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CEND0118 and CEND0218 Survey Report: Swallow Sand Marine Conservation Zone

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JNCC EQA Statement:

This report is compliant with the JNCC **Evidence Quality Assurance Policy** https://jncc.gov.uk/about-jncc/corporate-information/evidence-quality-assurance/.

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Glossary

BACI	Before-After-Control-Impact
BSH	Broadscale Habitat
Cefas	Centre for Environment, Fisheries and Aquaculture science
Defra	Department of Environment, Food and Rural Affairs
GPS	Global Positioning System
JNCC	Joint Nature Conservation Committee
MCZ	Marine Conservation Zone
MBES	Multibeam Echosounder
NIS	Non-Indigenous Species
PSA	Particle Size Analysis
USBL	Ultra Short Baseline

1 Background and Introduction

1.1 Survey Rationale

On behalf of Defra, Cefas and the Joint Nature Conservation Committee (JNCC), undertook a survey of the Swallow Sand Marine Conservation Zone (MCZ) to collect a benthic dataset that would form the first monitoring event in a 'Before-After-Control-Impact' (BACI) study to allow for the future evaluation of the effectiveness of proposed fisheries management measures at the site.

1.2 Survey Project Team

The operations conducted at the Swallow Sand MCZ were planned to span two sequential expeditions on the RV *Cefas Endeavour*; expedition codes CEND0118 and CEND0218. Expedition CEND0118 was carried out between 7 - 10 January 2018 and expedition CEND0218 was carried out between 14 - 29 January 2018. Expedition CEND0218 was only partly concerned with acquiring information from the Swallow Sand MCZ; with most of the survey time dedicated to an integrated survey of the Norfolk Bank region. Rationale and survey objectives are reported separately for this aspect of CEND0218 and are outside the scope of the work presented here.

The multidisciplinary survey team on CEND0118 & 0218 included Cefas fisheries scientists, benthic ecologists, marine surveyors, habitat mappers and marine biogeochemists from Cefas in addition to P&O Maritime Services vessel crew (see Table 1 for information on scientific staffing and roles).

Table 1. Scientific survey team and primary roles for each expedition.

Expedition code	Floating shift (07:00-19:00)	Day shift (06:00-18:00)	Night shift (12:00-24:00)
CEND0118	Habitat Mapper, SIC	Hydrographic surveyor, shift lead	Hydrographic surveyor, shift lead
		Survey scientist	Survey scientist
		Survey scientist	Survey scientist
CEND0218	Marine ecologist, SIC	Fisheries Scientist, Day-lead	Benthic Ecologist, Night-lead
	Fisheries lead scientist	Habitat Mapper	Benthic ecologist
	Fisheries scientist, deck master	Plankton ecologist	Instrument technician
	Hydrographic surveyor	Oceanographer, water sampling lead	Fisheries Scientist
	Sedimentologist, data manager	Instrument technician	Plankton ecologist
			Fisheries Scientist

1.3 Swallow Sand MCZ

Swallow Sand MCZ is an expansive site located approximately 100km offshore from the Northumberland coast, in the Mid North Sea (Figure 1). The site comprises a predominantly sandy plain with areas of deeper bathymetry and increased fine sediment (e.g. the glacial tunnel valley geological feature in the north-west corner of the site comprises 'muddier' sediments) and ranges in depth below chart datum from approximately 50m at its shallowest, down to approximately 150m. The site covers 4,746km^2 and is designated to protect the features outlined in Table 2. Two of the protected features (A5.1: Subtidal coarse sediment & North Sea glacial tunnel valley (Swallow Hole)) have a general management approach to maintain in favourable condition. However, A5.2 Subtidal sand is set to recover. For more detailed information on this site please refer to JNCC's Site Information Centre (http://jncc.defra.gov.uk/page-6558).

Table 2. Protected features of Swallow Sand Marine Conservation Zone.

