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Mid Irish Sea reefs habitat mapping report

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Contents

Summary

Funding for this work has been provided by the Department for Food and Rural Affairs (DEFRA) Natural Environment Group Science Division (Contract No CRO 361).

The aim of this research contract was to improve understanding of the habitats and communities present in an area of the Irish Sea identified as potentially containing Annex I reef habitat according to the Habitats Directive. The potential Annex I reef area for this area was roughly delineated using British Geological Survey (BGS) 1:250,000 Seabed Sediment data (Graham., 2001). This area of habitat represented a number of polygons of quaternary sediment and rock according to the modified version of the Folk classification scheme used by BGS, and may consist of particles from am diameter up to cobbles and boulders.

To investigate and characterise the habitats and biotopes of an area of potential reef in the mid Irish Sea, new acoustic survey and biological survey was undertaken. The extent and distribution of the habitats and communities with the target area were mapped, and an assessment was made as to whether any of the habitats found fit within the interpretation of Annex I reef according to the Habitats Directive.

Survey cruises were undertaken in November 2006 and January 2007 onboard the University Marine Biological Station, Millport (UMBSM) Research Vessel *Aora*, with specialists from the National Oceanography Centre (NOC), ERT (Scotland) Ltd (ERT), UMBSM and Seatronics Ltd.

In discussion with JNCC, the survey area was split into three sections covering the northern, central and southern patches of potential reef identified by BGS.

In spite of bad winter weather and technical issues with camera equipment, the survey successfully collected acoustic data from target areas within the central Irish Sea and sufficient ground-truthing data to enable the classification and mapping of seabed habitats for the northern part of the survey area. Further acoustic data will be required to map the central survey area, and further ground-truthing data will be required to map both the southern and central areas.

The surveyed depth ranged from approximately 60 to 155m. The shallowest depths were located on the western side of the southern survey area deepening gradually to the east and north. The deepest area was found in the south eastern corner of the northern survey area where a trough, approximately 2 km wide, deepened from a surrounding seabed of 90m to approximately 155m in its centre. There was a trend across the whole survey area of increasing depth from west to east, towards the deepest part of the Saint George’s Channel.

The sandiest sediments were found in the sand wave field in the north of the northern survey area in depths of less than 90m. The transition to coarser sandy sediments with an increased percentage of shell debris, pebbles and gravel followed an abrupt transition away from the sand wave field and this was reflected in both the bathymetry and backscatter data. The area of coarse sandy sediments covered the majority of the northern survey area at 90m. In deeper ground more stable mixed sediments became dominant. Sparse patches of small boulders were found at several sites.

The biotopes identified from the survey were a close fit to those present in version 04.05 of the marine habitat classification (Connor *et al.*, 2004) but with the exception of SS.SSa.OSa, occurred in depths greater than those used to describe circalittoral biotopes. The cut-off between CMx and OMx appeared to occur at 50m, and yet both SS.SCS.CCS.PomB and SS.SMx.CMx.FluHyd were present in depths of 90 to 120m. It may be that the depth bands of the circalittoral biotopes should be extended to cover slightly deeper habitats, or further species data should be collected to establish of there is subtle difference in characteristic fauna that could be used to define new biotope equivalents to SS.SCS.CCS.PomB and SS.SMx.CMx.FluHyd in the offshore section of the classification.

Patches of cobbles and boulder habitat 25 to 50m^2 were observed at several locations. The sparseness of these patches, and also the inclusion of cobbles and boulders in SS.SMx.CMx.FluHyd led to these areas being classified as sediment, rather than rocky habitat within ver. 04.05 marine habitat classification. The greatest abundance of cobble and boulder habitat occurred in sites 15, 16, 27 and 32.

Using the broader JNCC interpreted definition of Annex I reefs (Johnston *et al.*, 2002), it was apparent that areas within the SS.SMx.OMx/SS.SMx.CMx.FluHyd mapped area could be considered Annex I reef habitat. The problem encountered in identifying such patches within the survey area was that it is difficult to resolve these from the surrounding mixed sediments from 16m pixel backscatter and 5m pixel bathymetry. With further analysis it would be possible to highlight areas for further ground-truthing from the backscatter data, but it may be that detailed side-scan sonar survey of the SS.SMx.OMx /SS.SMx.CMx.FluHyd would have been the most accurate way of delineating such patches.

1. Introduction

As part of the implementation of the 1992 Directive on the Conservation of natural habitats and of wild flora and fauna (92/43/EEC) (the 'Habitats Directive'), the Joint Nature Conservation Committee (JNCC) provide advice to UK Government on suitable areas in UK offshore waters (i.e. from 12 to 200 nautical miles from the coast and the UK Continental Shelf as set out in Orders made under Section 1(7) of the Continental Shelf Act 1964) that may qualify as Special Areas of Conservation (SAC). These SAC must contain habitats listed on Annex I and/or species listed on Annex II to the Directive.

As part of the work to identify and locate draft SACs for UK offshore waters, the location and extent of areas of possible Annex I habitat have been identified by the JNCC (2006), principally using existing British Geological Survey seabed geological map interpretations and bathymetry (Graham *et al.*, 2001). Since 2000, the JNCC has supplemented this with a programme to collate relevant physical and biological data that are available from publications, marine research institutions, marine industry surveys and international sources. This work had led to the identification of eight areas that the JNCC has advised UK Government should be designated as a SAC. From the original list of Areas of Search (AoS) for Annex I habitat identified in 2006, there were up to 21 areas to be assessed against the SAC selection criteria, but for which JNCC had insufficient or no data to enable such an assessment.

ERT (Scotland) Ltd (ERT) was contracted by JNCC to undertake Contract no F90-01-942, *Understanding the Marine Environment – seabed habitat investigations of offshore SAC priority Areas of Search in 2006* for AoS 7 in the Irish Sea (Figure 1.1).

1.1 Area of search 7: Mid Irish Sea reefs project

The aim of this research contract was to improve understanding of the habitats and communities present in an area of the Irish Sea identified as potentially containing Annex I reef habitat according to the Habitats Directive. The potential Annex I reef area for this AoS was roughly delineated using BGS 1:250,000 Seabed Sediment data (Graham *et al.*, 2001). This area of habitat represented a number of polygons of quaternary sediment and rock according to the modified version of the Folk classification scheme used by BGS, and was considered to consist of particles from am diameter up to cobbles and boulders. Only boulder and cobble areas were likely to fit the Habitats Directive interpretation of reef.

The focus of this project was to investigate the extent and biological character of an area of potential Annex I reef in the mid Irish Sea by;

1. undertaking new acoustic survey and biological survey using photographic methods;
2. mapping the distribution and extent of the habitats and communities found during the survey;
3. assessing whether any of the habitats fit the interpretation of Annex I reef according to the Habitats Directive, and
4. assessing the biological quality of the communities of this AoS in relation to those of other similar habitat areas in inshore and offshore UK waters.

1.2 Objectives

The project had the following objectives:

1. Undertake the collection and analysis of new data on Annex I habitats in AoS 7: Mid Irish Sea reef.
2. Identify and map the extent of Annex I reef habitat using multibeam sonar and drop video to enable relevant physical sub-types of reef to be distinguished, in particular bedrock from boulder/cobble/stony reef, and biogenic reef (formed by organisms such as *Lophelia pertusa* (cold water coral), *Modiolus modiolus* (horse mussel) or *Sabellaria spinulosa* (ross worm).
3. Biologically characterise the different sub-types of reef identified above, providing structured descriptions and supporting data (quantitative where possible) for each, and provide good quality photographic records of the habitats and organisms present.
4. To identify and record the nature and location of any obvious human impacts in the AoS (e.g. trawl marks, dumped or discarded material, gear or nets).
5. To record and describe new habitat types discovered in UK offshore waters
6. Evaluate the effectiveness of data collection methods, techniques and technical equipment.
7. Provide all data collected in a format which will allow subsequent use for other purposes.
8. To establish a baseline for future assessment of change.
9. Present findings in a succinct and clear final report.

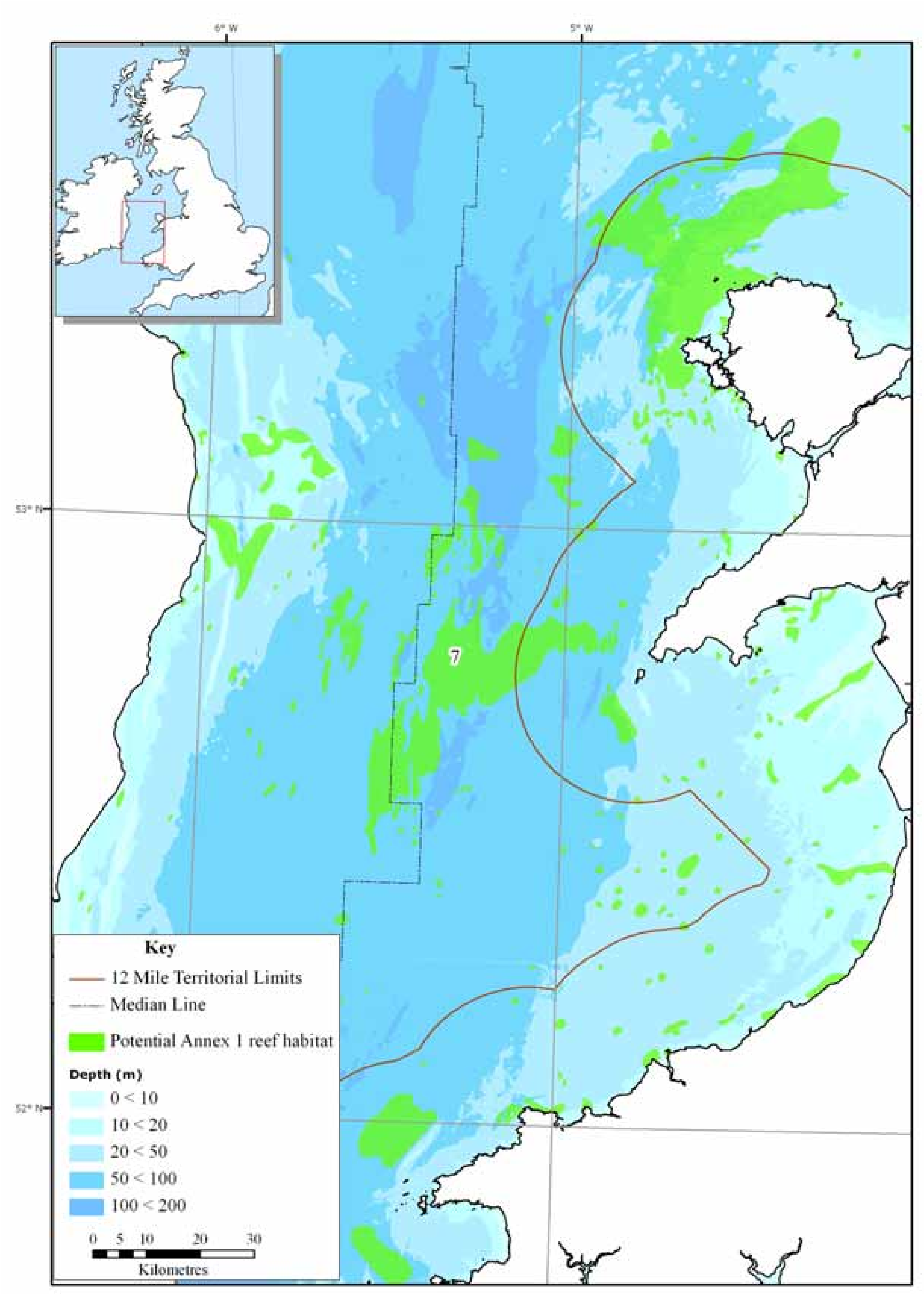

Figure 1.1 Potential areas of reef habitat and AoS 7 (after Graham *et al.*, 2001). © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

1.3 Background environment

The Irish Sea is one of the smaller Regional Seas, about 58,000 sq km (23,000 sq miles) in area. In character, it has the form of a fairly shallow basin, with depths ranging from 20 to 100m over considerable areas, but with a deeper channel, exceeding 100m, extending north to south in the western part of the Irish Sea which reaches a maximum depth of 315m in Beaufort Dyke. This deeper channel connects with the Celtic Sea via St George's Channel in the south, and with the Malin Shelf through the North Channel (Vincent *et al.*, 2004).

1.3.1 Hydrography

Semi-diurnal tides are the dominant physical process in the Irish Sea, propagating from the Atlantic Ocean through both the North Channel and the St George’s Channel. The tides have a period of 12.4 hours and vary on a Spring and Neap cycle. Tidal patterns also occur over an equinoctial and yearly time scale.

The strength of tidal currents varies in the Irish Sea from nil in sheltered embayments to values exceeding 1ms^{-1} during spring tides throughout the St George’s Channel, northwest of Anglesey, north of the Isle of Man and in the North Channel. Within these areas, particularly high values can be found locally near headlands for instance exceeding 2 ms^{-1} during spring tides northwest of Anglesey.

The Irish Sea is sheltered to oceanic wave action with only two relatively narrow fetch windows along the axes of the St George’s and North Channels. The majority of waves are locally generated, of a fairly short period, and are steep. Swell waves are only present near entrances, at the southern end of the St George’s Channel and the northern end of the North Channel.

The annual mean sea surface temperature ranges from 11°C at the southern end of the St George’s Channel to 10°C in the North Channel. During the winter months the temperature decreases to 5 to 7°C in coastal areas.

Salinity is classed as fully marine and decreases from 34.9‰ at the southern end of the St George’s Channel to 34.0‰ in the North Channel. Throughout most of the region tidal mixing is sufficiently intense to ensure that the water column remains well mixed throughout the year. (DTI, 2006a.)

1.3.2 Seabed sediments

During the middle to late Pleistocene, the survey area was subject to periods of intense erosion during glaciations. Sequences of glacial and glacio-marine sediments were deposited, particularly in the Celtic Trough.

Within the Irish Sea, seabed sedimentary processes are driven by near-bed stress, originating from interaction of the seabed with strong currents generated by tidal streams and by waves. In areas where the seabed stress from waves is dominant, the seabed sediments coarsen. In the most highly stressed seabed environments, exposed bedrock and strongly cohesive unsorted gravely, sandy and muddy sediments are often swept clean of unconsolidated muds, sands, granular gravel and pebbles. Parts of the seabed in these areas may consist of cobbles and boulders.

Mobile sand waves are characteristic of areas where sediments are being transported along the seabed in environments that are situated between the areas of extremely high near-bed stress and very low near-bed stress. Environments of least near-bed stress are characterised by fine-grained muddy sediments (Holmes and Tappin, 2005).

1.3.3 Benthos

The benthos of the Irish Sea has been described in a number of recent reports including the Irish Sea Pilot Project and Strategic Environmental Assessment for Area 6, Irish Sea (Vincent *et al.*, 2004; DTI, 2006b). Mackie (1990) provides an excellent summary of information available up to late 1980's.

Most of the benthos of the Celtic Trough is described as either 'deep *Venus*/hard' or 'deep *Venus*' by Mackie (1990). These two communities are the most dominant in the offshore benthic environment. Other reports confirm the generalisations made by Mackie (1990). The bivalve *Glycimeris glycimeris* was found to be common in areas where cobbles protrude into the current (Rees, 1993), accumulations of which have also been recorded from the St Georges Channel in the south (Rees, 2004).

The southern Irish Sea is considered to represent a boundary between different biogeographical regions with several species reaching their distribution limits and, is regarded as a significant source of benthic biodiversity (Mackie *et al.*, 1995).

The richest assemblage, and that with the most extensive geographical coverage, is that associated with gravely sediments and includes conspicuous serpulids, other large polychaetes, an exclusive tubiculous ampharetid species and the amphipod *Guernea coalita* (Wilding *et al.*, 2005).

2. Methods

2.1 Introduction

Survey planning was based on the specification outlined in the JNCC invitation to tender which detailed areas to be surveyed, the resolution of data required and, a range of methods and equipment that could be used. ERT subcontracted a team from the National Oceanography Centre (NOC) to undertake the acoustic components of the survey. The vessel used for the work was the University Marine Biological Station Millport's (UMBSM) *RV Aora* (Figure 2.1). Biological survey of the seabed was undertaken by ERT staff using camera equipment supplied by Seatronics Ltd.

Figure 2.1 Photograph of *RV Aora.*

It was originally envisaged that it should be possible to survey approximately 70% of the AoS in the available survey window. The acoustic survey was planned to concentrate on topographically defined areas within the AoS with 100% ensonification of the seabed. Larger track spacing was to be used where featureless sediments were observed or between discrete targets within the AoS. JNCC had stated the requirement to be able to distinguish 100 × 100m patches of bedrock and stony reef from the surrounding sediment.

The drop-down video/stills survey was used to provide information on the species and communities present in the areas of interest, and enable identification of biotopes for subsequent mapping and assessment of the principle conservation interests of the area. Data on the species and communities present were collected using a drop-down video camera and photography system using methods outlined in *Procedural Guidelines 3-14* in situ *Survey of Sublittoral Epibiota using Towed Sledge Video and Still Photography* and *3-5 Identifying Biotopes using Video Recording*, from the Marine Monitoring Handbook (Davies *et al.*, 2001). Procedural Guideline 3-5 was updated in Sotheran & Foster-Smith (2004). The

Review of Standards and Protocols for Seabed Habitat Mapping (Coggan *et al.*, 2005) was also used in survey planning. After meetings with JNCC and NOC a survey area was agreed for survey in November 2006 (Figure 2.2).

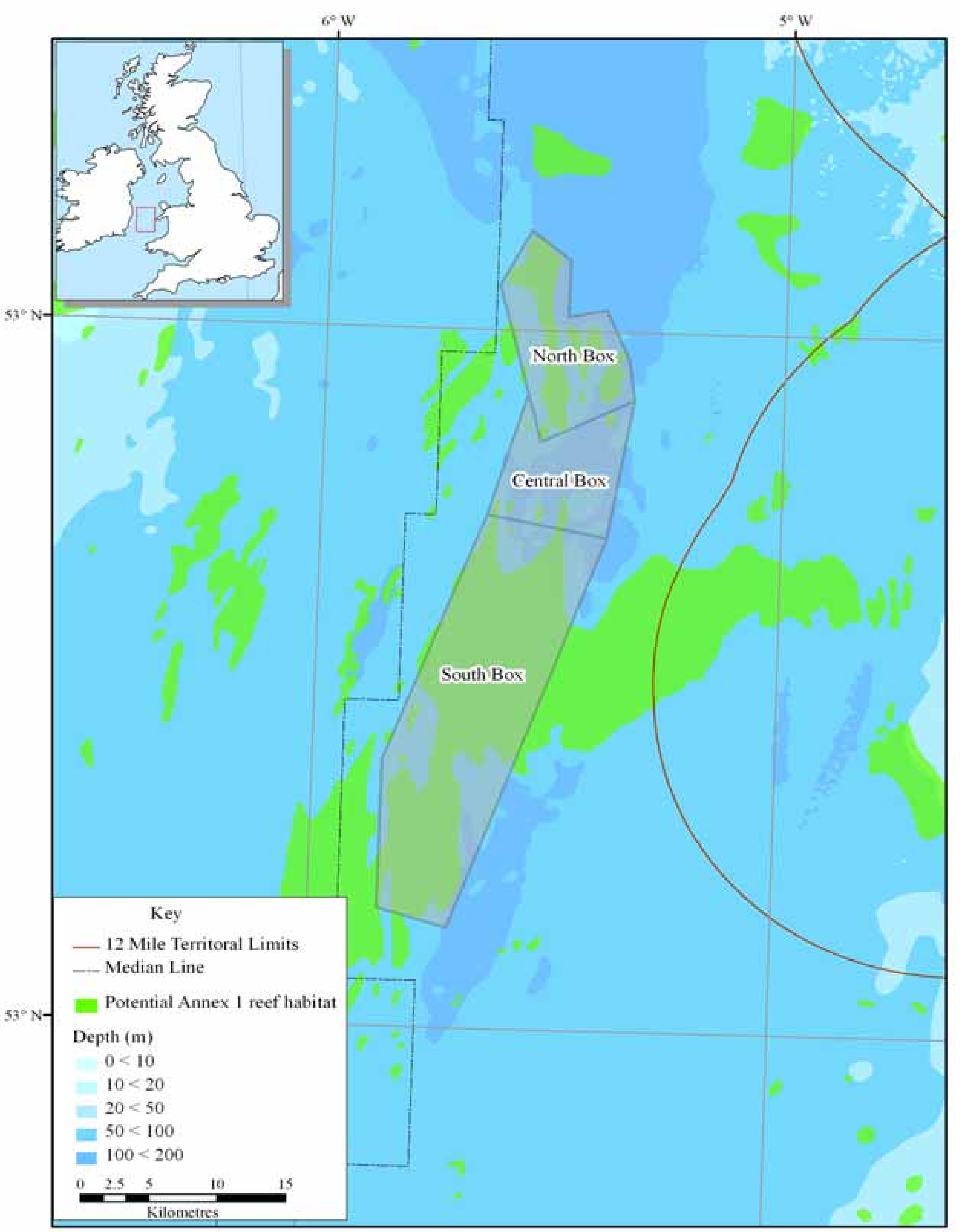

Figure 2.2 Location of the proposed survey area. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

2.2 Survey dates and personnel

Survey	Personnel	Role
Acoustic survey 14 to 24 November 2006	Tim Le Bas, NOC	Survey Leader
	Veit Huhnerbach, NOC	Surveyor
	Tom Stevenson, UMBSM	Surveyor
	Matt Dalkin, ERT	Project Manager
Biology survey 29 January to 1 February 2007	Tony Craig, Seatronics Ltd	Engineer
	Craig Cameron, Seatronics Ltd	Engineer
	Tom Stevenson, UMBSM	Surveyor
	Matt Dalkin, ERT	Project Manager

2.3 Acoustic survey

2.3.1 Area covered

The scope of the multibeam survey was to target the North and South Boxes (Figure 2.2) with 100% coverage and the Centre Box with 50% coverage (100% if time allowed). Track spacing was planned for 300 to 350m with every second transit line surveyed in each area to give 50% coverage of the entire region, and then the remaining lines filled to provide 100% coverage in the North and South Boxes.

The multibeam survey was due to be conducted over approximately seven days, with an additional day for equipment set-up and calibration. In recognition of the high risk of bad weather affecting such a survey being conducted in winter, a total of three days had been planned for weather down time, giving a total survey window of eleven days.

As a result of the continued bad weather encountered during the survey period, which considerably reduced the number of days it was possible to survey, as well as the quality of data obtained, a revised scope for the acoustic survey was agreed with JNCC as follows:

1. To cover all the three boxes at 50% coverage if possible (rather than getting 100% of some of the area(s) and nothing for others).
2. If 50% coverage of all three boxes was achieved and there was still time spare within the period for acoustic survey (plus contingency), then greater coverage for the north or south areas would be acquired.
3. If 50% over all coverage of the areas during the planned time (with contingency days) was not achievable for the acoustic survey, then JNCC preference was to use days planned for biological survey until 50% multibeam coverage was achieved (as far as was possible with staff availability), then move on to biological survey if/when conditions allowed.

During weather gaps approximately 50% multibeam coverage was obtained from the North Box and South Box, with one line run within the Centre Box (Figures 2.3 and 3.1).

2.3.2 Multibeam survey

The survey was conducted using a Reson SeaBat 8101 multibeam system operated by NOC from RV *Aora*. Where possible, QTC-View AGDS data was collected using a 38 kHz transducer during the multibeam survey.

The SeaBat 8101 was mounted on a pole fixed on the side of *Aora*. The transducer head was connected to the shipboard electronics via a cable that ran up inside the pole mounting. A differential GPS array was used for high resolution positioning with two GPS receivers and a DGPS receiver. This often gave position accuracy better than 0.4m. Finally the system was linked to an inertial motion unit (IMU) to give attitude information such as roll, pitch and gyro heading.

The DGPS receiver was programmed with waypoints which were amalgamated into a desired route or survey pattern. The receiver then worked through the route, sending directions to the autopilot which controlled the steering gear. The autopilot worked to keep the vessel on the calculated track or Course Over Ground (COG) between two successive waypoints by continually adjusting the heading to minimise cross-track error. The vessel heading and COG may be different, particularly when coping with strong wind or tide. Maximum and minimum turn radii were set to keep the vessel on track when changing between successive waypoints, particularly at the ends of closely spaced survey lines.

A surface positioning calibration was needed to tie in the GPS antennae to the DGPS signal to provide accurate position and attitude. This required the boat to perform a series of movements and turns that can change the angles and speeds of the relative acquisition GPS receivers so that phase difference can be measured and thus calibrate the system. This was attempted on leaving Holyhead in a relatively sheltered area. The calibration quickly got to a reasonably high level of accuracy but did not actually find a full calibration solution. A forced solution was therefore used and the resulting precision was 0.5m in position and 0.7° heading error. Due to worsening weather conditions these figures slowly degraded to about 1.0m and 1.3°. Occasionally total navigation positioning was lost and the system had to be restarted. This resulted in small data gaps.

Following installation of the SeaBat 8101 transducer head, a calibration was required to orientate the exact position and attitude of the system. To do this a series of repeated survey lines were required to calibrate the variation in orientation in three dimensions (roll, pitch and yaw) and to measure any system latency (time errors).

The tests were:

- Time latency – repeat a line at different speeds.
- Pitch test – repeat a line but in opposite directions on a slope perpendicular to the ship track.
- Roll test – repeat a line but in opposite directions on a flat piece of ground.
- Yaw test – two parallel bur separated lines in the same direction over flat ground with a recognisable feature located between the lines.

Initially two lines were chosen just north of the starting point of the survey. The lines were parallel and existing charts suggested they had a slope, flat area and a wreck. However, as the weather was not optimal it was decided to postpone the calibration as it is not necessarily needed until the final processing stage. Previous calibration values were used and these proved satisfactory for initial viewing.

A second calibration test was attempted in a sheltered area in shallower water (40m) on a day when the sea state in the main target area prohibited survey. Two lines were chosen and data acquired. The first line of data was of reasonable quality and the second line of much poorer quality as the weather had deteriorated by that time. Calibration was attempted on these datasets but the correction factors were varied and often inconclusive. After several measurements the calibration figures were decided to be:

- Roll latency 1.35sec.
- Pitch latency 0.5sec.
- Roll offset 1.85°.
- Pitch offset 1.01°.
- Yaw offset 0.0°.

To test the sound velocity profile a probe was successfully deployed at the northern end of the North Box in a water depth of 99m. The profile obtained effectively gave no thermocline or any layered structure suggesting an extremely well mixed water mass (where depth is the only variable in the velocity equation).

2.3.3 QTC-View survey

QTC-View data were collected and processed by UMBSM during the multibeam survey. The QTC system was connected to one quadrant of the Simrad EK60 echosounder’s split beam ES38B 38kHz transducer. The transducer was housed in a faired pod on the port side of the keel, just aft of and below the bow thruster. The Sounder settings were 200W power; 1.024ms pulse length, 1 ping per second. The transducer had a 7° beam angle. More power than this can interfere with other acoustic systems on board, in particular multibeam or swathe bathymetry equipment. These settings remained unchanged throughout the survey. The QTC Series V digitally captures each ping for post-processing and classification using QTC Impact. Track spacing followed that of the multibeam survey.

2.4 Biology survey

The biology survey was originally planned to take place immediately following the acoustic survey in November 2006. Due to the bad weather encountered at the time, the biology survey was postponed until a suitable window of calm weather in January 2007.

The drop-down video and photography survey was conducted to ground-truth the previous acoustic survey undertaken in November 2006, and in particular, to confirm the presence of potential Annex I reef features within the survey area. The camera system used was the Seatronics DTS6000 deployed from the RV *Aora* over a five day period. The camera system included a Kongsberg Simrad OE14-208 Digital Stills Camera System (5 Megapixel) and Kongsberg OE14266/1366MK2 Colour Video Camera (460 TVL) with four 35W HID lights. For accurate camera positioning fixing the system used a Sonardyne Scout USBL.

Camera drops of up to ten (average five) minutes were recorded to collect information on the main substrata and to identify conspicuous epifauna and assess abundance across the northern area of the AoS. Digital still photographs were taken at one minute intervals at each station to show ground type and additional photographs were taken of conspicuous epifauna and rocky substrata.

The locations of video sampling stations were agreed *a priori* the survey with JNCC to cover a range of acoustic ground types identified in the November 2006 survey. It was anticipated that 102 stations would be surveyed (Figure 2.3) over five days from 29 January 2007. USBL calibration was undertaken by Seatronics prior to video sledge deployment. The USBL system worked intermittently during the first few deployments of the camera frame. The pole was lifted for the remainder of the survey and positions recorded from the vessels DGPS.

Each video deployment was logged by Seatronics on DVD and the stills camera hard drive. ERT recorded ancillary information on habitat type and species observed and maintain a video and stills photograph log. Video and still photographs were then recorded onto an ERT hard drive.

Strong tidal currents and very low visibility meant that it was impossible to 'fly' the camera over the sea bed. Instead a method of hopping was adopted, and a still photograph was taken each time the camera landed on the seabed before it was tilted over. Section 3.2.1 indicates coverage of ground truth sampling stations prior to camera equipment failure on 31st January 2007. After 24 hours attempting to fix the equipment the survey was aborted.

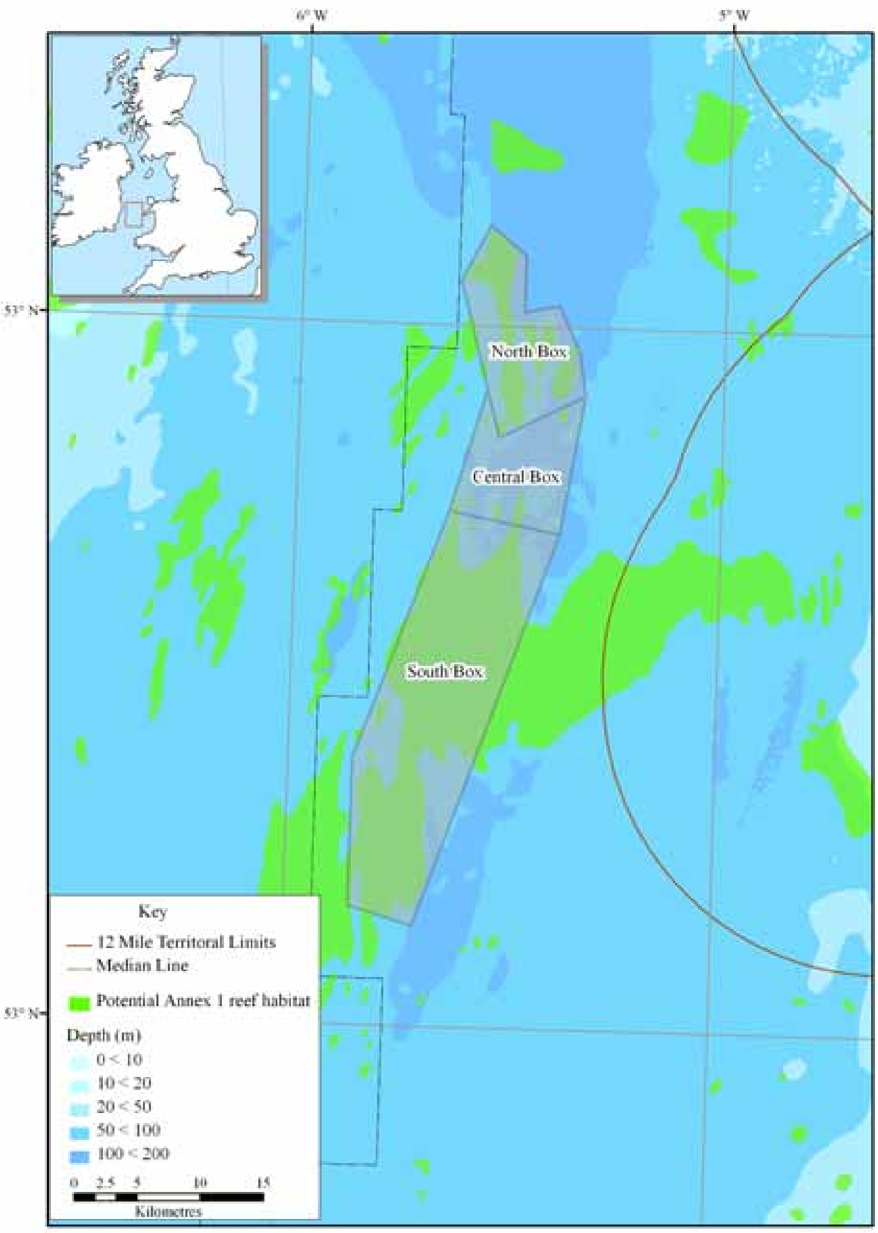

Figure 2.3 Proposed ground truth sampling locations overlaid on acoustic survey lines with potential Annex 1 reef habitat. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

2.5 Analysis

2.5.1 Multibeam data

Multibeam bathymetric data were processed by NOC using CARIS HIPS software to produce cleaned XYZ data. The processing was completed on a 5m resolution grid and depths are given in metres below lowest astronomical tide (LAT). Where there were minor gaps in the data, interpolation was used to give continuous coverage along track (time constraints due to weather prevented completion of over the whole survey area). PRISM software was used to process the backscatter amplitudes stored in batches by the Reson 8101 system. These amplitudes were corrected using basic radiometric and geometric techniques on a 4 and 16m resolution grid and UTM projected data mosaic images produced.

Multibeam data for all sites were provided as XYZ, IMG and GeoTIF files and as backscatter mosaics IMG and GeoTIF. The XYZ files contained positions given in Universal Transverse Mercator Zone 30N projection, based on 5m grid spacing. The data was loaded into ArcView 9.2, and grid files created using the Spatial Analyst extension, which use depth as the elevation field. From the raster grids, contour lines, slope angles, and grey-scale images highlighting topographic features were generated using Spatial Analyst. The accompanying datasets (AGDS track data, ground-truthing data) were overlaid on these bathymetric layers to improve habitat interpretation. The multibeam backscatter images were presented in ArcView and also added into. Where necessary, image greyscales were manipulated to accentuate features. False colour classed backscatter was used to accentuate potential sediment distributions over the North Box survey area.

2.5.2 QTC-View data

The data were analysed using QTC Impact software, which undertakes Principal Components Analysis (PCA) to pick the three features which best account for the variation between each captured echo. These become Q1, Q2 and Q3. The cluster analysis section groups the captured pings on the basis of these three values. This is done by taking each existing class in turn (initially there is only one) splitting it along each of its three axes, and seeing which one gives the most statistically significant split. Five classes were identified by the QTC Impact software.

