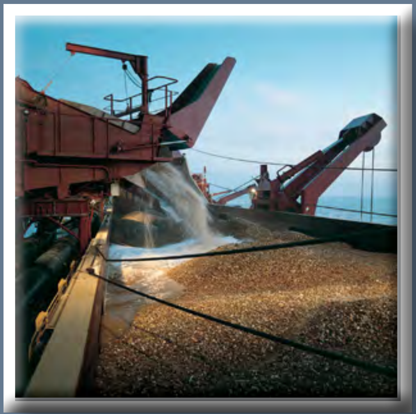
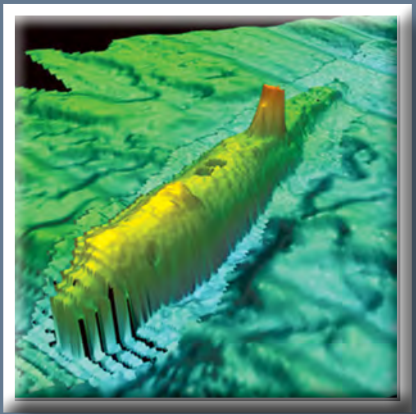
Marine
Aggregate Levy
Sustainability Fund
MALSF

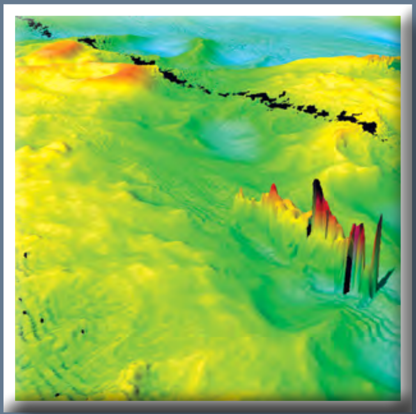
Developing new ground truthing techniques for seabed mapping

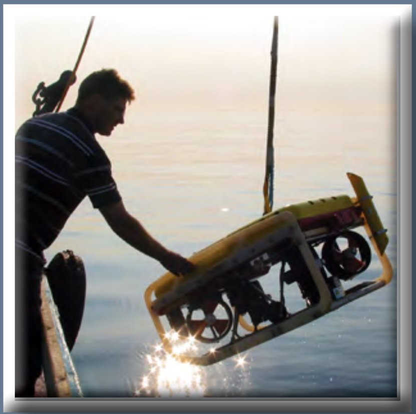
MEPF Ref No: **MEPF 08/64**

Project Date: **February 2010**









Marine Aggregate Levy Sustainability Fund MALSF

Marine Aggregate Sustainability Levy Fund (MASLF)

Final report

“Developing new ground truthing techniques for seabed mapping”

MEPF Ref No – MEPF/08/64

01 August 2008 – 28 February 2010

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This work was funded by the **Marine Aggregate Sustainability Fund** (MALSF) and commissioned by **the Marine Environment Protection Fund** (MEPF).

Background to the fund

In 2002 the Government imposed a levy on all primary aggregates production (including marine aggregates) to reflect the environmental costs of winning these materials. A proportion of the revenue generated was used to provide a source of funding for research aimed at minimising the effects of aggregate production. This fund, delivered through Defra, is known as the Aggregate Levy Sustainability Fund (ALSF); **marine** is one element of the fund.

Governance

The Defra-chaired MALSF Steering Group develops the commissioning strategy and oversees the delivery arrangements of the Fund.

Delivery Partners

The Marine ALSF is currently administered by two Delivery partners -
the **MEPF** (based at Cefas, Lowestoft) and **English Heritage**.

Contents

1 Executive summary

1. The purpose of the project was to develop a towed video sledge combined with low altitude sidescan system to obtain concurrent visual samples of the seafloor and high resolution acoustic images. It is intended that such a device would bridge the gap between standard sidescan survey and ground truth sampling. The specifications for the device were that the technology would be inexpensive, easy to use, deployable from small vessels and operate in depths of at least 30m.
2. A system has been designed meeting these specifications that has been termed a **c**amera and **l**ow **al**titude **s**ide**s**can (CLASS) device. It consisted of a sledge with sidescan trailing 1.3m above the sea floor from an attachment on the sledge towing cable. Bullet cameras were attached close to the sea floor for viewing in low visibility. A StarFish 450kHz chirp sidescan was connected to the surface using a local area network and the transducer unit was rendered slightly positively buoyant and directionally stable by attaching it to a fish with tail fins and net floats.

3. The design went through a series of tests and modifications. The final design of the sledge was small and light-weight and easily constructed from aluminium sheet and threaded steel bars.
4. The CLASS device was trialled in areas known to have supported reef created by the Ross worm *Sabellaria spinulosa*, including the licensed aggregate extraction site Area 107. The device obtained acoustic and video images of the sea floor in all but the strongest tidal currents. However, the device performed best (in terms of directional stability and maintenance of a constant altitude) as a sledge towed on the sea floor in conditions of low currents. With moderate currents the system worked well with the sledge acting as a depressor flown slightly above (but in occasional contact with) the sea floor. The slightly higher sidescan altitude of 3 metres resulted in a marginal reduction in the resolution of small targets.
5. The sidescan deployed at low altitude could detect small sea floor features under 10cm high, such as sand ripples and erosion features in sediment consolidated by faunal turf, worm tubes and also sea grass. However, no well defined Ross worm reef was observed and the system has not been tested against the full range of biogenic reef.
6. It is considered that the CLASS device would find a use in targeted surveys where it is desirable to describe and map habitats and habitat boundary characteristics in fine detail. Another potential use might be for marine archaeological survey where a potential area of small, dispersed targets (such as wreckage) has been located but needs fine scale investigation.

2 Background

Features of conservation interest on sand and gravel areas of the seabed are difficult to survey with a high degree of confidence due to the limitations of standard acoustic survey techniques. Remote survey techniques, such as sidescan sonar, are reported to deliver high resolution images capable of detecting and discriminating biogenic and cobble habitats. However, recent studies (MAL008: “Best methods for identifying and evaluating biogenic and cobbly reefs” collaborative project between CEFAS, Envision and JNCC) have shown that many of the features associated with these habitats (such as agglomerations of the Ross worm *Sabellaria spinulosa*) lie at or beyond the limit of resolution depending upon the nature of the surrounding seabed. Whilst it is possible that reefs may be discriminated against a background of sand, it is by no means certain that they will be discriminated against mixed sand, gravel and pebbles. Indeed, the experience from the MAL008 project was that many sidescan images that appeared to indicate reefs actually contained very little reef (as observed by video ground truthing devices). The features assumed to be reef turned out to be sand waves and gravel streaks.

Higher resolution acoustic images might help to improve detection of fine scale features. Detection of features and discrimination between habitats using sidescan sonar relies on being able to discern patterns in backscatter strength as seen in the images. Backscatter strength is affected by fine scale topography of the features and particularly acoustic shadows cast behind upstanding objects. Resolution can be improved by deploying the systems close to the seabed and reducing the range (increasing the sampling density across the swath). Low altitude will also result in a low grazing angle and this will increase the variation in backscatter strength caused by fine scale topography. The lower grazing angle will also increase the likelihood that small features will cast shadows from which feature heights can be calculated.

However, even if resolution can be improved it is likely that confirmation by direct observation will remain a recommendation for survey. Ground truthing can be effectively carried out over moderate distance by towed video, but this is dependent upon water clarity and has a restricted coverage. It is also difficult to co-locate video pictures and sidescan images with high precision. The need for precise location of video observations within the acoustic images was stressed in the MAL008 project report. Unless this is achieved, there will always be uncertainty if the features observed in the acoustic images and sampled by ground truthing are one and the same. This makes it difficult to assess the extent, coverage (patchiness) and degree of development (height above surrounding seafloor) of many habitats. Without this critical information many habitats cannot be completely assessed.

An attempt was made in the MAL008 project to overcome some of these technical problems by deploying a scanning sonar on a tripod lander with bullet cameras attached. This was successful in giving high resolution images and co-located video records. However, the device needed to remain stationary on the seabed for at least one rotation of the scanning head (approximately 30 seconds) before the device could be lifted. Thus, it sampled only a small area and it also proved difficult to operate in tidal currents. Nevertheless, the experienced showed that a short range sidescan technique deployed close to the sea floor and coupled to video may provide the basis for a system that effectively bridges the gap between remote sensing and ground truthing. In order to make it easy to refer to such a system in the following text, it will be termed a camera and low altitude sidescan (CLASS) device.

