PROJECT: Comparison of three acoustic techniques from concurrent data sets

PARTNER: Envision Mapping Ltd.

Project Summary

The scope of the survey is to determine seabed conditions pre- and post-construction for three offshore wind farms off the Lincolnshire coast. This report presents the survey results and analysis of the pre-construction phase.

The purpose of the survey was to:-

- Identify the occurrence of *Sabellaria spinulosa* and, if present, describe the extent of development of reef communities likely to be of conservation importance;
- Identify of other benthic habitats that might be sensitive to the construction and operation of wind farms;
- Provide a baseline from which the effects of construction can be assessed, especially on any *Sabellaria spinulosa*;
- Survey the seabed bathymetry

To achieve these objectives, a range of acoustic techniques were to used including an Acoustic Ground Discrimination System to measure sediment characteristics and water depth at a coarse resolution, swath bathymetry for detailed 100% coverage of the depths of the sea floor and sidescan-quality images of the sea floor for the description of seabed features, particularly signs of substantial reef development.

The acoustic data were checked for quality and the AGDS point data interpolated to create continuous data for hardness, roughness, ground variability and depth. The swath data were corrected for predicted tide adjusted for local departure from the predicted (due to atmospheric conditions) with tide data from the gauge at Spurn. The data were mosaiced and a 5m resolution image created for the whole area with more detailed 1m or 2m resolution images for selected features.

The bathymetric data show a stony/gravel shoal area within the Lynn, Lincs and Inner Dowsing sites that has a fairly well-marked drop off at the eastern margin into slightly deeper water. This slope is crossed by channels that lead to the deeper water where there are a number of large crescent sand waves/dunes (lunate waves crests) lying across the north/south tidal current indicating a highly dynamic environment. The shoal also has a series of well-defined, curved scarp slopes facing north and north east. Apart from these very clear features, the gravel shoal has few features apart from irregular waves and troughs. The cable route has small sand waves with their long axis running northeast/southwest that are probably wave-generated.

The survey strategy stipulated that grab sampling was to be avoided where reefs were detected. No substantial reef structures were detected on the sidescan sonar and this permitted a more representative grab sampling program. 30 samples were taken for sediment size and infauna. The infauna were analysed using multivariate techniques and trend analysis in a geographic information system (GIS). The sediments were classed into categories and these used to classify the AGDS data. One of the 'sediment' classes was the biogenic sediment *Sabellaria spinulosa* tubes. The classification predicted that the location most likely to support *Sabellaria spinulosa* reef was at the margin of the stony/gravel shoal.

The biological communities were described from video and infauna from analysis of grab data. Five main biotopes were described based on infauna: (1) dense *Sabellaria spinulosa,* **SS.SBR.PoR.SspiMx (dense)**; (2) sparse *Sabellaria spinulosa,* **SS.SBR.PoR.SspiMx (sparse)**; (3) **SS.SCS.CCS (Amp)** dominated by *Ampelisca* sp.; (4) **SS.SMX.IMx (PomL)** dominated by *Pomatoceros lamarki*, and; (5) **SS.SMX.CMx.FluHyd**, biotopes rich in epifauna.

Although no substantial *Sabellaria spinulosa* reefs were found, dense aggregations were observed and the predicted distribution of habitats most likely to support this biogenic habitat, derived from the interpretation of the acoustic data, lay on the eastern margin of the Lynn, Lincs and Inner Dowsing sites. This also coincided with high species diversity. The majority of the shallow gravel shoal which makes up the proposed wind farm sites support low to moderate diversity epifaunal biotopes typical of the southern North Sea and are of low conservation significance when taken in their wider geographic context.

Discussion of results from the techniques

Two acoustic systems were used to survey the area: a RoxAnn™ AGDS system and a GeoSwath™ interferometric swath bathymetric system. This proved to be an efficient use of vessel time in that AGDS and GeoSwath data (side scan, swath bathymetry and backscatter) were collected simultaneously. The high resolution of the swath system gives information on bedform features as well as general bathymetry and major seabed sediment categories. The system has accurate motion-sensing so that all final outputs are corrected for motion and tide. Although AGDS gives poor resolution, it supplements swath data by giving greater discrimination between different sediment types. The two systems can be operated at a vessel speed of around 10-12kmhr^{-1}, which enabled areas to be covered relatively rapidly.