The processed QTC-View data were provided as a Microsoft Excel file with bathymetry, Q values and PCA Class referenced to date, time and Latitude and Longitude and UTM coordinates. The changes in cluster membership along the tracks were examined with respect to bathymetric changes revealed from the multibeam data and reflectance changes shown in the backscatter analysis. The QTC-View data aided interpretation of the multibeam data with respect to the spatial discrimination of habitats.

2.5.3 Video and still photography data

The video data were played back and where the footage was of adequate quality, notes were made of sediment type and characterising species. In addition, notes were made of the topography of the area. Positional data, taken from navigational track recordings or from video (where USBL was available), were used to track the position of the camera over the seafloor, and were added to an Excel template provided by JNCC along with associated substrate and species information. The stills images showed more detail than the video footage, with good records from all sampling locations, and added to the habitat descriptions by facilitating species identification. Substratum type was recorded for each still image and then averaged to give an overall estimate from each site. Once all footage had been examined, final habitat categories were assigned to each area based upon the species and sediment descriptions. Habitat classification, to biotope level where possible, adheres to the National Marine Habitat Classification for Britain and Ireland (Connor *et al.*, 2004). Stills data are visually presented within the GIS according to the habitat/biotope codes and are overlain upon the acoustic dataset.

Biotope attributes and species identification was cross-checked within ERT for all records to ensure consistency of approach.

2.5.4 Data integration and biotope map production

All acoustic and ground-truthing data were presented in the associated GIS. This incorporated ground-truthing data and QTC-View data, bathymetric grids and backscatter mosaics. Where possible, GIS file metadata have been completed in MESH Data Exchange Format (DEF). A log of electronic data is presented in Appendix 3.

The final habitat maps were generated by combining the interpretation of each of the different data (Figure 2.4). The base assumption for interpretive mapping was that a biotope was mapped where it was identified from ground-truthing consistently upon similar topographic regions, upon a similar substratum, and with similar acoustic signatures (Figure 2.4). A major assumption in predictive mapping is that an area surrounding the ground-truthing site with similar properties can be considered to be the same habitat or biotope. Habitat areas were drawn by hand within the GIS environment to create a series of polygons, each of which is given the relevant biotope/habitat code and description.

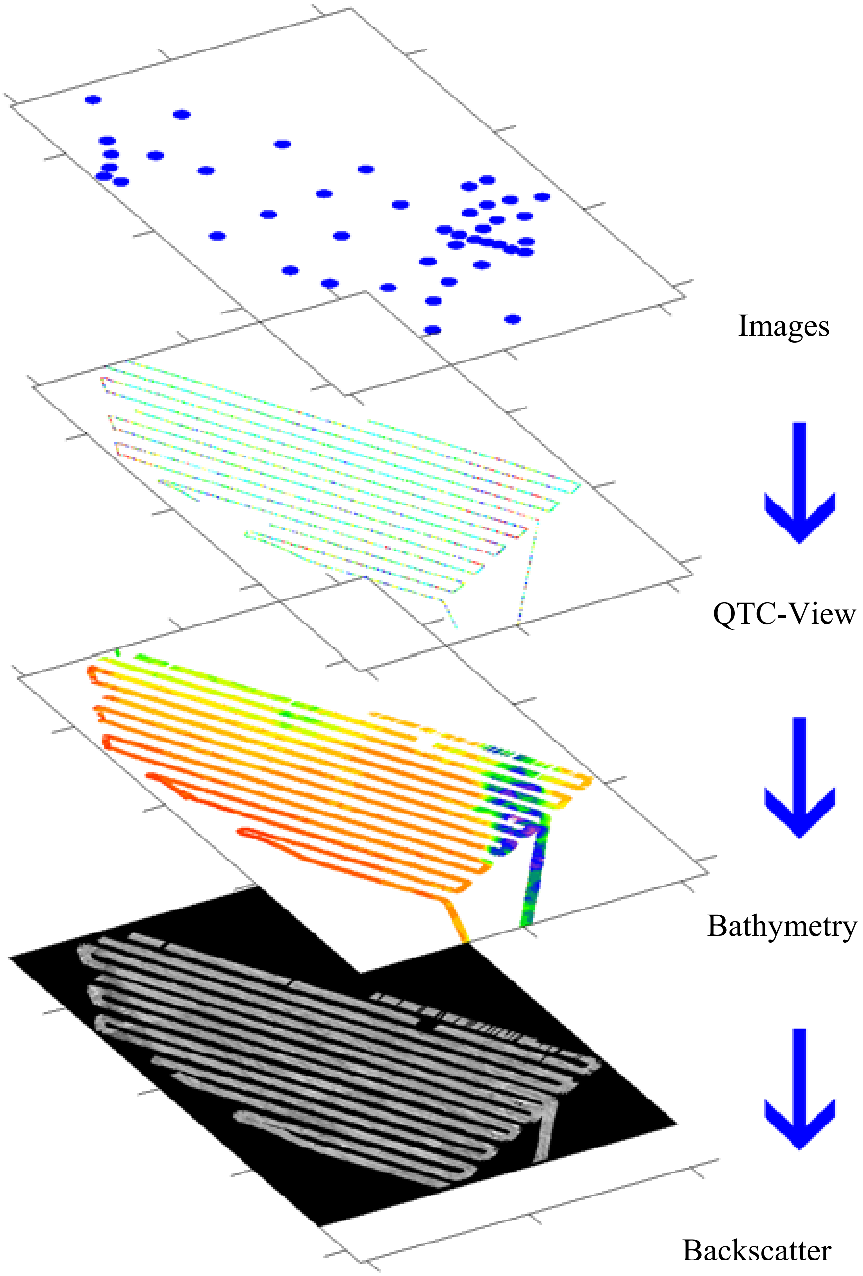

Figure 2.4 Data integration and the layering of data to produce habitat maps

3. Results

3.1 Acoustic survey

3.1.1 Area of survey

Within the window of opportunity presented in November 2007 RV *Aora* was able to complete 50% coverage of the North and South survey Boxes, with one continuous line running through the middle of the Centre Box (Figure 3.1). As poor weather conditions prevented further coverage, it was agreed with JNCC that the data obtained were adequate for mapping the main features in the two primary survey boxes. Post survey processing of the data required clipping of the bathymetry data, due to wave induced motion exceeding the tolerances of the IMU, this reduced bathymetry data to slightly less than 50% by area. Clipping did not impact on the coverage of available backscatter data.

Occasional gaps were present in the acoustic data on the east side of the North Box (Figure 3.1, 3.3 and 3.4). These were due to the system requiring re-booting when the mulitibeam signal was lost due to an unresolved software issue.

3.1.2 Bathymetry

The bathymetry data are presented as 5m resolution gridded raster files. Effects of rough weather and wave induced motion are apparent as 'see-saw' lines on bathymetry images if the Z axis is exaggerated. Where data were deemed of poor quality these have been excluded from the processed images. Overall the bathymetry, while providing greater detail, showed a good correlation with published Admiralty charts and Seazone data. Charted depths in the area range from 56 to 150m (UKHO, 1999).

Figure 3.2 provides an overview of the bathymetry of the survey area. The surveyed depth ranged from approximately 60 to 155m (measured from below LAT). The shallowest depths were located on the western side of the South Box with a large area ranging from 60 to 80m, deepening gradually to the east and north. The deepest area was found in the south-eastern corner of the North Box where a trough, approximately 2 km wide, deepened from a surrounding seabed of 90m on either side to approximately 155m in its centre. There was a trend across the whole survey area of increasing depth from west to east, towards the deepest part of the Saint George's Channel.

The bathymetry of the North Box is presented in Figures 3.3 and 3.4. The surveyed depth of the North Box ranged from approximately 80m in the north and west of the box to 155m in the trough dominating its south-eastern corner (Section 3.1.3; Figure 3.12). The majority of the North Box was between 90 to 100m deep. A deeper area (120m) formed a triangular bite into north-eastern side of the box. A field of sand waves was visible in the north of the box (Section 3.1.3; Figure 3.9).

One survey track cut through the middle of the Centre Box following the deep trough from the North Box at 150m and gradually shallowed to approximately 90m at the northern end of the South Box (Figures 3.4 and 3.5). A large solitary sand wave was visible half way between the North and South Boxes (Section 3.1.3; Figure 3.10).

Figures 3.5 to 3.8 provide an overview of the bathymetry of the South Box. The shallowest point of the survey was encountered in the mid section of the South Box at approximately 60m, with the majority of the area less than 90m deep. The shallower area was found on the western side of the South Box, with a number of deeper areas biting into the Box from the east. The deepest parts of the South Box were in the north (a continuation of the North Box trough) and in the south-eastern corner at 110 to 120m. The bathymetry of the eastern side of the South Box was more heterogeneous than the west with greatest variation seen in areas deeper than 90m (Section 3.1.3; Figure 3.13 and 3.14). Several large solitary sand waves were visible in the northern half of the box (Section 3.1.3; Figure 3.11).

3.1.3 Bathymetry features

A number of features were observed from the bathymetry and these are detailed in Figures 3.9 to 3.14. Independent grey scale shading has been applied to highlight these features. These depths are not to scale and true depths below LAT can be seen in Figures 3.2 to 3.8.

Sand waves
An area of sand waves was observed in the north of the North Box (Figure 3.9). Each wave was approximately 2 to 3m high with a wavelength of approximately 80 to 100m. In the Centre Box and also the northern end of the South Box several features were observed that appeared to be large solitary sand waves (Figures 3.10 and 3.11). They averaged 20m high, with a wavelength of 200m and length along the crest estimated at 400m.

Troughs and deeper areas
In the south of the North Box and north and southeast of the South Box deeper areas exhibited a more varied topography per unit area than the shallower more level sea bed found over the rest of the survey area (Figures 3.12 to 3.14).

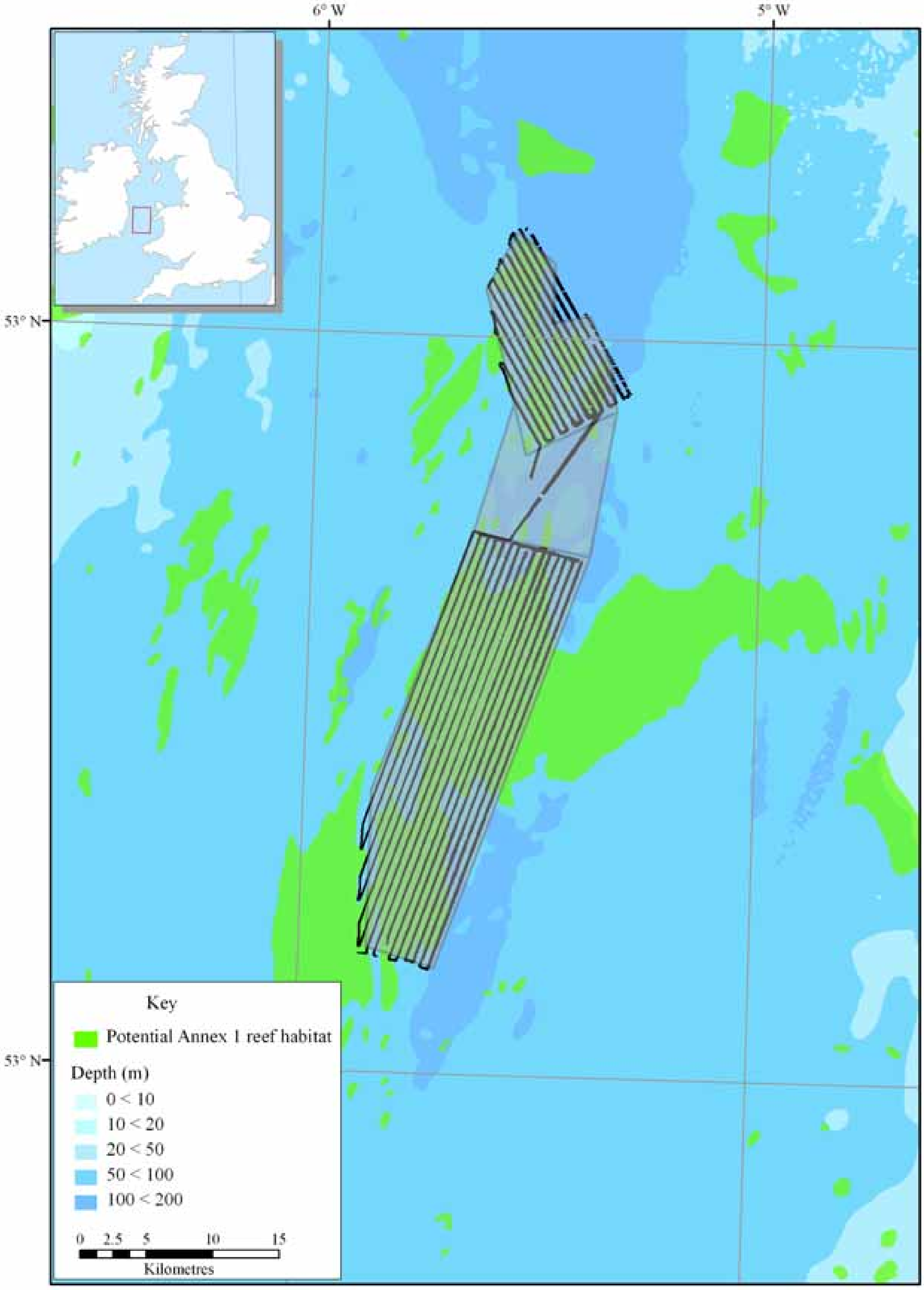

Figure 3.1 Area of multibeam survey coverage with potential Annex 1 reef habitat. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

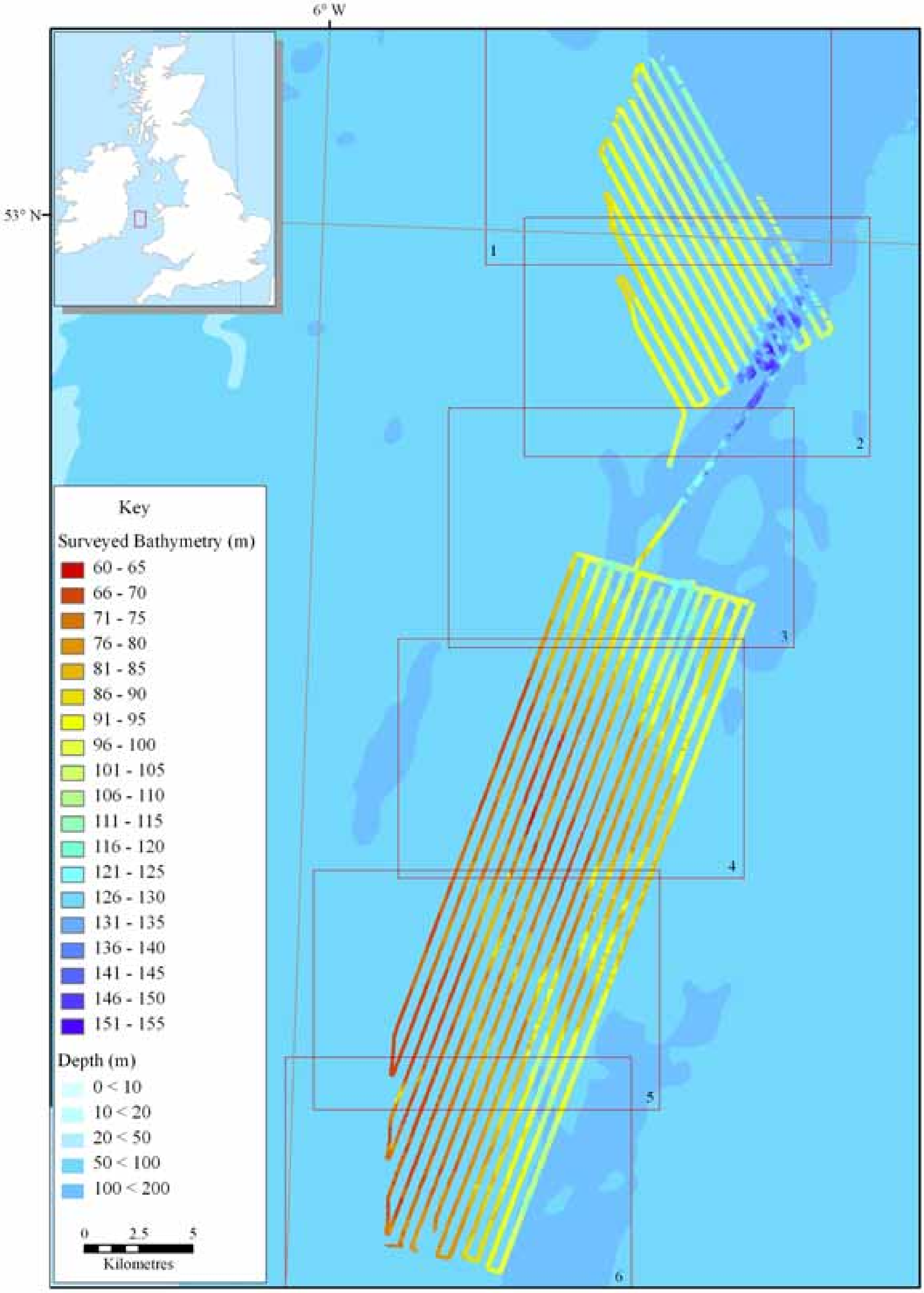

Figure 3.2 Overview of bathymetry of the survey area. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

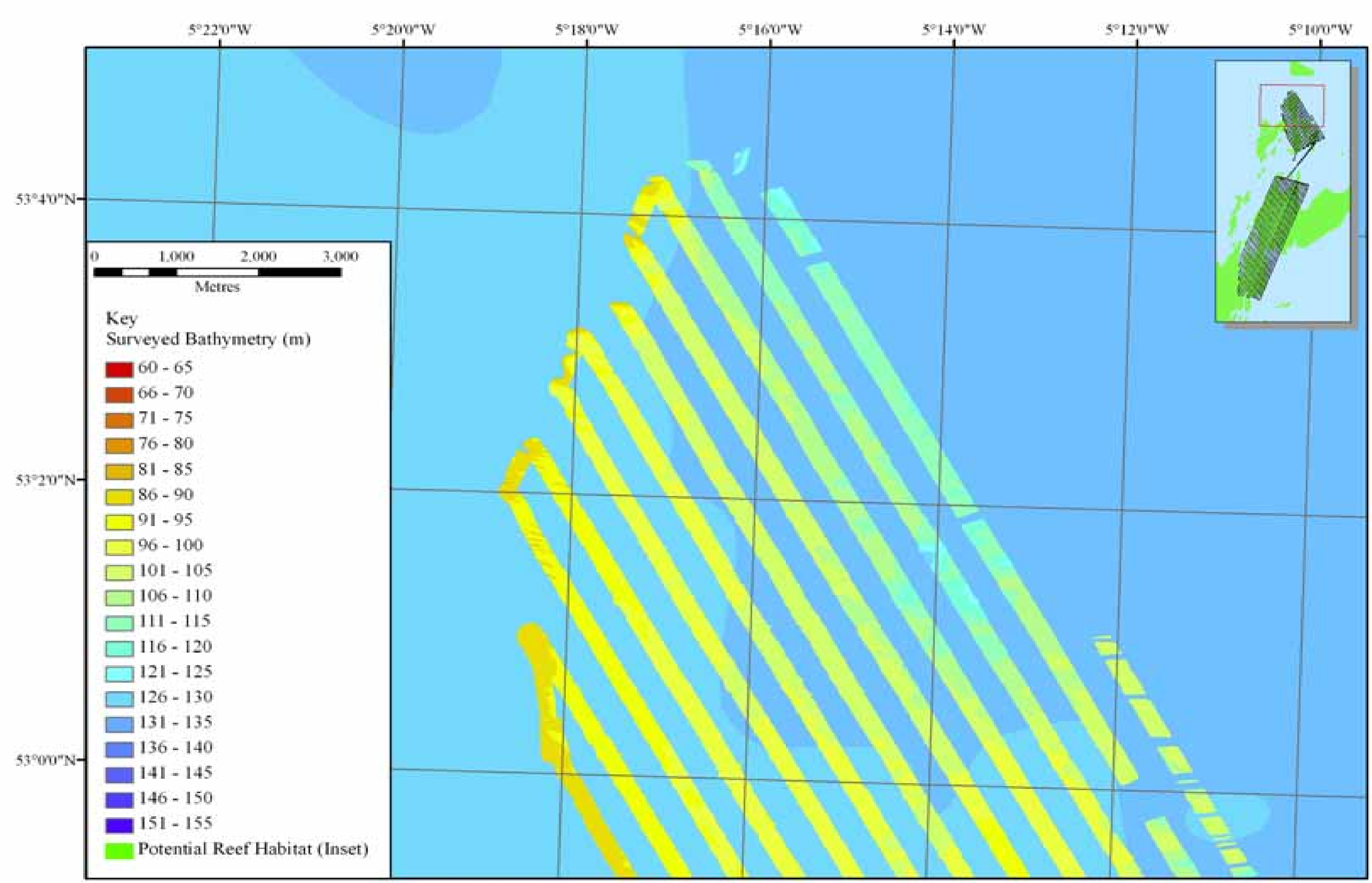

Figure 3.3 Bathymetry detail box 1. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

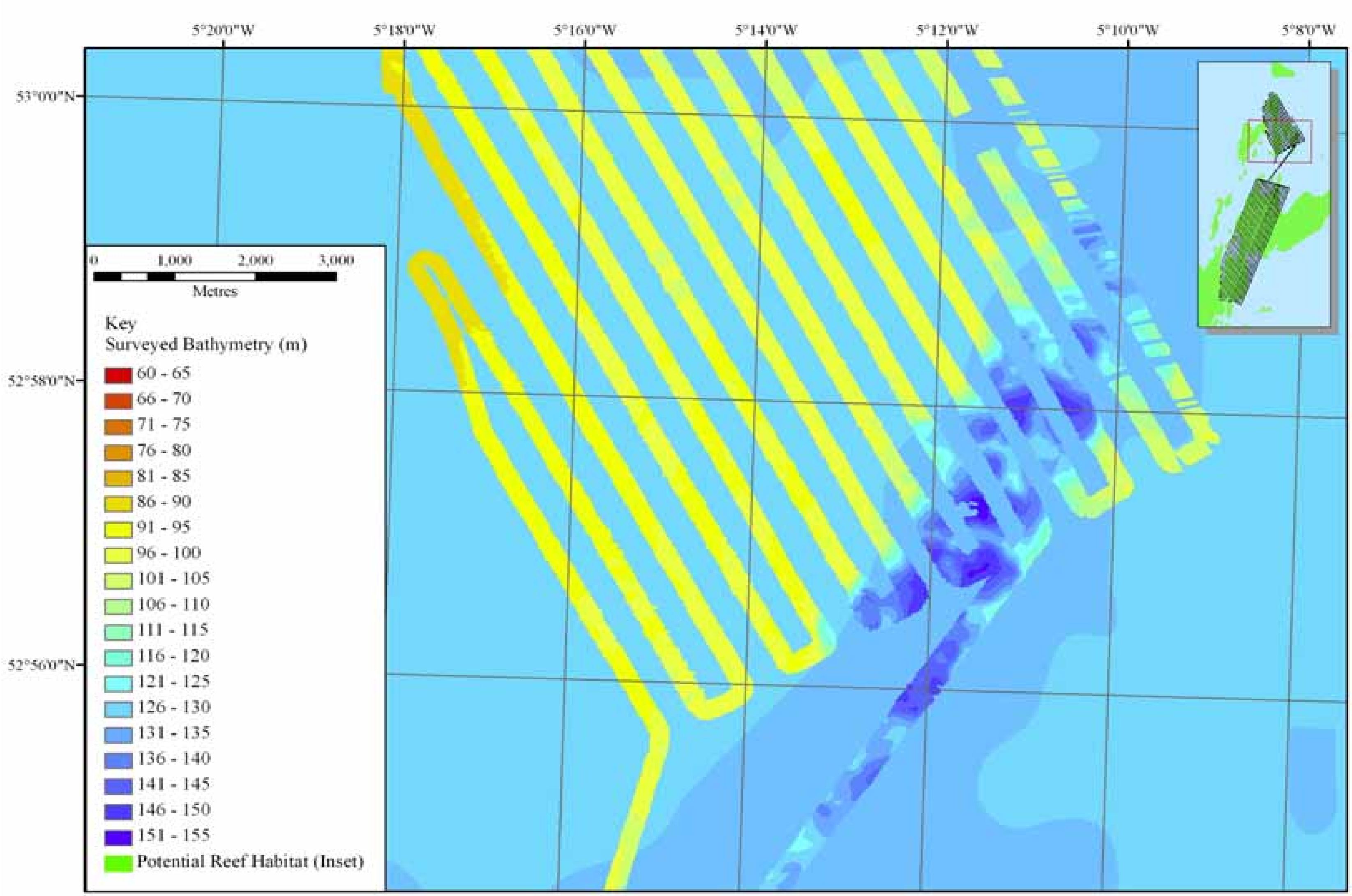

Figure 3.4 Bathymetry detail box 2. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

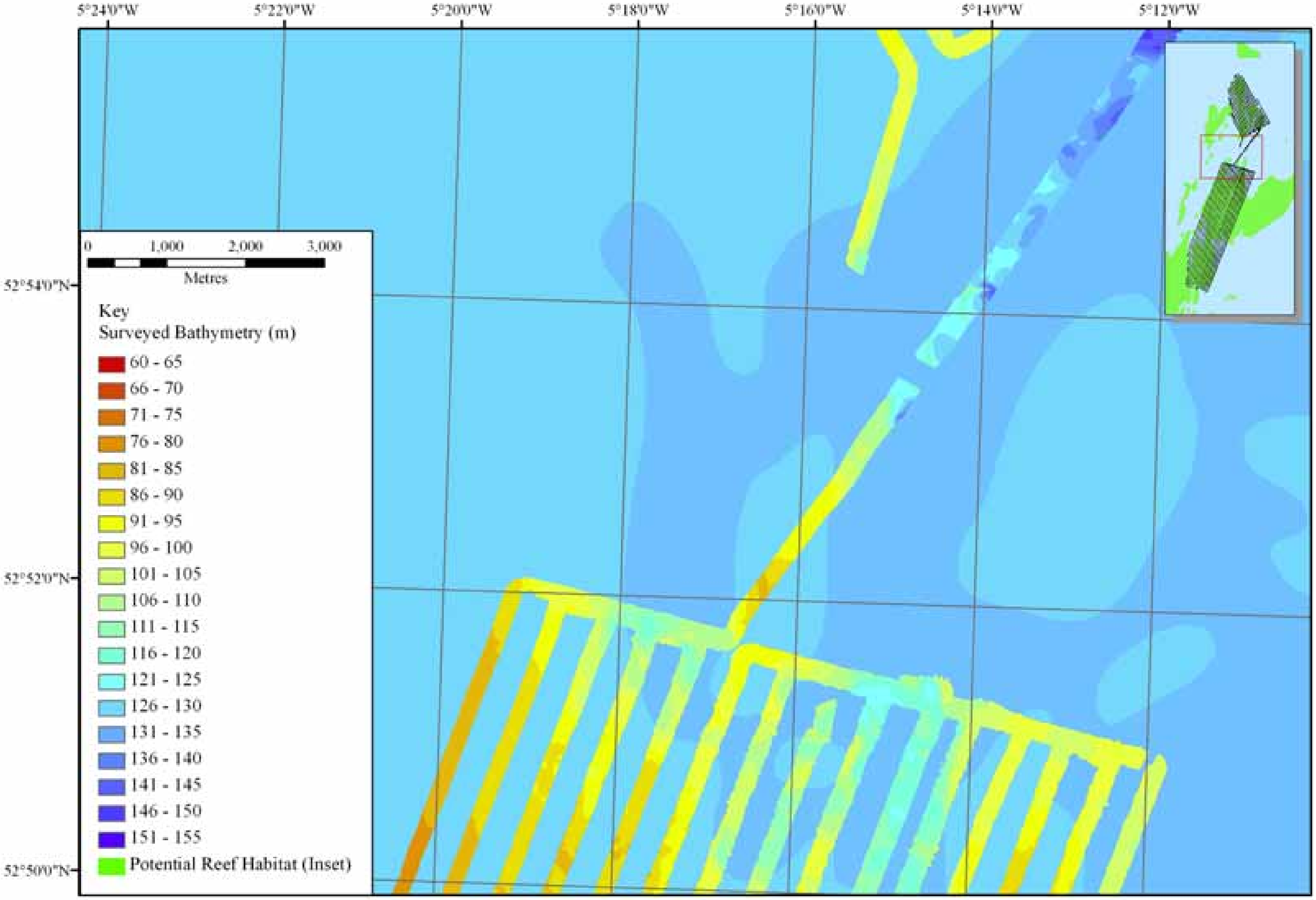

Figure 3.5 Bathymetry detail box 3. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

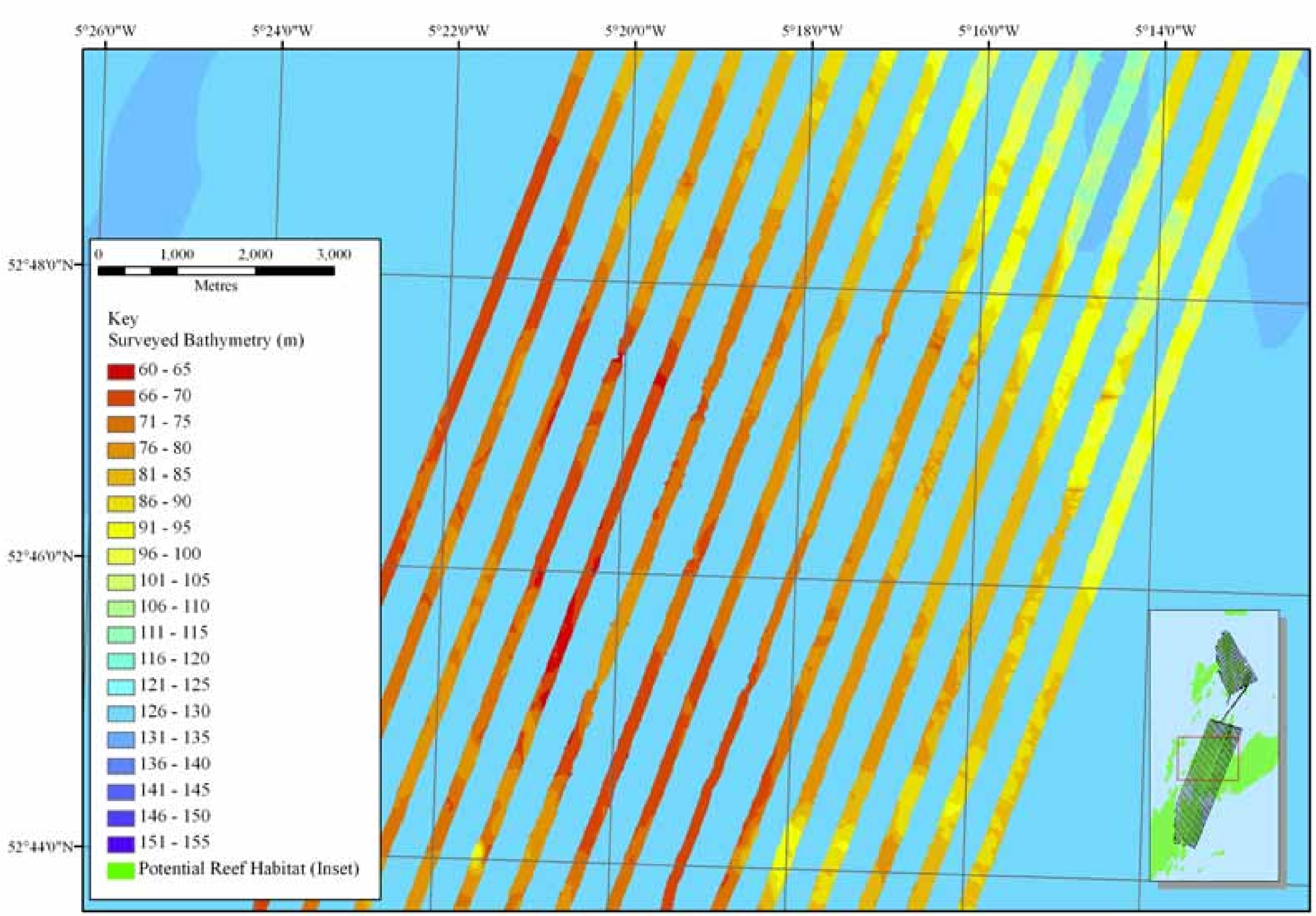

Figure 3.6 Bathymetry detail box 4. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

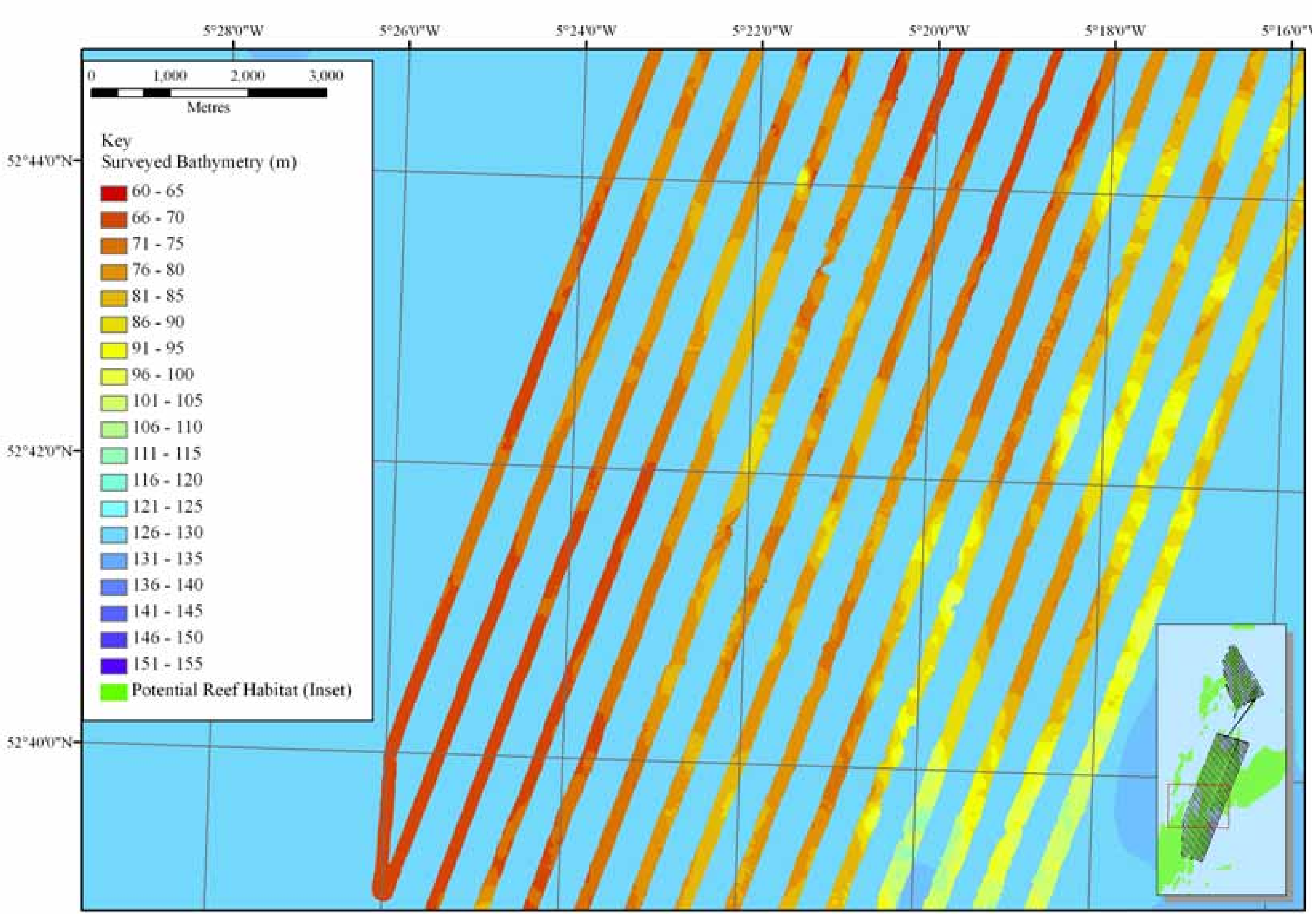

Figure 3.7 Bathymetry detail box 5. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