EUNIS Code: Protected Features	**Feature Type**	**General Management Approach (to achieve conservation objective)**
A5.1: Subtidal coarse sediment	Broad-Scale Habitat	Maintain in favourable condition
A5.2: Subtidal sand	Broad-Scale Habitat	Recover to favourable condition
North Sea glacial tunnel valley (Swallow Hole)	Geological/Geomorphological feature	Maintain in favourable condition

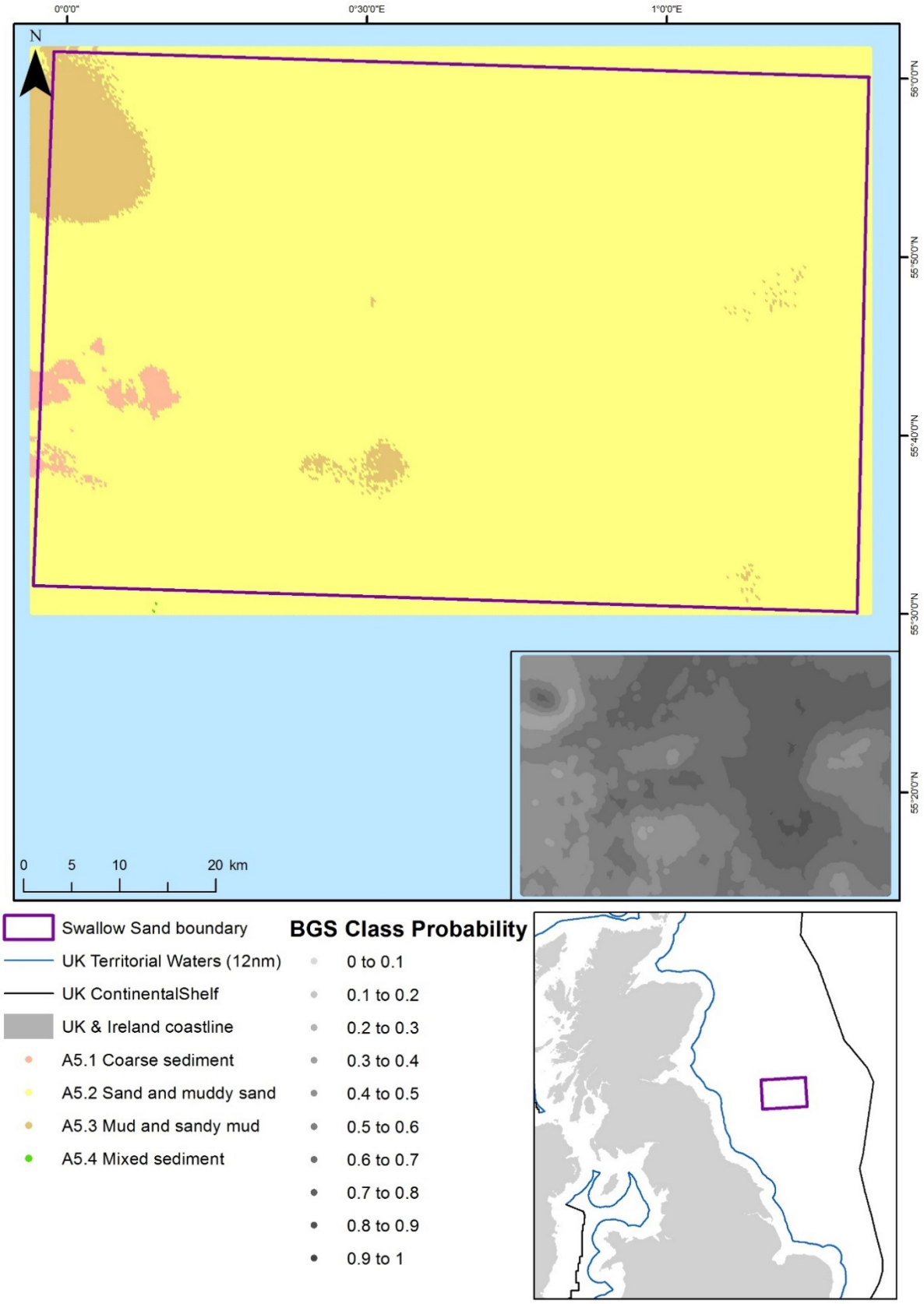


Figure 1. Map showing location of Swallow Sand MCZ and the distribution of BSH habitats within the MCZ boundary.