The primary acoustic technique for broad scale mapping was a RoxAnn acoustic ground discrimination system (AGDS) operating at 200 kHz. This system is based on a single beam echo sounder and its use in broad scale mapping has been described by Foster-Smith *et al.* (2001) and Foster-Smith & Sotheran (2003). It returns point values of hardness (termed E2) and roughness (termed E1) of the sea floor for areas ensonified by the sounder as the boat traverses the survey area. A complete coverage of an area is interpolated from these track point data. Resolution is primarily determined by track spacing and this varied from 60m to 90m depending on depth. Although AGDS are low resolution systems, they can be used to discriminate sediment types and the digital data are readily handled by computer image processing software.

Although the data were displayed in real time to enable an assessment of the seafloor types to be made during the progress of the survey, Envision analyse the data using image processing and GIS (Sotheran *et al.* 1997) after carrying out detailed data quality assurance procedures. Further processing was required to correlate AGDS values to swathe/side scan features to assist with their interpretation.

GeoAcoustics' GeoSwath is an interferometric system operating at 250kHz that use the phase content of the signal to measure the angle of the wave front of the returning echo. The depth of the seabed reflecting surface is calculated from this angle and elapsed time. The system also measures signal amplitude and sidescan images are derived from this information. The system offers a good resolution from which accurate and detailed bathymetric models can be produced.

Ground truth data on the nature of the seabed to interpret the AGDS data were obtained using a drop-down/towed video system. The digital camera was controlled from the surface and the footage recorded digitally within the camera in its housing. Additionally, the video picture was relayed to a surface unit and the full drop was recorded in digital format. The surface unit also had the facility to record GPS position onto the digital tape.

Grab samples were taken using a 0.1m^2 van Veen grab at selected sites and the infauna retained on a 1mm sieve from these have been identified and counted

A total of 30 video drops/short tows were taken of between 1 and 2 minute's duration. Long tows traversing different ground types were avoided to simplify the classification of the records. Notes were made on survey of the conspicuous habitat features seen on the surface monitor.

The survey area lies in a zone of moderate tidal currents (2.1 knots at springs) with a residual tidal current and sediment transport running south. The sediments are mostly gravels of glacial or fluvioglacial origin, often quite thin, overlying an erosional surface of till (Cameron *et al.* 1992). The gravel is not subject to significant sediment transport and is overlain in places by sand which does show bedforms characteristic of sediment transport.

Figure 7 is a vertical view of the sun-illuminated bathymetry derived from the swath system. The colours show depth. The various features referred to in the following text correspond with the letter-coded text on the figure. The bathymetric data show a stony/gravel shoal area within the Lynn, Lincs and Inner Dowsing sites (a) that has a fairly well-marked drop off at the eastern margin into slightly deeper water. This slope is crossed by small channels (b) that lead to the deeper water. These channels may be caused by tidal current spilling off the shallow shoal. The eastern edge of the survey area has many features indicative of the strong tidal currents running north/south that fall into two categories: large crescent and straight crested sand waves/dunes lying across the direction of current (c) and troughs possibly caused by movement of sandwaves (d). Further offshore the sand is in more irregular banks (e)

The shoal also has a series of well-defined, curved scarp slopes facing north and north east so that the seabed falls in a series of steps towards the north (f). These may be re-workings of the underlying till by erosion. The gravel shoal has few features apart from irregular hummocky waves and troughs (a) possible due to interference between waves and tide. There are also larger hollows in the deeper gravel cobble which appear to coincide with finer sediments (g). The cable route has small sand waves with their long axis running northeast/southwest that are

probably wave-generated (h). The tracks closest to the beach picked up sand ridges resulting from outwash that overlay gravel.