3 Design of the CLASS ground truthing device

The proposal for the MEPF-64 project was to develop a towed system in contact with the seafloor that was a combination of video and sidescan sonar in order to bridge this gap between conventional acoustic remote sensing and ground truthing. The sledge would be equipped with video capable of being adapted for use in a range of water conditions from poor to good visibility.

In addition to the technical issues that need to be overcome, it was considered important that the final product was inexpensive, required the minimum of technical expertise to operate and was easy to deploy from small vessels. This would ensure that the device was accessible to a wide range of organisations. However, these important additional requirements could potentially place limitations on the design and performance of the device.

3.1 The video system

CCTV bullet camera video systems were chosen for deployment on the sledge because they are inexpensive enough to be considered sacrificial: A definite advantage for deployment close to the seafloor.

The bullet cameras (Model 37CSHR-LED) were purchased from RF Concepts (http://www.rfconcepts.co.uk/cctv%20cameras.htm). They are contained in a small (approximately 10cm x 3cm) but very robust brass housing with glass port and are rated as being fully submersible to 50m. The cameras have inbuilt LED lights and in some deployments these were disconnected so that oblique lighting from a separate source could be used. Although the images are not of the highest quality, they give 500 TV lines with good colour balance in low light conditions and an excellent depth of focus: characteristics which are sufficient for ground truthing features. (N.B., It is unlikely that the benefits of high definition video would be seen in conditions of poor visibility).

The bullet cameras were positioned so that they were close to the seafloor (10-15 cm) when the sledge was in contact with the sediment and this had the potential for obtaining visual confirmation of the substratum in poor visibility.

The video was recorded on a mini tape recorder on the surface. More than one camera can be fitted to the sledge and both images recorded using a splitter at the surface. The purpose of using more than one camera was to increase coverage in low visibility.

The mini tape recorder displays elapsed time and the GPS start time was noted in order to synchronise the video and the sidescan. The video is also time-stamped by the recorder and this can be set to GPS time. However, real time cannot be displayed and the time stamp is lost converting to DVD format without the use of video MP4 converter software.

3.2 The sonar system

The trials of sidescan sonar in the MAL008 project towed the fish at a minimum altitude of 6m above the sea floor, which was considered to be reasonably safe for standard survey deployment. Based on the results, it was considered that a much lower altitude would be required (Figure 1).

3.2.1 Arrangement for deployment of the sidescan

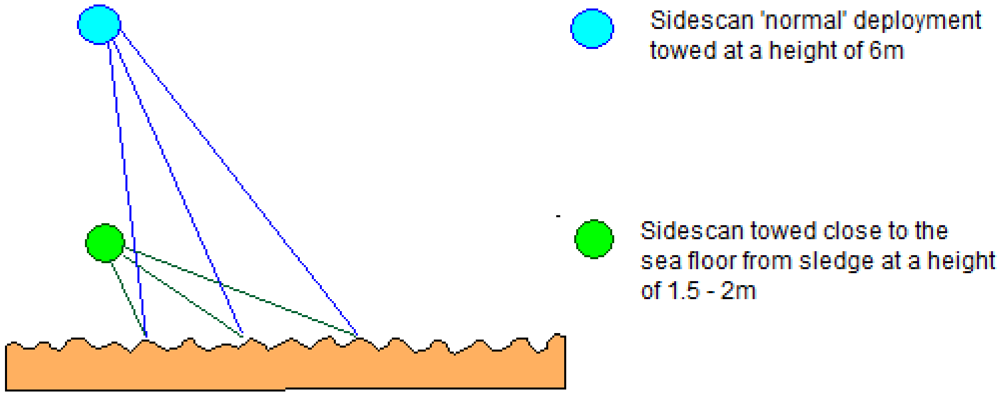

Figure 1: A deployment of a sidescan at an altitude of 1.5 – 2m would result in much smaller grazing angles than when towed at the more standard minimum height of 6m.

Towing a sidescan safely at this altitude requires a specially designed system. Different methods were considered, including fixing the sidescan rigidly to a sledge at the required height. However, this might have created problems for deployment and have resulted in a very jerky image.

The method chosen was to trail the sidescan from the sledge's towing cable at the desired height above the seafloor. This was deemed to have the advantages of simplicity of design and compactness of the sledge, the dampening effect of the sidescan umbilical to counteract the movement of the sledge and the ability to alter the towing altitude easily by changing the point of attachment to the tow cable.

The sidescan fish needed to be made buoyant in a balanced fashion so that it towed horizontally but did not sink and make contact with the seafloor at very slow tow speeds. Trials with a scale model of a 'fish' showed that slight positive buoyancy, but with the nose dipping, provided the best configuration: the fish was pulled down to the correct altitude and then followed the sledge as towing continued and floated safely above the sea floor when the sledge came to rest.

3.2.2 Selection of sidescan system

It was the intention at the outset of the project to design the system around a traditional sidescan sonar fish but at the low cost end of the market. The system also needed to be rated to operating depths of at least 30m and have sufficient cable for towing at this depth (at least 3x water depth). Suppliers were contacted and the following offered suitable products that were within the target price range of £4-6,000: TriTech (Seaking

Towfish either 675 or 325 kHz); Hydro Products (Imaginex Sportscan dual frequency 330/800 kHz); JW Fisher (SSS-100/600K) and GeoAcoustics (159D). All are supplied with umbilicals of up to 120m.

A new product became known to us: the StarFish digital chirp sidescan (http://www.starfishsonar.com/technology/starfish.htm). This is small (378mm long) and light (1.2kg in sea water) and is very inexpensive (about £2700 including Scanline software). It has an operating frequency of 430 – 470 kHz chirp and the body is sealed in a rubber casing and it depth rated to 50m.

However, the StarFish connects to a computer via a USB connection and is only supplied with 20m of cable – not enough to operate the system at the desired 30m. On discussion with Bill Meadows (CEFAS) it was thought that this might be overcome using local area networking and it was decided that the StarFish would be the sidescan of first choice given its other advantages.

3.2.3 Networking

The StarFish Top Box was linked to a USB network hub and both were contained in a water proof housing. Power was supplied to the system from the surface. A 120m network cable was connected to a wireless router on the surface which transferred the data to a laptop.

3.2.4 The sidescan ‘fish’ assembly

The light weight of the StarFish considerably reduced the engineering required to transform it into a positively buoyant fish. A 1m aluminium tube (1cm diameter) was inserted through a selection of net floats to achieve positive buoyancy. The tube had stabilising fins at the rear and a shackle at the forward end. The body of the StarFish was drilled through the thick rubber case and attached via two aluminium plates to the aluminium tube. Thus, the sidescan was rigidly fixed in-line with the tube. The buoyancy of the completed assemblage was adjusted using small lead weights so that it floated nose-down.

3.2.5 Depth and heading sensors

It was considered at the design stage that yawing of the sidescan with respect to the direction of tow could potentially degrade the quality of the images. In order to measure the heading of the sidescan a heading/depth sensor was mounted in a waterproof housing in-line with the fish, positioned above the sidescan. This provided useful data during the testing phase of the construction of the device and showed that, as long as the sledge is towed into tidal currents, the sidescan maintained a constant heading that was more or less the same as the direction of tow. It is not proposed that these sensors are a required part of the design and the sensors were removed in the final design.

3.3 Design of the sledge

Two different designs were used during the project. The first was conceived at the outset of the project based on preconceptions of how the whole system would be operated and its behaviour. The second design took shape towards the end of the project and was based on the experience of the field trials. Both designs were based on the general layout of the components as shown in Figure 2.

The first design: The sledge was designed to be very stable on the sea floor and to be able to take counteract lift from the towing cable. It was conceived as having one leading runner and two stabilising runners at the rear. This arrangement combined stability with ease of leading the sledge around tight turns at the end of straight runs. It was constructed from 2.5 inch steel tube bent to shape the runners and welded. The sledge had extra weights on the runners and floats on the top of the sledge to improve handling (Figure 3). The whole sledge weighed 30kg in air.

The frame had many positions from which the video could be attached, and the underwater housing for the network hub and top side box could be securely and safely stowed under the protection of the top of the frame.

The cables to and from the sidescan and cameras are fastened to the rope with tape at 1 metre intervals.

