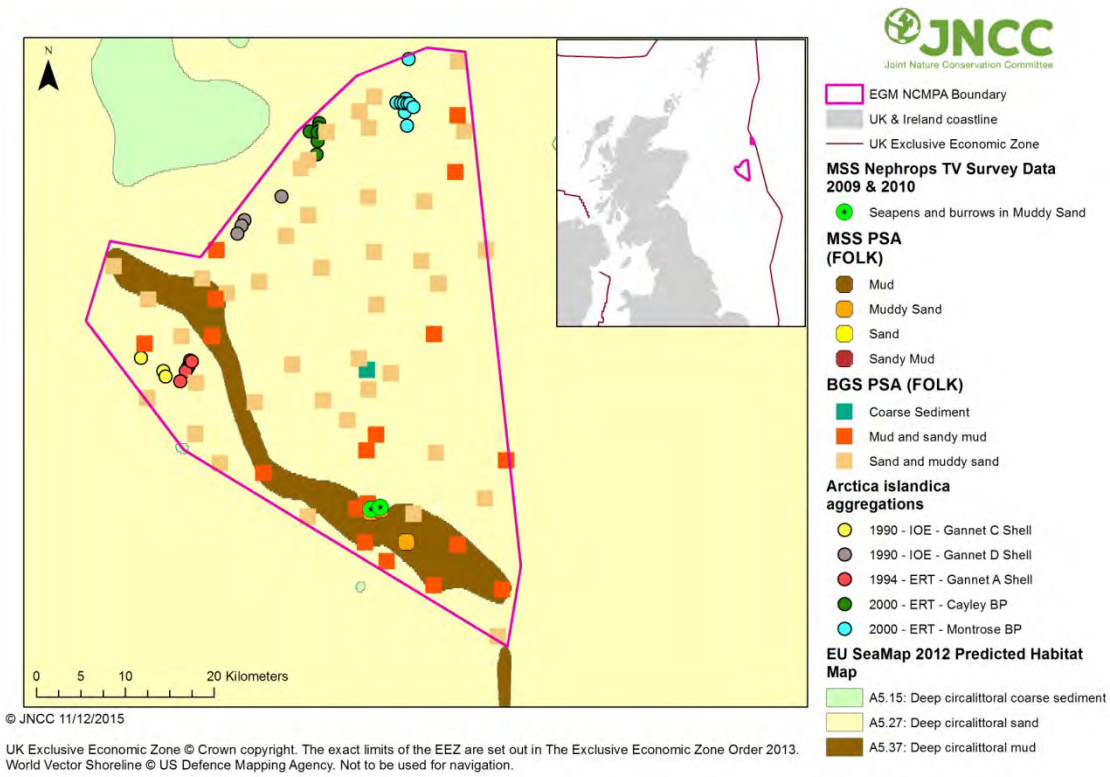


Figure 2. Data used to inform 1515S survey planning for East of Gannet and Montrose Fields NCMPA (note that EUNIS code A5.37 “deep circalittoral mud” correlates directly with “offshore deep sea muds”).

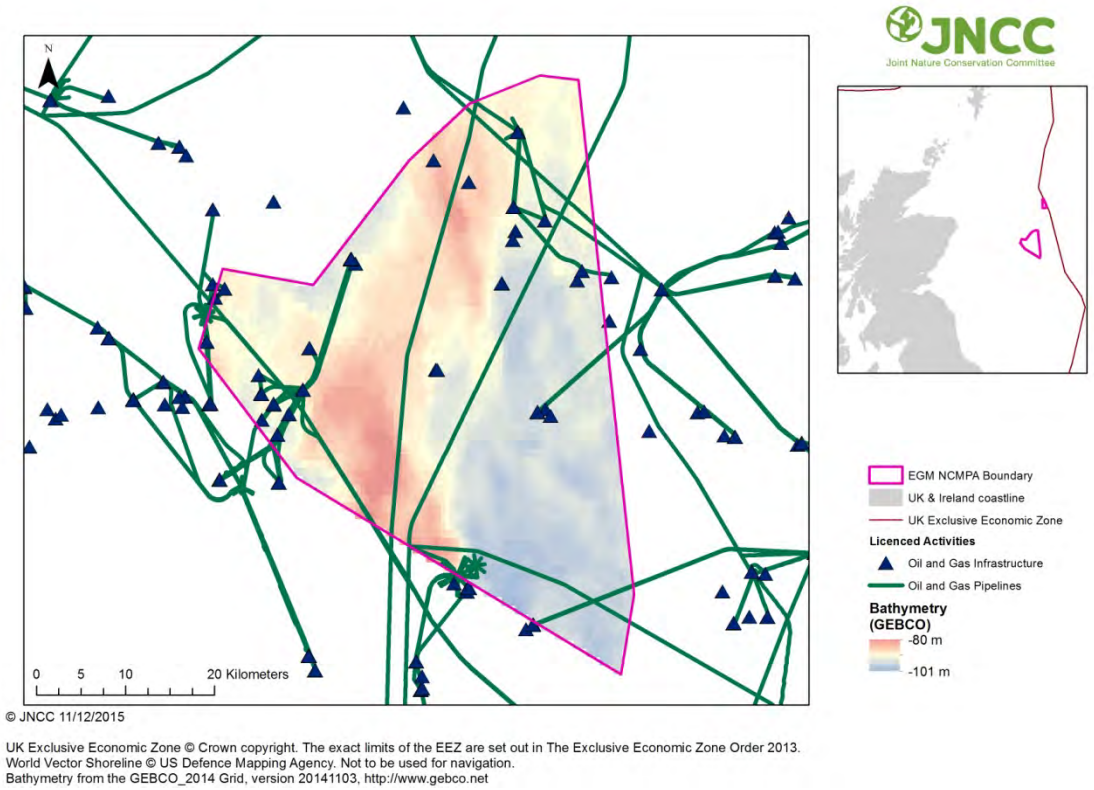


Figure 3. Bathymetry and Oil and Gas infrastructure present at East of Gannet and Montrose Fields NCMPA at time of 1515S survey.

1.4 Norwegian Boundary Sediment Plain NCMPA

The Norwegian Boundary Sediment Plain NCMPA (hereafter NSP) lies within a relatively shallow sediment plain adjacent to the offshore limit of UK waters. **The protected features of NSP are *A. islandica* aggregations (including offshore subtidal sands and gravels as their supporting habitat)**.

Evidence available prior to the 1515S survey suggests that NSP is comprised mainly of sand and gravel habitats that support a range of benthic species, including the *A. islandica* (the ocean quahog), which is considered Threatened and/or Declining in the Greater North Sea by the OSPAR Commission (OSPAR 2009). To support the protection of *A. islandica*, offshore subtidal sand and gravel habitats are also designated for protection in the context of providing habitat suitable for *A. islandica* colonisation. Survey data records from NSP have confirmed the presence of *A. islandica* within the depth range and sediment types in which they are expected to occur.

Site area: 164km^2
Site depth range: The site ranges in depth between **80m** below sea level to **120m** below sea level.
Site boundary description: The MPA boundary was drawn to include both surveyed records of *A. islandica* and areas of sediments considered suitable for *A. islandica* colonisation.

The **Conservation Objective** for the protected features of NSP is:
Subject to natural change, **conserve** the ***A. islandica* aggregations** in favourable condition, such that:

- the quality and extent of its habitat is stable or increasing; and
- the population structure allows numbers to be maintained or increased.

According to the JNCC Site Information Centre, there was no direct evidence available of damage to the protected feature within NSP before the 1515S survey (see link below), though oil and gas infrastructure is present within the site (see Figure 5). Demersal fishing and shipping also occur.

For further information please refer to the NSP Site Information Centre:

- http://jncc.defra.gov.uk/page-6485

1.4.1 Existing Information used to Inform Survey Planning

The environmental data available for survey planning and the infrastructure present within the NSP at the time of the 1515S survey are represented in Figures 4 and 5 respectively below.

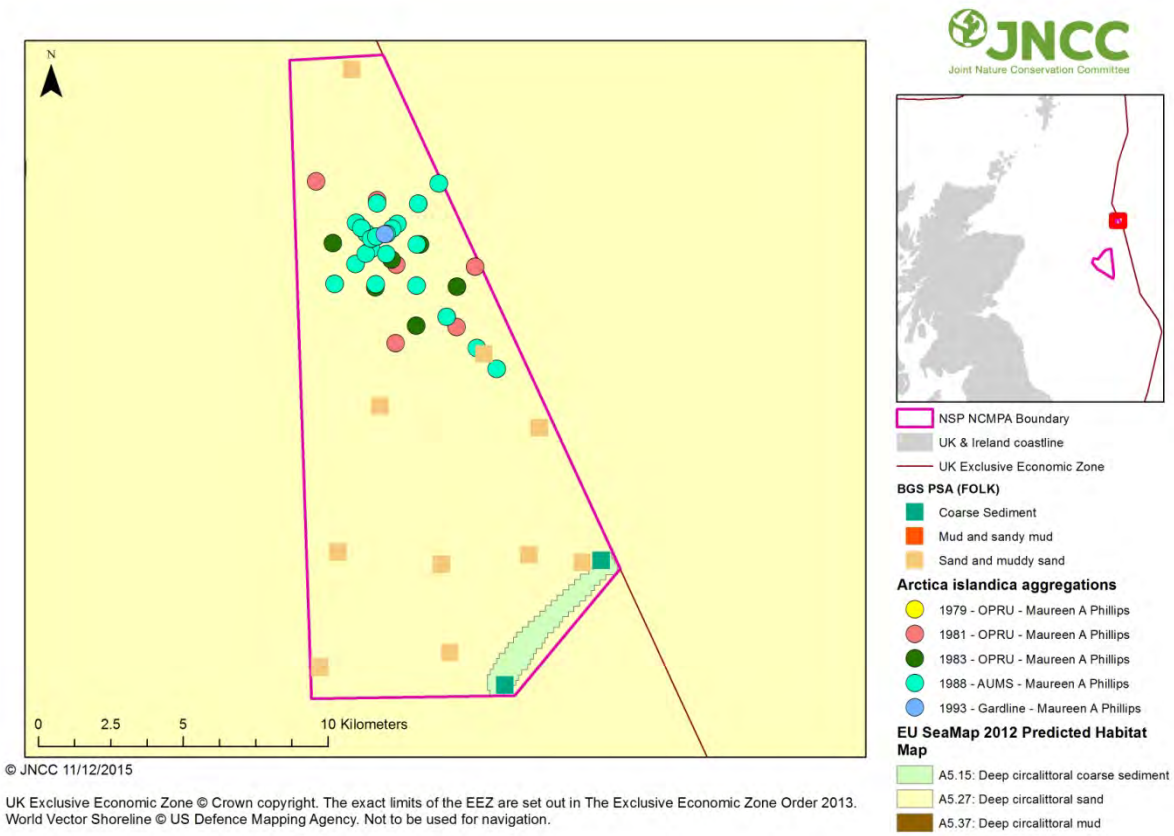


Figure 4. Data used to inform 1515S survey planning for Norwegian Boundary Sediment Plain NCMPA.

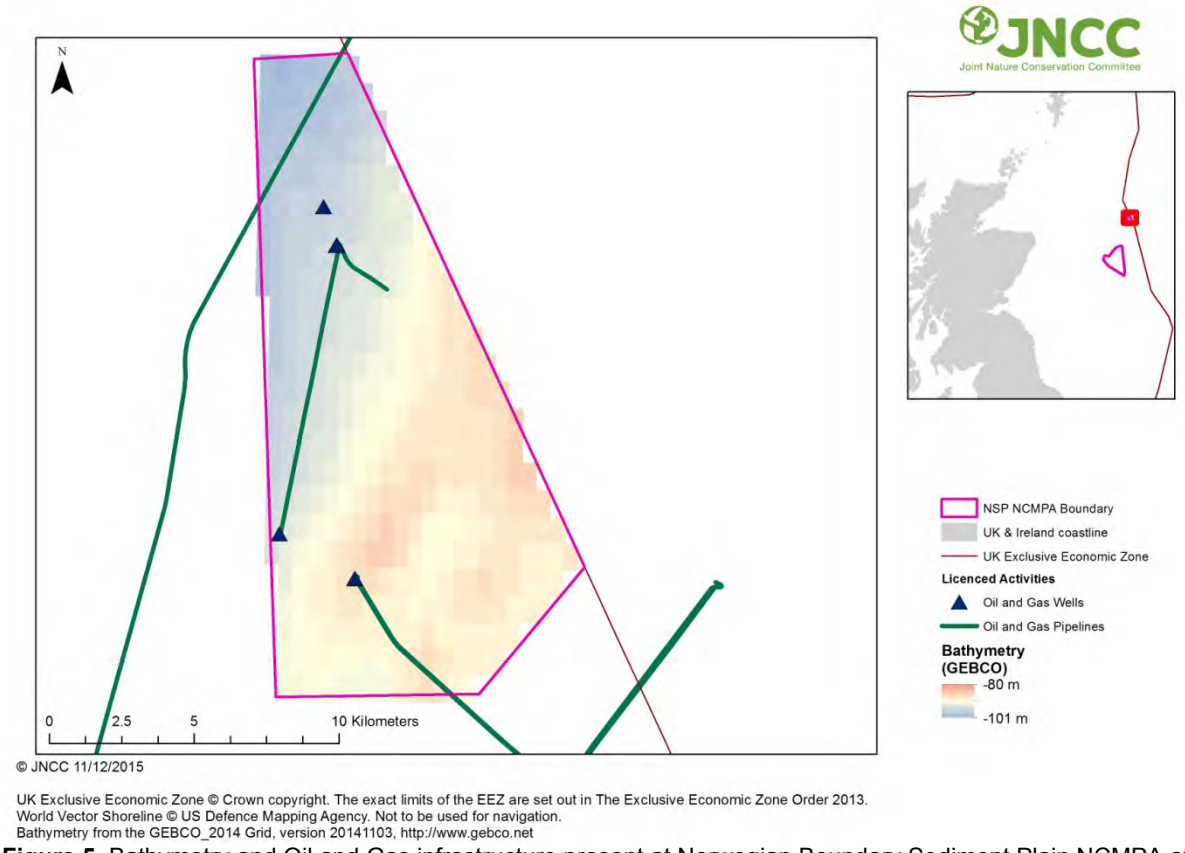


Figure 5. Bathymetry and Oil and Gas infrastructure present at Norwegian Boundary Sediment Plain NCMPA at time of 1515S survey.

2 Aim, Objectives & Outputs

The aim of the 1515S survey was to gather the initial dataset of a site monitoring time-series for East of Gannet and Montrose Fields (EGM) NCMPA and Norwegian Boundary Sediment Plain (NSP) NCMPA, and to contribute information on the habitats found at these sites for more general habitat specific assessments (e.g. under MSFD).

The survey focused on Type 1 monitoring (see Table 2 below) of the designated features of these sites, to measure the rate and direction of change in the long-term.

Table 2. Monitoring types (Kröger & Johnston (in prep); hereafter these monitoring types will be referred to as Type 1, 2 and 3.

Box 1: The three Monitoring Types

Sentinel Monitoring of long-term trends (Type 1 monitoring) – Objective: to measure rate and direction of long-term change.
This type of monitoring provides the context to distinguish directional trends from short-scale variability in space and time by representing variability across space at any one time and documenting changes over time.
To achieve this objective efficiently, a long-term commitment to regular and consistent data collection is necessary; this means time-series must be established as their power in identifying trends is far superior to any combination of independent studies.

Operational Monitoring of pressure-state relationships (Type 2 monitoring) – Objective: to measure state and relate observed change to possible causes.
This objective complements monitoring long-term trends and is best suited to explore the likely impacts of pressures on habitats and species and identify emerging problems. It leads to setting of hypotheses about processes underlying observed patterns.
It relies on finding relationships between observed changes in biodiversity and observed variability in pressures and environmental factors. It provides inference but it is not proof of cause and effect. The spatial and temporal scale for this type of monitoring activity will require careful consideration of the reality on the ground to ensure inference will be reliable; for example, inference will be poor in situations where the presence of a pressure is consistently correlated to the presence of an environmental driver (e.g. a specific depth stratum).

Investigative Monitoring to determine management needs and effectiveness (Type 3 monitoring) – Objective: to investigate the cause of change.
This monitoring type provides evidence of causality. It complements the above types by testing specific hypothesis through targeted manipulative studies. The design and statistical approach that can be used in these cases gives confidence in identifying cause and effect. It is best suited to test state/pressure relationships and the efficacy of management measures.

The **objectives** of the survey, listed in order of priority, were:

- Collect data to form the first dataset of a time-series against which to monitor change in condition of the designated features of EGM (*Arctica islandica* including offshore subtidal sands and gravels as their supporting habitat, **and** offshore deep sea muds).

- Collect data to form the first dataset of a time-series against which to monitor change in condition of the designated features of NSP (*A. islandica* including offshore subtidal sands and gravels as their supporting habitat).

The **contingency objectives** of the survey, listed in order of priority, were:

- Collect replicate samples (three per station) from a subset of stations to inform an assessment of the small-scale patchiness of *A. islandica.*

- Collect MBES bathymetry and backscatter data as a contingency objective at both sites in case of equipment or weather down time.

To prepare for the possibility that a prolonged period of poor weather could necessitate the ship to transit to a more sheltered location, inshore contingency survey locations were identified following discussion with Scottish Natural Heritage (SNH).

The **outputs that** the 1515S survey aims to deliver include:

1. the initial datasets of a time-series to monitor *A. islandica* and associated benthic communities in EGM and NSP (i.e. to enable assessment of change of features); and
2. the initial dataset of a time-series to monitor offshore deep sea muds and associated epifaunal communities in EGM (i.e. to enable assessment of change of features).

3 Sampling Design

3.1 Power Analysis

Power analyses were conducted by JNCC, using industry data collected from both sites. This analysis determined the number of samples that would be required from each site to enable an assessment of change to be made with acceptable statistical power and significance.

The metrics used in the analysis were taxon richness and taxon abundance. Analyses were conducted using R (R Core Team, 2013) to determine the number of samples required to detect a given percentage change in each metric at a power of 0.8 and a statistical significance (p) of 0.05.

The available datasets were combined and rationalised to reduce extraneous 'noise' which could result in artificially inflated variance. This involved the removal of samples which were not comparable in volume, were acquired using different sampling equipment, included juvenile macrofauna, or were contaminated by hydrocarbons. All included samples were acquired within similar depths and sediment types for each site.

Please note that the limited availability of existing data has not allowed for stratification of sampling by predicted habitat type within either site.

3.1.1 EGM

A power analysis was carried out on the 61 industry samples available from EGM, of which 14 were collected in June 2007, 11 were collected in August 2010 and the remaining 36 were collected in August 2013. Samples were collected using a 0.1m^2 dual van Veen grab.

It should be noted that all of these samples correspond to sand habitats only. No data was available to run power analyses on mud habitats. Power plots for the analyses are shown in Figure 9 and Figure 10.

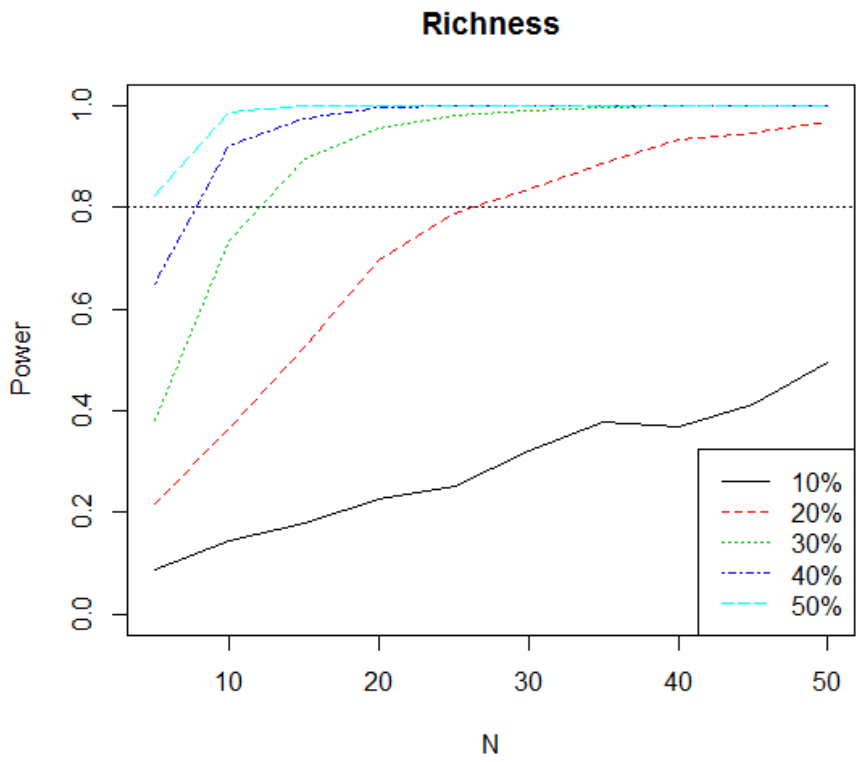


Figure 6. Power plot for EGM with significance (p) of 0.05 based on Taxon Richness. N = Number of samples, % = percentage of change in Taxon Richness.

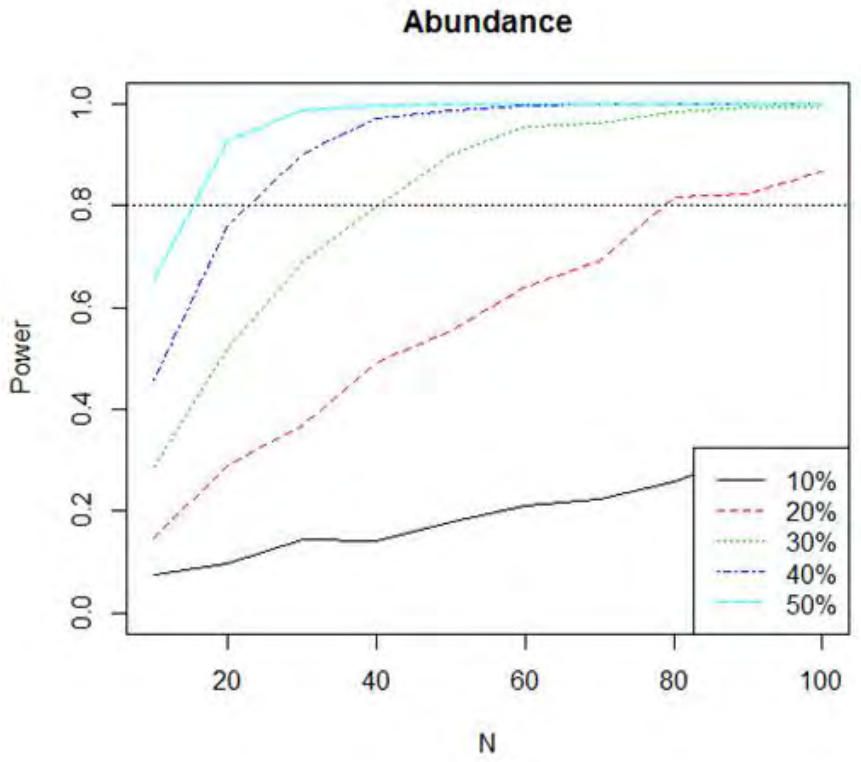


Figure 7. Power plot for EGM with significance (p) of 0.05 based on Taxon Abundance. N = Number of samples, % = percentage of change in Taxon Abundance.

The results of the analyses suggested that more samples would be required for taxon abundance than the other variables because of the much higher variation amongst the abundance levels per sample. As such, the taxon abundance power analysis was chosen to inform the sampling strategy, to ensure a precautionary approach to determining the number of samples should future metrics be considered for monitoring that exhibit lower spatial variability. The number of stations selected was based on detecting a 20% level of change in taxon abundance with a power of 0.8 or higher and a significance (p) of 0.05. A value of 20% change was chosen in alignment with monitoring work carried out by JNCC previously (Ware & McIlwaine and Callaway, both 2015). The power value of 0.8 was identified as appropriate, having considered the guidance outlined in the paper on statistical significance and power presented at the Healthy & Biologically Diverse Seas Evidence Group in February (Marubini 2014).

It was determined that a total of **78 samples** would be required to achieve this level of power and significance for sand habitats. In the absence of data for offshore deep sea muds, this number was then doubled to account for the presence of this habitat within the site[1], giving a total number of **156 samples**. Although arbitrary, this approach was considered to align with the precautionary principle.

3.1.2 NSP

Fifteen industry samples were available from NSP (collected in September 2008) to inform the power analysis (see Figure 4). Samples were collected using a 0.1m^2 Day grab. Power plots for the analysis are shown in Figure 11 and Figure 12Figure 9.

[1] Number of samples doubled on the assumption that half the site could be composed of mud, so that sufficient mud samples would also be collected

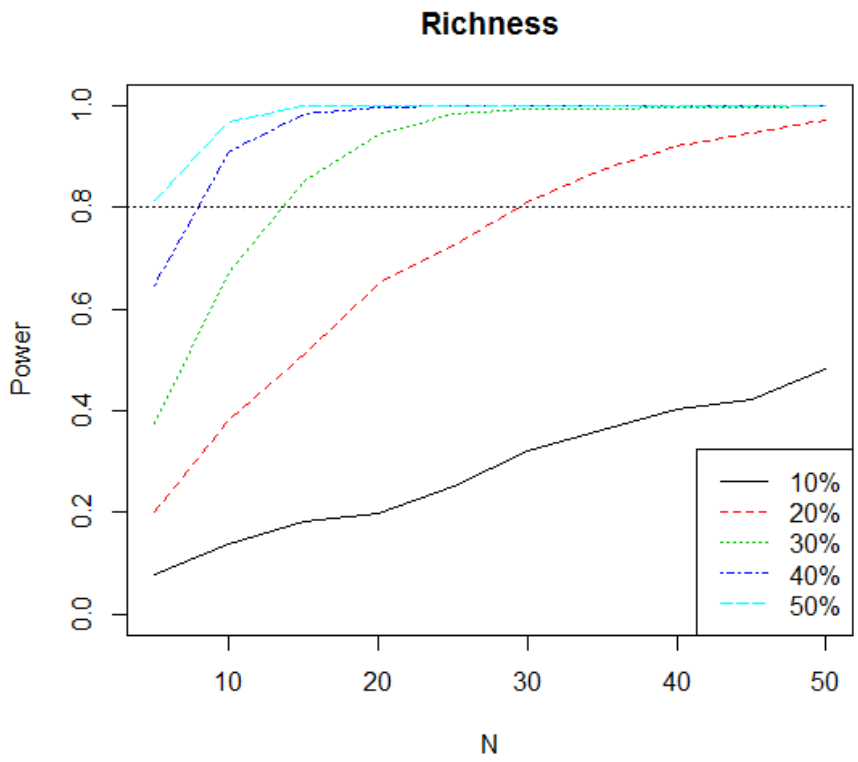


Figure 8. Power plot for NSP significance (p) of 0.05 based on Taxon Richness. N = Number of samples, % = percentage of change in Taxon Richness.