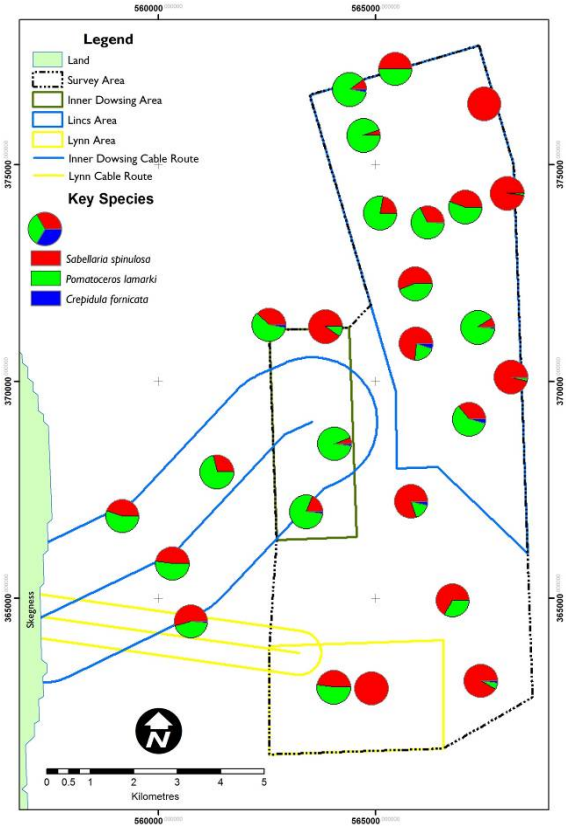

Figure 1 Key species distribution

There are four main components of the community in the survey area as determined by the infauna and small epifauna quantitatively sampled by the grab: (1) a high abundance/high diversity dense Sabellaria community; (2) a high diversity epifaunal community characterised by Pomatoceros lamarki; (3) a moderately high diversity Ampelisca diadema community, and; (4) a low diversity community with small numbers of (right)Sabellaria and Pomatoceros