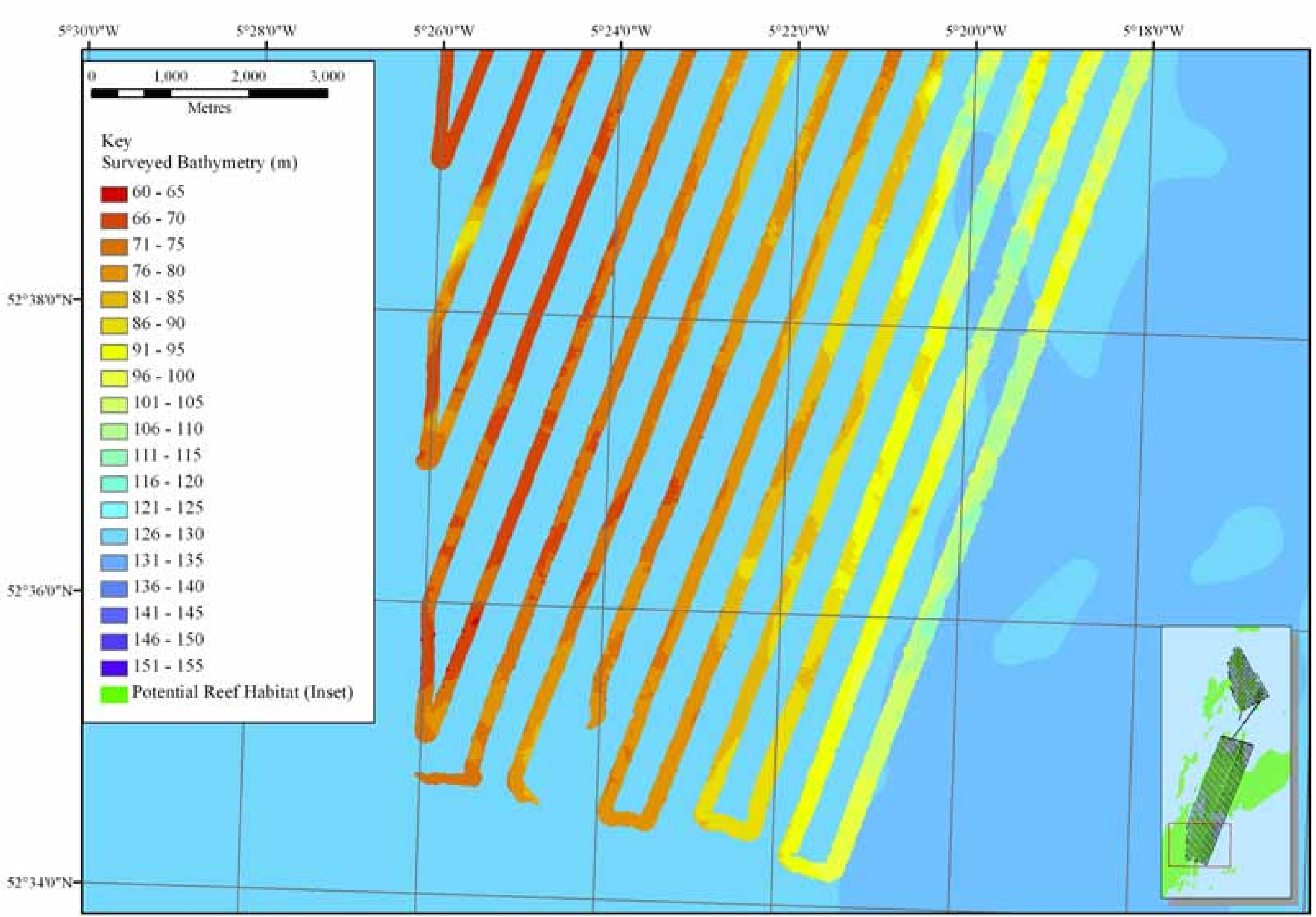

Figure 3.8 Bathymetry detail box 6. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

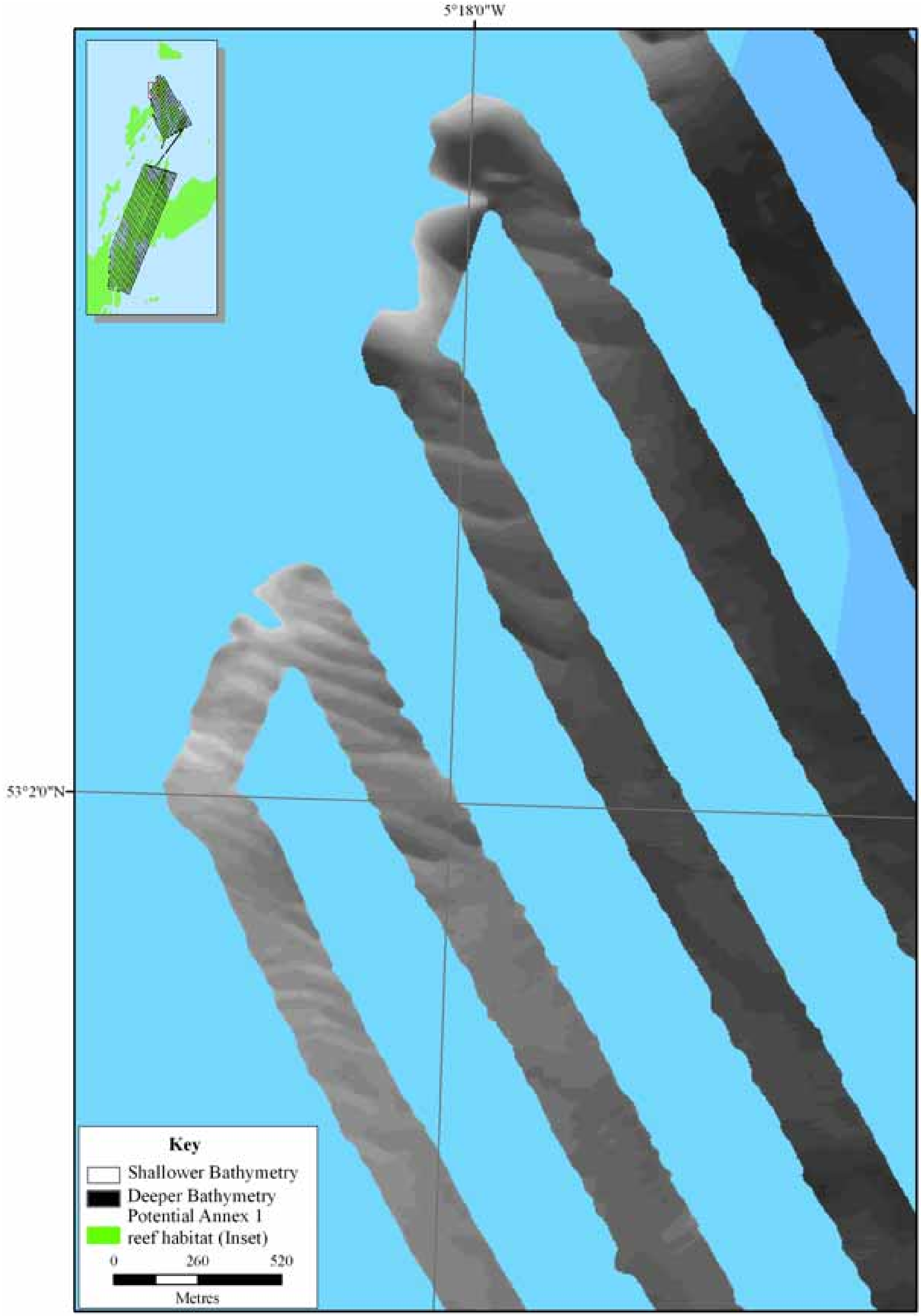

Figure 3.9 Detail of sand wave field in the North Box. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

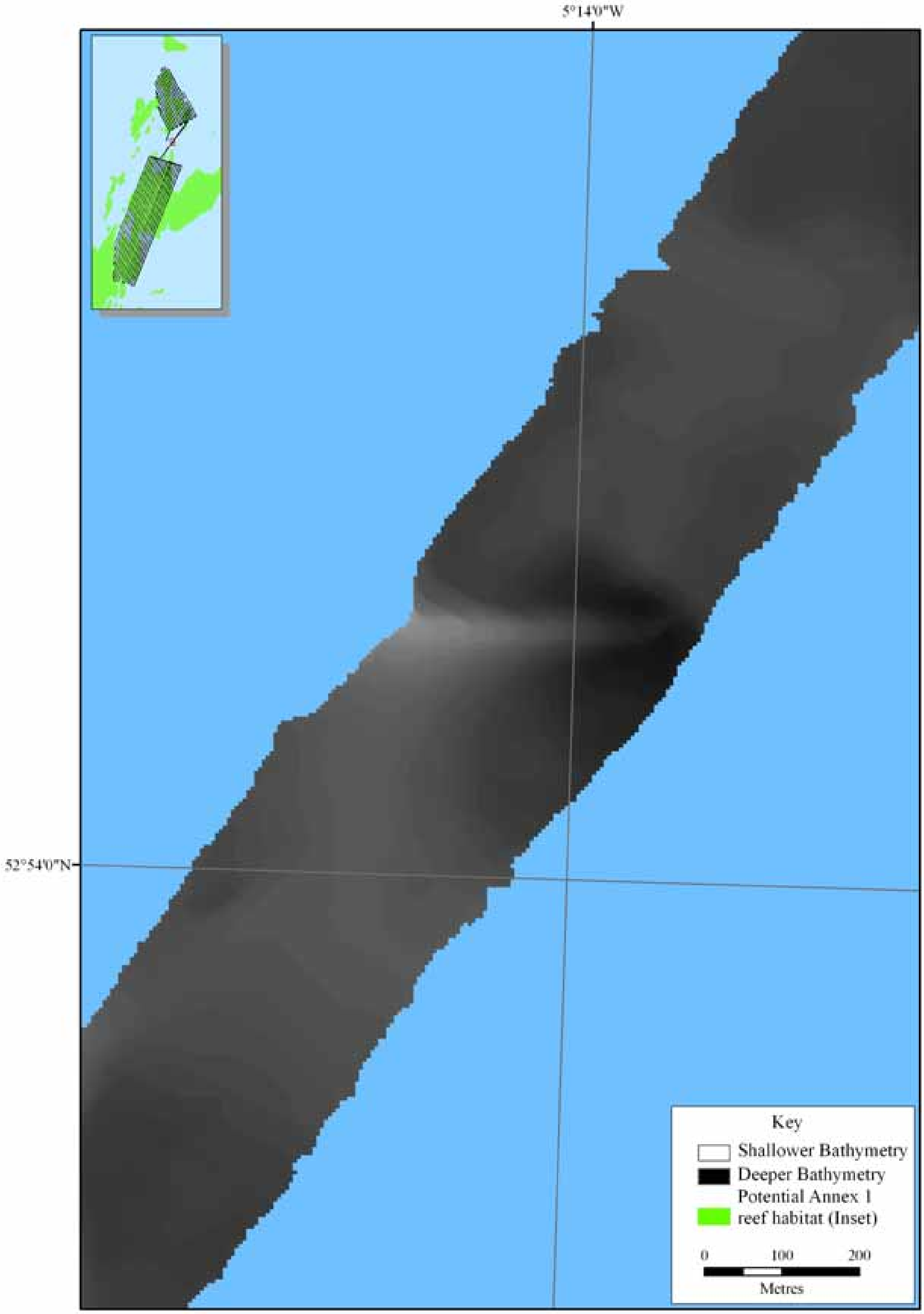

Figure 3.10 Detail of solitary sand wave in the Centre Box. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

Figure 3.11 Detail of solitary sand waves in the South Box (highlighted in red). © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

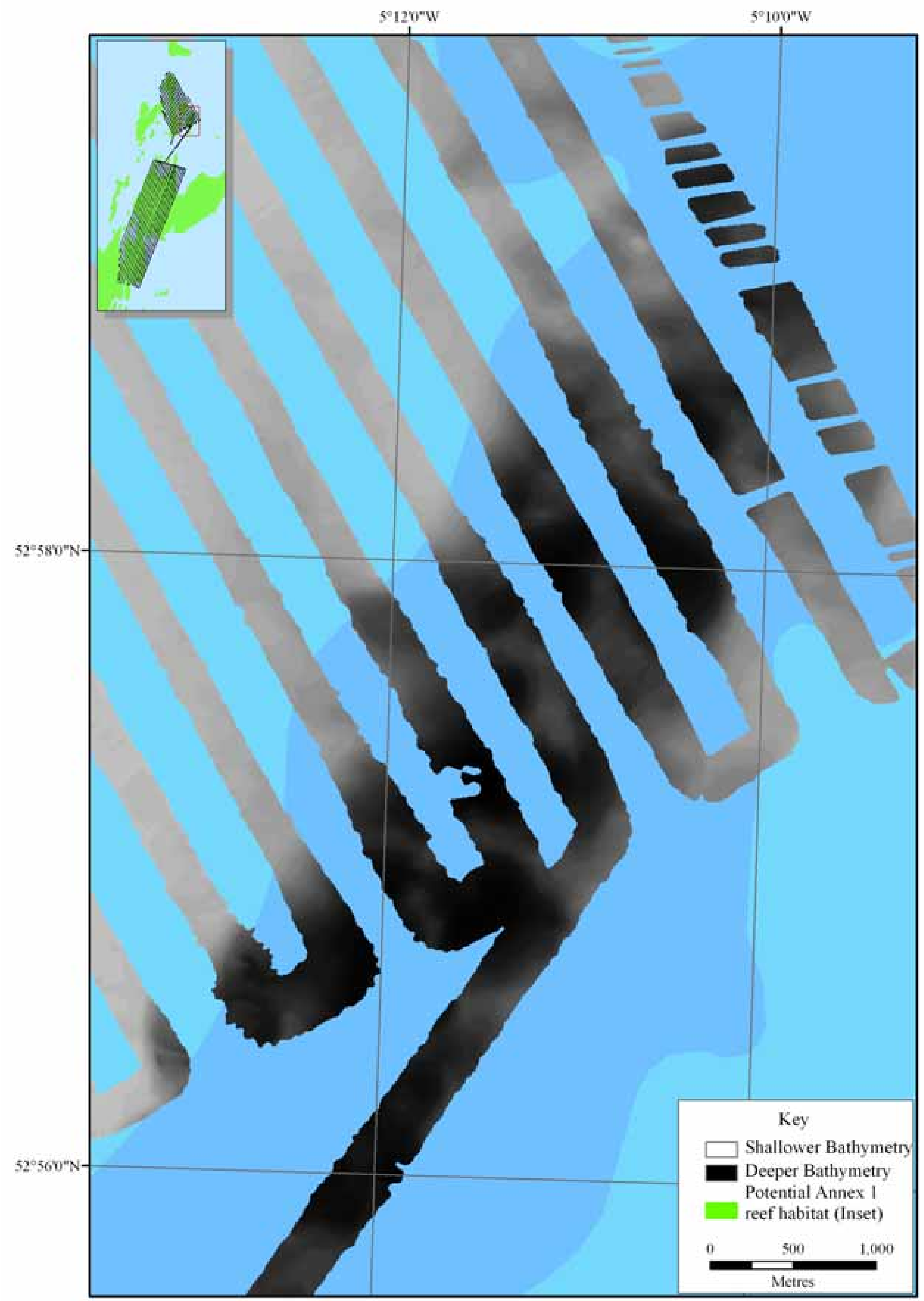

Figure 3.12 Detail of deep trough in the North Box. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

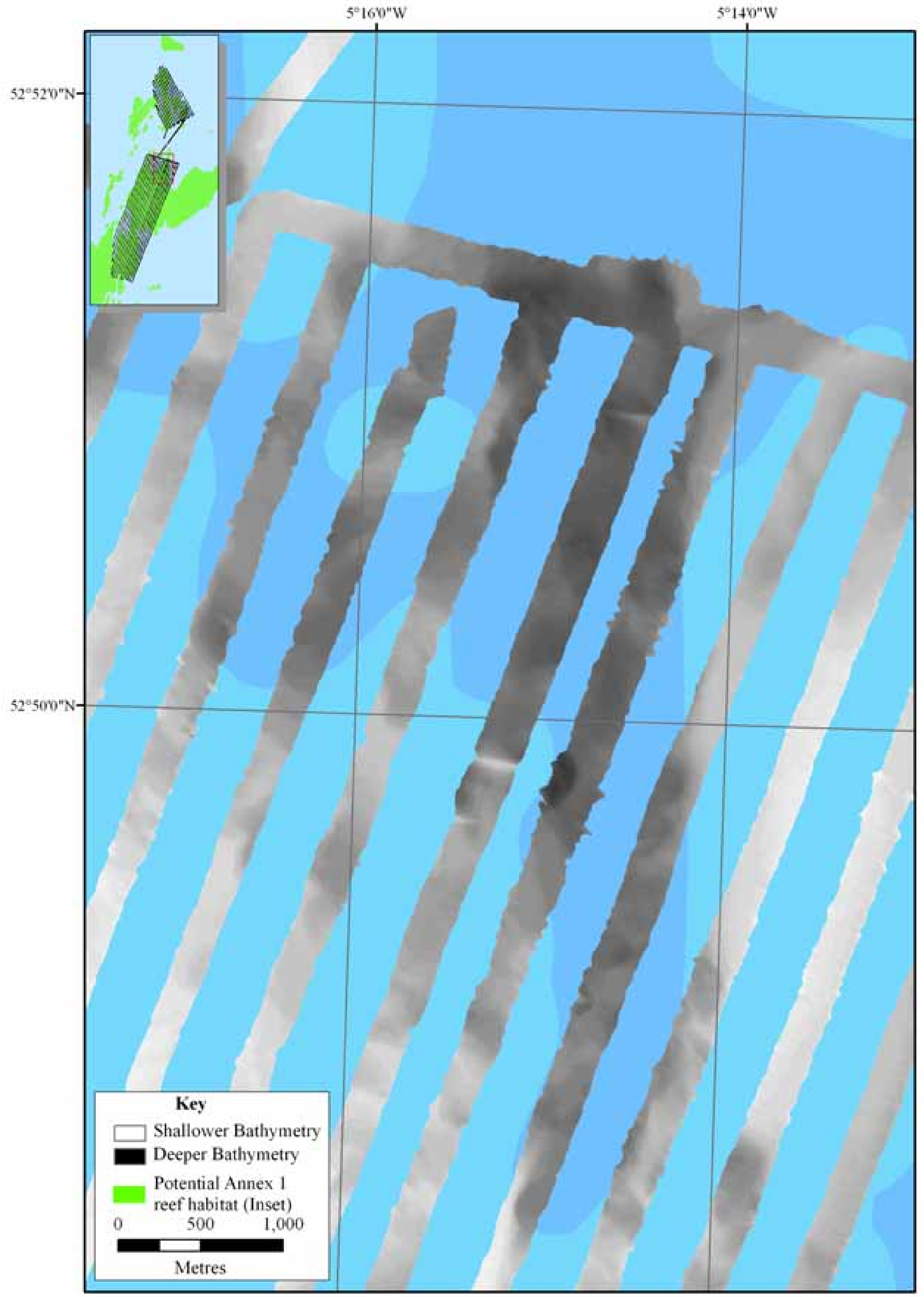

Figure 3.13 Detail of the deeper area in the north of the South Box. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

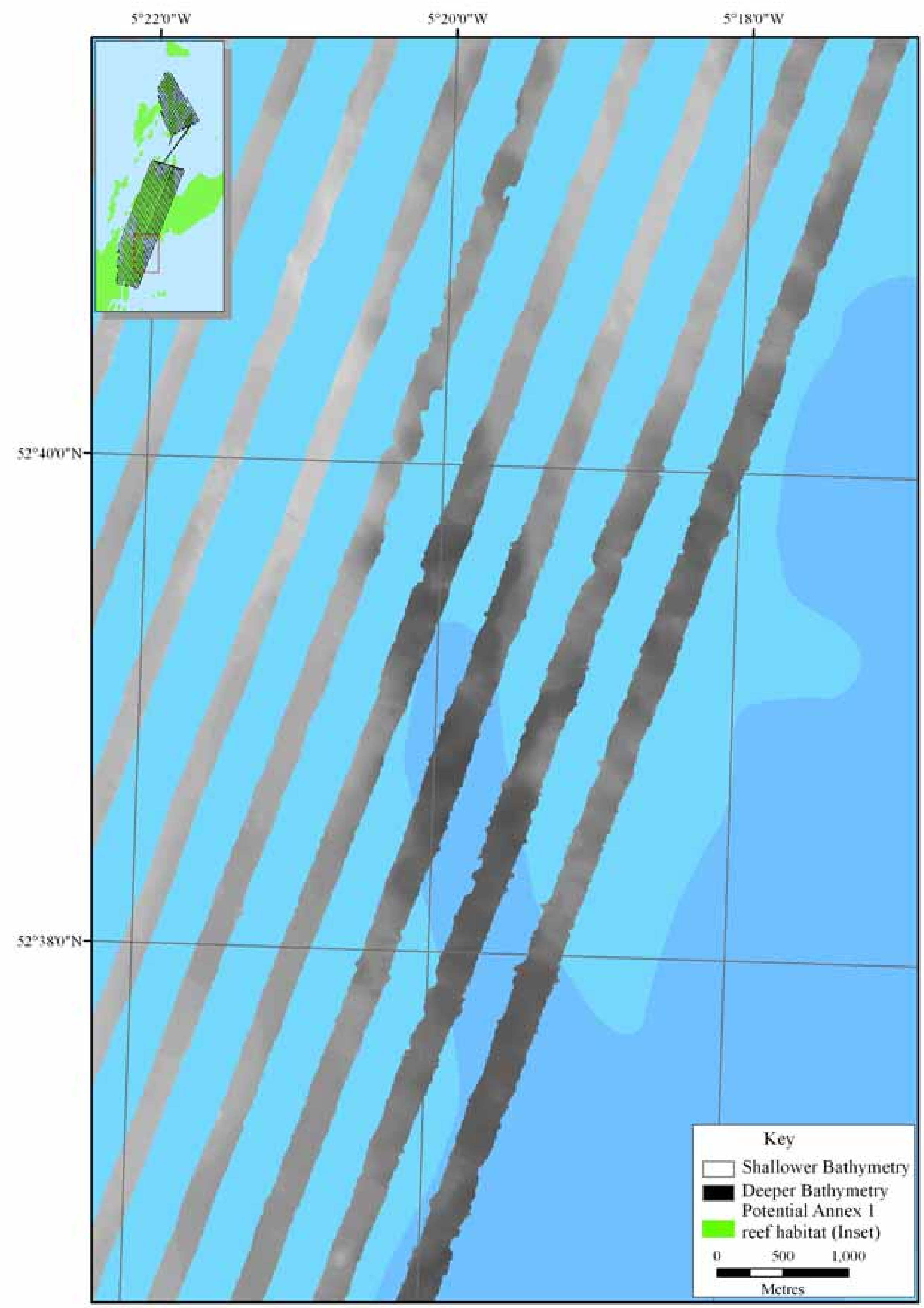

Figure 3.14 Detail of the deeper area in the southeast of the South Box.

3.1.4 QTC-View

QTC-View data were provided in Microsoft Excel format. Raw Q values are illustrated in Figures 3.15 to 3.17 and classed data are presented as an overlay on the backscatter figures 3.19 to 3.24. There were several data gaps in QTC-View coverage of the survey area. Small gaps appear where individual echo-sounder pings have been removed from the data during data analysis. QTC-View data are absent from one line in the South Box where the system did not record due to operator error.

Raw Q values, particularly Q1 (Figure 3.15) and QTC-View classes, showed a strong correlation to bathymetry and changes in slope angle with classes Q1 and Q5 characteristic of both small changes in topography such as those seen in the sand wave field of the North Box (Figure 3.19) and also larger scale changes such as those observed in the trough section of the North Box (Figure 3.20) and in the deeper sections of the South Box (Figures 3.21 to 3.24). Classes Q2, Q3 and Q4 appeared most commonly over the whole survey area, and appeared to be characteristic of the more featureless areas surveyed.

3.1.5 Backscatter

Backscatter data are presented as 16m resolution gridded grey-scale raster tiles. 4m resolution grids have also been provided as a digital product but were considered to contain too much noise to be of use for broad-scale habitat interpretation. Areas of low backscatter appear dark; areas of high backscatter are lighter. Straight lines of contrast running vertically and horizontally at a scale of approximately 5km are artefacts of the tiles used for the PRISM analysis. Overall the backscatter showed gradual transitions in sediment type throughout the survey area. The main features identified from the backscatter were the darker areas associated with the field of sand waves in the north of the North Box, striations in the centre of the North Box running approximately in north-south direction and an overall increase in patchiness in deeper areas, with increased backscatter, such as the trough in the south of the North Box, and the eastern side of the South Box (Figure 3.18).

The field of sand waves identified from bathymetry (Figure 3.9) was also apparent in the backscatter image (Figure 3.19). The central area of the North Box showed a series lines running approximately in a north-south direction, reflecting sediment distribution along the tidal axis. Larger scale patchiness was also observed at a scale of 2.5km, although this pattern is disrupted by the horizontal discontinuities present from the PRISM analysis. The southeast of the North Box (Figure 3.20) showed greater patchiness in backscatter at a resolution of 0.5km, and this corresponded to the trough observed from the bathymetric data (Figure 3.4).

Backscatter data from the survey line that ran through the Central Box showed a continuation of the patchiness observed in the south of the North Box with the large solitary sand wave appearing as a dark band (Figure 3.21).

The South Box backscatter data showed increased patchiness in the north and eastern sides, corresponding to broad changes in bathymetry, with patchiness increasing in deeper areas. Figure 3.22 shows large dark bands, similar to those seen in the north of the North Box, with lighter areas of backscatter apparent in the deeper sections. This patchiness in backscatter was also observed in the deeper areas along the east of the South Box (Figures 3.23 and 3.24). At a finer scale, north-south striations similar to those apparent in the North Box were also observed in the shallower areas of the South Box.

False colour classed backscatter of the North Box has been used to help visualise sediment distribution (Section 3.23; Figure 3.26).

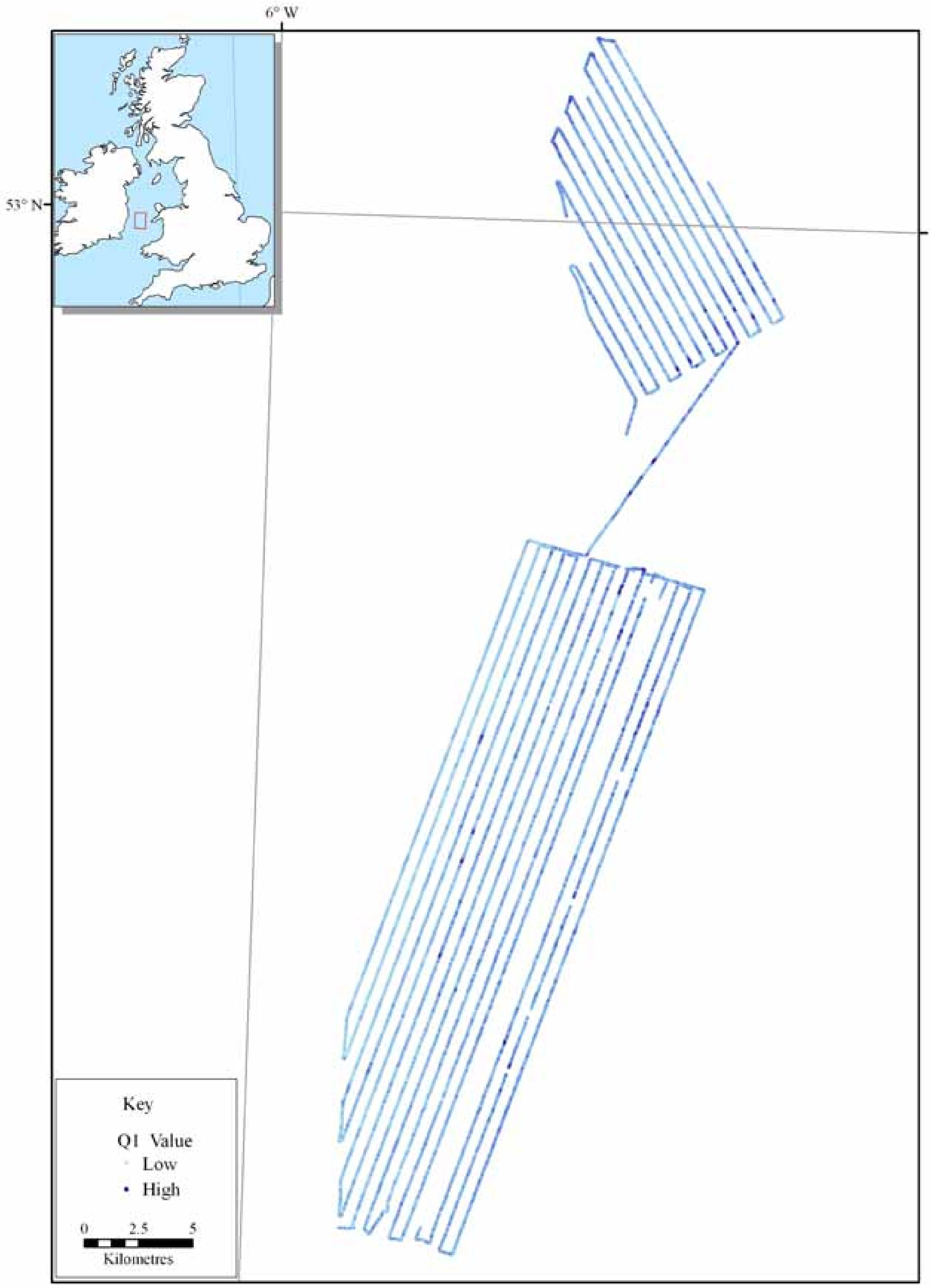

Figure 3.15 Raw Q1 values from QTC-View data.

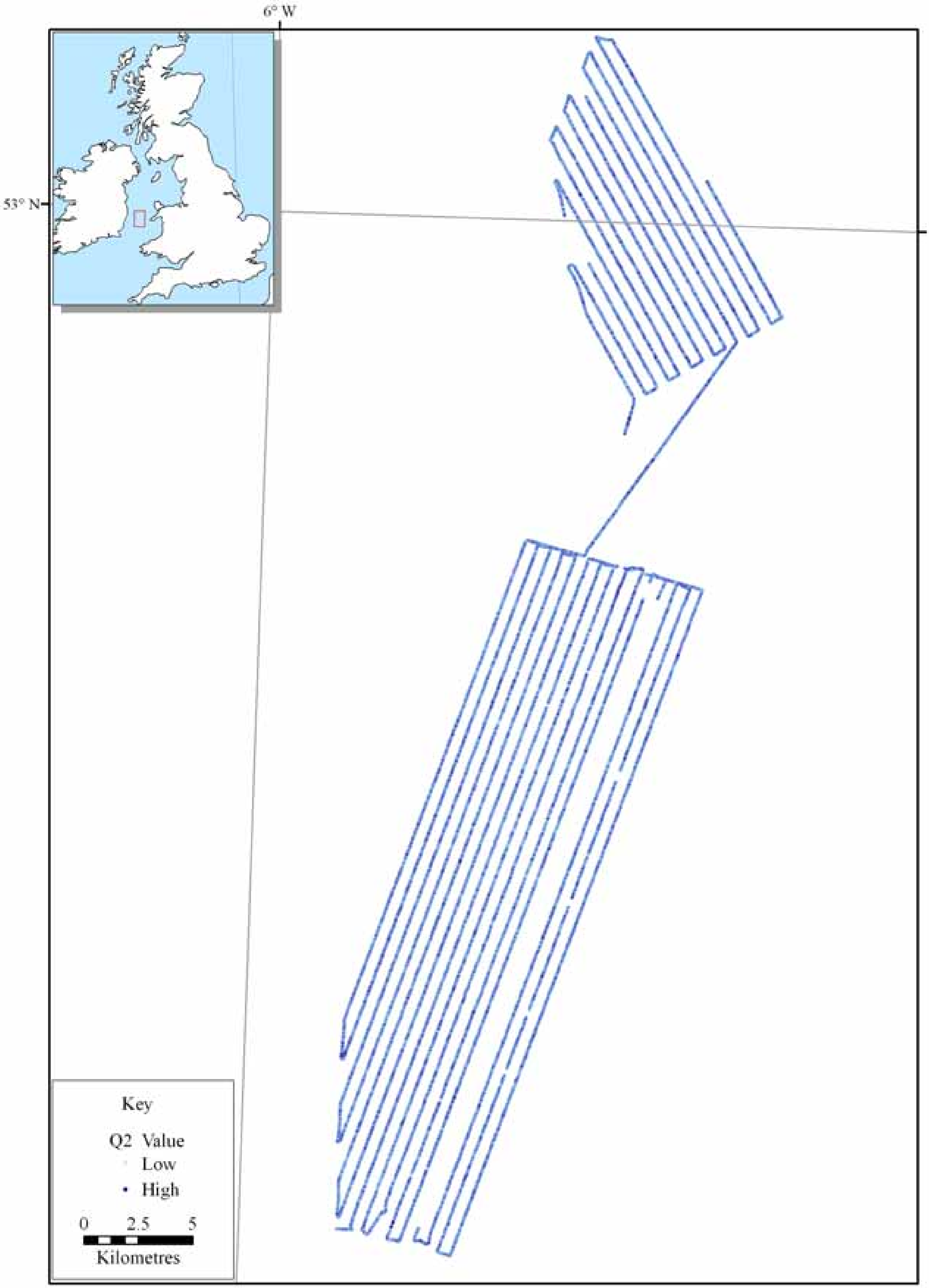

Figure 3.16 Raw Q2 values from QTC-View data.