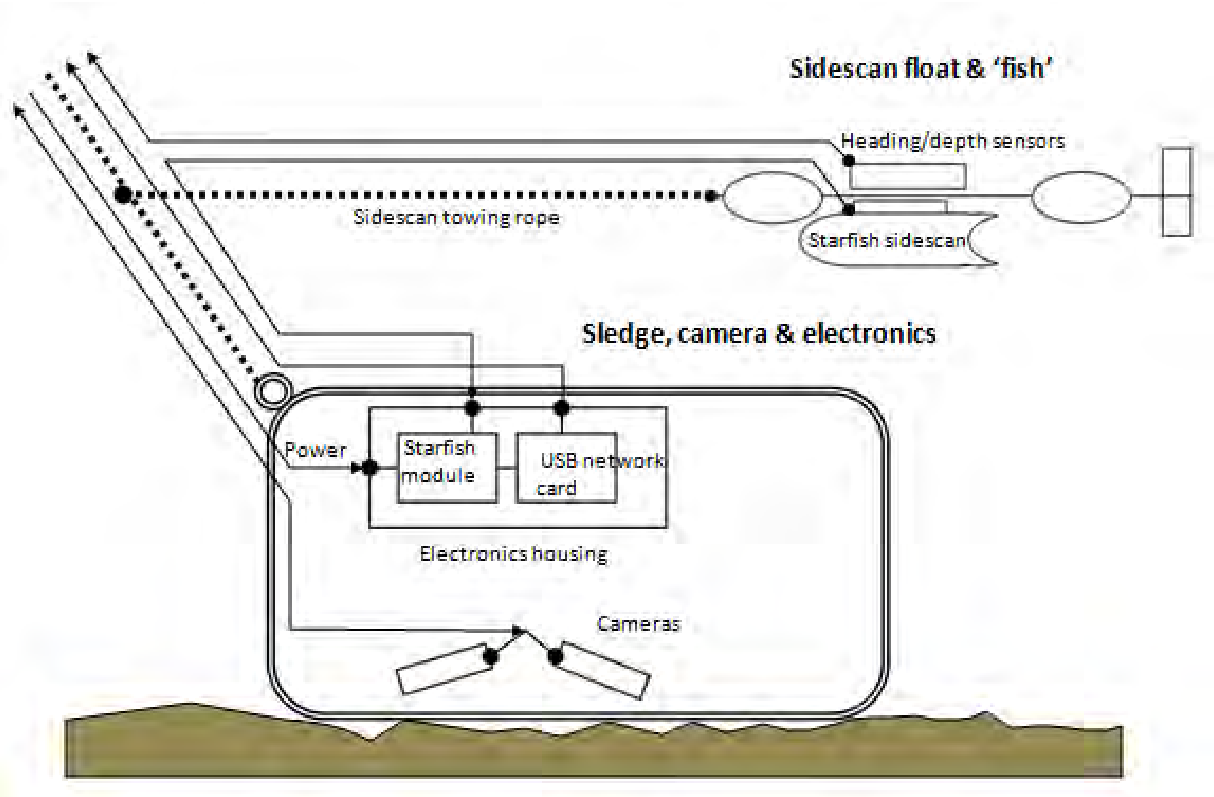

Figure 2: General assembly of the components of the CLASS ground truthing device.

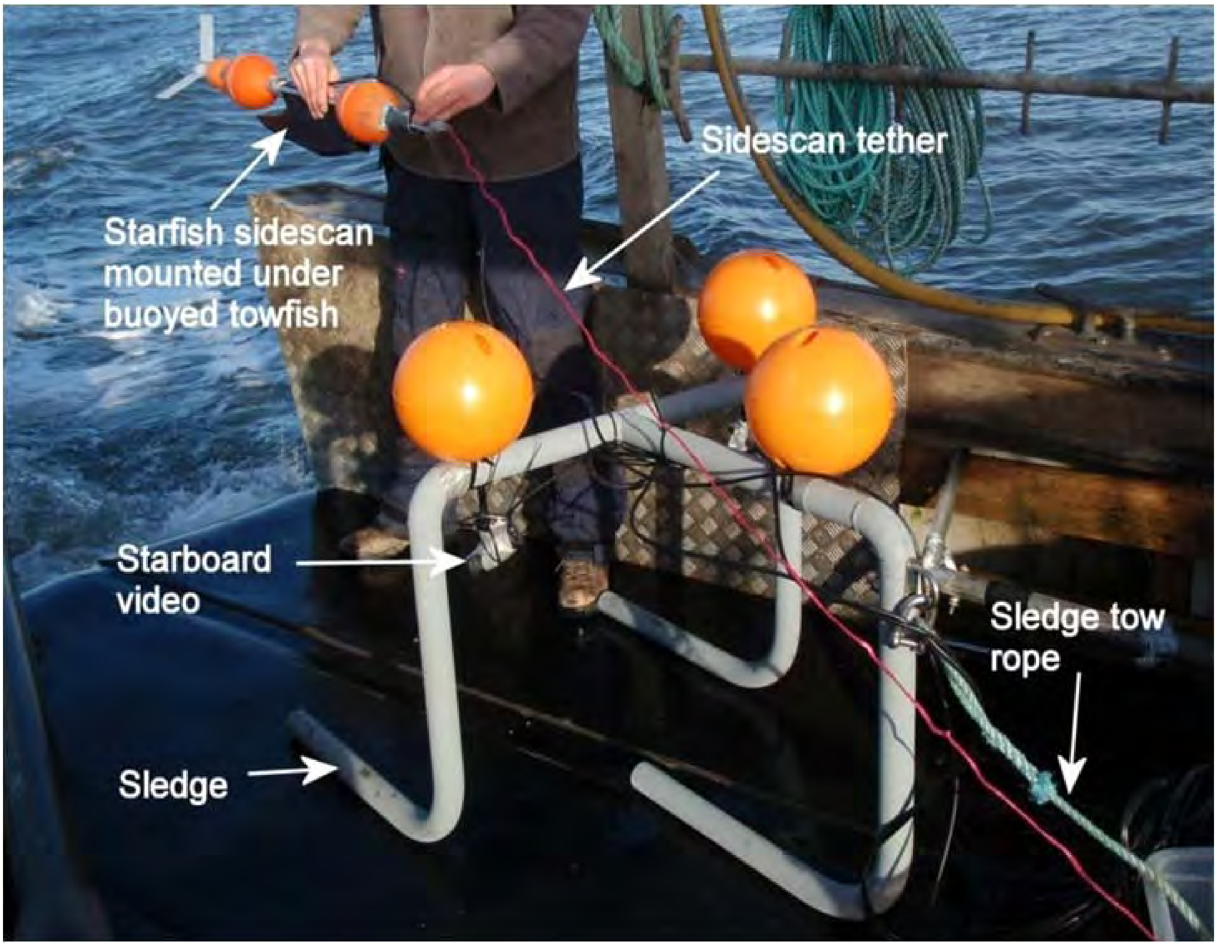

Figure 3: The first design of the sledge undergoing trials showing the arrangement of the major components.

The second design: The experience of using the first sledge in high tidal currents (discussed in more detail in Section 4) showed that the performance (sidescan image quality and direction of tow) improved if the sledge was towed at a speed such that it lifted clear of the sea floor. This suggested an alternative design for a sledge that acted as a depressor could be towed either just above the seafloor or in occasional contact with it. This second sledge was much smaller and lighter than the first. It was manufactured from 3mm thick aluminium sheet that was bent into shape and strengthened by threaded steel rods bolted to the aluminium with alcathene tube spacers over the rods (Figures 4 and 5). The sledge was given added protection from the substratum by alcathene tubing runners. The sledge was big enough to contain the underwater housing for the StarFish top box and hub and the video cameras, but small enough to be handled easily by one person.