Figure 2 Key species distribution

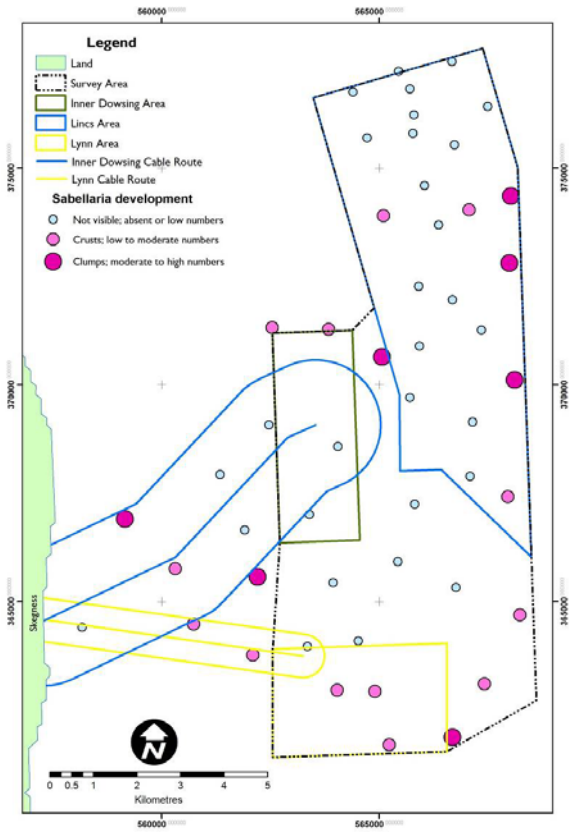

Figure 3 Sabellaria spinulosa development

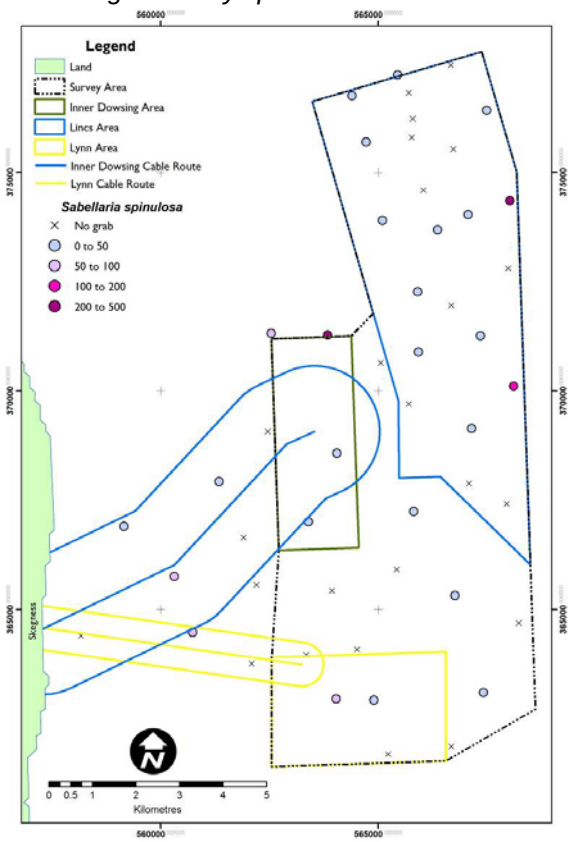

Figure 4 Sabellaria spinulosa abundance

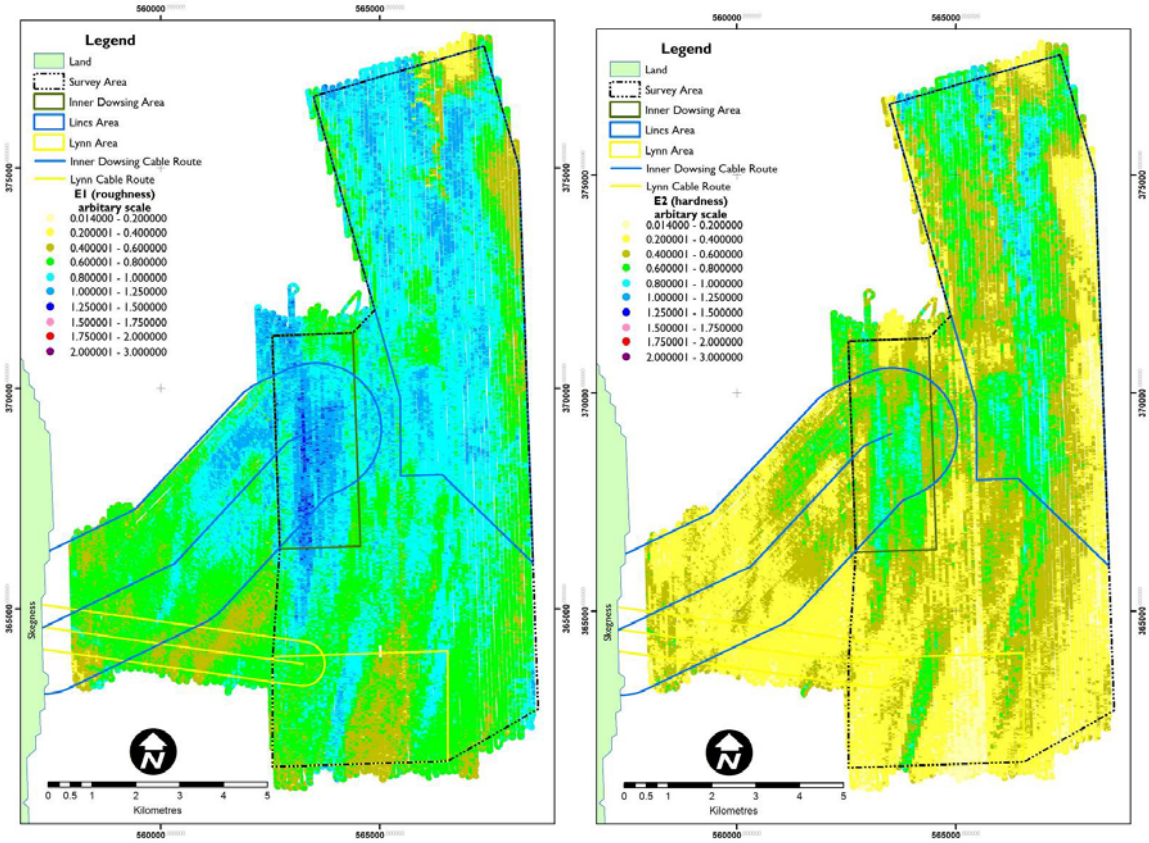

Figure 5 Track data coloured by E1 (roughness) and E2 (hardness)