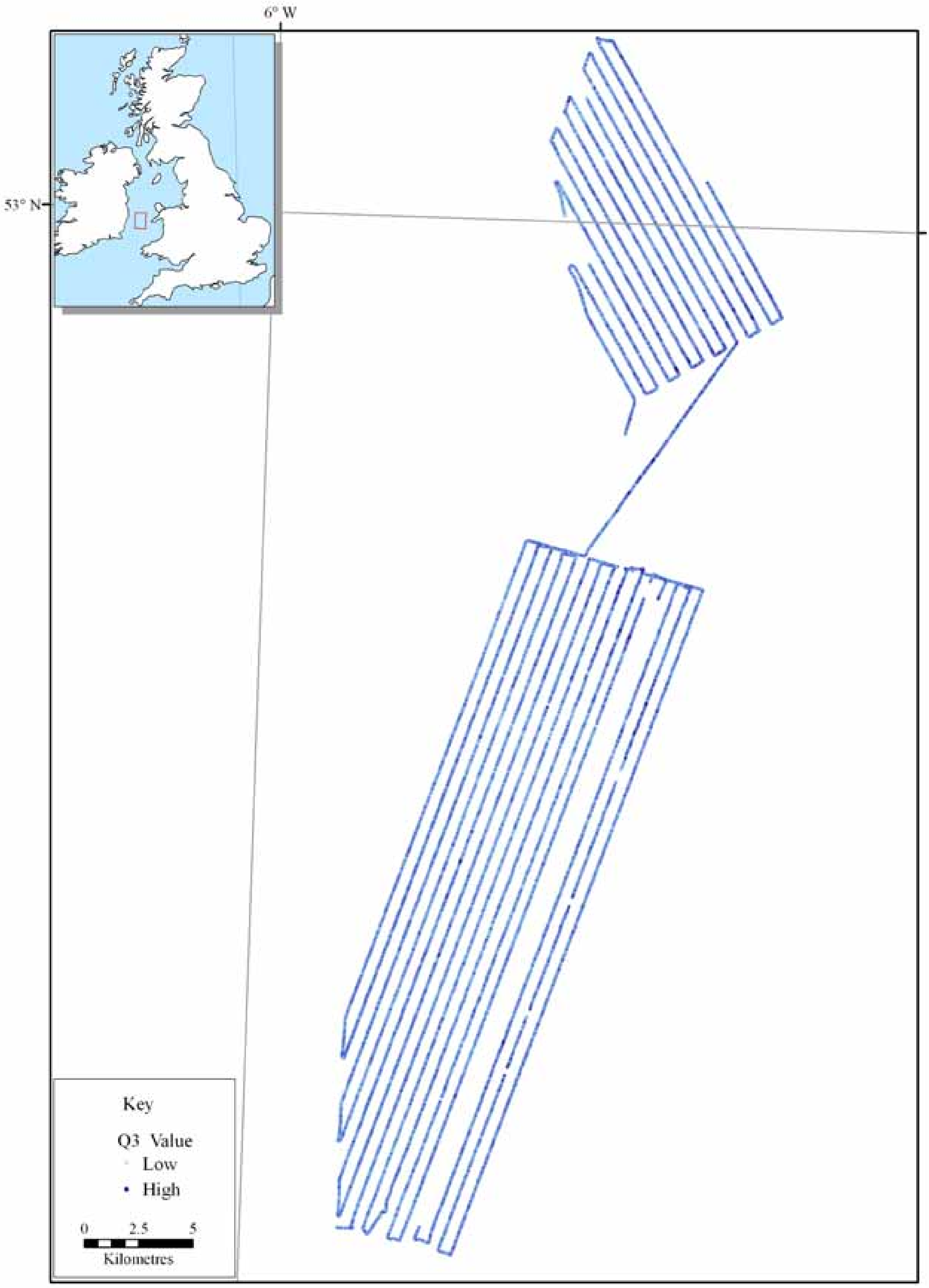

Figure 3.17 Raw Q3 values from QTC-View data.

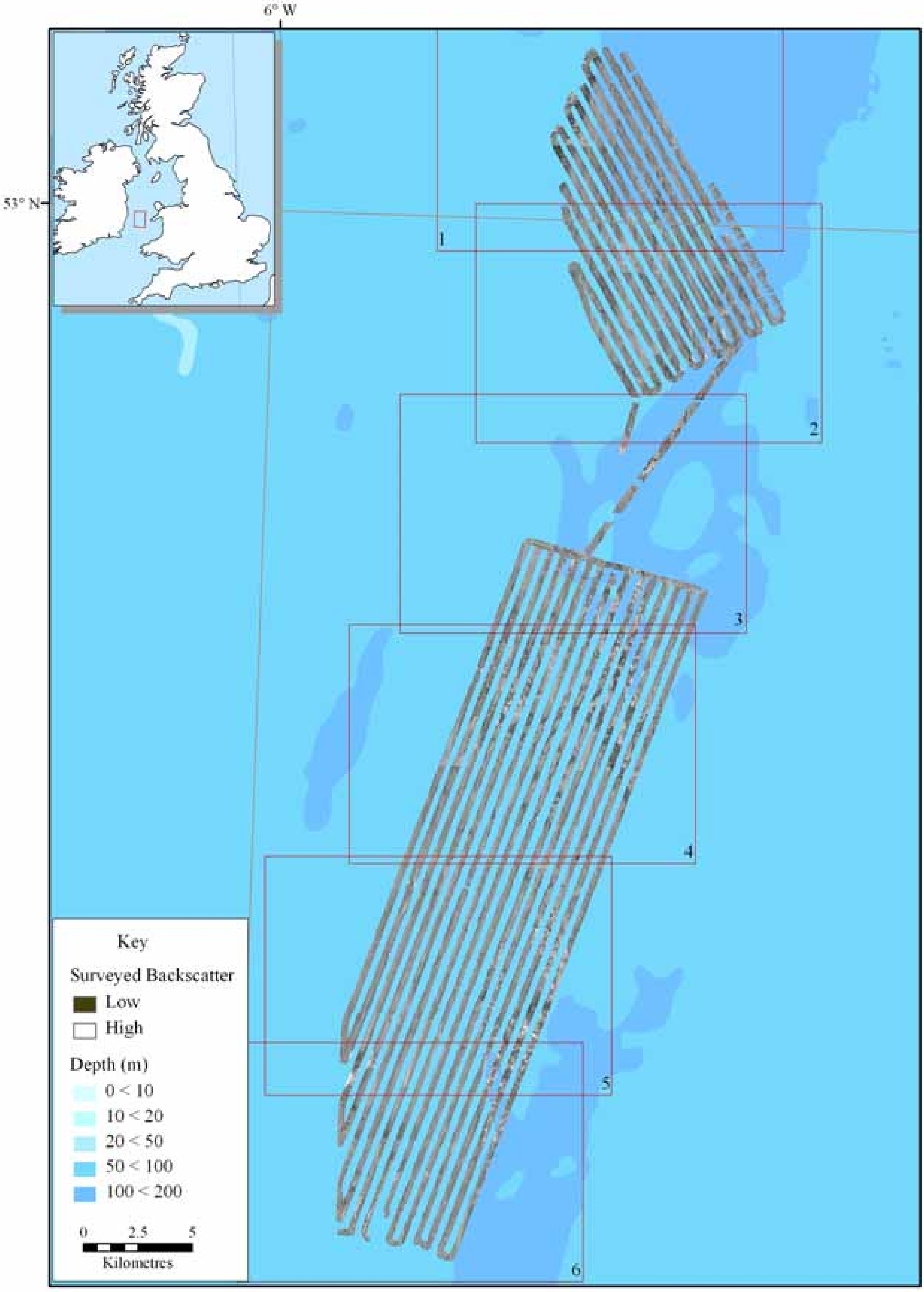

Figure 3.18 Overview of backscatter for the survey area. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

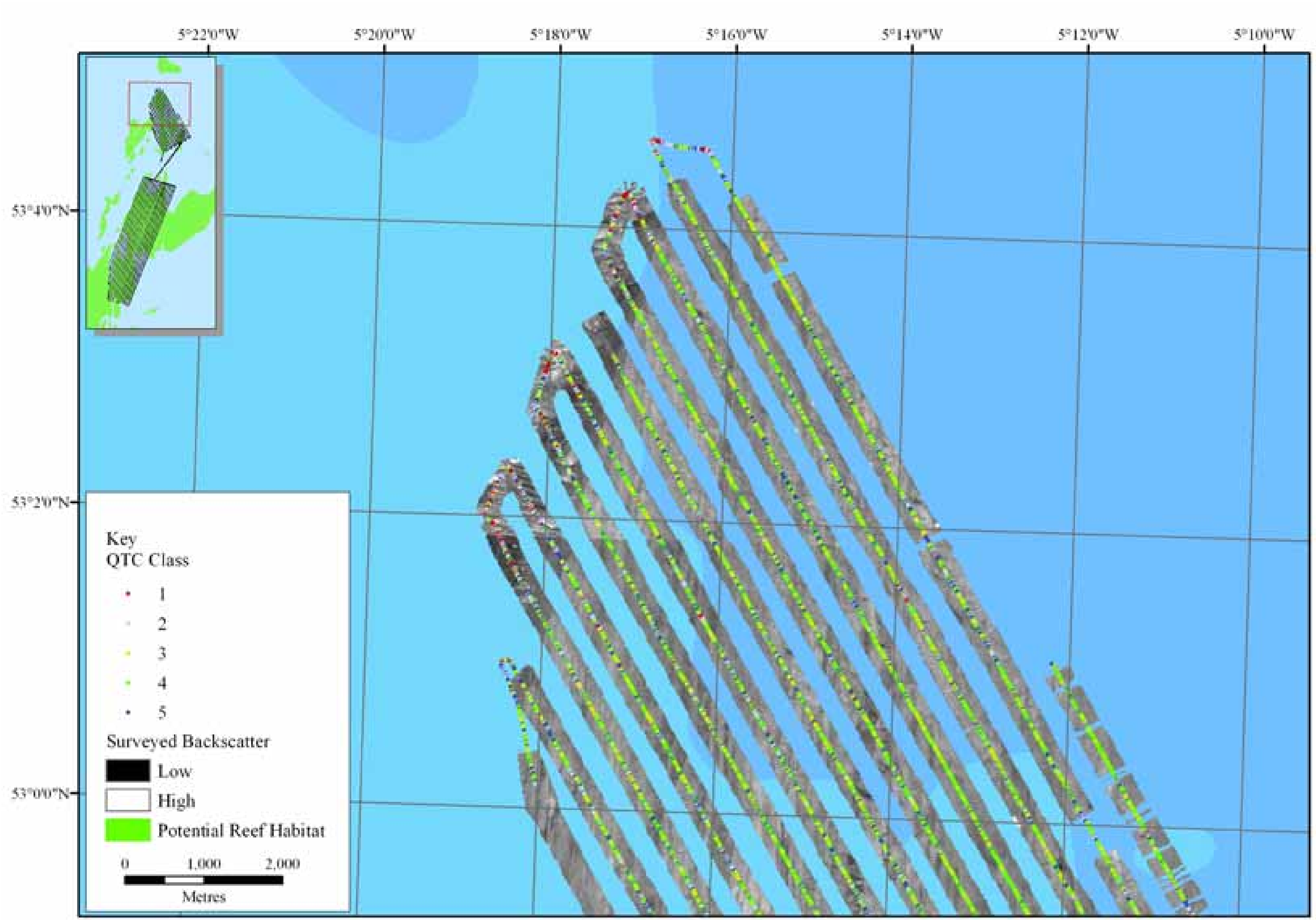

Figure 3.19 Backscatter and classed QTC-View detail box 1.

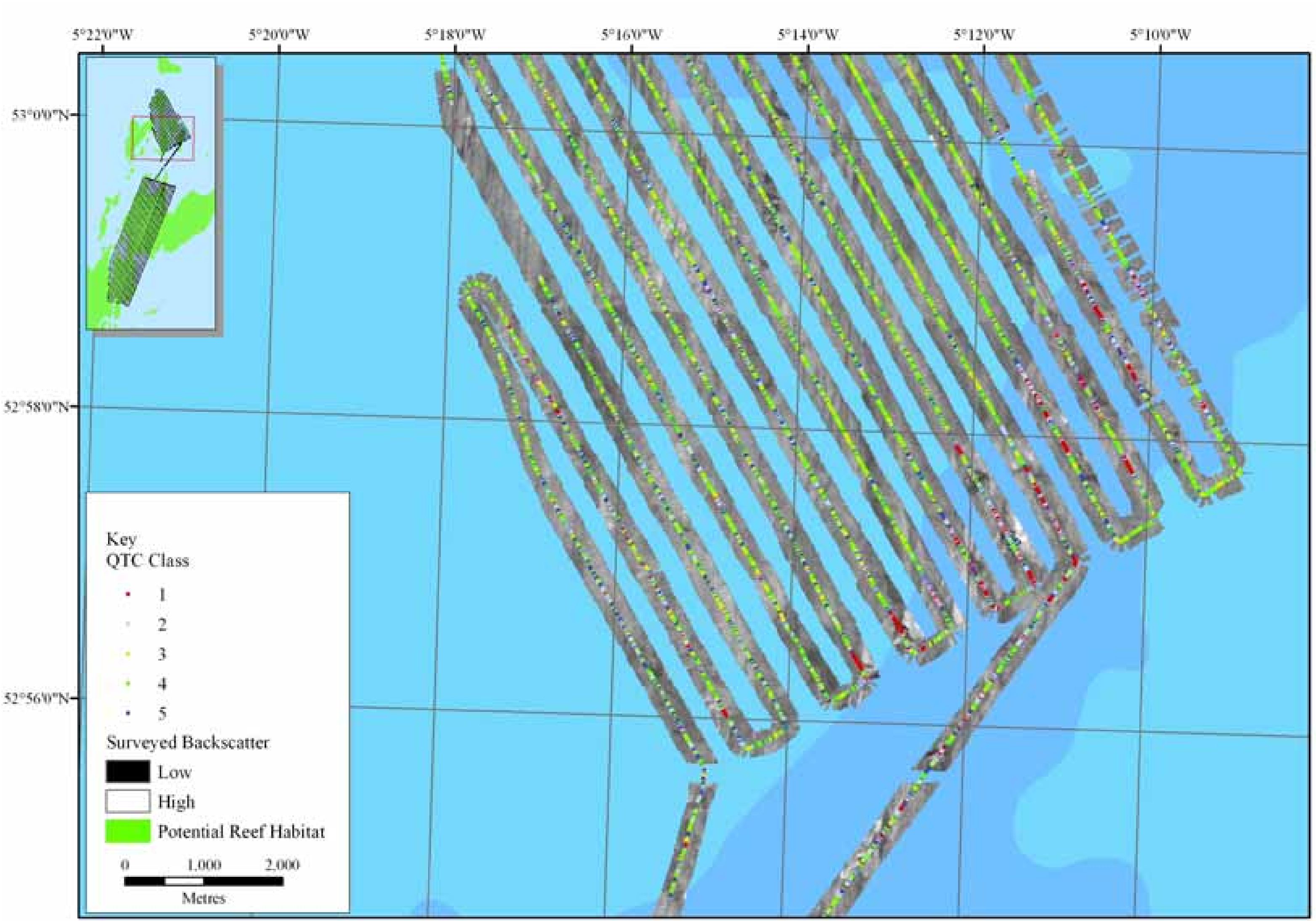

Figure 3.20 Backscatter and classed QTC-View detail box 2. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

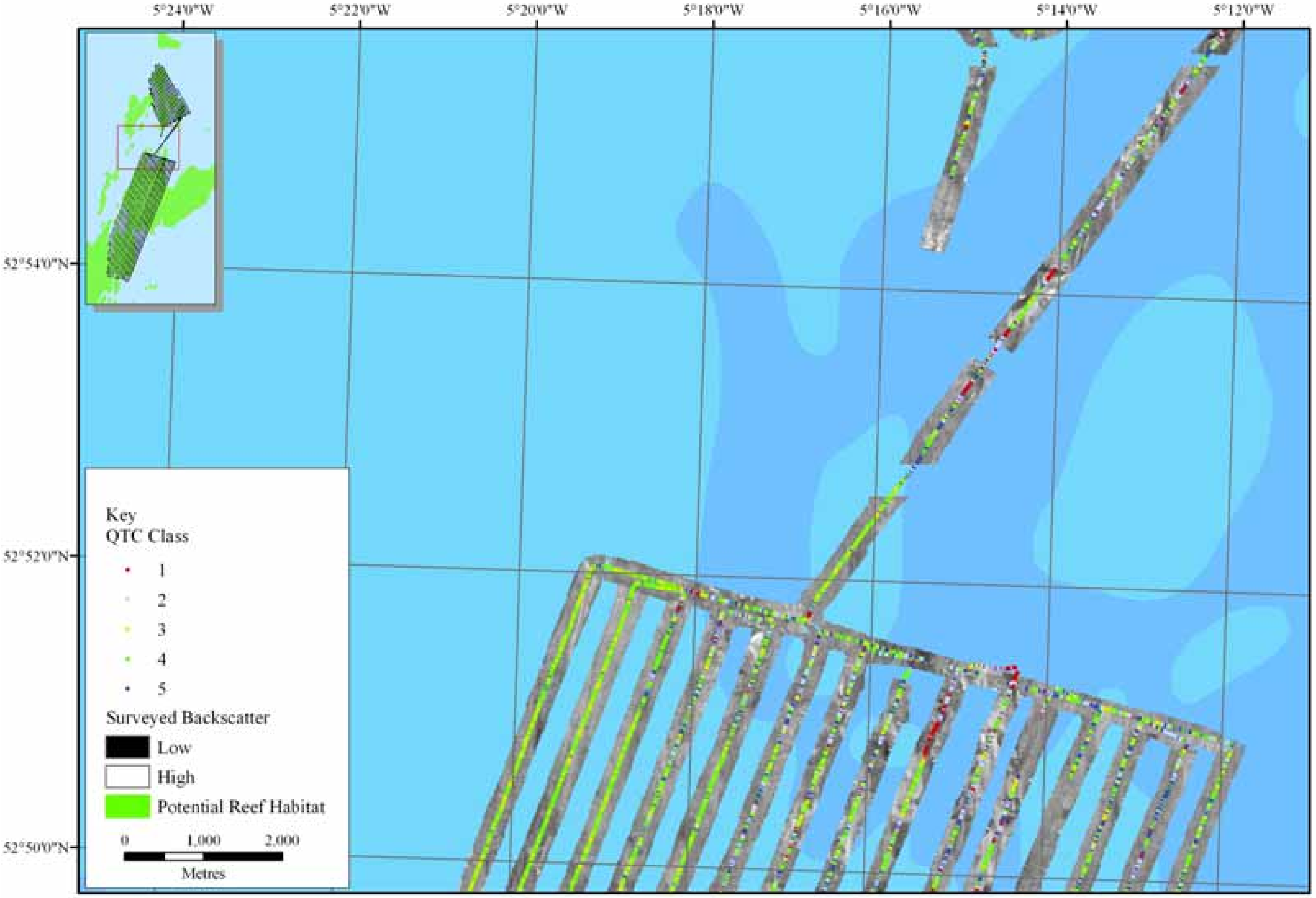

Figure 3.21 Backscatter and classed QTC-View detail box 3. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

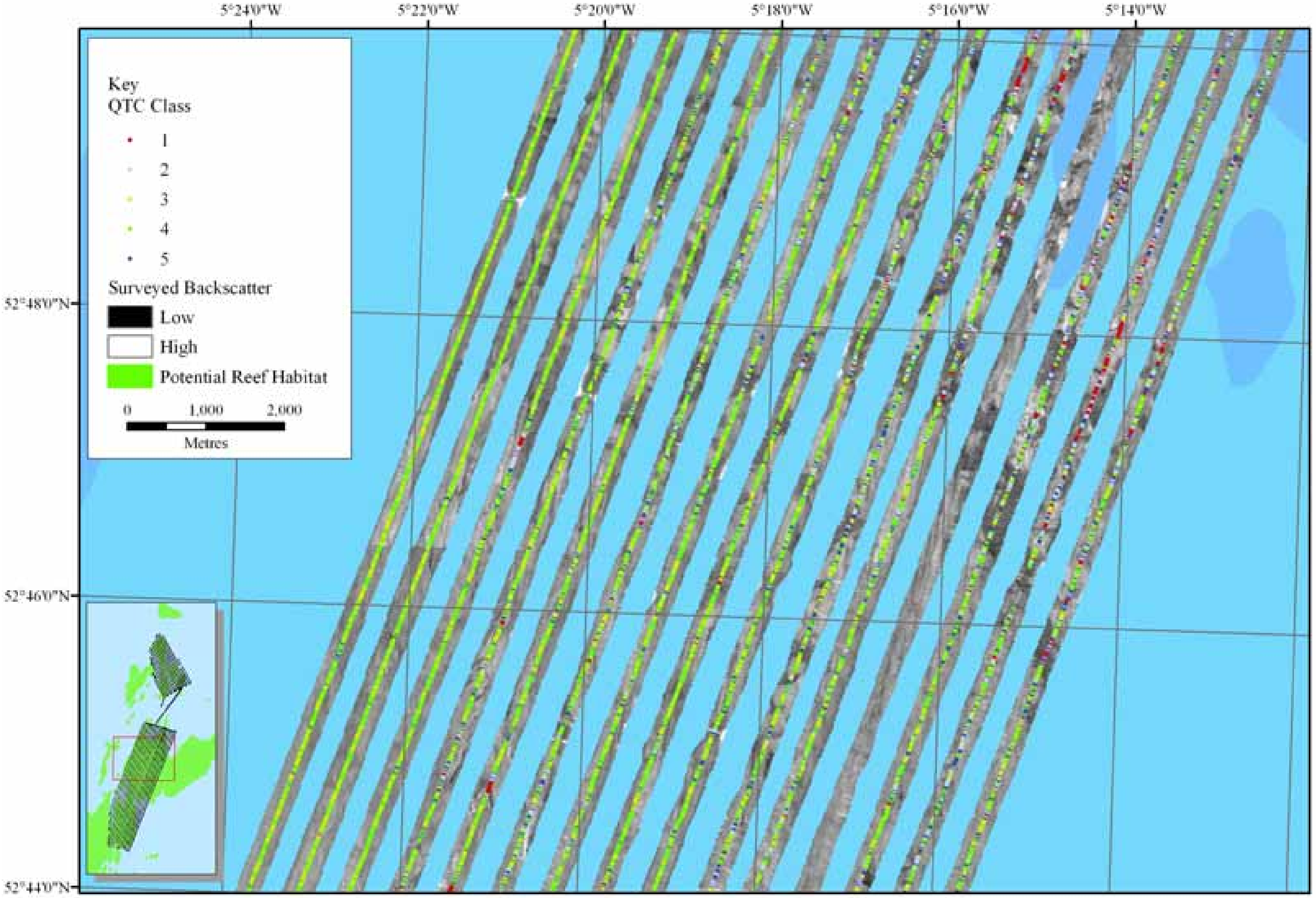

Figure 3.22 Backscatter and classed QTC-View detail box 4. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

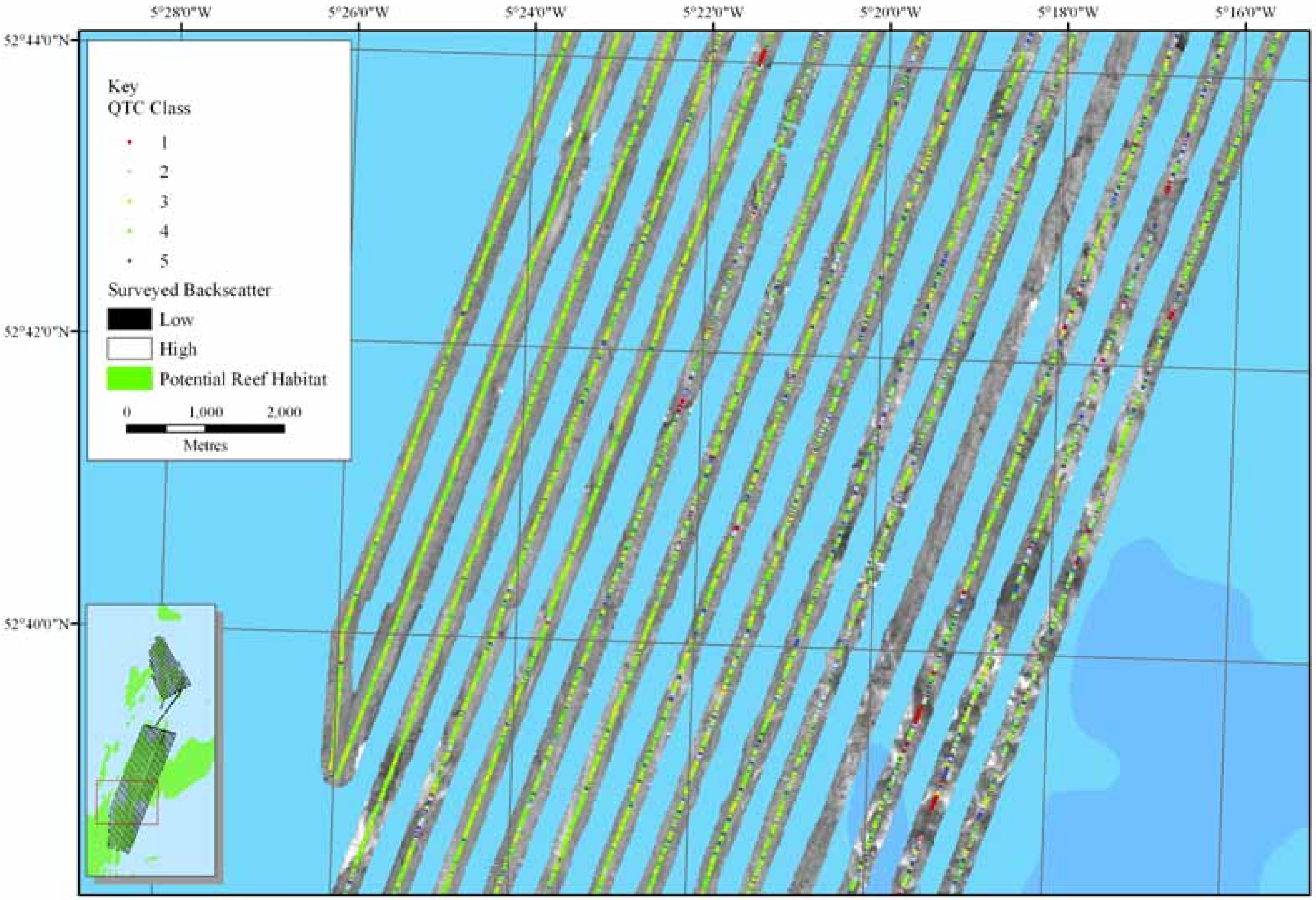

Figure 3.23 Backscatter and classed QTC-View detail box 5. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

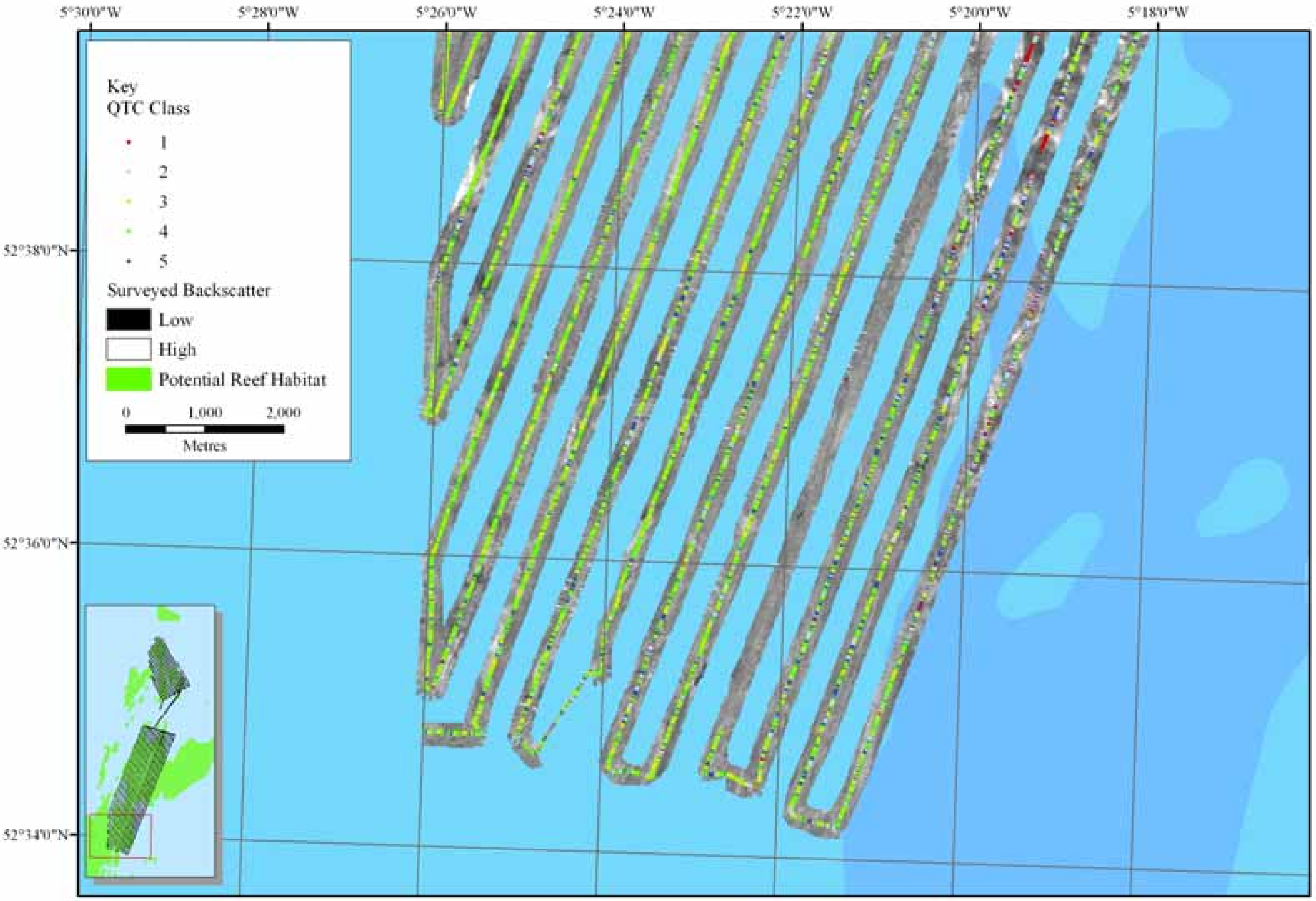

Figure 3.24 Backscatter and classed QTC-View detail box 6. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

3.2 Biology survey

3.2.1 Area of coverage

A total of 34 camera system drops were undertaken over the survey area covering the majority of the North Box (Figure 3.25). The camera system malfunctioned which led to the surveys being aborted before an adequate coverage of samples could be obtained to map the biotopes of the Centre and South Boxes.

3.2.2 Video and still photography

The video footage from the survey was of poor quality due, in part, to the limited underwater visibility (less than 1m) and strong tidal currents, but also due to the low resolution of the recorded image. The reason for poor video image quality was due to the compression of the digital video stream by the modem used to the send the signal along the umbilical. The stills images were of excellent quality and their high resolution facilitated identification of epifaunal species that were too pixelated on the video footage. These images permitted more accurate identification/classification of biotopes. Underwater visibility at all sites was typically very poor. Moderate water currents found across the survey area necessitated that a series of bounces were used during each drop to enable the camera system to land vertically and record a still image of the seabed.

Two hundred and twenty three photographs were taken using the stills camera. The images are presented as JPEG files as electronic data with the report. Video footage is provided as DVD format. Table 3.1 provides an overview of samples and main substratum during the biology surveys.

Table 3.1 Sampling positions (vessel), number of records and substratum at each site.

