JNCC/Cefas Partnership Report Series

Report No. 30

CEND0719 Survey Report: Monitoring Survey of Greater Haig Fras MCZ

Wood, D., Taylor, J., Sperry, J. & Downie, A.

June 2020

ISSN 2051-6711

CEND0719 Survey Report: Monitoring Survey of Greater Haig Fras MCZ

Wood, D., Taylor, J., Sperry, J. & Downie, A.

June 2020

ISSN 2051-6711

For further information please contact:

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

This report should be cited as:

Wood, D., Taylor, J., Sperry, J. & Downie, A. (2020). CEND0719 Survey Report: Monitoring Survey of Greater Haig Fras MCZ. JNCC/Cefas Partnership Report No. 30. JNCC, Peterborough, ISSN 2051-6711.

JNCC EQA Statement:

This report is compliant with the JNCC **Evidence Quality Assurance Policy.**

Contents

1 Background and Introduction

Marine Conservation Zones (MCZs) are designed to meet conservation objectives under the Marine and Coastal Access Act (2009). These sites will also contribute to an ecologically coherent network of Marine Protected Areas (MPAs) across the North-east Atlantic, as agreed under the Oslo Paris (OSPAR) Convention and other international commitments to which the UK is a signatory.

Under the Marine and Coastal Access Act (2009), Defra is required to provide a report to Parliament every six years that includes an assessment of the degree to which the conservation objectives set for MCZs are being achieved. To fulfil its obligations, Defra has directed the Statutory Nature Conservation Bodies (SNCBs) to carry out a programme of MPA monitoring. The Joint Nature Conservation Committee (JNCC) is the SNCB responsible for nature conservation offshore (between 12nm (22km) and 200nm (370km) from the coast). Where possible, this monitoring will also inform assessment of the status of the wider UK marine environment; for example, assessment of whether Good Environmental Status (GES) has been achieved, as required under Article 11 of the Marine Strategy Framework Directive (MSFD).

The scale and potential cost of monitoring all biodiversity across UK waters necessitated the development of an overarching strategy to ensure that monitoring is prioritised effectively, and robust monitoring data are collected using standardised approaches. This strategy categorised monitoring approaches into three 'types of monitoring' which are described by (Kröger & Johnston, 2016) . Broadly these are defined as: **Sentinel monitoring** of long-term trends **(Type 1)**; **Operational monitoring** of pressure-state relationships **(Type 2)**; and **Investigative monitoring** to determine management needs and effectiveness **(Type 3)**. For further details of these monitoring types see Kröger and Johnston (2016).

JNCC and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) completed an offshore seabed Type 1 monitoring survey of Greater Haig Fras (GHGF) MCZ. The survey was undertaken onboard the Research Vessel (RV) *Cefas Endeavour* between 24 May and 13 June 2019, to acquire data to support monitoring of the designated features of the MCZ. The code for the survey was CEND0719. This report describes the survey activities undertaken. GHGF was identified for MPA monitoring survey effort in 2019 based on discussion between JNCC and Cefas, following application of JNCC Offshore MPA Monitoring Prioritisation Principles (McBreen & O'Connor 2018).

1.1 Site description

GHGF MCZ is located in the Western Channel and Celtic Sea, 12km offshore from the south-west of England (Figure 1). The site contains the Haig Fras rock complex, a geological feature, which is approximately 45km long and 15km wide, running diagonally through the site. GHGF comprises 2,041km^2 of seabed, with a depth range of less than 50m to 200m. The subtidal rocky habitat within this site is designated under the Haig Fras Special Area of Conservation (SAC).

The broadscale sediment habitats surrounding the Haig Fras rocky reef are designated as MCZ habitat Features of Conservation Importance (FOCI) of GHGF (Table 1). The subtidal sediment types include mud and sandy habitats to the south-west of the site, and mixed and coarser sediments located to the north-east of the site. The subtidal mud habitat supports Sea-pen and burrowing megafauna communities and the Norway lobster *Nephrops norvegicus* that have an important functional role as part of the wider burrowing megafauna community. The bioturbating activity of these species aid oxygen penetration deeper into the sediment, releasing nutrients and increasing the structural complexity of the habitat.

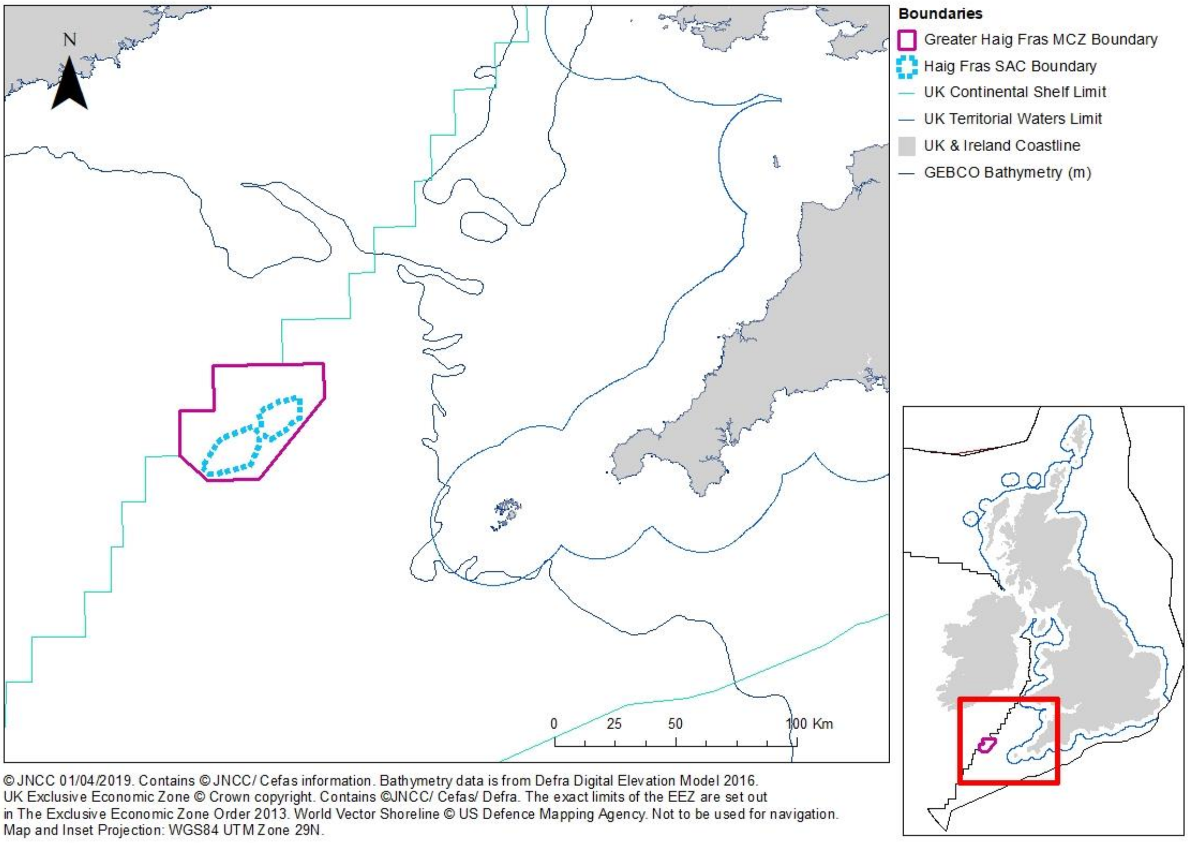


Figure 1. Location of Greater Haig Fras MCZ, selected for survey on CEND0719.

1.2 GHGF Conservation Objectives

The Conservation Objectives (CO) for GHGF MCZ are that the protected features:

- so far as already in favourable condition, remain in such condition; and
- so far as not already in favourable condition, be brought into such condition, and remain in such condition.

With respect to designated Subtidal coarse sediment, Subtidal sand, Subtidal mud, Subtidal mixed sediments and Sea-pen and burrowing megafauna communities Features of Conservation Importance (FOCI) within the MCZ, this means that:

- extent is stable or increasing; and
- structure and function, quality, and the composition of characteristic biological communities (which includes a reference to the diversity and abundance of species forming part of or inhabiting each habitat) are such as to ensure that they remain in a condition which is healthy and not deteriorating.

For more information on this site please refer to JNCC's Site Information Centre: (http://jncc.defra.gov.uk/page-7135http://jncc.defra.gov.uk/page-7135).

Table 1. Designated features of Greater Haig Fras MCZ and associated General Management Approach.

Designated Feature/s	Feature Type	General Management Approach (GMA)
Subtidal coarse sediment (A5.1)	Broadscale habitat	Recover to favourable condition.
Subtidal sand (A5.2)	Broadscale habitat	Recover to favourable condition.
Subtidal mud (A5.3)	Broadscale habitat	Recover to favourable condition
Subtidal mixed sediments (A5.4)	Broadscale habitat	Recover to favourable condition.
Sea-Pen and burrowing megafauna communities	Habitat Feature of Conservation Importance	Recover to favourable condition
Haig Fras rock complex	Geological Feature	Maintain in favourable condition

1.3 Aims and Objectives

The primary aim of this survey was to collect data from GHGF MCZ to inform assessment of the condition of the feature attributes (extent, distribution, structure and function, and supporting processes) of the designated features (sediment habitats, Sea-pens and burrowing megafauna communities). Data acquired from this survey will form the first survey point (T0) in a monitoring series, to enable reporting on change in the designated features over time.

The aims of this survey were developed using all available evidence from the site, including an evaluation of all fishing pressure and proposed management measures, as well as focusing on the feature attributes defined in the statutory advice on conservation objectives (SACOs [1]).

1.3.1 Monitoring Type

Assessment of suitable monitoring type was completed prior to developing survey design. To inform which monitoring types are appropriate, fishing activity data has been used to indicate the extent and intensity of activity over time within the site. Full details on the suitability assessment of different monitoring types can be found within the Monitoring Objective Development Documents created for the site (Taylor & Ferguson, available on request). A summary of this document is given below.

1.3.1.1 Type 2 monitoring

There is no clear gradient of pressure across the site, making it impossible to examine changes in the designated features across space. While there are some areas of intensified effort, these are spatially confined. Furthermore, disparity between predicted habitat maps (UKSeaMap) and habitat mapping derived from acoustic data (CEND1012) results in a poor understanding of the underlying habitat distribution, especially at small spatial scales.

1.3.1.2 Type 3 monitoring

There are very few areas where fishing pressure is at consistent levels in areas within and outside the proposed management boundaries. In areas where consistent pressure is present, the absolute intensity of this pressure is, in most cases, very low (<50 hours per

[1] Links to the SACO's for both sites can be found on the JNCC Site Information Centres for each site (GHFRGHF - http://jncc.defra.gov.uk/page-7135.

year) which will likely preclude detection of any impacts if the pressure is further reduced. In addition, the 0.05 decimal degree (approx. 5.8nm^2) resolution of gridded effort and swept area ratio cannot accurately discriminate where the pressure occurs at small spatial scales, making the design of a robust BACI study at small scales challenging. Disagreement between the predicted habitat map and acoustic and ground truthing data (collected during CEND1012) lower the confidence in the predicted map to the degree that we cannot assume that the substrate will be consistent in areas where BACI stations could be placed.

In areas to the south of the site that could be considered, no suitable and comparable site within proposed management boundaries to the south of the reef complex exist, raising the issue of spatial autocorrelation.

The spatial complexities of pressure, poor understanding of underlying substrate and lack of suitable control sites therefore preclude development of type 3 monitoring at GHGF.
As type 2 and 3 monitoring were not considered suitable, a type 1 monitoring approach was selected for GHGF.

1.3.2 Assumptions

The aims for this survey were developed with the following assumptions in mind:

- Data from this survey will form the first point (T0) in a Sentinel (Type 1) monitoring programme. The MCZ will be revisited in the future to collect data to assess temporal change in the condition of the habitats. Data collected during site verification survey CEND0112 were not collected with the intention for use in MPA monitoring. The survey placed greater emphasis on acoustic survey than physical sampling or imagery, both of which are key to describing the condition of the MPA in line with the conservation objectives. Using site verification data as T0 would result in a comparison of dissimilar and incompatible datasets;
- data from this survey will be used to inform future development of indicators for assessing change in condition and, where possible, determining the implications of any observed changes in the context of the MCZ conservation objectives;
- the level of replication proposed is not based on the response of any metric (due to insufficient data being available to inform an *a priori* power analysis). Rather, the level of replication ultimately required will be reviewed as part of the development of suitable metric(s) and this information will inform future monitoring survey designs applied at this site; and
- the potential for differences in any metric between surveys resulting from seasonal cycles or other natural phenomenon cannot be accounted for with a single spatial survey approach. The assumption is that the site would be revisited at a similar time of year to minimise any changes attributable to seasonal variability.

1.4 GHGF MCZ objectives

Table 2. GHGF monitoring objective 1.

Monitoring Objective 1. Conduct type 1 (sentinel) monitoring of the biological structure and function within the Subtidal coarse sediment, Subtidal mixed sediment, Subtidal mud and Subtidal sand features (hereafter: sediment habitats) associated with the GHGF MCZ.			
Sub-objectives	Rationale/Justification	Hypotheses (to be tested after a second monitoring survey (T1))	Proposed analysis and metrics (if relevant)
1.1. Acquire semi-quantitative epifaunal data using still and video imagery within the sediment habitats of GHGF.	Imagery will allow us to enumerate and identify what epifauna (including key and characteristic epifauna) are present on each **sediment habitat** using non-damaging techniques.	There is no difference/change in epifaunal communities in association with designated habitats within the site between T0 and T1.	Analyses to consider: • Community composition and structure; • Biotope identification; • Abundance/density of species; • Species richness; • Taxonomic distinctness Functional attributes
1.2 Acquire quantitative infaunal data by collecting physical samples from each sediment habitat within GHGF.	Grab sampling will allow us to identify the infauna (present in each sediment habitat and allow quantitative assessments to be carried out.	There is no difference/change in infaunal communities associated with designated habitats within the site between T0 and T1.	Analyses to consider: • Community composition and structure; • Biotope identification; • Abundance of species; • Species richness; • Taxonomic distinctness Diversity indices (e.g. Shannon, Pielou's, Margalef)

Table 3. GHGF monitoring objective 2.

Monitoring Objective 2: Conduct type 1 (sentinel) monitoring of the extent, distribution and physical structure of the sediment habitat features of GHGF.			
Sub-objectives	Rationale/Justification	Hypotheses	Proposed analysis and metrics (if relevant)
2.1 Acquire sediment particle size data across sediment habitat features within GHGF.	Grab sampling will allow us to quantify in detail what sediment type is located where.	There is no difference/change in the broadscale habitats between T0 and T1.	Particle size analysis
2.2 Acquire semi-quantitative data using still and video imagery within the sediment habitat features of GHGF	Imagery will allow us to identify the spatial distribution of each sediment habitat more broadly than grab sampling.	N/A	Analyse distribution of broad scale habitats from video data
2.3 Acquire bathymetry and backscatter data from within nested boxes to enable the production of a higher resolution habitat map for GHGF to determine where possible, the distribution and extent of the designated features.	The current habitat map for GHGF is a predictive habitat map and due to the mosaic nature of the site a higher resolution habitat map is needed to determine extent of the broadscale habitats in the MPA where possible and inform the design of future monitoring.	There is no difference/change to the predicted extent of broadscale habitats in the site.	Production of new habitat map for the nested boxes within GHGF.

Table 4. GHGF monitoring objective 3

Monitoring Objective 3: Collect evidence to improve our understanding of the extent and distribution of the Sea-pen and burrowing megafauna communities within GHGF.			
Sub-objectives	Rationale/Justification	Hypotheses	Proposed analysis and metrics (if relevant)
3.1. Analyse imagery data collected under sub-objective 1.1 for the presence/absence of Sea-pens and burrowing megafauna/burrows.	Acquiring data on SPBMF will improve our understanding of how widely dispersed and where the feature is found within the site, allowing us to better inform and advise on this feature.	N/A	Quantify abundance and density of burrows and Sea-Pens.

Table 5. GHGF monitoring objective 4.

