![MESH MAPPING EUROPEAN SEABED HABITATS]

Title:	**Case Study: Piloting the use of drop down scanning sonar for the detection of reef features**
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Summary:	A series of novel surveys were carried out from June-October 2006, investigating the possibility of using a drop-down scanning sonar rig, for the detection of small reef-like benthic features. This case study presents the results obtained.
	There are many reports of the detection of *Sabellaria* reefs through the inspection of side scan images and the identification of unusual textures thought to be caused by the reefs. However, the link between the texture features and reefs is assumed rather than proven. This project aimed to directly investigate this link, using side scan sonar technology to detect features, while at the same time the exact area of ensonified sea bed was being videoed.
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1. Introduction

A series of surveys were carried out from June-October 2006, to investigate the possibility of using a drop-down scanning sonar rig, for the detection of small reef-like benthic features. This case study presents the results obtained. Scanning sonar techniques were used in combination with video, to detect fine details of reef-like topographic seabed features, in particular those associated with biogenic *Sabellaria spinulosa* reefs.

Biogenic reefs shelter fauna which is distinct from other biotopes, and allow species to become established in predominantly sedimentary areas where they would not otherwise be found. Therefore, *S. spinulosa*, a reef builder of this type*,* has been identified as a priority habitat under the Biodiversity Action Plan (BAP). Consequently, more rigorous techniques are required for monitoring such systems.

Side scan sonar is thought to produce high definition images of small features across a wide swath and, therefore, has the potential to be an ideal tool for the detection and identification of reef-like structures. There are many reports of the detection of *Sabellaria* reefs through the inspection of side scan images and the identification of unusual textures thought to be caused by the reefs. However, the link between the texture features and reefs is assumed rather than proven. One of the problems with establishing this link is that positioning a ground truth device, such as a video, in an exact location indicated by side scan sonar is extremely difficult. Georegistering side scan sonar is prone to positional error, especially if high precision is required to validate particular features.

1.1. Goals of Mapping

This project aimed to use side scan sonar technology to detect features, while at the same time the exact area of ensonified sea bed was being videoed. Scanning sonar is an established technology based on side scan sonar theory that is used for ROV navigation and collision avoidance. Instead of the sonar being static within a fish which is towed past objects, the scanning sonar has a rotating head fixed (in this study at least) to a static object (a lander). The rotating head scans the sea bed and builds up a circular image of the sea floor, around the sonar head in the centre. The scanning sonar devices can produce a much higher resolution image than ordinary towed side scan since it can be held very close to the sea floor and scan a small area in greater detail.

Linking the sonar systems to a video device, allows objects to be simultaneously seen and ensonified, with absolute certainty in the relative positions of the sensors. Fitting the 'lander' with a system for recording orientation, allows the images to be registered relative to north, and the features seen properly interpreted. The images are directly comparable to side scan images, and it is reasonable to assume that the high resolution features seen can be directly related to the similar, coarser features apparent on side scan images.

1.2. Pilot Sites

There are only a few areas of known *Sabellaria spinulosa* reef in UK waters (and very few in other European waters). Two sites were used for testing the apparatus: The primary site used for testing was an aggregate extraction site, known as site 107, off the Lincolnshire coast. Selected areas within this site were chosen on the basis of video tows that showed there to be well developed *Sabellaria* reef, areas of non-reef sand and other sand wave features, which

were ideal for the purposes of the study. The survey took advantage of the CEFAS *Endeavour* cruise on 13th -19th July, 2006. The site was chosen because it had been thoroughly surveyed using side scan sonar and towed video. A transect of 7 drops was taken across a change in sea floor from well developed reef, through poorly developed reef to sand waves.

The second was an intertidal reef in the Wash that is exposed at extreme low spring tides. This survey took place on 10th -12th September, 2006 on board the Eastern Sea Fisheries Joint Committee survey vessel. This was particularly useful since the reef could be seen and the reef features measured directly. The lander was deployed at chosen locations on the following high tide.

1.3. Methods Summary

The system used a Mercury Scanning Sonar (SonaVision), which has a selectable frequency output between 600kHz and 1200kHz. The range and speed of scan can also be selected. The height is determined by the deployment method. Thus, the resolution is variable dependant upon the settings chosen and equipment set up. In this study the sonar was positioned on a steel tripod with the sonar head attached centrally between the tripod legs at the apex (for protection). The head was 1 metre above the sea floor when the tripod was landed.