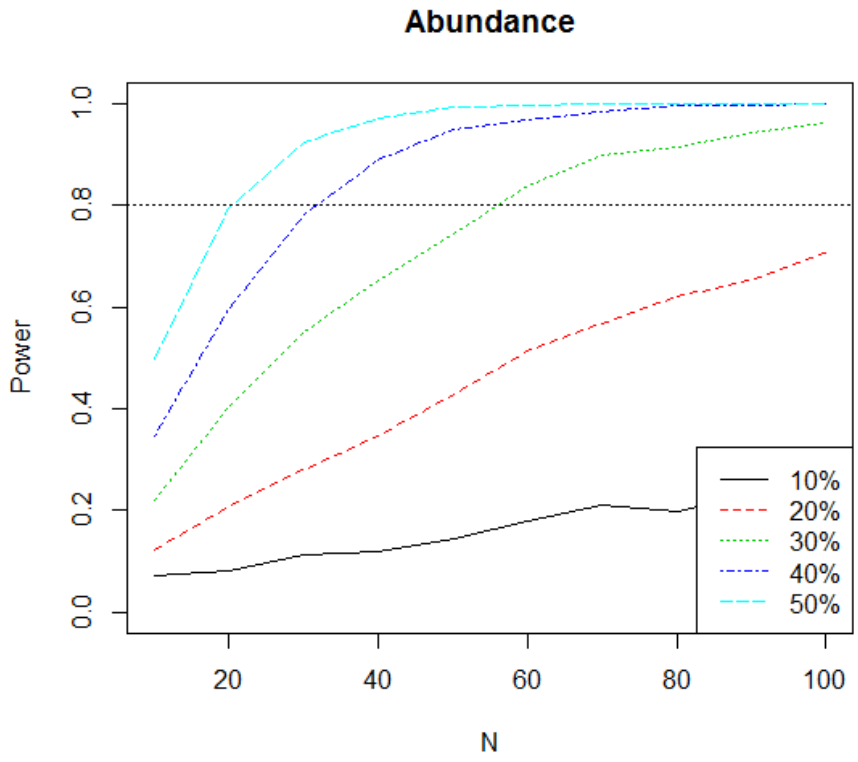


Figure 9. Power plot for NSP with significance (p) of 0.05 based on Taxon Abundance. N = Number of samples, % = percentage of change in Taxon Abundance.

As observed for EGM, the results of the analyses suggested that more samples would be required for taxon abundance than richness, due to much higher variation in abundance per sample. As such, the taxon abundance power analysis was chosen to inform the sampling strategy to ensure a precautionary approach to determining the number of samples should future metrics be considered for monitoring that exhibit lower spatial variability. The number of stations selected was based on detecting a 20 % level of change in species abundance with a power of 0.8 or higher and a significance (p) of 0.05.

As a result it was determined that a total of **120 samples** would be required to achieve this level of power for sand habitats at NSP.

3.2 Objective 1: Collect initial dataset of a site monitoring time-series for monitoring of the designated features of EGM

A triangular systematic grid of stations was preferred to randomised sampling stations to complete this objective, as a triangular grid delivers a more even spatial distribution across the site than randomised placement, allowing for distribution of features to be more accurately assessed, and providing broad coverage for the purpose of potential future monitoring (e.g. monitoring of adaptive management measures).

Consideration was given to positioning sample stations to include control station coverage outside of the site in the event of site level management measures being implemented (i.e. to allow Before-After-Control-Impact (BACI) studies be undertaken). As potential closures have not been defined it was considered more appropriate to concentrate sampling effort within the site boundary for this survey.

Please note that limited existing data did not allow for further stratification of sampling within the site.

Using ArcGIS 10 (ESRI 2011), a triangular systematic grid of 156 survey stations was plotted within the boundary of EGM to determine sampling locations (Figure 10).

Spacing between grid points was ~3.5km, as determined by the relationship between number of samples required and the area and shape of site boundary.

Samples were collected from within 100m of the centroid of each grid point identified.

Camera sledge tow transects were carried out at a subset of survey stations to sample epifauna associated with the offshore deep sea muds feature; stations were selected using the following rationale:

- Firstly, stations where sea pens were found in grab samples were selected for camera operations (i.e. as sea pens are a key feature of the offshore deep sea mud feature)
- Following this, as the preliminary assessment of grab samples collected suggested that all EGM stations contained potentially muddy sediments, and thus stratification by sediment type within the site would not be possible, station selection was randomised to reduce station selection bias
- The number of camera sledge transects carried out was thus determined by both the number of grab samples collected containing sea pens and the time available following completion of grabbing operations

The midpoint of each camera sledge transect was as close as was feasible to the corresponding grab sample location (i.e. given sea and weather conditions at time of camera sledge deployment).

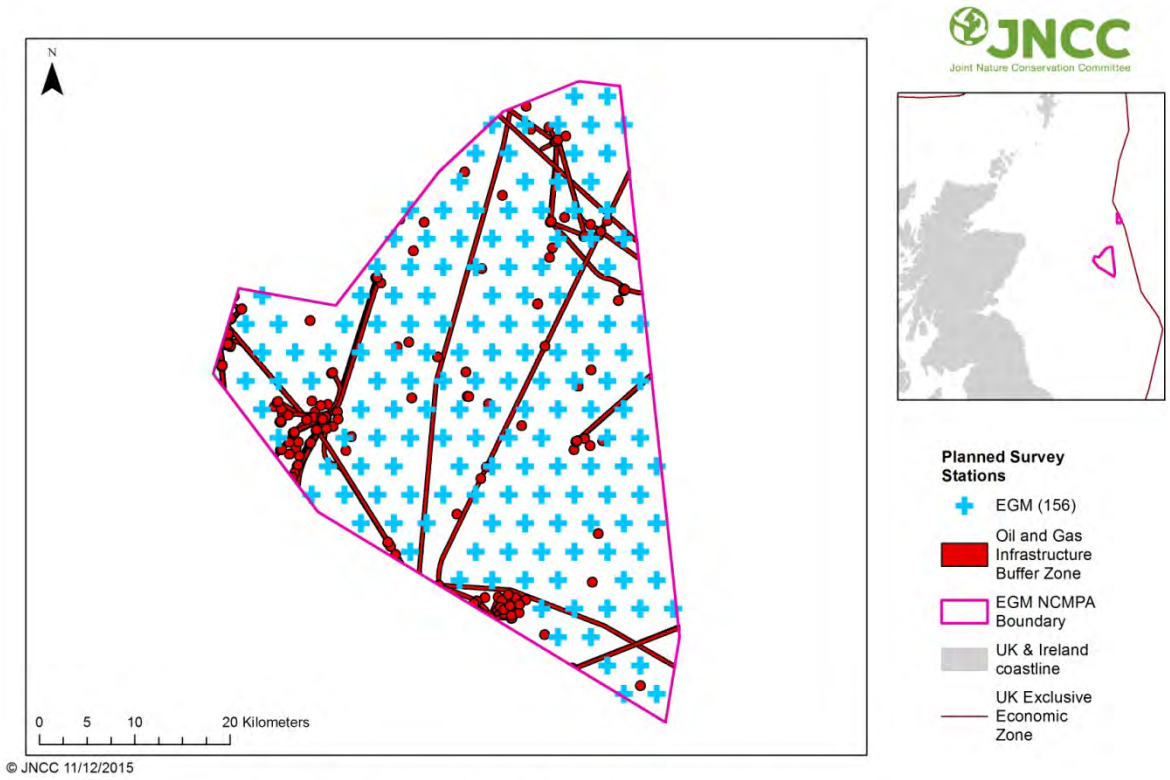


Figure 10. Triangular grid of survey stations identified for monitoring survey of the designated features of EGM.

3.3 Objective 2: Collect initial dataset of a site monitoring time-series for monitoring of the designated features of NSP

As is the case at EGM, a triangular systematic grid of stations was preferred to randomised placement of sampling stations.

Using ArcGIS 10 (ESRI 2011), a triangular systematic grid of 120 survey stations was plotted within the boundary of NSP to determine sampling locations (Figure 11).

Spacing between grid points was ~1km, as determined by the relationship between number of samples required and the area and shape of site boundary.

As at EGM, samples were collected from within 100m of the centroid of each grid point identified.

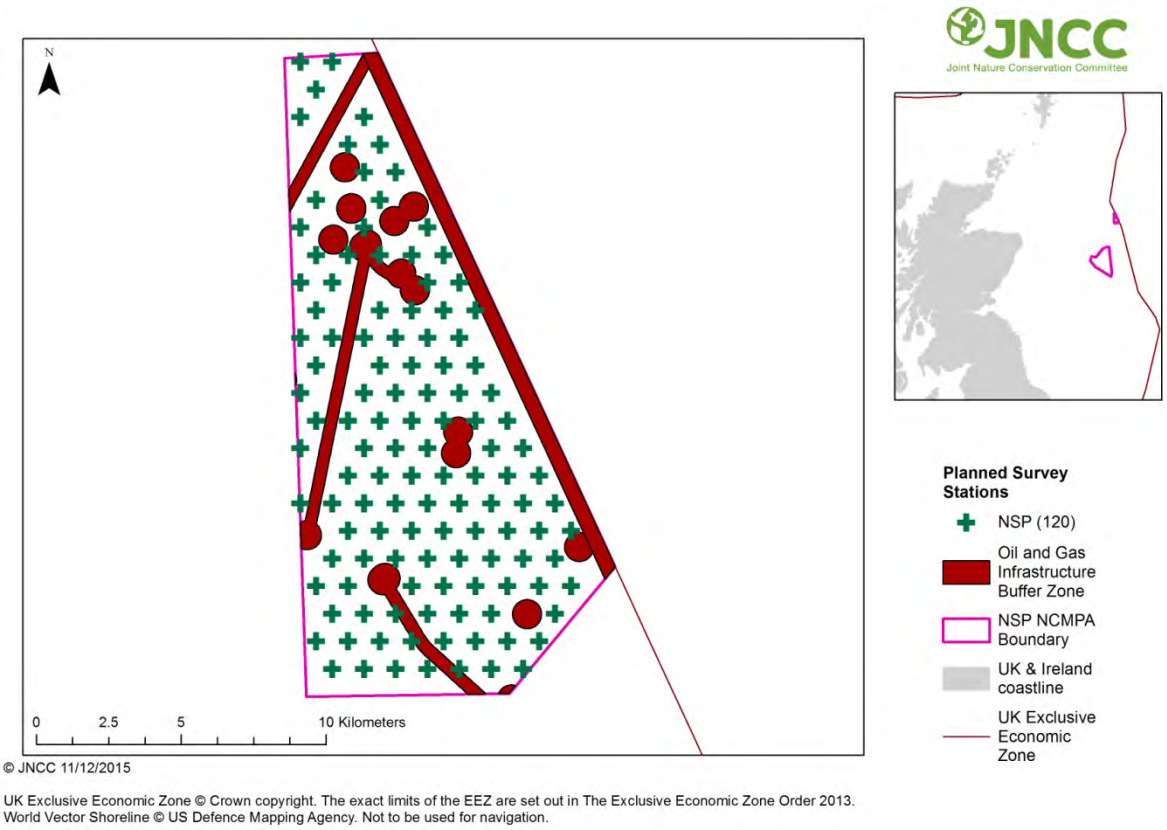


Figure 11. Triangular grid of survey stations identified for monitoring survey of the designated features of NSP.

4 Site-Specific Considerations

4.1 Oil and gas infrastructure

Oil and Gas UK were contacted and informed the operators of oil fields and infrastructure of the planned operations within the 1515S survey area.

Presence of oil and gas industry infrastructure in EGM and NSP was taken into account by placing an exclusion zone buffer of 500m around infrastructure and 200m either side of pipelines before applying the triangular systematic sampling grid within the site boundary.

4.2 UK and Norway territorial waters boundary

An exclusion zone buffer of 500m was applied to the boundary between UK and Norwegian territorial waters before applying the triangular systematic grid within the site boundary, to ensure sampling did not require MRV Scotia to enter Norwegian waters.

5 Methods Used

5.1 Large (0.25m^2) Hamon Grab

The survey involved direct sampling of the designated feature common to both sites, namely *Arctica islandica* including offshore subtidal sands and gravels as their supporting habitat.

A 0.25m^2 (grab surface area) Hamon Grab was used as primary sampling device to gather data relating to this feature.

Figure 12. 0.25 m^2 Hamon Grab (Grab provided by Cefas, image © JNCC, 2015).

Sampling operations, including gear deployment and recovery and preliminary sample processing, were conducted according to MESH Recommended Operating Guidelines for grab sampling and sorting and treatment of samples (Guerra & Freitas 2012), Cefas SOP 1380 Collection of samples using a Hamon Grab (Coggan 2006) and Marine Scotland Science Procedure/Risk Assessment No. EEC/ B040: Sediment sampling by Day and Van Veen grab (Robertson 2015).

Benthic infauna and PSA sub-samples were collected from each valid (>5l) grab sample; samples were preliminarily processed on transit between stations according to Cefas & MSS guidance (Coggan 2006 and Robertson 2015). Processing involved:

- Washing benthic infauna samples using 1mm sieves, storing samples in suitably sized and labelled sample containers, and chemically preserving and securely stowing samples.
- Storing PSA sub-samples in suitably sized and labelled sample bags and securely stowing samples in a freezer.

A. islandica specimens collected were visually identified in the field by survey scientists following guidance from the Scientist in Charge, who also confirmed the identification of the first specimens collected.

Specimens were photographed and measured (see Table 3) by the survey scientists before being returned to the sea.

5.2 Camera Sledge

An MSS camera system mounted on a sledge was used to gather epibenthic video and still photographic data relating to the offshore deep sea mud designated feature at EGM.

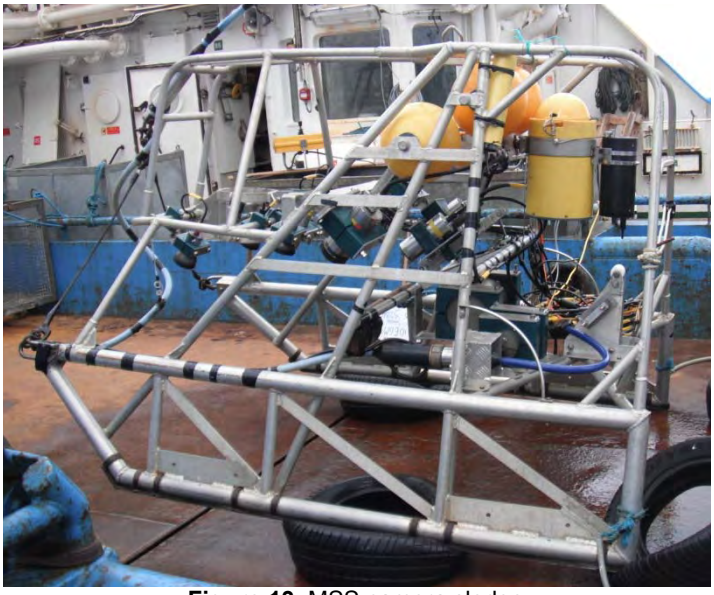


Figure 13. MSS camera sledge

The camera system supported the following instruments:

- SubC 1 Alpha video camera (recorded HD internally).
- Standard definition Kongsberg OE 14-408 digital camera (10MP) with dedicated flash unit for still images capture (camera controlled topside, images recorded internally).
- Kongsberg 14-366 colour TV camera for primary TV observation and topside recording to mini-DV tape and DVD.
- Four LED lamps for illumination.
- Two reference lasers.

Set-up and operation followed the MESH 'Recommended Operating Guidelines (ROG) for underwater video and photographic imaging techniques' (see Appendix 2 for further information on camera set-up). A video overlay was used to provide time. Field notes were made during each camera deployment, noting station and sample metadata and real-time observations of substrate and taxa.

The station location selected was assigned as the midpoint of each transect. During deployments, the vessel executed a controlled drift at ~ 1 knot through the specified station.

The camera sledge was controlled by winch; the operator had sight of the video monitor.

Short (10 minute/~300m) camera sledge transects were carried out, with HD video recorded continuously and stills captured every minute during the camera sledge tow transect.

Two point lasers, with laser points 120mm apart, were used to provide scaling for video and stills captured.

5.3 Metadata

Positional data for grab samples was obtained by use of a USB-Comms adaptor to link the ship's GPS feed to the JNCC Survey Laptop ArcGIS 10 software to allow 'fixes' of the ship's position to be recorded.

Positional data for the camera sledge was obtained using a Sonardyne Scout Ultra Short Baseline (USBL) system and equipment-mounted Sonardyne Omni-directional Transponder.

'Fixes' of the vessels GPS position were also recorded, and linked to USBL positions by matching timestamps.

Cable out and depth were logged for each deployment to enable a calculation of layback be made in case of USBL failure.

JNCC log sheets and Sampling Metadata spreadsheet were completed for each sampling event.

6 Cruise Narrative

The MRV Scotia (hereafter “Scotia”) mobilised for the 1515S offshore seabed survey from Aberdeen Harbour from 16-19 October 2015.

JNCC scientists joined Scotia on Sunday 18 October 2015.

A ship’s induction was carried out at 09:00 on Monday 19 October 2015. Scotia departed Aberdeen Harbour for EGM at 13:00 on Monday 19 October 2015, with a safety drill (general muster) following at 13:30. A toolbox talk, led by Scientist In-Charge (SIC) Mike Robertson, was held between JNCC and MSS scientists and the captain (Don Smith) at 14:00 on Monday 19 October 2015.

Scotia arrived on the first station (**EGM2**) at EGM at 20:45 on Monday 19 October 2015 and began Hamon grab sampling operations.

Sampling operations were suspended from 15:30 to 23:00 on Thursday 22 October 2015 due to inclement weather conditions rendering operations unsafe.

The final EGM grab sampling station (**EGM116**) was successfully completed at 08:00 on Saturday 24 October 2015.

Following transit to NSP, Hamon grab sampling operations began at grab sampling station **NSP17** at 11:00 on Saturday 24 October 2015.

Sampling operations were suspended from 03:00 to 07:00 on Sunday 25 October 2015 due to inclement weather conditions rendering operations unsafe.

Having successfully completed 42 Hamon grab sampling stations, Scotia transited to EGM from 14:00 to 20:00 on Sunday 25 October 2015 due to favourable weather for camera sledge operations, and camera sledge transect operations began at **EGM116**.

Sampling operations were suspended from 16:30 to 18:15 on Monday 26 October 2015 to replace a faulty camera sledge scaling laser.

The final planned EGM camera sledge station (**EGM136**) was successfully completed at 05:00 on Wednesday 28 October 2015.

Following transit back to NSP, Hamon grab sampling operations recommenced at grab sampling station **NSP31** at 08:00 on Wednesday 28 October 2015.

Sampling operations were suspended from 15:30 on Wednesday 28 October 2015 to 07:45 on Thursday 29 October 2015 and again from 08:30 to 09:45 on Thursday 29 October 2015 due to inclement weather conditions rendering operations unsafe.

Sampling operations were suspended from 10:30 to 14:00 on Thursday 29 October 2015 to repair the Hamon grab.

Sampling operations were suspended from 08:00 to 21:45 on Friday 30 October 2015 due to inclement weather conditions rendering operations unsafe.

The final planned Hamon grab sampling station at NSP (**NSP113**) was successfully completed at 15:00 on Saturday 31 October 2015.

Scotia transited from NSP to EGM from 15:00 to 18:00 on Saturday 31 October 2015, and camera sledge transect operations began at **EGM62**.

Sampling operations ceased at camera sledge transect station **EGM6** at 06:00 on Sunday 1 October 2015, and Scotia departed EGM for Aberdeen Harbour.

Scotia arrived alongside in Aberdeen Harbour at 17:00 on Sunday 1 October 2015.

7 Variations to Survey Plan

7.1 Adaptations to Running Order

The following sample station running order was specified in the Survey Plan:

1. Grab sampling at EGM.
2. Grab sampling at NSP.
3. Collection of camera sledge transects at EGM.
4. Replicate grab sampling at EGM.
5. Replicate grab sampling at NSP.
6. Collection of MBES data.

The running order was revised ‘on the fly’ by the JNCC Lead as is outlined in 7.1.1 below, and the revised running order agreed at sea with the SIC and master and by email with representatives of JNCC’s Monitoring and Evidence Teams.

The following sample station running order was completed on survey:

1. Grab sampling at EGM.
2. Begin grab sampling at NSP.
3. Begin collection of camera sledge transects at EGM.
4. Complete grab sampling at NSP.
5. Continue collection of camera sledge transects at EGM.

There was insufficient time available to complete the contingency objectives.

7.1.1 Rationale for prioritising camera sledge transects ahead of Hamon grab sampling at NSP

Following completion of Hamon grab stations at EGM it was decided to prioritise collection of 50 camera sledge transects at EGM ahead of Hamon grab sampling at NSP. This decision was taken to ensure collection of a comprehensive dataset for both protected features at EGM.

The following reasoning was used:

- Preliminary review of samples collected at EGM suggested a greater extent of potential offshore deep sea muds habitat in the site than was predicted by EU SeaMap; camera sledge transects would help inform assessment of whether this was the case.
- Survey was ahead of schedule, mitigating for the risk of decreasing the time available for completing the NSP grab sampling posed by prioritising camera sledge transects

at EGM, as there remained sufficient time available to complete both EGM camera sledge and NSP grab sampling stations using the timings set out in the Survey Plan.

- Although weather conditions encountered to this point were likely to have been inappropriate for camera sledge work, the Hamon grab had been successful on every deployment. Favourable weather for camera sledge work was forecast for the short term following completion of Hamon grab stations at EGM, so it was decided to collect camera sledge transects during the forecasted favourable weather window.

8 Preliminary Results

Please note that observations made in the Cruise Report represent preliminary field observations. These observations have not been subject to Quality Assurance procedures.

8.1 EGM

One hundred and fifty-six stations were successfully sampled for infauna and PSA using the 0.25m^2 Hamon grab at EGM; representative images of each grab sample are shown in Appendix 1.

Ten minute, approximately 300m camera sledge transects were successfully completed at 57 stations; representative images of each camera transect are shown in Appendix 2.

Locations of completed stations are shown in Figure 14.

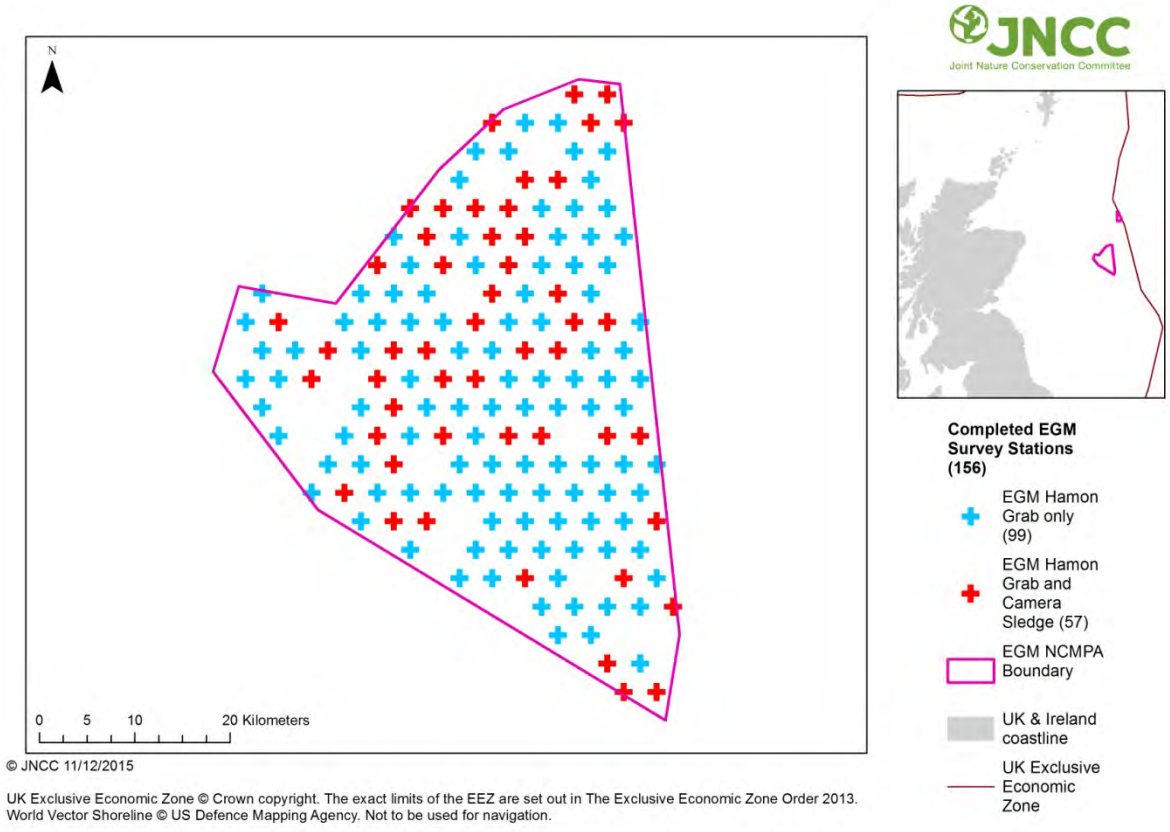


Figure 14. Completed 0.25m^2 Hamon grab and camera sledge transect stations at EGM.