Monitoring Objective 4: conduct type 1 (sentinel) monitoring of the supporting processes relating to the sediment habitat features of GHGF.			
Sub-objectives	Rationale/Justification	Hypotheses	Proposed analysis and metrics (if relevant)
4.1. Acquire CTD and turbidity data within sediment habitat features of GHGF	Quantitative environmental data (e.g. temperature, salinity and turbidity) will improve our understanding of natural, supporting processes at the seabed within the site and form part of critical time series data.	N/A	Supporting processes data will contextualise and support analysis of the data.
4.2 Acquire Ferrybox data continuously during survey			

Table 6. GHGF monitoring objective 5

Monitoring Objective 5: Collect evidence to improve our understanding of the extent and distribution of marine litter and non-indigenous species (NIS) within GHGF.			
Sub-objectives	Rationale/Justification	Hypotheses	Proposed analysis and metrics (if relevant)
5.1. Analyse imagery data and samples collected under objective for the presence litter and NIS.	Acquiring data on litter and NIS will improve our understanding of how widely dispersed and where litter is found within the site, allowing us to better inform and advise on this feature.	N/A	Quantify abundance and extent of marine litter and NIS

2 Survey Objectives

The monitoring objectives described in Table 2 to Table 6 were developed into survey priorities and objectives as outlined below. To aid in decision making whilst on the vessel, the decision tree in Figure 2 was created. Survey activities were broken down into their constituent parts according to priority and logistics for the survey.

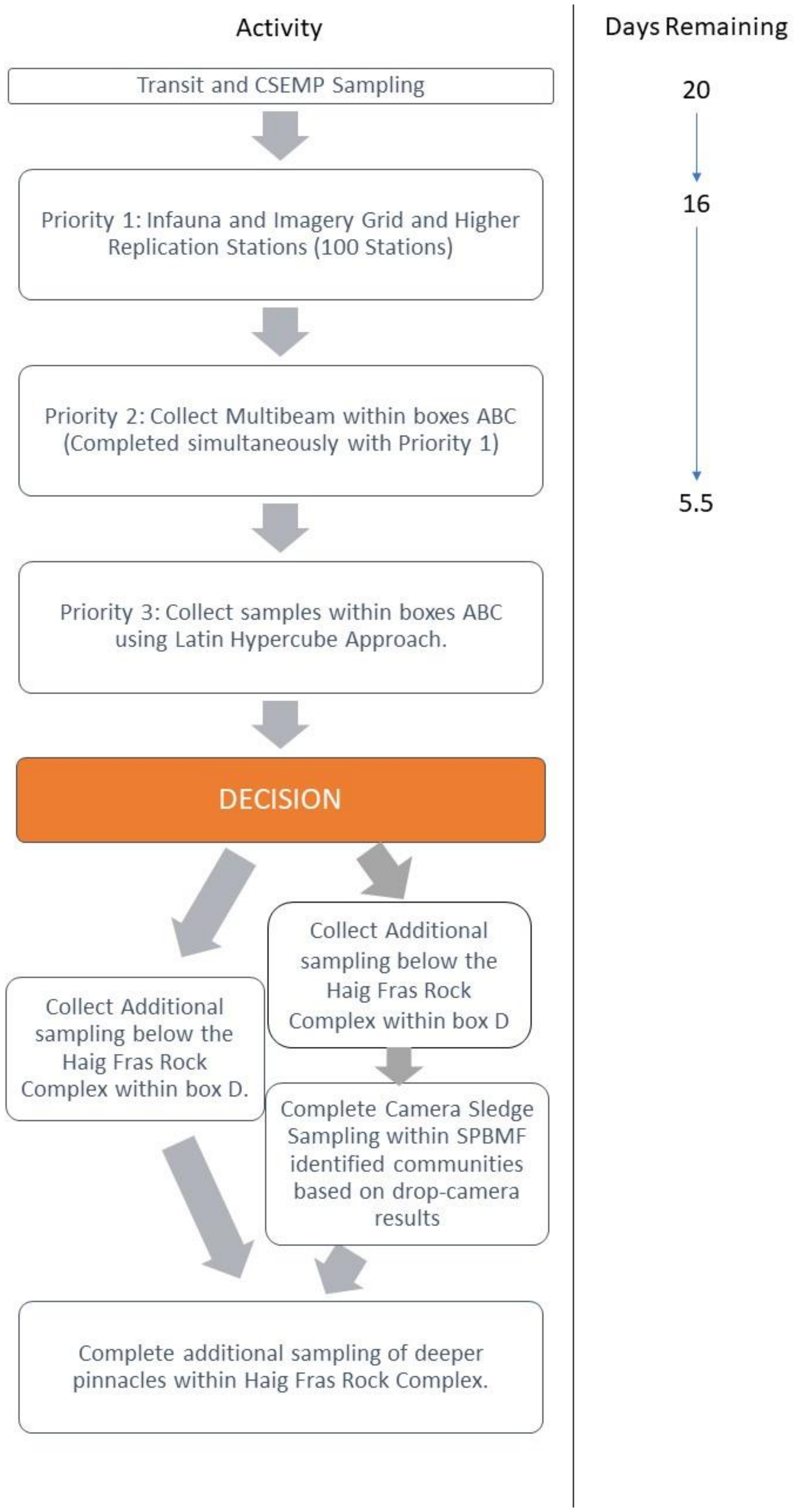


Figure 2. Decision tree for sampling on CEND0719. CSEMP are 5 Day grab samples collected en-route to GHGF site.

2.1 Objective Priorities

1. Collection of imagery, infaunal and particle size data from a regular grid across the site to improve the understanding of biological communities within GHGF. (Objectives 1, 2.1, 2.2 and 3).
2. Collect bathymetry data within nested boxes (A, B & C), increasing multibeam coverage across the site to help improve knowledge of habitats and underpin future monitoring. (Objective 2.3). Boxes were designed using pre-existing bathymetry data for GHGF, to be representative of each depth contour (Figure 3).
3. Increased replication of drop-frame camera transects and grab samples within a selection of stations from a variety of different habitats across the site. Four higher replication stations (5x drop-frame camera replications, 3 x grab stations) were identified pre-survey, one within each broadscale habitat (Figure 3). Additional high replication stations were identified on survey based on data collected, with the aim of increasing the number of higher replication stations within each broadscale habitat if time permitted. (Objectives 1, 2.1, 2.2 and 3).
4. Complete additional grab and camera transects within the acquired multibeam boxes (A, B & C) and an additional box south of the rock complex (Box D). These stations (9 per box) provide added ground truthing of acquired multibeam and created a higher resolution of sampling within the boxes. The station positions were decided on survey using the acquired multibeam. A stratified random 'Latin Hypercube' approach was applied (see Section 3.2 below). (Objectives 1, 2.1, 2.3 and 3).
5. Where 'mini' Hamon grab deployments were invalid (less than 5 l), at the discretion of the SIC/ Shift Leads, samples were retained to support the Natural History Museums Darwin Tree of Life project. (Not linked to a monitoring objective).

2.2 Survey Project Team

The survey team for the duration of the fieldwork included marine scientists, hydrographers and technicians from Cefas and JNCC.

Roles across the 12 hour working shifts were assigned:

Cross-shifts	**Day Shift**	**Night Shift**
Scientist in Charge Data Manager / Hydrographer	Shift lead Benthic ecologist Marine instrument technician Habitat mapper JNCC PoA lead Field scientist	Shift lead Benthic ecologist Marine instrument technician JNCC survey scientist 2 x survey scientists

3 Survey Operations: Design and Methods

The 2019 survey of GHGF was undertaken aboard the RV *Cefas Endeavour*. Details of the vessel and the equipment used are provided in the Appendix 1. A triangular 4km grid of sampling stations and four nested boxes were assigned for survey within the GHGF MCZ (Figure 3). Three of the nested boxes were targeted for collecting full acoustic coverage. Due to the size of the site, a full coverage MBES survey was not feasible within the available time.

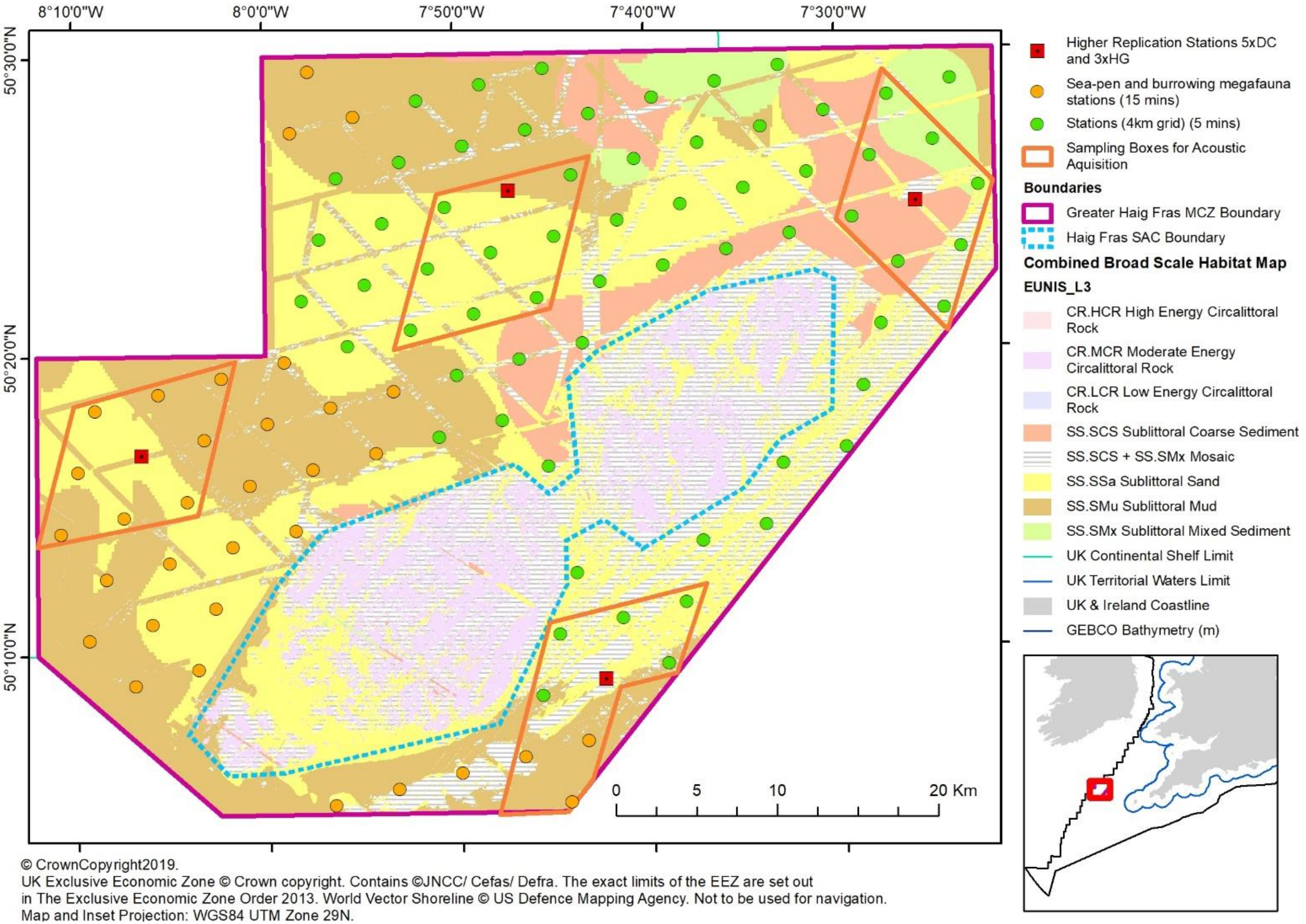
100 stations were plotted on the 4km triangular grid for Objectives 1, 2.1, 2.2 and 3. A camera transect was carried out at each of the 100 gridded stations. The transects were either 5 minutes long or 15 minutes (approximately 50 or 150m respectively) in areas where existing data indicated potential for burrowing megafauna and sea-pens (Objective 3.1). At each station a Hamon grab sample was attempted if the video footage from the camera transect showed suitable seabed. Four of the 100 gridded stations, one within each BSH, were selected for higher replication. At each of these stations an additional four camera transects were carried out and two additional grab samples were taken (where the substrate was suitable (Table 7).

For Monitoring Objective 2.3, three MBES survey boxes (A, B & C) were plotted to the north of Haig Fras SAC (Figure 3). A fourth box (Box D) was plotted south of Haig Fras SAC, using the MBES data from survey CEND0211. The MBES data from the newly acquired Boxes A-C, plus Box D were processed and used to identify nine stations in each box using Latin Hypercube sampling (see section 3.2). The data collected from these Latin Hypercube stations will be used to compare the results of the triangular grid approach against those of the Latin Hypercube stations. These Latin Hypercube stations were each sampled with a camera transect and a single Hamon grab replicate to ensure comparability across the two different approaches. In addition, in order to make the Latin Hypercube camera stations comparable with the gridded stations, transects within Boxes B-D were 5 minutes long, while transects in Box A were 15 minutes long, to match the longer transects taken at the gridded stations in areas of possible burrowing megafauna. The data from the Latin Hypercube stations may also be used to inform Objectives 1, 2.1, 2.2 and 3, depending on the outcomes of the comparison.

Grab samples of <5 litres were processed for DNA samples from infauna and epifauna as time permitted (see section 3.4).

Table 7. Sampling strategy and number of planned stations at Greater Haig Fras MCZ on CEND0719. DC = Drop Camera, HG = mini Hamon Grab. *Note that replicates were planned to be collected from a sub-set of 4 of the 100 gridded stations.

Strategy	No. of stations	Samples to be collected
Gridded Stations	66	DC x 5 mins, HG
Gridded Stations – Burrowing megafauna	34	DC x 15 mins, HG
Gridded Stations – Replicates*	4	4 x DC x 5 minutes, 2 x HG
Latin Hypercube sampling	36	DC x 5 mins in Boxes C-D, 15 mins in Box A.



Map and Inset Projection: WGS84 UTM Zone 29N.

Figure 3. 4km triangular grid, plus the four nested boxes at Greater Haig Fras MCZ.

3.1 Acoustic data acquisition

Multibeam echosounder data (bathymetry and backscatter) were acquired within the predefined survey boxes to provide information about seabed depth and to distinguish between hard and softer substrata. Two cross-lines were acquired from each box to verify tidal corrections made during processing. Data were also used to infer habitat in the boxes. A conductivity, temperature, depth (CTD) probe was deployed at each MBES survey box and a sound velocity profile (SVP) generated for use with the MBES acquisition software. Full details of the MBES survey will be provided in a separate report (Sperry 2019).

3.2 Acoustic Data Interpretation

Following the collection and a rapid initial processing of the MBES data, bathymetry and backscatter intensity values were exported as geotiffs at 2m grid resolution and imported into QGIS (v.3.2). Bathymetry was resampled to a 5m grid. Bathymetry and backscatter for Box D were extracted from the existing CEND0211 data. The seabed in Boxes B and C was very low relief, and consequently artefacts and edge effects were more prominent than in Boxes A and D. Hence, the mesh denoise tool was used on Boxes B and C before calculation of topographic derivatives. Bathymetric rugosity, relative slope position (location on a topographic elevation ranging from 0 at the bottom of a slope to 1 at the top of a slope) and valley depth (depth relative to local elevated topography, indicating likely locations for sediment accumulation) were calculated for all boxes using the SAGA terrain tools in QGIS.

Each box was segmented into patches with similar backscatter and relative slope position (RSP) values using the GRASS *i.segment* tool in QGIS with a difference threshold of 0.25 and the minimum segment size of 10 pixels. The raster segments were converted to polygons and the mean and standard deviation calculated for bathymetry, backscatter and relative slope position values within each segment. Each image object, with associated environmental data, represent an environmentally coherent segment of the sea floor. The object centroids, therefore, form the ‘sampling population’ of possible sample locations. The *Pole of inaccessibility* tool in QGIS was used to find the object centroid, defined as the point in each polygon that is furthest away from the polygon edge.Segments large enough to contain a 50m radius bullring around their centroid were selected to form the source population of potential sampling locations.

