British Geological Survey
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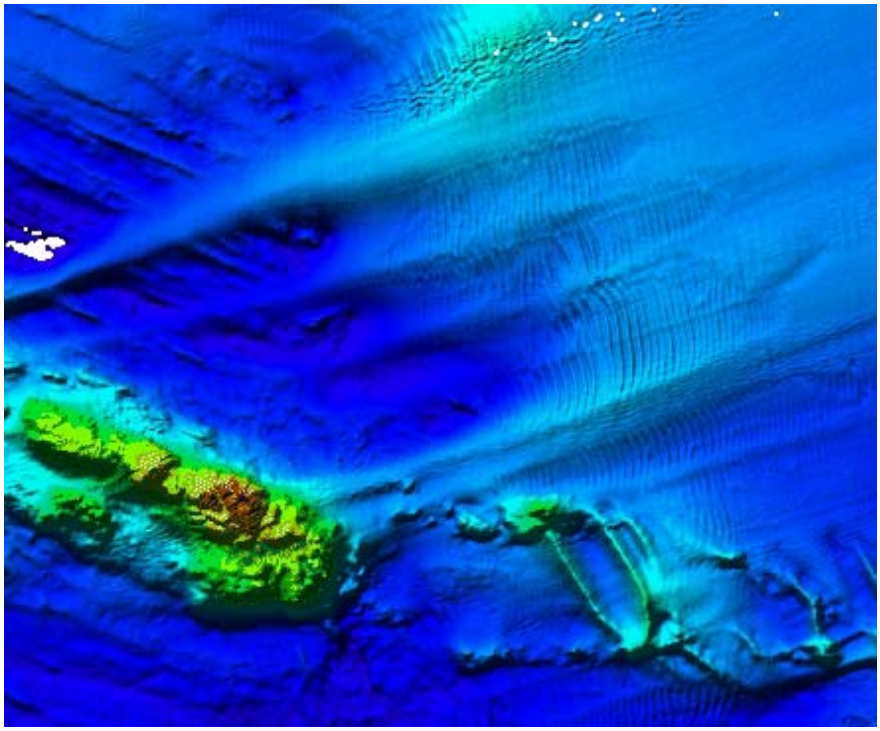
Operations Report - BGS Project 03/03
Marine Geophysics Survey 2003
RV Prince Madog

Outer Bristol Channel Marine Habitat Study

Coastal Geoscience and Global Change Programme

Internal Report IR/04/012



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BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT IR/04/012

Operations Report - BGS Project 03/03 Marine Geophysics Survey 2003 Outer Bristol Channel

D. J. Smith

Coastal Geoscience and Global Change Programme

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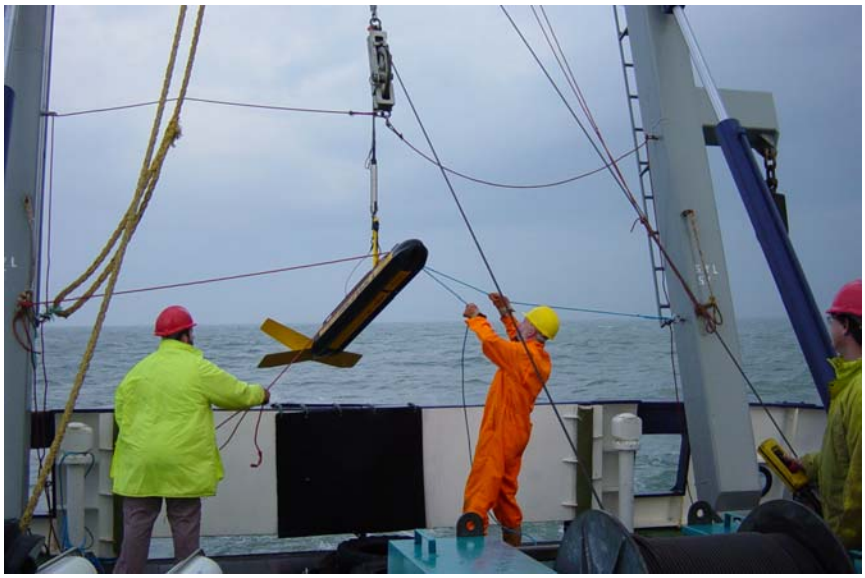

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Multibeam bathymetry, Horseshoe rocks

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Foreword

This report covers the operation of RV Prince Madog, BGS Project 03/03, a marine geophysical survey in the Outer Bristol Channel, carried out from 29th October to 15th November 2003. This field operation is the first project carried out by the BGS with high-resolution multibeam bathymetry. This cruise was undertaken for the Outer Bristol Channel Marine Habitat Study, which is funded by the Aggregate Levy Sustainability Fund For Wales (administered by the Welsh Assembly Government) and the Sustainable Land Won and Marine Dredged Aggregate Minerals Programme of ODPM (administered by MIRO) with a contribution from the Crown Estate and BMAPA.

