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JNCC
Joint Nature Conservation Committee

JNCC/Cefas Partnership Report Series

Report No. 6

North Norfolk Sandbanks and Saturn Reef SCI: CEND 22/13 & 23/13 Cruise Report

Vanstaen, K. & Whomersley, P.

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- All Cefas and JNCC scientific staff who participated in the survey;
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1 Background and Introduction

1.1 Survey Project Team

The survey at the North Norfolk Sandbanks and Saturn Reef Site of Community Interest (NNS & SR SCI) was carried out between 4 and 25 November 2013 on the RV Cefas Endeavour (Survey CEND 22/13 and CEND 23/13). The survey was split in two parts: Part 1 (4–11 November 2013 – CEND 22/13) included a training element for JNCC staff, and the survey team therefore included a large number of JNCC staff (Table 1). The survey team for part 2 (12 – 25 November 2013 – CEND 23/13) was focussed on science objectives and included Cefas marine ecologists, habitat mappers and survey technicians along with three representatives from the Joint Nature Conservation Committee (JNCC) (Table 2). The survey team was split into a night shift (00:00 – 12:00) and day shift (12:00 – 24:00), providing a 24h survey capability throughout the survey.

Table 1. Survey team part 1 (4-11 November 2013)

Name	Institute	Job role
Koen Vanstaen	Cefas	Scientist in Charge
Sue Ware	Cefas	Shift Leader – Night
Nigel Lyman	Cefas	Technical support – Night
Paul Whomersley	Cefas	Shift Leader – Day
Marc Whybrow	Cefas	Technical support - Day
Julia Rance	Cefas	Data management
Bill Meadows	Cefas	Acoustic data processing
Gareth Johnson	JNCC	Night shift
Laura Cornick	JNCC	Night shift
Declan Tobin	JNCC	Night shift
Joey O'Connor	JNCC	Night shift
Laura Robson	JNCC	Night shift
Neil Golding	JNCC	Day shift
Mike Nelson	JNCC	Day shift
Megan Parry	JNCC	Day shift
Fionnuala McBreen	JNCC	Day shift
Oliver Crawford-Avis	JNCC	Day shift

Table 2. Survey team part 2 (12-28 November 2013)

Name	Institute	Job role
Paul Whomersley	Cefas	Scientist in Charge
Chris Jenkins	Cefas	Shift Leader – Night
Nigel Lyman	Cefas	Technical support – Night
Jo Murray	Cefas	Shift Leader – Day
Marc Whybrow	Cefas	Technical support - Day
Julia Rance	Cefas	Data management
Bill Meadows	Cefas	Acoustic data processing
Gareth Johnson	JNCC	JNCC-Lead
Briony Silburn	Cefas	Night shift
Thi Bolam	Cefas	Night shift
Joey O'Connor	JNCC	Night shift
Linford Mann	Cefas	Day shift
Julia Hunt	Cefas	Day shift
Rebecca Oliver	JNCC	Day shift

1.2 Site Description

The North Norfolk Sandbanks and Saturn Reef SCI is situated in the southern North Sea, around 40 kilometres northeast of East Anglia (Figure 1). The North Norfolk Sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters (Graham *et al* 2001). They are subject to a range of current strengths which are strongest on the banks closest to shore (Collins *et al* 1995). The outer banks are the best example of open sea, tidal sandbanks in a moderate current strength in UK waters. The banks support communities of invertebrates which are typical of sandy sediments in the southern North Sea such as polychaete worms, isopods, crabs and starfish. The sandbanks have a north-west to south-east orientation and are thought to be progressively, though very slowly, elongating in a north-easterly direction (perpendicular to their long axes) (Cooper *et al* 2008). The banks included are: Leman, Ower, Inner, Well, Broken, Swarte and four banks called, collectively, the Indefatigables (Figure 1). The crests of the banks are in water shallower than 20m below Chart Datum, and the flanks of the banks extend into waters up to 40m deep.

The Saturn *Sabellaria spinulosa* biogenic reef, first discovered in 2002, consists of thousands of fragile sand-tubes made by *Sabellaria spinulosa* (Ross worm) which are consolidated together creating a solid structure rising above the seabed (BMT Cordah, 2003). This structure qualifies as Annex I Reef according to European Commission interpretation (CEC 2007) (Table 3). Reefs formed by *Sabellaria spinulosa* allow the settlement of other species not found in adjacent habitats leading to a diverse community of epifaunal and infaunal species (MarLIN 2006a). In 2003, Saturn Reef covered an area approximately 750m by 500m just to the south of Swarte Bank (BMT Cordah 2003). The formation/presence of such a substantial reef of *Sabellaria spinulosa* in this area indicates favourable conditions for reef formation at that time.

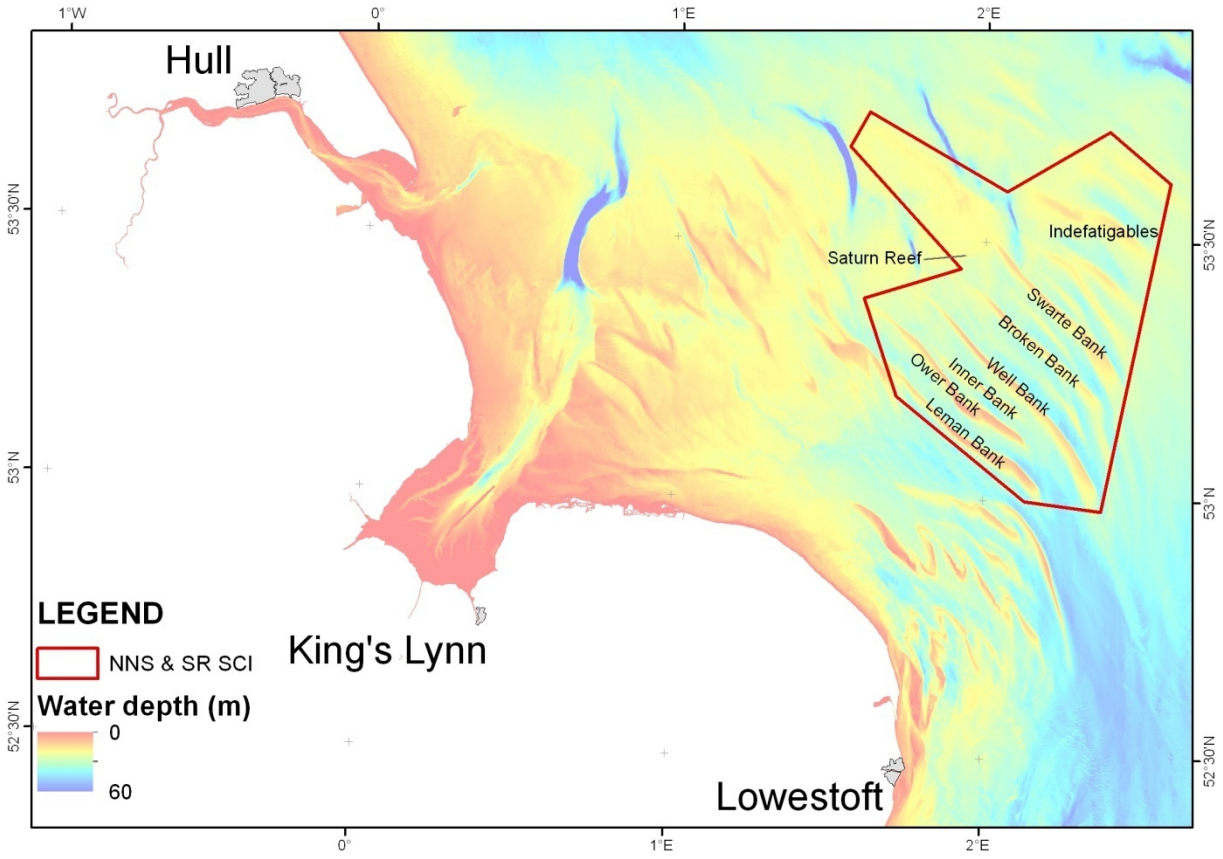


Figure 1. Location of the North Norfolk Sandbank complex & Saturn Reef SCI.

Table 3. Interest features under the EU Habitats Directive.

Feature code	Feature name
1110	Sandbanks which are slightly covered by sea water all the time
1170	Reefs

1.3 Existing data and information used to inform survey planning

1.3.1 Biogenic Reef

The *Sabellaria spinulosa* biogenic reef was surveyed by Subsea 7 Ltd under contract to ConocoPhillips in 2003. Formed by dense aggregations of *Sabellaria spinulosa*, it was located between Swarte and Broken banks on the edge of a small sandbank in the southern North Sea (BMT Cordah 2003). The density of Saturn *Sabellaria spinulosa* biogenic reef varied across the area. A core section of near continuous and high profile reef (10cm high) with very dense coverage (90% of the seabed) was identified, with some sections rising to up to 25cm above the seabed). Also observed were patchier reef areas with 10-50% coverage and even sparser reef patches with less than 10% coverage (BMT Cordah 2003). Overall, the extent of the reef was estimated to be approximately 750m x 500m, with approximately 50% (500m x 250m) consisting of the higher profile reef (BMT Cordah 2003). Reef patches were either broken by various shaped 'holes' or were elongated strips, raised above surrounding seabed. Surrounding sediment included both tube debris and non-tube sediment consisting of silty sand/stones (Figure 2).

Figure 2. A patch of *Sabellaria spinulosa* reef observed as part of previous surveys (BMT Cordah 2003)

Further surveys were undertaken by Cefas in July 2006 within the same area where *Sabellaria spinulosa* reef was found in 2003. Sidescan sonar, multibeam echosounder and video tow data were collected, but did not identify any reef features in the area.

1.3.2 Sandbank Characterisation

Planning of the sandbank characterisation sampling made use of historic bathymetry surveys in the area. The Defra Digital Elevation Model (DEM) combines all best available bathymetry data for the North Norfolk sandbanks and in this area is made up of single beam survey undertaken in the 1980-90s. The data show water depths vary between 2 and 60 metres below Chart Datum (Figure 3). The shallowest depths are reached on top of the sandbanks in the southwestern part of the site, whereas deepest areas are found in the narrow troughs in the northern part of the site.

The seabed sediment map from the British Geological Survey shows primarily sand, slight gravelly sand and gravelly sand in the area (Figure 3). Whereas the sands are mainly

associated with the sandbanks, the coarser sediments are mainly found in the deeper troughs between the sandbanks.

The distribution of UKSeaMap 2010 predictive modelled habitats for the NNSB SCI is also shown in Figure 3.