A table containing the centre point coordinates and mean bathymetry, backscatter and RSP values of each selected segment in each box were imported into R. Nine sampling locations representative of the environmental conditions were selected in each box using conditioned Latin hypercube sampling (cLHS). Latin hypercube is a stratified random procedure that provides an efficient way of sampling variables from their multivariate distributions and is most commonly used in terrestrial soil sampling. Samples are selected from the available sample population to provide a full coverage of the range of each target variable by maximally stratifying the marginal distribution (Minasny & McBratney 2006). The variables chosen to represent desired environmental gradients were backscatter intensity and RSP. Bathymetry was excluded as the bathymetric range within each box was only approximately 10m. The placement of the boxes across the bathymetric gradient ensured coverage over the entire site. The X and Y coordinates were included as variables to ensure even geographical coverage over each box.

3.3 Environmental data acquisition

3.3.1 Seabed imagery

Seabed imagery was acquired for assessment of the benthic epifaunal communities, with a drop camera system deployed at all stations. High definition video footage and digital still images were captured during each drop camera deployment. Sensors logging bottom temperature, altitude, bearing and depth were recording data for the duration of the tow. At stations where the habitat type was highly variable the length of tow was extended beyond 5 minutes to ensure a suitable number of usable still images were collected. The extension of tows was also applied if there were sections of very poor visibility. The 15 minute tows were not extended as these were typically the same habitat type.

3.3.2 Grab sampling

A 0.1m^2 mini-Hamon grab was used in preference to a 0.25m^2 Hamon grab following recommendations outlined in Boyd *et al.* (2006). Sample stations that had the potential to be suitable for collection of grab samples were identified from the 4km grid. Additional potential stations were added based on the newly acquired MBES data. The video data from the drop camera were examined to check for the likelihood of a successful grab. At some stations the video data showed both rock or very coarse material and sediment was present. In these cases, the grabs were targeted at areas of sediment within the 50m bullring. Grabs were not attempted at stations where the video data indicated the station was predominantly rock or very coarse material (Figure 5). Three grab attempts were made at each station before moving on to the next station.

3.3.3 Physical environmental parameters

An ESM2 logger was attached to the drop camera frame to record turbidity data. These were collected to help identify images that were likely to be unusable due to high levels of turbidity.

The RV *Cefas Endeavour's* ‘ferrybox’ is an underway continuous logging system and was operated throughout CEND0719. The instrument measures the surface values of those same parameters recorded using the ESM2 logger, with an additional sensor measuring variable fluorescence (a measure of phytoplankton photosynthetic efficiency). These data will provide high quality physical parameters to relate to various benthic observations. These data will also be used to supplement Cefas's shelf sea modelling activities.

3.3.4 Water sample processing

As with most, if not all, *in-situ* instrumentation, data need to be validated and the equipment calibrated to ensure robust datasets. Discrete water samples were collected using the continuous flow ‘ferrybox’ system for salinity, oxygen, suspended particulate matter (SPM) and chlorophyll.

Chlorophyll samples were collected by syphoning off water into a high-density polypropylene sample bottle and 250ml of sample was then filtered through a glass fibre filter. The filters were then folded in half and wrapped in foil and stored at -80^{o}C. Samples were taken every few hours over the tidal cycle to observe the full range of conditions experienced at the site.

3.4 DNA sampling

Specimens for DNA analysis were collected from grab samples that were too small for the main sampling objectives and as time permitted. The grab sample was passed through a 1mm mesh sieve. Fauna >1mm were removed and transferred in sea water into the microscope annex on the *RV Cefas Endeavour*. A 10mm section of each specimen was placed into a cryovial and preserved in 2ml of ethanol. The samples were stored at -80°C. The rest of the specimen was placed in a glass bottle and preserved in 4% formalin at room temperature. The samples pairs will be used for DNA analysis and to identify the animals respectively. Tools were sterilised in 10% lab disinfectant and then rinsed in ethanol.

4 Survey Narrative

All times are GMT. Survey equipment and consumables were mobilised in advance of sailing.

Saturday 25 May 2019: A vessel induction and familiarisation induction was held at 09:30 for staff who had not had one in the previous six months. All staff were onboard by 11:30. The Master gave a safety talk to all staff at 11:40. This was followed by a scientific briefing to all scientists and engineers. The vessel departed Lowestoft at 12:30 and headed for Lyme Bay.

Sunday 26 May: The vessel arrived at CSEMP station East536_238 at approximately 09:30. The vessel held position to allow an Abandon Ship Drill to take place at 10:15. A toolbox talk was held at 11:20 for day shift scientists and prior to the Day grabbing operations. Day grab attempts were made at five stations. Stations East536_238 and East536_225 were unsuccessful. Good samples were collected at stations 536_213 and 536. The vessel left Lyme Bay at approximately 18:00 and transited to GHGF.

Monday 27 May: The vessel reached the boundary of GHGF at approximately 11:00. The first action was to find the wreck of *Ben Vrackie*. A search for the wreck was carried out for approximately 3 hours at the coordinates provided by Historic England, however, the wreck was not found. Instead a rock pinnacle was used to calibrate the MBES. A CTD drop for Sound Velocity Profile (SVP) was made at 15:57. Calibration lines were run over the pinnacle and the MBES calibrated accordingly. MBES survey lines of Box B began (Survey Objective 2) at 18:37 and continued throughout the night. A brief software crash at 23:45 resulted in small gap in the data that would be in-filled later.

Tuesday 28 May: MBES lines continued until 06:06 before the vessel headed for station GHF_055. A toolbox safety talk for night shift was held at 07:10 before camera and grab operations began at 07:50 (Survey Objectives 1 and 3). A second toolbox talk was held on the deck for dayshift at the start of their shift. Camera and grab operations then continued while new scientists were trained in their different tasks.

Wednesday 29 May: The MBES survey of Box A was started with an SVP drop at 02:33 (Survey Objective 2). MBES survey was carried out for the rest of the day. The MBES software crashed at 23:01 during a line but was restarted immediately resulting in minimal delay to the start of the next line at 23:14. No in-fill was required.

Thursday 30 May: The MBES surveying continued (Survey Objective 2). An SVP drop was carried out at 02:57 before the survey resumed. Line A25 had to be restarted at 07:29 to make way for a fishing vessel. Line A02X was also paused briefly to make way for another fishing vessel. However, the line was restarted with no loss of data. Box A was completed including 2 cross-lines at 14:05. Drop camera and grabbing operations then resumed on the main station grid (Survey Objectives 1 and 3). Four camera stations were re-run due to poor focusing on the stills camera on Tuesday/Wednesday. The Dynamic Positioning System cut out twice due to a loss of GPS signal. On both occasions the system was quickly restored with only minimal time lost. The safety toolbox talk was revised for both shifts in case the issue arose again.

Friday 31 May: Drop camera and Hamon grab operations continued throughout the day (Survey Objectives 1 and 3). The camera system crashed on station GHF_079 but was quickly restarted. The camera system crashed again at 03:55. Station GHF_096 was abandoned 5 minutes into the 15 minute camera tow due to very poor visibility. A good grab sample was however collected. This station was re-visited later in the survey.

Saturday 1 June 2019: Camera and grab operations continued until 08:18 (Survey Objectives 1 and 3). An SVP drop was made at 08:55 before the remaining MBES operations resumed in Box B at 09:27 for the rest of the day (Objective 2.3). As a precaution, the topside computer on the drop camera was swapped over and all connections cleaned and re-greased in case of water ingress.

Sunday 2 June: The MBES survey of Box B was completed at 06:44 including the infill line from the MBES software crash earlier in the survey (Survey Objective 2). Camera and grab operations then resumed on the main grid (Survey Objectives 1 and 3) initially working in north-south lines. These were swapped to an east-west running order due to incoming gale force 8 winds. While this route was slower in terms of transit time, it allowed work to continue in the poor weather.

Monday 3 June: Camera and grab operations continued until Box C was reached. An SVP drop was made at 04:19, before the MBES survey of Box C started at 04:38 (Survey Objective 2). The survey lines were run on a 220° bearing. This was to avoid strong winds and a large south-westly swell. A toolbox discussion was held at 10:00 to brief staff on actions to be taken in the event of migrant boats being found in the channel.

Tuesday 4 June: An SVP drop was made at 07:20. MBES survey continued until 18:17, marking the completion of Survey Objective 2. Camera and grab operations continued on the main grid (Survey Objectives 1 and 3).

Wednesday 5 June: The camera and grab survey continued on the main grid (Survey Objectives 1 and 3). Meanwhile the MBES data were processed before being entered into the Latin Hypercube model Survey Objectives 2 and 4.

Thursday 6 June: 2.5 hours of downtime were recorded when the drop camera lost connection to the folder where still images were saved (Survey Objectives 1 and 3). The fault appears to have been related to the large file size of the raw images causing problems when downloading from the camera to the computer onboard. The problem was resolved by downloading in batches. The first of the Latin hypercube stations were started at 20:34 (Survey Objective 4).

Friday 7 June: An additional 15 stations were selected for higher replication imagery (four additional 5 minute camera tows per station), at stations noted to have high broadscale habitat variability, on review of the still images from the completed camera tows. Camera and grabbing operations continued throughout the day collecting data at the Latin hypercube stations and replicate stations (Survey Objectives 3 and 4). Station GHF_096 was re-run at 14:24 marking the completion of Survey Objective 1. Strong winds from Storm Miguel stopped work at 22:00.

Saturday 8 June: Work resumed at 04:45 once winds had dropped. The Latin hypercube stations in Box B were completed at 08:52 (Survey Objective 4). The final replicate station (GHF_061) was completed at 22:46 marking the end of Survey Objective 3.

Sunday 9 June: Drop and grab sampling continued at the Latin hypercube stations until 16:55. This marked completion of all five survey objectives.

The minimal downtime meant there was time available for additional work. Two new boxes were planned for MBES – Box E and Box F. A subset of Pinnacle stations was also selected on the Haig Fras SAC. Two of the Pinnacle stations were sampled with drop camera transects en-route to Box E. An SVP drop was made at 20:19 before MBES lines were run for the rest of the day.

Monday 10 June: The MBES survey of Box E continued until all lines and a cross line had been run. An SVP drop was made at 10:00. The Pinnacle stations were resumed at 21:40.

Tuesday 11 June: The last Pinnacle station camera transect was run at 04:07. The SVP was deployed at 04:54. The vessel then attempted to run MBES lines in Box F. Gale force 8 winds however, slowed progress and meant lines had to be run in a south to north direction only, rather than a more efficient east-west direction.

Wednesday 12 June: The MBES survey of Box F continued until midnight. Progress was slowed by strong winds and a rough sea state. The sea state reduced after midday and MBES lines were resumed in both directions. The final line ended at 19:17. The vessel began the transit to Falmouth.

Thursday 13 June: The vessel docked at approximately 14:00.

Friday 14 June: Scientists left the vessel at 08:30 marking the end of the survey.

A summary of survey operation time is presented in Appendix 2. The survey metadata are presented as in Appendix 3 and the acoustic data, video footage and still images collected are summarised in below.

5 Data Acquisition

All survey objectives were completed as planned. Despite the exposed location of GHGF with no shelter from any direction, time lost to weather was only seven hours. Most of the predicted adverse weather did not arrive at the survey site, instead heading off to Ireland or the east of Britain. In addition, equipment downtime was minimal, with only 2.5 hours lost due to problems with the drop camera. The camera sledge was not deployed on the survey. Firstly, because the footage from the drop camera were sufficient to detect burrowing megafauna and secondly because of the time required to set up the camera sledge.

All planned stations in the triangular grid were sampled (Figure 4, Figure 5 and Table 8). The sub-sample of four replicate stations from the triangular grid were sampled. An additional 16 stations were also sampled for replicates (Figure 4) due to the additional available time. All Latin hypercube stations were sampled (Figure 6 and Table 8). In addition to the planned work, drop-frame camera transects were completed at 9 stations within the Haig Fras SAC rock complex. These stations were placed to better characterise the fauna living on the steep pinnacle structures of the reef.

Acoustic data from MBES were successfully collected in the three planned boxes. In addition, data were collected from a further two boxes (Figure 7). The camera survey at stations to the north west of the Haig Fras SAC revealed the presence of rocky seabed. MBES Box E was positioned to collect data that would help better understand the distribution of this rock. The camera and grab stations between MBES Boxes B and C confirmed a complex matrix of substrates. MBES Box F was positioned to help better understand the distribution of BSHs in this area.

DNA samples were taken at five stations (see Table 13 in Appendix).

Table 8. Camera transects and grab samples collected at Greater Haig Fras MCZ on CEND0719. DC = Drop camera, HG = Hamon grab. *Note that replicate stations were in addition to the sampling at each station as part of the 100 grid.

Strategy	Activity	Survey Priority	Stations Planned	Stations Achieved	DC transects	HG Samples
Gridded Stations	Drop-camera and Hamon Grab	1	100	100	199*	101*
Latin Hypercube sampling	Drop-camera (5 min) and Hamon Grab	4	36	36	36	33
Pinnacle Sampling at HF SAC	Drop-camera (10 min)	N/A	N/A	9	9	N/A
Totals				**145**	**244**	**134**

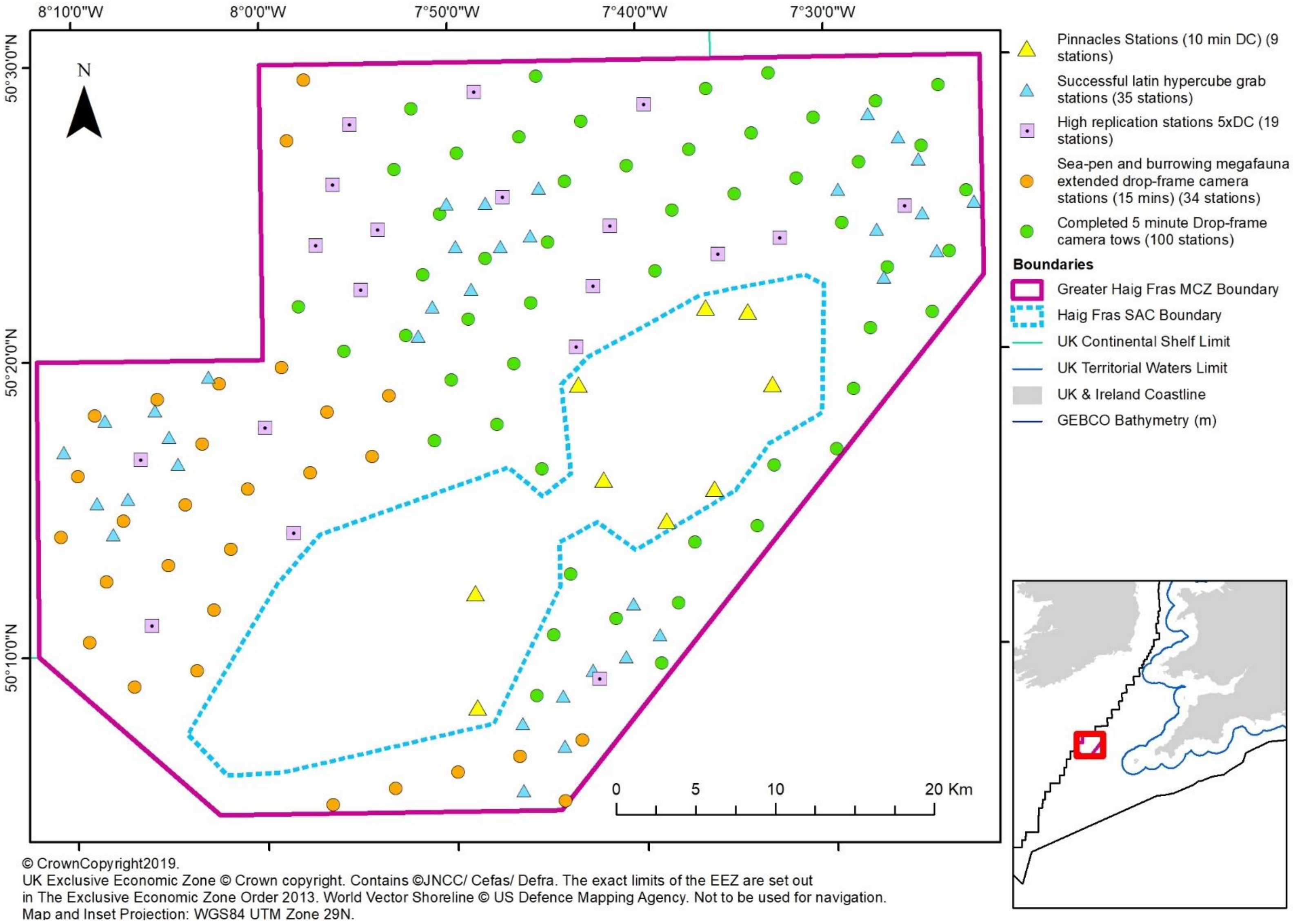


Figure 4. Imagery data acquired within Greater Haig Fras MCZ during CEND0719.