Acknowledgements

As with any offshore work programme, this project was a team effort, with each and every person playing their full part in the continuous 24 hour operations. A full list of the BGS personnel taking part is included in the report and their contribution to the success of the operation is hereby acknowledged. Grateful thanks are also due to Captains Steve Duckworth and Alun Price, the other officers and crew of the RV Prince Madog, the technical support provided by the University on Bangor and Vosper Thornycroft, for their efforts and assistance to make this an efficient and smooth operation. Thanks also to Dave Wallis and Alister Skinner for the report review and Ceri James for the 'Introduction'.

Contents

Summary

This report describes the operation for BGS Project 03/03, managed and run by BGS Marine Operations and Engineering. The report covers the mobilisation on the 30th October, the geophysical survey and the demobilisation on the 14th November 2004. The main objective of the survey was to provide baseline physical and geological data for the sustainable development of sea-bed resources. This survey is part of a larger BGS project 'The Outer Bristol Channel Marine Habitat Study'

The operational aims of the survey project were:

- To carry out a planned programme of 100% data coverage for 11 corridors, 1km wide of multibeam and sidescan sonar
- Additional run the centre line for each corridor with surface tow boomer
- Map any interesting features found during the survey

The geophysical techniques employed were high-resolution multibeam bathymetry, high-resolution sidescan sonar and single channel seismic reflection, (surface tow boomer). All systems were digitally recorded. This is the first time BGS has mobilised a high-resolution multibeam bathymetry system for one project and the first time BGS has used a high speed, high-resolution SSS system.

The vessel used was the RV Prince Madog. This platform proved reliable and fuel-efficient. Laboratory space was adapted to provide adequate area. An over the side pole mounted multibeam transducer produced good data collected in marginal weather conditions, the data suffering slightly from pole vibrations. Poor line steerage proved to be a concern and reduced the efficiency of the survey.

The poor weather played a large part in the survey, which both confirmed the concerns of the Party Chief at the planning stage of carrying out an operation in the Outer Bristol Channel at this time of year and put added pressure on all aspects of the survey.

Despite weather and technical problems encountered over 1500 km of multibeam, over 500 km of SSS and 38 km of surface tow boomer data were collected. It must be noted that without the multibeam being able to collect data in very marginal weather conditions this survey would not have been successful as even with this capability the survey suffered from 16% weather down time.

Thanks must be given to the officers, crew and survey personnel who kept going despite being thrown around for days on end.

1 Introduction

The British Geological Survey Project 03/03 was a marine geophysical survey (multibeam, sidescan sonar and seismic reflection) across the Outer Bristol Channel. This survey was part of a marine habitat, biodiversity and geodiversity survey in the outer Bristol Channel, providing baseline physical, geological and biological data for the sustainable development of sea-bed resources and provide information and input into the planning and regulatory process with regard to marine conservation

The overall aim of the project is to integrate geological and biological information gathered through geophysical and benthic surveys into a comprehensive interpretation of marine habitats. The study is designed to incorporate new survey data gathered through modern techniques with the historical records held in the archives of the National Museum of Wales and the British Geological Survey and other organisations. The final outputs will produce detailed bedform, sediment and faunal distributions, and interpretations. The results will be disseminated through interactive multimedia applications, public exhibition and forums, and publications.

Pressure on marine resources in the Bristol Channel continue to develop with a number of issues including aggregates, fisheries and wind farm developments. There are also legislative obligations with regard to marine conservation, in a European context with the *Habitats Directive* and in national initiatives such as the designation of Carmarthen Bay, the Pembrokeshire Coast and Lundy as candidate Special Areas of Conservation. Within this framework the Welsh Assembly Government under section 121 of the Government of Wales Act 1998 has a duty to promote sustainable development in the exercise of its functions and this includes its obligations within the marine environment.

To inform the policy and decision making process in terms of developments in the marine environment requires knowledge of its current physical state. This includes the morphology, geology, biology and sediments of the sea-bed. Baseline information on these is essential for strategic management and the conservation of biological diversity. Responsible stewardship requires an understanding of the way the marine environment functions and how the sea may respond to human activity. It also means involving stakeholders as an integral part of policy making.

The project has been designed to supply up-to-date, robust, and independent science for the policy making process — as well as providing information, through innovative media, to the public at large as stakeholders in the marine environment

This report only deals with the operation for the marine geophysical survey conducted between 30th October and 14th November 2003.