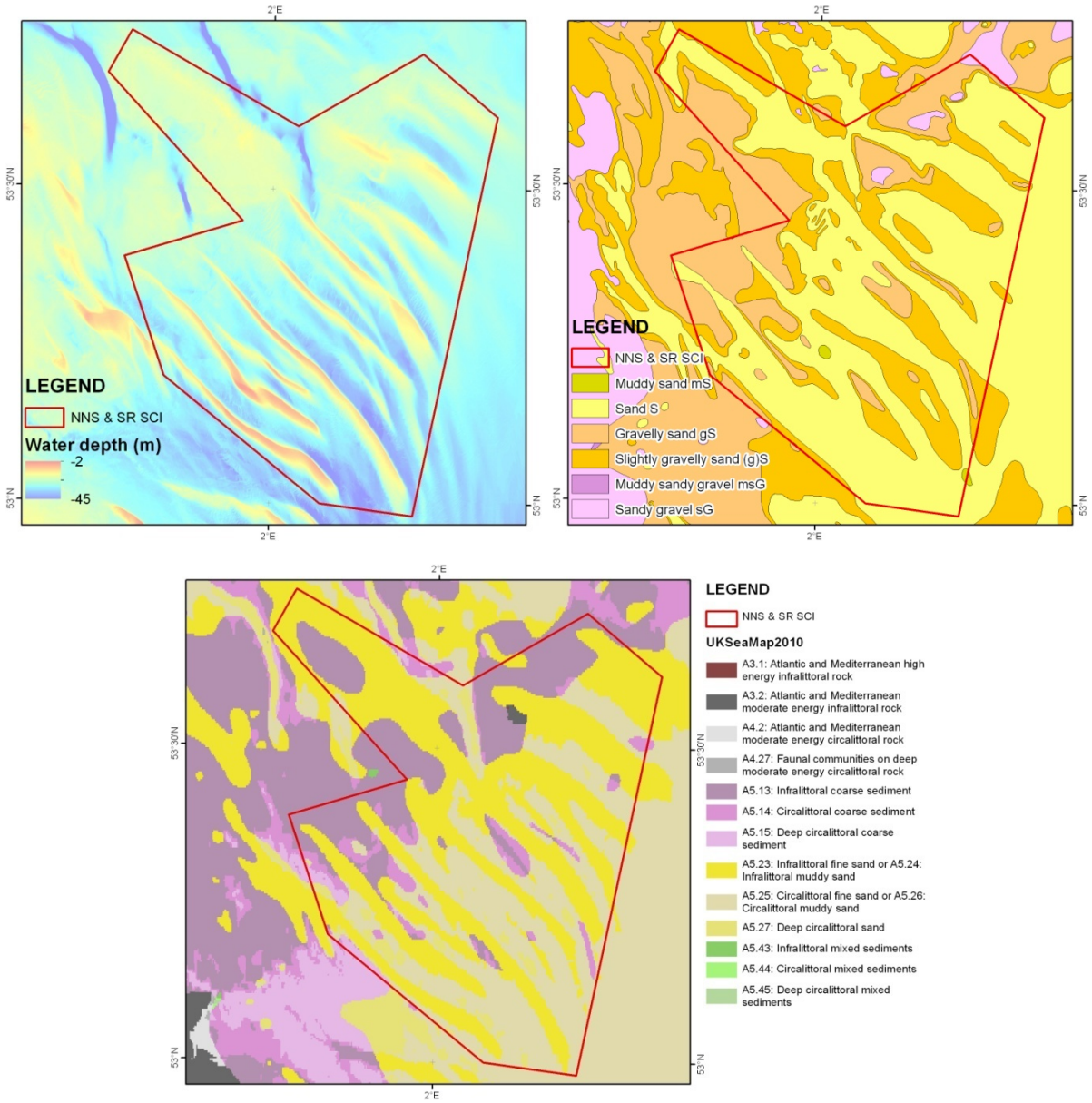


Figure 3. (Top left) Seabed bathymetry of the NNSB SCI (From Defra DEM model); (Top right) Seabed sediment distribution from British Geological Survey map; (Bottom) UKSeaMap 2010 modelled EUNIS habitat distribution.

2 Survey Design and Methods

2.1 Survey planning and design

The aim of surveys CEND 22/13 and CEND 23/13 was to gather additional seabed data to assist with the development of management advice. Objectives were prioritised as follows:

1. Survey areas of existing known *Sabellaria spinulosa* reef or areas where it has previously been found

2. Assess presence, and where possible, delineate the Annex I biogenic reef feature and characterise associated fauna; and

3. Survey areas of sandbank to characterise distribution of infauna communities in order to better understand their sensitivities to a range of pressures.

In addition, survey CEND22/13 had a parallel aim to train participating JNCC survey staff so that they are able to lead offshore surveys for JNCC in the future. Though this training will contribute to the participants eventually becoming JNCC lead scientists on certain surveys, it is not expected that this cruise alone will necessarily enable them to reach this level of competency.

The survey was designed around six areas of search (Figure 4) and a coarse sampling grid was provided by the JNCC. The areas of search were labelled A to E. Survey lines were created at 200m line spacing to achieve full seafloor coverage using a high resolution sidescan sonar system. Simultaneous multibeam data would be collected, recognising that full seafloor coverage would not be achieved.

2.1.1 Sabellaria spinulosa sampling methodology

Stations within each area of search carried the prefix of the area of search (e.g. A22 for a sample from area of search A). The coarse sampling grid had a spacing of 1.5 km between stations and stations were allocated a station code between 1 and 42 (e.g. D1 to D42) (Figure 4). Additional sampling or video transects that were selected during the survey, targeting specific areas, were allocated station code numbers over 50 (e.g. A51).

A combination of seabed sampling and video observations was undertaken. Due to the hard and coarse sediments expected, a 0.1m^2 Hamon Grab was employed for all seabed sampling. The video data were collected from a drop frame to avoid potential damage to *Sabellaria spinulosa* reef.

At stations located on the 1.5km grid, the drop camera was deployed to collect two minutes of video data and three stills images, or longer if *Sabellaria spinulosa* reef was observed (Figure 5). At each station, a seabed sample was collected for sediment and macrofauna analysis. After review of the sidescan sonar data, additional sampling stations were situated in areas where the acoustic signature suggested the potential occurrence of *Sabellaria spinulosa* reef. At these stations, a minimum 10 minute tow using the drop camera was undertaken, followed by a targeted Hamon Grab sample if *Sabellaria spinulosa* was observed (Figure 6). In total six areas of interest (survey boxes A-F) were surveyed using the techniques detailed above (Figure 7).

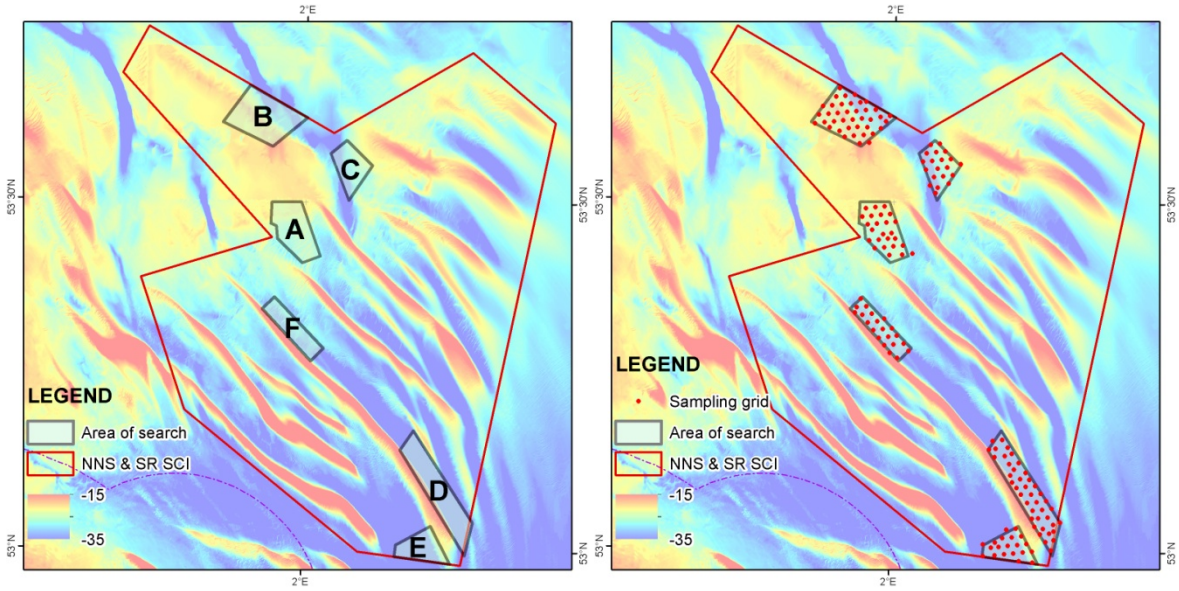


Figure 4. (Left) Areas of search within the NNSB SCI; (Right) Survey design for the primary sampling at the NNSB SCI.

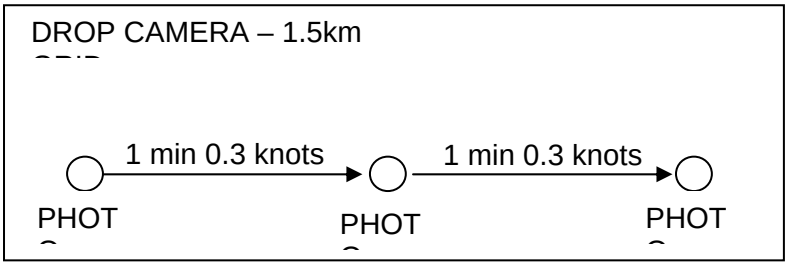


Figure 5. Schematic of video operations at station located on the 1.5km grid.

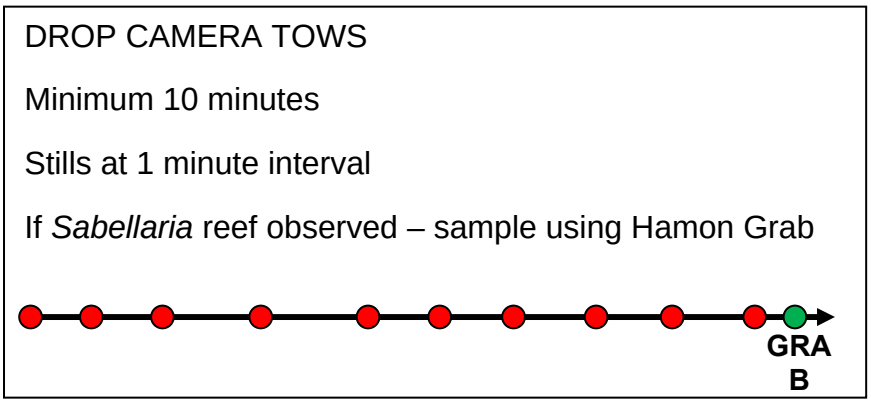


Figure 6. Schematic of video operations at targeted ground-truthing stations.