1.4 High Level Hypotheses and Operational Aims

Overall aim: Collect a benthic dataset to act as the *first* monitoring event in a Before-After-Control-Impact (BACI) study to allow the future evaluation of the effectiveness of proposed fisheries management measures at Swallow Sand MCZ. As such, any results from the analysis of samples collected during this sampling event (T0) may act only as a characterisation of the status at this first event.

High level hypotheses (Priority 1)

- There is no difference in terms of bathymetric features between the two areas of interest selected for the study.
- There is no difference in the benthic community associated with a broadscale habitat (BSH), within a single area of interest (i.e. control or impact boxes), between surveys T0 and T1.
- There is no difference in the particle size distribution associated with a BSH, within single area of interest (i.e. control or impact boxes), between surveys T0 and T1.

High level hypotheses (Priority 2)

- There is no difference in the supporting processes (as described by the 'Ferrybox' environmental data acquired continuously during survey) at the sea surface between surveys T0 and T1.

2 Survey Design and Methods

2.1 Swallow Sand MCZ

Two survey areas, of fixed size, were identified for further investigation within the time scale permitted by the survey duration; one within the Swallow Sand MCZ site boundary, in the southeast of the site, and one approximately 10km to the south and outside of the MCZ. These control and impact boxes (Box01 and Box02 respectively) are within and adjacent to a larger area originally proposed by Defra for study, and are referred to as the Areas of Interest in this investigation (Figure 2).

Acoustic multibeam echosounder (MBES) data, collected on the first part of the expedition, was used in conjunction with the density of vessel monitoring system (VMS) pings to locate several sampling stations within each box. A single sediment sample for infaunal community composition and particle size analysis (PSA) was collected from each target station.

Analysis of the MBES data, acquired and processed aboard during CEND0118, revealed distinct regions of elevated bathymetry coincident with the highest fishing intensity (as described by density of VMS pings). Therefore, sampling points were concentrated on the crests of the suspected sandbanks within each box (Figure 3). The location of a single hazard (an unnamed, charted wreck) was confirmed and an exclusion area designated, whereby no gears would be deployed within a 1km zone centred on the wreck. This wreck is located on the western edge of the suspected sandbank in Box01, outside of the region of highest VMS ping density.