8.1.1 Large (0.25m^2) Hamon Grab

Arctica islandica Presence

Locations of stations with samples containing *A. islandica* specimens are shown in Figure 15. Images and measurements of *A. islandica* specimens are presented in Table 3.

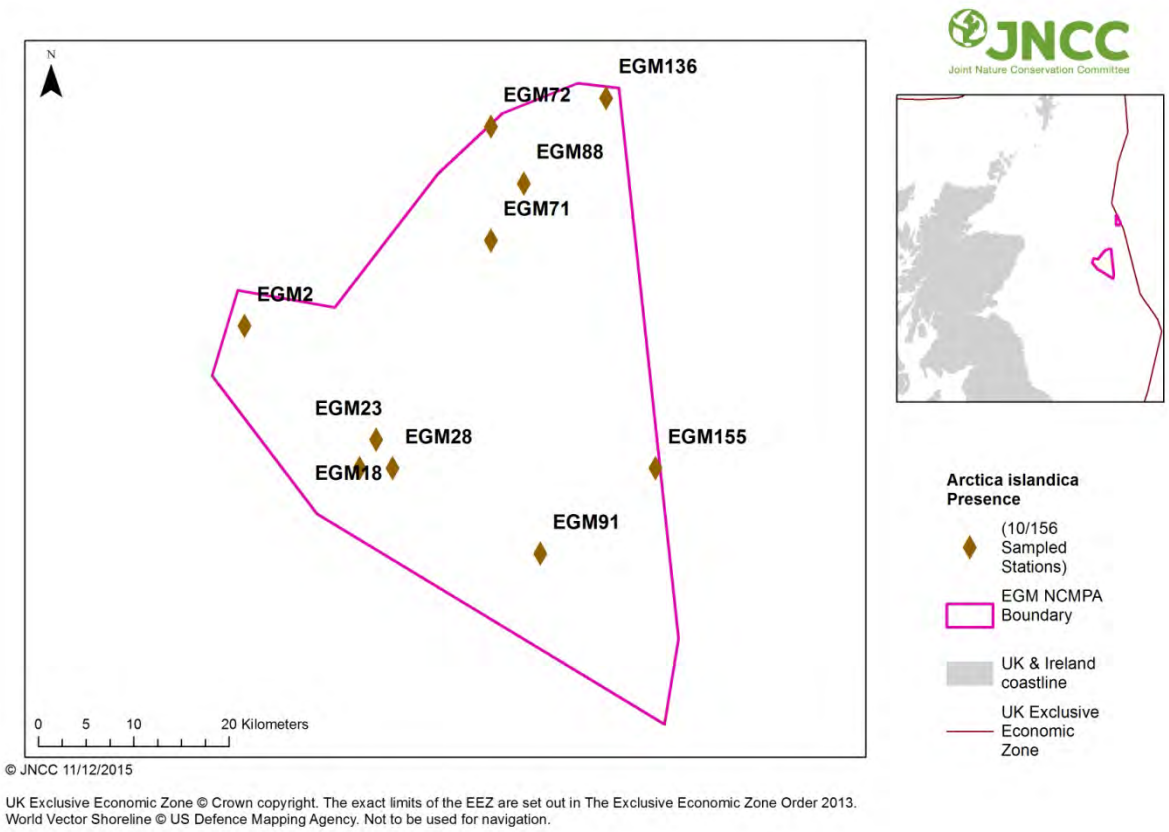
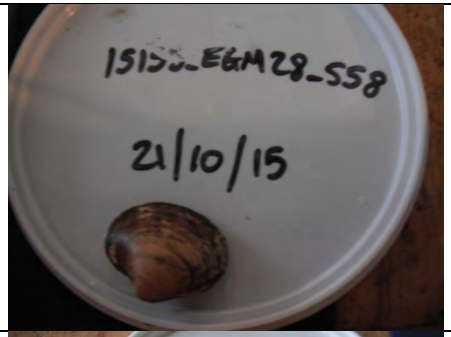
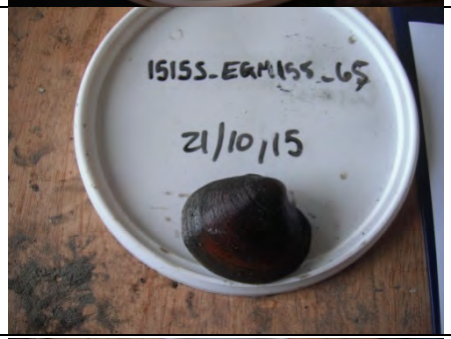
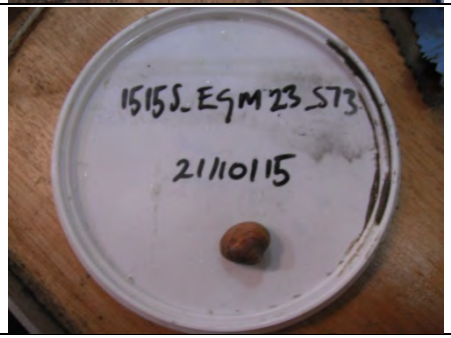
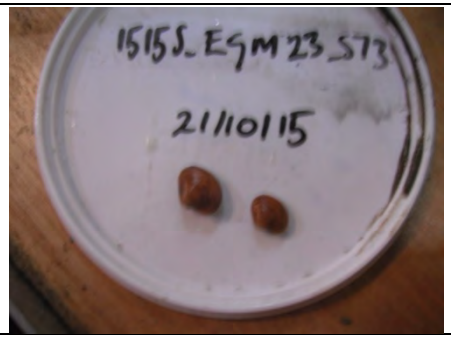
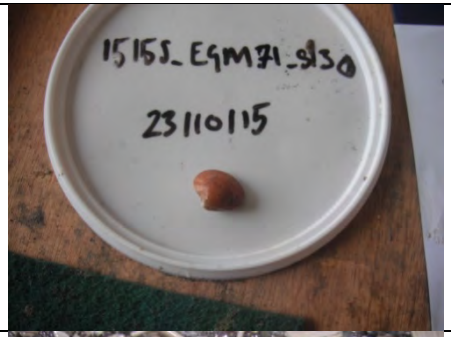
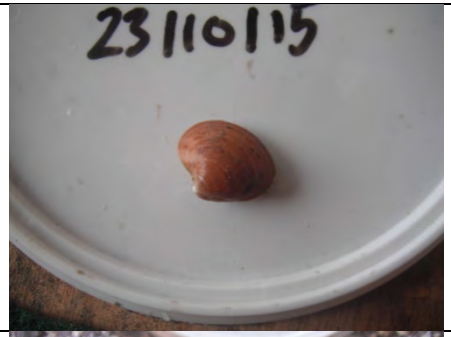
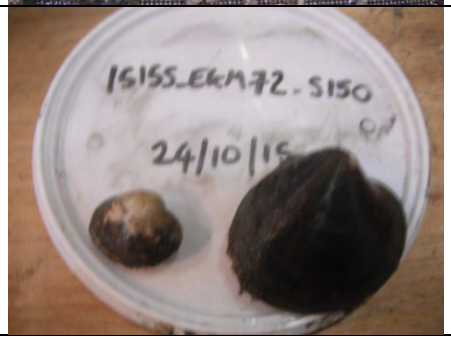


Figure 15. Summary of *Arctica islandica* specimens found in 0.25m^2 Hamon grab samples at EGM.

Table 3. Images and measurements of *Arctica islandica* collected by 0.25m^2 Hamon grab from EGM.

Station Name	***Arctica islandica* (image 1)**	***Arctica islandica* (image 2)**	**Length (mm)**	**Width (mm)**	**Height (mm)**
1515S_EGM2_S1			35	27	16
1515S_EGM91_S35			19	17	7
1515S_EGM18_S57			82	70	40

Station Name	*Arctica islandica* (image 1)	*Arctica islandica* (image 2)	Length (mm)	Width (mm)	Height (mm)
1515S_EGM28_S58			50	40	25
1515S_EGM155_S65			65	53	30
1515S_EGM23_S73			25 20 22	23 15 20	13 10 12

Station Name	*Arctica islandica* (image 1)	*Arctica islandica* (image 2)	Length (mm)	Width (mm)	Height (mm)
1515S_EGM71_S130			27	23	14
1515S_EGM88_S143					
1515S_EGM72_S150			75 44	66 35	40 22
1515S_EGM136_S155	No image		35	30	12

8.2 NSP

One hundred and twenty stations were successfully sampled for infauna and PSA using 0.25m^2 Hamon grab at NSP; representative images of each grab sample are shown in Appendix 1.

Locations of completed stations are shown in Figure 16.

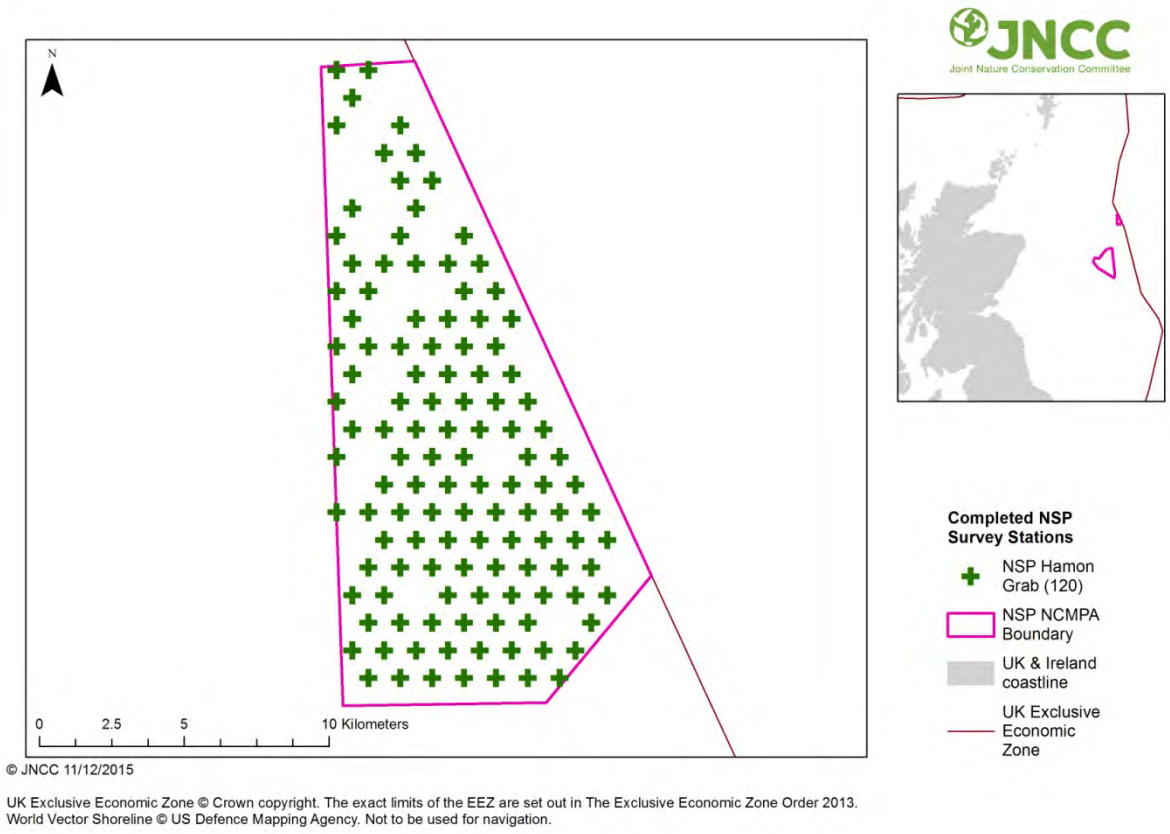


Figure 16. Completed 0.25m^2 Hamon grab and camera sledge transect stations at NSP.

8.2.1 Large (0.25m^2) Hamon Grab

Arctica islandica Presence

Locations of stations with samples containing *A. islandica* specimens are shown in Figure 17. Images and measurements of *A. islandica* specimens are presented in Table 4.

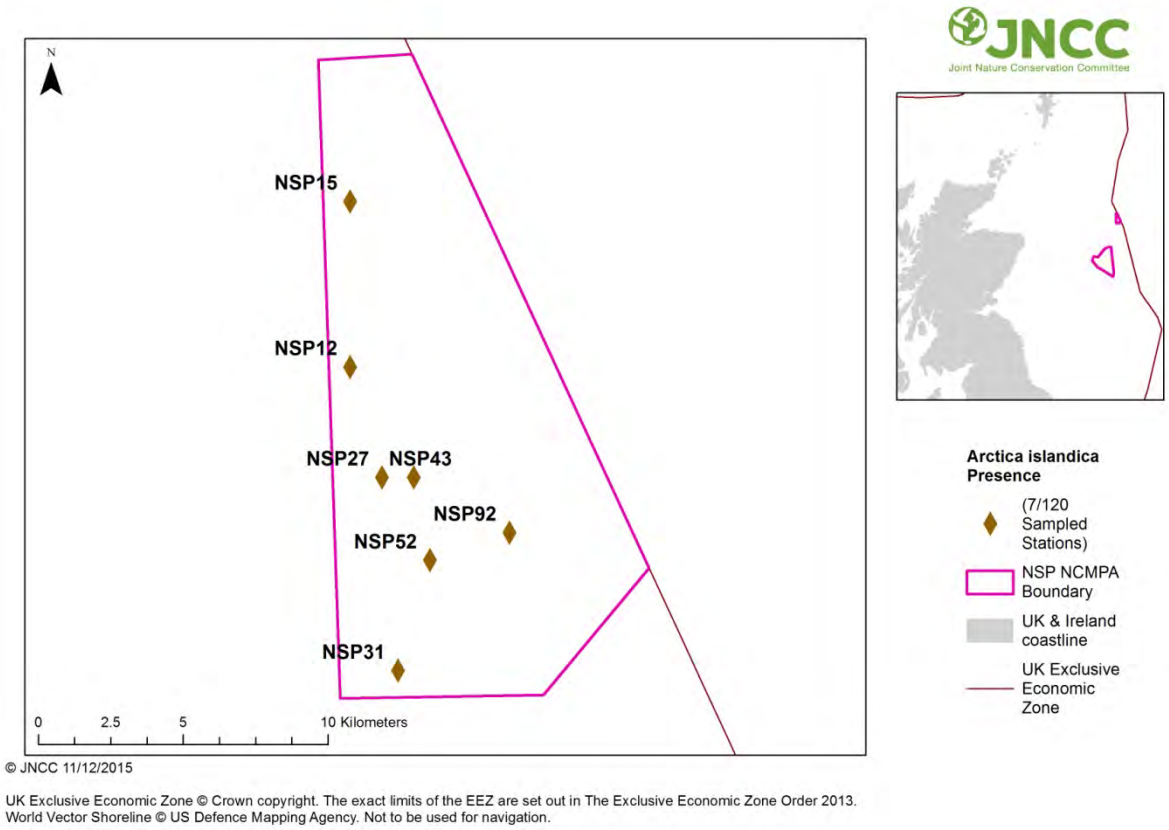
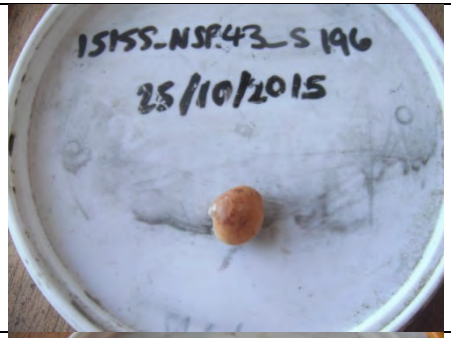
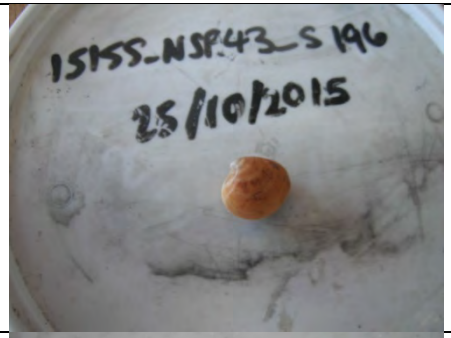
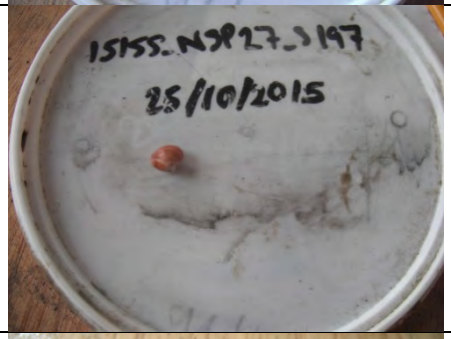
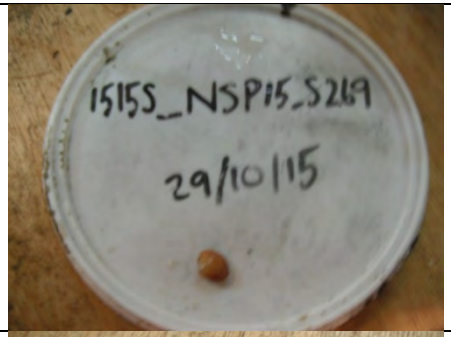
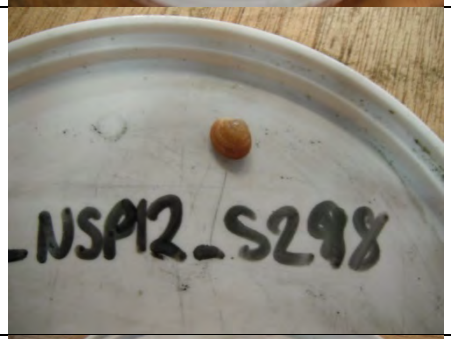
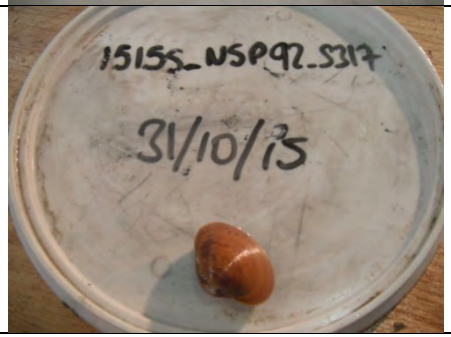
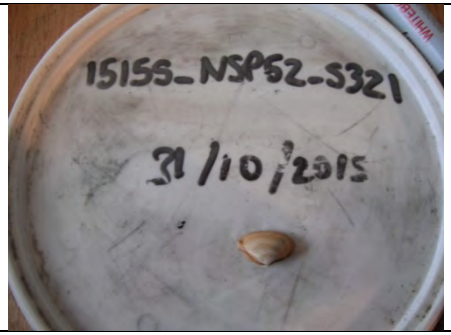


Figure 17. Summary of *Arctica islandica* specimens found in 0.25m^2 Hamon grab samples at NSP.

Table 4. Images and measurements of *Arctica islandica* collected by 0.25m^2 Hamon grab from NSP.

Station Name	*Arctica islandica* (image 1)	*Arctica islandica* (image 2)	Length (mm)	Width (mm)	Height (mm)
1515S_NSP43_S196			23	19	11
1515S_NSP27_S197			13	11	7
1515S_NSP31_S250			21	15	10

Station Name	***Arctica islandica* (image 1)**	***Arctica islandica* (image 2)**	**Length (mm)**	**Width (mm)**	**Height (mm)**
1515S_NSP15_S269			17	14	8
1515S_NSP12_S298			11	10	6
1515S_NSP92_S317			35	28	20

Station Name	***Arctica islandica* (image 1)**	***Arctica islandica* (image 2)**	**Length (mm)**	**Width (mm)**	**Height (mm)**
1515S_NSP52_S321			22	15	10

9 Data Formats

The 1515S survey collected data in the formats described in Table 5.

Table 5. 1515S collected data formats.

Data Type	Raw Format	Converted To	Saved
High Definition video	.m2ts	n/a	Electronically
Standard Definition video	.vob	n/a	DVD, mini DV tape
Stills	.cr2	.jpeg	Electronically
Grab sample images	.jpeg	n/a	Electronically
USBL	.csv	.xls	Electronically

10 Quality Control (QC)

10.1 Positioning

A USB-Comms adaptor was used to link the ship's GPS feed to ArcGIS 10 to record ship's position for Hamon Grab and Camera Sledge sampling events.

Ship's position 'fixes' were recorded in ArcGIS 10 simultaneously to each time the Hamon grab reached the seabed and for still image taken.

Additionally, for Camera Sledge sampling a Sonardyne Scout Plus Ultra Short Baseline (USBL) system with a DDV mounted Sonardyne Omni-directional Transponder were employed.

Ship's positioning has been linked to USBL positioning using time stamps recorded from 'fixes'.

Length of cable paid out and depth were logged at the start and end of each deployment to enable layback to be calculated in case of USBL failure.

Layback has been calculated for positions where USBL positions are not available using the Cefas Camera Sledge Position calculator MS Excel tool version 4, modified for Scotia specific use. This tool uses the ships positions, depth, cable out and heading to determine the position of the Camera Sledge.

Layback was calculated for the still image positions outlined in Table 6.

Table 6. Layback positions calculated.

Station Name	Still number
1515S_EGM_144_S248	7
1515S_EGM_144_S248	8
1515S_EGM_144_S248	9
1515S_EGM_136_S249	1

10.2 Data Management

A data manager was assigned to each shift. For details of on-board data management procedures please refer to the Data Management Plan (O'Connor 2015 which is available on request from JNCC)

11 Human activity

Potential anthropogenic impacts were observed at seven camera sledge transect stations at EGM (Table 7 and Figure 18).

Table 7. Potential anthropogenic impacts observed at camera sledge stations.

Station Name	Date	Time	Potential Anthropogenic Impact
1515S_EGM63_S204	26/10/2015	00:17	Litter
1515S_EGM93_S216	26/10/2015	13:31	Trawl marks
1515S_EGM137_S220	26/10/2015	19:35	Heavily trawl marked
1515S_EGM78_S242	27/10/2015	21:50	Litter (Rope)
1515S_EGM87_S243	27/10/2015	22:46	Litter (Rope and bottle)
1515S_EGM62_S327	31/10/2015	20:38	Litter
1515S_EGM129_S329	31/10/2015	23:53	Litter (Rope)

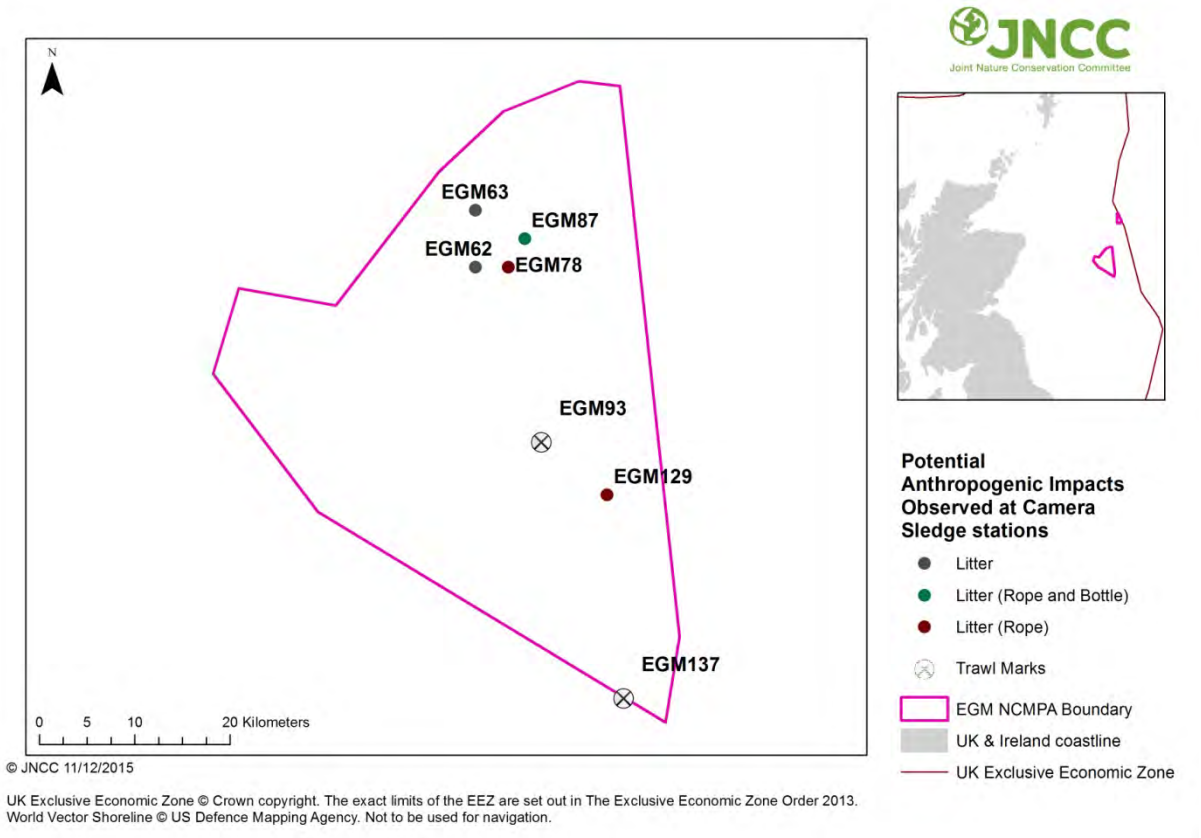


Figure 18. Potential anthropogenic impacts observed at camera sledge stations.