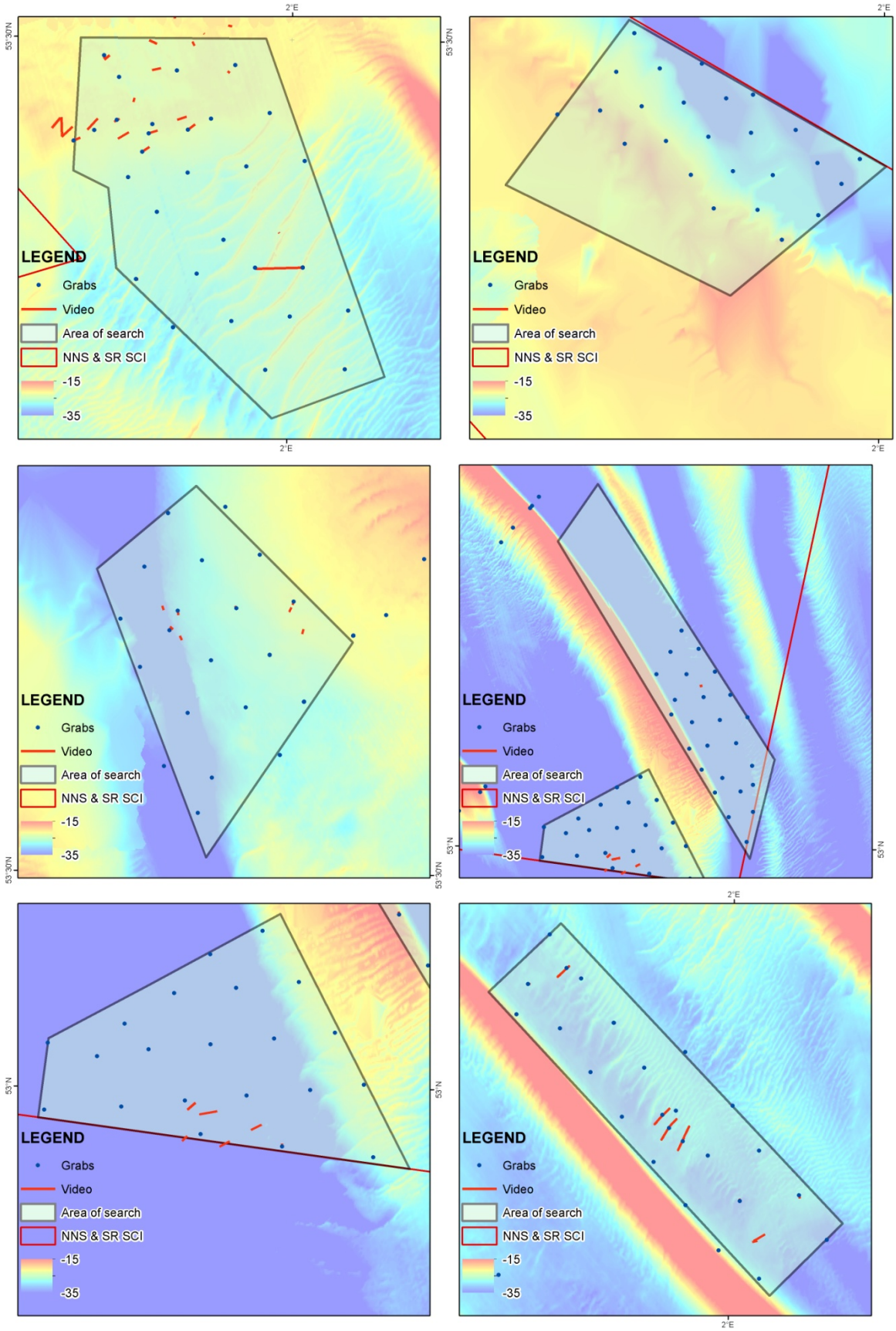


Figure 7. (Top left) Location of grab and video stations within area of search A; (Top right) Location of grab and video stations within area of search B; (Middle left) Location of grab and video stations within area of search C; (Middle right) Location of grab and video stations within area of search D; (Bottom left) Location of grab and video stations within area of search E; (Bottom right) Location of grab and video stations within area of search F.

2.1.2 Sandbank transects

Sandbanks suitable for survey on RV Cefas Endeavour (no banks in < 13m of water were considered) were identified using the Defra Digital Elevation Model bathymetry layer (Figure 8).

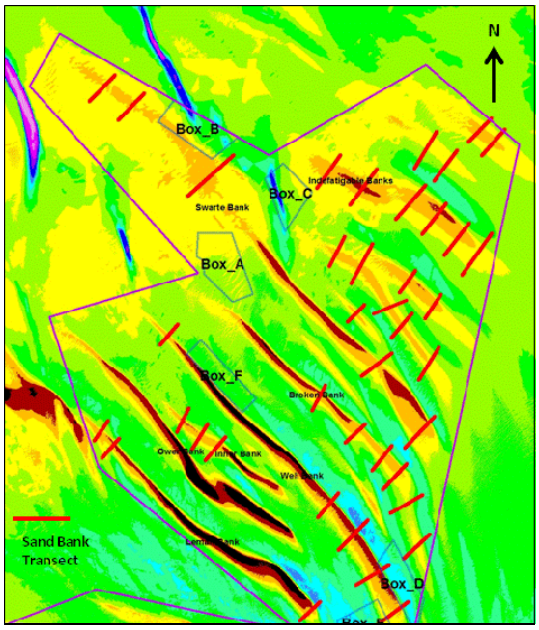


Figure 8. Map showing the location of proposed sandbank transects. Not all transects were surveyed due to time constraints.

To define the profile of the sandbank a transect of multibeam was acquired across the sandbank. Once this had been completed the profile of the sandbank was plotted using the profile tool in OLEX. Five grab samples were then positioned across the sandbank (Trough, Flank, Crest, Flank, and Trough) (Figure 9). Hamon grab samples from each of the stations across the sandbank were then collected for macrofauna (>1 mm) and Particle Size Analysis (PSA).

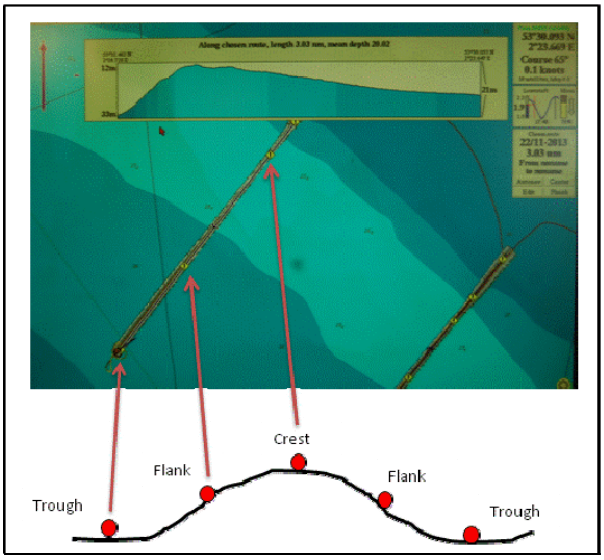


Figure 9. Diagram demonstrating the use of the seabed profiling tool in OLEX and how the Multibeam acoustic transect line was used to plot the profile of the sandbank and then position sample stations in troughs, on flanks and on the crest of the sandbank.

2.2 Survey Equipment and sample processing

2.2.1 Sidescan sonar

High resolution sidescan sonar data were acquired using an Edgetech FS4200 system. The sonar simultaneously acquires data at 300 and 600 kHz frequencies. The towed body was deployed from the stern of the vessel. Data were recorded using the Edgetech Discovery software in both proprietary JSF and universal XTF format. During survey operations cable out was recorded to allow layback calculations to be applied during post-processing of the data.

All post-processing of data was undertaken using the Triton Imaging ISIS software suite. Georeferenced TIFF images were created using DelphMap software and exported at 30cm resolution.

2.2.2 Multibeam bathymetry and backscatter

Multibeam bathymetry and backscatter data were acquired using the Kongsberg EM2040 system operated at 300 kHz and deployed on the drop keel of RV Cefas Endeavour, which was lowered to 1 m below the underside of the vessel. Variations of sound velocity with water depth were determined using a CTD (conductivity-temperature-depth) probe taken at 24 hour intervals and applied during multibeam data processing. Details of the multibeam equipment are provided in Annex I. Since no system changes had been made since the last 2 system calibrations in January and March 2013, previous calibration settings were adopted. No data quality issues were found, suggesting system recalibration was not required.

The raw multibeam bathymetry data were processed using CARIS HIPS and QPS Fledermaus. Tidal information was extracted from a high precision CNAV 3050 DGPS receiver. Tide height data were smoothed and extracted to reduce the bathymetry data to Chart Datum. Multibeam backscatter data were processed with the QPS Fledermaus Geocoder Toolbox (FMGT) software to produce floating point (FP) GeoTiff images.

2.2.3 Ground-truth sampling

Ground-truth sampling was achieved using grabs and underwater video cameras, as described below.

2.2.3.1 ***Grabs***

The grab system comprised a 0.1m^2 mini Hamon grab (Figure 10). Where sampling targeted specific features, the Hamon grab was equipped with a camera, the combined gear being known as a 'HamCam'. Samples were collected from within a 100m radius 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 PSA. The sample was stored in a labelled 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 fauna were collected by washing the sample with sea water over a 5mm and 1mm sieve. Material retained on the 5mm and 1mm sieves were photographed. The retained >1mm fraction was transferred to a labelled container and preserved in buffered 4% formaldehyde for later analysis ashore. A visual assessment was made of the sediment type sampled by the grab and noted on the field records, assigning the sample to a Folk class and its equivalent EUNIS and Broadscale Habitat (BSH) sediment classes. Where *Sabellaria spinulosa* reef fragments were recovered a full assessment of the fragments was undertaken, measuring height, width and depth, investigation of live worm presence and photographs taken.

Figure 10. Mini Hamon grab with video camera (HamCam).

2.2.3.2 ***Cameras***

Video observations were made with a drop camera system (Figure 11), including a video camera with capability to also capture still images. The camera (Kongsberg 14-208) was mounted in a rectangular drop-frame and deployed from the side gantry, amidships. Illumination was provided by four high intensity LED striplights and a dedicated flash unit. The camera was oriented to provide a forward oblique view of the seabed and was fitted with a four-spot (red) laser-scaling device, projecting the corners of a 17cm x 17cm square along the axis of the lens onto the seabed. During deployments the vessel executed a controlled drift at ~ 0.3 knots along the specified path. Set-up and operation followed the MESH 'Recommended Operating Guidelines (ROG) for underwater video and photographic imaging techniques[1]. Video was recorded simultaneously to a Sony GV-HD700 DV tape recorder and a computer hard drive. A video overlay was used to provide station metadata, time and position (of the GPS antenna) in the recorded video image. Stills images were captured at regular one minute intervals and with additional opportunistic images if specific features of interest were encountered. The height of the camera off the seabed was controlled by a winch operator who had sight of the video monitor.