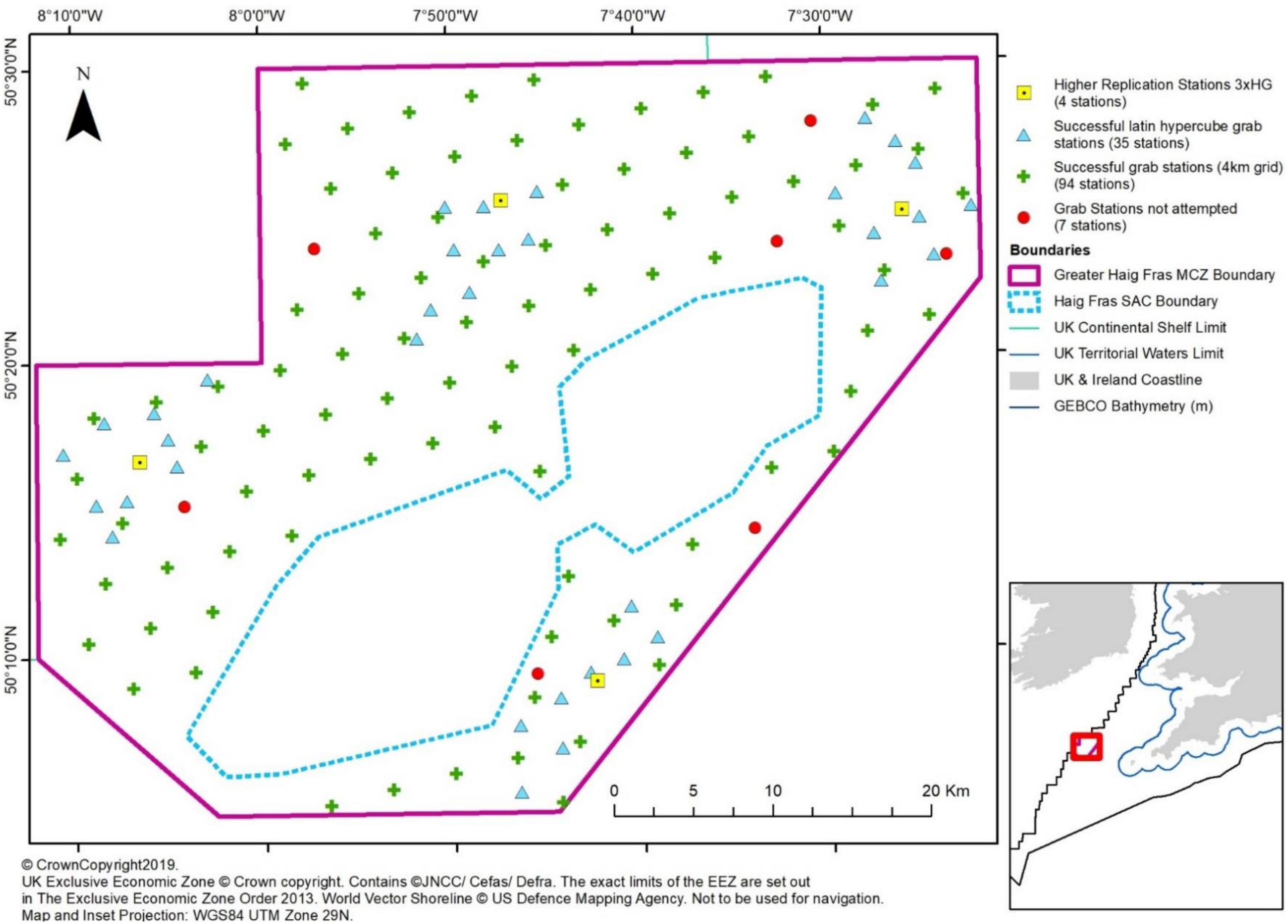


Figure 5. Infaunal samples acquired within Greater Haig Fras during CEND0719 using 0.1m^2 Hamon grab. Stations were not attempted where the video data showed unsuitable seabed.

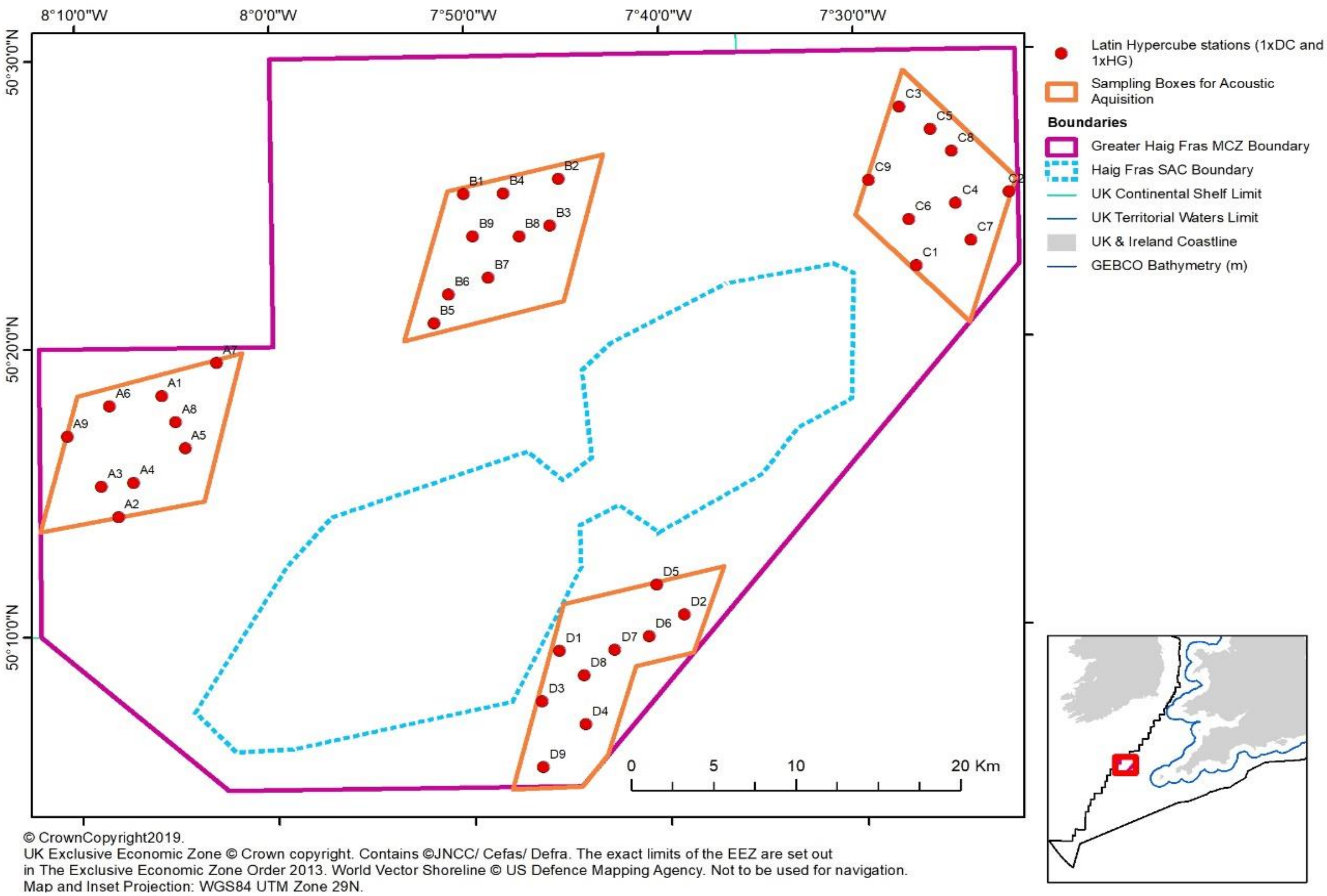
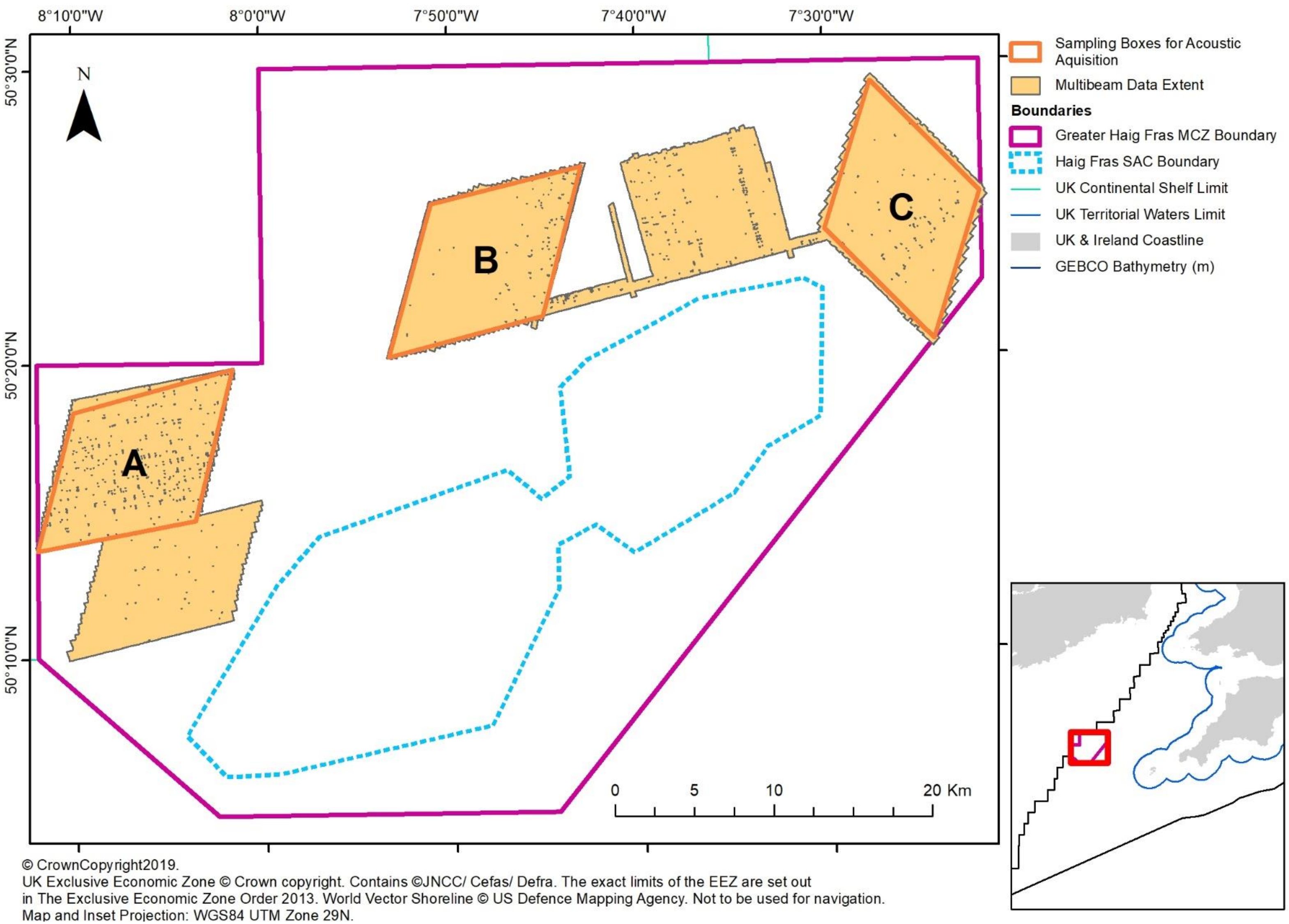


Figure 6. Latin Hypercube Stations sampled for imagery and grabs within Greater Haig Fras MCZ on CEND0719.



Map and Inset Projection: WGS84 UTM Zone 29N.

Figure 7. Multibeam data acquired within Greater Haig Fras MCZ on CEND0719.

6 Health and Safety and Ships Drills

Table 9. Safety drills and toolbox talks. All times in GMT.

Drill	Date	Time	Staff
Vessel Induction	25/05/2019	09:30	7 x new staff
Master's Safety Talk	25/05/2019	11:40	All staff
Toolbox talk – Day grab and Hamon grab	25/05/2019	11:20	Day Shift
Toolbox talk – drop camera and Hamon grab	28/05/2019	07:10	Night Shift
Toolbox talk – drop camera and Hamon grab	28/05/2019	10:00	Day Shift
Migrants in Channel	3/06/2019	10:00	All staff

7 References

Boyd, S.E., Barry, J. & Nicholson, M. 2006. A comparative study of a $0.1m^2$ and $0.25m^2$ Hamon grab for sampling macrobenthic fauna from offshore marine gravels. Journal of the Marine Biological Association of the United Kingdom.

Hinchen, H. 2014. *Review of marine biodiversity assessment obligations in the UK.* JNCC Report No. 497 Part 1, JNCC, Peterborough, ISSN 0963-8091.

Kröger, K. & Johnston, C. 2016. *The UK marine biodiversity monitoring strategy v4.1.* [Online]
Available at: http://jncc.defra.gov.uk/pdf/Marine_Monitoring_Strategy_ver.4.1.pdf.

McBreen, F., Jesus, A., Camplin, M., Clark, L., Edwards, H., Pirie, C., James, B., Young, M., Steel, L., Johnston, C. & Hawkridge, J. 2016. *A review of monitoring and assessment of seabed habitats in UK Inshore Marine Protected Areas, 1999 - 2013.* JNCC Report No. 540, JNCC, Peterborough, ISSN 0963-8091.

McBreen, F. & O'Connor, J. 2018. Prioritisation for seabed habitat surveys of offshore MPAs in 2019-20 and beyond. *available on request,* Issue Version 1.1.

Minasny, B. & McBratney, A.B. 2006. A conditioned Latin hypercube method for sampling in the presence of ancillary information. *Computers and Geosciences .*

Sperry, J. 2019. CEND0719 - Greater Haig Fras MCZ - MBES Report of the Survey.

Taylor, J. & Ferguson, M. Available on request. *Monitoring Objective Development Document for Greater Haig Fras MPA,* s.l.: JNCC.