Site	Start latitude	Start longitude	End latitude	End longitude	No of still images	Substratum
1	53 4 1.080N	5 16 58.080W	53 03.981N	5 16.804W	12	Muddy sand with sparse shell debris
1 (second drop)	53 04.054N	5 17.051W	53 04.175N	5 16.923W	7	Muddy sand with sparse shell debris
2	53 02.911N	5 17.613W	53 02.957N	5 17.533W	6	Muddy sand with shell debris
2 (second drop)	53 02.815N	5 17.677W	53 03.035N	5 17.496W	10	Muddy sand with shell debris, small pebbles and occasional cobble
3	53 02.430N	5 17.880W	53 02.702N	5 17.630W	8	Mainly muddy sand with ribbon of pebbles in sand
4	53 02.095N	5 18.282W	53 02.287N	5 18.050W	6	Muddy sand
5	53 01.925N	5 18.660W	53 02.155N	5 18.478W	6	Muddy sand with sparse broken shell sand
6	53 01.607N	5 18.322W	53 01.912N	5 18.138W	4	Muddy sand with sparse broken shell sand, occasional small stones
7	53 02.033N	5 16.944W	53 02.475N	5 16.702W	9	Sand with mixed shell and stone gravel, occasional cobble
8	53 02.847N	5 15.471W	53 03.205N	5 15.328W	4	Sand with mixed shell and stone gravel
9	53 01.465N	5 13.960W	53 01.974N	5 13.720W	2	Consolidated stony gravel with sand and cobbles
10	53 01.342N	5 16.244W	53 01.655N	5 16.025W	4	Sand with mixed shell and stone gravel
11	52 59.412N	5 17.524W	52 59.551N	5 17.323W	7	Sand with mixed shell and stone gravel
12	52 59.740N	5 15.798W	52 59.801N	5 15.534W	8	Mixed shell and stone gravel with muddy sand
13	52 59.836N	5 14.056W	52 59.870N	5 13.899W	6	Mixed shell and stone gravel with muddy sand
14	53 00.240N	5 12.704W	53 00.225N	5 12.448W	10	Mixed shell and stone gravel with muddy sand, occasional cobble
15	52 59.087N	5 10.177W	52 58.970N	5 10.062W	11	Consolidated gravel and cobbles
16	52 59.152N	5 10.792W	52 58.900N	5 10.557W	11	Cobbles, small boulders and consolidated gravel
17	52 59.146N	5 12.785W	52 58.920N	5 12.603W	6	Mixed shell and stone gravel with muddy sand, occasional cobble
18	52 58.713N	5 14.805W	52 58.460N	5 14.643W	6	Sand with shell and stone gravel
19	52 58.147N	5 16.738W	52 57.863N	5 16.623W	5	Sand with mixed shell and stone gravel, occasional cobble

Site	Start latitude	Start longitude	End latitude	End longitude	No of still images	Substratum
20	52 57.612N	5 16.383W	52 57.456N	5 16.377W	6	Coarse sand with occasional pebble and cobble
21	52 56.993N	5 15.052W	52 56.748N	5 15.019W	7	Mixed shell and stone gravel with muddy sand
22	52 57.347N	5 13.463W	52 57.170N	5 13.887W	6	Mixed shell and stone gravel with muddy sand, occasional cobble
23	52 57.622N	5 12.451W	52 57.440N	5 12.308W	6	Mixed shell and stone gravel with muddy sand, occasional cobble
24	52 58.130N	5 12.441W	52 57.966N	5 12.237W	6	Consolidated gravel and cobbles
25	52 57.898N	5 12.119W	52 57.835N	5 12.009W	7	Mixed shell and stone gravel with muddy sand
26	52 58.287N	5 10.158W	52 58.596N	5 09.952W	4	Mixed shell and stone gravel with muddy sand, occasional cobble
27	52 58.233N	5 10.783W	52 58.441N	5 10.524W	7	Cobbles, small boulders and consolidated gravel
28	52 57.921N	5 10.185W	52 57.921N	5 10.185W	5	Mixed shell and stone gravel with muddy sand
29	52 57.781N	5 10.772W	52 58.349N	5 10.550W	5	Mixed shell and stone gravel with muddy sand
30	52 58.230N	5 11.334W	52 58.591N	5 11.947W	5	Mixed shell and stone gravel with muddy sand, occasional cobble
31	52 57.659N	5 11.394W	52 58.032N	5 11.249W	5	Mixed shell and stone gravel with muddy sand, occasional cobble
32	52 57.420N	5 11.951W	52 57.735N	5 11.869W	6	Consolidated gravel and cobbles

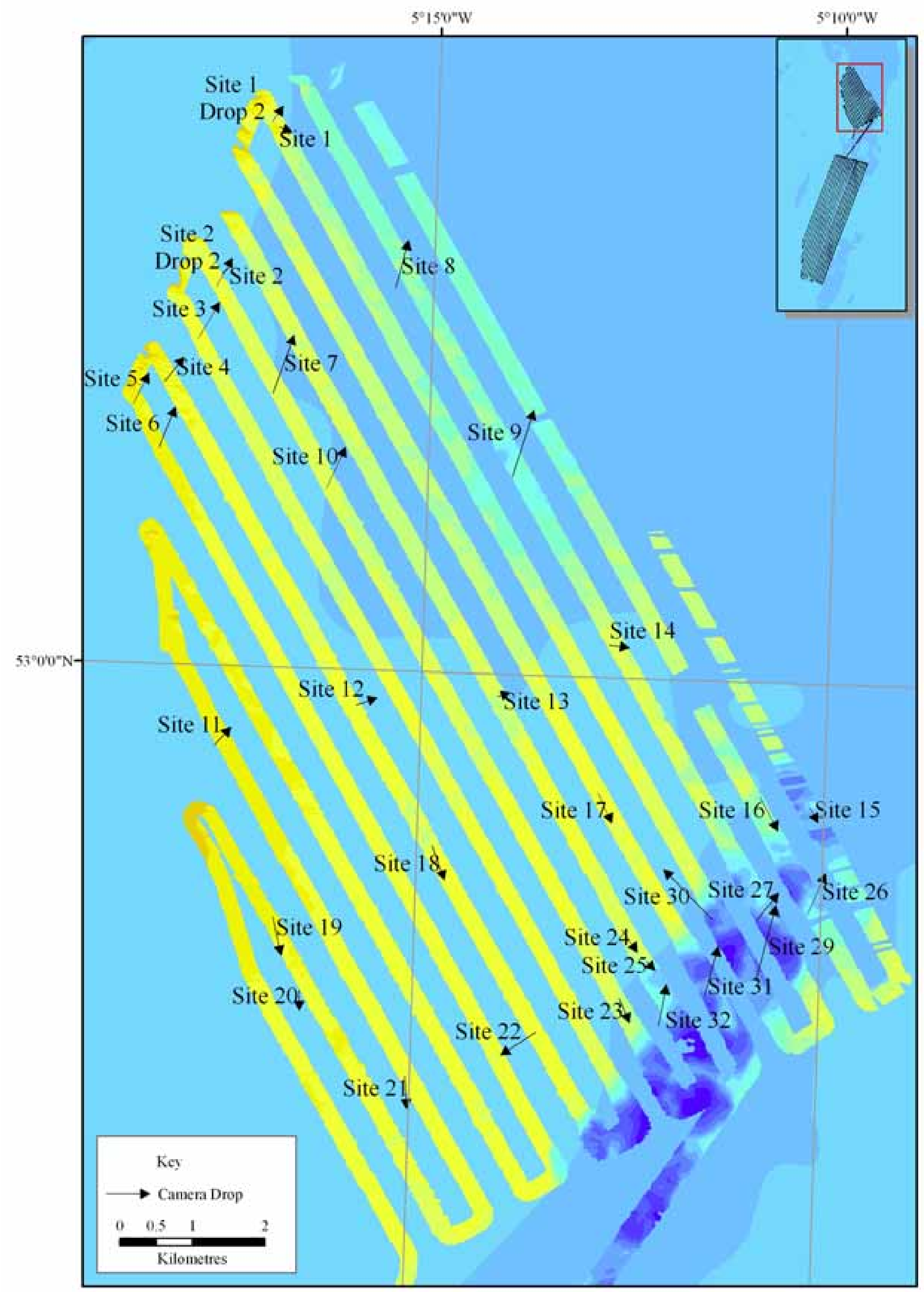

Figure 3.25 Ground-truthing drop-down camera sites overlaid on bathymetry (arrow shows direction and length of drop). © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

3.2.3 Sediments

Figure 3.26 shows average substratum types for each ground-truthing site. The sandiest sediments were found in the sand wave field in the north of the North Box in depths of less than 90m. The transition to more coarse sandy sediments with an increased percentage of shell debris, pebbles and gravel followed an abrupt transition away from the sand waves field and this is reflected in both the bathymetry and backscatter data. The area of coarse sandy sediments covers the majority of the North Box at 90m. Areas of more stable mixed sediments became dominant in deeper ground. Sparse patches of small boulders were found at several sites (See Section 3.2.4).

False colour backscatter showed potentially coarser sediments as darker blue patches, and sandier sediments as more pale and yellow. Care must be taken with direct use of the backscatter in this way as the data quality; processing and 'reality' of the actual data are open to interpretation. However, the figure does illustrate the small scale heterogeneity of the acoustic reflectance of the seabed across the survey area.

3.2.4 Biotope analysis

Table 3.3 shows the biotopes identified from the biology survey along with main habitat type. Three biotopes were identified from the still photographs. The three biotopes appear to be deeper versions of circalittoral biotopes found in Connor *et al.,* (2004). They have been classed as "offshore" due to the depth range encountered being greater than 50m across the whole of the survey area. Fauna were identified and relative abundances were derived from SACFOR tables to enable biotope identification. Figure 3.27 shows the distribution of biotopes across the area surveyed for biology. Few clear boundaries were identified between biotopes, except in the north of the North Box where the transition from sandy to coarse sediments was observed as a sharp line in the backscatter and QTC-View data. Across the area surveyed, biotopes appeared to grade into each other depending on the relative stability of the substratum.

Areas of slightly silty sand supported no conspicuous epifauna. Shell debris, mostly comprising dead *Modiolus modiolus* and tough shelled *Glycimeris*, was apparent in troughs between the sand waves in the north of the North Box in water depths less than 90m. These areas have been classed as SS.SSa.OSa Offshore circalittoral sand. Further refinement of the biotope would require samples to be taken of the infauna. As the substratum became more stable, with a higher percentage of shell debris and pebbles, *Pomatoceros* sp and barnacles appeared on larger pebbles and cobbles. These areas have been classed as SS.SCS.OCS Offshore coarse sediment/SS.SCS.CCS.PomB *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles, but could be considered a middle ground between SS.SSa.OSa and more stable pebble and cobble habitat. While there was an abundance of *Modiolus modiolus* shell debris, only one potentially live specimen was recorded at Site 12 in more stable substratum. SS.SCS.OCS/SS.SCS.CCS.PomB occurred around the 90m depth band across the west central section of the North Box.

Where the substratum comprised consolidated pebbles, gravel and cobbles it supported a more diverse fauna, with similar species to the circalittoral biotope SS.SMx.OMx Offshore mixed sediment/SS.SMx.CMx.FluHyd *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment. Characterising species of this biotope included a patchy turf of the hydroids *Nemertesia antennina*, *Sertularella* sp, ?*Aglaophenia* sp and the bryozoans *Flustra foliacea*, *Bugula* sp and *Cellaria* sp. The barnacle *Balanus crenatus* and a range of serpulid worm species including *Pomatoceros* sp, *Serpula vermicularis* and *Filograna complexa* occurred consistently in each sample. A range of anemones were present both on stable cobbles and burrowing in the coarse silty sediment including *Urticina felina*, *Sagartia* spp, *Mesacmaea mitchellii* and *Aureliania heterocera*. The most stable substratum supported branching and encrusting sponges ?*Raspalia hispida* and ?*Esperiopsis fucorum* and the dead man's fingers *Alcyonium digitatum*. More rocky areas were grazed by *Echinus* sp. Crustacea, other than barnacles, observed included pink shrimps, possibly *Pandalus* sp, *Cancer pagurus* and *Inachus* sp. SS.SMx.OMx/SS.SMx.CMx.FluHyd was characteristic of sediments deeper than 98m in the deeper eastern section and also southern trough of the North Box. The more stable cobble areas could be classified as CR.HCR.XFa.SpNemAdia Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata, although the size of such areas is uncertain.

All of the samples recorded could be considered as silty habitats, with fine sediment resuspended and deposited on each tidal cycle, as observed in the photographic record. Dredge or grab sampling would be required to clarify the resolution of these epifaunaly derived biotopes with SS.SMx.OMx.PoVen Polychaete-rich deep *Venus* community in offshore mixed sediments, a biotope commonly recorded from similar habitats in the Irish Sea.

Patches of cobbles and boulder habitat 25 to 50m^2 were observed at several locations. The sparseness of these patches, and also the inclusion of cobbles and boulders in SS.SMx.CMx.FluHyd lead to these areas being classified overall as sediment, rather than rocky habitat. The greatest abundance of cobble and boulder habitat occurred in sites 15, 16, 27 and 32 (Figures 3.28 to 3.31). All of the samples had average cobble and boulder densities less than 50% but could possibly be considered as patchy examples of CR.HCR.XFa.SpNemAdia surrounded by SS.SMx.CMx.FluHyd.

No evidence of physical damage from anthropogenic activity was observed.

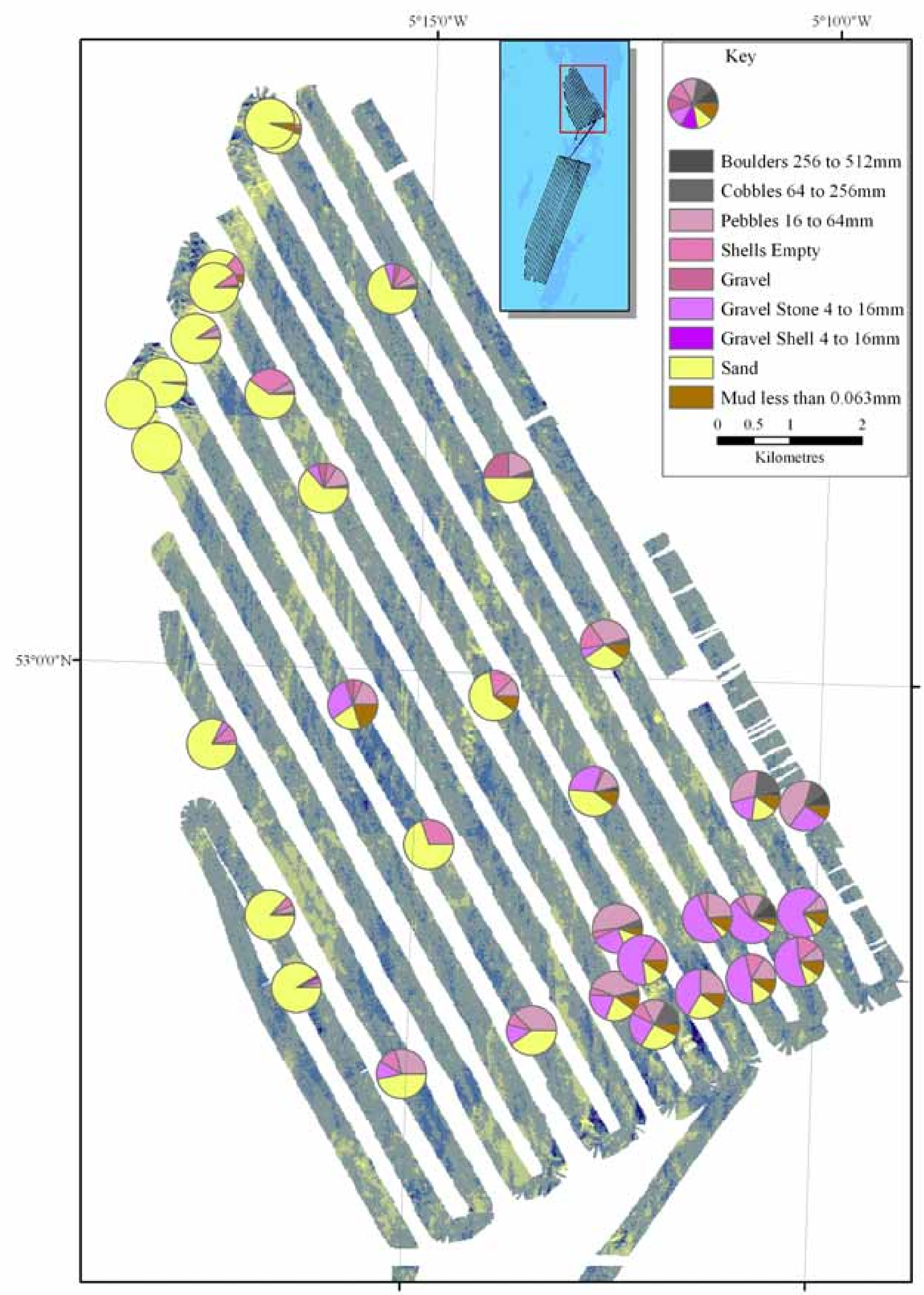

Figure 3.26 Distribution of sediment types from ground truth sampling overlaid on classed false colour backscatter.

Table 3.2 Biotopes present in the survey area.

Biotope	Biotope name	Sites	Substrate	Characterising species	Example image
SS.SSa.OSa	Offshore circalittoral sand	1, 1 Second Drop, 2, 2 Second Drop, 3, 4, 5, 6, 18, 20	Sand with shell debris	None	
SS.SCS.OCS (SS.SCS.CCS.PomB)	Offshore circalittoral coarse sediment (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles)	3, 7, 8, 10, 11, 13, 14, 19, 20, 21, 22, 32	Sand with pebbles and cobbles	*Pomatoceros* sp, *Balanus crenatus*	
SS.SMx.OMx (SS.SMx.CMx.FluHyd)	Offshore circalittoral mixed sediment (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment)	9, 12, 15, 16, 17, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32	Silty gravel and pebbles with cobbles and occasional boulders.	*Flustra foliacea*, *Pomatoceros* sp, hydroids, *Serpula vermicularis*, *Balanus crenatus*, *Raspalia hispida*	

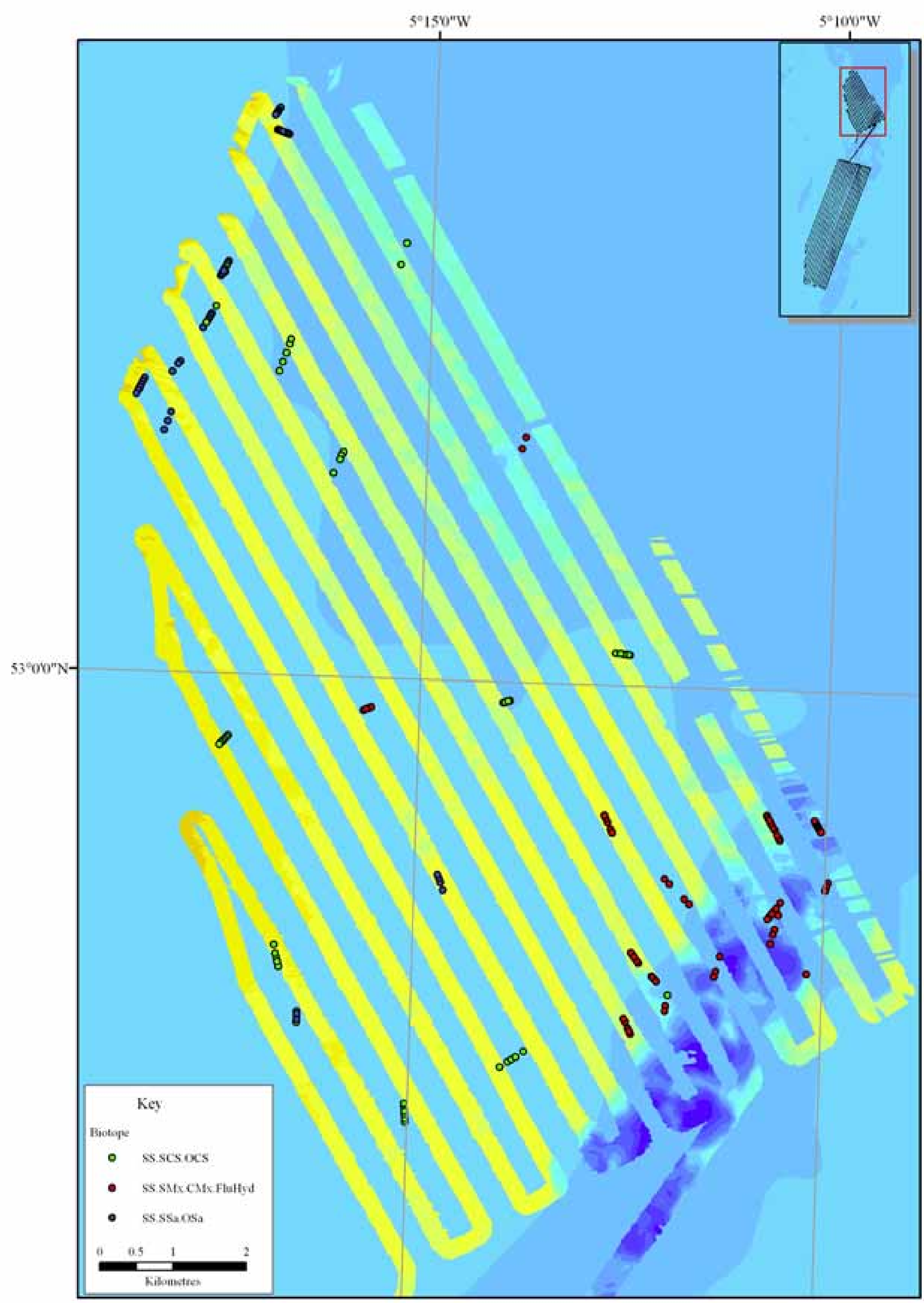

Figure 3.27 Distribution of biotopes from analysis of ground truth sampling. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

Figure 3.28 Habitat photograph of Site 15 Image 6 (silty pebbles, cobbles and gravel with hydroids, serpulids, erect sponges and barnacles).

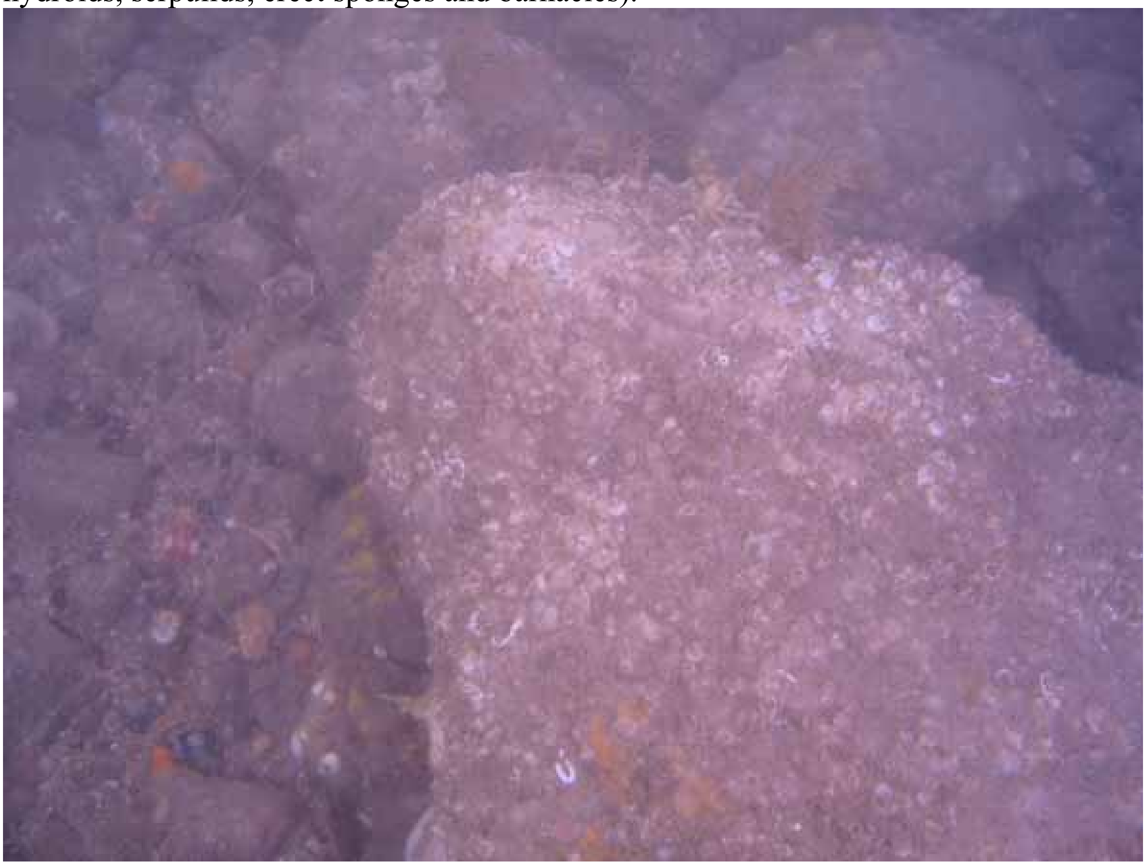

Figure 3.29 Habitat photograph of Site 16 Image 4 (silty cobbles and boulders with gravel and sand with barnacles, hydroids, anemones and dead man's fingers).

Figure 3.30 Habitat photograph of Site 27 Image 6 (small boulders and cobbles with barnacles and serpulids).

Figure 3.31 Habitat photograph of Site 32 Image 3 (silty pebbles, gravel, small boulders and cobbles with shell debris).

3.3 Data integration

As outlined in Section 3.2.4, data from the acoustic and biological surveys were used to produce a composite map of the survey area in the GIS environment. Slope angle was also calculated from the bathymetry data to investigate if boundaries could be identified from topographic features not easily observed in the bathymetry data alone (Figure 3.32). Biotope boundaries were then identified based on assumptions of how the substratum and its associated fauna change in relation to bathymetry and backscatter (Figure 3.33). For biotope mapping purposes, data have not been extrapolated beyond confidence of ground truth data.

There was a strong correlation between depth and substratum type with sandier habitats being confined to the shallower areas surveyed. The sand wave field in the north of the North Box SS.SSa.OSa was clearly defined in both the acoustic and ground-truthing data. This biotope has been mapped with a high degree of confidence. The area south of the sand wave field showed relatively few features at a fine scale, with changes in bathymetry and sediment type correlating over a scale measured in kilometres.

The striations observed in the backscatter data across the central section of the North Box were not apparent in the bathymetry data, and were inconsistently picked up by QTC-View. It has been assumed that these features reflect ribbons of finer sediment across the more coarse sediments characteristic of the central area of the North Box SS.SCS.CCS.PomB and SS.SCS.CCS combined. The data are of insufficient resolution to separate these two classes. The boundaries of this class are well defined in the north with SS.SSa.OSa, but are restricted in other areas, by a combination of data resolution and also by a lack of clear transition with more stable, deeper habitats.

In the deeper area to the east and south of the North Box the substratum became coarser and more stable and was able to support a more diverse epifauna SS.SMx.CMx.FluHyd. The transition from SS.SCS.CCS.PomB to SS.SMx.CMx.FluHyd is difficult to define as a hard line, but it appeared to follow the 98m contour line and also a change in QTC-View class from classes 2, 3 and 4 to classes 1 and 5 (although this also occurred in the sand wave field to the north and may simply be a reflection of changing slope).

There was an apparent correlation with increased depth and increased patchiness of backscatter data, which was supported by the stonier habitat found in these areas. QTC-View supported both bathymetry and backscatter data, but appeared to be affected more by small scale changes in bathymetry and slope, than by ground type observed from the ground-truthing data. Only QTC-View data seemed to correlate well with slope angle (Figure 3.32) at macro or micro scales within the trough and sand wave habitats where similar QTC-View classes contained both SS.SSa.OSa and SS.SMx.CMx.FluHyd.

The biotope boundaries show some similarities with the quaternary sediment deposits identified as potential Annex I reef habitat by the JNCC. Differences can be attributed to the survey scale and methods used and also to the likely mobility of the surface sediments illustrated by the sand wave field in the north of the North Box.

Figure 3.32 Slope angle of North Box from gridded bathymetry. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

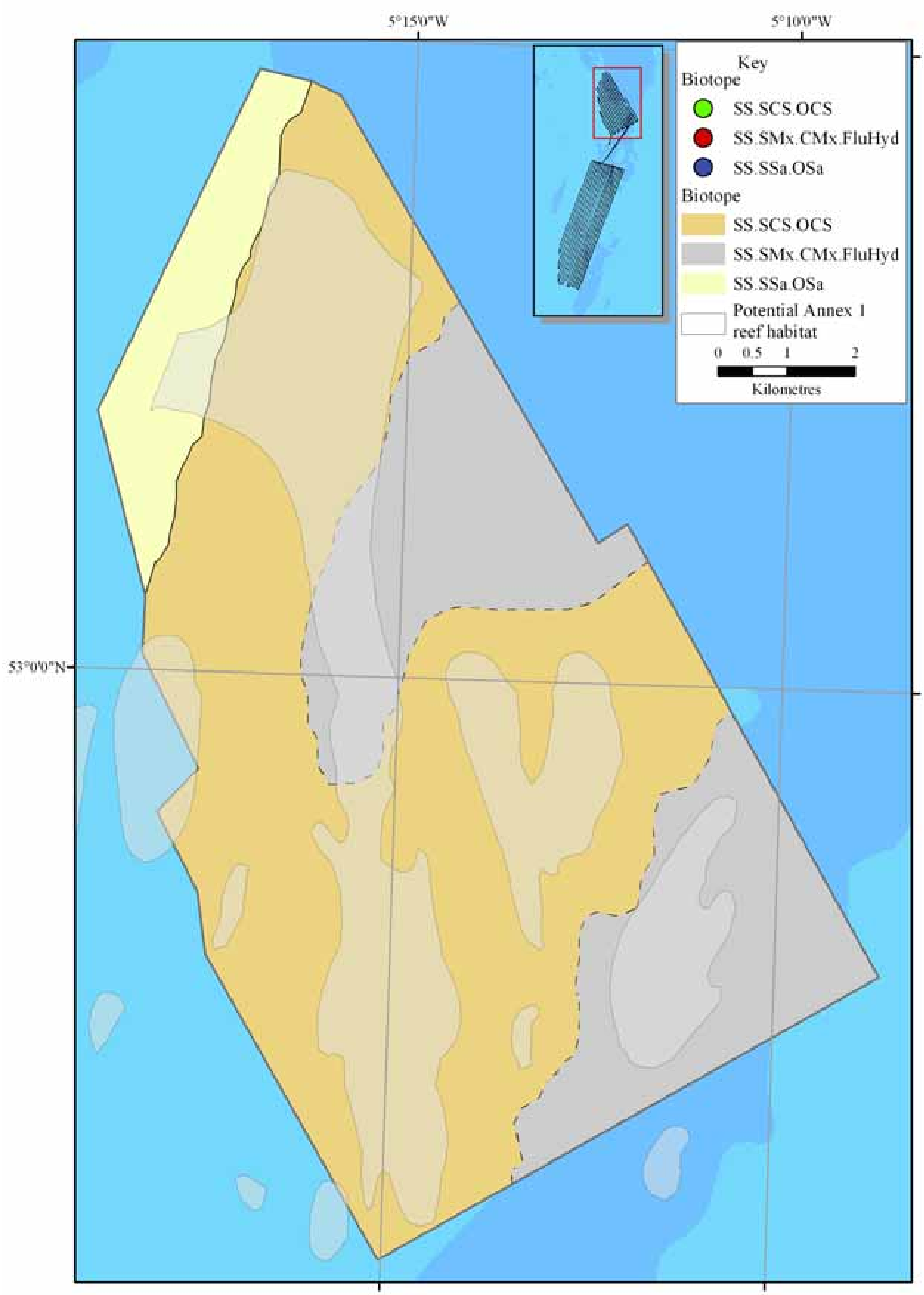

Figure 3.33 Biotope map of North Box. © British Crown and SeaZone Solutions Ltd. All rights reserved. Product Licence no PGA042006.003 (Seabed habitat derived from BGS 1:250,000 seabed sediment maps © NERC (Licence No. 2002/85)).

4. Discussion

4.1 Introduction

The project has successfully collected acoustic data from the northern and southern target areas for AoS 7 and sufficient ground-truthing data to enable the classification and mapping of sea bed habitats for the northern target area, the North Box. Further acoustic data will be required to map the central target area, and further ground-truthing data will be required to map both the southern and central areas. If subsequent ground-truthing is undertaken then it is recommended that a video and photographic sledge is used that is able to operate in moderate tidal streams and that infauna is collected by either dredge or grab to enable more robust classification of the sediment biotopes. To accurately map small boulder patches in the deeper sections of the survey areas, a high resolution multibeam or sidescan sonar survey will be required.

One of the main objectives of the survey was to identify and map the extent of Annex I reef habitat using multibeam sonar and drop video to enable relevant physical sub-types of reef to be distinguished, in particular bedrock from boulder/cobble/stony reef, and biogenic reef (formed by organisms such as *Lophelia pertusa* (cold water coral), *Modiolus modiolus* (horse mussel) or *Sabellaria spinulosa* (ross worm).

This objective has been partially achieved. As mentioned above the project has achieved partial coverage of the planned survey areas. The acoustic survey suffered from poor weather, which is an accepted risk of conducting surveys during winter months. The lack of ground-truthing data was a result of repeated technical failure of the camera equipment.

4.1.1 Acoustic survey

During the acoustic survey the multibeam system and in particular the Inertial Measurement Unit coped well with often harsh weather conditions. It was able to operate from the 22m vessel in swells of 3m and retain a reasonable quality of data. The swath multibeam system was able to cover approximately 50% of the two primary target survey areas during the survey period. This coverage was adequate to observe large scale features with confidence, but the probability remains that features up to a few hundred metres in size may have been missed in the gaps produced by this corridor survey approach. The areas mapped by the multibeam system included a number of sediment features, such as sand waves, which were of a scale of 100 to 400m, and it is possible that several of these features may not have been picked up by the survey. No rocky reef areas were encountered during the survey, and the patchy stony cobble habitats observed during the ground-truthing survey were several kilometres across and seemed to have been delineated adequately by the swath coverage for mapping purposes. Small patches of boulder habitat (tens of metres across) were found in the ground-truthing survey, but these were not picked up in the bathymetry, but were apparent to some degree from the backscatter. The quality of the multibeam was affected by the rough weather in that the resolution of the produced image was constrained to 5m pixels for bathymetry and 16m pixels for backscatter. This reduced the quality of the images produced, and it was this, rather than actual coverage that has limited the precision of the mapping process to features at a scale of 50 to 100m or greater. Andrews (2003) considered the differences of spatial and habitat scale in the visualisation of benthic maps and concluded that mapping precision is the factor of resolution of survey data and the actual size of the particular habitat. JNCC had specified that the mapping process should be able to identify patches of reef 100 x 100m in size. The data collected indicate that habitat patchiness within the survey area occurs at a scale of several hundred metres to kilometres for each biotope, but small patches of apparent stony habitat occur at scales much smaller than this. The survey methods are considered to have been adequate to map reef features at the objective resolution of 100m across, but not to identify, with certainty, patches 5, 10 or 20m across. If small scale patchiness is required to be mapped to identify boulder and cobble areas 5 to 20m across then acoustic survey will need to be attempted with sub-metre accuracy over tightly defined target areas.

Backscatter data processed through PRISM provided a good indication of the patchiness of sediments across the survey area, particularly where there were no bathymetric features visible. Interpretation of the backscatter data was by-eye interpretation and was not processed through an automated classification package. False colour backscatter data was presented to highlight apparent patchiness in the sediments and this was classed to 5 equal intervals by GIS. However, care must be taken in attributing any direct correlation with backscatter intensity and substratum type and no simple assumptions can be made without subjective interpretation of the data. The broken coverage of the survey area and the resolution of the data prevented fine details to be observed, but the data were of a sufficient quality and coverage to enable the identification of gross changes in the substratum that correlated well with both QTC-View and ground-truth data. Sand waves were clearly defined in the backscatter as were sediment ribbons and also the increased heterogeneity of the mixed sediments in the deeper trough in the North Box. If the findings from the backscatter data of the North Box can be applied to the South Box, then it likely that mixed sediments similar to those found in the North Box trough will be found in the deeper sections to the east of the South Box. Future ground truth surveys should prioritise the north and east of the South Box when looking for Annex 1 reef habitat.