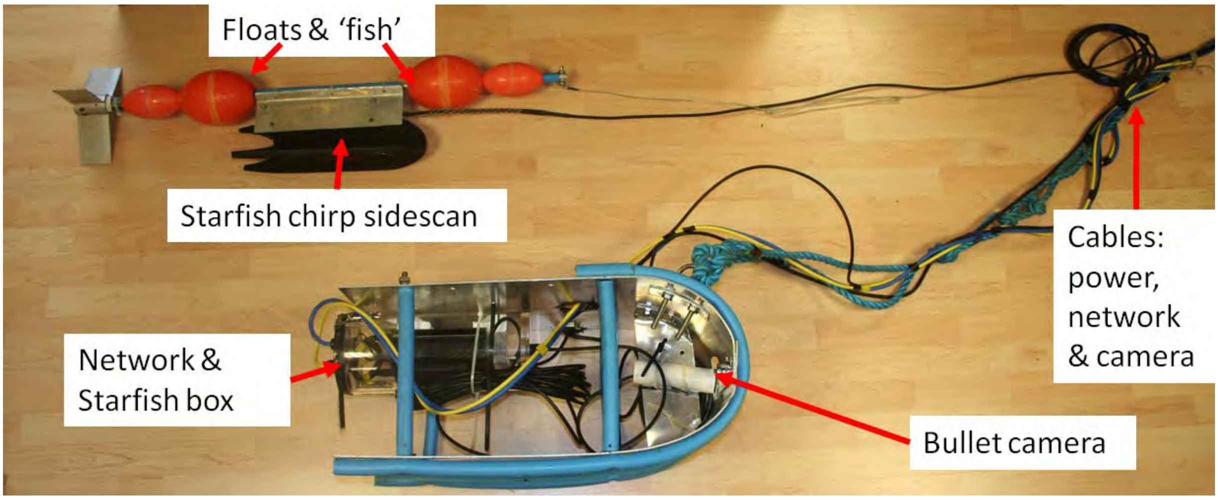

Figure 4: The second design was much more compact and easily handled. The sledge is about 60cm long, 50 cm wide and 30cm deep.

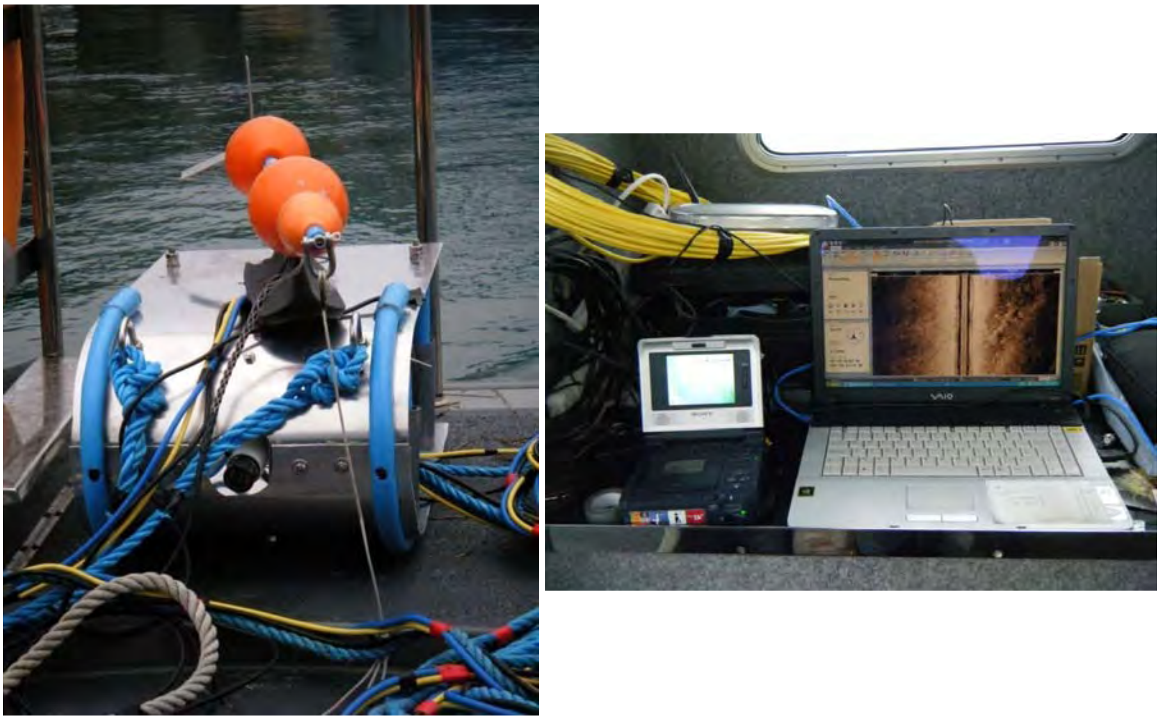

Figure 5: The second design (left) being tested at Lyme Bay. The lap top is running the Scaline data acquisition software and the mini DV tape recorder is to the left.

4 Results and discussion of the outputs from the sea trials

The device was tested during the development phase off the Northumberland coast (near to Envision premises) in work-up trials and modifications made between December 2008 and July 2009. These trials proved that the sledge and sidescan could be deployed satisfactorily and that the images obtained from the sidescan were of good quality.

The full trials were conducted in Wash and its environs at two sites (Figure 6): The first was the licensed aggregate dredging site Area 107. This site was selected because of its history of records of *Sabellaria spinulosa* reefs. The second site was located north of Lynn Knock. This site was close to the boundary of the Wash and North Norfolk Coast SAC and also has records of reefs. The purpose was to test the system's ability to detect features associated with reef habitats. The trials were conducted on spring tides in order that the sledge could be tested in adverse conditions.

The opportunity also arose to test the device on sea grass beds in Studland Bay, Dorset.

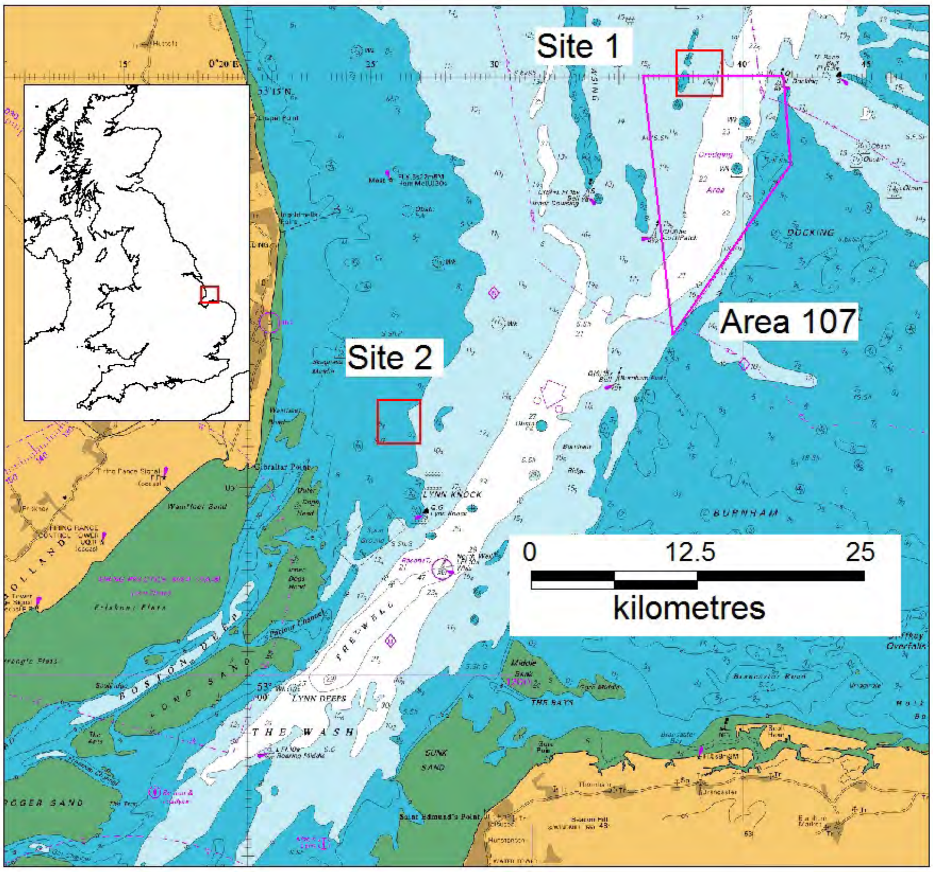

Figure 6: The location of the two sites selected for the full trials of the CLASS ground truthing device.

4.1 Performance trials of the system during the work-up phase

Scaline (the software provided with StarFish for capture and display of the data) is very easy to use but has limited functionality. The data are displayed as a waterfall image and no slant range corrections or TVG can be applied. The data are stored and can be replayed and snapshots taken of the display. No mosaicing is possible within Scaline. The files are in xtf format (e**X**tended **T**riton **F**ormat) and these require specialist software for further manipulation.