8 List of Abbreviations

BSH	Broadscale Habitats
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CP2	Charting Progress 2
CHP	Civil Hydrography Programme
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EUNIS	European Nature Information System
FOCI	Feature of Conservation Interest
GES	Good Environmental Status
GMA	General Management Approach
IFCA	Inshore Fisheries and Conservation Authority
JNCC	Joint Nature Conservation Committee
NMBAQC	North East Atlantic Marine Biological Analytical Quality Control Scheme
MBES	Multibeam echosounder
MCZ	Marine Conservation Zone
MPA	Marine Protected Area
MPAG	Marine Protected Areas Group
MSFD	Marine Strategy Framework Directive
NE	Natural England
NIS	Non-Indigenous Species
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PSA	Particle Size Analysis
PSD	Particle Size Distribution
RV	Research Vessel
SAC	Special Area of Conservation
SNCB	Statutory Nature Conservation Body
SOCI	Species of Conservation Interest
SVP	Sound Velocity Profile
SSS	Side-scan sonar

9 Appendices

Appendix 1. Vessel and equipment used

RV Cefas Endeavour

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

MMSI	235005270
Lloyds/IMO number	9251107
Side Gantry	7.5 tonne articulated side A-frame
Stern Gantry	25 tonne stern A-frame
Winches	3 x cranes 35tM, heave compensated 2 x trawl winches 2 x drum winches, (1 double) Double barrel survey winch with motion compensation and slip rings Double barrel survey winch with slip rings Double barrel towing winch with slip rings Side-scan sonar winch with slip rings 3 x Gilson winches (one fitted to stern A-frame)
Transducers/Sea tube	Drop keel to deploy transducers outside the hull boundary layer in addition to hull mounted transducers 1.2m diameter sea tube/moon-pool
Acoustic equipment	Kongsberg Simrad: HiPAP 500 positioning sonar EK60, 38/120kHz scientific sounder EA 600, 50/200kHz scientific sounder Scanmar net mensuration system SH80 high frequency omni-directional sonar EM3002 swathe bathymetry sounder Hull mounted Scanmar fishing computer transducers
Boats	2 x 8m rigid work and rescue boats with suite of navigational equipment deployed on heave-compensated davits
Laboratories	8 networked laboratories designed for optimum flexibility of purpose 4 serviced deck locations for containerised laboratories
Special features	Dynamic positioning system Intering anti-roll system Local Area Network with scientific data management system Ship-wide general information system CCTV
Class	LRS 100A1+LMC UMS SCM CCS ICC IP ES(2) DP(CM) ICE class 2

Acoustic equipment

Data were collected using a Kongsberg EM2040 multi beam echo sounder (MBES), SBG motion reference unit (MRU) and CNAV 3050 high precision GPS. Bathymetry data were processed using CARIS HIPS and backscatter data were produced with the QPS FMGT software package.

Variations of sound velocity with water depth were determined using a SAIV conductivity, temperature, depth (CTD) probe with a sound velocity profile (SVP) measurement taken at least once every 24h when collecting MBES data; acquired SVP data were applied during multibeam data acquisition.

STR SeaSpyder “Telemetry” drop camera system

- Telemetry Operation over fibre optic cable
- 1080p high definition video camera
- 720p forward facing video camera
- 18 mega pixels underwater digital stills camera
- High power camera flash
- 20W high intensity led lights x 6 (2 forward facing)
- Dual scaling subsea lasers x 2 (spaced at 250mm)

- Dual line lasers with 50cm spacing
- 250kHz precision altimeter
- Combined compass and depth
- Temperature sensor
- Ultra-short base length positioning beacon

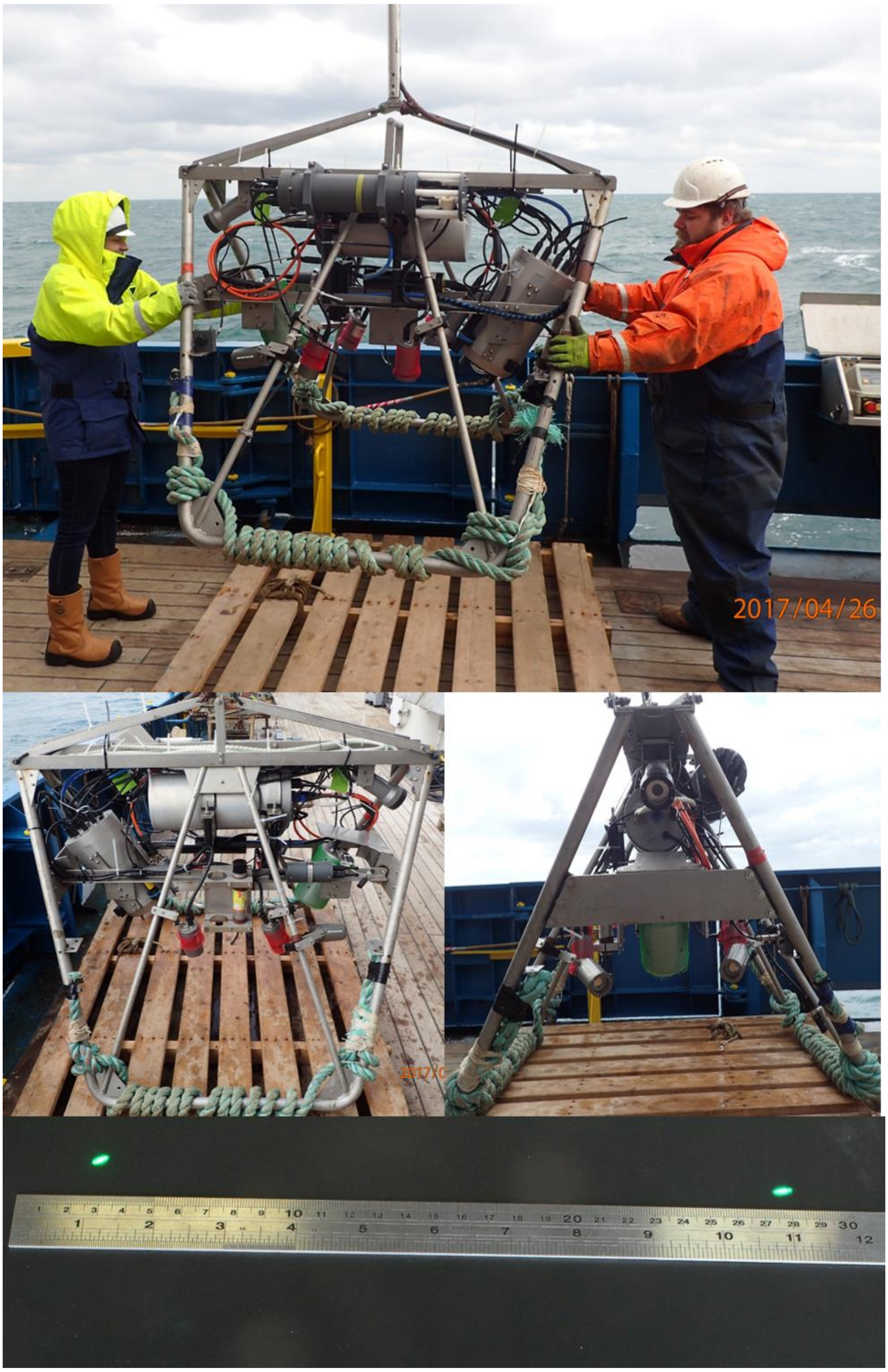


Figure 8. Drop frame mounted camera system with ESM2 logger and scaling lasers.

Video and digital still imagery was acquired using a STR SeaSpyder “Telemetry” drop camera system. Set-up and operation followed the MESH ‘Recommended Operating Guidelines (ROG) for underwater video and photographic imaging techniques’ (Coggan *et al*. 2007).

High definition footage for semi-quantitative assessment of the benthos (with scaling lasers and dedicated lighting) was acquired, using the downward facing camera, along predefined transects of approximately five or 15 minutes. Speed over ground of the survey vessel was maintained at 0.3 knots for the duration of the tow.

Still images were captured; at 15 second intervals at around 1m distance from the seabed; when appropriate to ensure availability of high-quality images for later epifauna identification.

The side gantry position was used for recording drop camera deployments. The position calculated by the ships High Precision Acoustic Positioning (HiPAP) system is considered more accurate than that of the deployment/steer point gantry. However, the USBL beacon attached to the drop camera frame may fail during a tow due to shadowing effects of the vessel hull and turbulence/water bodies. If this is the case the steer point gantry is considered accurate to within an area calculated using the winch cable out and actual water depth values.

To aid scaling the drop frame was fitted with a pair of spot lasers and a pair of line lasers. The spot lasers were positioned so that the spots were 250mm apart. The line lasers ran vertically along the sides of the video footage and were spaced 500mm apart at a height of 1m.

Positional fixes were taken, for both the side gantry steer point and the position derived from HiPAP, continuously at five second intervals throughout the tow. This allows the position of the camera system above the seabed to be plotted. Still images can be geo-referenced by matching the time stamp of each image to the nearest fix taken (steer point or HiPAP position as appropriate).

Video images were recorded simultaneously onto the local drives of two computers, the files renamed and copied onto the ships network. A video overlay was used to provide station metadata, time and position (of the GPS antenna) in the recorded video image. Field notes were made during each camera deployment, noting station and sample metadata, real-time observations of substrate and taxa, an initial assessment of the range of Broad Scale Habitats (BSHs) seen and the general quality of the imagery.

The internal clock of the camera used on the sledge was synchronised with GPS time to within one second. This clock creates a timestamp in the EXIF data stored in the digital image which is used to match the image to the positional reference. Positional fixes were taken, for both the stern gantry steer point and the position derived from HiPAP, continuously at five second intervals throughout the tow. This allows the position of the camera system on the seabed to be visualised. Still images can be geo-referenced by matching the time stamp of each image to the nearest fix taken (steer point or HiPAP position as appropriate).

Positioning Software and Offsets

Vessel offsets are defined from the pitch roll centre of the vessel i.e. the Central Reference Point (CRP) is used by the Tower CEMAP software to calculate offsets to deployment gantry.

GPS fixes were recorded using the Tower Navigation system on RV *Cefas Endeavour*. This records the positional coordinates of the gantry from which the sampling equipment is being deployed, automatically compensating for the offset between these gantries and the GPS antenna, as well as the corrected position provided by the Ultra-Short Base Length HiPAP beacon, when in use.

The vessel offsets used to calculate a more accurate position for equipment deployed from the RV *Cefas Endeavour* are shown for the stern gantry, side gantry, and HiPAP (Figure 9 to Figure 11).

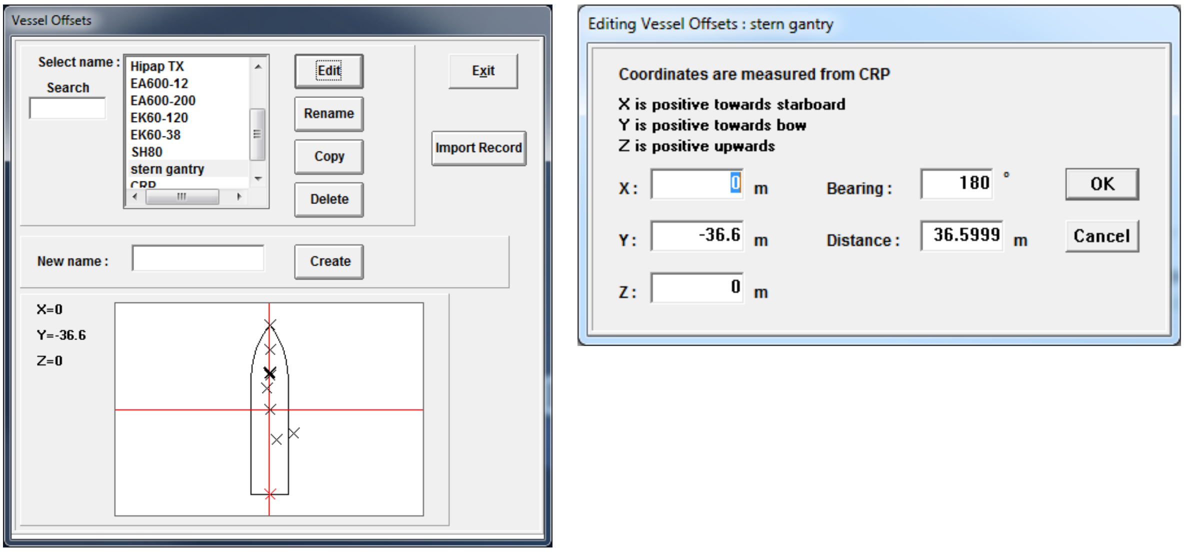


Figure 9. Stern Gantry vessel offsets in the Tower Navigation system.

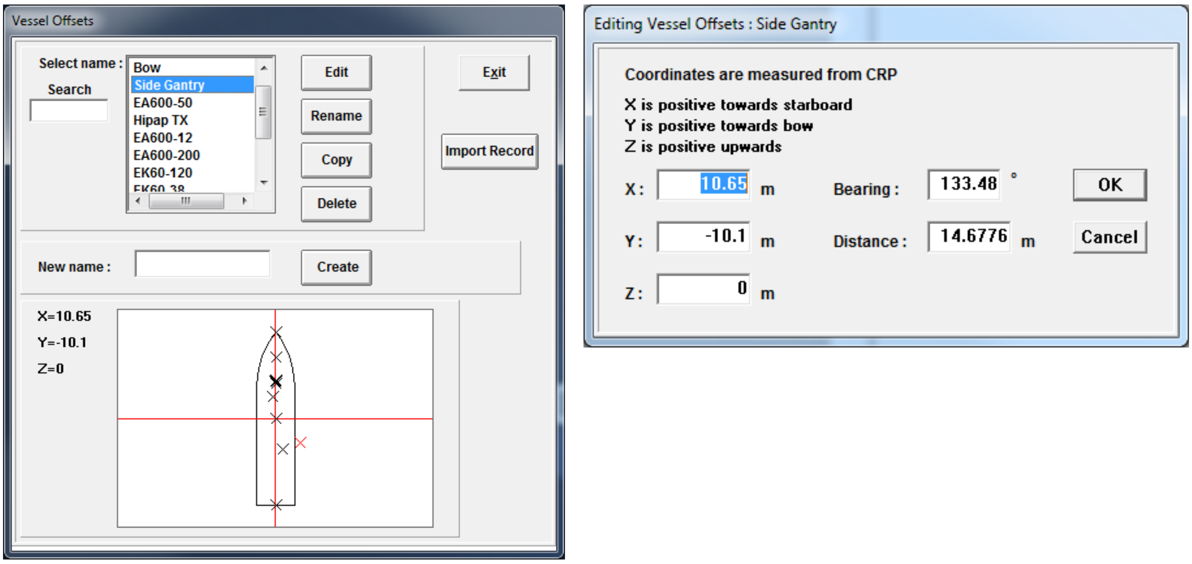


Figure 10. Side Gantry vessel offsets in the Tower Navigation system.

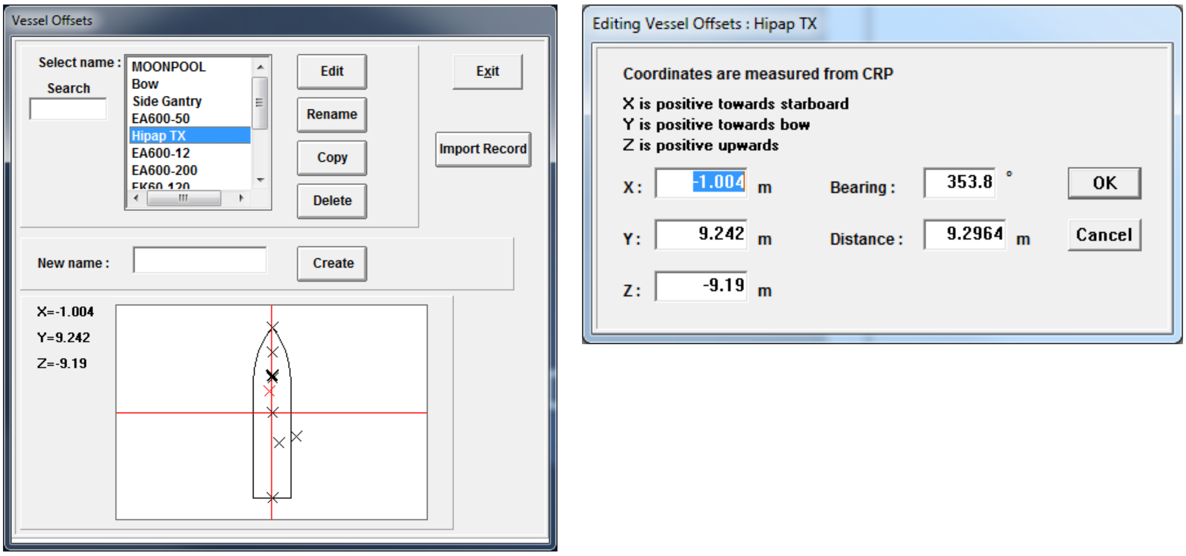


Figure 11. HiPap vessel offsets in the Tower Navigation system.

Appendix 2. Summary of survey operation time

Table 10. Breakdown of survey operations.