12 H&S events

No unplanned H&S events occurred.

One safety drill was undertaken:

- A ‘general muster’ was held at 13:30 on 19 October 2015.

13 Intellectual Property Rights and confidentiality

Rights to all knowledge (including but not limited to data, information, know-how, designs, drawings and specifications) brought to the project by either party (JNCC or MSS) will remain with that party, and such knowledge is to be used solely for the purposes of conducting this project.

Rights to knowledge jointly generated within the project will be jointly owned by JNCC and MSS.

The project is publically funded and all knowledge generated within the project will be made publically available under Open Government Licence (http://www.nationalarchives.gov.uk/doc/open-government-licence/version/2/).

Data must be accompanied by the following statement:

“Contains Joint Nature Conservation Committee and Marine Scotland Science materials ©JNCC/MSS 2015/2016”

14 References

CALLAWAY, A. 2015. *JNCC/Cefas Partnership Report Series*, **No. 5.** CEND0915 survey report: Baseline monitoring at Haig Fras candidate Special Area of Conservation/Site of Community Importance and East of Haig Fras Marine Conservation Zone.

COGGAN, R. 2006. Cefas Standard Operating Procedure 1380. Issue 4. Collection of Macrofaunal samples using a Hamon grab

COGGAN, R., MITCHELL, A., WHITE, J. & GOLDING, N. 2007. Recommended operating guidelines (ROG) for underwater video and photographic imaging techniques. MESH. http://www.emodnet-seabedhabitats.eu/pdf/GMHM3_Video_ROG.pdf

ESRI. 2011. ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.

GUERRA, M.T. & FREITAS, R. 2012. Recommended Operational Guidelines (ROG) for grab sampling and sorting and treatment of samples. MESH http://www.emodnet-seabedhabitats.eu/pdf/MeshA_ROG_grab_sampling_v1.4.pdf JNCC, 2015. http://jncc.defra.gov.uk/page-5661

KRÖGER, K. & JOHNSTON, C. *In prep*. The UK marine biodiversity monitoring strategy.

MARUBINI, F. 2014. Levels of statistical significance and power in marine biodiversity monitoring. Paper HBDSEG 29.8.2, submitted to the 29th meeting of the Healthy & Biologically Diverse Seas Evidence Group

MCBREEN, F. 2015. Prioritisation for seabed habitat surveys of offshore MPAs in 2015-16 and beyond. JNCC, Version 3.0

OSPAR. 2009. Background Document for Ocean quahog *Arctica islandica* http://www.ospar.org/documents/dbase/publications/p00407/p00407_ocean_quahog.pdf

R CORE TEAM. 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
URL http://www.R-project.org/

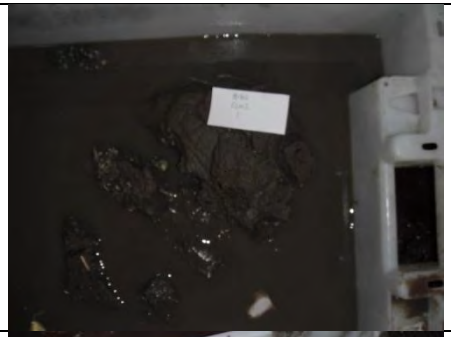
ROBERTSON, M. 2015. Marine Scotland Science Procedure/Risk Assessment No. EEC/ B040: Sediment sampling by Day and Van Veen grab

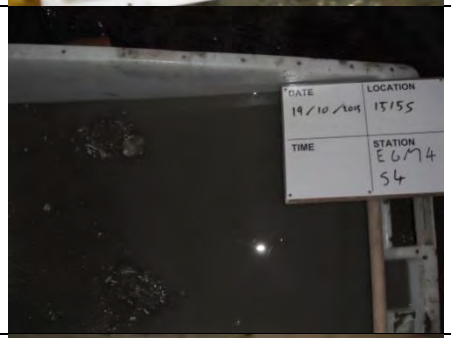
WARE, S. & MCLLWAINE, P. 2015. *JNCC/Cefas Report Series*, **No. 3**. Dogger Bank SCI Monitoring Survey - CEND 10/14 Cruise Report.

APPENDIX 1 Representative images of each grab sample

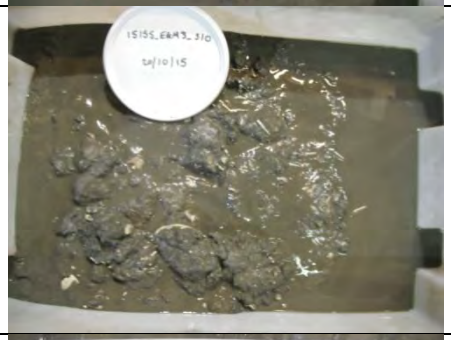
Please note that presence/absence of *Arctica islandica* is based on preliminary field observations and has not been Quality Assured.

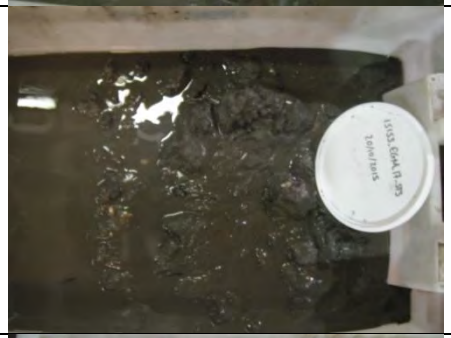
EGM

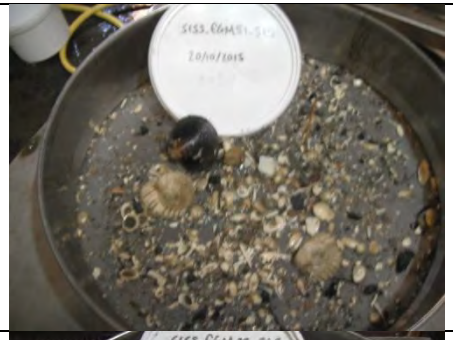
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM2_S1 **Y**			
1515S_EGM5_S2			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM8_S3			
1515S_EGM4_S4			
1515S_EGM9_S5			

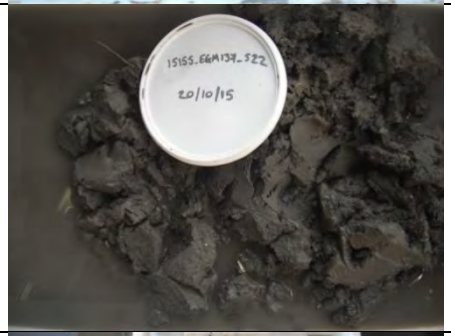
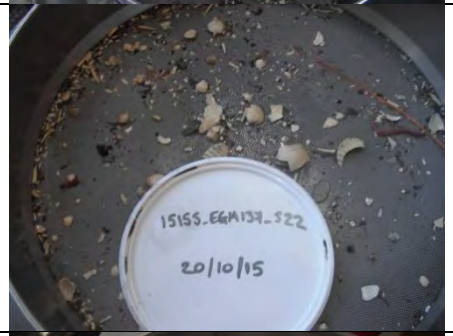
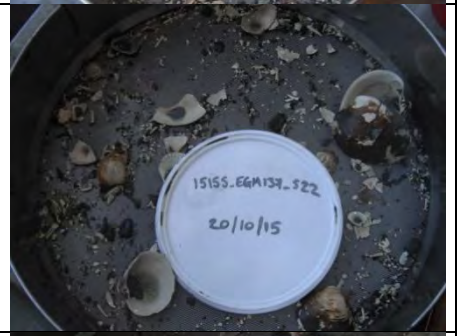
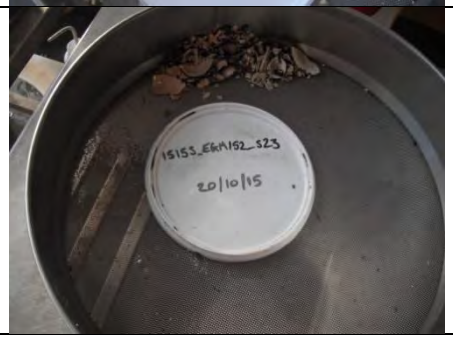
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM13_S6			
1515S_EGM11_S7			
1515S_EGM7_S8			

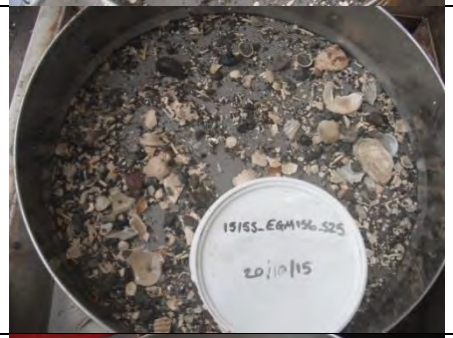
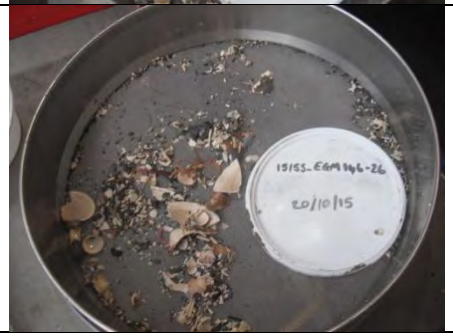
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM1_S9			
1515S_EGM3_S10			
1515S_EGM6_S11			

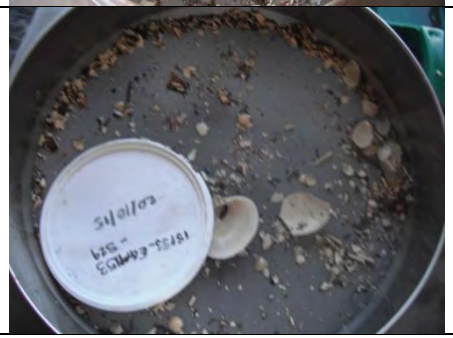
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM10_S12			
1515S_EGM17_S13			
1515S_EGM33_S14			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM51_S15			
1515S_EGM65_S16			
1515S_EGM81_S17			

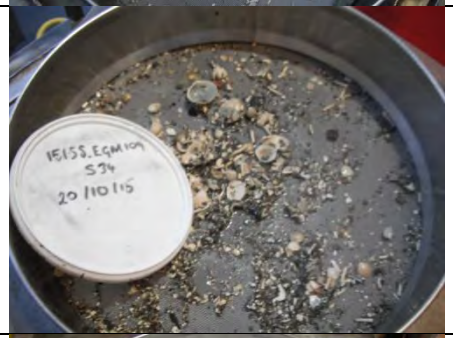
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM90_S18			
1515S_EGM98_S19			
1515S_EGM117_S20			

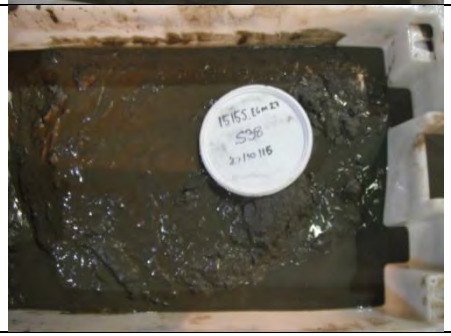
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM126_S21			
1515S_EGM137_S22			
1515S_EGM152_S23			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM145_S24			
1515S_EGM156_S25			
1515S_EGM146_S26			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM127_S27			
1515S_EGM108_S28			
1515S_EGM153_S29			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM138_S30			
1515S_EGM99_S31			
1515S_EGM147_S32			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM128_S33			
1515S_EGM109_S34			
1515S_EGM91_S35 **Y**			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM73_S36			
1515S_EGM57_S37			
1515S_EGM27_S38 **Y**			

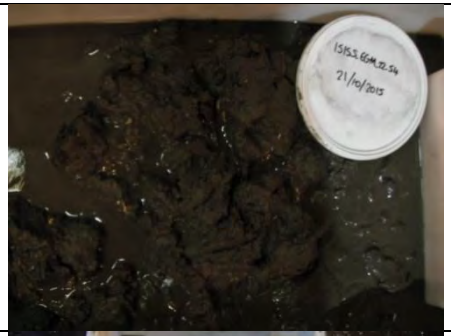
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM40_S39			
1515S_EGM66_S40			
1515S_EGM82_S41			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM100_S42			
1515S_EGM118_S43			
1515S_EGM139_S44			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM154_S45			
1515S_EGM148_S46			
1515S_EGM129_S47			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM110_S48			
1515S_EGM92_S49			
1515S_EGM74_S50			

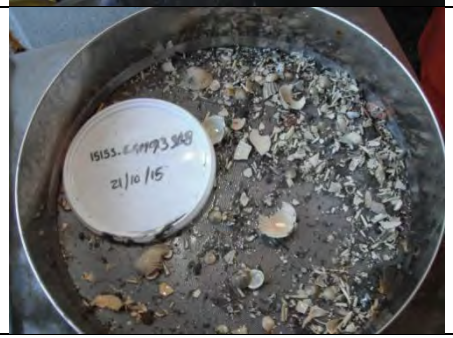
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM58_S51			
1515S_EGM45_S52			
1515S_EGM34_S53			

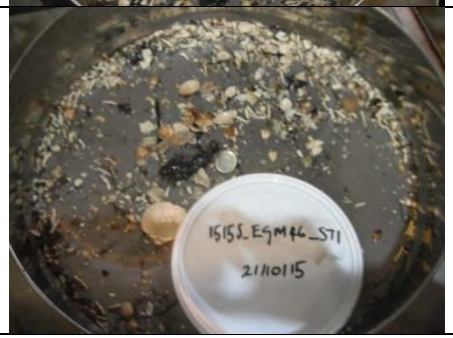
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM22_S54			
1515S_EGM14_S55			
1515S_EGM12_S56			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM18_S57 **Y**			
1515S_EGM28_S58			
1515S_EGM52_S59			

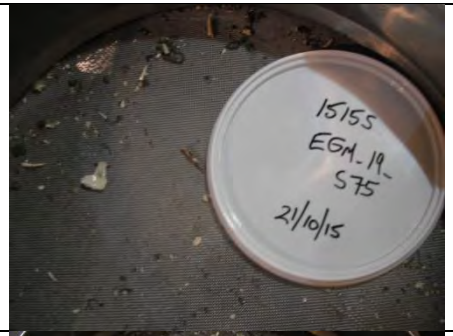
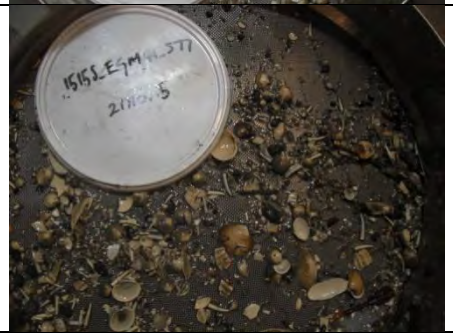
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM67_S60			
1515S_EGM83_S61			
1515S_EGM101_S62			

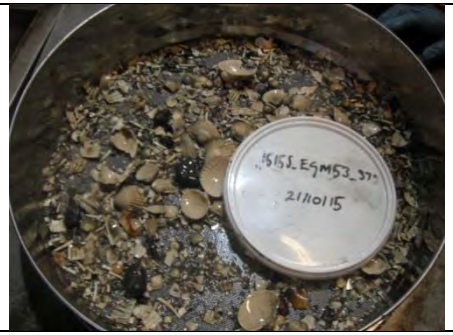
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM119_S63			
1515S_EGM140_S64			
1515S_EGM155_S65			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM149_S66			
1515S_EGM130_S67			
1515S_EGM93_S68			

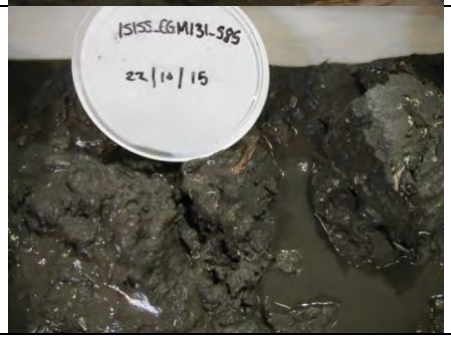
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM75_S69			
1515S_EGM59_S70			
1515S_EGM46_S71			

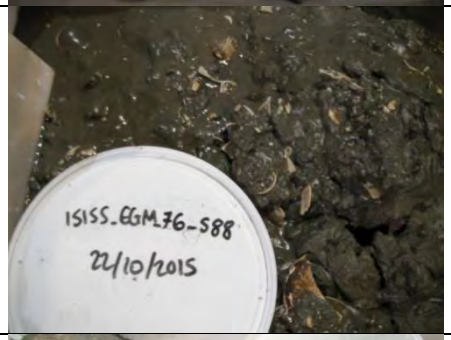
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM35_S72			
1515S_EGM23_S73 **Y**			
1515S_EGM15_S74			

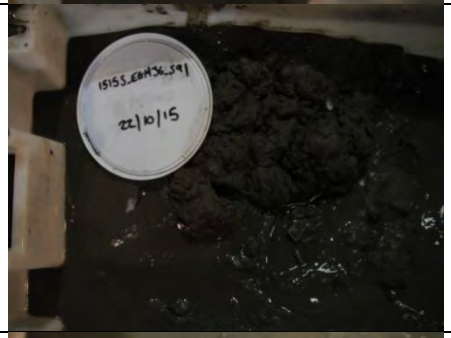
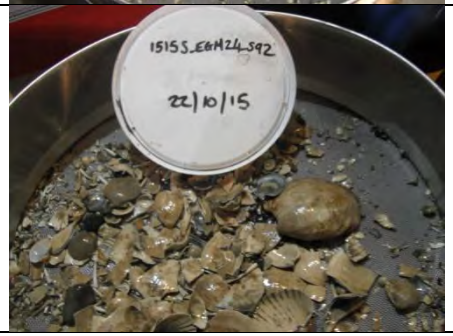
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM19_S75			
1515S_EGM29_S76			
1515S_EGM41_S77			

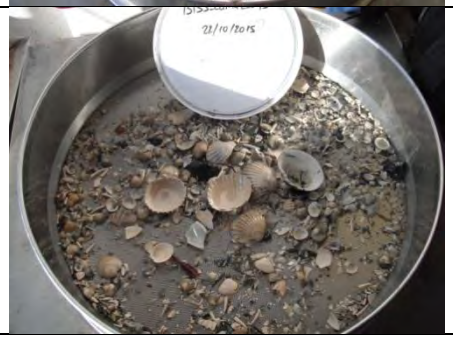
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM53_S78			
1515S_EGM68_S79			
1515S_EGM84_S80			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM102_S81			
1515S_EGM120_S82			
1515S_EGM141_S83			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM150_S84			
1515S_EGM131_S85			
1515S_EGM111_S86			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM94_S87			
1515S_EGM76_S88			
1515S_EGM60_S89			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM47_S90			
1515S_EGM36_S91			
1515S_EGM24_S92			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM20_S93			
1515S_EGM30_S94			
1515S_EGM42_S95			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM54_S96			
1515S_EGM69_S97			
1515S_EGM85_S98			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM103_S99			
1515S_EGM121_S100			
1515S_EGM142_S101			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM151_S102			
1515S_EGM132_S103			
1515S_EGM112_S104			

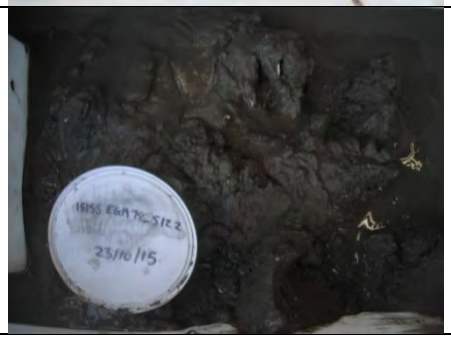
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM95_S105			
1515S_EGM77_S106			
1515S_EGM61_S107			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM48_S108			
1515S_EGM37_S109			
1515S_EGM25_S110			

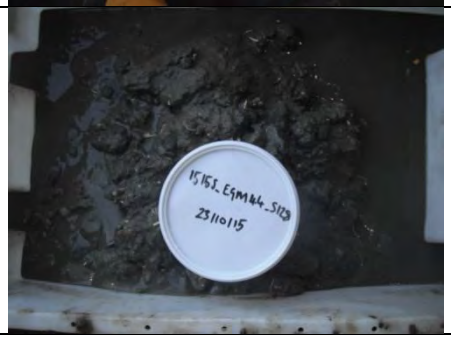
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM16_S111			
1515S_EGM21_S112			
1515S_EGM31_S113			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM43_S114			
1515S_EGM70_S115			
1515S_EGM86_S116			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM104_S117			
1515S_EGM122_S118			
1515S_EGM133_S119			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM113_S120			
1515S_EGM96_S121			
1515S_EGM78_S122			

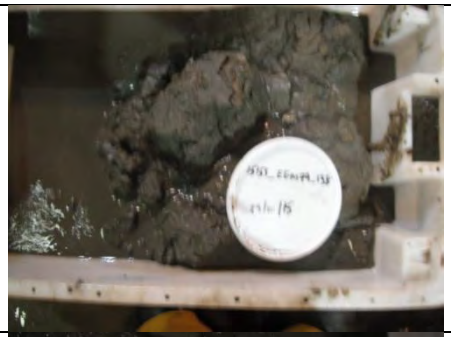
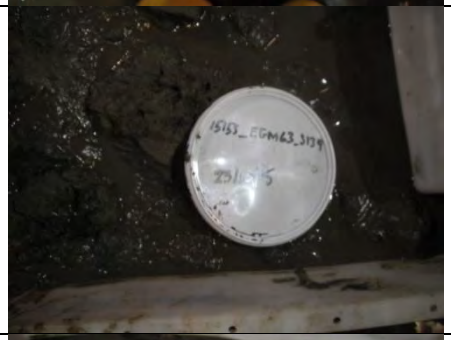
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM62_S123			
1515S_EGM49_S124			
1515S_EGM38_S125			

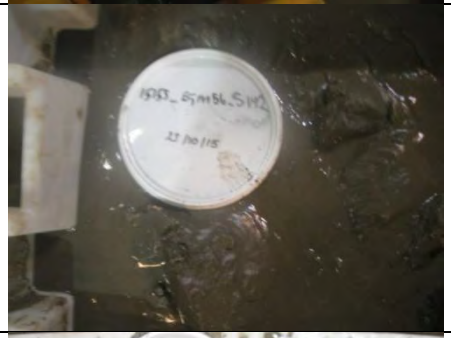
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM26_S126			
1515S_EGM32_S127			
1515S_EGM44_S128			

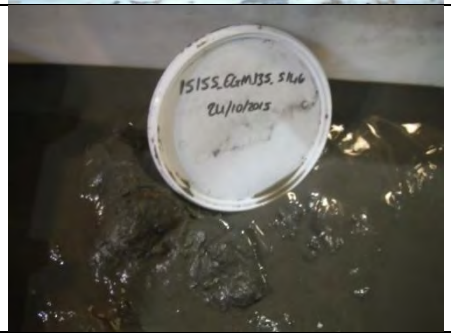
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM55_S129			
1515S_EGM71_S130 **Y**			
1515S_EGM87_S131			

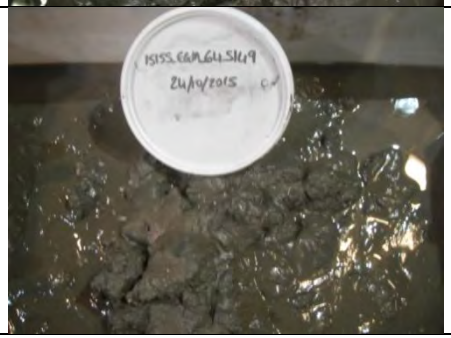
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM105_S132			
1515S_EGM123_S133			
1515S_EGM143_S134			

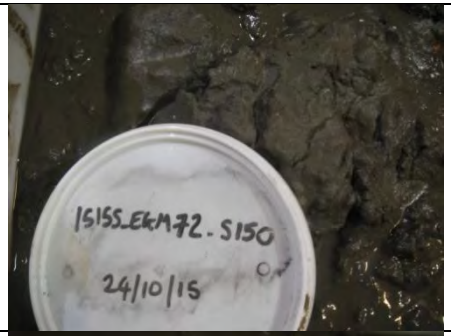
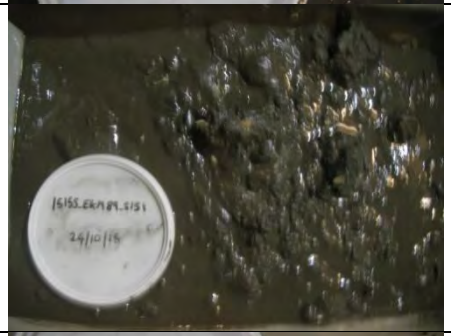
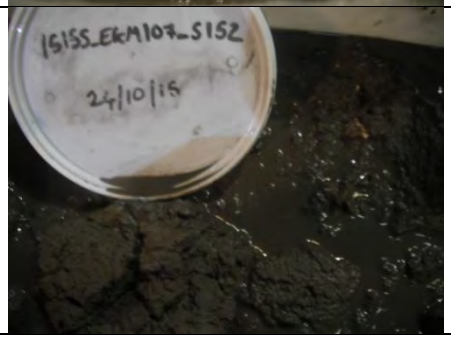
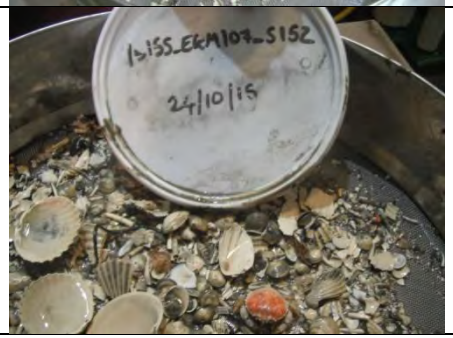
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM134_S135			
1515S_EGM114_S136			
1515S_EGM97_S137			