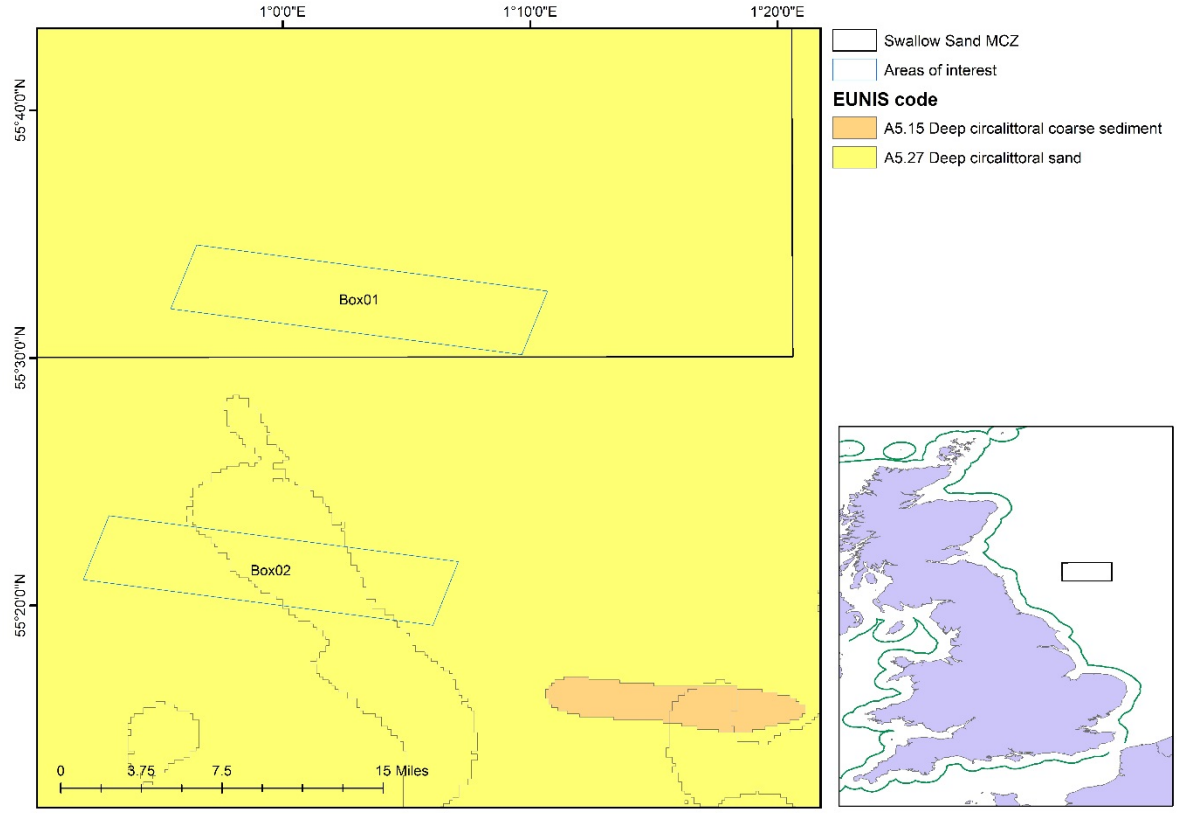


Figure 2. Location of the areas of interest within and immediately outside of the Swallow Sand MCZ.

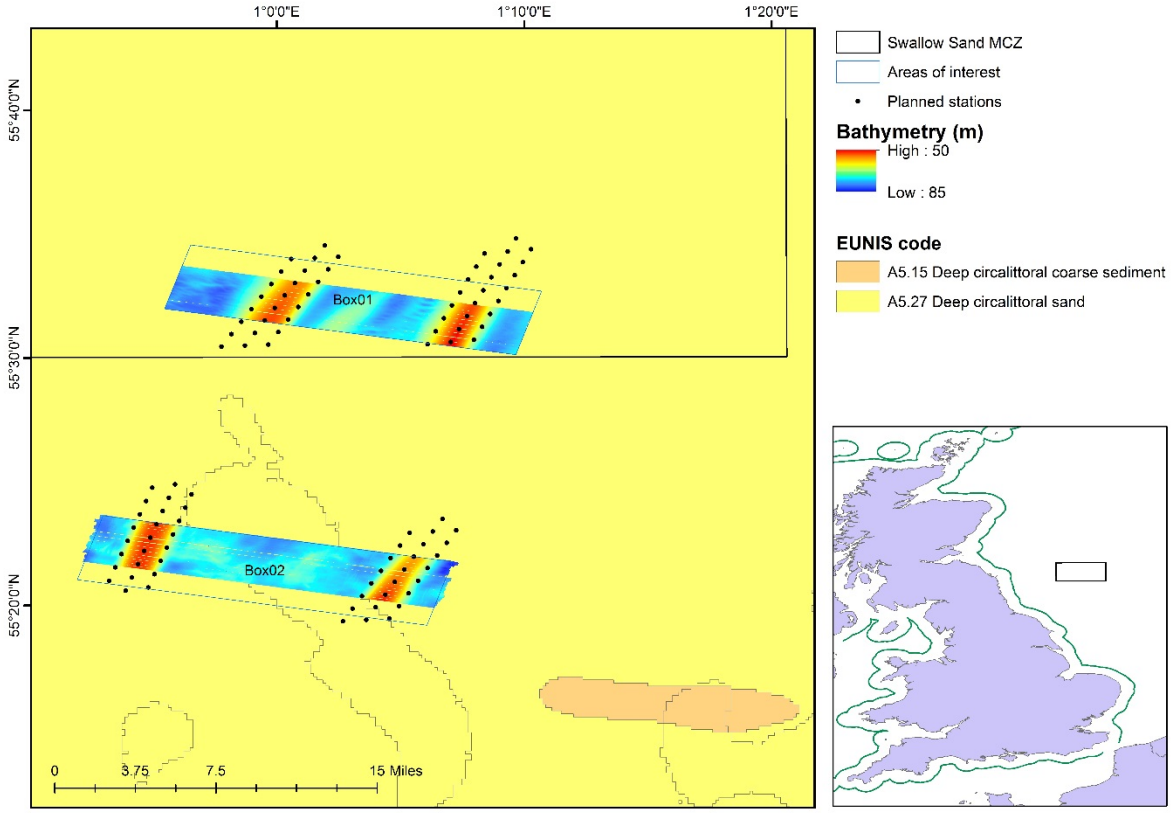


Figure 3. MBES coverage and locations the sampling points; associated with the bank crests.