QTC-View data complimented the multibeam survey in providing an indication of classified ground type very quickly, and on-the-fly analysis was possible during the acoustic survey. It is worth noting that the QTC-View data was not intended as primary survey tool and was provided complimentary of UMBSM along with the charter of RV *Aora*. Post-survey processing of the data through QTC Impact identified five classes through PCA analysis that correlated well with bathymetry and the backscatter data obtained from the multibeam system. QTC-View mis-classed the shallow sand waves in the north of the North Box with the mixed sediments found in the trough in the south of the North Box. These mis-classes may have been due to the system averaging across the echosounder footprint. The apparent differences observed in the QTC-View, multibeam and observed biology highlight the benefits of using more than one survey technique for ecological mapping purposes.

Although not presented as part of this report, UMBSM further analysed the QTC-View raw Q value and depth data through *k-means* classification at a resolution of 570m grids. While this classification was undertaken at a very broad scale, it further showed a strong correlation between acoustic class and depth, and also the patchy distribution of acoustic classes across the central section of the North Box.

Overall the features identified in the acoustic survey correspond to those expected from previous surveys by BGS and reported in SEA 6. The report by Holmes and Tappin (2005) stated that sand ribbons are sometimes connected to the downstream side of static sea bed obstacles such as pebbles, cobbles, boulders, upstanding rock outcrop, and commonly feature in areas of sea bed scour and very high sea bed stress. In this environment, they usually align parallel to the peak tidal streams. Bedforms that are formed transversely to tidal streams include sand ripples and stable sand waves. Sandbanks are commonly formed sub-parallel to the prevailing tidal streams. Similar sediment features to these were identified in all data from the survey.

4.1.2 Biology survey

The biology survey covered an adequate resolution of sampling locations to identify and inform the mapping of biotopes for the North Box. The video camera system and method used struggled to cope with the poor visibility and moderate currents found in the survey areas. The sea state encountered during the biology survey was calm, with only a brief period of moderate swell encountered over a six hour period.

The video camera was able to produce an image of 470 TV lines, but this signal was degraded by the compression utilised by the modem to transmit the signal to the surface at 25 frames per second. The actual top-side recording of the video image was undertaken on DVD and it was observed that the video quality was sub 470 TV lines, compressed and striped with interference. The resulting quality of the image limited the use of the video data to broad descriptions of sediment type and as a guide for taking high resolution still images.

With the exception of limited visibility and occasional triggering of the digital camera in the water column, the 5 megapixel stills camera produced excellent results and enabled the identification of species, an estimation of substratum type and the classification of biotopes using epifauna. For more accurate classification of sediment biotopes, or those biotopes which support both characteristic epifauna and infauna, it is recommended that both visual survey and sampling of the sediment by grab or dredge is undertaken. The objective of this project was to identify areas of Annex I reef habitat and as such a suitable regime of Hamon Grab or dredge sampling was not planned. It is recommended that if further ground-truthing is undertaken in the area that quantitative sampling of the substratum is undertaken. Particle Size Analysis on such samples would provide more accurate data on the substratum characteristics than was possible by estimation.

The identification of species from photographic records is restricted to the resolution of the image and the characteristics of the species being identified. A number of identifications have been left as uncertain in the data obtained from the photographs but, as they can be positively identified to family or genus, the level of the taxonomic distinctiveness can be considered adequate for biotope identification purposes.

The biotopes identified from the survey were close fits to those present in the 04.05 classification but with the exception of SS.SSa.OSa, occurred in depths greater than those used to describe circalittoral biotopes. The cut-off between CMx and OMx appears to occur at 50m, and the records fitting within the description of SS.SCS.CCS.PomB and SS.SMx.CMx.FluHyd were present in depths of 90 to 120m. It may be that the depth bands of the circalittoral biotopes should be extended to cover slightly deeper habitats, or further species data should be collected to establish if there are subtle differences in characteristic fauna that could be used to define new biotope equivalents to SS.SCS.CCS.PomB and SS.SMx.CMx.FluHyd in the offshore section of the classification.

The main difficulty encountered in analysing the data from the biology survey was in resolving when to distinguish the boundary between two biotopes when the characteristic species and habitat information changed along a continuum. SS.SSa.OSa records were classed where the percentage of sand was high and other substrata including shell debris and pebbles and occurred in relatively low proportions. SS.SCS.OCS/SS.SCS.CCS.PomB was identified where the percentage of gravel, pebbles and shell debris became substantial and this was differentiated from SS.SMx.OMx/SS.SMx.CMx.FluHyd by a lack of epifauna other than *Pomatoceros* sp and barnacles. SS.SMx.OMx/SS.SMx.CMx.FluHyd was identified where the substrata appeared to be consolidated, relatively immobile and supported a range of epifauna. The biotope analysis should be treated as subjective and open to further interpretation.

The benthos of the Irish Sea has been described in a number of recent reports including the Irish Sea Pilot Project and Strategic Environmental Assessment for Area 6, Irish Sea (Vincent *et al.*, 2004; DTI, 2006b). Mackie (1990) provides an excellent summary of information available up to late 1980's. Most of the benthos of the Celtic Trough is described as either 'deep *Venus*/hard' or 'deep *Venus*' by Mackie (1990). These two communities are the most dominant in the offshore benthic environment. Other reports confirm the generalisations made by Mackie (1990). The bivalve *Glycimeris glycimeris* was found to be common in areas where cobbles protrude into the current (Rees, 1993), accumulations of which have also been recorded from the St Georges Channel in the south (Rees, 2004). The richest assemblage, and that with the most extensive geographical coverage, is that associated with gravely sediments and includes conspicuous serpulids, other large polychaetes, an exclusive tubiculous ampharetid species and the amphipod *Guernea coalita* (Wilding *et al.*, 2005).

Dredge or grab sampling would be required to clarify the resolution of the epifauna derived biotopes SS.SCS.OCS/SS.SCS.CCS.PomB and SS.SMx.OMx/SS.SMx.CMx.FluHyd with the infauna of SS.SMx.OMx.PoVen and SS.SCS.CCS.MedLumVen, which include the 'deep *Venus*' communities described by Mackie (1990).

The biotopes identified during the survey have been recorded from a number of locations around the UK where suitable sediments are exposed to increased tidal streams.

4.1.3 Data integration

The acoustic and biology data were of sufficient quality and extent to map the majority of the North Box, although data gaps in both the acoustic coverage and also the lack of biology samples from the southwest corner have required some interpolation.

The data showed a trend of increasing sediment stability with depth across the survey area, with high degree of small scale heterogeneity in sediment composition. The sand wave field in the north of the North Box was identified by all data and can be considered to have been mapped with high degree of accuracy. The central section of the North Box presented the greatest difficulty in mapping, as small patchiness observed in the backscatter was not apparent in the bathymetry or biological sampling. The assumption was made that this area contains gravely sediments with ribbons of sand overlaying the gravel in north-south orientation. A slightly deeper area to the east of the central section was observed to contain more consolidated pebbles and cobbles, and the boundary between this habitat and the mobile gravel and sand habitat was the least well defined by mapping. It may be possible to make further assumptions on the scale of the patchiness of the substratum across the central area of the North Box based on the backscatter data, but this approach would only be supported by the limited number of biology samples, and the patterns observed are not reflected in the bathymetry. Producing a raster-based sediment map from backscatter has not been attempted as it was considered this approach could not be defended by supporting data. The trough in the south of the survey area is well delineated by all of the acoustic data. Further ground-truthing data will be required to accurately assess the biotopes found in the west and southern sections of the trough. The high backscatter values found in the western section of the trough may indicate areas of more consolidated rocky sediments.

A difficulty encountered during data integration was reconciling the data quality and resolution of each dataset with the scale of changes observed across the survey area. Bathymetry was processed at a resolution 5m horizontally and 1m vertically, backscatter at 16m, QTC-View beam footprint averaged over tens of metres, and all acoustic data had only a 50% coverage of the survey area, leaving gaps of several hundred metres. With the exception of the southwest corner of the survey area, biology samples were taken at a scale of kilometres between stations. Backscatter showed changes in reflectance at a scale of less than 100m, QTC-View showed a similar scale of change while bathymetry and biological sampling showed major changes occurring at a range of scales, although the greatest changes occurred over hundreds of metres. Biotope mapping was restricted to the lowest resolution of a combination of both the survey resolution and the scale of changes observed in the habitats being studied.

One of the main issues encountered during data integration is that majority of biotopes do not have unique acoustic characteristics. This has been recognized by a number of biotope mapping projects and Brown *et al.,* (2004) summarises the issue in that it is likely that a range of visibly identifiable biotopes recorded using visual-survey techniques will fall within a single acoustic-map region. Consequently, it will not be possible to map every visibly identifiable biotope using acoustic methods. The acoustic signature may be affected by a number of factors including sediment veneers over rock and the water content of sediments. These factors may not be apparent in biology derived and classed from video samples or indeed grab samples (Brown *et al.,* 2001). Similarly, factors such as sediment stability may be apparent from visual analysis of well developed epifauna, but may not be acoustically distinct. This issue is further complicated by the fact that biotope classification itself, particularly in communities associated with the sediment-rock interface, is a largely subjective process. Boundary identification in soft or mixed sediments and in areas of small scale heterogeneity is notoriously difficult and has been discussed in detail by numerous authors.

4.1.4 Annex I reefs

The Interpretation Manual of European Habitats provides an overall definition of Annex I reefs. At a national level, for the purpose of SAC selection for both inshore and offshore sites, the definition of reefs has been further interpreted and clarified by JNCC. Importantly substratum has been defined to include bedrock, boulders and cobbles (cobbles generally greater than 64mm in diameter), including those composed of soft rock. Reefs have a variety of topographic features, including vertical rock walls, horizontal ledges, overhangs, pinnacles, gullies, ridges, sloping or flat bed rock, broken rock, and boulder and cobble fields. Reefs should be features ‘Arising from the sea floor’ and this is taken in the sense that the reef is topographically distinct. Rocky structures that are covered by a thin and mobile veneer of sediment are classed as reefs if the associated biota are dependent on the rock rather than the overlying sediment. There is no lower limit to size, subject to the reef being large enough to maintain its structure and functions (Johnston *et al.*, 2002).

It is interesting to note that in the 97.06 classification that both SS.SCS.OCS/SS.SCS.CCS.PomB and SS.SMx.OMx/SS.SMx.CMx.FluHyd were included in the circalittoral rock side of the classification and under this simple interpretation would be considered as Annex I reef habitat.

Looking at the broader JNCC interpreted definition of Annex I reefs, it is apparent that areas within the SS.SMx.OMx/SS.SMx.CMx.FluHyd mapped area, and particular sites 15, 16, 27 and 32 (Figures 3.28 to 3.31), could be considered Annex I reef habitat. The problem encountered in identifying such patches within the survey area is that it is difficult to resolve these from the surrounding mixed sediments from 16m pixel backscatter and 5m pixel bathymetry. With further analysis it would be possible to highlight areas for further ground-truthing from the backscatter data, but it may be that further detailed side-scan sonar survey of the SS.SMx.OMx/SS.SMx.CMx.FluHyd would be the most accurate way of delineating such patches.

The biotopes identified during the survey may not be included in direct translation to Annex I reef habitat, although the habitats themselves may qualify under the JNCC definition. If the biotopes found during the Irish Sea survey have been identified correctly and it is decided that the habitats do qualify as Annex I reefs, then some revision of the definition of which biotopes are included as Annex I reef habitat is recommended.

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Appendix 1. Biological survey log

A1. Biology survey log

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 1	Site 1 Image 1	30/01/2007	15:01	347071.42	5882146.91	93	Sand with shell debris.	SS.SSa.OSa	Moderate
Site 1	Site 1 Image 2	30/01/2007	15:02	347094.04	5882137.60	94	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good
Site 1	Site 1 Image 3	30/01/2007	15:03	347116.65	5882128.29	94	Sand with shell debris, and settled silt.	SS.SSa.OSa	Moderate
Site 1	Site 1 Image 4	30/01/2007	15:03	347116.65	5882128.29	94	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good
Site 1	Site 1 Image 5	30/01/2007	15:04	347139.26	5882118.99	96	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good
Site 1	Site 1 Image 6	30/01/2007	15:04	347139.26	5882118.99	96	Sand with shell debris, and settled silt.	SS.SSa.OSa	Moderate
Site 1	Site 1 Image 7	30/01/2007	15:05	347161.88	5882109.68	98	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good
Site 1	Site 1 Image 8	30/01/2007	15:05	347161.88	5882109.68	98	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good
Site 1	Site 1 Image 9	30/01/2007	15:06	347184.49	5882100.37	100	Sand with shell debris, and settled silt.	SS.SSa.OSa	Moderate
Site 1	Site 1 Image 10	30/01/2007	15:06	347184.49	5882100.37	100	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good
Site 1	Site 1 Image 11	30/01/2007	15:07	347207.10	5882091.07	101	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good
Site 1	Site 1 Image 12	30/01/2007	15:08	347229.71	5882081.76	101	Sand with shell debris, and settled silt.	SS.SSa.OSa	Good

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 1 Second Drop	Site 1 Second Drop Image 1	30/01/2007	16:03	347040.12	5882345.71	101	Sand with surface silt.	SS.SSa.OSa	Good
Site 1 Second Drop	Site 1 Second Drop Image 2	30/01/2007	16:04	347053.76	5882365.68	100	Sand with surface silt.	SS.SSa.OSa	Good
Site 1 Second Drop	Site 1 Second Drop Image 3	30/01/2007	16:04	347053.76	5882365.68	100	Sand with surface silt.	SS.SSa.OSa	Good
Site 1 Second Drop	Site 1 Second Drop Image 4	30/01/2007	16:05	347067.40	5882385.65	100	Sand with surface silt.	SS.SSa.OSa	Good
Site 1 Second Drop	Site 1 Second Drop Image 5	30/01/2007	16:06	347081.04	5882405.62	100	Sand with surface silt.	SS.SSa.OSa	Good
Site 1 Second Drop	Site 1 Second Drop Image 6	30/01/2007	16:07	347094.68	5882425.59	100	Sand with surface silt.	SS.SSa.OSa	Good
Site 1 Second Drop	Site 1 Second Drop Image 7	30/01/2007	16:08	347108.32	5882445.56	100	Sand with surface silt and scattered gravel.	SS.SSa.OSa	Good

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 2	Site 2 Image 1	30/01/2007	15:29	346318.20	5880176.64	93	Sand with overlying silt and shell debris.	SS.SSa.OSa	Moderate
Site 2	Site 2 Image 2	30/01/2007	15:29	346318.20	5880176.64	93	Sand with overlying silt and shell debris.	SS.SSa.OSa	Good
Site 2	Site 2 Image 3	30/01/2007	15:30	346327.41	5880184.87	93	Sand with overlying silt and shell debris.	SS.SSa.OSa	Good
Site 2	Site 2 Image 4	30/01/2007	15:31	346336.62	5880193.11	93	Sand with overlying silt and shell debris.	SS.SSa.OSa	Good
Site 2	Site 2 Image 5	30/01/2007	15:32	346345.82	5880201.34	93	Sand with overlying silt and shell debris.	SS.SSa.OSa	Good
Site 2	Site 2 Image 6	30/01/2007	15:33	346355.03	5880209.57	93	Sand with overlying silt and shell debris.	SS.SSa.OSa	Good
Site 2 Second Drop	Site 2 Second Drop Image 1	30/01/2007	16:29	346293.38	5880152.21	93	Sand with overlying silt and shell debris.	SS.SSa.OSa	Moderate
Site 2 Second Drop	Site 2 Second Drop Image 2	30/01/2007	16:30	346311.32	5880185.65	93	Sand.	SS.SSa.OSa	Good
Site 2 Second Drop	Site 2 Second Drop Image 3	30/01/2007	16:31	346329.25	5880219.08	93	Sand with sparse pebbles.	SS.SSa.OSa	Good
Site 2 Second Drop	Site 2 Second Drop Image 4	30/01/2007	16:32	346347.19	5880252.52	93	Sand with shell debris.	SS.SSa.OSa	Good

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 2 Second Drop	Site 2 Second Drop Image 5	30/01/2007	16:32	346347.19	5880252.52	93	Sand.	SS.SSa.OSa	Good
Site 2 Second Drop	Site 2 Second Drop Image 6	30/01/2007	16:33	346365.13	5880285.96	93	Sand with small boulder and pebbles.	SS.SCS.OCS	Good
Site 2 Second Drop	Site 2 Second Drop Image 7	30/01/2007	16:34	346383.06	5880319.40	93	Sand with shell debris.	SS.SSa.OSa	Moderate
Site 2 Second Drop	Site 2 Second Drop Image 8	30/01/2007	16:34	346383.06	5880319.40	93	Sand.	SS.SSa.OSa	Good
Site 2 Second Drop	Site 2 Second Drop Image 9	30/01/2007	16:35	346401.00	5880352.84	93	Sand with shell debris.	SS.SSa.OSa	Good
Site 2 Second Drop	Site 2 Second Drop Image 10	30/01/2007	16:35	346401.00	5880352.84	93	Sand with shell debris.	SS.SSa.OSa	Good
Site 3	Site 3 Image 1	30/01/2007	16:49	346054.32	5879443.24	92	Sand.	SS.SSa.OSa	Good
Site 3	Site 3 Image 2	30/01/2007	16:51	346093.71	5879509.27	92	Sand with pebbles and cobbles.	SS.SCS.OCS	Good

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 3	Site 3 Image 3	30/01/2007	16:52	346113.41	5879542.28	92	Sand.	SS.SSa.OSa	Moderate
Site 3	Site 3 Image 4	30/01/2007	16:53	346133.11	5879575.30	92	Sand with settled silt.	SS.SSa.OSa	Good
Site 3	Site 3 Image 5	30/01/2007	16:54	346152.80	5879608.31	92	Sand.	SS.SSa.OSa	Good
Site 3	Site 3 Image 6	30/01/2007	16:55	346172.50	5879641.32	92	Sand.	SS.SSa.OSa	Good
Site 3	Site 3 Image 7	30/01/2007	16:55	346172.50	5879641.32	92	Sand.	SS.SSa.OSa	Good
Site 3	Site 3 Image 8	30/01/2007	16:58	346231.59	5879740.36	92	Possibly sand with pebbles and cobbles.	SS.SCS.OCS	Poor
Site 4	Site 4 Image 1	30/01/2007	17:13	345629.45	5878847.20	88	Sand with silt.	SS.SSa.OSa	Good
Site 4	Site 4 Image 3	30/01/2007	17:16	345710.65	5878951.47	88	Sand with silt.	SS.SSa.OSa	Good
Site 4	Site 4 Image 4	30/01/2007	17:16	345710.65	5878951.47	88	Sand with silt.	SS.SSa.OSa	Good
Site 4	Site 4 Image 6	30/01/2007	17:17	345737.72	5878986.22	88	Sand.	SS.SSa.OSa	Good
Site 5	Site 5 Image 1	30/01/2007	17:32	345143.06	5878546.99	87	Sand.	SS.SSa.OSa	Good
Site 5	Site 5 Image 2	30/01/2007	17:33	345164.77	5878588.98	87	Sand.	SS.SSa.OSa	Good
Site 5	Site 5 Image 3	30/01/2007	17:34	345186.48	5878630.96	87	Sand.	SS.SSa.OSa	Good
Site 5	Site 5 Image 4	30/01/2007	17:35	345208.19	5878672.95	87	Sand with sparse shell debris.	SS.SSa.OSa	Good

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 5	Site 5 Image 5	30/01/2007	17:36	345229.90	5878714.94	87	Sand.	SS.SSa.OSa	Good
Site 5	Site 5 Image 6	30/01/2007	17:37	345251.60	5878756.92	87	Sand.	SS.SSa.OSa	Good
Site 6	Site 6 Image 1	30/01/2007	17:54	345517.57	5878045.91	90	Sand.	SS.SSa.OSa	Good
Site 6	Site 6 Image 2	30/01/2007	17:56	345567.31	5878170.09	90	Sand.	SS.SSa.OSa	Good
Site 6	Site 6 Image 3	30/01/2007	17:58	345617.05	5878294.27	90	Sand.	SS.SSa.OSa	Good
Site 7	Site 7 Image 1	30/01/2007	18:37	347095.22	5878850.00	102	Sand with shell debris.	SS.SCS.OCS	Good
Site 7	Site 7 Image 3	30/01/2007	18:39	347140.83	5878974.73	102	Sand with shell debris and sparse pebbles and cobbles.	SS.SCS.OCS	Good
Site 7	Site 7 Image 4	30/01/2007	18:41	347186.43	5879099.46	102	Sand with shell debris.	SS.SCS.OCS	Good
Site 7	Site 7 Image 7	30/01/2007	18:43	347232.04	5879224.19	102	Sand with shell debris.	SS.SCS.OCS	Good
Site 7	Site 7 Image 9	30/01/2007	18:44	347254.84	5879286.56	102	Sand with pebbles and shell debris.	SS.SCS.OCS	Good
Site 8	Site 8 Image 1	30/01/2007	18:58	348752.19	5880298.48	109	Coarse sand, shell debris and gravel.	SS.SCS.OCS	Good
Site 8	Site 8 Image 3	30/01/2007	19:02	348832.46	5880591.20	109	Coarse sand, pebbles, cobbles and gravel.	SS.SCS.OCS	Good
Site 8	Site 8 Image 4	30/01/2007	19:02	348832.46	5880591.20	109	Coarse sand, pebbles, cobbles and gravel.	SS.SCS.OCS	Good
Site 9	Site 9 Image 1	30/01/2007	19:32	350408.67	5877785.56	113	Coarse sand, pebbles, cobbles and gravel.	SS.SMx.CMx.FluHyd	Moderate

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 9	Site 9 Image 2	30/01/2007	19:34	350458.26	5877941.41	113	Coarse sand, pebbles, cobbles and gravel.	SS.SMx.CMx.FluHyd	Moderate
Site 10	Site 10 Image 1	30/01/2007	20:16	347831.58	5877456.36	100	Coarse sand, pebbles, cobbles and gravel.	SS.SCS.OCS	Moderate
Site 10	Site 10 Image 2	30/01/2007	20:20	347919.29	5877647.15	100	Coarse sand, pebbles, cobbles and gravel.	SS.SCS.OCS	Moderate
Site 10	Site 10 Image 3	30/01/2007	20:21	347941.22	5877694.85	100	Coarse sand, pebbles, cobbles and gravel.	SS.SCS.OCS	Poor
Site 10	Site 10 Image 4	30/01/2007	20:22	347963.14	5877742.55	100	Coarse sand, pebbles, cobbles and gravel.	SS.SCS.OCS	Moderate
Site 11	Site 11 Image 1	30/01/2007	20:53	346271.50	5873763.44	90	Sand with settled silt, pebbles and gravel.	SS.SCS.OCS	Moderate
Site 11	Site 11 Image 2	30/01/2007	20:54	346294.80	5873788.49	90	Sand with shell debris, pebbles and gravel.	SS.SCS.OCS	Moderate
Site 11	Site 11 Image 3	30/01/2007	20:54	346294.80	5873788.49	90	Sand with shell debris, pebbles and gravel.	SS.SCS.OCS	Moderate
Site 11	Site 11 Image 4	30/01/2007	20:55	346318.11	5873813.54	90	Sand with settled silt, pebbles and gravel.	SS.SCS.OCS	Moderate
Site 11	Site 11 Image 5	30/01/2007	20:56	346341.41	5873838.59	90	Sand with shell debris, pebbles and gravel.	SS.SCS.OCS	Moderate
Site 11	Site 11 Image 6	30/01/2007	20:57	346364.72	5873863.64	90	Sand with shell debris, pebbles and gravel.	SS.SCS.OCS	Moderate
Site 11	Site 11 Image 7	30/01/2007	20:58	346388.02	5873888.69	90	Sand with shell debris, pebbles and gravel.	SS.SCS.OCS	Moderate

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 12	Site 12 Image 2	30/01/2007	21:46	348235.48	5874230.26	96	Mixed sediment of pebbles, gravel and sand with a covering of silt.	SS.SMx.CMx.FluHyd	Poor
Site 12	Site 12 Image 3	30/01/2007	21:47	348254.15	5874236.74	96	Mixed sediment of pebbles, gravel and sand with a covering of silt.	SS.SMx.CMx.FluHyd	Poor
Site 12	Site 12 Image 4	30/01/2007	21:48	348272.83	5874243.22	96	Mixed sediment of pebbles, gravel and sand with a covering of silt.	SS.SMx.CMx.FluHyd	Poor
Site 12	Site 12 Image 5	30/01/2007	21:49	348291.51	5874249.70	96	Mixed sediment of pebbles, gravel and sand with a covering of silt.	SS.SMx.CMx.FluHyd	Moderate
Site 12	Site 12 Image 6	30/01/2007	21:50	348310.18	5874256.18	96	Mixed sediment of pebbles, gravel and sand with a covering of silt.	SS.SMx.CMx.FluHyd	Moderate
Site 12	Site 12 Image 7	30/01/2007	21:51	348328.86	5874262.66	96	Mixed sediment of pebbles, gravel and sand with a covering of silt.	SS.SMx.CMx.FluHyd	Poor
Site 12	Site 12 Image 8	30/01/2007	21:52	348347.53	5874269.14	96	Mixed sediment of pebbles, gravel and sand with a covering of silt.	SS.SMx.CMx.FluHyd	Moderate

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 13	Site 13 Image 2	30/01/2007	22:09	350147.27	5874330.49	103	Silty Sand with shell debris.	SS.SCS.OCS	Poor
Site 13	Site 13 Image 3	30/01/2007	22:10	350169.47	5874337.68	103	Silty Sand with shell debris.	SS.SCS.OCS	Poor
Site 13	Site 13 Image 4	30/01/2007	22:11	350191.66	5874344.86	103	Silty sand with pebbles.	SS.SCS.OCS	Poor
Site 13	Site 13 Image 5	30/01/2007	22:12	350213.86	5874352.05	103	Silty Sand with shell debris.	SS.SCS.OCS	Poor
Site 13	Site 13 Image 6	30/01/2007	22:13	350236.05	5874359.23	103	Silty sand with shell debris and pebbles.	SS.SCS.OCS	Poor
Site 14	Site 14 Image 1	30/01/2007	22:29	351681.44	5874992.44	100	Silty sand and shell debris.	SS.SCS.OCS	Good
Site 14	Site 14 Image 3	30/01/2007	22:32	351747.29	5874983.99	100	Silty sand with shell debris and pebbles.	SS.SCS.OCS	Poor
Site 14	Site 14 Image 4	30/01/2007	22:32	351747.29	5874983.99	100	Silty sand with shell debris and pebbles.	SS.SCS.OCS	Poor
Site 14	Site 14 Image 5	30/01/2007	22:34	351791.19	5874978.36	100	Silty sand with cobbles and pebbles.	SS.SCS.OCS	Moderate
Site 14	Site 14 Image 6	30/01/2007	22:34	351791.19	5874978.36	100	Pebbles with sand, gravel, shell debris and cobbles.	SS.SCS.OCS	Moderate
Site 14	Site 14 Image 7	30/01/2007	22:35	351813.14	5874975.54	100	Pebbles with sand, gravel, shell debris and cobbles.	SS.SCS.OCS	Moderate
Site 14	Site 14 Image 8	30/01/2007	22:36	351835.09	5874972.72	98	Pebbles with sand, gravel, shell debris and cobbles.	SS.SCS.OCS	Poor
Site 14	Site 14 Image 9	30/01/2007	22:37	351857.04	5874969.91	99	Silty pebbles with sand and shell debris.	SS.SCS.OCS	Moderate

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 14	Site 14 Image 10	30/01/2007	22:38	351878.99	5874967.09	99	Pebbles with sand, gravel, shell debris and cobbles.	SS.SCS.OCS	Moderate
Site 15	Site 15 Image 1	30/01/2007	23:03	354392.14	5872712.15	128	Small boulder.	SS.SMx.CMx.FluHyd	Poor
Site 15	Site 15 Image 2	30/01/2007	23:03	354392.14	5872712.15	128	Silty pebbles, gravel and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 15	Site 15 Image 3	30/01/2007	23:04	354401.53	5872695.17	128	Silty pebbles, gravel and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 15	Site 15 Image 4	30/01/2007	23:05	354410.92	5872678.18	129	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 15	Site 15 Image 6	30/01/2007	23:07	354429.71	5872644.22	127	Silty pebbles, cobbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 15	Site 15 Image 7	30/01/2007	23:08	354439.11	5872627.24	126	Silty pebbles, cobbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 15	Site 15 Image 8	30/01/2007	23:09	354448.50	5872610.25	126	Silty pebbles, cobbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 15	Site 15 Image 9	30/01/2007	23:10	354457.89	5872593.27	126	Silty pebbles, cobbles and gravel.	SS.SMx.CMx.FluHyd	Moderate
Site 15	Site 15 Image 10	30/01/2007	23:11	354467.29	5872576.29	126	Silty pebbles, cobbles and gravel.	SS.SMx.CMx.FluHyd	Moderate
Site 15	Site 15 Image 11	30/01/2007	23:12	354476.68	5872559.31	126	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Moderate
Site 16	Site 16 Image 1	30/01/2007	23:28	353741.31	5872785.75	108	Silty cobbles and pebbles.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 2	30/01/2007	23:29	353759.07	5872751.82	103	Silty cobbles with gravel and sand.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 3	30/01/2007	23:30	353776.84	5872717.88	104	Silty cobbles with gravel and sand.	SS.SMx.CMx.FluHyd	Good

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 16	Site 16 Image 4	30/01/2007	23:31	353794.61	5872683.95	107	Silty cobbles and boulders with gravel and sand.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 5	30/01/2007	23:32	353812.37	5872650.01	108	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 6	30/01/2007	23:33	353830.14	5872616.07	110	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 7	30/01/2007	23:34	353847.91	5872582.14	110	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 8	30/01/2007	23:36	353883.44	5872514.27	109	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 9	30/01/2007	23:36	353883.44	5872514.27	109	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 10	30/01/2007	23:37	353901.21	5872480.33	109	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 16	Site 16 Image 11	30/01/2007	23:38	353918.97	5872446.39	112	Silty pebbles and gravel.	SS.SMx.CMx.FluHyd	Good
Site 17	Site 17 Image 1	31/01/2007	00:03	351525.22	5872789.66	96	Silty sand with pebbles and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 17	Site 17 Image 2	31/01/2007	00:03	351525.22	5872789.66	96	Silty sand with pebbles.	SS.SMx.CMx.FluHyd	Good
Site 17	Site 17 Image 3	31/01/2007	00:04	351546.40	5872742.41	96	Small boulder, silty sand with pebbles and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 17	Site 17 Image 4	31/01/2007	00:05	351567.59	5872695.16	97	Silty sand with pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 17	Site 17 Image 5	31/01/2007	00:07	351609.96	5872600.66	97	Silty sand with pebbles.	SS.SMx.CMx.FluHyd	Moderate

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 17	Site 17 Image 6	31/01/2007	00:08	351631.14	5872553.42	98	Silty gravel with pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 18	Site 18 Image 1	31/01/2007	00:32	349248.20	5871982.54	96	Sand and shell debris? Bad visibility on all images.	SS.SSa.OSa	Poor
Site 18	Site 18 Image 2	31/01/2007	00:32	349248.20	5871982.54	96	Sand and shell debris? Bad visibility on all images.	SS.SSa.OSa	Poor
Site 18	Site 18 Image 3	31/01/2007	00:33	349266.71	5871929.80	96	Sand and shell debris? Bad visibility on all images.	SS.SSa.OSa	Poor
Site 18	Site 18 Image 4	31/01/2007	00:34	349285.22	5871877.06	96	Sand and shell debris? Bad visibility on all images.	SS.SSa.OSa	Poor
Site 18	Site 18 Image 5	31/01/2007	00:36	349322.24	5871771.57	96	Sand and shell debris? Bad visibility on all images.	SS.SSa.OSa	Poor
Site 18	Site 18 Image 6	31/01/2007	00:36	349322.24	5871771.57	96	Sand and shell debris? Bad visibility on all images.	SS.SSa.OSa	Poor
Site 19	Site 19 Image 1	31/01/2007	01:00	347009.40	5871029.56	92	Sand with cobbles.	SS.SCS.OCS	Poor
Site 19	Site 19 Image 2	31/01/2007	01:02	347034.29	5870911.65	93	Sand with pebbles.	SS.SCS.OCS	Poor
Site 19	Site 19 Image 3	31/01/2007	01:03	347046.74	5870852.69	93	Sand with pebbles and shell debris.	SS.SCS.OCS	Poor
Site 19	Site 19 Image 4	31/01/2007	01:04	347059.18	5870793.74	93	Sand with pebbles and shell debris.	SS.SCS.OCS	Poor

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 19	Site 19 Image 5	31/01/2007	01:05	347071.63	5870734.78	93	Sand with pebbles and shell debris.	SS.SCS.OCS	Poor
Site 20	Site 20 Image 1	31/01/2007	01:14	347324.27	5870116.36	91	Sand with pebbles.	SS.SCS.OCS	Moderate
Site 20	Site 20 Image 2	31/01/2007	01:15	347324.02	5870087.42	91	Sand.	SS.SSa.OSa	Moderate
Site 20	Site 20 Image 3	31/01/2007	01:16	347323.78	5870058.48	91	Sand with shell debris.	SS.SSa.OSa	Moderate
Site 20	Site 20 Image 4	31/01/2007	01:18	347323.29	5870000.61	91	Sand with shell debris.	SS.SSa.OSa	Moderate
Site 20	Site 20 Image 5	31/01/2007	01:18	347323.29	5870000.61	91	Sand with shell debris.	SS.SSa.OSa	Moderate
Site 20	Site 20 Image 6	31/01/2007	01:19	347323.05	5869971.67	91	Sand with pebbles.	SS.SCS.OCS	Moderate
Site 21	Site 21 Image 1	31/01/2007	01:36	348789.73	5868856.52	95	Coarse sandy sediment with pebbles and shell debris. Bad visibility.	SS.SCS.OCS	Poor
Site 21	Site 21 Image 2	31/01/2007	01:37	348791.48	5868821.50	95	Coarse sandy sediment with pebbles and shell debris.	SS.SCS.OCS	Poor
Site 21	Site 21 Image 3	31/01/2007	01:38	348793.23	5868786.48	95	Coarse sandy sediment with pebbles and shell debris.	SS.SCS.OCS	Poor
Site 21	Site 21 Image 4	31/01/2007	01:39	348794.97	5868751.46	95	Coarse sandy sediment with pebbles and shell debris.	SS.SCS.OCS	Poor