During the survey, limited trials were also undertaken with a new camera system: SubC Imaging Chimaera. This camera has a far superior specification compared to the Kongsberg camera, but had not been deployed by Cefas before. The camera was deployed on the dropframe in a similar fashion to the Kongsberg camera.

[1] Coggan, R., Mitchell, A., White, J. and Golding, N. (2007) Recommended operating guidelines (ROG) for underwater video and photographic imaging techniques. MESH Project guideline document. Online: http://www.searchmesh.net/pdf/GMHM3_Video_ROG.pdf.

On selected tows, the drop frame was also equipped with GoPro cameras. A single camera was mounted in an outward looking position, to provide a wider context to the observations made by the main camera.

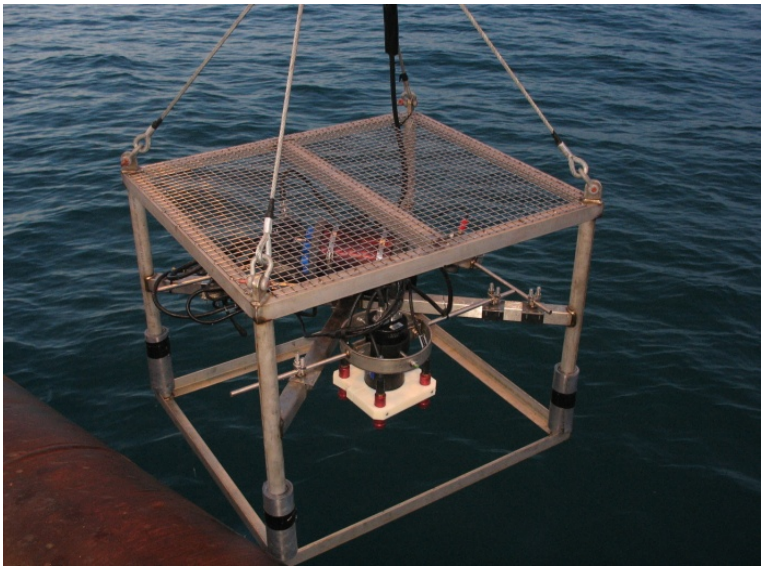


Figure 11. Drop camera frame showing camera and 4-spot laser scaling device.

Field notes were made during each camera deployment, noting station and sample metadata, real-time observations of substrate and taxa, and an initial assessment of the range of broadscale habitats (BSHs) seen. A summary pencil sketch depicting the main site characteristics was generally included.

2.2.4 Camera clock synchronisations

The internal clock of the camera used on the drop frame was synchronised with GPS time. This clock creates a timestamp in the EXIF data stored in the digital image. A calibration test was conducted using the camera to photograph a clock set to GPS time, and confirmed the camera clock was synchronised to GPS time.

2.2.5 GPS positions and corrections.

GPS fixes were recorded using the Tower Navigation system on RV Cefas Endeavour. The software records the geographic position of the sampling equipment depending on the deployment location and then applies an offsets to the logged positional data. Fixes for grab samples were taken at the instant the grab contacted the seabed. The grab was always deployed from the side gantry and the position recorded is taken to be the true position of the grab sample, as the grab typically drops directly down from the gantry. In extreme conditions an offset of up to ~10 metres may occur, but was not accounted for.

Fixes were made for each still image taken by the cameras. The drop camera was always deployed from the side gantry. The HiPAP underwater positioning system was activated during deployments, but often resulted in poor performance. This may have been caused by shallow water depth, dynamic positioning operation or other factors affecting the acoustic detection capability. Where the HiPAP system did provide accurate underwater positioning data, it proved that only minor variations were observed between HiPAP and side gantry positions. Side gantry positions were therefore selected as the source for all drop camera tows and stills positioning.

3 Survey Narrative

The RV *Cefas Endeavour* left Lowestoft at 20:00 on Monday 4 November 2013. On leaving port, the vessel set sail for the North Norfolk Sandbanks & Saturn Reef SCI survey site. At 21:30 on Monday 4 November 2013 an operations toolbox talk was held with scientific staff, officers and deck crew present. This was followed by equipment wet testing between 22:30 and 01:30. Some faults were identified and addressed. The vessel arrived at area of search A within the survey site at 7:30 on Tuesday 5 November 2013 when acoustic survey operations started. The drop keel was deployed to 1m and a sound velocity profile was collected. An emergency drill was held at 13:00 requiring all staff to get in an immersion suit and move to their life raft station. Acoustic survey operations continued until 18:50 on Wednesday 6 November 2013. Following some camera checks, drop camera and Hamon grab sampling started 19:35. Communication issues with the camera were experienced. Software changes and system reset did not resolve camera issues. Whilst camera operations were halted, Hamon grab sampling continued at four stations. Following rewiring of the camera distribution box, the camera system was operational again by 23:06 and no further issues were experienced. On Thursday 7 November video and sampling operations continued at the stations on the 1.5 km grid. Following processing and review of sidescan sonar data, additional survey stations were selected for longer video tows. Operations at these additional stations started 12:00. Stations in the north east of area A did not reveal any *Sabellaria spinulosa* reefs. At 14:30, at station A54, camera comparison trials were undertaken. The same tow was repeated with both SubC Imaging and Kongsberg cameras. Issues were experienced with the SubC Imaging flash system, resulting in poor quality stills images. Operations continued with the Kongsberg camera system. As stations in the north west of area A were visited, medium/high quality reef features were encountered at several stations. In order to assess whether the reef was occupied by live worms, targeted sampling using the Hamon grab was undertaken at selected sites. The samples recovered allowed estimates of reef height and revealed worms living within the tubes. Ground-truthing operations at area A were completed 04:00 on Friday 8 November 2013.

The vessel then transited to area C, where industry data previously identified *Sabellaria spinulosa* reef. Sidescan sonar and multibeam echosounder data acquisition started 05:00 on Friday 8 November 2013 and continued until 07:00 on Saturday 9 November 2013. As weather conditions had deteriorated, conditions were assessed whilst maintenance work was undertaken on the Tower logging system. Sampling and video work was resumed at 09:00 and continued throughout the day. Some problems were experienced with the drop camera system throughout the day, which resulted in 30 minutes of lost time. Some observations of patchy *Sabellaria spinulosa* reef were made. Ground-truthing work in area of search C was completed in the early hours of Sunday 10 November 2013. As no major reef observations were made in area C, it was decided not to undertake any additional work here. In the meantime an in-depth review of Area A data had identified a few new areas which would benefit from further investigation. Additional sidescan sonar lines were run, which were completed by 11:30. Along the additional sonar lines, further video tows were planned. All were successful in locating *Sabellaria spinulosa* reef features. Camera issues were experienced at the last video station, which resulted in some equipment downtime. During the day weather forecasts were reviewed and discussions had with the Lowestoft pilot to assess if planned docking at 16:00 on Monday 11 November would be possible. Conditions were not deemed favourable and it was agreed to delay docking by 12 hours until Tuesday 12 November 04:00. Survey plans were adapted to incorporate an additional 12 hours of work.

The vessel set sail for a new area of search, F, where *Sabellaria spinulosa* reef had been reported by industry surveys. Sidescan operation started 22:45 and continued until 16:30 on Monday 11 November 2013.

RV Cefas Endeavour docked in Lowestoft at 02:30 on Tuesday 12 November. JNCC trainee survey leads disembarked and were replaced by Cefas staff as planned. Cefas Endeavour sailed at 15:30, 12 November and transited to North Norfolk and Saturn Reef SCI, arriving at 04:30, 13 November. On arrival a Sound Velocity Cast (SVP) cast was carried out before continuing the Sidescan and Multibeam (SS/MB) survey at Box F. The SS/MB survey was completed 12:00, 13 November. On completion of the SS/MB survey of Box F work then began on the ground-truthing survey. During this time the SS data was processed and interpreted. Areas of possible *Sabellaria spinulosa* reef were delineated and additional ground truthing stations targeting these specific areas planned.

At 04:30, 14 November the weather and underwater visibility deteriorated sufficiently to prevent further Drop Camera deployments. RV Cefas Endeavour then transited north to begin the planned SS/MB survey at Box B. At 14:30, worsening weather condition prevented further acoustic data acquisition. Efforts were made to collect data in the direction of the prevailing weather conditions but the data was still deemed to be of insufficient quality.

Work restarted 06:15, 15 November on the SS/MB survey at Box B. At 16:15, 15 November the survey had to be halted due to a problem with a connector on the sidescan fish. While this connector was replaced work began on the planned ground truthing survey at Box B. Once the sidescan fish was repaired work continued on the SS/MB survey. The SS/MB survey was completed 15:00, 16 November.

On completion of the SS/MB survey work resumed on the ground-truthing survey, during which time the SS data was processed and interpreted [No potential areas on *Sabellaria spinulosa* reef were identified]. The ground-truthing survey was completed 22:30, 16 November.

RV Cefas Endeavour then transited back to Box F to survey the remaining ground truthing stations. The remaining stations were successfully surveyed 10:10, 17 November after which RV Cefas Endeavour transited south to begin the SS/MB survey at Box E. On arrival a SVP cast was carried prior to the start of the survey. The SS/MB survey was completed 14:09, 18 November after which RV Cefas Endeavour transited to the first ground-truthing station. Work continued on the ground-truthing survey until poor underwater visibility prevented the use of the Drop Camera. Cefas Endeavour then transited north to Box D to begin the planned SS/MB survey and to allow time for the underwater visibility to improve.

Due to further deterioration in sea state and data quality the SS/MB survey of Box B was halted 13:15, 19 November. Work then commenced on the planned ground-truthing survey at Box D however due to still worsening weather conditions all operations were stopped at 07:00, 20 November.

At 15:00, 20 November a trial SS/MB survey line was run to assess data quality, unfortunately the data quality was still poor. With weather conditions still preventing the deployment of the Hamon grab and Drop Camera, a decision was made to run some MB infill lines at Box E which resulted in 100% coverage of both SS and MB at Box E.

Due to there being no improvement in the weather it was then decided to transit north to begin work on the planned sandbank transects (Aim 2). On arrival 18:20, 21 November an SVP cast was carried out before beginning the planned MB and Hamon grab surveys of selected sandbanks. Work continued on the sandbank transects until the northern section of the sandbank survey plan had been completed at 00:30, 23 November. During this time the weather had improved sufficiently to return to Box D to continue the SS/MB survey 05:00, 23 November. On completion of the SS/MB several ground truthing stations were planned over areas identified as possible *Sabellaria spinulosa* reef from the acoustic record. Several attempts were made to survey these areas with the Drop Camera but poor underwater visibility prevented the acquisition of usable video and still images.