3 Survey methods and sample processing

3.1 Swallow Sand MCZ

3.1.1 Acoustic

The Kongsberg EM2040 single head MBES system was calibrated successfully over a known wreck site in advance of acquisition of survey lines, to determine any errors in pitch, roll and heading that would affect the quality of the MBES data. Results of this calibration are presented in section 6.3 “Annex 3: MBES calibration”. Sound velocity profiles were collected using a calibrated mini SAIV conductivity temperature depth (CTD) probe and imported into the Kongsberg SIS (seafloor information systems) acquisition software before data acquisition: at the calibration site; at each new survey area; at least once every 24 hours of active survey.

Survey line planning was adjusted to achieve maximum survey coverage and it was accepted that this might reduce resolution in the data (4m resolution achieved). The data were acquired through the Kongsberg SIS software and processed *in situ* using Caris HIPS and SIP software for bathymetry and QPS FMGT software for backscatter. The data were initially acquired at 200kHz frequency but was altered to 300kHz to reduce the negative affect on the backscatter data caused by external interference. Vessel motion data were monitored throughout acquisition, particularly during periods of poor weather conditions. Survey lines were acquired in only one direction when the vessel heave was considered too large to remove during processing. Survey line spacing and MBES parameters, e.g. beam angle, were adjusted during acquisition to ensure maximum coverage was achieved.

3.1.2 Sediment and infaunal sampling: Hamon grab

The grab system comprised a 0.1m^2 mini Hamon grab (Figure 4). Samples were collected from within a 50m radius bullring centred on the target location. On recovery, the grab was emptied into a large plastic bin and a representative sub-sample of sediment (approx. 0.5 litres) taken for Particle Size Analysis (PSA). The sample was stored in a labelled plastic bag inside a plastic container and frozen ready for transfer to a laboratory ashore. The remaining sample was photographed and the volume of sediment measured and recorded. Benthic infauna were collected by washing the sample with seawater over a 1mm capture sieve. The retained >1mm fraction was transferred to a labelled container and preserved in buffered 4% formaldehyde for later analysis back at the laboratory. A visual assessment was made of the sediment type sampled by the grab and noted in the field records, assigning the sample to a Folk class and its equivalent EUNIS Level 3 and Broadscale Habitat (BSH) sediment classes.

Figure 4. Image of the 0.1m^2 'mini' Hamon grab on deck prior to deployment.

4 Survey Narrative

4.1 CEND0118: Swallow Sand MCZ

The RV *Cefas Endeavour* departed the Lowestoft quay at 00:30 on 7th January 2018 and transited directly to the Swallow Sands MCZ, following inductions and vessel familiarisation.

On route, the acoustic acquisition equipment was successfully calibrated, using a suitable feature (a known wreck of appropriate size and physical characteristics).

Data acquisition commenced at the southern edge of the first site (Box01) at 22:00 on 7th January 2018. Following the analysis of the first lines of data it was identified that the port channel was experiencing a high level of interference. To counter the interference the beam angle on the port channel was reduced to remove the interference and the starboard channel was extended. No survey time was lost during the troubleshooting and seabed coverage remained as planned.

MBES data was collected continuously until 19:33 on 8th January 2018 when due to deteriorating weather conditions data could only be collected travelling east to west, with a following sea. This continued until 06:30 on 9th January 2018 when operations in Box01 were halted and the vessel was directed to begin operations in Box02. At 00:19 on 10th January 2018 the weather improved sufficiently to acquire acoustic data in both directions. MBES operations continued in Box02 until 17:30 on 10th January 2018.