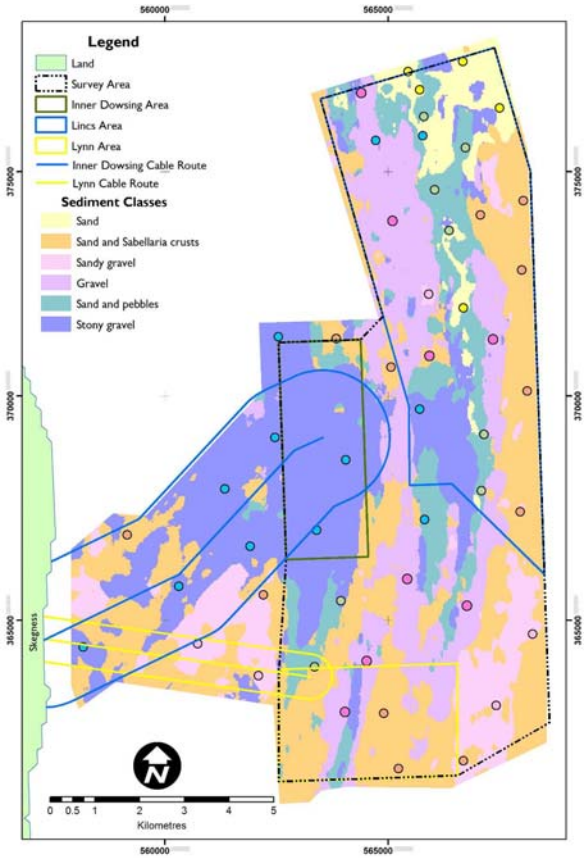

Figure 6 Sediment class map produced from AGDS, grab and video sample data. Sample data is overlain onto the map