On completion of Box D SS/MB survey RVCefas Endeavour transited west back to Box E to survey the remaining Drop Camera stations which had been targeted at possible *Sabellaria spinulosa* reef signatures interpreted from the acoustic record. On completion of these stations RV Cefas Endeavour proceeded northwest to continue collecting data from sandbank transects located in the west of the site (Aim 2) 06:00, 24 November. RV Cefas Endeavour surveyed a further six sandbank transect before leaving the site at 2:00, 25 November.

4 Preliminary Results

4.1 Acoustic Maps

Sidescan sonar and multibeam echosounder data were collected in a number of predefined areas of search. The surveys were designed to achieve full seafloor coverage using sidescan sonar. As a result, only partial seafloor coverage was achieved with the multibeam echosounder.

Sidescan sonar and multibeam data were processed onboard following standard Cefas procedures (see method section). Detailed technical “Reports of Survey” are provided as deliverables for the multibeam bathymetry and backscatter datasets.

Area of search A showed a variation in water depths between 15 and 30m below Chart Datum (Figure 12). The southern part of the area was characterised by large sandwaves with general NNE-SSW orientation. To the north, a relatively flat area of seabed was found, which on the backscatter and sidescan sonar revealed coarser sediment. In the northwestern part of the area, sidescan sonar signatures often indicative of *Sabellaria spinulosa* reef could be seen and were investigated further using camera systems (Figure 11).

Area of search B was characterised by a water depth between 25 and 30m and two deeper trenches with NNW-SSE orientation deepening to 40m below Chart Datum (Figure 13). The shallows were characterised by high backscatter intensity suggesting coarse and hard substrates. Locally, patches with lower backscatter were observed, associated with sandwave features. The deeper trenches were also characterised by lower backscatter returns.

Area of search C was characterised by a deep trench with NNW-SSE orientation, reaching 55 m below Chart Datum (Figure 14). The remainder of the areas was generally featureless and flat, at a water depth between 25 and 30m below Chart Datum. Backscatter and sidescan sonar data revealed coarser sediment to the east of the trench. The trench itself and the area to the west revealed much softer, sandier sediments.

Area of search D was situated in-between sandbanks. In the deeper lying parts water depths reached around 50m below Chart Datum, whereas shallower depths of 25m were reached on the flanks of the sandbank (Figure 15). In the southern part of the area, sedimentary bedforms could be observed. The backscatter strength in these areas was lower compared to surrounding areas, similar to those on the flanks of the sandbank. We should mention that gap in middle of dataset was due to oil and as infrastructure safety zones which the vessel needed to avoid?

Area of search E was characterised by a water depth decreasing from west (50m) to east (20m) (Figure 16). The shallow edges of the sandbanks were also characterised by the presence of sedimentary bedforms. The backscatter associated with these features was lower compared to the deeper lying areas. In the central part of the block a few more isolated beforms were present, characterised by slightly higher backscatter returns around them.

Area of search F was characterised by water depths varying between 20 and 30m below Chart Datum (Figure 17). In the northwestern corner, water depths reached 50m. Large parts of the morphology of the area was characterised by sedimentary bedforms with slightly lower backscatter response. The deeper areas to the west and east showed slightly stronger backscatter return suggesting coarser or harder substrates.

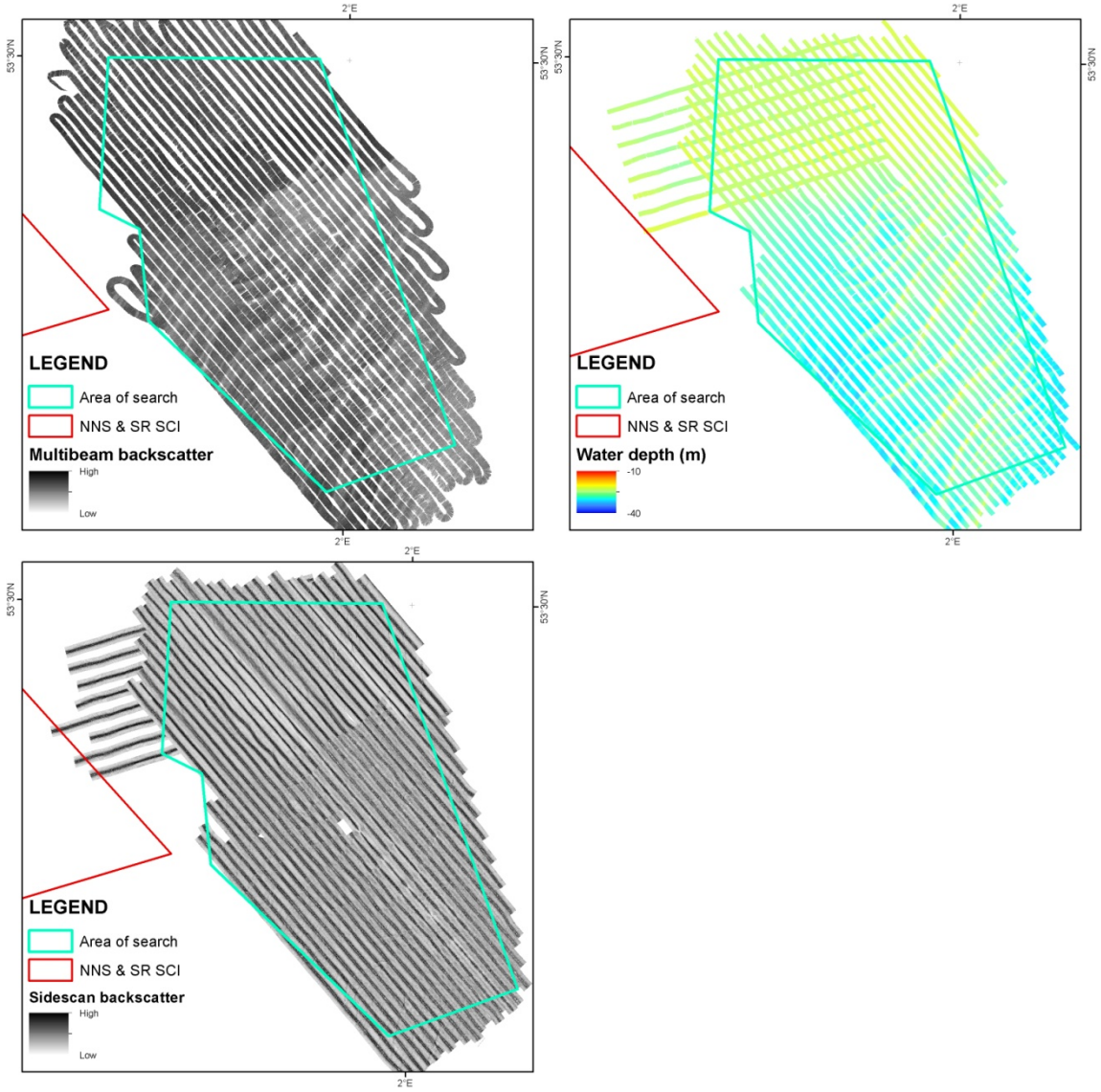


Figure 12. (Top left) Multibeam backscatter for area of search A; (Top right) Multibeam bathymetry for area of search A; (Bottom left) Sidescan sonar backscatter for area of search A.

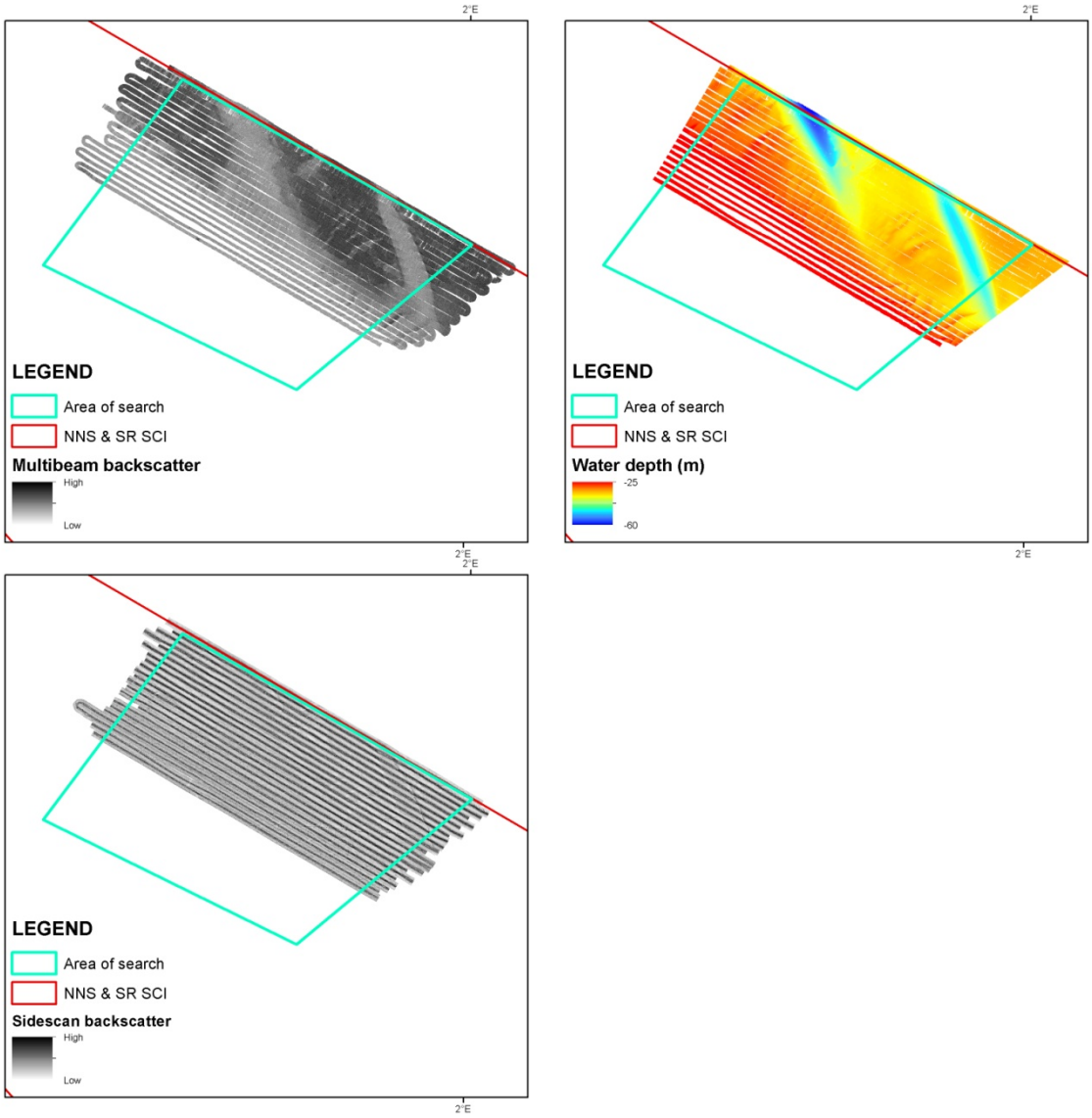


Figure 13. (Top left) Multibeam backscatter for area of search B; (Top right) Multibeam bathymetry for area of search B; (Bottom left) Sidescan sonar backscatter for area of search B.