Despite these limitations, the images are good and the information is sufficient for real-time survey. Figure 7 shows a snapshot of the Scaline display from the work-up trials. The ranges are clearly marked on the display and the altitude profile shown below the waterfall display (Depth Plotter). This reading accords well with the central water column in the display indicating that the automatic bottom detection works well.

The nature of the sea floor was sandy with ripples (as observed on the video) and occasional rocky outcrops. The ripples are clearly seen on the display. The illustration also shows that the sidescan was maintained at a constant altitude of about 1.3m.

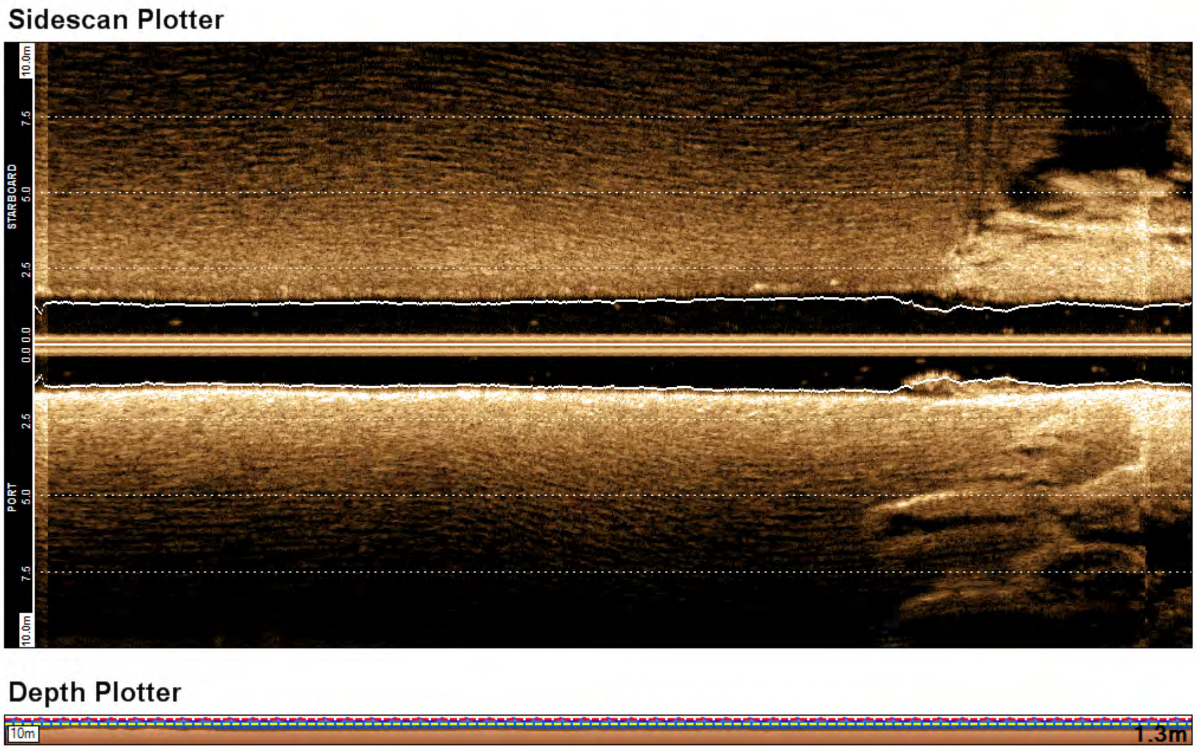

Figure 7: A snapshot from Scaline of rippled sand and rocky reef from the testing area off the Northumberland coast.

Successive images can be exported and merged into continuous images, although this is somewhat laborious. Figure 8 shows a longer section of the data towed at a constant altitude from the sledge compared with the sidescan deployed in the more usual mode towed free (not from the sledge) behind the boat. It is clear that short range (and, consequently, best resolution) is only possible when towed from the sledge since a greater range must be selected to obtain images from the seafloor when towed in normal mode in deep water. The images also show that the images from the normal tow were more irregular as the motion of the boat was transferred to the sidescan. It was apparent from the trials that the sledge acted in such a way as to damp the motion of the boat and smooth the passage of the sidescan through the water. This was something as a surprise as we thought that towing from the sledge would create a jerky motion.

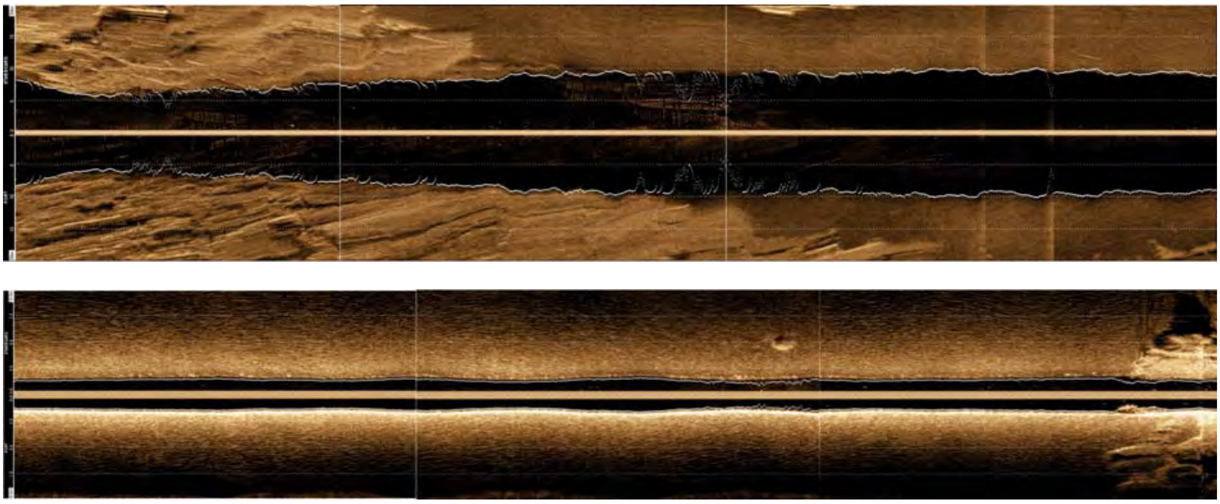

Figure 8: Examples of images obtained on the sand and reef testing ground. Top: sidescan deployed normally (i.e., trailing behind the boat with the sledge). Lower: sidescan deployed attached to the tow rope of the sledge.

The trials tested the resolution of the ripples at different range settings (6m and 10m). A section of the images equivalent to a 5 x 5m area of the sea floor has been displayed at the same scale (Figure 9). Also included for comparison is an equivalent area taken from images obtained with the sidescan towed in normal mode.

Figure 9: 5m x 5m sections of rippled sand with an altitude of 1.3m and a range of 6m (left) and 10m (middle) and with the sidescan deployed normally and a range of 20m (right).

The difference in resolution between the ranges 6m and 10m is not marked. The resolution of the image with the sidescan deployed normally is greatly reduced. It was concluded that deep towing was the critical factor determining resolution and that the system had the potential to produce high quality images by ensuring the sidescan was towed smoothly at a constant, low altitude.

4.2 Trials at Area 107and Lynn Knock

Although only the waterfall display was observed during the trials at sea, it was considered that geo-referencing and mosaicing the images would give a more complete assessment of the performance of the system. In order to do this, the xtf files were processed in Chesapeake Technologies SonarWiz sonar processing software package. All the images shown in this section have been post-processed.

The conditions were very testing for the CLASS device with very strong tidal currents. In the strongest tides it was not possible to tow the sledge against the current and make any headway. Towing with the current resulted in very fast tow speeds and this was also unsatisfactory. However, it was usually possible to deploy the sledge an hour either side of slack water so that the sledge was in visual contact with the sea floor. The underwater visibility was exceptionally good during the trials and, whilst this certainly helped characterise the sea floor, it did not put the low visibility potential of the bullet cameras to the test.

However, the CLASS device was used during the stronger tidal currents and this proved to be a valuable experience. The sledge was lifted clear of the sea floor and acted as a depressor for the sidescan. The acoustic images obtained were of reasonable quality although the altitude was about 6m and the range set at 20m.