Two high definition CCTV cameras were positioned on the legs about 30 cm from the sea floor and lights attached further up the legs to avoid backscatter as much as possible. The cameras were fixed 180^0 from each other. One camera had a small compass held just in the field of view so that the orientation of the tripod lander could be estimated.
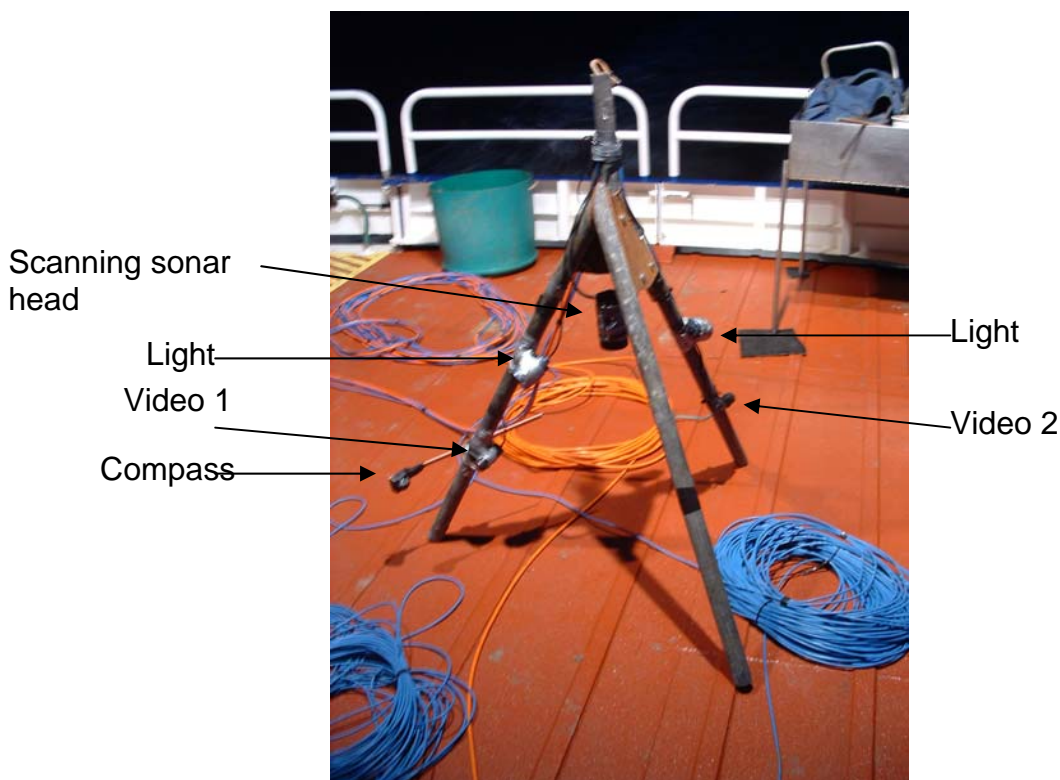

Figure 1: The 'Lander' Structure used to simultaneously deploy scanning sonar and two video systems, with directional capability (compass) shown.

2. The characteristics of the habitat type

The 'ross worm', *Sabellaria spinulosa* Leuckart 1849, is a sedentary, epifaunal polychaete that builds rigid tubes from sand or shell fragments. It is a suspension feeder that is generally found individually but can be gregarious in favourable conditions, and colonies consisting of fused sand-tubes may form thin crusts or extensive reefs. The reefs are solid but fragile structures, which can be up to several metres across and raised above the sea bed by up to 30cm.

Preliminary video surveys showed that the reefs in the surveyed area of 107 to be wave-like structures about 15-30cm tall with non-*Sabellaria* species in the wave troughs. The long axis of the reefs ran east/west. Sediment profile information further showed the *Sabellaria* tubes to originate from underlying sand waves and not a cobble base. The reefs can persist for many years and as such, they provide a biogenic habitat that allows many other associated species, including epibenthos and crevice fauna, to become established. The fauna is distinct from other biotopes and species can become established in predominantly sedimentary areas where they would not otherwise be found. *S. spinulosa* has therefore been identified as a priority habitat under the Biodiversity Action Plan (BAP), the UK's initiative to maintain and enhance biodiversity.