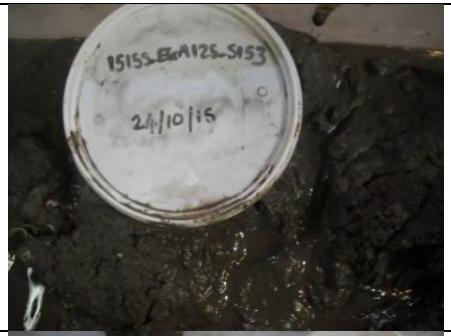
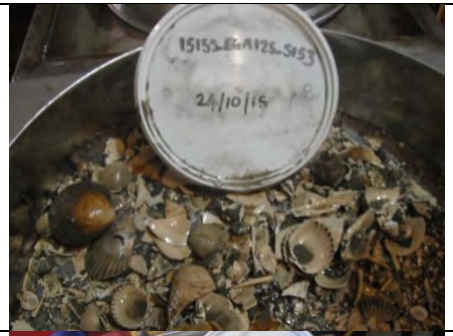
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM79_S138			
1515S_EGM63_S139			
1515S_EGM50_S140			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM39_S141			
1515S_EGM56_S142			
1515S_EGM88_S143 **Y**			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM106_S144			
1515S_EGM124_S145			
1515S_EGM135_S146			

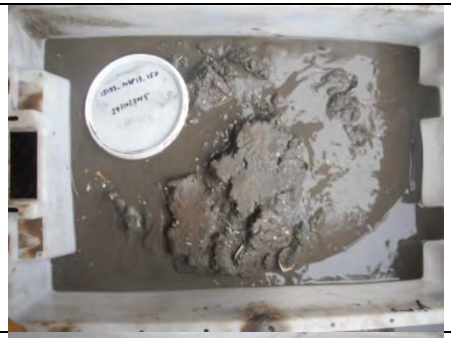
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM115_S147			
1515S_EGM80_S148			
1515S_EGM64_S149			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM72_S150 **Y**			
1515S_EGM89_S151			
1515S_EGM107_S152			

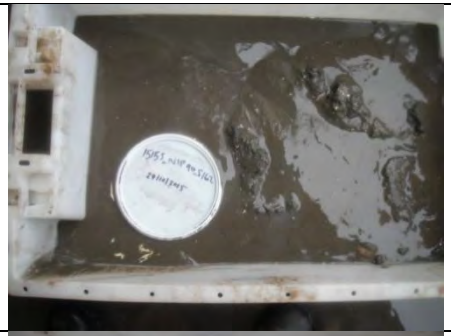
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM125_S153			
1515S_EGM144_S154			
1515S_EGM136_S155 **Y**			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_EGM116_S156			

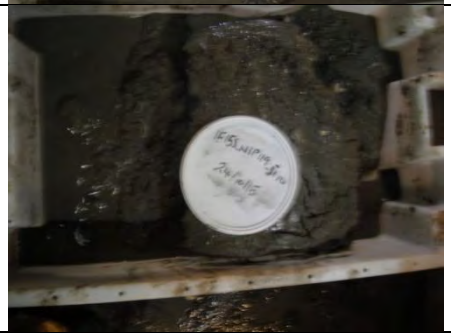
NSP

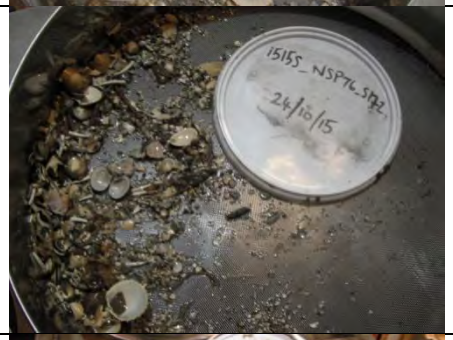
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	Grab Sample	1mm Sieve (image 1)	1 mm Sieve (image 2)
1515S_NSP17_S157			
1515S_NSP50_S158			

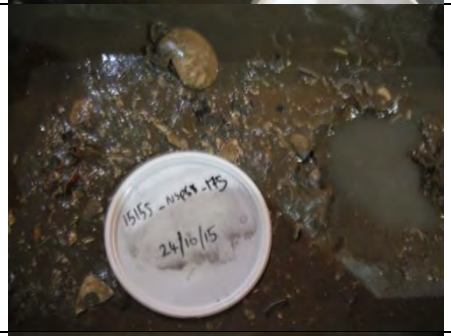
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP83_S159			
1515S_NSP108_S160			
1515S_NSP112_S161			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP90_S162			
1515S_NSP58_S163			
1515S_NSP24_S164			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP9_S165			
1515S_NSP32_S166			
1515S_NSP67_S167			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP98_S168			
1515S_NSP116_S169			
1515S_NSP119_S170			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP104_S171			
1515S_NSP76_S172			
1515S_NSP25_S173			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP33_S174			
1515S_NSP68_S175			
1515S_NSP99_S176			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP117_S177			
1515S_NSP120_S178			
1515S_NSP105_S179			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP77_S180			
1515S_NSP42_S181			
1515S_NSP1_S182			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP34_S183			
1515S_NSP118_S184			
1515S_NSP110_S185			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP100_S186			
1515S_NSP86_S187			
1515S_NSP69_S188			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP53_S189			
1515S_NSP115_S190			
1515S_NSP106_S191			
1515S_NSP106_S192			

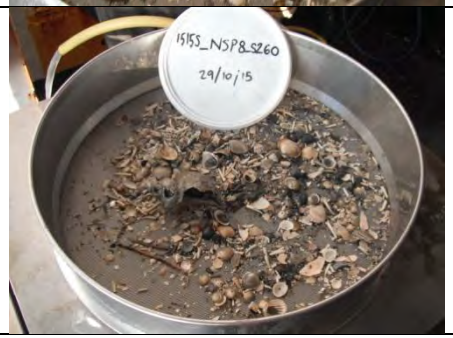
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP93_S193			
1515S_NSP78_S194			
1515S_NSP61_S195			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP43_S196 **Y**			
1515S_NSP27_S197 **Y**			
1515S_NSP111_S198			

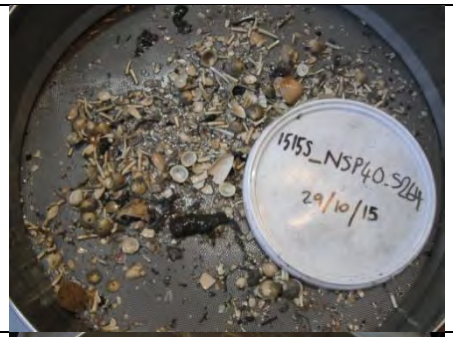
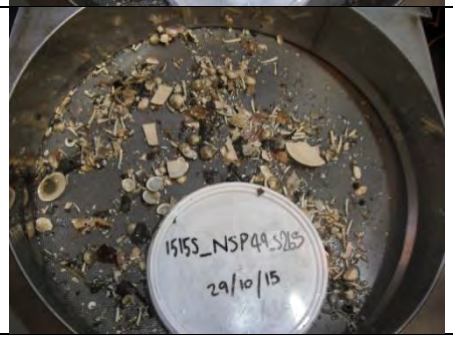
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP101_S199			
1515S_NSP31_S250 **Y**			
1515S_NSP66_S251			

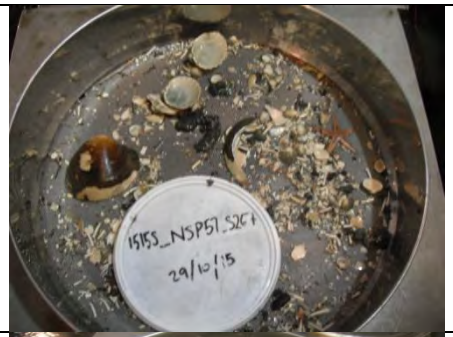
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP97_S252			
1515S_NSP41_S253			
1515S_NSP75_S254			

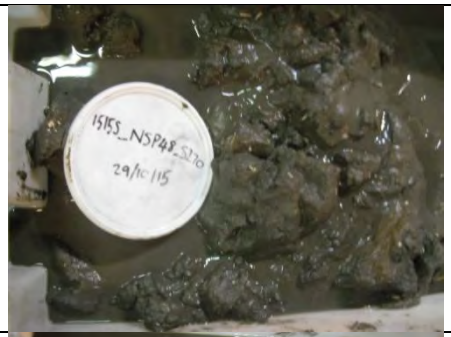
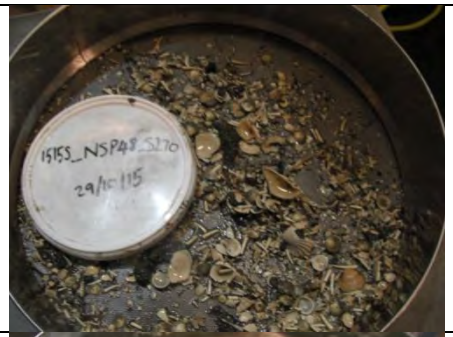
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP103_S255			
1515S_NSP18_S256			
1515S_NSP51_S257			
1515S_NSP84_S258			

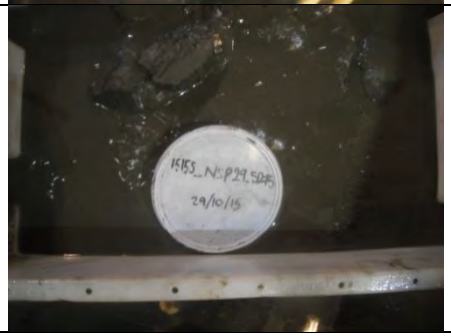
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP10_S259			
1515S_NSP56_S259			
1515S_NSP8_S260			

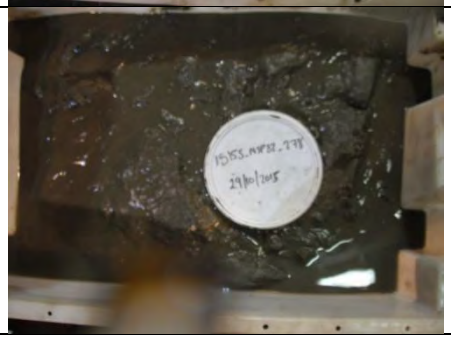
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP23_S261 **Y**			
1515S_NSP16_S262			
1515S_NSP7_S263			

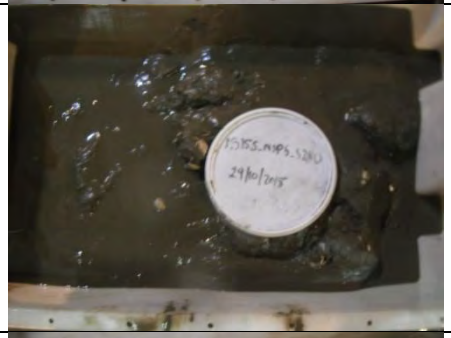
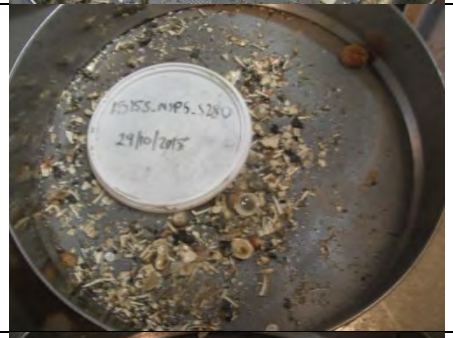
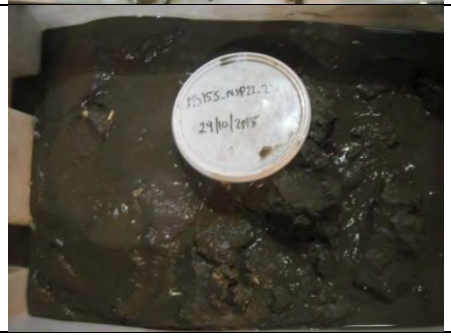
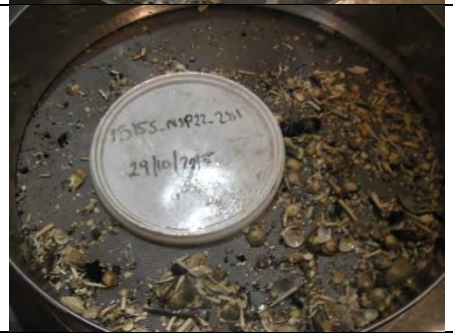
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP40_S264			
1515S_NSP30_S265			
1515S_NSP49_S266			

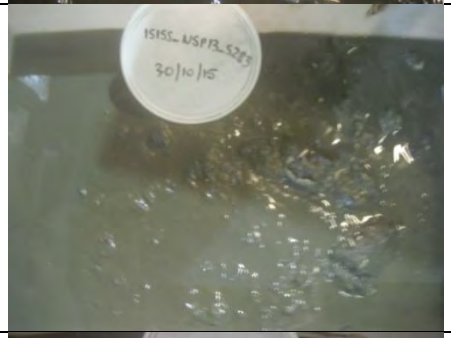
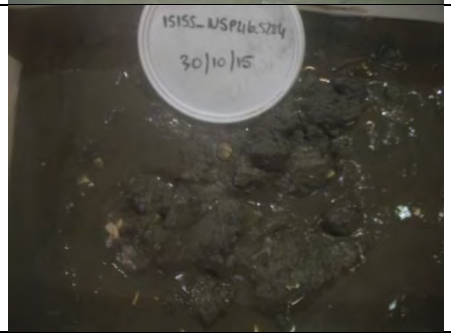
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP57_S267			
1515S_NSP39_S268			
1515S_NSP15_S269			

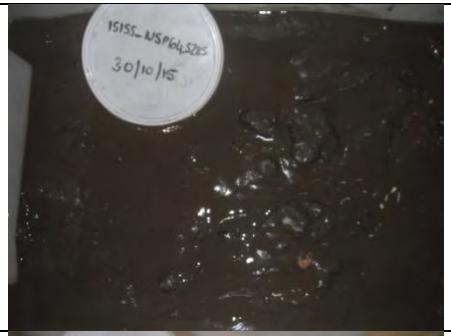
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP48_S270			
1515S_NSP74_S271			
1515S_NSP38_S272			

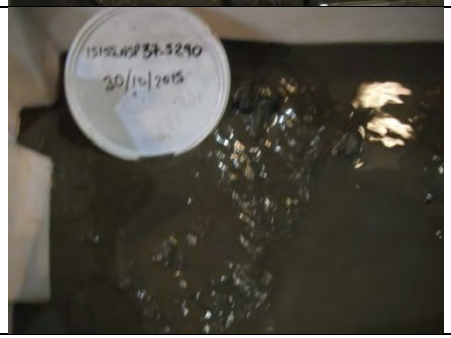
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP6_S273			
1515S_NSP14_S274			
1515S_NSP29_S275			

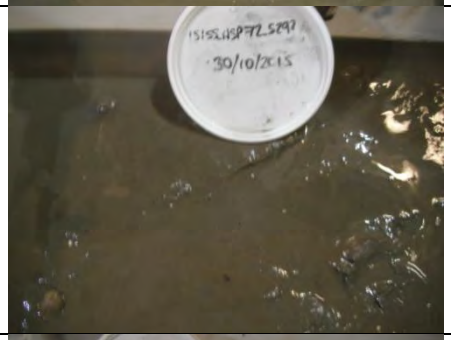
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP47_S276			
1515S_NSP65_S277			
1515S_NSP82_S278			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP89_S279			
1515S_NSP5_S280			
1515S_NSP22_S281			

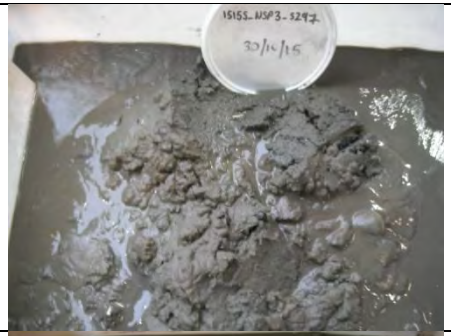
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP73_S282			
1515S_NSP13_S283			
1515S_NSP46_S284			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP64_S285			
1515S_NSP81_S286			
1515S_NSP96_S287			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP4_S288			
1515S_NSP21_S289			
1515S_NSP37_S290			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP88_S291			
1515S_NSP72_S292			
1515S_NSP45_S293			

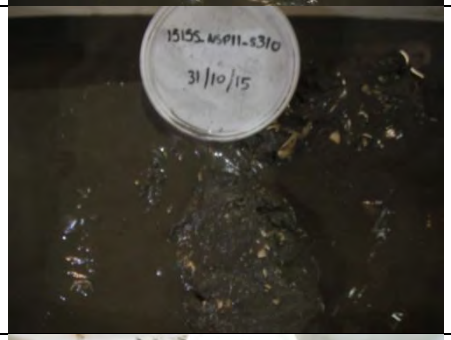
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP63_S294			
1515S_NSP80_S295			
1515S_NSP95_S296			

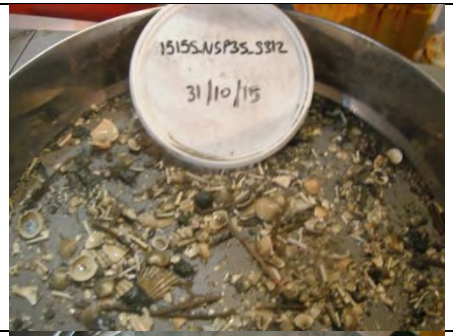
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP3_S297			
1515S_NSP12_S298 **Y**			
1515S_NSP36_S299			

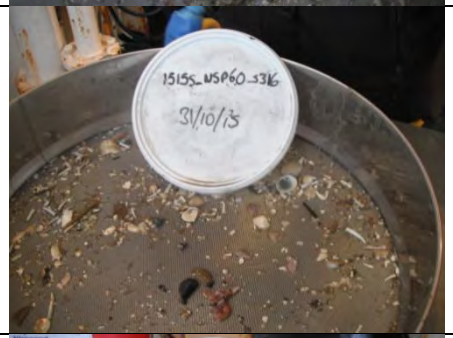
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP71_S300			
1515S_NSP102_S301			
1515S_NSP107_S302			

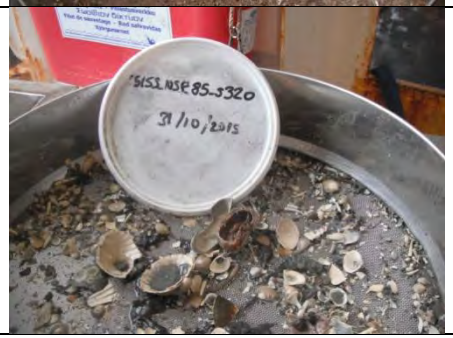
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP94_S303			
1515S_NSP79_S304			
1515S_NSP62_S305			

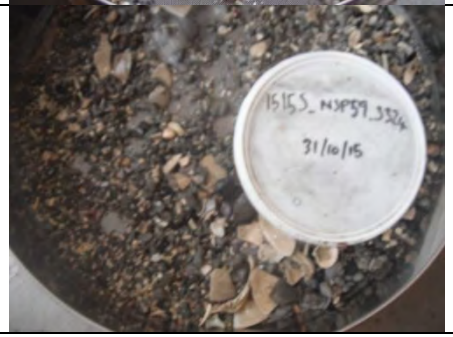
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP55_S306			
1515S_NSP44_S307			
1515S_NSP87_S308			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP28_S309			
1515S_NSP11_S310			
1515S_NSP2_S311			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP35_S312			
1515S_NSP54_S313			
1515S_NSP70_S314			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP20_S315			
1515S_NSP60_S316			
1515S_NSP92_S317 **Y**			

Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP114_S318			
1515S_NSP109_S319			
1515S_NSP85_S320			

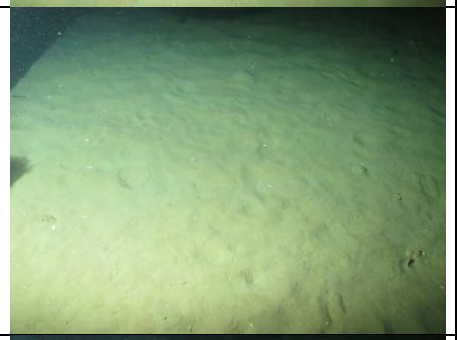
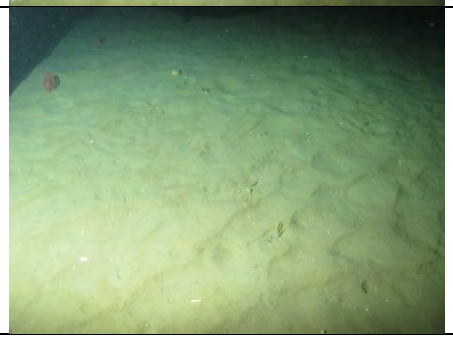
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP52_S321 **Y**			
1515S_NSP26_S322			
1515S_NSP19_S323			
1515S_NSP59_S324			

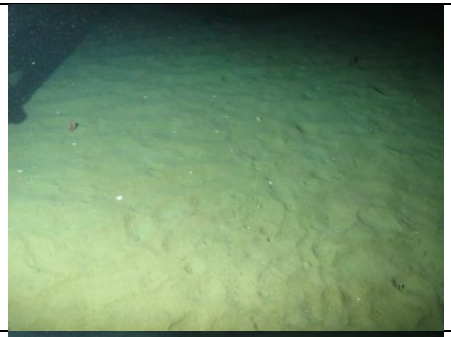
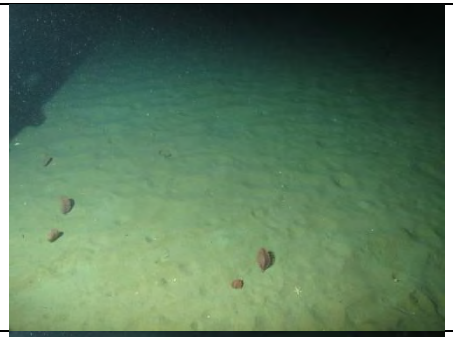
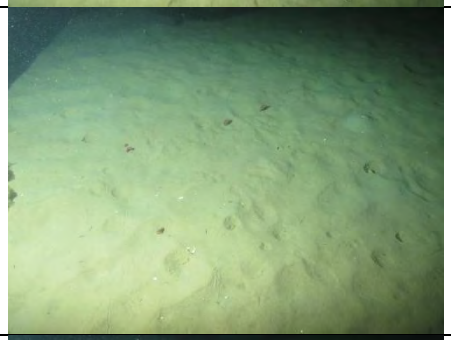
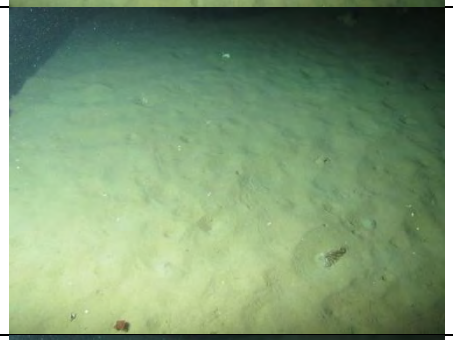
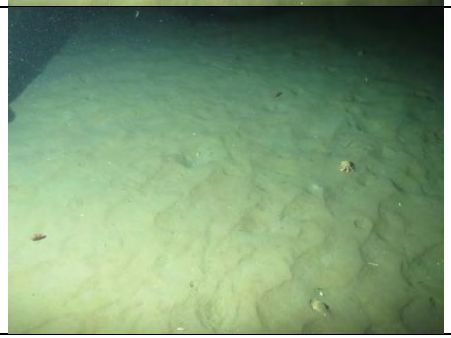
Station Name Note potential *Arctica islandica* presence in sample is indicated by **Y**	**Grab Sample**	**1mm Sieve (image 1)**	**1 mm Sieve (image 2)**
1515S_NSP91_S325			
1515S_NSP113_S326			

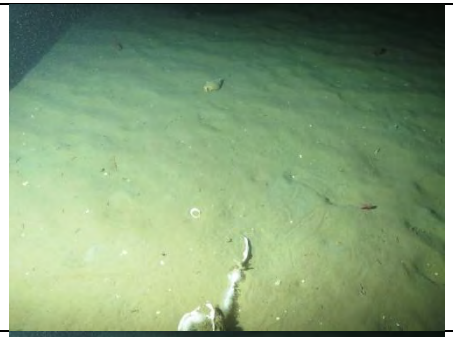
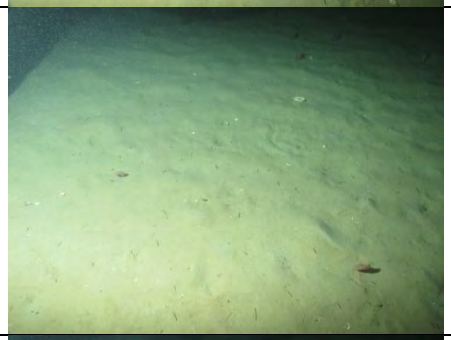
APPENDIX 2 Representative images of each camera transect (EGM only)

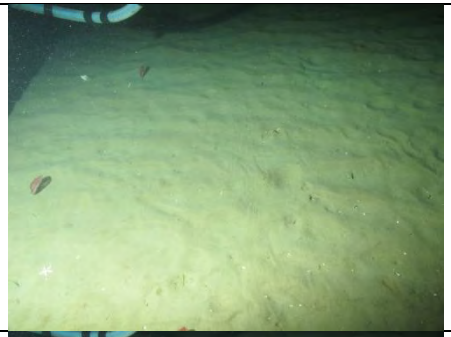
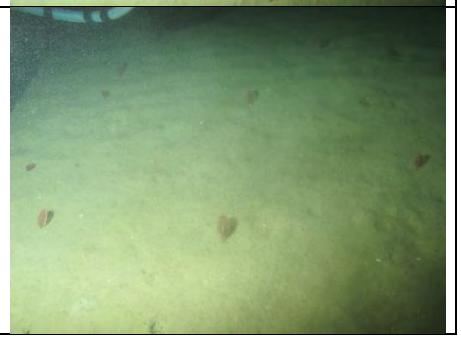
EGM