Action	Cumulative Time (hours)	Remarks
Mob/Demob	00:00	
Offshore Calibration	03:30	Excludes searching for wreck
Total Operational Acoustic Survey	167:10	
Total Operational Sampling	215:07	
Equipment Downtime	02:30	Drop camera file error
Waiting on Weather	06:58	
Transit	62:15	
Total	457:30	

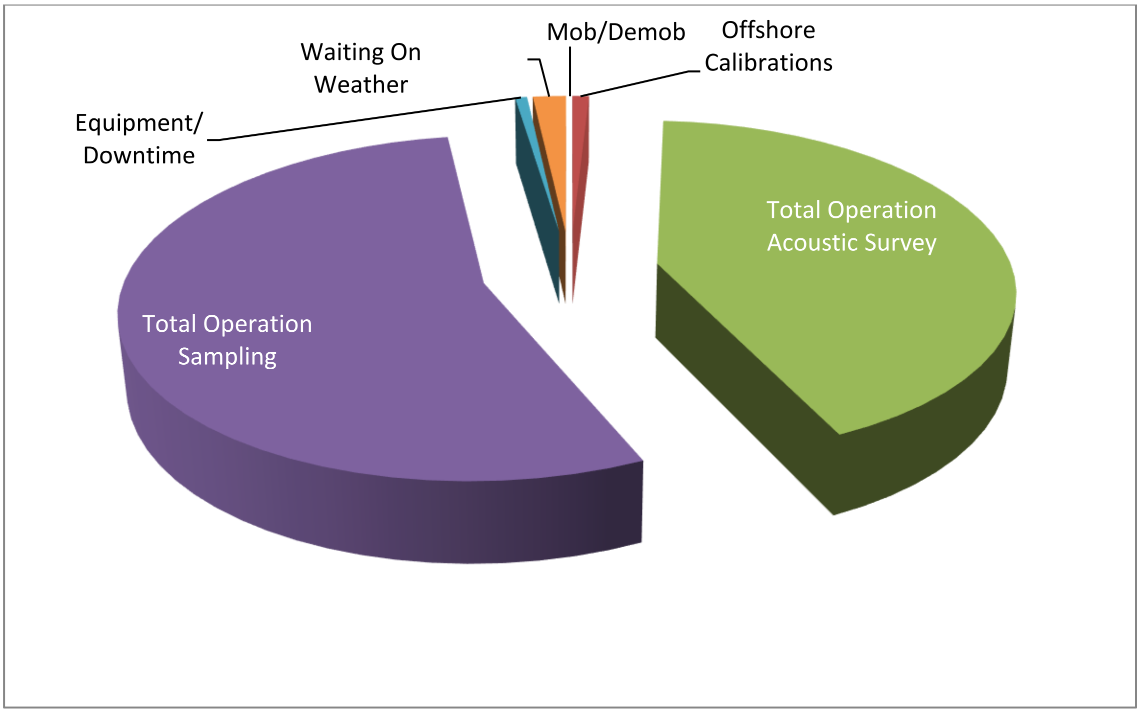


Figure 12. Summary of operations time.

Appendix 3. Survey metadata

Table 11. Drop camera samples taken at Greater Haig Fras MCZ on CEND0719. Failed attempts not included. SOL = Start of Line, EOL = End of line.

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
11	GHF_055	A1	120	28/05/2019	08:52	50.3464603	-7.8730745	08:57	50.3466972	-7.8735939
12	GHF_054	A1	116	28/05/2019	09:51	50.3378414	-7.9278225	09:56	50.3380913	-7.9283178
14	GHF_053	A1	116	28/05/2019	11:49	50.3291300	-7.9828308	12:03	50.3295306	-7.9843903
16	GHF_052	A1	119	28/05/2019	13:17	50.3203801	-8.0381268	13:32	50.3211608	-8.0397008
18	GHF_041	A1	120	28/05/2019	14:38	50.2863913	-8.0537062	14:53	50.2868416	-8.055565
20	GHF_031	A1	118	28/05/2019	15:39	50.2522489	-8.0694339	15:52	50.2528515	-8.0709118
22	GHF_030	A1	124	28/05/2019	17:31	50.2437192	-8.1246395	17:46	50.2445885	-8.1260115
24	GHF_040	A1	123	28/05/2019	18:46	50.2776312	-8.1081125	19:01	50.2778411	-8.1100242
24	GHF_040	B1	129	28/05/2019	19:16	50.2779909	-8.1095377	19:21	50.2779217	-8.1089463
24	GHF_040	C1	122	28/05/2019	19:28	50.2778466	-8.1089866	19:33	50.2779075	-8.1095605
24	GHF_040	D1	124	28/05/2019	19:41	50.2776376	-8.1095858	19:46	50.2775817	-8.1089752
24	GHF_040	E1	124	28/05/2019	19:51	50.2775167	-8.1091487	19:56	50.2775784	-8.1096814
26	GHF_051	A1	131	28/05/2019	21:38	50.3121615	-8.0927258	21:52	50.3117907	-8.0944471
28	GHF_050	A1	133	28/05/2019	22:41	50.3034559	-8.1479740	22:56	50.3028421	-8.1496109
30	GHF_039	A1	137	28/05/2019	23:55	50.2692152	-8.1637680	00:00	50.2689214	-8.1643302
30	GHF_039	B1	137	29/05/2019	00:10	50.2688421	-8.1644837	00:25	50.2681665	-8.1660588
32	GHF_029	A1	140	29/05/2019	01:14	50.2349924	-8.1791321	01:30	50.2343722	-8.1808543
38	GHF_050	A1	133	30/05/2019	15:04	50.3035551	-8.1482053	15:19	50.303018	-8.1500021
39	GHF_051	A1	128	30/05/2019	16:41	50.3122695	-8.0928945	16:55	50.3119281	-8.0947387
40	GHF_040	A1	124	30/05/2019	17:34	50.2780089	-8.1084431	17:49	50.2773379	-8.110038
40	GHF_040	B1	124	30/05/2019	18:04	50.2774587	-8.1091799	18:08	50.2776318	-8.1087889
40	GHF_040	C1	124	30/05/2019	18:20	50.2775267	-8.1087861	18:26	50.2773131	-8.1094366
40	GHF_040	D1	124	30/05/2019	18:36	50.2778503	-8.1092656	18:40	50.2780673	-8.108719
40	GHF_040	E1	124	30/05/2019	18:49	50.2780055	-8.1093339	18:57	50.278212	-8.1087456
41	GHF_030	A1	123	30/05/2019	19:38	50.2431672	-8.1253291	19:53	50.2439756	-8.1238894

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
42	GHF_032	A1	120	30/05/2019	20:54	50.2606135	-8.0154772	21:09	50.2610179	-8.0136435
44	GHF_042	A1	115	30/05/2019	22:09	50.2955875	-7.9986536	22:24	50.2946889	-8.0000713
46	GHF_065	A1	118	30/05/2019	23:35	50.3637448	-7.9674232	23:45	50.3629991	-7.9679692
48	GHF_076	A1	120	31/05/2019	00:33	50.3977179	-7.9514786	00:38	50.3974839	-7.9520495
50	GHF_087	A1	123	31/05/2019	01:50	50.4317735	-7.9357373	01:55	50.4316117	-7.9363895
52	GHF_095	A1	125	31/05/2019	02:41	50.4575024	-7.9755090	02:56	50.4565959	-7.9769209
54	GHF_100	A1	128	31/05/2019	03:57	50.4915433	-7.9598197	04:14	50.4907922	-7.9617541
56	GHF_096	A1	120	31/05/2019	05:02	50.4660388	-7.9203820	05:08	50.4657417	-7.9208832
58	GHF_097	A1	116	31/05/2019	06:02	50.4745925	-7.8653251	06:09	50.4741746	-7.865789
60	GHF_088	A1	119	31/05/2019	07:15	50.4402807	-7.8812949	07:20	50.4404239	-7.8806922
62	GHF_077	A1	113	31/05/2019	08:17	50.4059487	-7.8972013	08:22	50.4061771	-7.8966796
64	GHF_066	A1	110	31/05/2019	09:13	50.3723663	-7.9125572	09:18	50.3720027	-7.9128706
66	GHF_043	A1	113	31/05/2019	10:46	50.3040745	-7.9429047	11:00	50.3032936	-7.9443768
68	GHF_033	A1	117	31/05/2019	11:58	50.2699698	-7.9588852	12:08	50.2694613	-7.9595652
70	GHF_034	A1	113	31/05/2019	13:07	50.2784906	-7.9037681	12:22	50.2775788	-7.9051634
72	GHF_044	A2	115	31/05/2019	14:29	50.3126315	-7.8880400	14:44	50.3119027	-7.8895919
74	GHF_067	A1	110	31/05/2019	15:46	50.3805385	-7.8571327	15:52	50.3802809	-7.8577649
76	GHF_078	A1	113	31/05/2019	16:47	50.4147851	-7.8414286	16:52	50.4145878	-7.8420517
78	GHF_089	A1	115	31/05/2019	17:39	50.4488399	-7.8256919	17:45	50.4486469	-7.8263939
80	GHF_098	A2	114	31/05/2019	18:41	50.4829448	-7.8100153	18:46	50.4832841	-7.8094556
81	GHF_099	A1	115	31/05/2019	19:33	50.4913206	-7.7549900	19:43	50.4919595	-7.7540873
83	GHF_090	A1	109	31/05/2019	20:29	50.4572829	-7.7708609	20:34	50.4575514	-7.7703881
85	GHF_079	A1	110	31/05/2019	21:24	50.4229051	-7.7864986	21:30	50.4233304	-7.7861269
85	GHF_079	B1	110	31/05/2019	21:38	50.4232219	-7.7858616	21:44	50.4228341	-7.7861659
85	GHF_079	C1	110	31/05/2019	21:50	50.4229204	-7.7862807	21:59	50.4233979	-7.785875
85	GHF_079	D1	110	31/05/2019	22:08	50.4235131	-7.7861633	22:13	50.4231636	-7.7864567
85	GHF_079	E1	112	31/05/2019	22:22	50.4232695	-7.7865910	22:26	50.4235252	-7.7863516
87	GHF_068	A1	109	31/05/2019	23:36	50.3893444	-7.8017175	23:41	50.3890014	-7.8021544

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
89	GHF_056	A1	113	01/06/2019	00:32	50.3551932	-7.8176353	00:37	50.354778	-7.8179215
91	GHF_045	A1	111	01/06/2019	01:22	50.3211001	-7.8332652	01:28	50.3206779	-7.8336834
93	GHF_035	A1	111	01/06/2019	02:09	50.2868700	-7.8485258	02:15	50.2866749	-7.8492438
95	GHF_027	A1	109	01/06/2019	03:13	50.2698760	-7.7543845	03:18	50.2696467	-7.7549211
97	GHF_036	A1	110	01/06/2019	04:16	50.2953964	-7.7936150	04:21	50.2951666	-7.7941783
99	GHF_046	A1	110	01/06/2019	05:04	50.3295559	-7.7782286	05:10	50.3294105	-7.7789154
101	GHF_057	A1	108	01/06/2019	05:51	50.3636493	-7.7624097	05:58	50.3633762	-7.7631706
103	GHF_069	A1	110	01/06/2019	07:09	50.3975004	-7.7467762	07:15	50.3977614	-7.7461675
105	GHF_080	A1	109	01/06/2019	07:57	50.4316992	-7.7314334	08:02	50.4319436	-7.730915
111	GHF_047	A1	107	02/06/2019	07:50	50.3378561	-7.7236138	07:55	50.3378753	-7.7229813
113	GHF_058	A1	106	02/06/2019	09:12	50.3720506	-7.7066500	09:19	50.3720432	-7.7075031
115	GHF_070	A1	109	02/06/2019	10:25	50.4063803	-7.6908768	10:32	50.4061556	-7.6917823
117	GHF_081	A1	107	02/06/2019	11:45	50.4404689	-7.6752370	11:50	50.4401751	-7.6757323
119	GHF_091	A1	116	02/06/2019	12:36	50.4660671	-7.7146785	12:41	50.465817	-7.7152217
121	GHF_092	A1	109	02/06/2019	13:28	50.4745814	-7.6593486	13:34	50.4743171	-7.6598099
123	GHF_093	A1	110	02/06/2019	14:28	50.4829822	-7.6039139	14:33	50.4827728	-7.6045391
125	GHF_082	A1	113	02/06/2019	15:25	50.4489494	-7.6199612	15:36	50.4483105	-7.6208108
127	GHF_071	A1	111	02/06/2019	16:46	50.4146884	-7.6356232	16:52	50.4145078	-7.6363484
129	GHF_094	A1	111	02/06/2019	19:01	50.4912330	-7.5484448	19:10	50.4910879	-7.5494737
131	GHF_084	A1	105	02/06/2019	20:08	50.4656140	-7.5090942	20:14	50.4656696	-7.5099697
133	GHF_083	A1	108	02/06/2019	21:35	50.4573129	-7.5642473	21:42	50.4575287	-7.5651007
135	GHF_073	A1	102	02/06/2019	22:35	50.4315079	-7.5249342	22:44	50.4317661	-7.5260429
137	GHF_072	A1	103	02/06/2019	23:32	50.4231026	-7.5802483	23:38	50.4231597	-7.5808951
139	GHF_061	A1	105	03/06/2019	00:36	50.3976321	-7.5409250	00:42	50.3974504	-7.5416801
141	GHF_060	A1	111	03/06/2019	01:49	50.3890914	-7.5961426	01:56	50.3889934	-7.5969932
143	GHF_059	A1	112	03/06/2019	02:47	50.3805971	-7.6513524	02:53	50.3805275	-7.652296
151	GHF_062	A2	103	04/06/2019	19:01	50.4058673	-7.4858910	19:06	50.4060146	-7.4865439
153	GHF_074	A1	102	04/06/2019	19:54	50.4399765	-7.4697167	19:59	50.4401222	-7.4702828

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
155	GHF_085	A1	105	04/06/2019	20:52	50.4737611	-7.4537814	20:57	50.4740635	-7.4542883
157	GHF_086	A1	95	04/06/2019	21:45	50.4820833	-7.3985189	21:50	50.4823346	-7.3989926
159	GHF_075	A1	98	04/06/2019	22:39	50.4480780	-7.4145849	22:44	50.4484354	-7.414998
161	GHF_064	A1	102	04/06/2019	23:25	50.4223346	-7.3751644	23:30	50.4227733	-7.3754103
163	GHF_063	A1	99	05/06/2019	00:20	50.4138840	-7.4304201	00:25	50.4143141	-7.4306946
163	GHF_063	B1	97	05/06/2019	00:34	50.4142427	-7.4313087	00:38	50.413448	-7.4308555
163	GHF_063	C1	98	05/06/2019	00:48	50.4138955	-7.4307194	00:53	50.4143155	-7.4309453
163	GHF_063	D1	98	05/06/2019	01:02	50.4145584	-7.4303989	01:08	50.4141672	-7.4299807
163	GHF_063	E1	99	05/06/2019	01:16	50.4140452	-7.4301950	01:21	50.4144129	-7.4304461
165	GHF_049	A1	103	05/06/2019	02:19	50.3884512	-7.3908034	02:24	50.3886689	-7.3914115
167	GHF_048	A1	102	05/06/2019	03:40	50.3802228	-7.4462266	03:46	50.3801527	-7.4470545
169	GHF_038	A1	105	05/06/2019	04:30	50.3546114	-7.4069697	04:36	50.354404	-7.4076596
171	GHF_037	A1	105	05/06/2019	05:25	50.3461408	-7.4622491	05:30	50.3461691	-7.4629868
173	GHF_028	A1	107	05/06/2019	07:06	50.3119263	-7.4781612	07:11	50.3120681	-7.4788372
175	GHF_022	A1	105	05/06/2019	07:57	50.2779541	-7.4942338	08:04	50.2781639	-7.4950225
177	GHF_022	A2	104	05/06/2019	08:52	50.2776085	-7.4947455	08:57	50.2778642	-7.4952308
178	GHF_021	A1	100	05/06/2019	09:38	50.2694326	-7.5493337	09:44	50.2697771	-7.5498866
180	GHF_017	A1	102	05/06/2019	10:50	50.2353180	-7.5661764	10:57	50.2349062	-7.5656317
182	GHF_016	A1	99	05/06/2019	11:57	50.2266816	-7.6209280	12:02	50.2270735	-7.621014
184	GHF_012	A1	104	05/06/2019	12:44	50.1925763	-7.6366793	12:51	50.1931369	-7.6366892
186	GHF_009	A1	108	05/06/2019	13:37	50.1584794	-7.6522192	13:44	50.1589365	-7.6527784
188	GHF_011	A1	103	05/06/2019	14:37	50.1844463	-7.6913256	14:43	50.1843762	-7.6920007
190	GHF_015	A1	100	05/06/2019	15:39	50.2101846	-7.7308696	15:44	50.2097688	-7.7313088
192	GHF_010	A1	107	05/06/2019	16:46	50.1760632	-7.7465673	16:51	50.1756901	-7.7468858
194	GHF_008	A1	108	05/06/2019	17:38	50.1505197	-7.7072322	17:43	50.1503108	-7.7078341
194	GHF_008	B1	108	05/06/2019	17:52	50.1502169	-7.7078412	17:57	50.1504009	-7.707204
194	GHF_008	C1	108	05/06/2019	18:02	50.1503260	-7.7071455	18:07	50.1501382	-7.7076671
194	GHF_008	D1	108	05/06/2019	18:14	50.1500559	-7.7076072	18:19	50.150244	-7.7070022