The vessel returned to the Lowestoft quay and demobbed on the evening of the 11th January 2018.

4.2 CEND0218: Swallow Sand MCZ

The RV *Cefas Endeavour* departed Lowestoft at 18:30 on the 14th January 2018 and carried out work at the Norfolk Banks Stratum of the North Sea (under the auspices of Cefas/Defra monitoring research and development program) until 16:00 on the 26th January 2018.

The vessel transited to the Swallow Sand MCZ and the first grab deployment was successfully performed at 21:00, from station Box01_18. Sediment sampling was completed at 10:00 on the 29th January 2018, with all 100 target stations successfully yielding samples for benthic infauna and PSA. The vessel returned to the Lowestoft quay and demobbed on the morning of the 30th January 2018.

5 Sample inventory

Acoustic data (MBES bathymetry and backscatter), collected from two areas of interest within and immediately outside Swallow Sand MCZ during CEND0118 to identify suitable locations for sediment collection, were processed aboard CEND0118 to rapidly generate bathymetric and backscatter products. Raw soundings and processed data (in the form of a georeferenced raster layer for bathymetry and backscatter) are available for each area of interest (Figure 5 & Figure 6). In total, 100 stations (25 from each bank crest and 50 within each area of interest) were successfully sampled for macrofauna and particle size distribution analyses, during CEND0218; one at each location. The location of the successfully sampled target stations are provided in Figure 3, showing their position relative to the MBES data.