Figure 9 is a mosaic of the tracks with the sledge towed at about 6m from the northern margin of Area 107 (boundary in red). The relict tracks from the dredging can be seen in the lower left quarter of the image running northeast-southwest. Figure 10 (left) is one of the tracks showing the grainy texture of the ground associated with these marks. Figure 10 (right) also shows the track when the sidescan was towed at the lower altitude of 1.3m superimposed. To accommodate the grey scales of both images, they underlying track is much lighter in tone than the superposed track. The extra detail of the topography is quite marked with small features running northwest-southeast across the larger features. These smaller topographic features are approximately 10cm high.

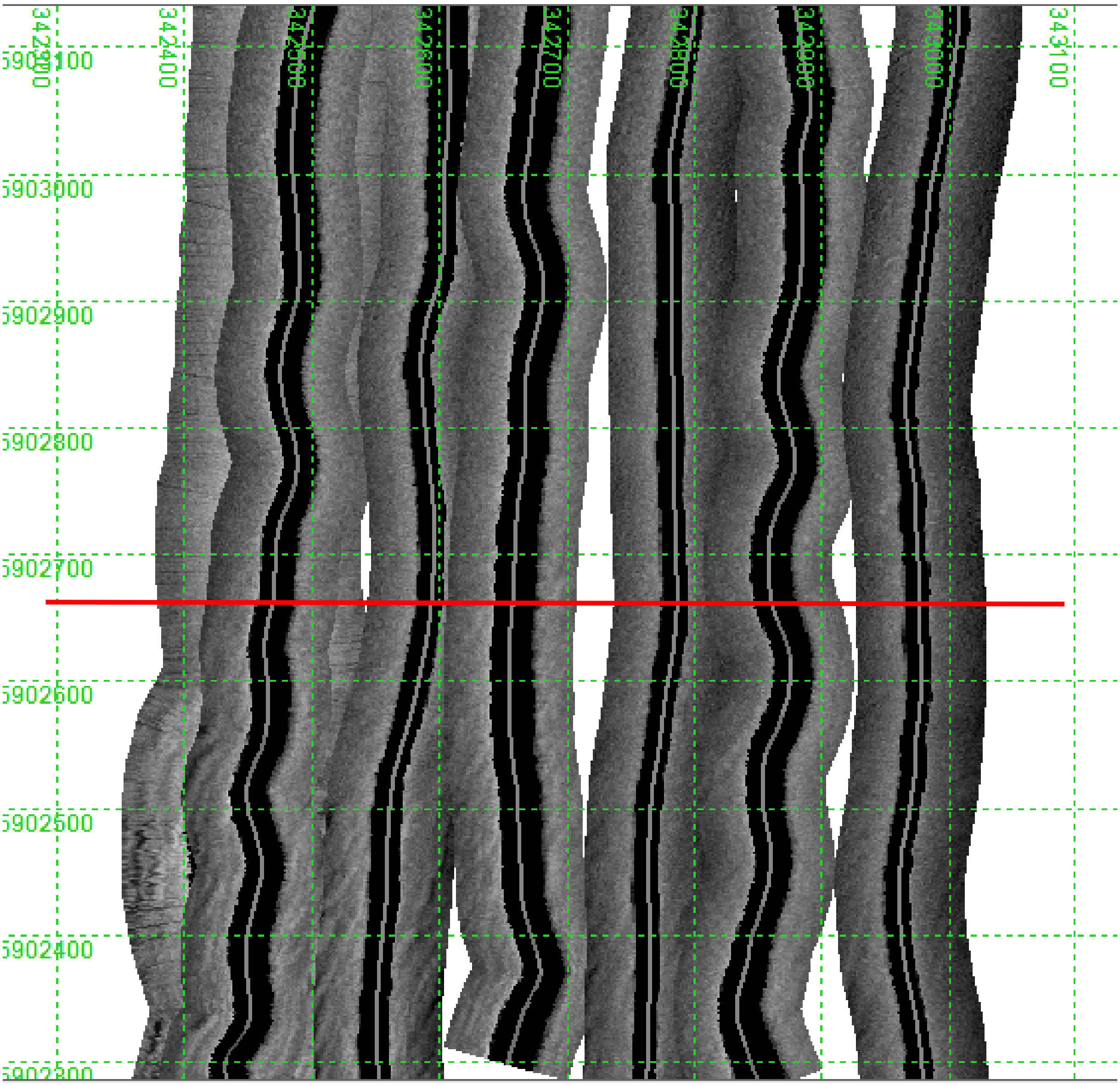

Figure 10: Sidescan mosaic of tracks (altitude 6m) spanning the northern boundary of Area 107 (red line) with well defined dredge tracks in the lower left quarter.

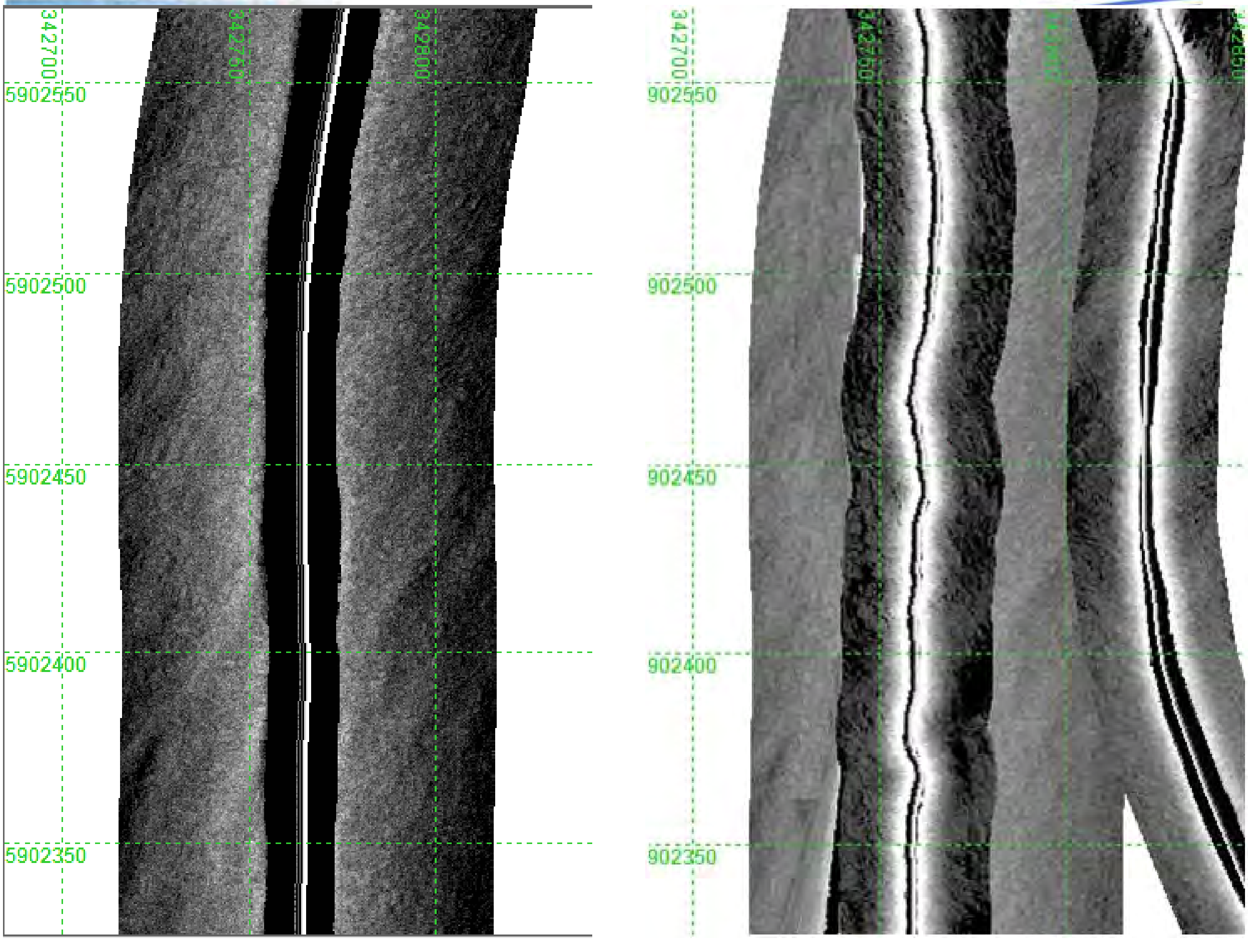

Figure 11: Left: section of track (altitude 6m). Right, same track overlain with higher resolution sidescan tracks (altitude of 1.3m).