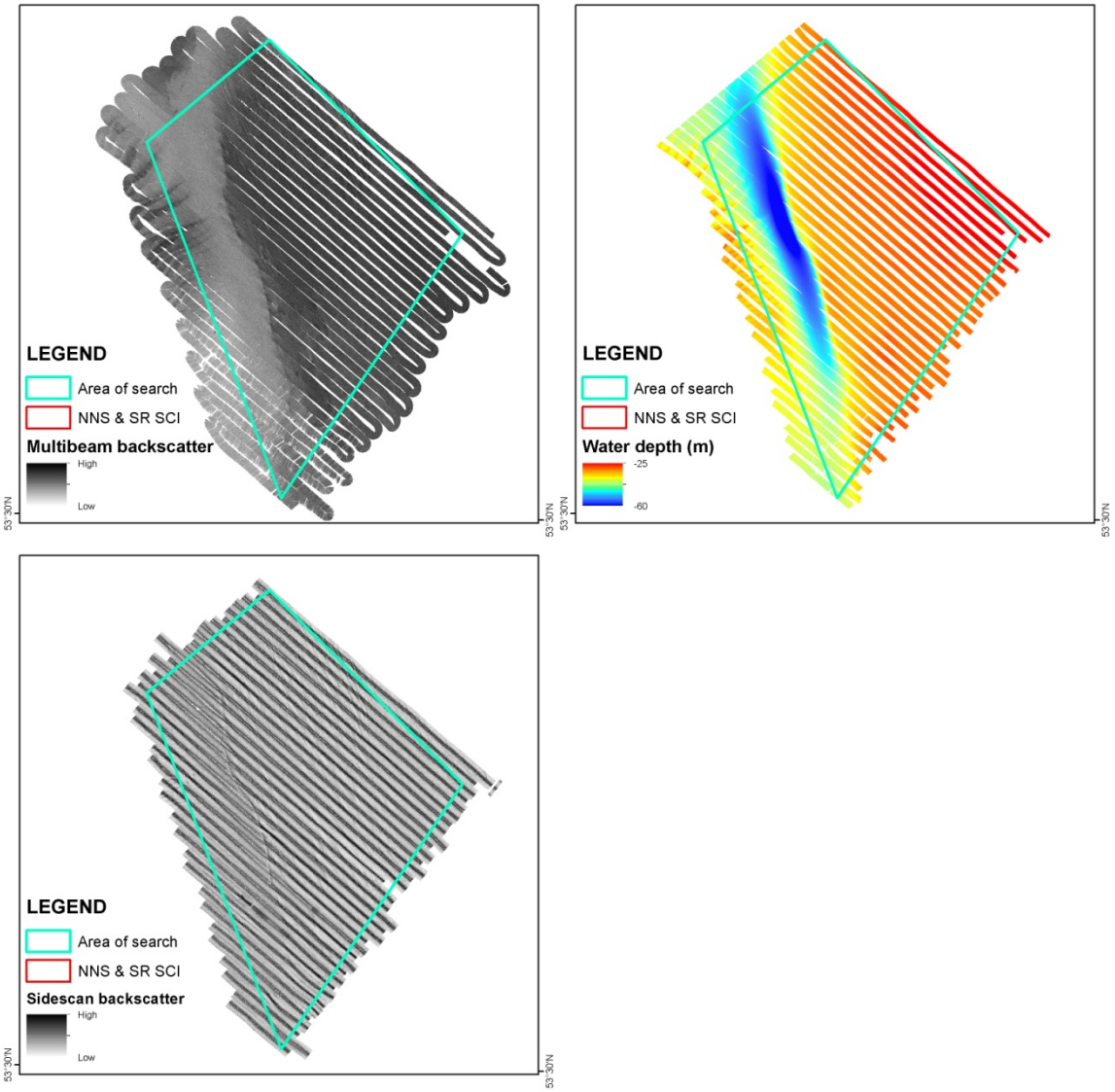


Figure 14. (Top left) Multibeam backscatter for area of search C; (Top right) Multibeam bathymetry for area of search C; (Bottom left) Sidescan sonar backscatter for area of search C.

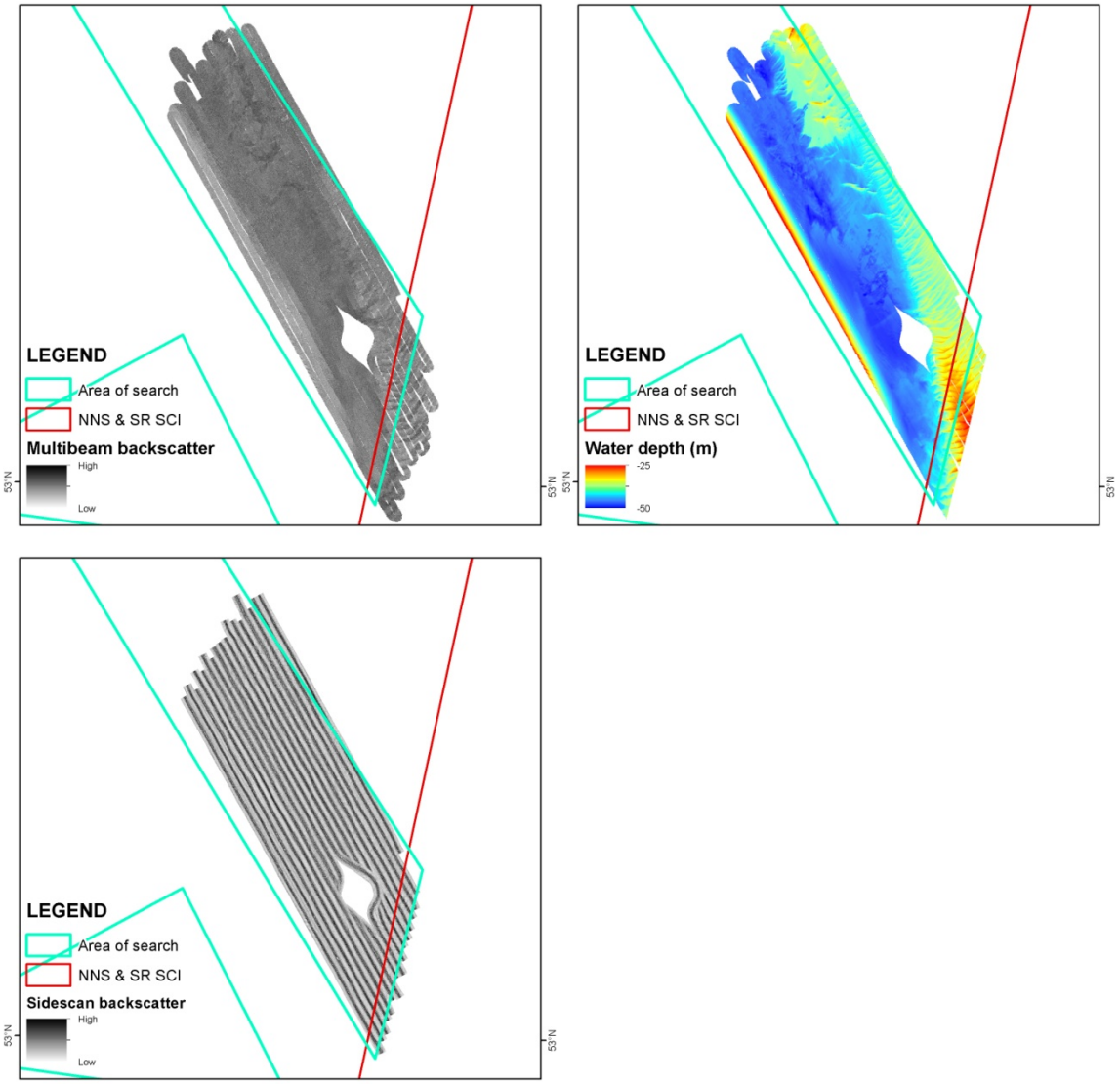


Figure 15. (Top left) Multibeam backscatter for area of search D; (Top right) Multibeam bathymetry for area of search D; (Bottom left) Sidescan sonar backscatter for area of search D. The gap in the data is due to a gas installation.