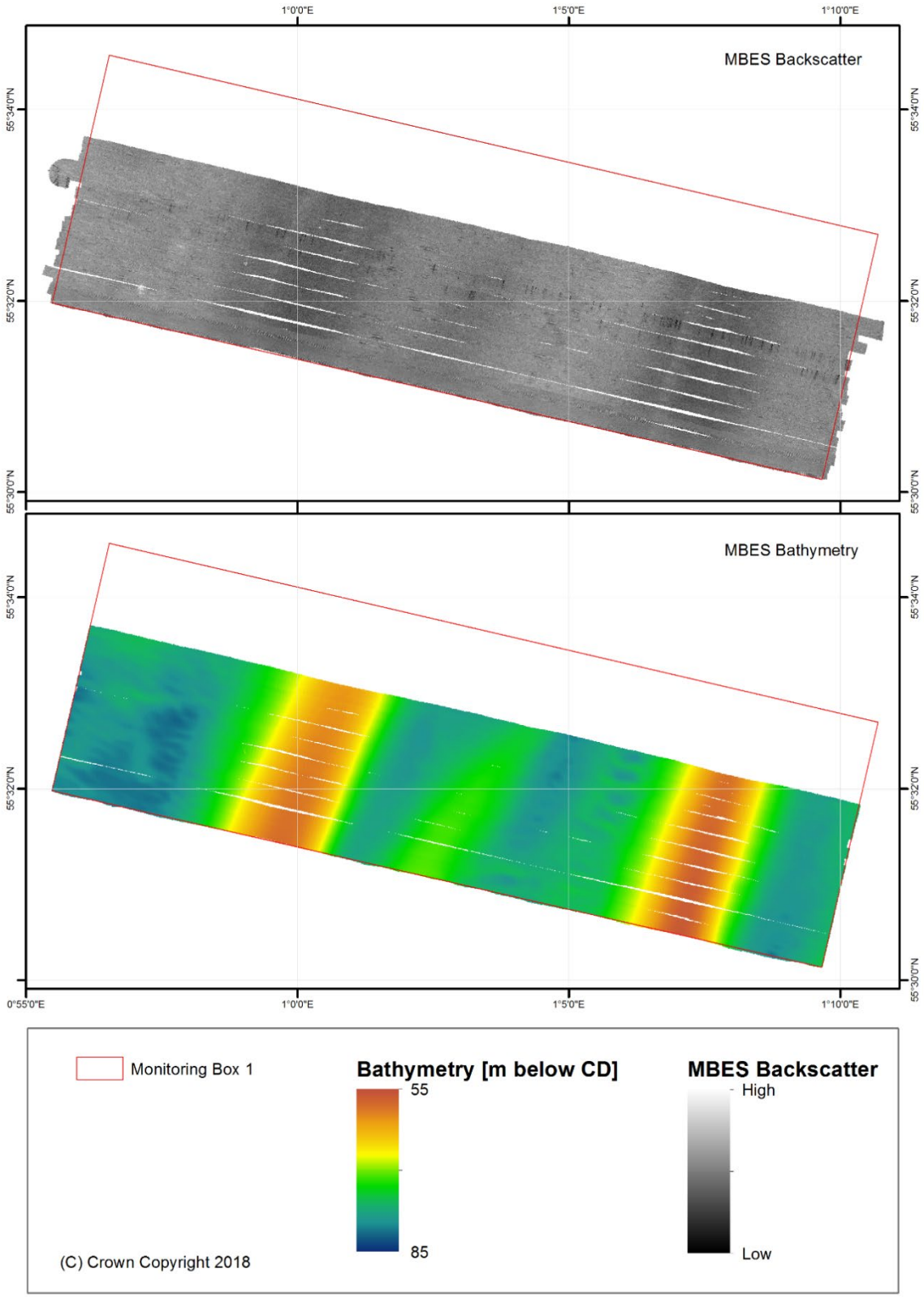


Figure 5. Processed bathymetry and backscatter data from the Box01 survey area, acquired during CEND0118 and used in the sediment sample design.