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 21	Site 21 Image 5	31/01/2007	01:40	348796.72	5868716.44	95	Coarse sandy sediment with pebbles and shell debris.	SS.SCS.OCS	Poor
Site 21	Site 21 Image 6	31/01/2007	01:42	348800.21	5868646.41	95	Coarse sandy sediment with pebbles and shell debris.	SS.SCS.OCS	Poor
Site 21	Site 21 Image 7	31/01/2007	01:43	348801.96	5868611.39	95	Coarse sandy sediment with pebbles and shell debris.	SS.SCS.OCS	Poor
Site 22	Site 22 Image 1	31/01/2007	02:07	350417.01	5869562.90	94	Coarse sandy sediment with gravel and pebbles.	SS.SCS.OCS	Poor
Site 22	Site 22 Image 2	31/01/2007	02:09	350309.27	5869493.27	94	Pebbles with gravel and sand.	SS.SCS.OCS	Poor
Site 22	Site 22 Image 3	31/01/2007	02:09	350309.27	5869493.27	94	Coarse sandy sediment with pebbles and gravel.	SS.SCS.OCS	Poor
Site 22	Site 22 Image 4	31/01/2007	02:10	350255.39	5869458.45	94	Pebbles with gravel and sand.	SS.SCS.OCS	Poor
Site 22	Site 22 Image 5	31/01/2007	02:11	350201.52	5869423.63	94	Coarse sandy sediment with pebbles and gravel.	SS.SCS.OCS	Poor
Site 22	Site 22 Image 6	31/01/2007	02:13	350093.77	5869354.00	97	Pebbles with gravel and sand.	SS.SCS.OCS	Poor
Site 23	Site 23 Image 2	31/01/2007	02:33	351783.28	5870013.80	104	Silty pebbles, gravel, sand and cobbles.	SS.SMx.CMx.FluHyd	Poor
Site 23	Site 23 Image 3	31/01/2007	02:34	351801.99	5869971.01	104	Silty pebbles, gravel and sand.	SS.SMx.CMx.FluHyd	Poor

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 23	Site 23 Image 4	31/01/2007	02:36	351839.43	5869885.42	106	Silty pebbles, gravel and sand.	SS.SMx.CMx.FluHyd	Poor
Site 23	Site 23 Image 5	31/01/2007	02:37	351858.14	5869842.62	105	Silty pebbles, gravel and sand.	SS.SMx.CMx.FluHyd	Poor
Site 23	Site 23 Image 6	31/01/2007	02:38	351876.86	5869799.83	104	Silty pebbles, gravel and sand.	SS.SMx.CMx.FluHyd	Poor
Site 24	Site 24 Image 2	31/01/2007	02:59	351886.74	5870913.79	101	Silty pebbles and gravel with sand.	SS.SMx.CMx.FluHyd	Moderate
Site 24	Site 24 Image 3	31/01/2007	03:00	351906.65	5870885.52	101	Silty pebbles and gravel with cobbles and sand.	SS.SMx.CMx.FluHyd	Moderate
Site 24	Site 24 Image 4	31/01/2007	03:01	351926.55	5870857.25	101	Silty pebbles and gravel with sand.	SS.SMx.CMx.FluHyd	Moderate
Site 24	Site 24 Image 5	31/01/2007	03:03	351966.36	5870800.71	102	Silty pebbles and gravel with sand.	SS.SMx.CMx.FluHyd	Moderate
Site 24	Site 24 Image 6	31/01/2007	03:04	351986.27	5870772.44	102	Silty pebbles and gravel with sand.	SS.SMx.CMx.FluHyd	Poor
Site 25	Site 25 Image 1	31/01/2007	03:13	352168.81	5870587.57	121	Silty gravel with sand.	SS.SMx.CMx.FluHyd	Moderate
Site 25	Site 25 Image 2	31/01/2007	03:14	352179.67	5870576.61	122	Silty gravel with sand.	SS.SMx.CMx.FluHyd	Poor
Site 25	Site 25 Image 3	31/01/2007	03:15	352190.53	5870565.66	123	Silty gravel with sand.	SS.SMx.CMx.FluHyd	Poor
Site 25	Site 25 Image 4	31/01/2007	03:16	352201.40	5870554.70	124	Silty gravel with sand.	SS.SMx.CMx.FluHyd	Poor
Site 25	Site 25 Image 5	31/01/2007	03:17	352212.26	5870543.74	125	Silty gravel with sand.	SS.SMx.CMx.FluHyd	Poor
Site 25	Site 25 Image 6	31/01/2007	03:18	352223.13	5870532.78	125	Silty gravel with sand.	SS.SMx.CMx.FluHyd	Poor

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 25	Site 25 Image 7	31/01/2007	03:19	352233.99	5870521.82	126	Silty gravel with sand.	SS.SMx.CMx.FluHyd	Poor
Site 26	Site 26 Image 1	31/01/2007	08:50	354533.73	5871759.48	113	Silty gravel with pebbles and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 26	Site 26 Image 2	31/01/2007	08:51	354556.26	5871810.92	116	Silty gravel with pebbles.	SS.SMx.CMx.FluHyd	Good
Site 26	Site 26 Image 3	31/01/2007	08:51	354556.26	5871810.92	120	Silty gravel with pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 26	Site 26 Image 4	31/01/2007	08:52	354578.78	5871862.36	124	Silty gravel with pebbles and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 27	Site 27 Image 1	31/01/2007	09:16	353749.16	5871368.37	127	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 27	Site 27 Image 2	31/01/2007	09:17	353779.31	5871406.05	128	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 27	Site 27 Image 3	31/01/2007	09:18	353809.47	5871443.73	129	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 27	Site 27 Image 4	31/01/2007	09:19	353839.62	5871481.41	130	Silty gravel with pebbles, shell debris and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 27	Site 27 Image 5	31/01/2007	09:20	353869.78	5871519.09	130	Silty gravel with pebbles, shell debris and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 27	Site 27 Image 6	31/01/2007	09:22	353930.09	5871594.45	130	Small boulders and cobbles.	SS.SMx.CMx.FluHyd	Good

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 27	Site 27 Image 7	31/01/2007	09:22	353930.09	5871594.45	130	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 28	Site 28 Image 1	31/01/2007	09:39	354280.26	5870619.02	124	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 28	Site 28 Image 2	31/01/2007	09:40	354280.26	5870619.02	124	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 28	Site 28 Image 3	31/01/2007	09:41	354280.26	5870619.02	124	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 28	Site 28 Image 4	31/01/2007	09:42	354280.26	5870619.02	124	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Good
Site 29	Site 29 Image 1	31/01/2007	19:05	353790.69	5871032.75	144	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Poor
Site 29	Site 29 Image 3	31/01/2007	19:07	353825.74	5871163.40	136	Silty gravel with pebbles and shell debris.	SS.SMx.CMx.FluHyd	Moderate
Site 29	Site 29 Image 4	31/01/2007	19:08	353843.27	5871228.73	128	Silty gravel with pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 29	Site 29 Image 5	31/01/2007	19:11	353895.84	5871424.72	128	Silty gravel and sand with pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 30	Site 30 Image 1	31/01/2007	19:30	352679.06	5871575.95	140	Silty gravel with cobbles.	SS.SMx.CMx.FluHyd	Moderate
Site 30	Site 30 Image 2	31/01/2007	19:31	352612.51	5871644.97	137	Silty gravel.	SS.SMx.CMx.FluHyd	Moderate

Site	Sample name	Date	Time of sample	Easting (UTM 30)	Northing (UTM 30)	Depth (M) BCD	Habitat description	Biotope code	Visual quality of sample
Site 30	Site 30 Image 4	31/01/2007	19:34	352412.87	5871852.03	129	Silty gravel and pebbles with shell debris.	SS.SMx.CMx.FluHyd	Moderate
Site 30	Site 30 Image 5	31/01/2007	19:35	352346.32	5871921.05	123	Silty gravel and pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 31	Site 31 Image 1	31/01/2007	19:58	353022.39	5870586.34	141	Silty gravel and pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 31	Site 31 Image 3	31/01/2007	19:59	353040.73	5870654.99	143	Silty gravel and pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 31	Site 31 Image 5	31/01/2007	20:02	353095.75	5870860.94	149	Silty gravel and pebbles.	SS.SMx.CMx.FluHyd	Moderate
Site 32	Site 32 Image 2	31/01/2007	20:25	352343.87	5870113.71	120	Silty pebbles, gravel, cobbles with shell debris.	SS.SMx.CMx.FluHyd	Good
Site 32	Site 32 Image 3	31/01/2007	20:26	352357.57	5870186.34	123	Silty pebbles, gravel, small boulders and cobbles with shell debris.	SS.SMx.CMx.FluHyd	Moderate
Site 32	Site 32 Image 4	31/01/2007	20:26	352357.57	5870186.34	123	Silty pebbles, gravel and cobbles.	SS.SMx.CMx.FluHyd	Good
Site 32	Site 32 Image 6	31/01/2007	20:28	352384.98	5870331.61	129	Sand and gravel with shell debris.	SS.SCS.OCS	Good

Appendix 2. Acoustic survey cruise report

A2 Survey background

The aim of the research contract is to improve understanding of the habitats and communities present in an area of the Irish Sea identified as potentially containing Annex I reef habitat according to the EC Habitats Directive. The potential Annex I reef area for this Area of Search was roughly delineated using BGS 1:250,000 Seabed Sediment data (Figure A2.1). This area of habitat represented a number of polygons of quaternary sediment and rock according to the modified version of the Folk classification scheme used by BGS, and may consist of particles from 2mm diameter up to cobbles and boulders. Only boulder and cobble areas are likely to fit the Habitats Directive interpretation of ‘reef’.

The focus of this research contract is to investigate and characterise the habitats and biotopes of an area of potential reef in the mid Irish Sea identified above, by undertaking new acoustic survey and biological survey using mostly photographic methods, mapping the distribution and extent of the habitats and communities, assessing whether any of the habitats fit the interpretation of Annex I reef according to the EC Habitats Directive, and assessing the biological quality of the communities of this AoS in relation to those of other similar habitat areas in inshore and offshore UK waters.

The survey component of the project has the following aims and objectives:

1. Undertake the collection and analysis of new data on Annex I habitats in AoS 7: Mid Irish Sea reef.
2. Identify and map the extent of Annex I reef habitat using multibeam sonar and drop video to enable relevant physical sub-types of reef to be distinguished, in particular bedrock from boulder/cobble/stony reef, and biogenic reef (formed by organisms such as *Lophelia pertusa* (cold water coral), *Modiolus modiolus* (horse mussel) or *Sabellaria spinulosa* (ross worm).
3. Biologically characterise the different sub-types of reef identified above, providing structured descriptions and supporting data (quantitative where possible) for each, and provide good quality photographic records of the habitats and organisms present.
4. To identify and record the nature and location of any obvious human impacts in the AoS (e.g. trawl marks, dumped or discarded material, gear or nets).

This report outlines the work undertaken for objectives 1 and 2 above during a research cruise onboard *RV Aora* conducted between 14 and 24 November 2006.

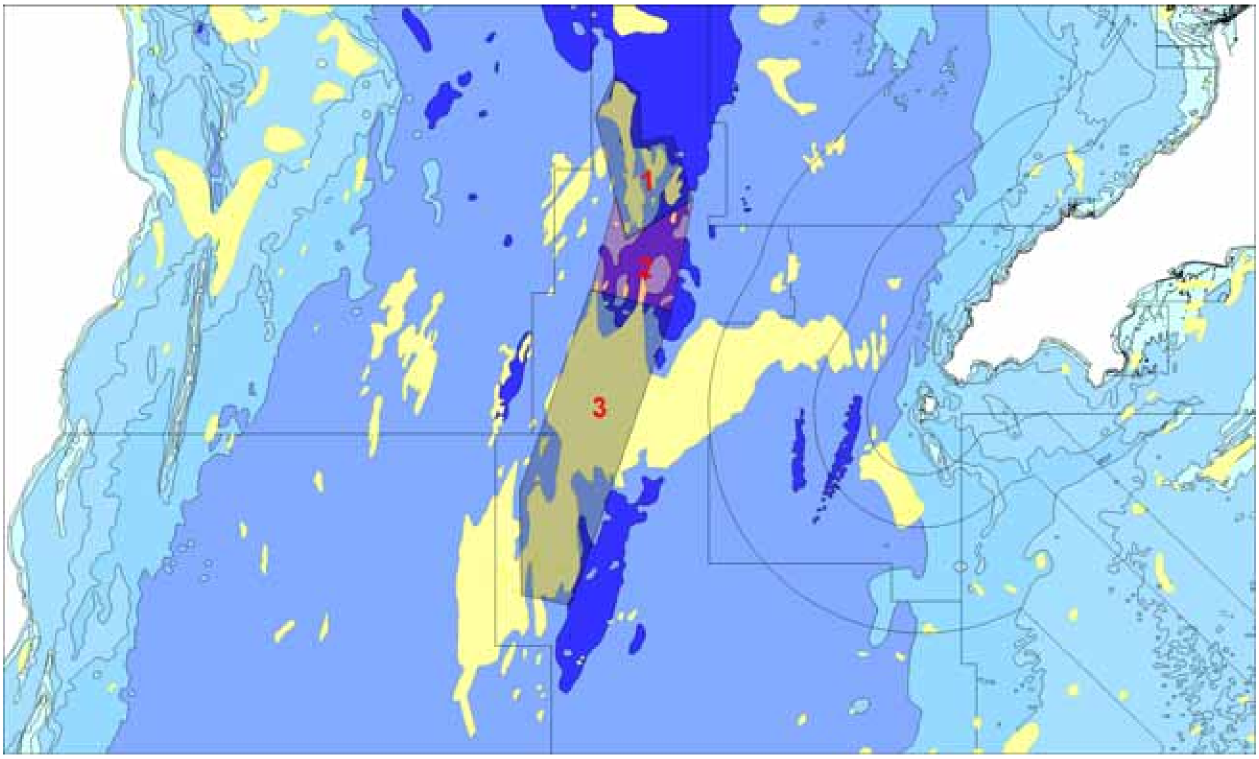


Figure A2.1 Proposed survey areas for multibeam survey. Yellow areas indicate potential reef from BGS data. © British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. PGA042006.003.

A2.1 Acoustic survey work scope

The RV *Aora* used a Reson Seabat 8101 for the survey with the data acquired and processed by the National Oceanography Centre (NOC). *Aora* ran QTC View in parallel to the multibeam system. Figure A2.1 outlines the proposed survey areas.

The scope of the multibeam survey was to target Areas 1 and 3 (Figure A2.1) with 100% coverage and Area 2 with 50% coverage (100% if time allowed). Track spacing was planned for 300-350m with every second transit line surveyed in each area to give 50% coverage of the entire region, and then the remaining lines filled to provide 100% coverage in Areas 1 and 3.

The multibeam survey was due to be conducted over approximately seven (170 hours), with an additional day for equipment set-up and calibration. In recognition of the high risk of bad weather affecting such a survey being conducted in winter, a total of three days had been planned for weather down time, giving a total survey window of 11 days.

As a result of the continued bad weather encountered during the survey period (see Section A2.6 Operational Summary for details), which considerably reduced the number of days it was possible to survey, as well as the quality of data obtained, a revised scope for the acoustic survey was agreed with JNCC as follows:

1. To cover all the three boxes at 50% coverage if possible (rather than getting 100% of some of the area(s) and nothing for others).

2. If 50% coverage of all three boxes is achieved and there is still time spare within the period for acoustic survey (plus contingency), then greater coverage for the north or south areas would be acquired.
3. If 50% over all of the areas during the planned time (with contingency days) is not achievable for the acoustic survey, then JNCC preference would be to use up some of the days planned for biological survey until 50% multibeam coverage is achieved (as far as is possible with staff availability), then move on to biological survey if/when conditions allow.

During weather gaps approximately 50% multibeam coverage was obtained from target Areas 1 and 3, with one line run within Area 2 (Figure A2.2).

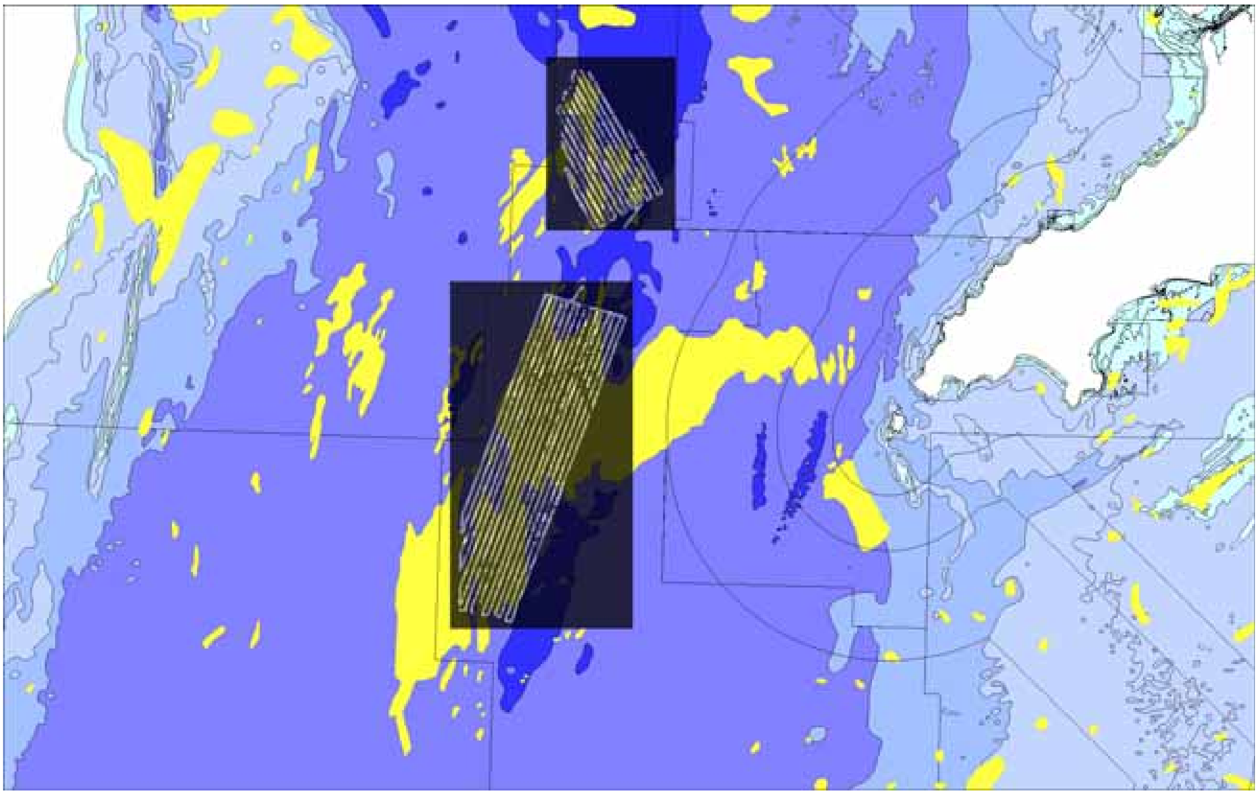


Figure A2.2 Multibeam coverage of target Areas 1 and 3 (single line in Area 2 only partially represented). © British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. PGA042006.003.

Due to bad weather, approximately three days (64.5 hours) were spent on site collecting acoustic data, out of a nine-day survey. The full contingency period was not used due to worsening weather conditions. The advance forecast indicated that the poor weather was continuing, and that for most of the period earmarked for biological survey it would also not be possible to conduct survey. Therefore it was agreed with JNCC that the survey be curtailed and further dates sought for the biological survey.

A2.1.1 Biological survey work scope

The biological survey was postponed due to bad weather and a window of opportunity has been reserved for January and early February 2007. The long range weather forecast will be consulted to enable the survey to be conducted during the most favourable conditions within that period. A separate method statement and risk assessment will outline the plan for this survey.

A2.2 Survey personnel and responsibilities

Matt Dalkin	Project manager (ERT)
Tim le Bas	Chief surveyor (NOC)
Veit Hűhnerbach	Surveyor (NOC)
Tom Stevenson	University Marine Biological Station Millport representative/Surveyor (UMBSM)

A2.3 Technical specifications

A2.3.1 RV Aora DGPS

The DGPS receiver was programmed with waypoints which were amalgamated into a desired route or survey pattern. The receiver then worked through the route, sending directions to the autopilot which controls the steering gear. The autopilot worked to keep the vessel on the calculated track (Course Over Ground) between two successive waypoints by continually adjusting the heading to minimise cross-track error. The vessel heading and COG may be different, particularly when coping with strong wind or tide. Maximum and minimum turn radii were set to keep the vessel on track when changing between successive waypoints, particularly at the ends of closely spaced survey lines.

RV Aora is equipped with:
- Simrad GN30D Differential GPS Receiver.
- Simrad AP30 Autopilot.

A2.3.2 QTC Series V AGDS

The QTC system was connected to one quadrant of the Simrad EK60 echosounder's split beam ES38B 38kHz transducer. The transducer was housed in a faired pod on the port side of the keel, just aft of and below the bow thruster. The Sounder settings were 200W power; 1.024ms pulse length, 1 ping per second. The transducer has a 7° beam angle. More power than this can interfere with other acoustic systems on board, in particular multibeam or swathe bathymetry equipment. These settings remained unchanged throughout the survey. The QTC Series V digitally captures each ping for post-processing and classification using QTC Impact.

A2.3.3 Multibeam system

The Reson SeaBat 8101 Multibeam Echosounder measures discrete depths, enabling complex underwater features to be mapped with precision. Dense coverage is achieved utilizing up to 3,000 soundings per second for a swath that can be over 600m wide. The survey vessel typically travels at speeds of about 7 knots. With high accuracy and a measurement rate up to 30 profiles per second, the SeaBat 8101 enables surveys to be completed faster and in greater detail then previously realized. The compact and portable SeaBat has become an industry standard for high performance bathymetry systems.

The SeaBat 8101 was mounted on a pole fixed on the side of *Aora*. The transducer head was connected to the shipboard electronics via a cable that ran up inside the pole mounting. A differential GPS array was used for high resolution positioning with two GPS receivers and a DGPS receiver. This often gave position accuracy better than 0.4m. Finally the system was linked to an inertial motion unit (IMU) to give attitude information such as roll, pitch and gyro heading.

A2.4 Calibrations

A2.4.1 Surface positioning calibration

A surface positioning calibration was needed to tie in the GPS antennae to the DGPS signal to provide accurate position and attitude. This required the boat to perform a series of movements and turns that can change the angles and speeds of the relative acquisition GPS receivers so that phase difference can be measured and thus calibrate the system. This was attempted on leaving Holyhead in a relatively sheltered area. The calibration quickly got to a reasonably high level of accuracy but did not actually find a full threshold calibration solution. A forced solution was therefore used and the resulting precision was 0.5m in position and 0.7° heading error. Due to worsening weather conditions these figures slowly degraded to about 1.0 m and 1.3°. Occasionally total navigation positioning was lost and the system had to be restarted. This unfortunately resulted in data gaps.

A2.4.2 Sonar head calibration

Following a new installation of the SeaBat 8101 transducer head, a calibration is required to orientate the exact position and attitude of the system. To do this a series a repeated survey lines are required to calibrate the variation in orientation in three dimensions (roll, pitch and yaw) and to measure any system latency (time errors).

The tests in order are:

1. Time latency – repeat a line at different speeds.
2. Pitch test – repeat a line but in opposite directions on a slope perpendicular to the ship track.
3. Roll test – repeat a line but in opposite directions on a flat piece of ground.
4. Yaw test – Two parallel bur separated lines in the same direction over flat ground with a recognisable feature located between the lines.

Initially two lines were chosen just north of the starting point of survey. The lines were parallel and existing charts suggested they had a slope, flat area and a wreck. However as the weather was not optimal it was decided to postpone the calibration as the calibration is not necessarily needed until the final processing stage. Previous calibration values were used and these proved satisfactory for initial viewing.

A second calibration test was attempted in a sheltered area in shallower water (40m) on a day when the weather and sea state in the main survey area was atrocious. Again two lines were chosen and data acquired. The first line data was of reasonable quality but the second line data was of much poorer quality as the weather had deteriorated considerably. Calibration was attempted on these datasets but the correction factors were varied and often inconclusive. After several measurements the calibration figures were decided to be:

- Roll latency 1.35 sec.
- Pitch latency 0.5 sec.
- Roll offset 1.85°.
- Pitch offset 1.01°.
- Yaw offset 0.0°.

A2.4.3 Sound velocity profile

Multibeam bathymetry systems measure all echoes in the time domain and therefore require a conversion to depth. For this a sound velocity profile is required. This can be obtained by a CTD and converting temperature and depth by empirical formula to sound velocity or by using a sound velocity probe which measures the sound velocity directly.

A probe was successfully deployed at the north end of the northern box in a water depth of 99m. The profile obtained effectively gave no thermocline or any layered structure suggesting an extremely well mixed water mass (where depth is the only variable in the velocity equation).

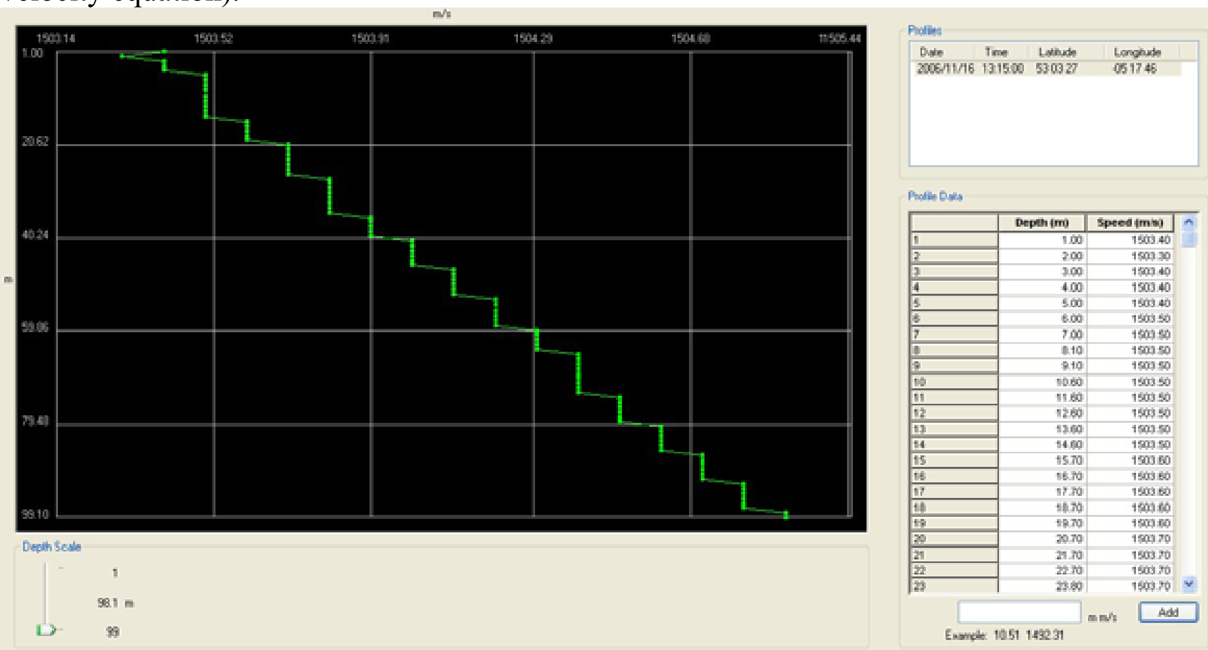


Figure A2.3 Sound velocity profile screen shot.

A2.5 Survey vessel offsets

Each time a Reson SeaBat 8101 system is installed on a boat the positions of the component parts must be accurately measured in 3 dimensions. Figures A2.4 and A2.5 shows all principal measurements needed relative to the IMU (yellow box). Accuracy is required to 0.5cm for the system parts (in black) and 0.5m for those in green (ship dimensions).

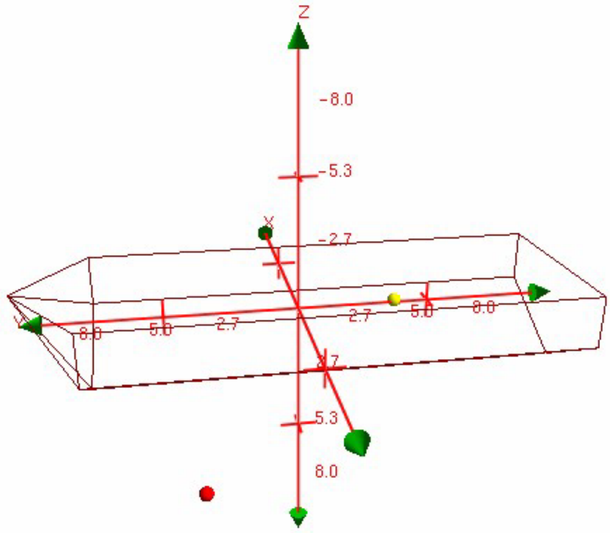


Figure A2.4 Three-dimensional diagram of the *RV Aora*. Yellow dot represents the IMU. Red dot represents the transducer head.

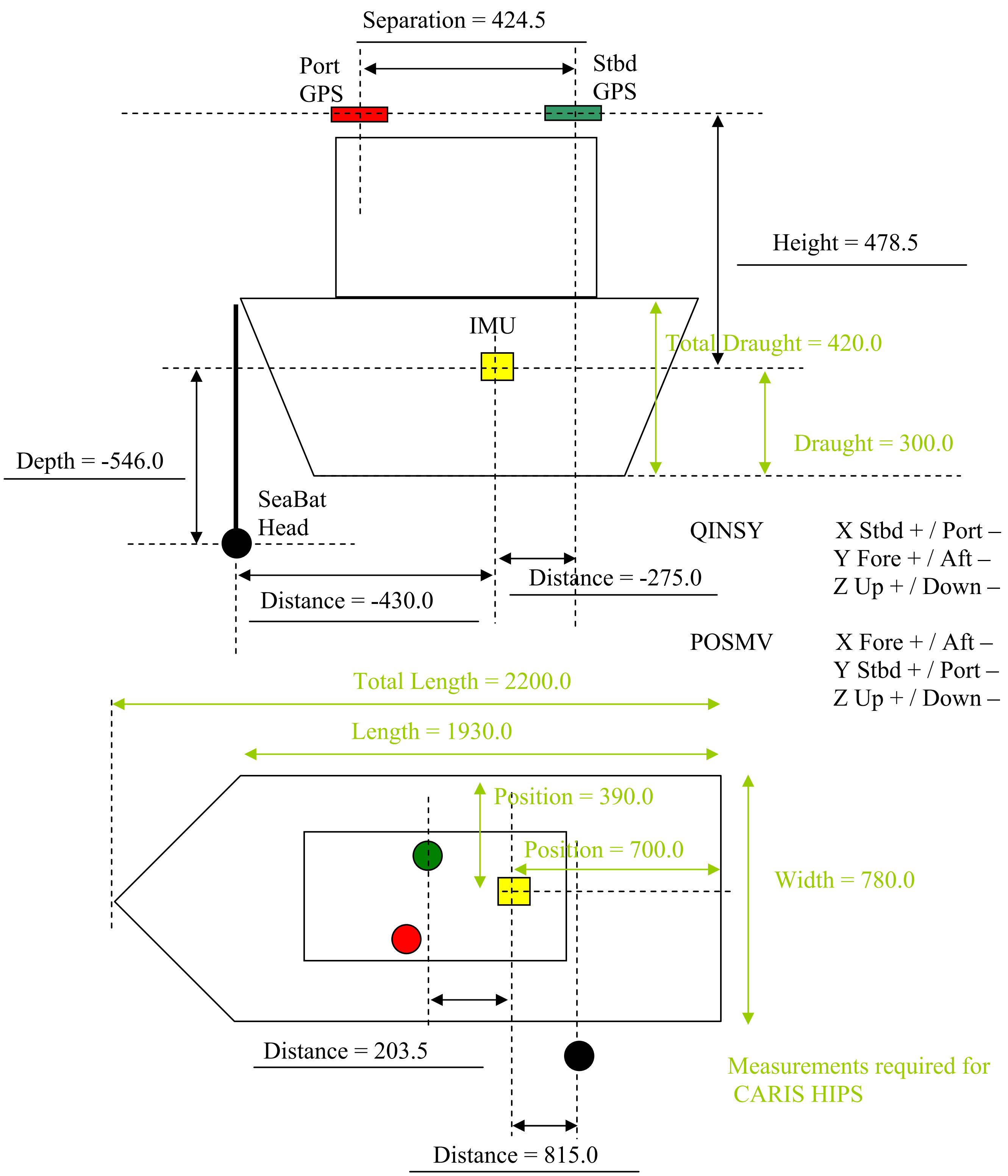


Figure A2.5 Measurements required for Caris HIPS (cms).

A2.6 Operational summary

UMBSM personnel mobilised from Millport 07:00 13 November 2006 and arrived at *RV Aora*, Fleetwood at 12:00. Weather forecast SW Force 5/6. *Aora* left Fleetwood 16:30 to begin passage to Holyhead.

Mobilisation of ERT equipment and personnel commenced 11:00. NOC mobilised 14:00 and at approximately 14:20 communication with *Aora* and JNCC lead to a stand down and postponement of 24 hours.

Aora arrived Holyhead 12:00 14 November after taking shelter East of Anglesey for wind to moderate. NOC departed Southampton 06:45, arrived Holyhead 14:00 and ERT departed Edinburgh 09:00 arrived Holyhead 14:30. Began multibeam equipment set-up and QTC View test. Forecast W/SW Force 6/7, gales later.

Aora remained in Holyhead 15 November while sonar head, GPS and motion sensor equipment was set up. Strong winds and rough seas delayed departure to 16 November. Forecast W/SW Force 5/6.

Aora left Holyhead 08:00 16 November and attempted GAMS Calibration (figure of 8s). 09:00 GAMS Calibration failed due to lack of satellite coverage. Multibeam calibration not attempted due to swell. 12:15 GAMS Calibration re-tried and resolved. 13:00 Arrived at target Area 1 and deployed sonar head. Sound Velocity probe deployed 53 03 26.91N 005 17 45.84W in 100m depth. No thermocline was observed and the water column appeared well mixed. Multibeam survey began (see Table 1 for track times). AGDS survey ran in parallel. Approximately 75% of Area 1 surveyed at 50% ensonification. 23:45 abandoned survey due to excessive roll and pitch impeding data quality and headed to Wicklow Bay, Ireland for shelter.

04:00 17 November *Aora* anchored in Wicklow Bay. 08:30 raised anchor and headed for Arklow. Forecast gales W/SW Force 6-8 increasing 9.

18 November tied alongside in Arklow. Forecast W Force 9.

10:00 19 November departed Arklow for multibeam calibration survey in shelter of Arklow Bank. Weather deteriorated rapidly and returned to Arklow 12:00.

Weather moderated over night. 08:00 20 November departed Arklow in hope of reasonable weather window. Wind 25-30 knots 210°. Arrived at target Area 3 12:30 and began multibeam and AGDS. 19:00 broken shackle on sonar pole mounting replaced.

21 November continuing survey. Wind from SSW. Moderating.

22 November continued to complete 50% ensonificiation of target Area 3, ran one line through Area 2 and then completed 50% coverage of Area 1. 17:00 departed survey area for Holyhead ahead of Severe Gale Force 9 from the south. Arrived Holyhead 21:00.