2.1. Classification

On the basis of the definition of biotopes, or biotope types, as the spatial components of an ecosystem characterized by "specific ecological, unique and more or less constant environmental conditions", *S. spinulosa* habitats have been classified according to the biotopes listed in Table 1, below. Only biogenic reef biotopes of *Sabellaria* have been included here for the purposes of comparison.

Table 1: Sabellaria spinulosa biotopes of five different classification systems.

Classification		
Code	Biotope(s)	Description
Britain / Ireland (MNCR BioMar – 97.06)		
CMX.SspiMx	S. spinulosa and Polydora spp. On stable circalittoral mixed sediment	The tube-building polychaete S. spinulosa at high abundances on mixed sediment, with Polydora spp. tubes attached. Infauna comprise typical sublittoral polychaete species, together with the bivalves Albra albra and Nucula nitidosa. Epifauna comprise calcareous tubeworms, pycnogonids, hermit crabs and amphipods. This biotope is considered a biogenic reef since Sabellaria performs an important stabilising function on the substratum.
Biodiversity Action Plan Priority Habitats (UK)		
	S. spinulosa reefs	
Europe (EUNIS Nov. 1999)		
A3.6/B-MCR.Csab	S. spinulosa communities on circalittoral rock	See MNCR MCR.CSab
A4.4/B-CMX.SspiMx	S. spinulosa and Polydora spp. on stable circalittoral mixed sediment	See MNCR CMX.SspiMx
Wadden Sea (1996)		

03.02.09	Sublittoral Sabellaria reef	
France (ZNIEFF-MER)		
III.3.3.1	Faciès à S. spinulosa	
III.5.1.1	Faciès d' épifaune à S. spinulosa	

2.2. Relationships (i.e. substrate to biota)

Thicker, and probably more permanent, crusts or reefs of *S. spinulosa* seem to have a considerable influence on the benthic community structure, and have been reported to contain a more diverse fauna than nearby areas. The UK National Rivers Authority found that sites in the Wash associated with *S. spinulosa* had more than twice as many species and almost three times as many individuals (excluding the *Sabellaria* themselves) as sites with low, or no, *S. spinulosa*. (see ENV CS01 SSS ID Biogenic Structures.doc)

3. Summary

3.1. Results

3.1.1. Aggregate Extraction Area 107

Selected areas within the primary site were chosen on the basis of video tows that showed there to be well developed *Sabellaria* reef, areas of non-reef sand and other sand wave features, which were ideal for the purposes of the study. A transect of 7 drops was taken across a change in sea floor from well developed reef, through poorly developed reef to sand waves.

The device successfully obtained acoustic images and video pictures of the sea floor. The images of the seven drops have been oriented with north up and are shown in the figure below. The inset image is an example of a frame grab of part of the reef seen in the first scan, as an example of the validation data.

The images show a gradation of Sabellaria reef from a well developed reef in image 1, with the reefs orientated with a long axis approximately south-west/north-east. This accorded well with the Sidescan images, but with much higher definition. The reef development decreased until the last station, which was on well developed sand waves.

Measurement of the acoustic shadows cast by the reefs indicate that were about 20-30cm high at their maximum. (Note that this does not mean that the reef tube structure was that extensive and, indeed, the profile image through reefs in the locality indicated that the tubes were probably no greater than 15cm but were overgrowing sand waves which elevated the overall height of the reefs). The sand waves were about 30 cm maximum height.