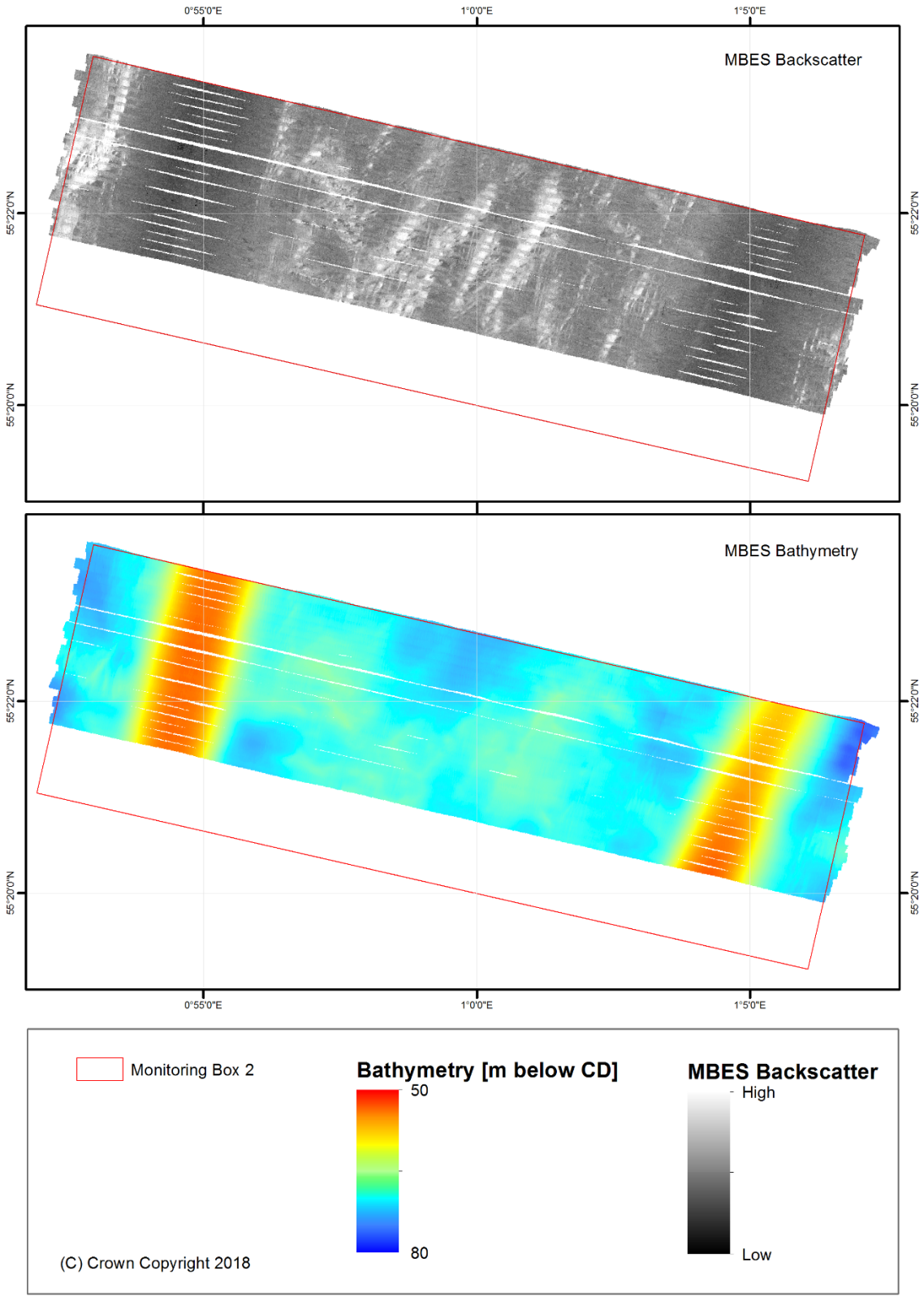


Figure 6. Processed bathymetry and backscatter data from the Box02 survey area, acquired during CEND0118 and used in the sediment sample design.

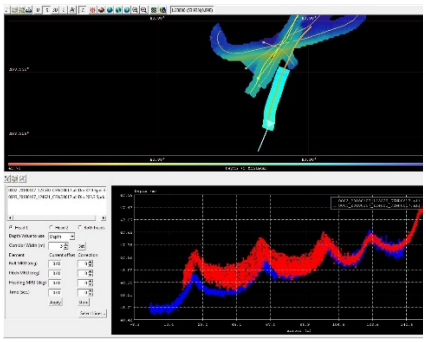
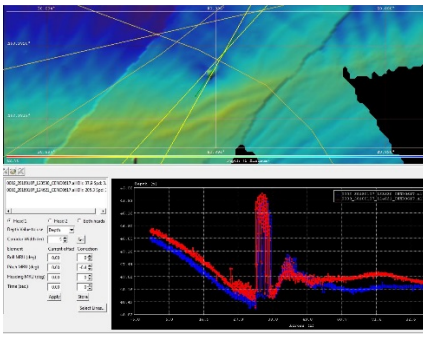
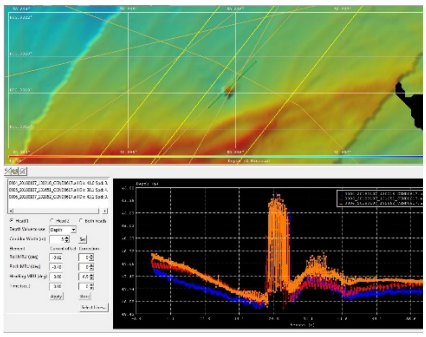
6 Annexes

6.1 Annex 1: 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 tandom electric DC motors Single screw
Power generation	3240Kw
Power propulsion	223 Kw
Thrusters	Bow thruster (flush mounted azimuthing) Stern thruster (tunnel)
Trial speed	14.4 knots
Bollard pull	29 tonnes
Call sign	VQHF3
Official number	906938
MMSI	235005270
Lloyds/IMO number	9251107

Side Gantry	7.5 tonne articulated side A-frame
Stern Gantry	25 tonne stern A-frame
Winches	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

6.2 Annex 2: MBES calibration

Calibration type	Line file name (.all)	Previous value	Change value	Online image
Roll	0002_20180107_123530_CEND0617 0003_20180107_124621_CEND0617	0	-0.02	
Pitch	0002_20180107_123530_CEND0617 0003_20180107_124621_CEND0617	0	-0.4	
Heading	0004_20180107_130216_CEND0617 0005_20180107_131651_CEND0617 0006_20180107_132852_CEND0617	0	0.5	

6.3 Annex 3: Survey Metadata

Station metadata for CEND0218 is provided as supplemental information:

See file ‘JNCC-Cefas-Report-33-Annex3-Station-metadata-CEND0218.xlsm’

Station number is a sequential event number for the expedition, so changes each time a new gear is used, or a new location is sampled. Station code is used to identify the location of the sampling station.

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