Station Name	Image 1	Image 2	Image 3
1515S_EGM116_S200			
1515S_EGM72_S201			

Station Name	Image 1	Image 2	Image 3
1515S_EGM39_S202			
1515S_EGM50_S203			
1515S_EGM63_S204			

Station Name	Image 1	Image 2	Image 3
1515S_EGM71_S205			
1515S_EGM44_S206			
1515S_EGM26_S207			

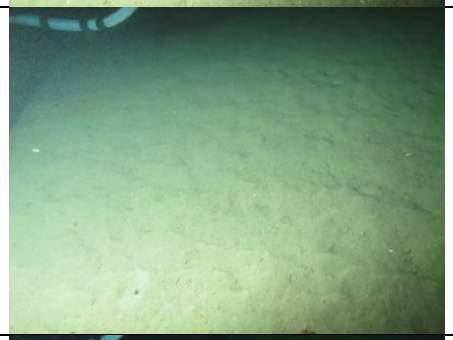
Station Name	Image 1	Image 2	Image 3
1515S_EGM13_S208			
1515S_EGM11_S209			
1515S_EGM24_S210			

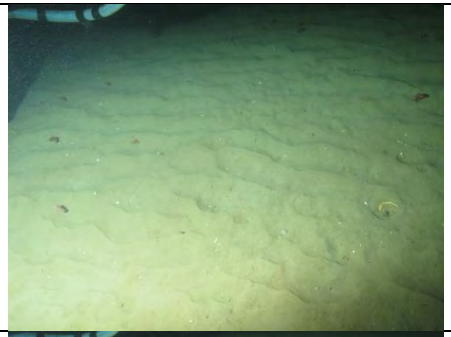
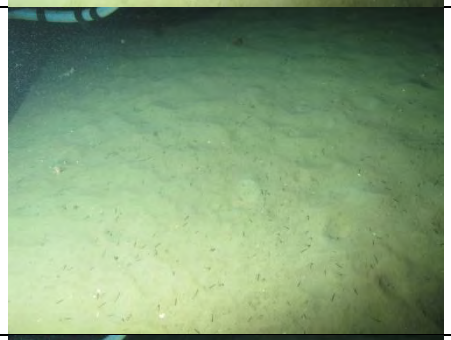
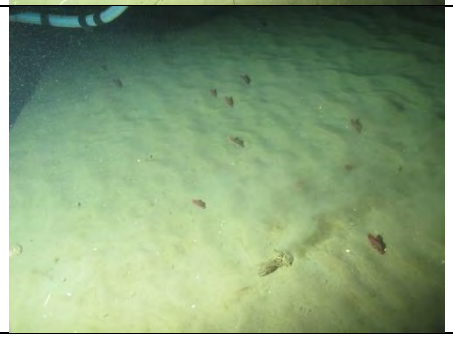
Station Name	Image 1	Image 2	Image 3
1515S_EGM30_S211			
1515S_EGM42_S212			
1515S_EGM47_S213			

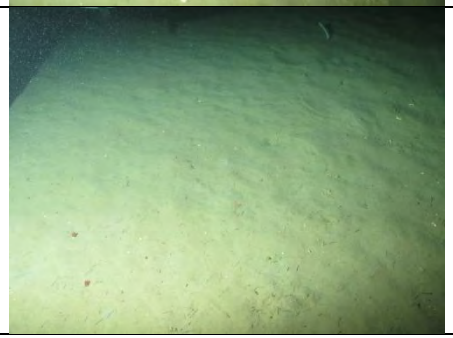
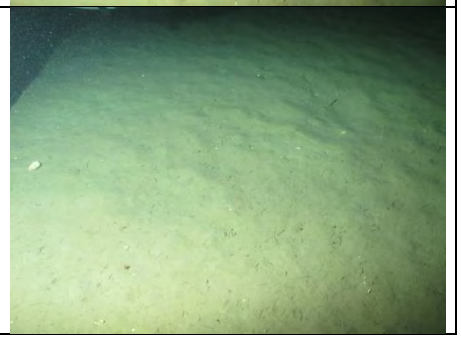
Station Name	Image 1	Image 2	Image 3
1515S_EGM60_S214			
1515S_EGM85_S215			
1515S_EGM93_S216			

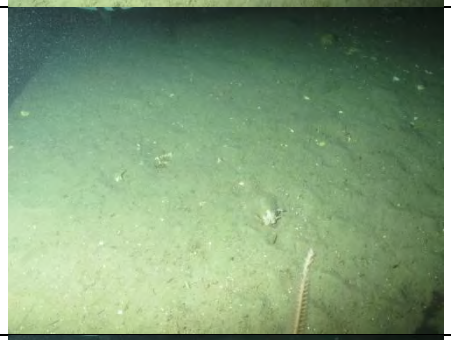
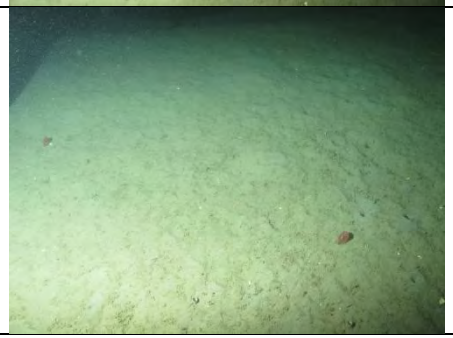
Station Name	Image 1	Image 2	Image 3
1515S_EGM149_S217			
1515S_EGM138_S218			
1515S_EGM152_S219			

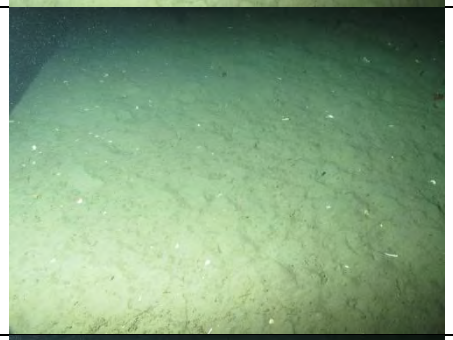
Station Name	Image 1	Image 2	Image 3
1515S_EGM137_S220			
1515S_EGM126_S221			
1515S_EGM156_S222			

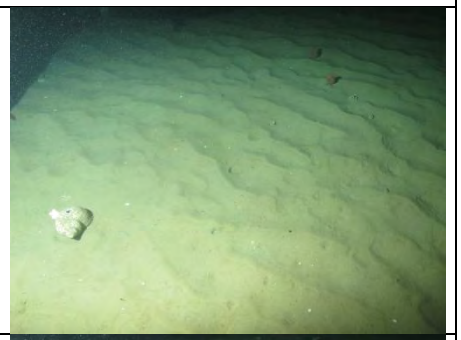
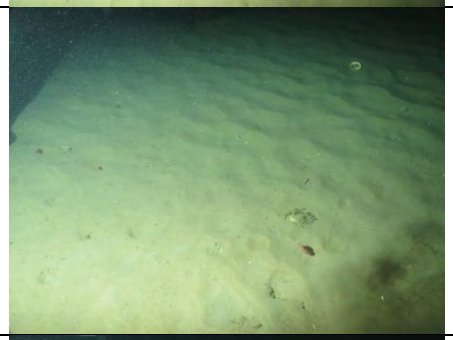
Station Name	Image 1	Image 2	Image 3
1515S_EGM154_S223			
1515S_EGM81_S224			
1515S_EGM40_S225			

Station Name	Image 1	Image 2	Image 3
1515S_EGM27_S226			
1515S_EGM14_S227			
1515S_EGM28_S228			

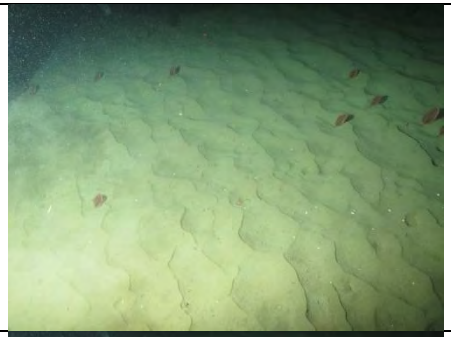
Station Name	Image 1	Image 2	Image 3
1515S_EGM23_S229			
1515S_EGM29_S230			
1515S_EGM46_S231			

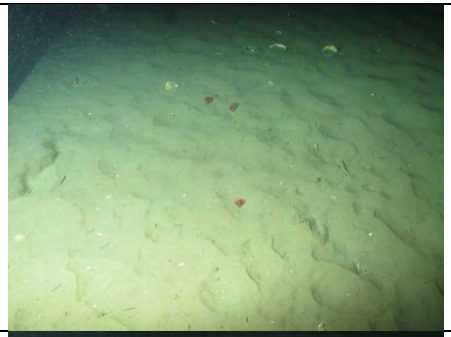
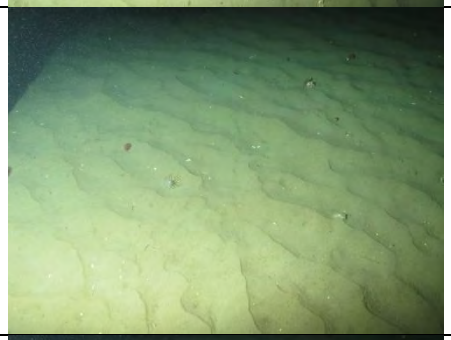
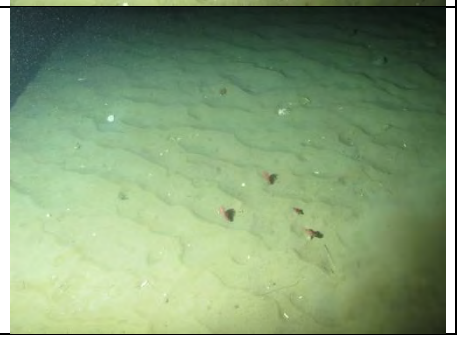
Station Name	Image 1	Image 2	Image 3
1515S_EGM75_S232			
1515S_EGM130_S233			
1515S_EGM132_S234			

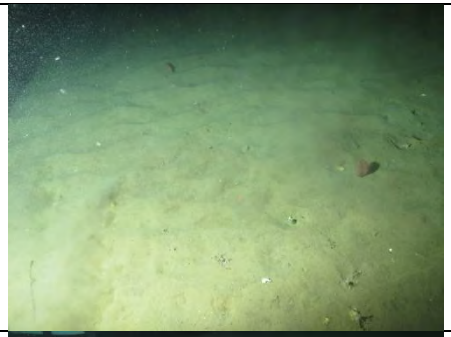
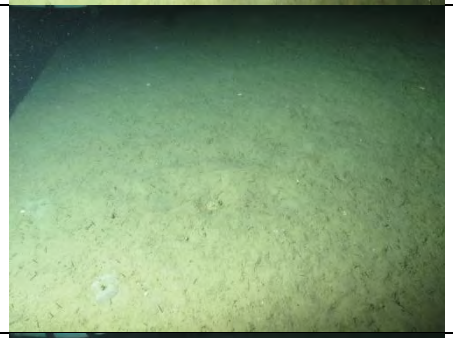
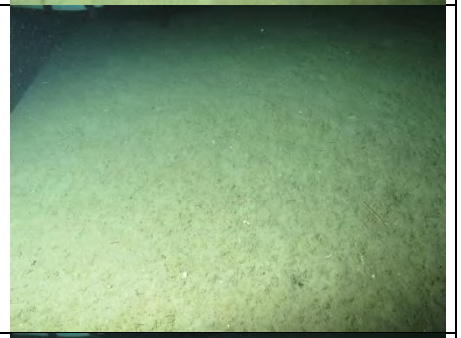
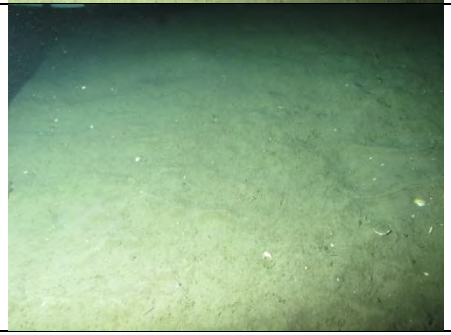
Station Name	Image 1	Image 2	Image 3
1515S_EGM103_S235			
1515S_EGM112_S236			
1515S_EGM104_S237			

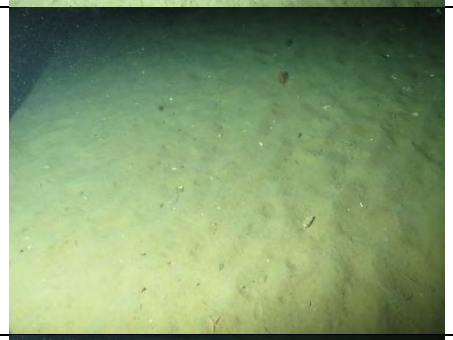
Station Name	Image 1	Image 2	Image 3
1515S_EGM70_S238			
1515S_EGM61_S239			
1515S_EGM8_S240			

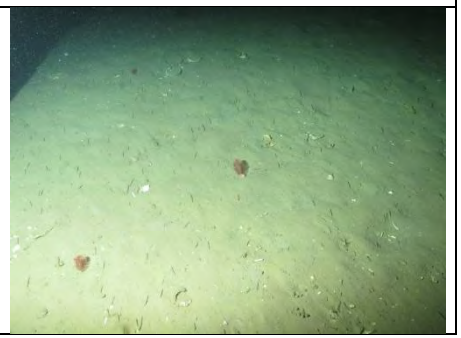
Station Name	Image 1	Image 2	Image 3
1515S_EGM49_S241			
1515S_EGM78_S242			
1515S_EGM87_S243			

Station Name	Image 1	Image 2	Image 3
1515S_EGM79_S244			
1515S_EGM88_S245			
1515S_EGM106_S246			

Station Name	Image 1	Image 2	Image 3
1515S_EGM125_S247			
1515S_EGM144_S248			
1515S_EGM136_S249			

Station Name	Image 1	Image 2	Image 3
1515S_EGM62_S327			
1515S_EGM142_S328			
1515S_EGM129_S329			

Station Name	Image 1	Image 2	Image 3
1515S_EGM58_S330			
1515S_EGM51_S331			
1515S_EGM17_S332			

Station Name	Image 1	Image 2	Image 3
1515S_EGM6_S333			

APPENDIX 3 Vessel and Equipment Used (Additional Information)

Vessel

For more information on MRV Scotia, please see:
http://www.scotland.gov.uk/Topics/marine/science/scienceops/vessels-technology/vessels/scotia

Sonar Scout Ultra-Short Base Line (USBL) acoustic transponder

For information on USBL system used, please see:
http://www.sonardyne.com/products/positioning/scout-usbl.html

APPENDIX 4 Equipment Configuration and Calibration

Camera

Camera	Viewing angle (nominal) deg	Viewing angle Horizontal (deg)	Viewing angle Vertical (deg)	Aspect Ratio	Field width (mm) at range 1.25m	Field height (mm) at range 1.25m
Kongsberg OE-14-366 (TV)	61 (diagonal)	50	41	4:3	975	750
Kongsberg OE-14-408 (Digital Stills)	62 (diagonal)	50	38	4:3	1125	870
SubC Control HD 1Cam Alpha	60 (horizontal)	60	34	16:9	1100	625

Digital Stills Camera configuration	
Focus	2 m (fixed)
Aperture	f5.6
Mode/Shutter	Manual (1/250)
ISO	200
Flash	1/8 +2
Resolution	RAW and JPEG
HD camera configuration	
File format	.M2TS
Image quality	HD-FH
Filename = recording start date and time	YYMMDDHHMMSS (eg 30/08/13 00:21:21)
Recording capacity	96GB (available time approx 7h 50m)
Frame rate	50 p (progressive)
Laser projectors	2 spot, 120mm apart

Other

- USBL system did not require calibration.

APPENDIX 5 Navigation Data

Navigation data (ship's position) is from the vessels main system (i.e. GPS aerial). Offsets were not applied.

Positional data for the USBL was supplied from the ship’s multibeam system and is corrected (to within 1m) for the drop keel, where the USBL transceiver is located. Therefore the USBL is corrected for its location. Vessel heading was supplied from the same source, and the motion reference for the USBL was supplied from the USBL unit.

APPENDIX 6 Sampling Equipment Rationale

Summary

The Joint Nature Conservation Committee (JNCC) and Marine Scotland Science (MSS) have undertaken an offshore seabed survey of East of Gannet and Montrose Fields (EGM) and Norwegian Boundary Sediment Plain (NSP) Scottish Nature Conservation Marine Protected Areas (NCMPAs) on the Marine Research Vessel (MRV) Scotia (survey code 1515S). The survey departed Aberdeen on 19 October 2015 and arrived back into Aberdeen on 2 November 2015.

The aim of this document is to capture the rationale concerning choice of sampling equipment for the 1515S survey. The document summarises the literature review undertaken, external advice received and sampling equipment options considered to inform the choice sampling equipment.

Following consideration of the available sampling options, JNCC decided that dredging (including Triple-D dredge) as the primary sampling method for this survey was not appropriate, due to being excessively destructive and loss of information on *Arctica islandica* juveniles and other small macrofauna.

Conducting a gear comparison study was determined to not be appropriate as the timeframe available is not likely to be sufficient for a robust comparison, due to need to focus efforts on collecting sufficient data to inform future monitoring, as well as the potentially patchy and sparse distribution of *A. islandica*.

JNCC concluded that the large Hamon grab (0.25m^2 sampling surface area) was the most appropriate primary sampling device for the 1515S survey. A large (0.5m^2 sampling surface area) Van Veen grab, two small (0.1m^2 sampling surface area) Van Veen grabs and a mini (0.1m^2 sampling surface area) Hamon grab will also be taken as contingency sampling devices.

Literature review

OSPAR (2009) recommends that surveys for *A. islandica* should use the **Triple-D dredge** supplemented with box core samples, and suggest the Triple-D dredge gives the best insight into the population structure by providing more information on abundance and density estimates than can be achieved by sampling by **single grab**, and by **beam trawl** (low catch efficiency and size selectivity) (Bergman & van Santbrink 1994). The Triple D dredge collects in-faunal species quantitatively by sampling a maximum of 20m^2 seabed to a depth of 12 to 18cm and retains juveniles and adults.

Bowden *et al* (2015) suggest that, for an 'optimal' survey designed to detect changes over time, use of non-destructive sampling using camera systems, potentially in combination with minimally destructive methods such as **box coring** if macrofauna, meiofauna, or sediments are deemed to be useful indicators of change.

The authors argue that destructive sampling is inappropriate for monitoring of sessile and sedentary fauna as the sampling method would introduce disturbance effects similar to those the study may be designed to measure. Furthermore, **photographic sampling** enables measurements of small-scale spatial structure and patch characteristics that are not possible using available physical sampling methods (Bowden & Hewitt 2012).

An Icelandic study (Ragnarsson and Thorarinsdóttir 2002) found that abundance estimates of *A. islandica* obtained using **photography** (siphon counting) were more than three times higher than estimates using a commercial dredge. Assessment of *A. islandica* abundance using **underwater photography** has the clear advantage that quantitative information can be assessed more rapidly and cheaply compared with surveys conducted with **hydraulic dredges**. However, estimation of stock size can be affected by seasonal vertical movement of individuals, and siphon counting using photography may not be suitable in sites where other bivalve species may be present, due to potential difficulties in distinguishing between species based on siphons alone.

Preliminary analysis of industry grab data from EGM indicated that adults were extremely sparse, although juveniles were present in samples (specimens were almost entirely <17mm; note that 85% of specimens sampled by the Icelandic study outlined above were between 70-95mm, with none observed <30mm). Therefore, video sampling may not accurately reflect the full community structure if this is the case, as juvenile siphons may be too small to be detected by underwater camera systems.

The literature reviewed above has not suggested one ideal sampling method to undertake representative yet non-destructive sampling of *A. islandica* communities.

External advice

JNCC contacted members of the Dogger Bank Monitoring Sub-Group, ICES Benthic Ecology Working Group and Joint Monitoring Programme for the North Sea and Celtic Sea Activity C Workshop Benthos Sub Group, who were asked:

"We would appreciate hearing opinions you might have regarding our choice of gear type for this survey, particularly if these are related to first-hand experience of sampling Arctica islandica in the North Sea. We would also welcome any recent relevant papers or reports which might help us inform the planning for this survey which we may have overlooked."

Responses received have been collated in Table 6.1.

Table 6.1. Responses from external partners on the most suitable gear type to sample *Arctica islandica.*

Responder	Recommendation	Response
Dogger Bank Monitoring Sub-Group	**3D Dredge, large box corer**	If you want to attempt anything quantitative (trends, spatial differences) with *Arctica* and reasonable statistical power then by far the best option in my view is the 3D dredge that Magda Bergman and colleagues developed at NIOZ. However, you would need to get a view from them on suitability for deployment on all these sediment types and at depth as I imagine it struggles on softer sediments and is unlikely to work well on gravel. A large box corer is an option, but suggest doing some preliminary power analyses based on trends you would want to/ expect to detect (and the expected densities and distribution of *Arctica* at the present time) to assess quite how high the levels of replication may need to be to provide data you can use (past experience suggests extremely high in several parts of the North Sea). We've also used various other types of dredge and small modified (heavy) beam trawls for *Arctica* with tolerable success in the past, but the area sampled is really too small or the quantification on a per unit area basis is a challenge with these gears- so not really

Responder	Recommendation	Response
		suitable if the long-term aim is to measure rates and directions of change
	Coring/dredging as ground-truthing and imaging/siphon counting as non-destructive approach.	I would suggest a two-way approach, comprising coring/dredging as ground-truthing and imaging/siphon counting as non-destructive approach.
	Undertaking a gear comparison including triple-D and video and comparing different habitats is the right approach	In the German part of the North Sea, *Arctica* is almost completely lacking; we only found single juveniles. The main problem of your box corer approach might be the statistical power. Thus from my point of view your attempt undertaking a gear comparison including triple-D and video and comparing different habitats is the right approach.
	Boxcorers to sample whole communities in soft bottoms, dredge to sample larger species/individuals	In The Netherlands we don't monitor one specific species, but we do have different sampling methods for specific goals/habitats. As of this year (considering MSFD and N2000 objectives), we adapted our macrozoobenthos monitoring programme, using: - boxcorers to sample whole communities in soft bottoms, including Dogger Bank (results are used to calculate MMIs) - also soft sediment (including Dogger Bank): dredge to sample larger species/individuals, this is in our view most suitable for bivalves (large quantities can be sampled, and this method is much quicker than boxcorers (lab-work not required unless species need to be further identified). Cannot replace boxcorers however, because the very small individuals disappear through the net) - in coarse sediments (CloaverBank): video and Hamon grabs
ICES Benthic Ecology Working Group	**NIOZ corer and SPI, 5 replicates per station, record grain-size, organic matter and temperature**	My experience with collecting soft sediment samples and *Arctica islandica* is from the Defra funded work that I conducted in 2007-08 in the North of the Dogger Bank and Oyster Grounds. We sampled over seasons and at both sites we used the NIOZ corer as a sampling tool and the Sediment Profile Imagery camera -SPI[2] to record in situ changes. Bear in mind the amount of replicates, as they are deep burrowers and 5 replicates may give you a chance to accurately record some. On the environmental characteristics it will be good to also record grain-size, organic matter and temperature if this is possible.
Joint Monitoring Programme for the North Sea and Celtic Sea Activity C Workshop Benthos Sub Group	**Box corer, dredge**	I have no expertise with sampling *Arctica*, because we have this species not in our area. A box-corer is of course best for sampling 'deeper' living bivalve species, compared to grab samplers. A disadvantage is the small sampling surface, which increase the chance of missing the species. Therefore, it is better to use a dredge (but can sample less deep into the sediment). In conclusion, no ideal method, but those are the best, as you also concluded.

[2] SPI was discounted previously due to shallow (20cm) penetration and potential issues with deployment in a site with limited available substrate data

Arctica islandica burrowing depth

Arctica islandica has been referred to as a deep-burrowing species by respondents from the ICES Benthic Ecology Working Group and Joint Monitoring Programme for the North Sea and Celtic Sea Activity C Workshop Benthos Sub Group (see Table). JNCC have carried out a 'rapid literature review' to determine the evidence available to indicate burrowing depth. Literature on the subject of *A. islandica* burrowing depth is extremely limited, and based on available references there is little evidence that *A. islandica* burrow deeper than 12-14cm (see Table 6.2).

Table 6.2. Results of the literature review of the evidence on burrowing depth of *Arctica islandica.*

Source	Region	Sediment	Conclusions
Strahl, J., Brey, T., Philipp, E.E.R., Thórarinsdóttir, G., Fischer, N., Wessels, W, & Abele, D. (2011) Physicological responses to self-induced burrowing and metabolic rate depression in the ocean quahog *Arctica islandica*	Laboratory (collected from German Bight and North Iceland)	2-3mm grain size pea gravel (20cm depth)	The exact burrowing depth of the clams was not determined in the experiment, but periods during which clams remained constantly burrowed lasted equally long, between 1 day and 6 days, in both populations.
	Field study North Iceland (10m depth)	0.25-0.49mm grain size medium sand	In situ burrowing depth of Icelandic *A. islandica* differed significantly between winter and summer. In February 2004, A. islandica were found in 4–12cm sediment depth [mean 8.5, standard deviation (s.d.) 1.7] whereas in June 2003, clams were found in 0–10cm sediment depth and were, on average, located significantly closer to the surface.
Taylor, A.C. (1976) Burrowing behaviour and anaerobiosis in the bivalve *Arctica islandica* (L.) Journal of the Marine Biological Association of the United Kingdom 56 (1) 95-109	Laboratory	Unknown	In laboratory tanks as well as in the sea *A. islandica* shows a pattern of intermittent burrowing activity. Periods spent at the surface of the deposit alternate with periods buried several centimetres beneath the surface of the sand, during which the animals respire anaerobically. There is no obvious rhythmicity to this behaviour; the duration of periods spent beneath the surface is very variable even in the same animal, but normally lasts between 1 and 7 days.
Thórarinsdóttir, G., Gunnarsson, K., & Bogason, E. 2009. 2009. Mass mortality of ocean quahog, *Arctica islandica*, on hard substratum in Lonafjördur, north-eastern Iceland after a storm. Marine Biodiversity Records 2: published online http://dx.doi.org/10.1017/S1755267209000736	n/a	n/a	Burrowing activity in Iceland has been related to season with maximum depth (14cm) during winter (Thorarinsdóttir, unpublished data).