Figure 2: A sequence of drops across a section of ground characterised by well developed reef (1) through poorly developed reef and finally sand waves (7). Continued on next page.
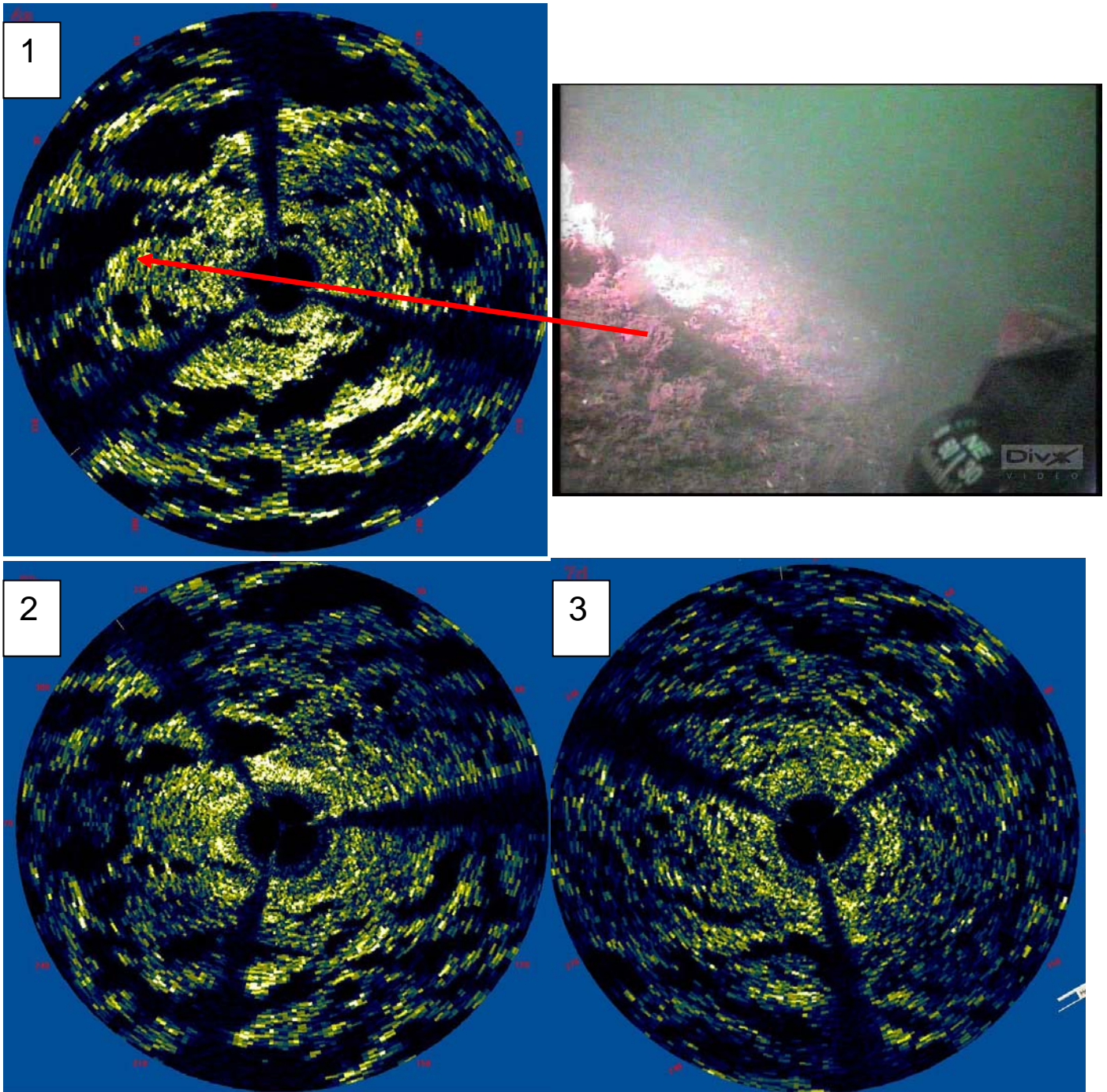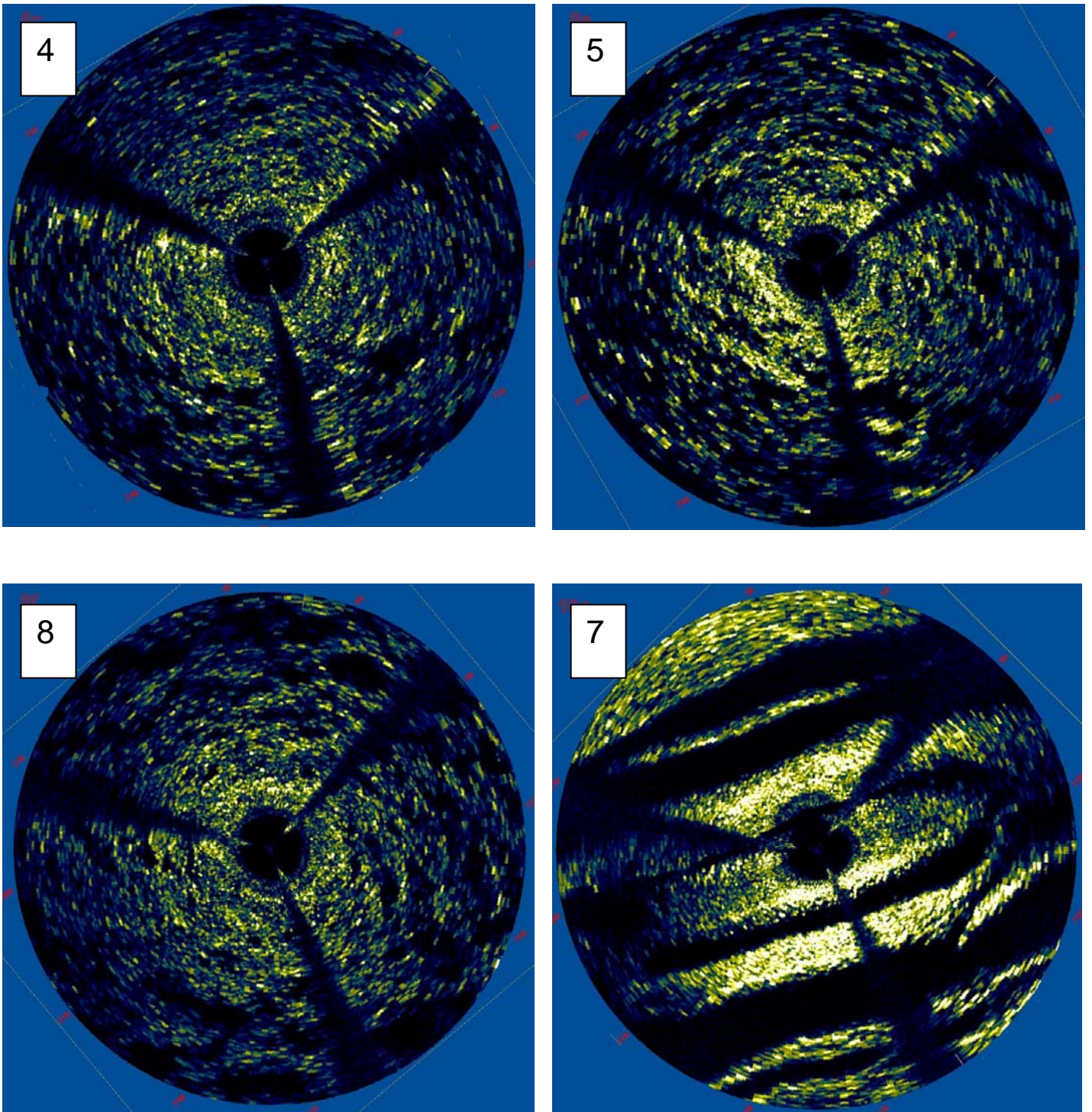
Figure 3: A sequence of drops across a section of ground characterised by well developed reef (1) through poorly developed reef and finally sand waves (7).