23 November contacted JNCC and agreed to cut short acoustic survey and delay video survey due to worsening weather conditions and poor long range forecast. NOC packed up equipment and at 13:00 ERT personnel transit to Edinburgh.

24 November 07:00 NOC transit home to Southampton, *Aora* left Holyhead in following SW Gale 8 and arrived Millport 23:00.

Table A2.1 Multibeam log

Date	Area	Line	Start of line	End of line	Comments
16/11/2006	1	20	13:30	14:52	Transmission power 6..
16/11/2006	1	22	14:55	16:13	Transmission power 7
16/11/2006	1	24	16:18	17:38	
16/11/2006	1	26	17:43	18:46	
16/11/2006	1	28	18:52	20:02	
16/11/2006	1	30	20:05	21:04	Error of 55m. POSMV rebooted, error reduced to 1m.
16/11/2006	1	32	21:15	22:05	Accuracy improving.
16/11/2006	1	34	22:10	22:51	
16/11/2006	1	36	23:09	23:35	
16/11/2006	1	28	23:36	NA	Abandoned line due to poor data quality.
20/11/2006	3	26	12:33	15:56	
20/11/2006	3	24	16:03	18:44	IMU acceleration bias error. Broken shackle.
20/11/2006	3	22	19:03	21:35	IMU Gyro bias error, heading error. Reset POSMV. Yaw 11-17°.
20/11/2006	3	20	21:41		Heading values good. Pitch ±5°.
21/11/2006	3	20		01:01	Roll ±10°. Positional accuracy 0.951 and 1.027.
21/11/2006	3	18	01:03	04:56	Positional accuracy 1.035 and 1.035.
21/11/2006	3	16	04:59	08:36	Pitch ±14°. Positional accuracy 1.4 and 1.2.
21/11/2006	3	14	08:38	11:41	Transmission power 6.
21/11/2006	3	12	11:44	14:40?	
21/11/2006	3	10	14:43?	17:42	17:42 Transit with pole up to SOL 28.
21/11/2006	3	28	18:18	21:37	Heading error 20:00. Navigation restarted.
21/11/2006	3	30	21:47		
22/11/2006	3	30		00:36	
22/11/2006	3	32	00:40	02:58?	
22/11/2006	3	34	03:02	05:41	Navigation degraded.
22/11/2006	3	36	05:45	08:13	
22/11/2006	3	38	08:20	10:04	Wreck noted FID397.
22/11/2006	2	29 (amended)	10:25	11:14	
22/11/2006	1	18 and 9	11:14	12:37	East side of Area 1 joined to make one track.
22/11/2006	1	7 and 16	12:41	13:51	
22/11/2006	1	14 and 5	13:53	15:34	Navigation degraded, rebooted.
22/11/2006	1	3 and 12	15:42	16:39	Multiple breaks due to loss of steered node position
22/11/2006	1	10	16:43	17:24	Multiple breaks due to loss of steered node position.

A2.7 Onboard sampling and processing procedures

A2.7.1 Multibeam acquisition

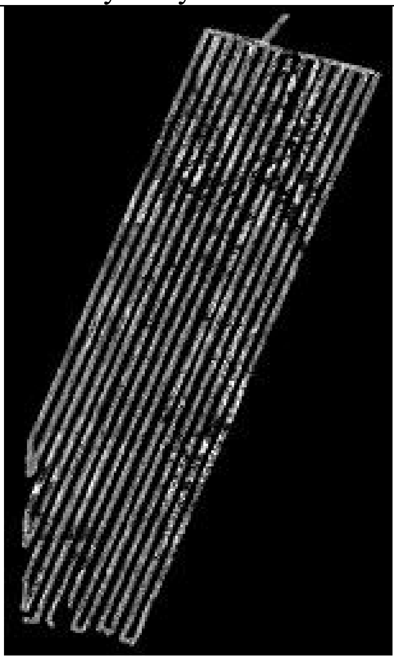
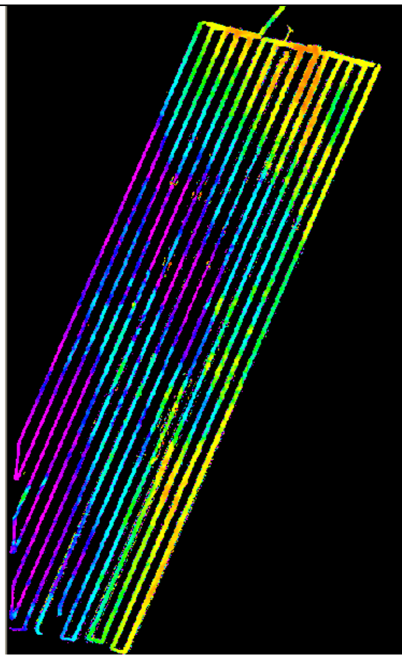
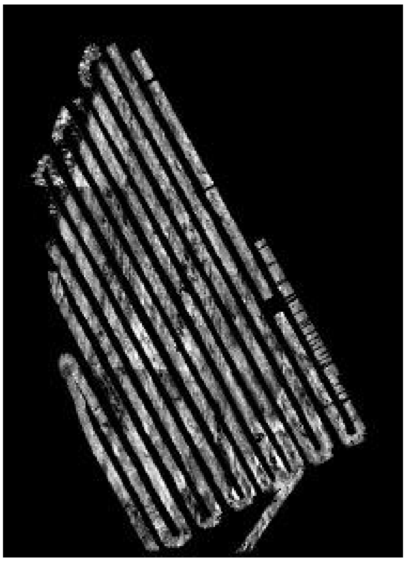
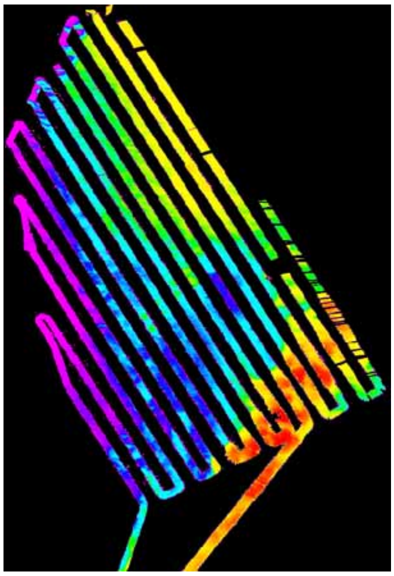
The QiNSY v7.5 acquisition was used (in preference to the 6042 system). Setup of the system driver was set to Reson SeaBat 81xx/900x (Network) XTF. This allows the converting of raw data (.db format) into XTF format and thus data can be fully reprocessed in many more systems (including the backscatter). It does use more disk space (100Mb in about 13 minutes) but this is a very small price to pay. In the vessel lab there were several acquisition displays which were:

- Individual Multibeam soundings from 8101 and diagnostics.
- Acquisition parameters and data control.
- Multibeam bathymetry map (updating continuously).
- GIS map on ship position and line control.
- Echosounder display.
- Ship navigation (on digital admiralty charts) – repeated from the wheelhouse.

A repeater display of the Multibeam bathymetry map was available on the wheelhouse to aid in navigation and communication.

The processing of the Multibeam data is separated into two parts bathymetry and backscatter. The CARIS HIPS software is used for the former data and PRISM and ERDAS Imagine are used for the latter. CARIS HIPS v6.0 and ERDAS Imagine v8.7 are commercial packages and are used under license.

Figure A2.6. Provisional bathymetry and backscatter results from the multibeam survey.

(a) Area 1 Bathymetry	(b) Area 1 Backscatter
	
(c) Area 3 Bathymetry	(d) Area 3 Backscatter
	

Appendix 3. Biological survey cruise report

A3 Survey background

The aim of the research contract was to improve understanding of the habitats and communities present in an area of the Irish Sea identified as containing potential Annex I reef habitat, defined according to the EC Habitats Directive. The potential Annex I reef area for the Area of Search was roughly delineated using British Geological Survey (BGS) 1:250,000 Seabed Sediment data under a separate contract undertaken by BGS for the JNCC (Graham *et al.*, 2001). This area of habitat represented a number of polygons of 'rock' according to the modified version of the Folk classification scheme used by BGS, and may consist of particles from am diameter up to cobbles and boulders. Only boulder and cobble areas are likely to fit the Habitats Directive interpretation of 'reef'.

The focus of this research contract was to investigate and characterise the seabed morphology and biological communities of an area of potential reef in the mid Irish Sea identified above, by undertaking new acoustic survey and biological survey using mostly photographic methods, mapping the distribution and extent of the habitats and communities, assessing whether any of the habitats fit the interpretation of Annex I reef according to the EC Habitats Directive, and assessing the biological quality of the communities of this AoS in relation to those of other similar habitat areas in inshore and offshore UK waters.

The survey component of the project had the following aims and objectives:

1. Undertake the collection and analysis of new data on Annex I habitats in AoS 7: Mid Irish Sea reef.
2. Identify and map the extent of Annex I reef habitat using multibeam sonar and drop-frame video to enable relevant physical sub-types of reef to be distinguished, in particular bedrock from boulder/cobble/stony reef, and biogenic reef (formed by organisms such as *Lophelia pertusa* (cold water coral), *Modiolus modiolus* (horse mussel) or *Sabellaria spinulosa* (ross worm).
3. Biologically characterise the different sub-types of reef identified above, providing structured descriptions and supporting data (quantitative where possible) for each, and provide good quality photographic records of the habitats and organisms present.
4. To identify and record the nature and location of any obvious human impacts in the AoS (e.g. trawl marks, dumped or discarded material, gear or nets).

The acoustic survey took place in November 2006. This report outlines the work undertaken for objectives 3 and 4 above during a research cruise onboard *RV Aora* conducted between 29 January and 1 February 2007.

A3.1 Biology survey work scope

The drop-down video/stills survey was conducted to ground-truth the previous acoustic survey undertaken in November 2006, and in particular to confirm the presence of potential Annex I reef features within the survey area. The camera system used was the Seatronics DTS6000 deployed from the *RV Aora*. The camera system included a Konsberg Simrad OE14-208 Digital Stills Camera System (5 Megapixel) and Kongsberg OE14266/1366MK2

Colour Video Camera (460 TVL) with four 35W HID lights. For accurate camera positioning fixing the system used a Sonardyne Scout USBL.

Camera drops of up to 10 to 15 minutes were recorded to collect information on the main substrata and to identify conspicuous epifauna and assess abundance across the northern area of the AoS. Digital still photographs were taken at 1 minute intervals at each station to show ground type and additional photographs were taken of conspicuous epifauna/rocky substrata.

The locations of video sampling stations were agreed *a priori* the survey with JNCC to cover a range of acoustic ground types identified in the November 2006 survey. It was anticipated that 102 stations would be surveyed (Figure A3.1). USBL calibration was undertaken by Seatronics prior to video sledge deployment.

Each video deployment was logged by Seatronics on DVD and the still camera hard drive. ERT recorded ancillary information on habitat type and species observed and maintain a video and stills photograph log. Video and still photographs were then recorded onto an ERT hard drive.

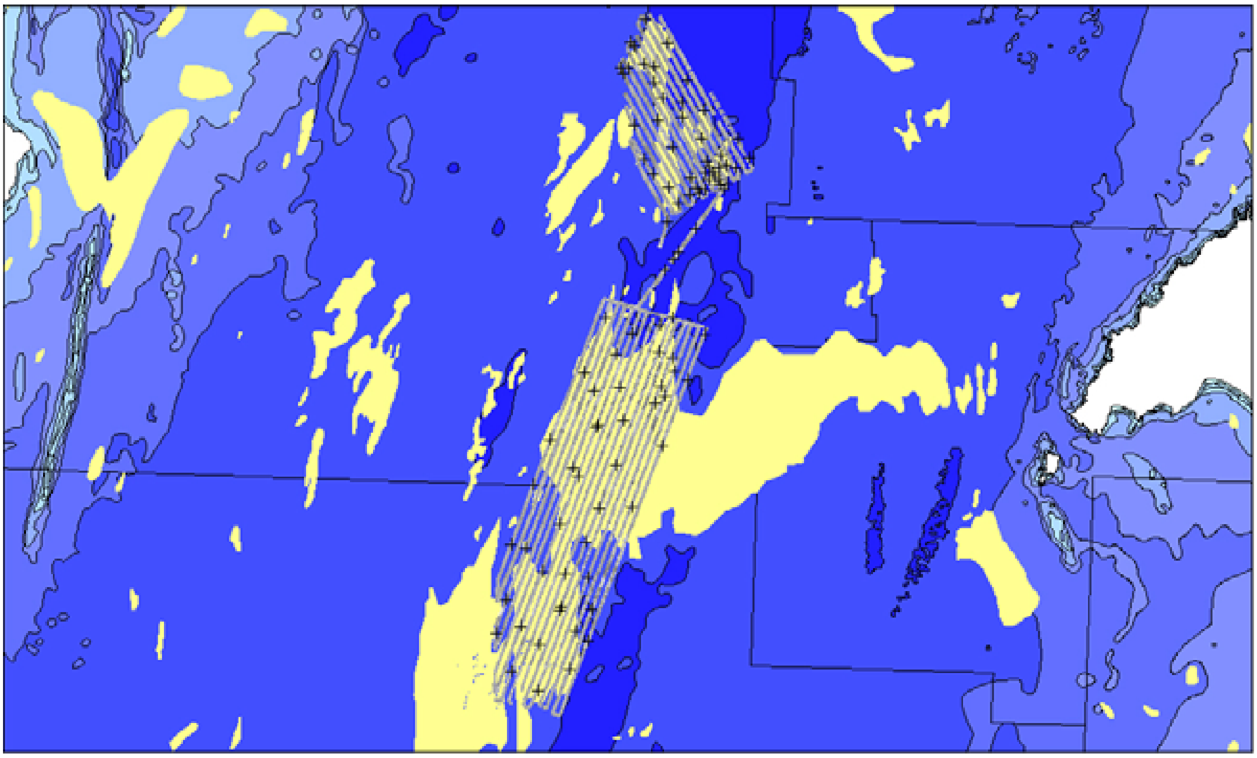


Figure A3.1 Proposed sampling locations overlaid on backscatter from acoustic survey (yellow areas indicate potential reef from BGS data). © British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. PGA042006.003.

Figure A3.2 indicates coverage of ground truth sampling stations prior to camera equipment failure on 31 January 2007.

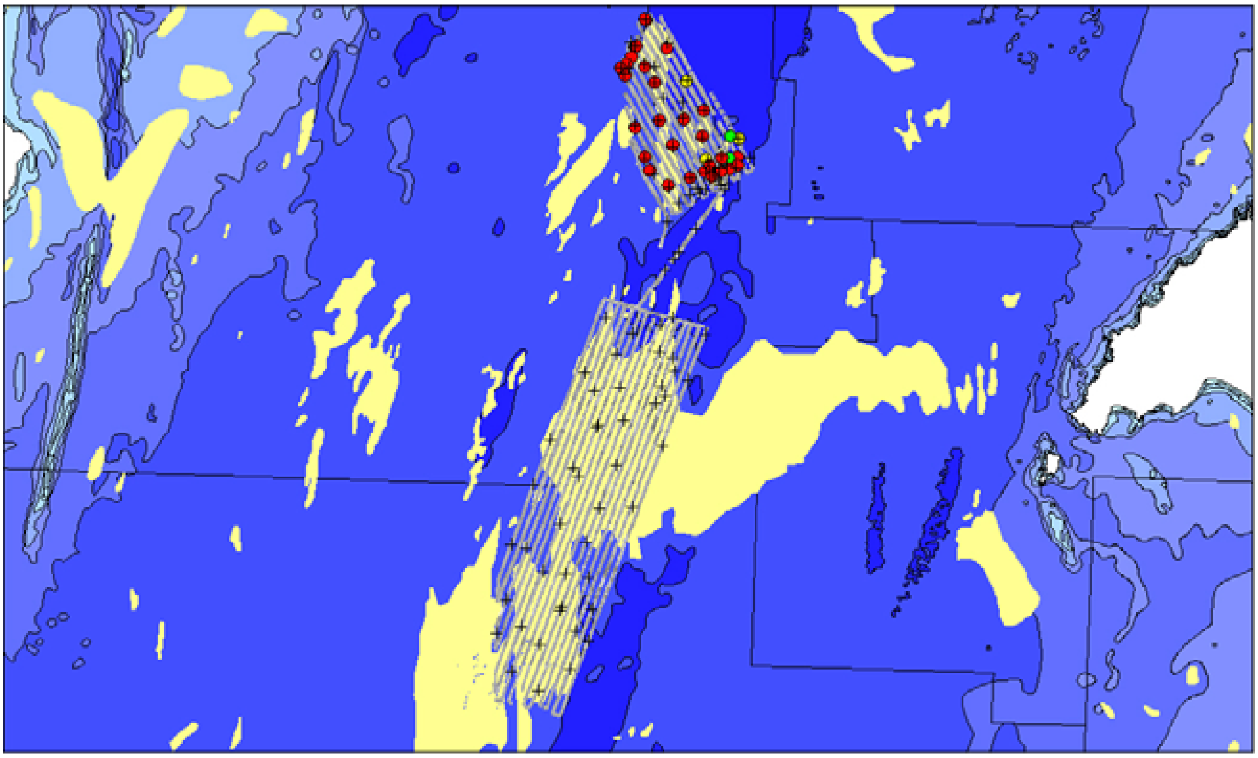


Figure A3.2 Sampling stations completed (red: sand/gravel, yellow: consolidated gravel and green: stony reef).

A3.2 Survey personnel and responsibilities

Matt Dalkin	Project Manager (ERT)
Tom Stevenson	University Marine Biological Station Millport representative/Surveyor (UMBSM)
Craig Cameron	Seatronics Engineer
Tony Craig	Seatronics Engineer

A3.3 Operational summary

Staff from ERT and Seatronics mobilised to meet *RV Aora* in Millport, Isle of Cumbrae on the 29 January 2007. Equipment set-up and USBL calibration was completed by 18:30. Weather Forecast W/SW Force 2/3. *Aora* departed for the survey area at 19:00 and arrived the following day 30 January at 13:00.

At 14:00 a test drop of the camera system was completed successfully. Weather remained good and the sea state was calm. The survey began with two drops at the first two sites due to problems with the DVD recording on the camera system. At 16:00 the USBL system began to lose signal intermittently. Strong tidal currents were observed across the northern survey area of 2 to 4 knots, and underwater visibility was poor, reduced to less than 1m, except during periods of slack water.

31 January 3:30. Wind increased to Force 6, and resultant swell and heave caused the tow cable to jump and become trapped in the block. The cable was released by 04:00 and work

postponed for weather down time to 08:00. On resumption of work the gyro on the camera frame was not functioning and at 09:00 work began without the gyro. Telemetry data was restricted to the altimeter. At 09:48 the vessel lost signal from the video and a decision was made to re-terminate the tow cable. The survey resumed at 19:00 with no gyro and at 20:36 the signal to video/camera was lost again. A further attempt was made to trace the fault, although none could be found the modems were changed in the unit. At 22:48 the system was still not working and an additional diagnostic check was undertaken. It was decided to return to the original modem and at 23:36 the system was still not working. At 23:52 the decision was made to return to Millport with 32 sites surveyed (See Table A3.1). The vessel arrived at Millport on 1 February at 21:00.

ERT and Seatronics staff remained on the vessel over night and travelled home on the 2 February.

Table A3.1 Biology log.

Site	Start latitude	Start longitude	End latitude	End longitude	Notes	Habitat	Annex 1 reef
1	53 4 1.080N	5 16 58.080W	53 03.981N	5 16.804W	Co-ordinate system of start is from USBL, rest from Aora GPS to be correlated	Muddy sand with sparse shell debris	No
1 (second drop)	53 04.054N	5 17.051W	53 04.175N	5 16.923W		Muddy sand with sparse shell debris	No
2	53 02.911N	5 17.613W	53 02.957N	5 17.533W		Muddy sand with shell debris	No
2 (second drop)	53 02.815N	5 17.677W	53 03.035N	5 17.496W		Muddy sand with shell debris, small pebbles and occasional cobble	No
3	53 02.430N	5 17.880W	53 02.702N	5 17.630W		Mainly muddy sand with ribbon of pebbles in sand	No
4	53 02.095N	5 18.282W	53 02.287N	5 18.050W		Muddy sand	No
5	53 01.925N	5 18.660W	53 02.155N	5 18.478W		Muddy sand with sparse broken shell sand	No
6	53 01.607N	5 18.322W	53 01.912N	5 18.138W		Muddy sand with sparse broken shell sand, occasional small stones	No
7	53 02.033N	5 16.944W	53 02.475N	5 16.702W		Sand with mixed shell and stone gravel, occasional cobble	No
8	53 02.847N	5 15.471W	53 03.205N	5 15.328W		Sand with mixed shell and stone gravel	No
9	53 01.465N	5 13.960W	53 01.974N	5 13.720W		Consolidated stony gravel with sand and cobbles	Possibly
10	53 01.342N	5 16.244W	53 01.655N	5 16.025W		Sand with mixed shell and stone gravel	No
11	52 59.412N	5 17.524W	52 59.551N	5 17.323W		Sand with mixed shell and stone gravel	No
12	52 59.740N	5 15.798W	52 59.801N	5 15.534W		Mixed shell and stone gravel with muddy sand	No

Site	Start latitude	Start longitude	End latitude	End longitude	Notes	Habitat	Annex 1 reef
13	52 59.836N	5 14.056W	52 59.870N	5 13.899W		Mixed shell and stone gravel with muddy sand	No
14	53 00.240N	5 12.704W	53 00.225N	5 12.448W		Mixed shell and stone gravel with muddy sand, occasional cobble	No
15	52 59.087N	5 10.177W	52 58.970N	5 10.062W		Consolidated gravel and cobbles	Possibly
16	52 59.152N	5 10.792W	52 58.900N	5 10.557W		Cobbles, small boulders and consolidated gravel	Yes
17	52 59.146N	5 12.785W	52 58.920N	5 12.603W		Mixed shell and stone gravel with muddy sand, occasional cobble	No
18	52 58.713N	5 14.805W	52 58.460N	5 14.643W		Sand with shell and stone gravel	No
19	52 58.147N	5 16.738W	52 57.863N	5 16.623W		Sand with mixed shell and stone gravel, occasional cobble	No
20	52 57.612N	5 16.383W	52 57.456N	5 16.377W		Coarse sand with occasional pebble and cobble	No
21	52 56.993N	5 15.052W	52 56.748N	5 15.019W		Mixed shell and stone gravel with muddy sand	No
22	52 57.347N	5 13.463W	52 57.170N	5 13.887W		Mixed shell and stone gravel with muddy sand, occasional cobble	No
23	52 57.622N	5 12.451W	52 57.440N	5 12.308W		Mixed shell and stone gravel with muddy sand, occasional cobble	No
24	52 58.130N	5 12.441W	52 57.966N	5 12.237W		Consolidated gravel and cobbles	Possibly
25	52 57.898N	5 12.119W	52 57.835N	5 12.009W		Mixed shell and stone gravel with muddy sand	No
26	52 58.287N	5 10.158W	52 58.596N	5 09.952W		Mixed shell and stone gravel with muddy sand, occasional cobble	No
27	52 58.233N	5 10.783W	52 58.441N	5 10.524W		Cobbles, small boulders and consolidated gravel	Yes
28	52 57.921N	5 10.185W	52 57.921N	5 10.185W	No end co-ordinate noted due to loss of power	Mixed shell and stone gravel with muddy sand	No

Site	Start latitude	Start longitude	End latitude	End longitude	Notes	Habitat	Annex 1 reef
29	52 57.781N	5 10.772W	52 58.349N	5 10.550W		Mixed shell and stone gravel with muddy sand	No
30	52 58.230N	5 11.334W	52 58.591N	5 11.947W		Mixed shell and stone gravel with muddy sand, occasional cobble	No
31	52 57.659N	5 11.394W	52 58.032N	5 11.249W		Mixed shell and stone gravel with muddy sand, occasional cobble	No
32	52 57.420N	5 11.951W	52 57.735N	5 11.869W		Consolidated gravel and cobbles	Possibly

A3.4 Example habitat photographs

The following photographs are examples of the range of habitats encountered during the survey.

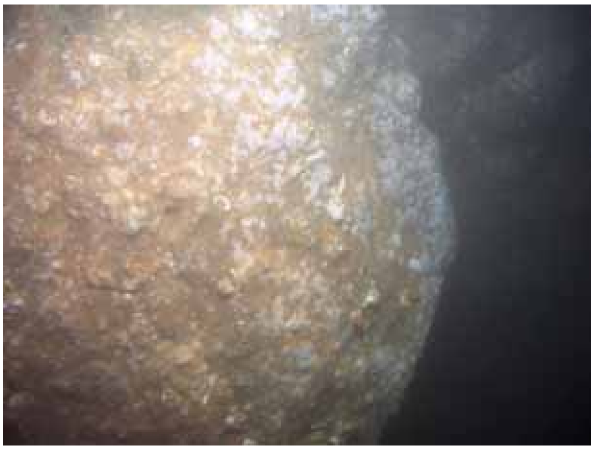
Site 1

Site 2

Site 8

Site 9

Site 27



Site 32

A3.5 References

GRAHAM, C., CAMPBELL, E., CAVILL, J., GILLESPIE, E. & WILLIAMS, R. 2001. JNCC Marine Habitats Version 3: its structure and content. *British Geological Survey Commissioned Report*, CR/01/238.

Appendix 4. Second biological survey cruise report

A4 Survey background

The aim of the research contract was to improve understanding of the habitats and communities present in an area of the Irish Sea identified as containing potential Annex I reef habitat, defined according to the EC Habitats Directive. The potential Annex I reef area for the Area of Search was roughly delineated using British Geological Survey (BGS) 1:250,000 Seabed Sediment data under a separate contract undertaken by BGS for the Joint Nature Conservation Committee (Graham *et al.*, 2001). This area of habitat represented a number of polygons of 'rock' according to the modified version of the Folk classification scheme used by BGS, and may consist of particles from am diameter up to cobbles and boulders. Only boulder and cobble areas are likely to fit the Habitats Directive interpretation of 'reef'.

The focus of this research contract was to investigate and characterise the seabed morphology and biological communities of an area of potential reef in the mid Irish Sea identified above, by undertaking new acoustic survey and biological survey using mostly photographic methods, mapping the distribution and extent of the habitats and communities, assessing whether any of the habitats fit the interpretation of Annex I reef according to the EC Habitats Directive, and assessing the biological quality of the communities of this AoS in relation to those of other similar habitat areas in inshore and offshore UK waters.

The survey component of the project had the following aims and objectives:

1. Undertake the collection and analysis of new data on Annex I habitats in AoS 7: Mid Irish Sea reef.
2. Identify and map the extent of Annex I reef habitat using multibeam sonar and drop-frame video to enable relevant physical sub-types of reef to be distinguished, in particular bedrock from boulder/cobble/stony reef, and biogenic reef (formed by organisms such as *Lophelia pertusa* (cold water coral), *Modiolus modiolus* (horse mussel) or *Sabellaria spinulosa* (ross worm).
3. Biologically characterise the different sub-types of reef identified above, providing structured descriptions and supporting data (quantitative where possible) for each, and provide good quality photographic records of the habitats and organisms present.
4. To identify and record the nature and location of any obvious human impacts in the AoS (e.g. trawl marks, dumped or discarded material, gear or nets).

The acoustic survey took place in November 2006. The first biology survey was undertaken in January and February 2007 but was aborted due to technical problems encountered with camera equipment. This report outlines the work undertaken in an attempt to complete the biology survey over the period of the 20 to 23 March 2007.

A4.1 Biology survey work scope

The drop-down video/stills survey was conducted to ground-truth the previous acoustic survey undertaken in November 2006, and in particular to confirm the presence of potential Annex I reef features within the survey area. The camera system used was the Seatronics DTS6000 deployed from the *RV Aora*. The camera system included a Konsberg Simrad OE14-208 digital stills camera system (5 Megapixel) and Kongsberg OE14266/1366MK2 colour video camera (460 TVL) with four 35W HID lights. For accurate camera positioning fixing the system used a Kongsberg HPR400 USBL.

Camera drops of up to 10 minutes were recorded to collect information on the main substrata and to identify conspicuous epifauna and assess abundance across the southern area of the AoS. Digital still photographs were taken at 1 minute intervals at each station to show ground type and additional photographs were taken of conspicuous epifauna/rocky substrata.

The locations of video sampling stations were agreed *a priori* the survey with JNCC to cover a range of acoustic ground types identified in the November 2006 survey. It was anticipated that 50 to 60 stations would be surveyed (Figure A4.1). USBL calibration was undertaken by Seatronics prior to video sledge deployment.

Each video deployment was logged by Seatronics on miniDV and the still camera hard drive. ERT recorded ancillary information on habitat type and species observed and maintain a video and stills photograph log. Still photographs were then recorded onto an ERT hard drive.

Figure A4.1 indicates coverage of attempted ground truth sampling stations prior to camera equipment failure on 21 March 2007. Strong Spring tide currents made sampling difficult compared to the first biology survey conducted over Neap Tides.

Figure A4.1 Proposed sampling locations overlaid acoustic survey: sampling stations attempted in red.

A4.2 Survey personnel and responsibilities

Kirsty McWilliam	Survey leader (ERT)
Tom Stevenson	University Marine Biological Station Millport representative/Surveyor (UMBSM)
Mark Robertson	Seatronics Engineer
Dharma Derwin	Seatronics Engineer

A4.3 Operational summary

Tuesday 20 March 2007

09:00 Seatronics engineers arrived at Fairlie Quay.

10:00 ERT representative, arrived at Fairlie Quay. The *RV Aora* tied up alongside the pier at Fairlie Quay. Due to the tides, the decision was made to leave for the survey area by 15:00.

11:00 Boat travelled to the Millport Marine Station, where the boat crew adapted the USBL fitting and attached the USBL pole to the side of the boat.

14:00 Seatronics found that the winch control had been left in Aberdeen. A courier was arranged to pick up the winch control and deliver it to Fairlie Quay, with an expected arrival time of 18:00.

16:30 Boat left Millport, as the drop in water level prevented the boat from staying alongside the pier with the USBL pole down. The boat moved into deeper water to allow the pole to stay down, to enable Seatronics to work out problems with USBL data.

18:30 Raised USBL pole and moved into Fairlie Quay to wait for courier to arrive with winch control.

20:00 It was established that the courier had been delayed outside Aberdeen due to an accident and had than become lost in Glasgow.

22:00 The winch control arrived with the courier. Seatronics checked part and fitted it prior to departure.

22:30 Boat departed Fairlie Quay to undertake a drop in a minimum of 100m of water off the Isle of Arran, allowing all of the equipment to be fully checked before departing for the survey area in the Irish Sea.

23:45 Arrived at site of test drop. Boat crew lowered the USBL pole.

Wednesday 21 March 2007

00:00 Test drop carried out in 150m of water. Both the video and camera appeared to be operating fine. The boat position, USBL and CTD data were set to record during the drop.

01:00 The USBL pole was raised, and all equipment was lashed down and packed away for transit.

18:00 Arrived at first drop site. The top northeast corner of the southern survey box was chosen for the first drop as the tide was running in the southerly direction. The boat crew lowered the USBL pole and put the camera frame over the back of the boat in preparation for the drop.

20:30 Drops 33 to 36 completed. During drop 37 there was difficulty in landing the camera frame. This site sloped quickly from 90m to 120m, which may have caused the camera frame to topple when it touch the seabed. The drop was abandoned after approximately 15 minutes, as only limited images of the seabed were obtained.

21:30 Problems with the video focus were noticed when the frame was returned to the surface. The frame was taken back onto the boat to refocus the video.
22:00 Problems landing the camera frame on the seabed meant that no photos were obtained from Drop 39.
23:30 The video image became degraded In order to increase the band width for the stills camera and gain a better image of the seabed, the decision was made to turn the video off. Therefore, no video footage was obtained from Drop 42.

Thursday 22 March 2007
00:00 Digital stills were much better on Drop 42 without the video, as it was easier to determine when the camera frame was on the bottom. Chose to leave the video off for the next few drops.
00:30 The connection was lost with the camera during drop 44, which meant no images of the seabed were received on the surface.
03:30 The vessel contacted Matt Dalkin (ERT Project Manager) for advice on the continuation of the survey. The decision was made to abandon the survey and return to Fairlie Quay, due to both the time constraints of the survey and doubt over whether the equipment would work after cable re-termination.

Friday 23 March 2007
02:00 Boat arrived at Fairlie Quay and moored for the night.
08:00 Van arrived to transport Seatronics equipment to Aberdeen.
10:45 ERT departed for Edinburgh.

Table A4.1 Biology log

Site	Start latitude	Start longitude	End latitude	End longitude	Notes	Habitat	Annex 1 reef
33	52 51.037 N	5 11.837 W	52 50.919 N	5 11.791 W		Consolidated pebbles and gravel with cobbles.	No
34	52 51.392 N	5 14.126 W	52 51.415 N	5 13.958 W		Silty pebbles and gravel with sparse cobbles.	No
35	52 51.008 N	5 14.430 W	52 51.208 N	5 14.238 W		Silty coarse sand and gravel.	No
36	52 50.940 N	5 15.214 W	52 51.194 N	5 15.041 W	Very low visibility.	Coarse sand and gravel with pebbles.	No
37	52 49.347 N	5 15.226 W	52 50.443 N	5 14.311 W		Coarse sand, gravel and shell debris.	No
38	52 49.481 N	5 14.274 W	52 50.049 N	5 13.994 W		Coarse sand and gravel with pebbles.	No
39	52 48.933 N	5 14.810 W	52 49.598 N	5 14.476 W	No photographs recorded. Strong currents and poor visibility.	Coarse sand.	No
40	52 48.860 N	5 14.246 W	52 49.547 N	5 13.876 W	Very low visibility.	Gravel and pebbles.	No
41	52 48.502 N	5 13.274 W	52 49.096 N	5 12.997 W	Very low visibility.	No data-	No
42	52 47.755 N	5 14.139 W	52 48.142 N	5 13.851 W	Problem with video signal.	No data-	No
43	52 47.925 N	5 14.646 W	52 48.165 N	5 14.444 W	Lost video signal. Still images only.	Mixed gravel and silty consolidated pebbles and cobbles.	No

A4.4 Example habitat photographs

The following photographs are examples of the range of habitats encountered during the survey.

Site 33

Site 34

Site 35

Site 36

A4.5 References

GRAHAM, C., CAMPBELL, E., CAVILL, J., GILLESPIE, E. & WILLIAMS, R. 2001. JNCC Marine Habitats Version 3: its structure and content. *British Geological Survey Commissioned Report*, CR/01/238.