Rationale for sampling gear selection

Following review of the information collated, the following options were identified by JNCC:

1. Use 3D or equivalent dredge as primary sampling device
2. Use grab as primary sampling device, include dredging in a gear comparison study
3. Use grab as primary sampling device, do not use dredge for sampling on this survey

In considering these options, the advantages and disadvantages of each option have been identified (see Table 6.3).

Table 6.3. Options considered by JNCC for sampling *Arctica islandica* during the 1515S survey.

Option	Advantages	Disadvantages
1. Use 3D or equivalent dredge as primary sampling device	May considerably increase the power of the sampling. Recommended by OSPAR and members of DBMSG (box corer also recommended). Would allow some degree of comparison with other dredge based studies in literature.	Higher impact on protected features at EGM and NSP than sampling with grab (destructive sampling method). Dredging would not capture full infaunal community (e.g. specimens smaller than net size would be lost) and dredge may not sample as deep as box corer. Impossible to georeference samples within tow. No PSA.
2. Use grab as primary sampling device, include dredging in a gear comparison study	Less impact on protected features at EGM and NSP. Potential to validate use of grab for future *Arctica* monitoring work (including by industry). Greater sampling depth possible. Would allow some degree of comparison/calibration with grab sampling were grab sampling used as the primary method. Would allow some degree of comparison/calibration with dredge based studies in literature.	May considerably decrease the power of the sampling. Unsure if number of comparison stations available will be sufficient for robust comparison to be made (potentially 21 stations per gear type). Unlikely to be feasible to source 3D dredge for gear comparison study as gear comparison study is third priority; would most likely use Agassiz or scallop dredge for this option.
3. Use grab as primary sampling device, do not use dredge for sampling on this survey	Less impact on protected features at EGM and NSP. Greater sampling depth possible. Undisturbed sample for full infaunal community and PSA analysis.	May considerably decrease the power of the sampling. Would **not** allow gear comparison be made on survey. Would **not** allow comparison/calibration with dredge based studies in literature.

After considering the three options identified, JNCC opted for using a grab as the primary sampling device, and not using dredge (option 3).

JNCC considered sampling by dredge (including Triple-D dredge) to be too destructive a sampling method for monitoring use (typical sampling footprint of 100-200m). However,

JNCC appreciates further research is required to quantitatively compare dredge sampling efficiency with grab and core sampling efficiency.

Conducting a gear comparison study was determined to not be appropriate as the timeframe available was not likely to be sufficient for a robust comparison, due to need to focus efforts on collecting sufficient data to inform future monitoring, as well as the potentially patchy and sparse distribution of *A. islandica*.

The use of photographic sampling (siphon counting), despite being a non-destructive alternative, was discounted as a primary sampling device for this survey based on issues identified in the literature review (e.g. seasonal vertical movement of individuals, difficulties in distinguishing between bivalve species based on siphons alone). Nevertheless, all camera sledge imagery collected will be assessed to determine presence and abundance of *A. islandica* siphons where possible. Results of this analysis may be used to inform the development of this non-destructive methodology.

Choice of grab sampling device

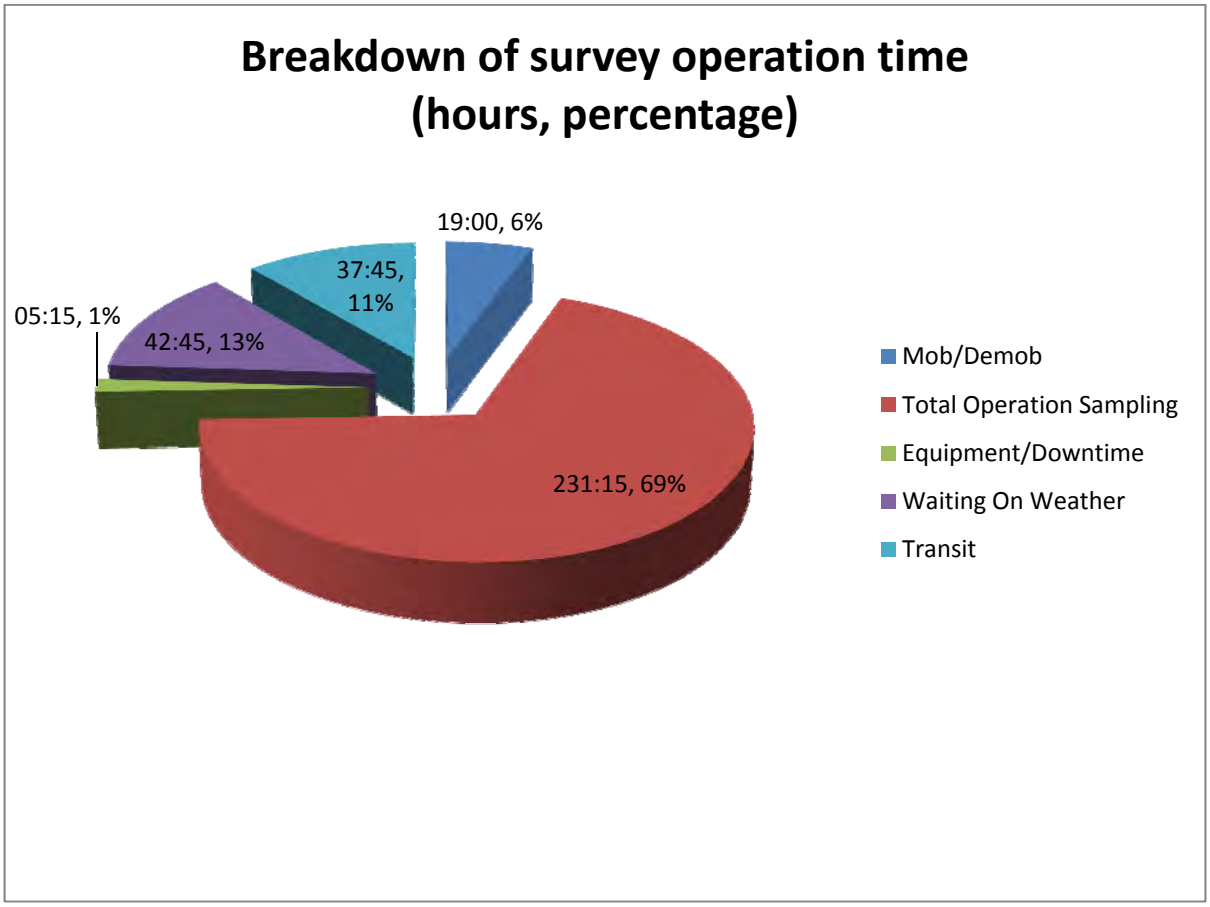
With regards to the choice of grab sampling device, several options were considered including different box corers and Hamon, Day and Van Veen grabs. Potential suppliers of these devices were contacted by JNCC and MSS to determine their availability and suitability for the 1515S survey.

After pondering on the pros and cons of the different options, JNCC determined that the large Hamon grab (0.25m^2 sampling surface area) was the most appropriate choice for the 1515S survey as:

- Grab sampler options requires less specialist operational experience and can be safely deployed in a greater weather window than box corer options
- The large Hamon grab can penetrate to 0.25m, has a large sampling surface area (0.25 m^2) and a larger sampling volume (22l) than alternative grab sampler options
- The large Hamon grab is preferred to a large Van Veen grab as it is designed to sample successfully in a greater variety of sediment types
- Gear comparison work carried out by JNCC and Cefas on Dogger Bank in 2014 will be available to inform standardisation between samples collected using different devices (e.g. existing industry data collected with 0.1m^2 Van Veen grab) if required.

APPENDIX 7 Breakdown of survey operation time

Activity	Hours Spent
Mob/Demob	19:00
Offshore Calibrations	00:00
Total Operation Sampling	231:15
Equipment/Downtime	05:15
Ship/Plant Downtime	00:00
Waiting On Weather	42:45
Transit	37:45
Standby Port	00:00
Others	00:00
Total:	**336:00**



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

APPENDIX 9 Survey metadata (summary version; full electronic spreadsheet (xls) available on request)

Table 8. Summary metadata for 1515S Large Hamon Grab (LHG) samples. Latitudes and Longitudes are from the ship's Central Reference Point.

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_EGM2_S1	1	LHG	19/10/2015 20:46	93.5	57.2714	0.8581
1515S_EGM5_S2	1	LHG	19/10/2015 21:49	93.8	57.2979	0.8851
1515S_EGM8_S3	1	LHG	19/10/2015 22:19	95.1	57.2979	0.8851
1515S_EGM4_S4	1	LHG	19/10/2015 22:55	94.8	57.2723	0.9146
1515S_EGM9_S5	1	LHG	19/10/2015 23:39	96.7	57.2444	0.8869
1515S_EGM13_S6	1	LHG	20/10/2015 00:16	96	57.2462	1.0008
1515S_EGM11_S7	1	LHG	20/10/2015 00:47	97	57.2189	0.9742
1515S_EGM7_S8	1	LHG	20/10/2015 01:13	96.7	57.2180	0.9171
1515S_EGM1_S9	1	LHG	20/10/2015 01:40	94.5	57.2168	0.8596
1515S_EGM3_S10	1	LHG	20/10/2015 02:10	97	57.1906	0.8900
1515S_EGM6_S11	1	LHG	20/10/2015 02:40	93.5	57.1641	0.9204
1515S_EGM10_S12	1	LHG	20/10/2015 03:14	96	57.1119	0.9822
1515S_EGM17_S13	1	LHG	20/10/2015 03:46	89.8	57.0850	1.0680
1515S_EGM33_S14	1	LHG	20/10/2015 04:18	87.7	57.0589	1.1525
1515S_EGM51_S15	1	LHG	20/10/2015 04:53	84	57.0346	1.2398
1515S_EGM65_S16	1	LHG	20/10/2015 05:17	94.2	57.0368	1.2979
1515S_EGM81_S17	1	LHG	20/10/2015 05:49	99.7	57.0355	1.3522
1515S_EGM90_S18	1	LHG	20/10/2015 06:15	102.1	57.0113	1.3823
1515S_EGM98_S19	1	LHG	20/10/2015 06:47	102.3	56.9832	1.4116
1515S_EGM117_S20	1	LHG	20/10/2015 07:50	98.9	56.9840	1.4681
1515S_EGM126_S21	1	LHG	20/10/2015 08:19	96.6	56.9582	1.4980

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_EGM137_S22	1	LHG	20/10/2015 08:45	98.8	56.9317	1.5268
1515S_EGM152_S23	1	LHG	20/10/2015 09:14	98.4	56.9323	1.5835
1515S_EGM145_S24	1	LHG	20/10/2015 09:41	100	56.9599	1.5545
1515S_EGM156_S25	1	LHG	20/10/2015 10:27	97	57.0131	1.6095
1515S_EGM146_S26	1	LHG	20/10/2015 11:15	98.7	57.0123	1.5563
1515S_EGM127_S27	1	LHG	20/10/2015 11:42	97.5	57.0117	1.4957
1515S_EGM108_S28	1	LHG	20/10/2015 12:24	100	57.0111	1.4393
1515S_EGM153_S29	1	LHG	20/10/2015 13:14	96.9	57.0394	1.5802
1515S_EGM138_S30	1	LHG	20/10/2015 13:45	97.45	57.0387	1.5235
1515S_EGM99_S31	1	LHG	20/10/2015 14:23	101.2	57.0375	1.4099
1515S_EGM147_S32	1	LHG	20/10/2015 15:10	96	57.0657	1.5501
1515S_EGM128_S33	1	LHG	20/10/2015 15:42	98.2	57.0651	1.4925
1515S_EGM109_S34	1	LHG	20/10/2015 16:18	96.3	57.0648	1.4345
1515S_EGM91_S35	1	LHG	20/10/2015 17:12	97.6	57.0634	1.3774
1515S_EGM73_S36	1	LHG	20/10/2015 17:41	96.8	57.0629	1.3228
1515S_EGM57_S37	1	LHG	20/10/2015 18:11	98.9	57.0621	1.2630
1515S_EGM27_S38	1	LHG	20/10/2015 19:02	84.5	57.0873	1.1192
1515S_EGM40_S39	1	LHG	20/10/2015 19:29	86.4	57.0883	1.1809
1515S_EGM66_S40	1	LHG	20/10/2015 20:06	95.8	57.0902	1.2958
1515S_EGM82_S41	1	LHG	20/10/2015 20:31	97.8	57.0913	1.3517
1515S_EGM100_S42	1	LHG	20/10/2015 20:56	99.5	57.0917	1.4088
1515S_EGM118_S43	1	LHG	20/10/2015 21:20	97.1	57.0925	1.4653
1515S_EGM139_S44	1	LHG	20/10/2015 21:46	97.1	57.0932	1.5208
1515S_EGM154_S45	1	LHG	20/10/2015 22:12	95.3	57.0934	1.5793

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_EGM148_S46	1	LHG	20/10/2015 23:09	96.4	57.1198	1.5545
1515S_EGM129_S47	1	LHG	21/10/2015 00:14	97.6	57.1194	1.4914
1515S_EGM110_S48	1	LHG	21/10/2015 01:06	93.5	57.1190	1.4361
1515S_EGM92_S49	1	LHG	21/10/2015 02:01	97.2	57.1177	1.3779
1515S_EGM74_S50	1	LHG	21/10/2015 02:45	96.2	57.1171	1.3205
1515S_EGM58_S51	1	LHG	21/10/2015 03:20	92.7	57.1160	1.2627
1515S_EGM45_S52	1	LHG	21/10/2015 04:11	90.6	57.1163	1.2088
1515S_EGM34_S53	1	LHG	21/10/2015 04:51	82.5	57.1155	1.1522
1515S_EGM22_S54	1	LHG	21/10/2015 05:38	89.1	57.1128	1.0956
1515S_EGM14_S55	1	LHG	21/10/2015 06:40	91	57.1125	1.0363
1515S_EGM12_S56	1	LHG	21/10/2015 07:07	91.7	57.1393	1.0060
1515S_EGM18_S57	1	LHG	21/10/2015 07:33	89.2	57.1402	1.0658
1515S_EGM28_S58	1	LHG	21/10/2015 08:37	86	57.1399	1.1206
1515S_EGM52_S59	1	LHG	21/10/2015 09:18	92.4	57.1415	1.2332
1515S_EGM67_S60	1	LHG	21/10/2015 09:43	94.6	57.1437	1.2924
1515S_EGM83_S61	1	LHG	21/10/2015 10:17	96.9	57.1436	1.3470
1515S_EGM101_S62	1	LHG	21/10/2015 11:10	97.4	57.1449	1.4051
1515S_EGM119_S63	1	LHG	21/10/2015 12:00	97	57.1457	1.4627
1515S_EGM140_S64	1	LHG	21/10/2015 12:36	96	57.1466	1.5190
1515S_EGM155_S65	1	LHG	21/10/2015 13:14	96	57.1471	1.5764
1515S_EGM149_S66	1	LHG	21/10/2015 13:57	95.8	57.1734	1.5454
1515S_EGM130_S67	1	LHG	21/10/2015 14:37	94.8	57.1736	1.4892
1515S_EGM93_S68	1	LHG	21/10/2015 15:25	97.7	57.1709	1.3759
1515S_EGM75_S69	1	LHG	21/10/2015 15:55	94.2	57.1705	1.3149

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_EGM59_S70	1	LHG	21/10/2015 16:19	93	57.1691	1.2603
1515S_EGM46_S71	1	LHG	21/10/2015 17:47	90.5	57.1689	1.2034
1515S_EGM35_S72	1	LHG	21/10/2015 18:14	82.2	57.1678	1.1483
1515S_EGM23_S73	1	LHG	21/10/2015 18:40	87.9	57.1671	1.0911
1515S_EGM15_S74	1	LHG	21/10/2015 19:09	88.2	57.1658	1.0337
1515S_EGM19_S75	1	LHG	21/10/2015 19:33	87.9	57.1937	1.0618
1515S_EGM29_S76	1	LHG	21/10/2015 20:07	83	57.1950	1.1207
1515S_EGM41_S77	1	LHG	21/10/2015 20:32	87.7	57.1960	1.1759
1515S_EGM53_S78	1	LHG	21/10/2015 20:58	92.8	57.1952	1.2332
1515S_EGM68_S79	1	LHG	21/10/2015 21:24	94.5	57.1967	1.2917
1515S_EGM84_S80	1	LHG	21/10/2015 21:50	96.2	57.1973	1.3471
1515S_EGM102_S81	1	LHG	21/10/2015 22:16	97.9	57.1972	1.4042
1515S_EGM120_S82	1	LHG	21/10/2015 22:38	95.6	57.1995	1.4607
1515S_EGM141_S83	1	LHG	21/10/2015 23:16	97.7	57.2000	1.5189
1515S_EGM150_S84	2	LHG	22/10/2015 00:05	93.9	57.2263	1.5470
1515S_EGM131_S85	1	LHG	22/10/2015 00:40	95.9	57.2266	1.4879
1515S_EGM111_S86	1	LHG	22/10/2015 01:19	95.3	57.2261	1.4295
1515S_EGM94_S87	2	LHG	22/10/2015 02:07	97.8	57.2251	1.3761
1515S_EGM76_S88	1	LHG	22/10/2015 02:42	89.7	57.2243	1.3168
1515S_EGM60_S89	1	LHG	22/10/2015 03:25	93.6	57.2235	1.2591
1515S_EGM47_S90	1	LHG	22/10/2015 04:20	88.6	57.2224	1.2010
1515S_EGM36_S91	1	LHG	22/10/2015 05:11	86.2	57.2213	1.1463
1515S_EGM24_S92	1	LHG	22/10/2015 06:02	86.7	57.2209	1.0888
1515S_EGM20_S93	1	LHG	22/10/2015 07:20	93	57.2468	1.0616

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_EGM30_S94	1	LHG	22/10/2015 07:47	87	57.2460	1.1147
1515S_EGM42_S95	1	LHG	22/10/2015 08:16	87.8	57.2489	1.1740
1515S_EGM54_S96	1	LHG	22/10/2015 09:00	93	57.2500	1.2313
1515S_EGM69_S97	1	LHG	22/10/2015 09:30	94.5	57.2501	1.2851
1515S_EGM85_S98	1	LHG	22/10/2015 10:01	95.8	57.2498	1.3425
1515S_EGM103_S99	1	LHG	22/10/2015 10:27	98.7	57.2517	1.4005
1515S_EGM121_S100	1	LHG	22/10/2015 11:03	95	57.2519	1.4573
1515S_EGM142_S101	1	LHG	22/10/2015 11:35	93.3	57.2525	1.5175
1515S_EGM151_S102	2	LHG	22/10/2015 12:15	95.1	57.2791	1.5473
1515S_EGM132_S103	1	LHG	22/10/2015 12:55	95	57.2792	1.4847
1515S_EGM112_S104	1	LHG	22/10/2015 13:24	Not Recorded	57.2790	1.4287
1515S_EGM95_S105	1	LHG	22/10/2015 13:59	95	57.2774	1.3711
1515S_EGM77_S106	1	LHG	22/10/2015 14:38	90	57.2762	1.3125
1515S_EGM61_S107	1	LHG	22/10/2015 15:09	90	57.2759	1.2561
1515S_EGM48_S108	1	LHG	22/10/2015 23:12	89	57.2762	1.2008
1515S_EGM37_S109	1	LHG	22/10/2015 23:50	88.7	57.2746	1.1413
1515S_EGM25_S110	1	LHG	23/10/2015 00:30	91.6	57.2741	1.0847
1515S_EGM16_S111	1	LHG	23/10/2015 01:06	95.6	57.2735	1.0279
1515S_EGM21_S112	1	LHG	23/10/2015 02:12	94.4	57.3015	1.0552
1515S_EGM31_S113	1	LHG	23/10/2015 02:47	91.8	57.3019	1.1131
1515S_EGM43_S114	1	LHG	23/10/2015 03:19	89.2	57.3023	1.1682
1515S_EGM70_S115	1	LHG	23/10/2015 04:10	88.2	57.3044	1.2839
1515S_EGM86_S116	1	LHG	23/10/2015 04:43	Not Recorded	57.3047	1.3416
1515S_EGM104_S117	1	LHG	23/10/2015 05:17	96.8	57.3056	1.3978

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_EGM122_S118	1	LHG	23/10/2015 05:51	95.9	57.3063	1.4562
1515S_EGM133_S119	1	LHG	23/10/2015 06:49	94.9	57.3334	1.4825
1515S_EGM113_S120	1	LHG	23/10/2015 07:18	95.3	57.3324	1.4257
1515S_EGM96_S121	1	LHG	23/10/2015 07:50	94	57.3319	1.3677
1515S_EGM78_S122	1	LHG	23/10/2015 08:20	89	57.3310	1.3077
1515S_EGM62_S123	1	LHG	23/10/2015 08:51	88.7	57.3305	1.2529
1515S_EGM49_S124	1	LHG	23/10/2015 09:19	90.3	57.3301	1.1966
1515S_EGM38_S125	2	LHG	23/10/2015 09:55	91.9	57.3297	1.1380
1515S_EGM26_S126	1	LHG	23/10/2015 10:29	95	57.3275	1.0815
1515S_EGM32_S127	1	LHG	23/10/2015 11:10	95.7	57.3552	1.1119
1515S_EGM44_S128	1	LHG	23/10/2015 11:39	92.3	57.3584	1.1703
1515S_EGM55_S129	1	LHG	23/10/2015 12:10	89.7	57.3585	1.2231
1515S_EGM71_S130	1	LHG	23/10/2015 12:37	87.7	57.3575	1.2832
1515S_EGM87_S131	1	LHG	23/10/2015 14:28	90	57.3601	1.3408
1515S_EGM105_S132	1	LHG	23/10/2015 15:12	93.4	57.3594	1.3945
1515S_EGM123_S133	1	LHG	23/10/2015 15:43	92	57.3601	1.4534
1515S_EGM143_S134	1	LHG	23/10/2015 16:11	92.7	57.3605	1.5119
1515S_EGM134_S135	1	LHG	23/10/2015 17:46	94.1	57.3870	1.4824
1515S_EGM114_S136	1	LHG	23/10/2015 18:22	92.3	57.3868	1.4245
1515S_EGM97_S137	1	LHG	23/10/2015 19:04	92.2	57.3849	1.3666
1515S_EGM79_S138	1	LHG	23/10/2015 19:46	89.4	57.3845	1.3093
1515S_EGM63_S139	2	LHG	23/10/2015 20:31	88.5	57.3825	1.2541
1515S_EGM50_S140	1	LHG	23/10/2015 21:12	91.6	57.3836	1.1903
1515S_EGM39_S141	1	LHG	23/10/2015 21:54	96.6	57.3821	1.1376

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_EGM56_S142	1	LHG	23/10/2015 22:33	89.7	57.4098	1.2221
1515S_EGM88_S143	1	LHG	23/10/2015 23:27	90.4	57.4125	1.3383
1515S_EGM106_S144	1	LHG	23/10/2015 23:52	93.6	57.4142	1.3948
1515S_EGM124_S145	1	LHG	24/10/2015 00:28	93.1	57.4154	1.4517
1515S_EGM135_S146	2	LHG	24/10/2015 01:03	92	57.4409	1.4819
1515S_EGM115_S147	1	LHG	24/10/2015 01:49	93	57.4416	1.4228
1515S_EGM80_S148	1	LHG	24/10/2015 02:42	89.9	57.4460	1.3110
1515S_EGM64_S149	1	LHG	24/10/2015 03:28	88.4	57.4368	1.2479
1515S_EGM72_S150	1	LHG	24/10/2015 04:01	Not Recorded	57.4650	1.2780
1515S_EGM89_S151	1	LHG	24/10/2015 04:35	91.8	57.4657	1.3340
1515S_EGM107_S152	1	LHG	24/10/2015 05:14	91.5	57.4658	1.3916
1515S_EGM125_S153	1	LHG	24/10/2015 05:43	92.7	57.4674	1.4510
1515S_EGM144_S154	1	LHG	24/10/2015 06:55	90.5	57.4680	1.5082
1515S_EGM136_S155	1	LHG	24/10/2015 07:25	92.2	57.4936	1.4780
1515S_EGM116_S156	1	LHG	24/10/2015 07:54	92.7	57.4930	1.4199
1515S_NSP17_S157	1	LHG	24/10/2015 11:16	92.7	57.9982	1.6833
1515S_NSP50_S158	1	LHG	24/10/2015 11:36	93.9	58.0002	1.7207
1515S_NSP83_S159	1	LHG	24/10/2015 11:58	90.2	58.0008	1.7588
1515S_NSP108_S160	1	LHG	24/10/2015 12:22	91.4	58.0021	1.8002
1515S_NSP112_S161	1	LHG	24/10/2015 13:01	91.6	58.0079	1.8047
1515S_NSP90_S162	2	LHG	24/10/2015 13:33	91.4	58.0105	1.7672
1515S_NSP58_S163	1	LHG	24/10/2015 13:57	90	58.0083	1.7312
1515S_NSP24_S164	1	LHG	24/10/2015 14:59	90.5	58.0080	1.6932
1515S_NSP9_S165	1	LHG	24/10/2015 15:20	92.9	58.0073	1.6736