2 Narrative

All times are GMT.

2.1.1 Mobilisation

The mobilisation on board the RV Prince Madog took place on the 30th October at the home berth of the vessel, the town pier Menai Bridge.

The pier lies at the end of 40m+ of gangway, the first 20m on the same level as the road. The last 20m of the gangway pivoted with the height of the tide, as the pier was a floating pontoon.

All equipment had to be transported to the vessel via this gangway. The main form of transport was via a small trailer towed by an electric tractor unit. An efficient system was set up by the vessel to move equipment from the shore to the vessel, though this did increase the anticipated time to load the vessel.

RV Prince Madog
at home berth,
Menai Bridge
Anglesey, N.Wales

After deck of RV Prince Madog showing some of the over the side survey equipment

The majority of survey equipment was mounted in the Wet Lab as this gave easy access and viewing of the after deck and there was insufficient available space in the Dry Lab to mount all the systems. The Dry Lab was used for the surface tow boomer's HV power supply and by the geologist for geological interpretation.

2.1.2 Survey

31st October: The vessel sailed from Menai Bridge on 31st after the mulitbeam transducer, the MP-X sidescan sonar (SSS) and the surface tow boomer had been wet tested. The multibeam motion sensor was successfully calibrated just off the pier by the vessel performing several figures of eight. The intention was to transit to the lee side of Great Orme and mount the multibeam pole on the side of the vessel in calm water. Unfortunately the pole could not be mounted as although there was shelter from the wind there was no shelter from an existing swell. The vessel transited back into the shelter of Anglesey where the pole was successfully mounted. Two lines where run to test that the multibeam and the SSS systems were functioning correctly.

At 15:00 with the pole in the horizontal position and the SSS recovered the vessel began the transit to the work area.

1st November: At 06:30 the vessel arrived at the NW corner of the survey area. The multibeam pole was deployed. This was followed by the calibration of the multibeam transducer positioning system, for pitch, roll, heave, yaw and navigation error. This was conducted over a feature on the sea bed that had a sharp profile and over an area of flat sea bed. It took several hours to find a feature on the sea bed. The line run over the feature had to be repeated exactly but on a reciprocal course and also run at different speeds in the same directions. In addition parallel lines offset from the centre line were run to calibrate yaw (3.1.2). It proved difficult for the vessel to steer both a straight line and lines that were repeatable.

By 17:00 the calibration had been completed. After the results had been processed a timing error still existed. This was eventually solved by reinstalling a previous version of the QPS acquisition software and the first survey line, (multibeam only) was started at 21:56 in a force 8, winds gusting to 47 knots. Line 1 was aborted midway along the intended line at 23:28 due to deteriorating weather and sea state. The vessel anchored in the lee of Caldey Island.

2nd November: At 08:15 the vessel weighed anchor and after an SV dip had been completed headed to the start of line 2, (where line 1 had been halted), multibeam only. During the day the swell continued to increase from the SW with wind speeds of 30 knots. By mid afternoon the weather had deteriorated further, winds gusting to 40 knots, sea state 3-4m. Line 3 was aborted part way along, with a short line 4 run on the way to shelter behind Caldey Island. The vessel was at anchor at 18:30.

3rd November: Through the night gusts up to 60 knots were recorded while at anchor in the most sheltered part off Caldey Island!

With winds still gusting to 38 knots at anchor, at 08:00, the vessel weighed anchor and headed for line 5, the point where line 3 had been broken off. Within minutes of weighing anchor the multibeam motion sensor failed to receive information from one of it's two dedicated GPS antennas. The failure was traced to water ingress in the connector to the antenna mounted above the bridge. With repairs successful, line 5 was started at 12:20. The MP-X SSS was deployed for the first time and data recorded. Line 6 started at 14:03 in shallow water north of Worms Head heading SW into a short steep swell and at 14:14 the SSS towing bracket failed. The SSS was successfully recovered by the safety cable, minus one tail fin with the others bent.

Later conversations with Edgetech revealed that the towing bracket for this towfish was inadequate and that there was no built-in weak link. This solved the reason why the towing bracket failed but left the project without a SSS that could be run a the same speed as the multibeam, the backup SSS unable to sensibly run at 8 knots. Edgetech immediately sent an identical towing bracket from the United States.

The survey continued with multibeam only until the start of line 10 where minor problems with the heading and attitude sensor for the multibeam delaying the start of line 7.