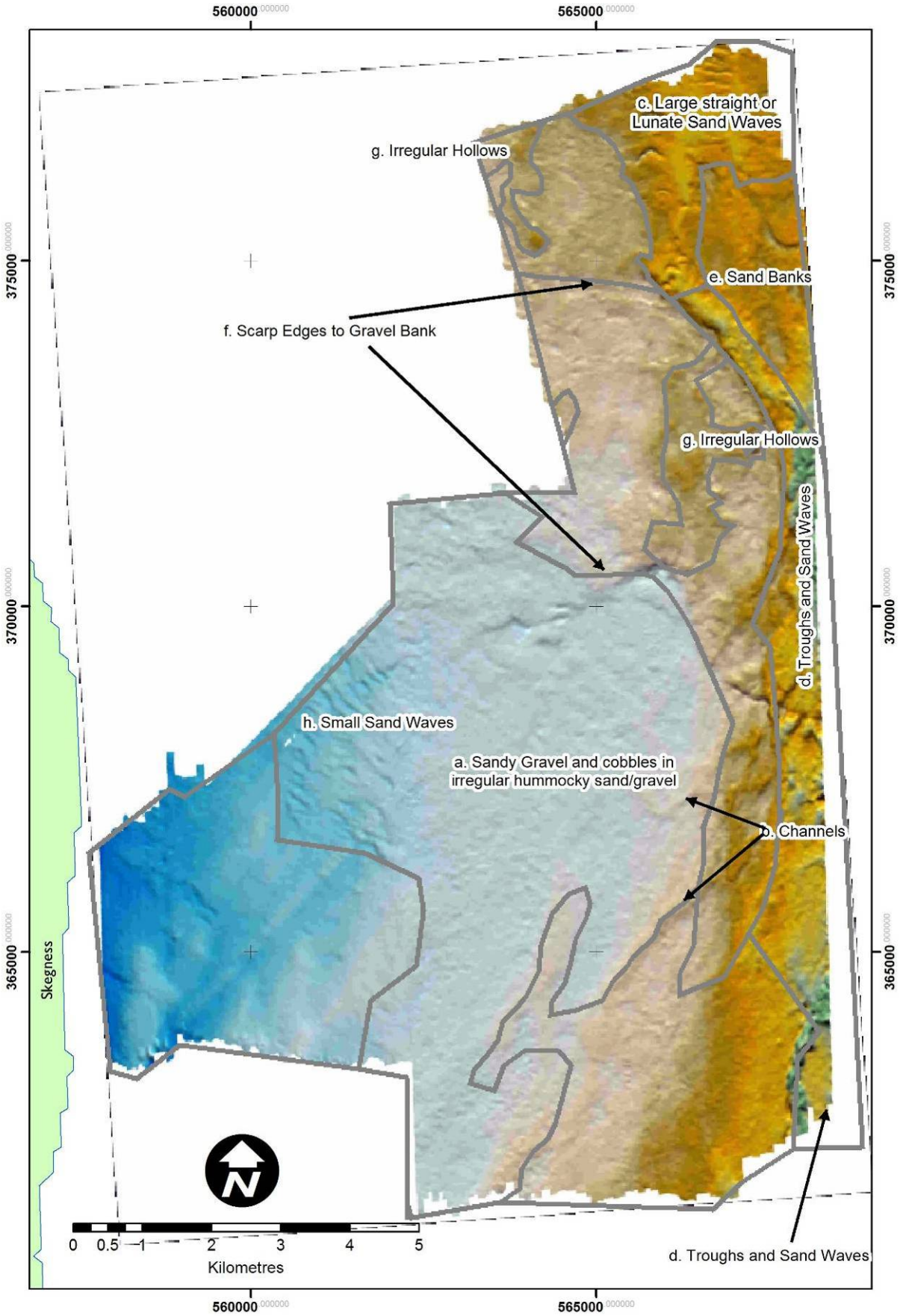

Figure 7 Main topographic and bedform features revealed by the mosaiced swath data (sun-illuminated, viewed vertically).

Conclusions and recommendations.

The survey area is characterised by a shallow, stony/gravel shoal area that has a fairly well-marked drop off at the eastern margin into slightly deeper water. There is also another distinct topographic feature running east/west in the centre of the survey area associated with a marked drop in depth to the north. Sandier sediments lay around this shallow hard ground shoal. These sandy sediments exhibit many distinct channels and sand waves indicating a dynamic sediment environment. These topographic features show well in the swath images.

The specifications of the survey state that reefs were to be identified as far as possible from sidescan in real time and assess any likely features using drop down cameras. However, biogenic structures, such as *Sabellaria* reefs, were not seen. This is not surprising given that low-lying reefs are difficult to pick up using sidescan sonar. English Nature advise against the use of grab samples on reefs because of the potentially damaging effects (English Nature, 2003). In the absence of large reef structures, and the requirement for information on less well-developed reefs, it was unavoidable that acoustically distinct ground (from both AGDS and swath system) was sampled representatively by video first and then by grab. This was justified as the only feasible way of collecting data that would enable an assessment of *Sabellaria spinulosa* in its range of development from low density to small clumps. However, reef development was also difficult to assess visually from video (not an unusual occurrence given the generally poor visibility of many sediment sites in the shallow southern North Sea) and a representative series of locations was used for grab sampling. This had the fortunate consequence that the sampling strategy resulted in a more comprehensive and representative quantitative infaunal dataset.

The communities are characteristic of sandy gravel and mixed sediment communities in the region, with low densities of large, conspicuous epifauna (bryozoans and hydroids), small epifauna (attached and encrusting), motile fauna and infauna. Many of the samples are species rich with a high number of individuals. *Sabellaria spinulosa* formed visible crusts throughout the area and small raised structures (lumps) at a few sites. Nowhere were any substantial worm tube structures above 10cm seen. However, reef definition is subject of debate and it is likely that 'reefs' might be encompass high density *Sabellaria* communities that have a less well developed structure (for example, tubes might simply coalesce and bind the underlying substratum) combined with elevated species diversity and abundance. If a broader definition along these lines is adopted, then some locations support *Sabellaria spinulosa* at levels where they might be considered to be of conservation significance and potentially to qualify as reefs. These communities appeared to be located mostly on the eastern margins near the drop-off. This would accord with recent experience that *Sabellaria spinulosa* favours sandy gravel and gravel where there is a good supply of mobile sand. However, it must be stressed that nowhere were there well-developed reefs and these sites can only be regarded as the most favourable in the survey area. The ability of *Sabellaria spinulosa* to develop into reefs from crusts if left undisturbed or to regenerate if damaged is poorly understood. At present, the only option is to assume that the best developed *Sabellaria spinulosa* communities might grow into more substantial structures, given favourable conditions. If this approach is adopted, then sites around the shallow shoal might be selected as the most likely to develop into larger reef structures.

It should also be stressed that the communities are not clearly distinguishable from each other and that there is considerable overlap and similarity between samples. Many of the non-*Sabellaria* biotopes with a higher representation of epifauna are equally as rich as the *Sabellaria spinulosa* biotopes. It could be argued that mapping overall diversity may be a better way of identifying the areas that could make a special contribution to the local ecosystem. The results suggests that the highest diversity/richness, once again, is to be found along the margins of the shallow hard ground.

The remainder of the survey area supports low to moderate diversity epifaunal biotopes and/or infaunal biotopes characterised by polychaetes and amphipods with low densities of *Sabellaria spinulosa.* These biotopes are common throughout the southern North Sea and, in this wider geographic context, these areas within the Lynn, Lincs and Inner Dowsing are of low conservation significance.