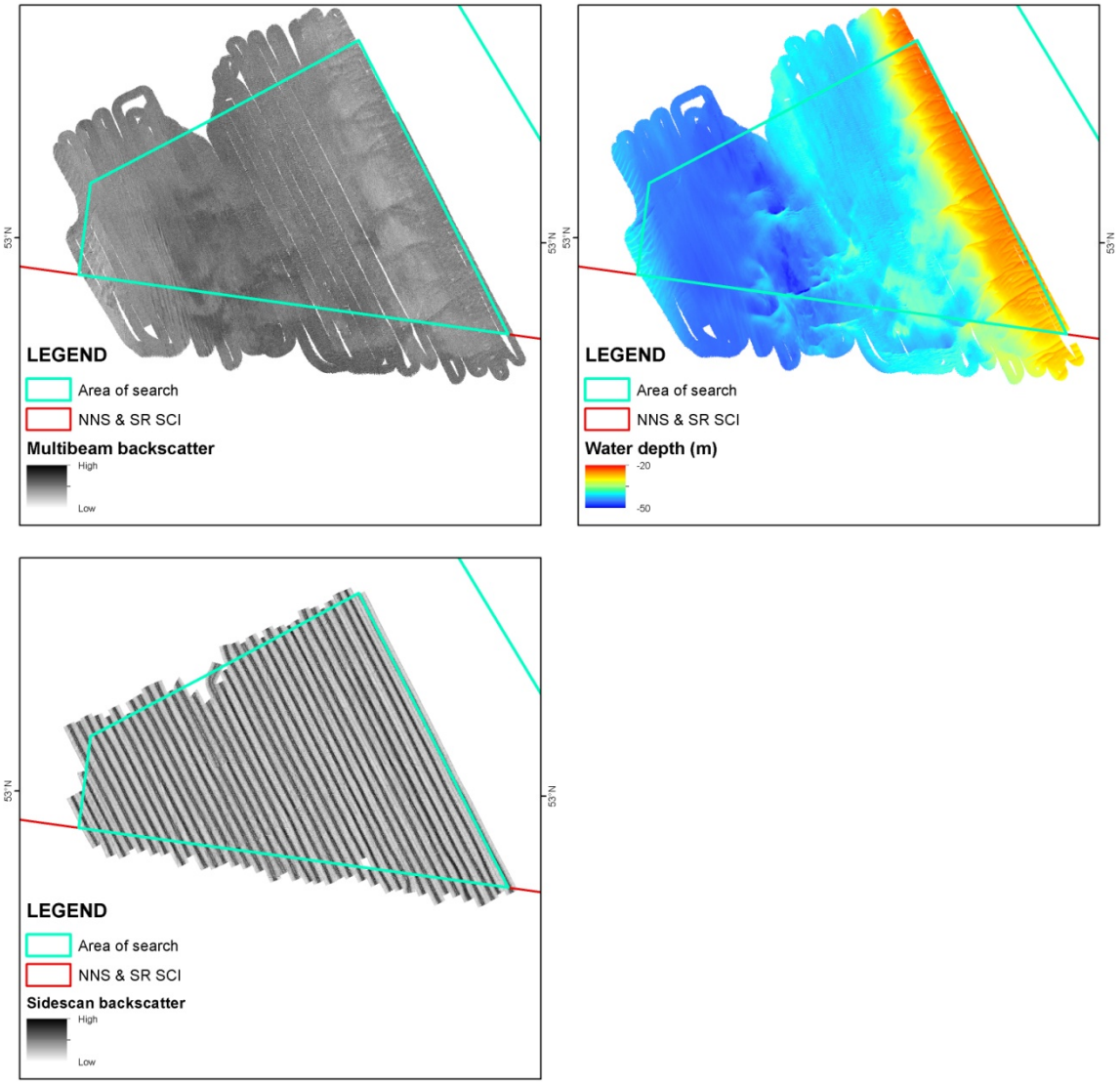


Figure 16. (Top left) Multibeam backscatter for area of search E; (Top right) Multibeam bathymetry for area of search E; (Bottom left) Sidescan sonar backscatter for area of search E.

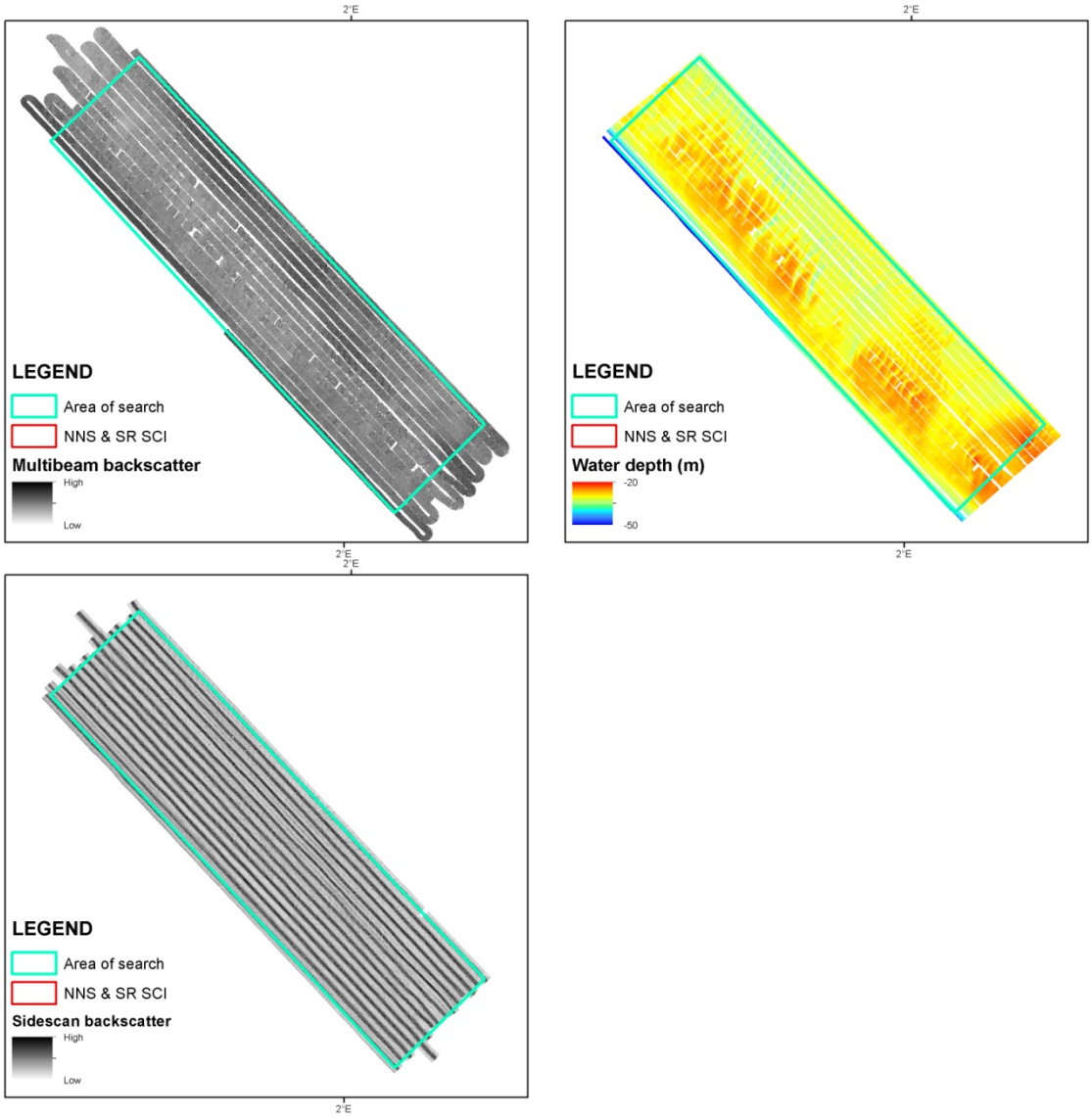


Figure 17. (Top left) Multibeam backscatter for area of search F; (Top right) Multibeam bathymetry for area of search F; (Bottom left) Sidescan sonar backscatter for area of search F.

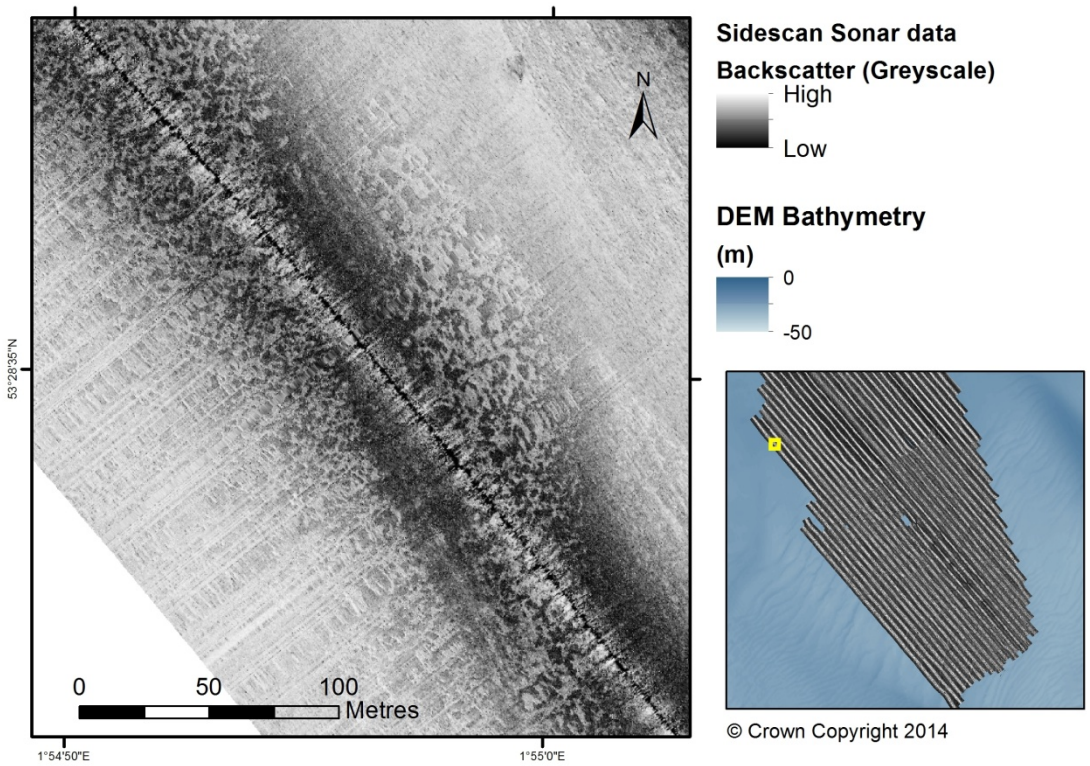


Figure 18. Characteristic potential *Sabellaria spinulosa* reef sidescan sonar signature identified in Box A.

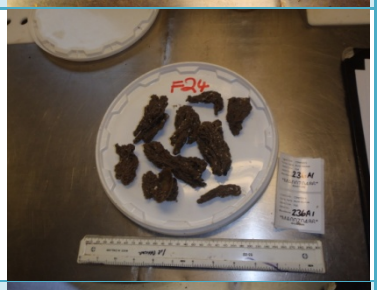
4.2 Grab samples (Sabellaria spinulosa reef survey)

Grab samples were collected at all planned survey grab stations (Figure 7). Images of each grab sample are presented in Tables 5-10 (Appendix VI).

Where *Sabellaria spinulosa* reef was collected using the Hamon grab additional images were taken of representative fragments of the reef (Table 4).

Table 4. Images of *Sabellaria spinulosa* reef taken from Hamon grab samples.

Station Code	Image of *Sabellaria spinulosa* reef fragments
NNSB_CEND2213_A57_STN_062_A4	
NNSB_CEND2213_A58_STN_067_A2	
NNSB_CEND2213_A59_STN_064_A2	
NNSB_CEND2213_A64_STN_059_A1	
NNSB_CEND2213_C19_STN_092_A2	
NNSB_CEND2213_F19_STN_161_A1	

Station Code	Image of *Sabellaria spinulosa* reef fragments
NNSB_CEND2213_F22_STN_231_A2	
NNSB_CEND2213_F24_STN_236_A1	
NNSB_CEND2213_F23_STN_237_A3	
NNSB_CEND2213_E06_STN_251_A1	
NNSB_CEND2213_E07_STN_253_A1	
NNSB_CEND2213_E08_STN_256_A1	

Station Code	Image of *Sabellaria spinulosa* reef fragments
NNSB_CEND2213_ E22_STN_254_A1	

4.3 Seabed Imagery (Sabellaria spinulosa reef survey)

A selection of three still images from each of the camera sledge deployments is presented in Tables 12-18 (Appendix VII), illustrating what was observed on the video tows.

4.4 Annex 1 interest feature (Sabellaria spinulosa reef)

Real-time assessment of the data collected during this survey suggested *Sabellaria spinulosa* reef was present in various locations within the North Norfolk Sandbanks and Saturn Reef SCI. At the actual location where Saturn Reef was reported in the past, only *Sabellaria spinulosa* tube rubble was observed. *Sabelleria spinulosa* reef (Figure 19) was however observed at several other locations within the SCI boundary. Figure 20 shows the distribution of those stations across the site based on preliminary reviews of the data collected during the survey.