Video of this ground reveals a gently undulating sea floor with the shallow crests and dips running northeast-southwest. There were also smaller features of the order of 5 - 10cm high (Figure 12). Some were clearly small agglomerations worm tubes or eroded tubes and sediment. Faunal turf was generally abundant. However, there was no very well developed reef and the exact nature of the smaller features in Figure 10 is hard to determine from the video. It is possible that they were created by a combination of the tubes and erosion features together with growths of faunal turf. It seems improbable that the sparse agglomerations of tube alone could explain the density of features on the sidescan images.

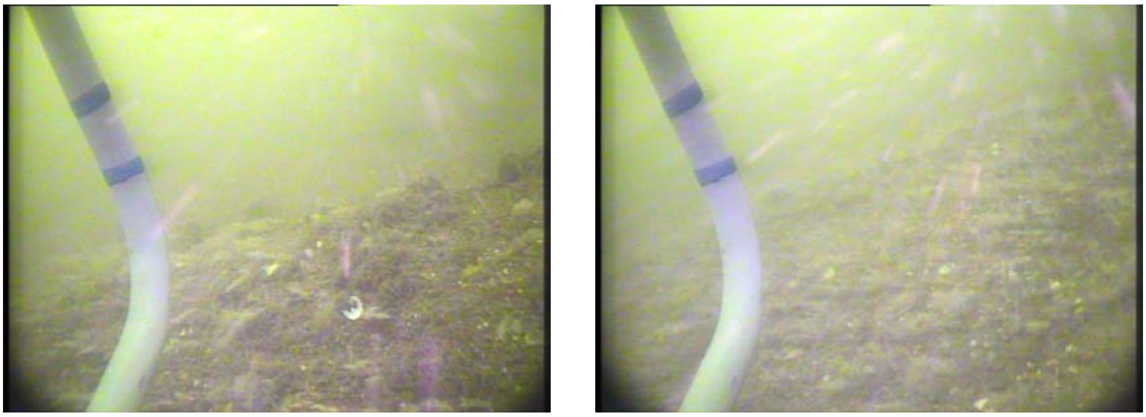

Figure 12: Frame grabs from video from Area 107. The black marks on the sledge frame are 10cm apart.

The area of Lynn Knock was generally flatter than Area 107 and, although small agglomerations of worm tubes were seen, the predominant life form was a dense faunal turf with large branching sponges, hydroids, bryozoans and soft corals (Figure 13).

The site at Lynn Knock was also strongly affected by tidal currents and the transects were run at different stages of the tide with (1) the sledge on the sea floor and the sidescan at an altitude of 1.3m and (2) the sledge towed slightly above the sea floor and sidescan at an altitude of 2.5 - 3m. Figure 14 shows an example of tracks nominally of the same area. Towing the sledge in contact with the sea floor and with the sidescan at an altitude of 1.3m resulted in a course that weaved around the intended track, due to the effect of the tides. By contrast the course was much more easily maintained with the sledge flying just off the sea floor and the sidescan at approximately 3m.

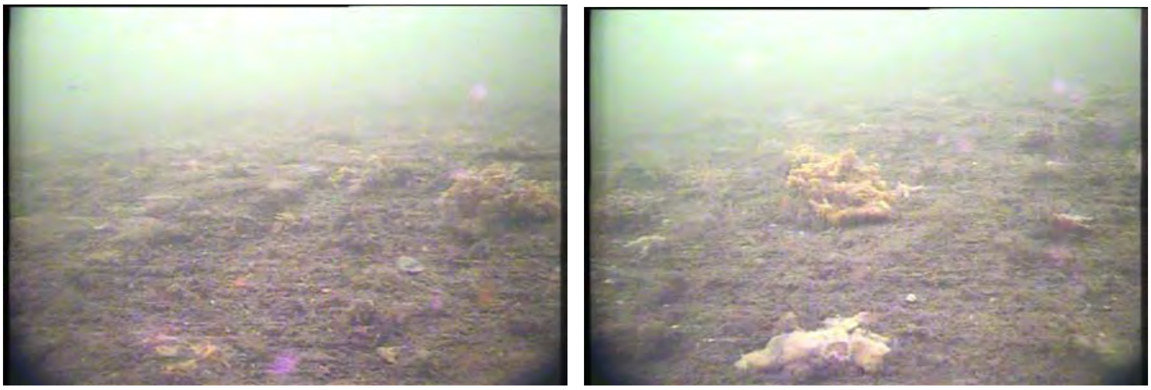

Figure 13: Frame grabs from video from Lynn Knock site.

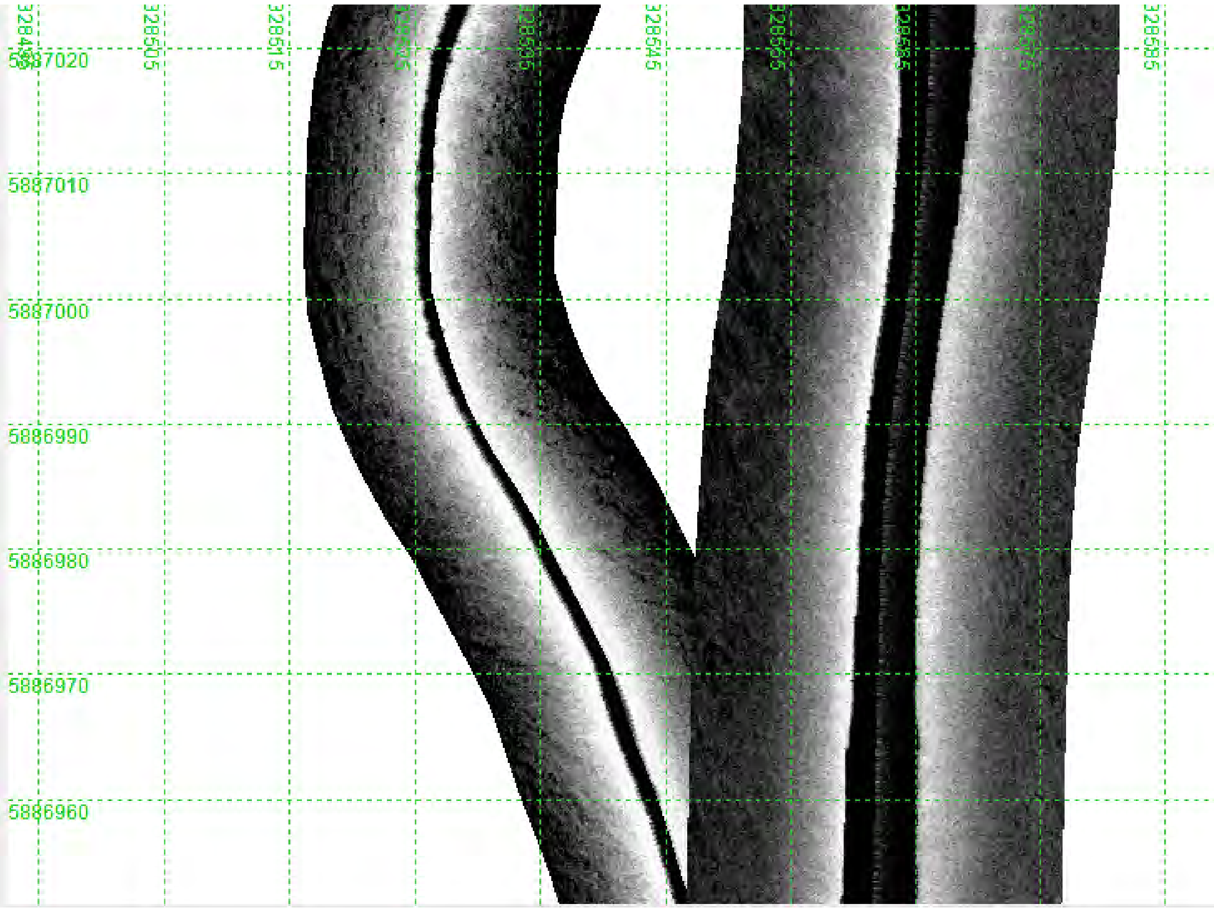

Figure 14: Track altitude 3m overlain on track altitude 1.3m.

The images obtained at the lower altitude did not reveal much more about the fine scale topographic features than for the higher altitude, which is in contrast to the experience with Area 107.