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
194	GHF_008	E1	108	05/06/2019	18:26	50.1501206	-7.7070499	18:31	50.1499658	-7.7076247
196	GHF_007	A1	110	05/06/2019	20:19	50.1417362	-7.7620673	20:24	50.1416292	-7.7627132
198	GHF_006	A1	114	05/06/2019	21:27	50.1163093	-7.7227048	21:37	50.1168256	-7.7241912
200	GHF_001	A1	114	05/06/2019	22:28	50.0815352	-7.7389681	22:37	50.0822793	-7.7395158
202	GHF_005	A1	106	05/06/2019	23:26	50.1072580	-7.7782988	23:32	50.1077815	-7.7781358
204	GHF_004	A1	106	06/06/2019	00:19	50.0986764	-7.8331624	00:34	50.0999096	-7.832834
206	GHF_003	A1	108	06/06/2019	01:23	50.0901705	-7.8882648	01:38	50.0913116	-7.8875535
208	GHF_002	A1	107	06/06/2019	02:24	50.0813212	-7.9430643	02:39	50.0825292	-7.9426797
210	GHF_013	A1	121	06/06/2019	04:13	50.1497552	-8.1154118	04:28	50.1494729	-8.1173062
212	GHF_013	A2	140	06/06/2019	05:45	50.1499226	-8.1154750	06:00	50.1496511	-8.1173676
213	GHF_014	A1	122	06/06/2019	07:05	50.1585372	-8.0604150	07:20	50.1580844	-8.0622019
215	GHF_020	A1	119	06/06/2019	08:09	50.1924419	-8.0449314	08:24	50.1929123	-8.0467612
217	GHF_019	A1	115	06/06/2019	09:11	50.1833204	-8.1001543	09:27	50.1845687	-8.1012237
220	GHF_018	A1	122	06/06/2019	11:36	50.1747837	-8.1558234	11:51	50.1758501	-8.1549577
221	GHF_023	A1	122	06/06/2019	12:32	50.2090320	-8.1404537	12:47	50.2100128	-8.1391507
223	GHF_024	A1	115	06/06/2019	13:32	50.2179568	-8.0856428	13:46	50.2182077	-8.0838593
224	GHF_025	A1	116	06/06/2019	14:17	50.2269008	-8.0307812	14:32	50.2265147	-8.0290549
226	GHF_026	A1	113	06/06/2019	15:22	50.2358967	-7.9748654	15:37	50.234655	-7.9752216
226	GHF_026	B1	114	06/06/2019	15:53	50.2352603	-7.9752994	15:59	50.2356505	-7.97521
226	GHF_026	C1	115	06/06/2019	16:43	50.2356269	-7.9753976	16:48	50.2352311	-7.9755148
226	GHF_026	D1	115	06/06/2019	17:01	50.2352525	-7.9748607	17:06	50.2356072	-7.9747673
226	GHF_026	E1	115	06/06/2019	17:19	50.2355975	-7.9746058	17:24	50.2352197	-7.9746982
228	GHF_019	A1	106	06/06/2019	18:44	50.1840533	-8.1009838	18:45	50.184233	-8.1004879
228	GHF_019	B1	106	06/06/2019	18:55	50.1843150	-8.1005558	19:03	50.1840155	-8.1013988
228	GHF_019	C1	107	06/06/2019	19:21	50.1835372	-8.1007563	19:28	50.1838317	-8.0999684
228	GHF_019	D1	111	06/06/2019	19:39	50.1836772	-8.0999883	19:44	50.1834663	-8.1006135
229	LHSA2	A1	128	06/06/2019	20:33	50.2359771	-8.1325033	20:49	50.2359741	-8.1346571
231	LHSA4	A1	127	06/06/2019	21:32	50.2551936	-8.1197247	21:47	50.2562465	-8.1206665

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
233	LHSA3	A1	130	06/06/2019	22:24	50.2529297	-8.1480741	22:27	50.2531682	-8.1480299
233	LHSA3	A2	130	06/06/2019	22:28	50.2533006	-8.1479356	22:43	50.2544032	-8.1473391
235	LHSA9	A1	132	06/06/2019	23:29	50.2822388	-8.1771882	23:31	50.2823257	-8.1770076
235	LHSA9	A2	132	06/06/2019	23:42	50.2823910	-8.1768847	23:57	50.2830557	-8.1753065
237	LHSA6	A1	132	07/06/2019	00:42	50.2995713	-8.1404316	00:57	50.3006704	-8.1394995
239	LHSA1	A1	126	07/06/2019	01:40	50.3053984	-8.0961591	01:55	50.3061318	-8.094719
241	LHSA8	A1	119	07/06/2019	02:32	50.2902028	-8.0843271	02:47	50.2909522	-8.0828136
243	LHSA5	A1	121	07/06/2019	03:47	50.2750243	-8.0762200	04:02	50.2759911	-8.0749443
244	LHSA7	A1	126	07/06/2019	04:44	50.3245426	-8.0474347	04:59	50.3241193	-8.0492862
246	GHF_042	A1	118	07/06/2019	05:47	50.2952996	-7.9993126	05:53	50.2954078	-7.9986626
246	GHF_042	B1	118	07/06/2019	06:08	50.2953043	-7.9985556	06:13	50.2952143	-7.9992372
246	GHF_042	C1	118	07/06/2019	06:22	50.2946886	-7.9990487	06:27	50.2948092	-7.9983945
246	GHF_042	D1	123	07/06/2019	06:36	50.2949558	-7.9984303	06:41	50.2948376	-7.9990201
247	GHF_066	A1	114	07/06/2019	07:51	50.3722243	-7.9120844	07:56	50.3722231	-7.9127739
247	GHF_066	B1	114	07/06/2019	08:06	50.3720916	-7.9128170	08:12	50.3721036	-7.9120954
247	GHF_066	C1	118	07/06/2019	08:21	50.3716962	-7.9120947	08:27	50.3717005	-7.9127642
247	GHF_066	D1	118	07/06/2019	08:35	50.3717987	-7.9128465	08:40	50.3717987	-7.912153
248	GHF_076	A1	120	07/06/2019	09:18	50.3975575	-7.9516308	09:24	50.3979131	-7.9521821
248	GHF_076	B1	120	07/06/2019	09:35	50.3979758	-7.9524040	09:41	50.3976043	-7.951966
248	GHF_076	C1	126	07/06/2019	09:49	50.3974045	-7.9521085	09:55	50.3970923	-7.951537
248	GHF_076	D1	119	07/06/2019	10:03	50.3970084	-7.9516462	10:08	50.3972865	-7.9521557
249	GHF_077	A1	115	07/06/2019	10:46	50.4061526	-7.8963977	10:52	50.4064816	-7.8969096
249	GHF_077	B1	115	07/06/2019	11:07	50.4064217	-7.8972515	11:12	50.4061567	-7.8966855
249	GHF_077	C1	114	07/06/2019	11:24	50.4059507	-7.8967147	11:30	50.405603	-7.8962152
249	GHF_077	D1	114	07/06/2019	11:44	50.4055613	-7.8965156	11:49	50.4058018	-7.896986
250	GHF_087	A1	120	07/06/2019	12:34	50.4315260	-7.9368818	12:39	50.4312086	-7.9364425
250	GHF_087	B1	120	07/06/2019	13:03	50.4313100	-7.9361115	13:08	50.4316221	-7.9365635
250	GHF_087	C1	120	07/06/2019	13:17	50.4317147	-7.9363649	13:24	50.4321853	-7.9369754

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
250	GHF_087	D1	120	07/06/2019	13:36	50.4320839	-7.9364189	13:44	50.4315036	-7.9356322
251	GHF_096	A1	123	07/06/2019	14:24	50.4651752	-7.9204320	14:40	50.4664352	-7.9210274
251	GHF_096	B1	118	07/06/2019	14:59	50.4661516	-7.9203811	15:04	50.4657811	-7.9201654
251	GHF_096	C1	118	07/06/2019	15:11	50.4657183	-7.9203315	15:16	50.4661125	-7.9205507
251	GHF_096	D1	119	07/06/2019	15:27	50.4660402	-7.9211074	15:32	50.4656392	-7.9208999
251	GHF_096	E1	119	07/06/2019	15:40	50.4655606	-7.9211007	15:45	50.4659812	-7.9212697
252	GHF_098	A1	114	07/06/2019	16:37	50.4831910	-7.8095733	16:42	50.4831939	-7.8102559
252	GHF_098	B1	114	07/06/2019	16:52	50.4830680	-7.8102138	16:57	50.483058	-7.8095914
252	GHF_098	C1	114	07/06/2019	17:06	50.4828579	-7.8095438	17:11	50.4828573	-7.810263
252	GHF_098	D1	115	07/06/2019	17:22	50.4827140	-7.8102081	17:27	50.4827301	-7.8095878
253	LHSB1	A1	114	07/06/2019	18:19	50.4202087	-7.8347815	18:24	50.420373	-7.8354833
255	LHSB4	A1	112	07/06/2019	19:02	50.4202058	-7.8008311	19:09	50.4204855	-7.8016463
257	LHSB9	A1	113	07/06/2019	19:58	50.3957479	-7.8275733	20:03	50.3959455	-7.8280601
259	LHSB6	A1	112	07/06/2019	21:03	50.3623280	-7.8487406	21:09	50.3625191	-7.849433
261	LHSB5	A1	108	08/06/2019	04:58	50.3458580	-7.8618206	05:03	50.3458377	-7.8625007
263	LHSB7	A1	114	08/06/2019	05:52	50.3717098	-7.8144067	05:57	50.3717881	-7.8151399
265	LHSB8	A1	112	08/06/2019	07:09	50.3955677	-7.7878604	07:15	50.3957054	-7.7885666
267	LHSB3	A1	112	08/06/2019	07:56	50.4013952	-7.7614471	08:01	50.4014889	-7.762076
269	LHSB2	A1	113	08/06/2019	08:45	50.4282266	-7.7533550	08:50	50.4283223	-7.7539918
271	GHF_092	A1	108	08/06/2019	12:12	50.4746834	-7.6591492	12:16	50.4747079	-7.6596278
271	GHF_092	B1	109	08/06/2019	12:27	50.4745601	-7.6593719	12:32	50.4745439	-7.6601074
271	GHF_092	C1	109	08/06/2019	12:42	50.4742754	-7.6592997	12:47	50.4742748	-7.6599498
271	GHF_092	D1	109	08/06/2019	13:02	50.4741287	-7.6592668	13:07	50.4741489	-7.6599332
272	GHF_070	A1	106	08/06/2019	13:57	50.4064596	-7.6909241	14:03	50.4064707	-7.6916223
272	GHF_070	B1	108	08/06/2019	14:13	50.4062991	-7.6912002	14:18	50.4062788	-7.6918479
272	GHF_070	C1	108	08/06/2019	14:26	50.4061244	-7.6911177	14:31	50.4061105	-7.6917483
272	GHF_070	D1	107	08/06/2019	14:41	50.4059587	-7.6911327	14:47	50.4059472	-7.6918728
273	GHF_058	A1	106	08/06/2019	15:25	50.3722749	-7.7070285	15:31	50.3722883	-7.7077098

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
273	GHF_058	B1	106	08/06/2019	15:40	50.3721567	-7.7071196	15:45	50.3721544	-7.7076537
273	GHF_058	C1	107	08/06/2019	15:54	50.3719663	-7.7070749	15:59	50.371947	-7.7076592
273	GHF_058	D1	109	08/06/2019	16:43	50.3718372	-7.7070406	16:48	50.3718392	-7.7077076
274	GHF_047	A1	108	08/06/2019	17:21	50.3382638	-7.7228178	17:26	50.3382707	-7.7234641
274	GHF_047	B1	108	08/06/2019	17:37	50.3381105	-7.7235197	17:42	50.3381137	-7.7228308
274	GHF_047	C1	108	08/06/2019	17:53	50.3378023	-7.7227649	17:58	50.3378162	-7.7234407
274	GHF_047	D1	108	08/06/2019	18:09	50.3376890	-7.7234845	18:14	50.3376922	-7.7228418
275	GHF_060	A1	108	08/06/2019	19:23	50.3892344	-7.5963327	19:28	50.3892368	-7.5969605
275	GHF_060	B1	108	08/06/2019	19:39	50.3891280	-7.5969275	19:44	50.3891318	-7.5962604
275	GHF_060	C1	108	08/06/2019	19:54	50.3888821	-7.5964221	19:59	50.3888662	-7.5970857
275	GHF_060	D1	108	08/06/2019	20:14	50.3887612	-7.5970352	20:19	50.3887701	-7.5963575
276	GHF_061	A1	106	08/06/2019	21:30	50.3978060	-7.5411170	21:35	50.3977418	-7.5417588
276	GHF_061	B1	106	08/06/2019	21:43	50.3976366	-7.5416502	21:48	50.3976955	-7.5410376
276	GHF_061	C1	106	08/06/2019	21:56	50.3975933	-7.5410641	22:01	50.3975593	-7.5416176
276	GHF_061	D1	106	08/06/2019	20:08	50.3972997	-7.5415629	22:13	50.3973557	-7.5409575
276	GHF_061	E1	106	08/06/2019	22:21	50.3972362	-7.5410205	22:26	50.3971622	-7.5416822
277	LHSC6	A1	105	08/06/2019	23:13	50.4017019	-7.4547219	23:18	50.4016293	-7.4553356
279	LHSC9	A1	104	08/06/2019	23:59	50.4243908	-7.4882208	00:05	50.4245289	-7.4890431
281	LHSC3	A1	105	09/06/2019	01:11	50.4666940	-7.4607189	01:16	50.4667154	-7.4613457
283	LHSC5	A1	100	09/06/2019	01:54	50.4532922	-7.4346037	02:00	50.4534537	-7.4352936
285	LHSC8	A1	100	09/06/2019	02:37	50.4405674	-7.4167090	02:42	50.4407053	-7.4174045
287	LHSC2	A1	102	09/06/2019	03:43	50.4162664	-7.3686301	03:48	50.4164122	-7.3692429
290	LHSC4	A1	104	09/06/2019	04:48	50.4105946	-7.4150947	04:53	50.4107191	-7.4145417
292	LHSC7	A1	106	09/06/2019	05:38	50.3891320	-7.4022010	05:43	50.3888781	-7.4027099
294	LHSC1	A1	100	09/06/2019	07:02	50.3747285	-7.4491933	07:08	50.3745096	-7.4498231
296	LHSD5	A1	106	09/06/2019	09:20	50.1926295	-7.6759085	09:25	50.192488	-7.676614
298	LHSD2	A1	106	09/06/2019	10:02	50.1750766	-7.6528495	10:08	50.1749659	-7.6535077
300	LHSD6	A1	108	09/06/2019	11:08	50.1627681	-7.6828549	11:14	50.162671	-7.683631