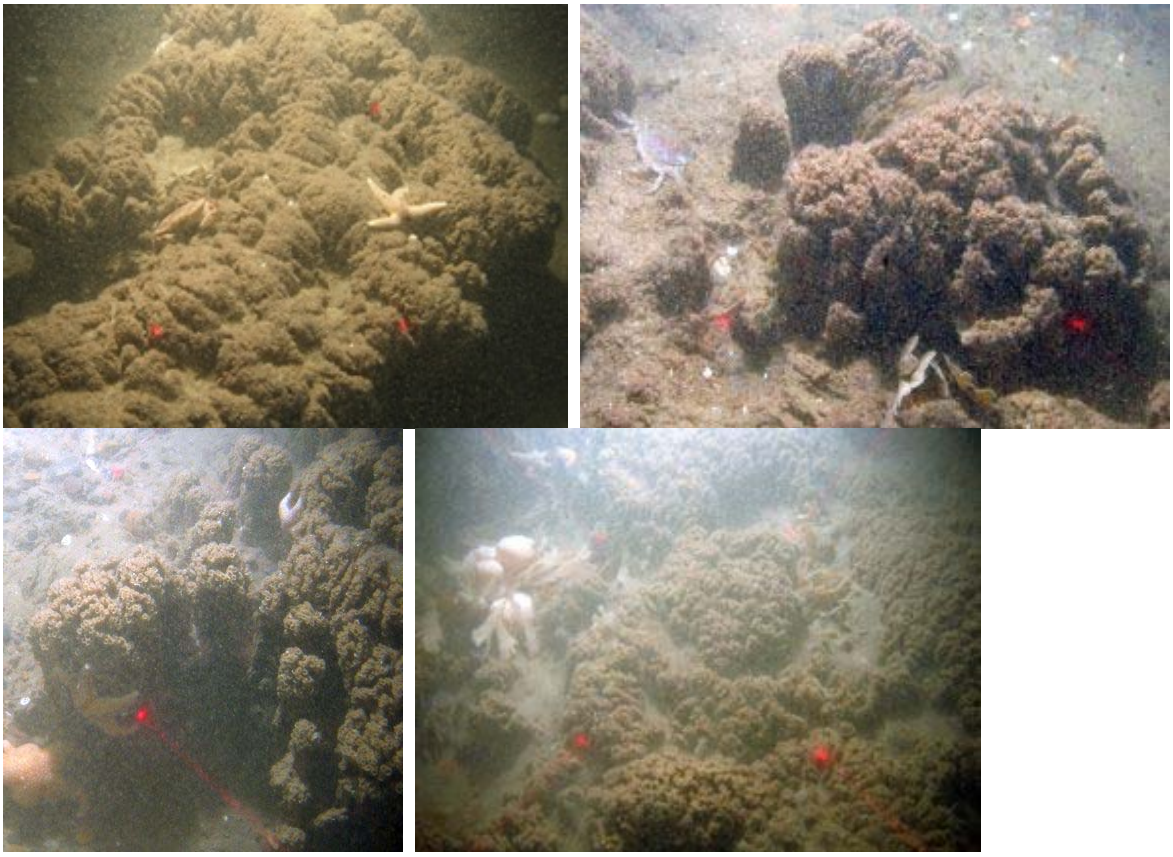


Figure 19. Underwater still Imagery of potential *Sabellaria spinulosa* reef features.

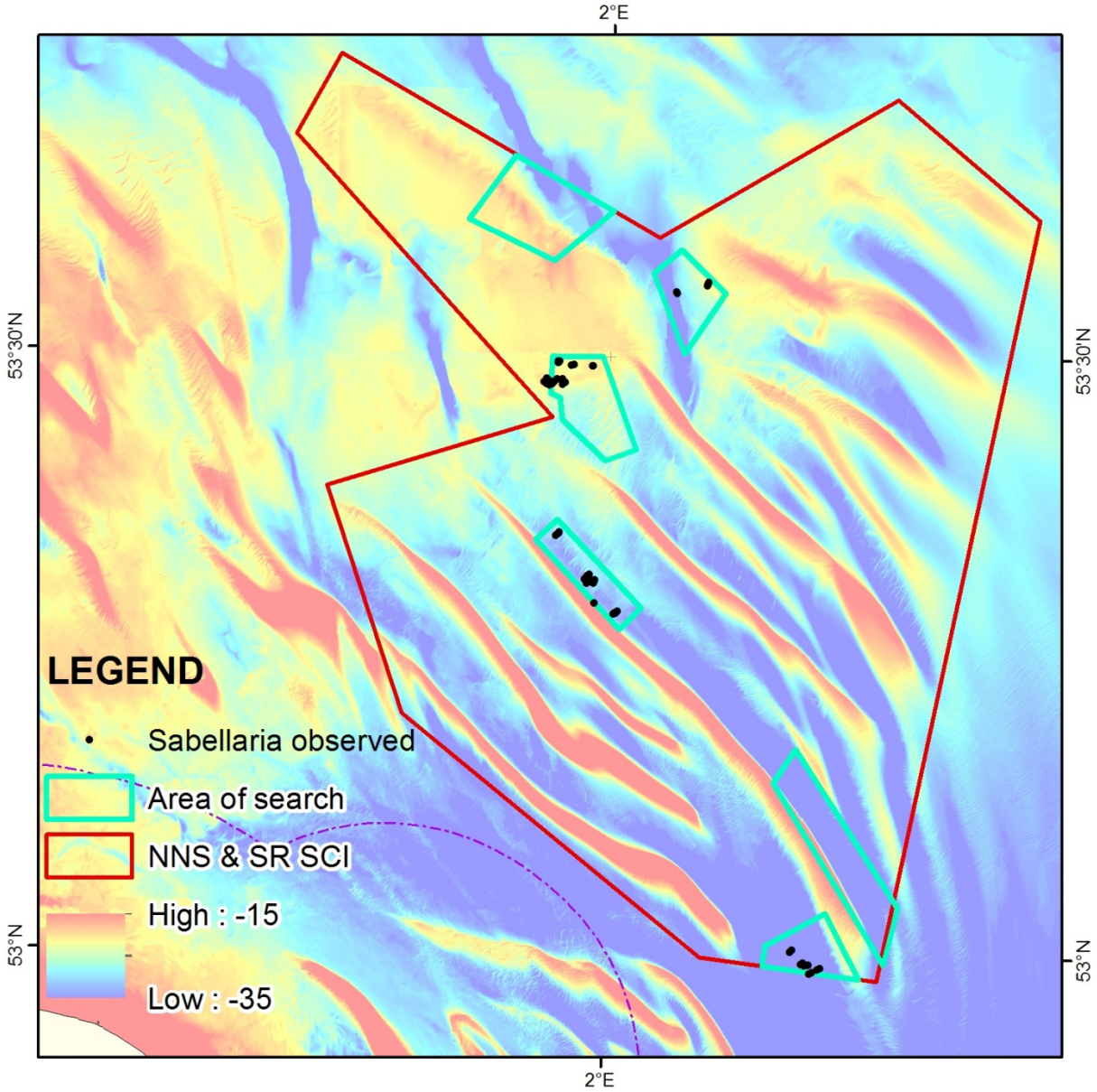


Figure 20. Potential *Sabellaria spinulosa* reef observed.

4.5 Grab samples (sandbank transect survey)

Grab samples were collected across the profile of several sandbanks (Figure 8). Images of each grab sample are presented in Appendix VII (Table 11). In general sediments were found to be more mixed in the troughs between the sandbanks when visually compared with samples acquired from the flanks and crests. At the time of writing this report the acoustic data collected during the sandbank survey had not been processed. This data will be included in the final report.

5 Evidence of anthropogenic impacts

During real time data acquisition, data were reviewed for evidence of anthropogenic disturbance. The North Norfolk Sandbanks and Saturn Reef SCI has a large number of gas platforms with its boundary. During the sidescan sonar surveys, pipelines were often observed in the records. These observations coincided with known locations of pipelines on the seabed. The processed sidescan sonar and backscatter mosaics also revealed trawl scars in several locations. These appeared mainly in the southern, sandier part of area of search A, and the northern, again sandier, part of area of search C (Figure 21). Pair-trawlers were observed fishing on the landward side of Well Bank West of Box F.

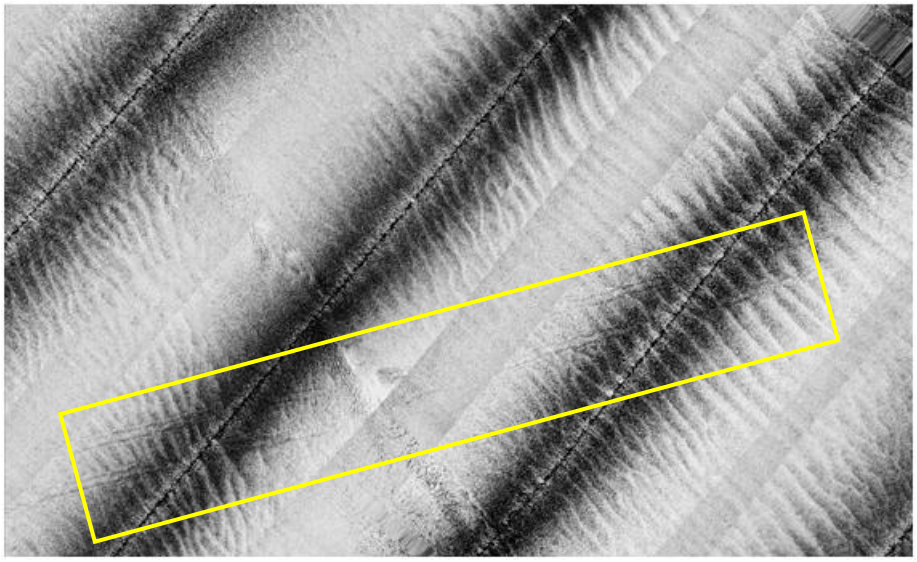


Figure 21. Detail of the sidescan sonar revealing trawls scars on the seabed.

6 Health and safety events

Health and safety inductions for staff who had not been onboard the vessel in the last six months took place on Monday 4 November 2013 at 16:00.

An emergency drill took place at 13:00 on Tuesday 5 November 2013 which required staff to report at the muster station and don an immersion suit. This was followed by a demonstration on launching life rafts. Further emergency drills took place on Tuesday 12 November which detailed fire fighting equipment held onboard and Sunday 17 November which demonstrated a man overboard scenario and finally on Sunday 24 November which demonstrated a fire in the galley scenario.

On the 10 November 2013 a health and safety incident occurred when a computer tower fell onto a scientist staff's foot. The incident was logged and appropriate action was taken to avoid reoccurrence.