4.3 Trials at Studland Bay

The second design for the sledge was stimulated by the experience from the full trials in Area 107 and Lynn Knock. The opportunity to test this second design arose from a survey conducted over sea grass in Studland Bay, Dorset. Although a very different habitat from those associated with aggregate extraction sites, the purpose of the survey was to test fine scale techniques for mapping small features.

The image in Figure 15 has been taken from one of the transects across the sea grass bed and shows small sandy clearings in the sea grass meadows.

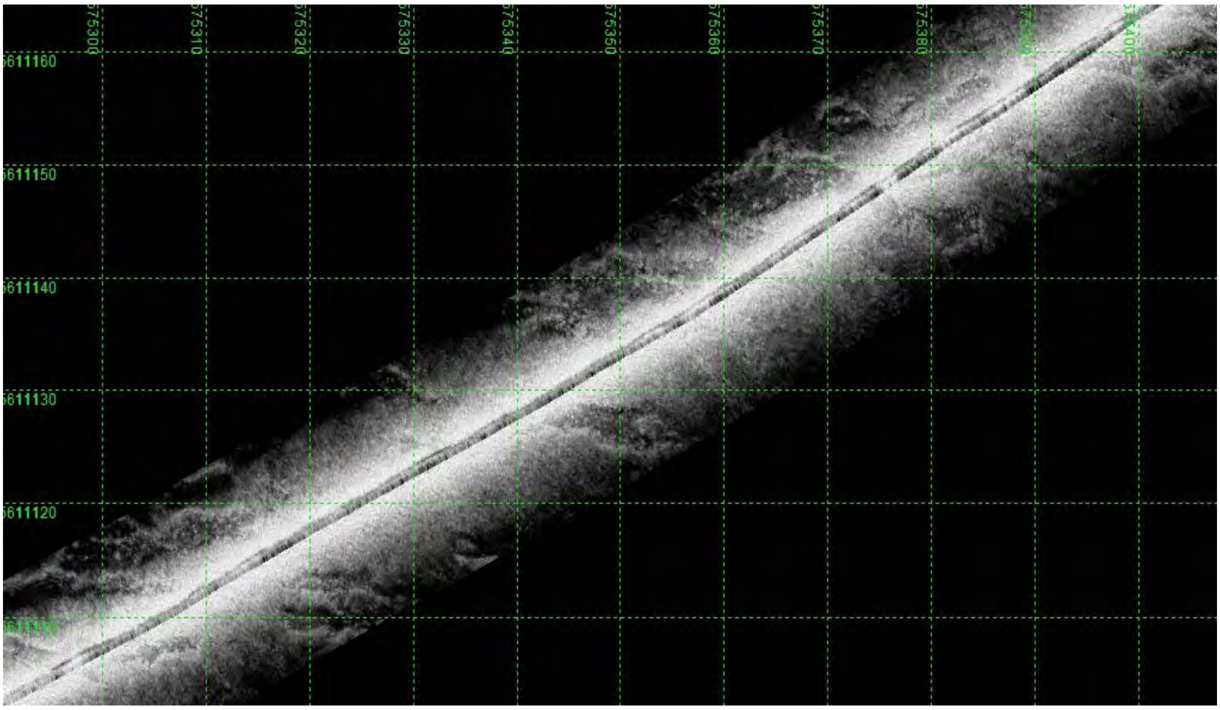

Figure 15: Sea grass meadows at Studland Bay, Dorset. Sidescan deployed at 1.3m.

5 Conclusions and project appraisal

The project can be appraised on two levels: Firstly, technical performance (was the design successful in towing a sidescan at very low altitude and obtaining coincident video images of the seafloor?) and secondly, information delivery and targter detection (did the system obtain information that was useful for assessing habitats – particularly biogenic reefs?).

5.1 Technical performance

The CLASS device met the specifications as set out in the proposal: the components of the system were inexpensive and the whole device was relatively easy to assemble. The sledge and sidescan were easy to handle on a small vessel (especially the second design of the sledge). Also, the sidescan data were easily displayed using Scanline without the need for extensive post-processing and this was sufficient to show fine scale topographic features at high resolution. However, if full georeferencing and mosaicing of the images is a requirement, then there will be a significant additional cost of suitable software that can manipulate xtf files.

In low tidal currents the arrangement of attaching the sidescan from the sledge tow cable damped the movement of the sidescan and the resulting images were generally free from distortion due to jerky movement. However, maintaining a constant heading of the sledge and sidescan was more problematic in faster tidal currents. The system worked better with the sledge flying slightly above the sea floor (acting as a depressor for the sidescan).

Thus, there are two ways in which the system could be deployed: (1) as a sledge in contact with the sea floor and (2) as a depressor that is capable of being towed very close to the sea floor or in occasional contact with it.

The bullet cameras obtain images of sufficient quality to identify features. However, the system suffers from an inherent problem with all sidescan sonar in that the high grazing angle close to nadir means that feature definition is poor in the near range (0m -2m). This would mean that the video, located close to nadir, could not validate targets within the optimal working range of the sidescan (2m – 10m at low altitude) unless visibility was exceptional. This means that the system as designed can only validate ground that is assumed to be homogeneous over at least 2m. This would be acceptable for many habitats but might present issues if the precise nature of small patches needed to be described and mapped.

5.2 Information delivery and target detection

Although no specific target was specified in the proposal as a yardstick against which to measure success in terms of information gained from the use of the system, the primary target was biogenic reef (the Ross worm *Sabellaria spinulosa*). Descriptions of reef vary considerably (see the MAL008 report for a summary of the literature) ranging from small isolated agglomerations to reefs tens of centimetres proud of the sea floor. Reef appears to grow on cobble substrata, but also may grow directly on sand waves. Thus, there is no single structure for reef and the potential variety of shapes and sizes of reef targets and background substrata presents problems when assessing the capability of any technique for detecting reef.

Unfortunately, reefs were not strongly developed at either of the sites within the Wash. Instead, the ground was flat or gently undulating with more or less well developed faunal turf. The homogeneous sea floor meant that no boundaries of singular targets presented themselves that could have acted as a calibration.

Nevertheless, despite the variable nature of the finescale features and the lack of unequivocal reef, the sidescan appears to respond to small features associated with reef habitats. Clearly, no system could detect reef unless the targets were very different in structure from the surrounding substratum.

Other images showed that the system could detect sand ripples (low but linearly extensive features) and boundaries between sea grass and sand.

5.3 Potential use

Low altitude sidescan combined with video could be used to investigate anomalies and targets identified from standard sidescan or bathymetric surveys. The ability to respond to the targets in the same way as the standard sidescan, but at higher resolution and with greater ability to form true cast shadows, would enhance the description of the features. Simultaneous video would confirm the nature of the features. However, there are limitations to this due to the lower powers of discrimination at the nadir of the sidescan. Thus, the features would need to be regularly distributed within a search area or to form boundaries between habitats or conspicuous singular feature, such as wreck debris. It is unlikely to be useful for detecting and distinguishing small singular features (such as very isolated agglomerations of worm tubes).

The system can be deployed in a systematic search pattern around a target and this might find applications for archaeological use. It is also possible that spaced transect lines could be used to characterise and map the extent of a particular habitat boundary.

It is unlikely that the system would be deployed as a broad scale mapping technique since the towing speeds are restrictive. Also, whilst the system is relatively robust and can withstand contact with the sea floor, it would be liable to be damaged or lost if it came into contact with substantial structures. Deployment in an area that had previously been surveyed by conventional sidescan or a swath bathymetric system would be recommended to ensure that large obstacles are avoided.

In summary, the system would make a useful addition to the techniques available for ground truthing conventional acoustic survey since it bridges the gap between remote sensing and towed video. The system is inexpensive, easy to assemble and use. It is not, therefore, a specialist technique but could find broad use in the survey field.

5.4 Future development

The device has been operated at depths of up to 27m. It is possible that greater depths could be achieved with modifications to the networking system, assuming that the depth rating of the StarFish is conservative at 30m.

The low visibility performance of the system has not been tested due to the exceptional visibility encountered on all surveys. However, experience with bullet cameras leads us to believe that the system has applications in low visibility environments. Experimentation with the positioning of the cameras could find the optimum lighting and height of the cameras above the seafloor for this purpose.

A robust sledge with the facility to accommodate instrumentation would also lend itself for experimentation with other sensors.

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