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_NSP32_S166	1	LHG	24/10/2015 15:41	90.8	58.0162	1.7007
1515S_NSP67_S167	1	LHG	24/10/2015 16:06	91.1	58.0164	1.7388
1515S_NSP98_S168	1	LHG	24/10/2015 17:30	90.1	58.0170	1.7761
1515S_NSP116_S169	1	LHG	24/10/2015 17:56	90.6	58.0174	1.8138
1515S_NSP119_S170	1	LHG	24/10/2015 18:13	91.8	58.0261	1.8226
1515S_NSP104_S171	1	LHG	24/10/2015 19:43	90.4	58.0244	1.7837
1515S_NSP76_S172	1	LHG	24/10/2015 20:06	93.7	58.0248	1.7469
1515S_NSP25_S173	1	LHG	24/10/2015 20:37	92.4	58.0238	1.6917
1515S_NSP33_S174	1	LHG	24/10/2015 21:12	90.4	58.0323	1.7014
1515S_NSP68_S175	1	LHG	24/10/2015 21:38	90.9	58.0332	1.7382
1515S_NSP99_S176	1	LHG	24/10/2015 22:04	Not Recorded	58.0335	1.7748
1515S_NSP117_S177	1	LHG	24/10/2015 23:02	90.7	58.0339	1.8123
1515S_NSP120_S178	1	LHG	24/10/2015 23:25	Not Recorded	58.0427	1.8211
1515S_NSP105_S179	1	LHG	25/10/2015 00:21	91	58.0427	1.7864
1515S_NSP77_S180	1	LHG	25/10/2015 01:02	92.2	58.0421	1.7473
1515S_NSP42_S181	1	LHG	25/10/2015 01:31	89	58.0416	1.7100
1515S_NSP1_S182	1	LHG	25/10/2015 02:07	96.7	58.0494	1.6640
1515S_NSP34_S183	1	LHG	25/10/2015 02:30	88.6	58.0500	1.7018
1515S_NSP118_S184	1	LHG	25/10/2015 06:46	88	58.0512	1.8140
1515S_NSP110_S185	1	LHG	25/10/2015 07:09	89.1	58.0518	1.7945
1515S_NSP100_S186	1	LHG	25/10/2015 07:55	92.1	58.0514	1.7739
1515S_NSP86_S187	1	LHG	25/10/2015 08:19	92.4	58.0506	1.7567
1515S_NSP69_S188	1	LHG	25/10/2015 08:48	88.7	58.0503	1.7363
1515S_NSP53_S189	1	LHG	25/10/2015 09:16	90.7	58.0498	1.7186

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_NSP115_S190	1	LHG	25/10/2015 09:53	88.7	58.0592	1.8021
1515S_NSP106_S192	2	LHG	25/10/2015 10:24	89.9	58.0582	1.7891
1515S_NSP93_S193	1	LHG	25/10/2015 10:47	92.9	58.0591	1.7654
1515S_NSP78_S194	1	LHG	25/10/2015 11:11	89.3	58.0589	1.7455
1515S_NSP61_S195	1	LHG	25/10/2015 11:36	98.4	58.0592	1.7273
1515S_NSP43_S196	1	LHG	25/10/2015 12:02	90.9	58.0582	1.7096
1515S_NSP27_S197	1	LHG	25/10/2015 12:28	90.87	58.0584	1.6909
1515S_NSP111_S198	1	LHG	25/10/2015 13:02	90.87	58.0680	1.7932
1515S_NSP101_S199	1	LHG	25/10/2015 13:24	91	58.0677	1.7747
1515S_NSP31_S250	2	LHG	28/10/2015 08:22	91	57.9989	1.7025
1515S_NSP66_S251	1	LHG	28/10/2015 08:50	90	57.9991	1.7396
1515S_NSP97_S252	1	LHG	28/10/2015 09:20	91.3	57.9995	1.7774
1515S_NSP41_S253	1	LHG	28/10/2015 09:57	90.3	58.0071	1.7112
1515S_NSP75_S254	1	LHG	28/10/2015 10:35	91.2	58.0077	1.7478
1515S_NSP103_S255	1	LHG	28/10/2015 11:05	92.6	58.0084	1.7856
1515S_NSP18_S256	1	LHG	28/10/2015 12:02	95.3	58.0163	1.6818
1515S_NSP51_S257	1	LHG	28/10/2015 12:39	91.1	58.0159	1.7193
1515S_NSP84_S258	1	LHG	28/10/2015 14:16	91.2	58.0164	1.7599
1515S_NSP10_S334	1	LHG	28/10/2015 14:55	92.1	58.0245	1.6735
1515S_NSP56_S259	1	LHG	29/10/2015 07:51	93.8	58.1016	1.7185
1515S_NSP8_S260	1	LHG	29/10/2015 09:44	101	58.1868	1.6579
1515S_NSP23_S261	1	LHG	29/10/2015 14:10	100.9	58.1871	1.6764
1515S_NSP16_S262	1	LHG	29/10/2015 14:30	Not Recorded	58.1779	1.6675
1515S_NSP7_S263	1	LHG	29/10/2015 14:49	101.4	58.1698	1.6584

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_NSP40_S264	1	LHG	29/10/2015 15:18	98.9	58.1703	1.6958
1515S_NSP30_S265	2	LHG	29/10/2015 15:42	98.9	58.1624	1.6880
1515S_NSP49_S266	1	LHG	29/10/2015 16:00	97.5	58.1621	1.7068
1515S_NSP57_S267	1	LHG	29/10/2015 16:23	96	58.1526	1.7146
1515S_NSP39_S268	1	LHG	29/10/2015 16:41	97.9	58.1527	1.6951
1515S_NSP15_S269	1	LHG	29/10/2015 17:01	99.2	58.1437	1.6678
1515S_NSP48_S270	1	LHG	29/10/2015 18:13	96.6	58.1448	1.7061
1515S_NSP74_S271	1	LHG	29/10/2015 18:36	93.3	58.1355	1.7362
1515S_NSP38_S272	1	LHG	29/10/2015 19:01	96.5	58.1365	1.6976
1515S_NSP6_S273	1	LHG	29/10/2015 19:30	99.2	58.1357	1.6591
1515S_NSP14_S274	2	LHG	29/10/2015 19:59	98.7	58.1264	1.6696
1515S_NSP29_S275	1	LHG	29/10/2015 20:27	97.4	58.1272	1.6882
1515S_NSP47_S276	1	LHG	29/10/2015 20:50	96.1	58.1273	1.7061
1515S_NSP65_S277	1	LHG	29/10/2015 21:43	94.4	58.1278	1.7247
1515S_NSP82_S278	1	LHG	29/10/2015 22:02	92.2	58.1278	1.7440
1515S_NSP89_S279	1	LHG	29/10/2015 22:24	91.2	58.1195	1.7529
1515S_NSP5_S280	1	LHG	29/10/2015 23:00	100.4	58.1184	1.6598
1515S_NSP22_S281	1	LHG	29/10/2015 23:23	99.1	58.1184	1.6793
1515S_NSP73_S282	1	LHG	30/10/2015 00:15	93	58.1189	1.7354
1515S_NSP13_S283	1	LHG	30/10/2015 00:52	99.8	58.1092	1.6678
1515S_NSP46_S284	1	LHG	30/10/2015 01:21	96	58.1102	1.7073
1515S_NSP64_S285	1	LHG	30/10/2015 01:44	Not Recorded	58.1102	1.7265
1515S_NSP81_S286	1	LHG	30/10/2015 02:04	92.7	58.1106	1.7444
1515S_NSP96_S287	1	LHG	30/10/2015 02:40	90.9	58.1109	1.7634

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_NSP4_S288	1	LHG	30/10/2015 03:24	100.2	58.1014	1.6611
1515S_NSP21_S289	1	LHG	30/10/2015 03:47	98.2	58.1014	1.6803
1515S_NSP37_S290	1	LHG	30/10/2015 04:06	96.6	58.1009	1.7000
1515S_NSP88_S291	1	LHG	30/10/2015 04:42	91.2	58.1016	1.7534
1515S_NSP72_S292	1	LHG	30/10/2015 05:08	92.2	58.1022	1.7358
1515S_NSP45_S293	1	LHG	30/10/2015 05:33	94.2	58.0924	1.7083
1515S_NSP63_S294	1	LHG	30/10/2015 05:55	92.8	58.0932	1.7285
1515S_NSP80_S295	1	LHG	30/10/2015 06:16	91.2	58.0944	1.7481
1515S_NSP95_S296	1	LHG	30/10/2015 06:42	89.6	58.0934	1.7630
1515S_NSP3_S297	1	LHG	30/10/2015 07:57	98	58.0829	1.6612
1515S_NSP12_S298	1	LHG	30/10/2015 21:57	97.7	58.0932	1.6701
1515S_NSP36_S299	1	LHG	30/10/2015 22:45	94.9	58.0840	1.6992
1515S_NSP71_S300	1	LHG	30/10/2015 23:17	91.1	58.0847	1.7358
1515S_NSP102_S301	1	LHG	30/10/2015 23:53	88	58.0855	1.7740
1515S_NSP107_S302	1	LHG	31/10/2015 00:16	90.9	58.0768	1.7841
1515S_NSP94_S303	1	LHG	31/10/2015 00:45	89.7	58.0766	1.7646
1515S_NSP79_S304	1	LHG	31/10/2015 01:13	90.7	58.0761	1.7459
1515S_NSP62_S305	1	LHG	31/10/2015 01:42	92.2	58.0759	1.7267
1515S_NSP55_S306	1	LHG	31/10/2015 02:09	93.9	58.0849	1.7170
1515S_NSP44_S307	2	LHG	31/10/2015 02:39	94.3	58.0760	1.7084
1515S_NSP87_S308	2	LHG	31/10/2015 03:27	Not Recorded	58.0843	1.7553
1515S_NSP28_S309	1	LHG	31/10/2015 04:04	Not Recorded	58.0751	1.6884
1515S_NSP11_S310	1	LHG	31/10/2015 04:21	97.5	58.0753	1.6701
1515S_NSP2_S311	1	LHG	31/10/2015 05:06	97.9	58.0672	1.6629

Station Name	Attempt	Gear code	Fix times	Depth (m)	Ship Latitude (GPS Aerial)	Ship Longitude (GPS Aerial)
1515S_NSP35_S312	1	LHG	31/10/2015 05:31	94.2	58.0673	1.6989
1515S_NSP54_S313	1	LHG	31/10/2015 05:53	92.3	58.0679	1.7179
1515S_NSP70_S314	1	LHG	31/10/2015 06:18	90	58.0672	1.7350
1515S_NSP20_S315	1	LHG	31/10/2015 07:53	94.6	58.0506	1.6839
1515S_NSP60_S316	1	LHG	31/10/2015 08:31	88	58.0416	1.7288
1515S_NSP92_S317	1	LHG	31/10/2015 09:04	93.5	58.0423	1.7653
1515S_NSP114_S318	1	LHG	31/10/2015 09:39	89.1	58.0423	1.8036
1515S_NSP109_S319	1	LHG	31/10/2015 10:02	88.5	58.0340	1.7938
1515S_NSP85_S320	1	LHG	31/10/2015 10:42	92.1	58.0337	1.7569
1515S_NSP52_S321	1	LHG	31/10/2015 11:14	88.4	58.0327	1.7194
1515S_NSP26_S322	1	LHG	31/10/2015 11:37	95.2	58.0414	1.6912
1515S_NSP19_S323	1	LHG	31/10/2015 12:16	92.7	58.0327	1.6833
1515S_NSP59_S324	1	LHG	31/10/2015 12:56	93.4	58.0244	1.7301
1515S_NSP91_S325	1	LHG	31/10/2015 13:27	91	58.0257	1.7679
1515S_NSP113_S326	1	LHG	31/10/2015 13:56	92.4	58.0254	1.8049

Table 9.2. Summary metadata for 1515S Camera Sledge (CS) transects, including Start of Line (SOL) and End of Line (EOL) information. Latitudes and Longitudes are USBL derived with exception of **1515S_EGM136_S249 SOL**, which has been determined by applying layback to the ships position as the USBL derived position was not available for this event.

Station Name	Gear code	SOL/EOL	Still Number	Date & Time	Water Depth (m)	CS Latitude (USBL)	CS Longitude (USBL)
1515S_EGM116_S200	CS	SOL	1	25/10/2015 20:07:08	92.7	57.4994	1.4253
1515S_EGM116_S200	CS	EOL	11	25/10/2015 20:17:12	92.3	57.4966	1.4256
1515S_EGM72_S201	CS	SOL	1	25/10/2015 21:15:31	89.5	57.4698	1.2850
1515S_EGM72_S201	CS	EOL	11	25/10/2015 21:25:42	86	57.4678	1.2822
1515S_EGM39_S202	CS	SOL	1	25/10/2015 22:31:29	96	57.3903	1.1493
1515S_EGM39_S202	CS	EOL	11	25/10/2015 22:41:30	95.9	57.3880	1.1464
1515S_EGM50_S203	CS	SOL	1	25/10/2015 23:21:51	91.5	57.3904	1.1995
1515S_EGM50_S203	CS	EOL	11	25/10/2015 23:31:54	91.9	57.3880	1.1964
1515S_EGM63_S204	CS	SOL	1	26/10/2015 00:17:23	89	57.3840	1.2516
1515S_EGM63_S204	CS	EOL	11	26/10/2015 00:27:39	89.2	57.3819	1.2470
1515S_EGM71_S205	CS	SOL	1	26/10/2015 01:10:54	87	57.3602	1.2832
1515S_EGM71_S205	CS	EOL	11	26/10/2015 01:20:57	86.9	57.3579	1.2784
1515S_EGM44_S206	CS	SOL	1	26/10/2015 02:06:45	92.6	57.3601	1.1696
1515S_EGM44_S206	CS	EOL	11	26/10/2015 02:16:47	92	57.3585	1.1645
1515S_EGM26_S207	CS	SOL	1	26/10/2015 03:03:06	95	57.3326	1.0841
1515S_EGM26_S207	CS	EOL	11	26/10/2015 03:14:09	95.2	57.3312	1.0781
1515S_EGM13_S208	CS	SOL	1	26/10/2015 04:28:00	94.4	57.2489	1.0025
1515S_EGM13_S208	CS	EOL	11	26/10/2015 04:39:31	94.1	57.2454	1.0019
1515S_EGM11_S209	CS	SOL	1	26/10/2015 05:32:05	95.1	57.2227	0.9763
1515S_EGM11_S209	CS	EOL	10	26/10/2015 05:42:08	95.2	57.2201	0.9753
1515S_EGM24_S210	CS	SOL	1	26/10/2015 06:44:34	85	57.2229	1.0901
1515S_EGM24_S210	CS	EOL	12	26/10/2015 06:54:36	87	57.2201	1.0875
1515S_EGM30_S211	CS	SOL	1	26/10/2015 08:38:05	86.9	57.2497	1.1149
1515S_EGM30_S211	CS	EOL	11	26/10/2015 08:48:10	86.5		

Station Name	Gear code	SOL/EOL	Still Number	Date & Time	Water Depth (m)	CS Latitude (USBL)	CS Longitude (USBL)
1515S_EGM42_S212	CS	SOL	1	26/10/2015 09:30:52	87.6	57.2525	1.1745
1515S_EGM42_S212	CS	EOL	11	26/10/2015 09:40:54	87.4	57.2503	1.1728
1515S_EGM47_S213	CS	SOL	1	26/10/2015 10:25:10	89.6	57.2247	1.2030
1515S_EGM47_S213	CS	EOL	11	26/10/2015 10:35:09	89.7	57.2222	1.2018
1515S_EGM60_S214	CS	SOL	1	26/10/2015 11:17:40	93.7	57.2265	1.2605
1515S_EGM60_S214	CS	EOL	10	26/10/2015 11:27:49	94	57.2243	1.2580
1515S_EGM85_S215	CS	SOL	1	26/10/2015 12:22:40	95.8	57.2541	1.3436
1515S_EGM85_S215	CS	EOL	11	26/10/2015 12:32:37	95.2	57.2511	1.3409
1515S_EGM93_S216	CS	SOL	1	26/10/2015 13:31:27	98.6	57.1763	1.3752
1515S_EGM93_S216	CS	EOL	11	26/10/2015 13:41:17	98.5	57.1731	1.3728
1515S_EGM149_S217	CS	SOL	1	26/10/2015 14:43:09	96.3	57.1780	1.5452
1515S_EGM149_S217	CS	EOL	12	26/10/2015 14:53:12	96.3	57.1753	1.5428
1515S_EGM138_S218	CS	SOL	1	26/10/2015 16:11:11	97	57.0433	1.5222
1515S_EGM138_S218	CS	EOL	12	26/10/2015 16:21:13	97	57.0433	1.5222
1515S_EGM152_S219	CS	SOL	1	26/10/2015 18:33:06	97.9	56.9367	1.5834
1515S_EGM152_S219	CS	EOL	11	26/10/2015 18:43:11	97.9	56.9341	1.5843
1515S_EGM137_S220	CS	SOL	1	26/10/2015 19:35:26	98.2	56.9371	1.5251
1515S_EGM137_S220	CS	EOL	12	26/10/2015 19:45:30	98.2	56.9345	1.5266
1515S_EGM126_S221	CS	SOL	1	26/10/2015 21:05:43	-	56.9604	1.4973
1515S_EGM126_S221	CS	EOL	10	26/10/2015 21:15:46	97	56.9578	1.4982
1515S_EGM156_S222	CS	SOL	1	26/10/2015 22:20:15	97.1	57.0163	1.6083
1515S_EGM156_S222	CS	EOL	11	26/10/2015 22:30:17	97.4	57.0139	1.6095
1515S_EGM154_S223	CS	SOL	1	26/10/2015 23:32:45	96	57.0964	1.5730
1515S_EGM154_S223	CS	EOL	11	26/10/2015 23:42:55	97.4	57.0936	1.5731
1515S_EGM81_S224	CS	SOL	1	27/10/2015 01:05:24	100.2	57.0363	1.3496
1515S_EGM81_S224	CS	EOL	10	27/10/2015 01:14:44	100	57.0329	1.3487
1515S_EGM40_S225	CS	SOL	1	27/10/2015 02:24:27	86.4	57.0924	1.1759

Station Name	Gear code	SOL/EOL	Still Number	Date & Time	Water Depth (m)	CS Latitude (USBL)	CS Longitude (USBL)
1515S_EGM40_S225	CS	EOL	11	27/10/2015 02:34:34	86	57.0897	1.1761
1515S_EGM27_S226	CS	SOL	1	27/10/2015 03:25:00	85.7	57.1008	1.1149
1515S_EGM27_S226	CS	EOL	11	27/10/2015 03:35:24	85.3	57.0976	1.1148
1515S_EGM14_S227	CS	SOL	1	27/10/2015 04:29:54	91	57.1159	1.0325
1515S_EGM14_S227	CS	EOL	11	27/10/2015 04:39:57	92.2	57.1135	1.0326
1515S_EGM28_S228	CS	SOL	1	27/10/2015 05:40:00	85.3	57.1460	1.1203
1515S_EGM28_S228	CS	EOL	11	27/10/2015 05:50:56	84.8	57.1448	1.1240
1515S_EGM23_S229	CS	SOL	1	27/10/2015 06:40:01	86.5	57.1721	1.0871
1515S_EGM23_S229	CS	EOL	11	27/10/2015 06:50:06	87.1	57.1689	1.0889
1515S_EGM29_S230	CS	SOL	1	27/10/2015 08:10:47	82.5	57.1988	1.1149
1515S_EGM29_S230	CS	EOL	11	27/10/2015 08:21:50	82.8	57.1966	1.1149
1515S_EGM46_S231	CS	SOL	1	27/10/2015 09:07:25	90.1	57.1699	1.2019
1515S_EGM46_S231	CS	EOL	11	27/10/2015 09:17:33	98.7	57.1678	1.2045
1515S_EGM75_S232	CS	SOL	1	27/10/2015 10:08:23	94.4	57.1724	1.3148
1515S_EGM75_S232	CS	EOL	11	27/10/2015 10:18:24	93	57.1702	1.3159
1515S_EGM130_S233	CS	SOL	1	27/10/2015 11:15:43	96.3	57.1735	1.4870
1515S_EGM130_S233	CS	EOL	11	27/10/2015 11:25:46	97.4	57.1706	1.4860
1515S_EGM132_S234	CS	SOL	1	27/10/2015 12:41:05	96.9	57.2830	1.4798
1515S_EGM132_S234	CS	EOL	11	27/10/2015 12:51:10	96.2	57.2800	1.4807
1515S_EGM103_S235	CS	SOL	1	27/10/2015 13:34:08	98.4	57.2547	1.3948
1515S_EGM103_S235	CS	EOL	11	27/10/2015 13:44:17	99.1	57.2518	1.3951
1515S_EGM112_S236	CS	SOL	1	27/10/2015 14:40:07	97.5	57.2838	1.4202
1515S_EGM112_S236	CS	EOL	11	27/10/2015 14:50:15	97.7	57.2810	1.4217
1515S_EGM104_S237	CS	SOL	1	27/10/2015 15:31:40	97	57.3101	1.3888
1515S_EGM104_S237	CS	EOL	11	27/10/2015 15:41:41	97	57.3078	1.3910
1515S_EGM70_S238	CS	SOL	1	27/10/2015 16:36:34	88.3	57.3084	1.2773
1515S_EGM70_S238	CS	EOL	11	27/10/2015 16:46:30	88.4	57.3056	1.2781

Station Name	Gear code	SOL/EOL	Still Number	Date & Time	Water Depth (m)	CS Latitude (USBL)	CS Longitude (USBL)
1515S_EGM61_S239	CS	SOL	1	27/10/2015 17:22:15	90	57.2809	1.2493
1515S_EGM61_S239	CS	EOL	11	27/10/2015 17:32:20	90	57.2788	1.2518
1515S_EGM8_S240	CS	SOL	1	27/10/2015 19:10:02	95	57.2750	0.9113
1515S_EGM8_S240	CS	EOL	11	27/10/2015 19:20:03	95	57.2731	0.9142
1515S_EGM49_S241	CS	SOL	1	27/10/2015 20:45:55	89	57.3339	1.1894
1515S_EGM49_S241	CS	EOL	11	27/10/2015 20:55:55	89	57.3319	1.1916
1515S_EGM78_S242	CS	SOL	1	27/10/2015 21:50:01	88.7	57.3339	1.3054
1515S_EGM78_S242	CS	EOL	11	27/10/2015 22:00:14	89.2	57.3315	1.3061
1515S_EGM87_S243	CS	SOL	1	27/10/2015 22:46:39	91.4	57.3604	1.3334
1515S_EGM87_S243	CS	EOL	11	27/10/2015 22:56:47	91.7	57.3583	1.3366
1515S_EGM79_S244	CS	SOL	1	27/10/2015 23:42:07	88	57.3861	1.3036
1515S_EGM79_S244	CS	EOL	11	27/10/2015 23:52:15	89	57.3837	1.3068
1515S_EGM88_S245	CS	SOL	1	28/10/2015 00:34:21	90.4	57.4128	1.3288
1515S_EGM88_S245	CS	EOL	11	28/10/2015 00:44:28	90.2	57.4095	1.3284
1515S_EGM106_S246	CS	SOL	1	28/10/2015 01:40:48	93.2	57.4151	1.3940
1515S_EGM106_S246	CS	EOL	11	28/10/2015 01:50:47	93	57.4119	1.3929
1515S_EGM125_S247	CS	SOL	1	28/10/2015 02:51:35	93.6	57.4685	1.4407
1515S_EGM125_S247	CS	EOL	11	28/10/2015 03:01:39	93.4	57.4658	1.4437
1515S_EGM144_S248	CS	SOL	1	28/10/2015 03:45:59	90.8	57.4689	1.4997
1515S_EGM144_S248	CS	EOL	11	28/10/2015 03:56:00	90.9	57.4663	1.5025
1515S_EGM136_S249	CS	SOL	1	28/10/2015 04:43:33	92.4	57.4975	1.4717
1515S_EGM136_S249	CS	EOL	11	28/10/2015 04:53:33	92.1	57.4952	1.4708
1515S_EGM62_S327	CS	SOL	1	31/10/2015 20:38:27	87.8	57.3342	1.2547
1515S_EGM62_S327	CS	EOL	12	31/10/2015 20:48:33	88.1	57.3322	1.2520
1515S_EGM142_S328	CS	SOL	1	31/10/2015 22:17:03	93.1	57.2567	1.5168
1515S_EGM142_S328	CS	EOL	11	31/10/2015 22:27:05	95.6	57.2545	1.5137
1515S_EGM129_S329	CS	SOL	1	31/10/2015 23:53:34	97.6	57.1237	1.4942

Station Name	Gear code	SOL/EOL	Still Number	Date & Time	Water Depth (m)	CS Latitude (USBL)	CS Longitude (USBL)
1515S_EGM129_S329	CS	EOL	11	01/11/2015 00:03:31	98.1	57.1208	1.4920
1515S_EGM58_S330	CS	SOL	1	01/11/2015 01:22:29	93.5	57.1163	1.2698
1515S_EGM58_S330	CS	EOL	11	01/11/2015 01:32:26	93.1	57.1151	1.2646
1515S_EGM51_S331	CS	SOL	1	01/11/2015 02:36:17	83.4	57.0346	1.2461
1515S_EGM51_S331	CS	EOL	11	01/11/2015 02:46:16	84.5	57.0336	1.2415
1515S_EGM17_S332	CS	SOL	1	01/11/2015 03:49:32	90.6	57.0867	1.0736
1515S_EGM17_S332	CS	EOL	11	01/11/2015 04:00:16	89.6	57.0855	1.0678
1515S_EGM6_S333	CS	SOL	1	01/11/2015 05:15:00	94.5	57.1649	0.9244
1515S_EGM6_S333	CS	EOL	11	01/11/2015 05:25:06	95.6	57.1638	0.9188