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3.1.2. Site 2, Intertidal Reef in the Wash

The second was an intertidal reef in the Wash, exposed only at extreme low spring tides. This allowed the reef to be seen and the reef features measured directly. The 'lander' was then deployed at previously chosen and hand surveyed locations on the following high tide.

Figure 4: Pilot Site 2, Intertidal Reef in the Wash exposed at extreme low spring tides. This site was particularly useful since the reef could be seen and the reef features measured directly. The lander was deployed at chosen locations on the following high tide.

The second survey was less conclusive. The reefs appeared patchy. In general, estimates of cover at low tide ranged from about 5% to 25% cover with patches of reefs being relatively small (compared to the previous site) and were maximally 15cm above the level of the sand. The tubes were based on gravel, pebble and sand and there were no sand waves. Thus, the target size for the sonar was much smaller than for the previous site at 107.
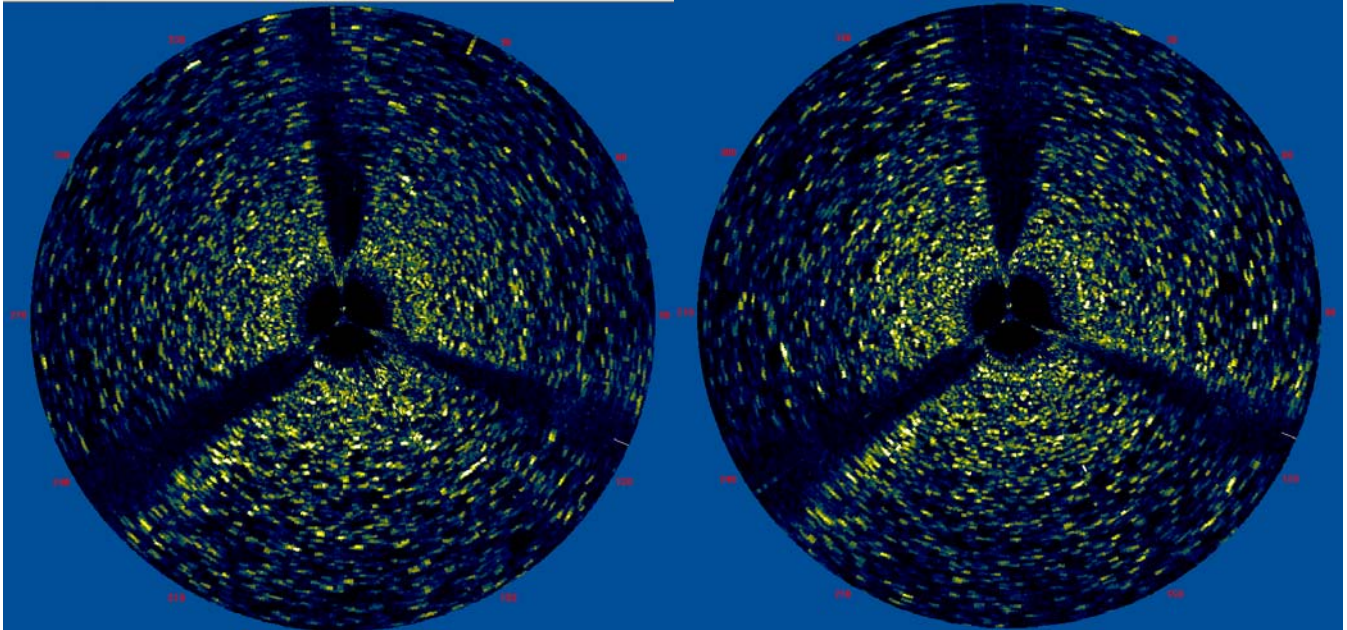
Figure 5: Images from Site 2, the intertidal reef in the Wash. Images show texture, but these are at the limit of resolution of the scanning sonar. Reefs appeared patchy and less developed than site 107, making the survey results less conclusive.

4. Recommendations

The scanning sonar images show texture, but particularly in the case of the second site, these are at the limit of resolution of the scanning sonar and suffer from the same problem that side scan images at their limit of resolution. It would seem reasonable to associate the pattern with the known reef occurrence. However, the same image might result from a number of sea bed types and it is doubtful if measurements made of heights of apparent targets based on 'shadows' cast can be regarded with any great certainty.

These techniques must be tested in a greater variety of environments to fully assess its utility for habitat mapping. Greater success may be anticipated, in areas of harder, rocky substrate, and it may be expected that the technique may have application for specific ground surveys, where high-resolution, short range, positionally very accurate information is required, e.g. for marine engineering applications, such as renewable energy construction or oil and gas work.

5. Conclusion

The system provides a means of connecting side scan image texture exactly to targets. However, the sonar is operating very close to the limit of its resolution. The features imaged using the scanning system are similar to those from side scan, but far more distinct, which obviously offers a greater chance of correct identification based on topology. The system could provide a quick method for validating side scan sonar with a very much greater certainty than other systems because of this sonar 'bridge' between video and side scan.

However, the limits to resolution of even this system become apparent if the reef is low lying. The same source of uncertainty arises as we remain unsure that the texture features really are

related to reef-like structures. Even if it is reasonable to assume this to be the case where reef is known to occur through ground truth sampling, the texture pattern cannot be used to detect reef without adequate ground truthing. The images still cannot be interpreted on their own, and conclusions as to their biogenic origin could not legitimately be made without the supplementary video data collected.

6. Acknowledgements