Event	Station Code	Replicate	Depth (m)	Date	SOL Time	Latitude	Longitude	EOL Time	Latitude	Longitude
302	LHSD7	A1	105	09/06/2019	11:50	50.1553526	-7.7124161	11:55	50.1553681	-7.7131367
304	LHSD1	A1	105	09/06/2019	12:35	50.1549730	-7.7595229	12:42	50.155155	-7.7603707
306	LHSD8	A1	108	09/06/2019	13:34	50.1409841	-7.7398999	13:40	50.1408522	-7.7392562
308	LHSD4	A1	112	09/06/2019	14:24	50.1124761	-7.7384571	14:29	50.11279	-7.7389279
310	LHSD9	A1	115	09/06/2019	15:20	50.0880483	-7.7756008	15:26	50.0883481	-7.7751184
312	LHSD3	A1	108	09/06/2019	16:42	50.1258420	-7.7757619	16:47	50.1260017	-7.7751496
314	GHFPIN10	A1	93	09/06/2019	17:41	50.1355924	-7.8146663	17:55	50.1349149	-7.8136254
315	GHFPIN08	A1	70	09/06/2019	18:45	50.1999251	-7.8152179	18:58	50.1993919	-7.8144106
320	GHFPIN07	A1	81	10/06/2019	21:40	50.2630099	-7.7003711	21:52	50.2636714	-7.7003739
321	GHFPIN11	A1	81	10/06/2019	22:36	50.2393185	-7.6456943	22:43	50.239605	-7.645795
321	GHFPIN11	A2	81	10/06/2019	23:14	50.2393001	-7.6456770	23:25	50.2398475	-7.645919
322	GHFPIN09	A1	83	11/06/2019	00:06	50.2586085	-7.6009841	00:18	50.2592266	-7.6011326
323	GHFPIN14	A1	80	11/06/2019	01:12	50.3154043	-7.5498236	01:23	50.3151642	-7.5489658
324	GHFPIN12	A1	86	11/06/2019	02:04	50.3568390	-7.5700672	02:18	50.3562925	-7.5709255
325	GHFPIN05	A1	73	11/06/2019	02:43	50.3593058	-7.6079367	02:57	50.3599071	-7.6087399
326	GHFPIN02	A1	88	11/06/2019	03:54	50.3170845	-7.7213142	04:07	50.3168261	-7.7202967

Table 12. Hamon grab stations sampled at Greater Haig Fras MCZ. Failed attempts not shown.

Event	Station Code	Replicate	Depth (m)	Date	Time	Latitude	Longitude
10	GHF_055	A1	109	28/05/2019	07:50	50.3464029	-7.8730783
13	GHF_054	A1	114	28/05/2019	10:07	50.3381032	-7.9284384
15	GHF_053	A1	117	28/05/2019	12:33	50.3292224	-7.9832964
17	GHF_052	A1	119	28/05/2019	13:44	50.3208161	-8.0389746
19	GHF_041	A1	118	28/05/2019	15:03	50.2865916	-8.0545273
21	GHF_031	A2	118	28/05/2019	16:47	50.2525097	-8.0701047
23	GHF_030	A1	125	28/05/2019	17:56	50.2437788	-8.1247808
25	GHF_040	A1	124	28/05/2019	20:06	50.2775150	-8.1092162
25	GHF_040	B1	124	28/05/2019	20:16	50.2776148	-8.1091886

Event	Station Code	Replicate	Depth (m)	Date	Time	Latitude	Longitude
25	GHF_040	C1	124	28/05/2019	20:29	50.2779194	-8.1090939
27	GHF_051	A1	128	28/05/2019	22:02	50.3118357	-8.0941568
29	GHF_050	A1	133	28/05/2019	23:16	50.3029866	-8.1491926
31	GHF_039	A1	137	29/05/2019	00:38	50.2687382	-8.1647117
33	GHF_029	A1	135	29/05/2019	01:42	50.2346211	-8.1801641
43	GHF_032	A1	116	30/05/2019	21:19	50.2607845	-8.0142721
45	GHF_042	A1	116	30/05/2019	22:34	50.2946556	-8.0001396
47	GHF_065	A1	116	30/05/2019	23:57	50.3629499	-7.9679798
49	GHF_076	A4	128	31/05/2019	01:10	50.3973955	-7.9522049
51	GHF_087	A1	124	31/05/2019	02:04	50.4315914	-7.9364714
53	GHF_095	A1	125	31/05/2019	03:05	50.4569361	-7.9764121
55	GHF_100	A1	124	31/05/2019	04:23	50.4911053	-7.9608524
57	GHF_096	A1	119	31/05/2019	05:16	50.4656904	-7.9209675
59	GHF_097	A1	115	31/05/2019	06:16	50.4741605	-7.8657542
61	GHF_088	A1	119	31/05/2019	07:32	50.4404211	-7.8805913
63	GHF_077	A1	114	31/05/2019	08:31	50.4061949	-7.8966365
65	GHF_066	A1	111	31/05/2019	09:26	50.3719559	-7.9129109
67	GHF_043	A1	114	31/05/2019	11:10	50.3033888	-7.9441785
69	GHF_033	A1	116	31/05/2019	12:26	50.2695464	-7.9595477
71	GHF_034	A1	113	31/05/2019	13:31	50.2778320	-7.9047165
73	GHF_044	A1	115	31/05/2019	14:53	50.3122483	-7.8891148
75	GHF_067	A1	110	31/05/2019	15:59	50.3803178	-7.8577194
77	GHF-078	A1	114	31/05/2019	17:00	50.4145783	-7.8420912
79	GHF_089	A1	114	31/05/2019	17:54	50.4487782	-7.8259497
82	GHF_099	A1	112	31/05/2019	19:53	50.4916174	-7.7544669
84	GHF_090	A1	119	31/05/2019	20:42	50.4571435	-7.7711606
86	GHF_079	A1	110	31/05/2019	22:34	50.4235505	-7.7863412

Event	Station Code	Replicate	Depth (m)	Date	Time	Latitude	Longitude
86	GHF_079	B1	109	31/05/2019	22:42	50.4234619	-7.7864099
86	GHF_079	C1	110	31/05/2019	22:58	50.4230347	-7.7861823
88	GHF_068	A1	110	01/06/2019	23:49	50.3889989	-7.8021709
90	GHF_056	A1	110	01/06/2019	00:45	50.3546843	-7.8179678
92	GHF_045	A1	111	01/06/2019	01:35	50.3206407	-7.8336378
94	GHF_035	A1	110	01/06/2019	02:24	50.2866342	-7.8493249
96	GHF_027	A1	109	01/06/2019	03:27	50.2696048	-7.7550260
98	GHF_036	A1	109	01/06/2019	04:29	50.2951576	-7.7942411
100	GHF_046	A1	110	01/06/2019	05:17	50.3294674	-7.7787450
102	GHF_057	A1	108	01/06/2019	06:05	50.3634243	-7.7629804
104	GHF_069	A1	110	01/06/2019	07:22	50.3977222	-7.7463035
106	GHF_080	A1	108	01/06/2019	08:10	50.4319774	-7.7308979
112	GHF_047	A1	107	02/06/2019	08:05	50.3378718	-7.7229411
116	GHF_070	A3	107	02/06/2019	10:56	50.4060826	-7.6910537
118	GHF_081	A1	107	02/06/2019	11:58	50.4401428	-7.6757448
120	GHF_091	A1	112	02/06/2019	12:50	50.4657863	-7.7152648
122	GHF_092	A2	109	02/06/2019	13:49	50.4742676	-7.6599282
124	GHF_093	A1	109	02/06/2019	14:40	50.4827137	-7.6046008
126	GHF_082	A1	112	02/06/2019	15:43	50.4485716	-7.6204223
128	GHF_071	A1	112	02/06/2019	17:02	50.4147467	-7.6356953
130	GHF_094	A1	110	02/06/2019	19:19	50.4910888	-7.5492514
134	GHF_083	A1	108	02/06/2019	21:50	50.4575297	-7.5651645
136	GHF_073	A1	103	02/06/2019	22:51	50.4317369	-7.5257972
138	GHF_072	A1	104	02/06/2019	23:52	50.4231854	-7.5809327
142	GHF_060	A1	107	03/06/2019	02:05	50.3889899	-7.5970562
144	GHF_059	A1	107	03/06/2019	03:03	50.3805385	-7.6523672
152	GHF_062	A1	103	04/06/2019	19:14	50.4060063	-7.4865401

Event	Station Code	Replicate	Depth (m)	Date	Time	Latitude	Longitude
154	GHF_074	A1	102	04/06/2019	20:07	50.4401334	-7.4703182
156	GHF_085	A1	106	04/06/2019	20:05	50.4740631	-7.4543335
158	GHF_086	A1	96	04/06/2019	21:58	50.4823606	-7.3990639
160	GHF_075	A1	98	04/06/2019	22:51	50.4484597	-7.4150143
162	GHF_064	A1	102	04/06/2019	23:38	50.4228086	-7.3754342
164	GHF_063	A1	99	05/06/2019	01:29	50.4144450	-7.4305300
164	GHF_063	B1	99	05/06/2019	01:36	50.4143954	-7.4304767
164	GHF_063	C1	99	05/06/2019	01:43	50.4143325	-7.4303631
168	GHF_048	A1	102	05/06/2019	03:53	50.3801294	-7.4471854
170	GHF_038	A1	103	05/06/2019	04:44	50.3543912	-7.4077024
172	GHF_037	A3	100	05/06/2019	05:53	50.3460053	-7.4631566
174	GHF_028	A1	101	05/06/2019	07:19	50.3120641	-7.4788657
176	GHF_022	A3	105	05/06/2019	08:38	50.2776398	-7.4947901
179	GHF_021	A1	99	05/06/2019	09:51	50.2697927	-7.5499267
183	GHF_016	A1	98	05/06/2019	12:10	50.2271313	-7.6210231
185	GHF_012	A1	104	05/06/2019	12:58	50.1931716	-7.6366633
187	GHF_009	A1	108	05/06/2019	12:43	50.1589835	-7.6527907
189	GHF_011	A2	104	05/06/2019	15:02	50.1843816	-7.6919302
191	GHF_015	A1	100	05/06/2019	15:51	50.2097362	-7.7313574
193	GHF_010	A1	107	05/06/2019	16:58	50.1756515	-7.7469329
195	GHF_008	A3	109	05/06/2019	18:55	50.1502705	-7.7074098
195	GHF_008	B2	109	05/06/2019	19:12	50.1504751	-7.7074265
195	GHF_008	C3	109	05/06/2019	19:39	50.1502075	-7.7076638
197	GHF_007	A1	110	05/06/2019	20:32	50.1415965	-7.7627398
199	GHF_006	A1	113	05/06/2019	21:50	50.1163654	-7.7236497
201	GHF_001	A1	114	05/06/2019	22:46	50.0821901	-7.7393672
203	GHF_005	A1	107	05/06/2019	23:40	50.1078168	-7.7781292

Event	Station Code	Replicate	Depth (m)	Date	Time	Latitude	Longitude
205	GHF_004	A1	106	06/06/2019	00:44	50.0993007	-7.8329890
207	GHF_003	A1	108	06/06/2019	01:47	50.0907282	-7.8878548
209	GHF_002	A1	107	06/06/2019	07:47	50.0825711	-7.9426854
211	GHF_013	A1	120	06/06/2019	04:37	50.1496976	-8.1163546
214	GHF_014	A1	122	06/06/2019	07:31	50.1581852	-8.0614875
216	GHF_020	A1	120	06/06/2019	08:34	50.1927203	-8.0460077
218	GHF_019	A1	107	06/06/2019	09:41	50.1835321	-8.1003506
219	GHF_018	A1	122	06/06/2019	11:06	50.1749604	-8.1557249
222	GHF_023	A1	121	06/06/2019	12:56	50.2095989	-8.1396522
225	GHF_025	A1	116	06/06/2019	14:44	50.2268822	-8.0306850
227	GHF_026	A1	116	06/06/2019	17:31	50.2351956	-7.9746723
230	LHSA2	A1	127	06/06/2019	20:58	50.2359641	-8.1340312
232	LHSA4	A1	130	06/06/2019	21:55	50.2559979	-8.1205202
234	LHSA3	A1	130	06/06/2019	22:54	50.2538961	-8.1475919
236	LHSA9	A1	136	07/06/2019	00:07	50.2826910	-8.1758648
238	LHSA6	A1	132	07/06/2019	01:07	50.3004353	-8.1400009
240	LHSA1	A1	126	07/06/2019	02:04	50.3058283	-8.0949334
242	LHSA8	A1	119	07/06/2019	02:55	50.2906941	-8.0830342
245	LHSA7	A1	122	07/06/2019	05:08	50.3242999	-8.0484438
253	LHSB1	A1	115	07/06/2019	18:32	50.4203792	-7.8355905
256	LHSB4	A1	112	07/06/2019	19:16	50.4205106	-7.8016817
258	LHSB9	A1	112	07/06/2019	20:10	50.3960046	-7.8282715
260	LHSB6	A1	110	07/06/2019	21:15	50.3625515	-7.8494534
262	LHSB5	A1	109	08/06/2019	05:12	50.3458287	-7.8625474
264	LHSB7	A1	110	08/06/2019	06:05	50.3717878	-7.8151537
266	LHSB8	A1	112	08/06/2019	07:23	50.3957068	-7.7885953
268	LHSB3	A1	112	08/06/2019	08:09	50.4014701	-7.7621460

Event	Station Code	Replicate	Depth (m)	Date	Time	Latitude	Longitude
270	LHSB2	A1	112	08/06/2019	08:52	50.4283368	-7.7541333
278	LHSC6	A1	101	08/06/2019	23:26	50.4016100	-7.4553871
280	LHSC9	A3	104	09/06/2019	00:29	50.4245496	-7.4888092
282	LHSC3	A1	105	09/06/2019	01:24	50.4666958	-7.4614029
284	LHSC5	A1	101	09/06/2019	02:11	50.4534465	-7.4354375
286	LHSC8	A1	100	09/06/2019	02:50	50.4407135	-7.4174481
289	LHSC2	A1	103	09/06/2019	03:56	50.4164412	-7.3693147
291	LHSC4	A2	101	09/06/2019	05:09	50.4105505	-7.4149871
293	LHSC7	A1	102	09/06/2019	05:51	50.3888407	-7.4027255
295	LHSC1	A1	100	09/06/2019	07:16	50.3744943	-7.4498546
297	LHSD5	A1	106	09/06/2019	09:33	50.1924760	-7.6766494
301	LHSD6	A1	108	09/06/2019	11:22	50.1627348	-7.6833194
303	LHSD7	A1	106	09/06/2019	12:03	50.1553593	-7.7127819
307	LHSD8	A1	108	09/06/2019	13:48	50.1408370	-7.7391997
308	LHSD4	A1	112	09/06/2019	14:37	50.1126385	-7.7386715
311	LHSD9	A1	115	09/06/2019	15:33	50.0881206	-7.7754368
313	LHSD3	A1	108	09/06/2019	16:55	50.1259546	-7.7753421

Table 13. Stations where grab samples were used for DNA sampling.

Event	Station Code	Replicate	Depth (m)	Date	Time	Latitude	Longitude
106	GHF_080	B1	108	01/06/2019	08:18	50.4320214	-7.7307689
114	GHF_058	A1	106	02/06/2019	09:27	50.3720438	-7.7072506
114	GHF_058	A2	106	02/06/2019	09:36	50.3720295	-7.7073740
114	GHF_058	A3	106	02/06/2019	09:44	50.3720092	-7.7075008
211	GHF_013	B1	120	06/06/2019	04:44	50.1497376	-8.1162415

JNCC/Cefas Partnership Report Series. *CEND0719 Survey Report: Monitoring Survey of Greater Haig Fras MCZ*, **No. 30**. Wood, D., Taylor, J., Sperry, J. & Downie, A. 2020. ISSN 2051-6711