4th November: At 02:00, the backup Waverley Sonar 3000 SSS was deployed at the start of line 10 SW-NE with the swell. Data was successfully recorded although the vessel speed had to be reduced. The towfish was recovered at the end of the line, shallow water, before the vessel turned into the swell. The survey continued with multibeam only and after Line 11 was successfully completed in sea state 2-4m, confused sea, wind southerly 28 knots an SV dip was taken. Part way along line 13 the multibeam QPS acquisition software hung, resulting in several attempts to restart the line. The problem was traced to a corrupted grid file and the solution was to create a new grid file. Unfortunately this meant that data already collected in this corridor could not be viewed online, making it difficult to ensure that there was 100% swath coverage. This resulted in a more conservative offset being used for running the adjacent line.

On line 14 the TracC time lost sync with the GPS received time, this resulted in an error +18 minutes in the logged data positions. This error was also passed to the CODA navigation string (SSS data recorder), although the SSS was not operating at the time. The error was traced to a time when the DGPS signal jumped to 0 deg latitude and longitude. These jumps appeared to occur when the vessel took a severe roll and maybe due to the antenna being masked by the vessel's mast.

5th November: Multibeam only lines 15 to 23 were completed. The wind strengthened throughout the day from 25 to 43 knots with the wind direction moving around from S/SE to NE creating a confused sea with swells from many directions and with varying periods and height. Line 21 was aborted due to poor quality multibeam data, caused by the swell hitting the vessel on the starboard side and hence the multibeam pole. Headed south to run lines in more sheltered area.

6th November: Multibeam only lines 24 to 27 were completed by 08:23, at which point the vessel headed to Ilfracombe where the vessel's small boat picked up the spare MP-X SSS towing bracket. By midnight lines 28 to 35 were completed, although SSS was only started from line 30. The new towing bracket had been sent without a support plate and pins, fortunately the vessel's chief engineer was able to manufacture the pins and SSS operations could begin again.

7th November: In the early hours the borrowed CODA's DAT drive that was recording the SSS data began to give problems. Start recording data onto the CODA's hard drive. Despite worsening weather throughout the day, wind increasing from 33 knots at 10:00 to 45 knots by 18:00 and confused sea, lines 36 to 45 were completed, though SSS data collection was terminated after line 38.

8th November: 00:18, in deteriorating sea conditions at the end of line 46 the survey was suspended. The vessel proceeded to shelter north of 'Worms Head'. At 07:30 the vessel weighed anchor, wind 25 knots in lee of 'Worm's Head'. As the vessel moved out of shelter, line 47, the wind measured 43 knots, the sea conditions deteriorating the further west from shelter. Manorbier firing range communicated that they were about to start firing in the area line 47 was due to cross at longitude of 4° 40' W. Line 47 was stopped at 4° 36' W. Line 48 was on a reciprocal course to 47, NE and into the swell. This line was abandoned after 1.3 km poor data on the multibeam transducer. It was decided to head to the southern part of the survey area and hopefully more sheltered water. Line 49 was run across the survey area at 130 deg, towards Ilfracombe. Line 50, dir SE (corridor 3) with the swell was OK. Tried reciprocal course into the swell after line 50, multibeam data too noisy. Headed around east side of Lundy to line 51 dir NE (corridor 2). Multibeam acquisition hung after approximately 9km, resulting in loss of access to corridor 2 database and unable to view data already collected on this corridor. Adjustments to line spacing had to be made so that 100% swath coverage was achieved. 20:00 wind 30 knots gusting 40 knots. 20:44 line 52, dir SW (corridor 3). Complete line 22:38 and transit around Lundy on the sheltered west side to run line 53 (the most southerly line on corridor 1), wind 25-30 knots, the most sheltered part of the survey area!

9th November: Completed line 53 at 02:05 at the NE end of corridor 1. A series of short lines (54 to 61) over Horseshoe Rocks were completed, line 61 included SSS. Line 62 was run NE perpendicular to lines 54-61 across the top of Horseshoe Rocks. 11:50 after an SV dip the SSS was deployed and line 63, dir SW (corridor 6) was run. 12:30 the multibeam data acquisition system hung resulting in the loss of 1280m of data. Line 64 and 65 (corridor 7) were completed and line 66 started.

10th November: Line 66 and 67 were completed with equipment recovered and secured by 02:30. Transit to Milford Haven for port call, tied up Milford Haven 06:55. Resupply vessel and crew change. Receive DVD recorder for Coda and install, start back up of a Coda hard drive to DVD. TSS motion sensor installed for multibeam system to provide a check of the performance of the POS MV motion sensor.

11th November: 06:38 leave Milford haven dock, 07:30 multibeam POS MV failed, continue to proceed to calibration site at NE of survey area to calibrate newly installed TSS motion sensor. 08:00 Castle Martin firing range inform vessel that they are about to start firing in the area of calibration site, turn vessel and head west. POS MV still down, head back to Milford Haven to await Applanix engineer. 15:46 POS PV processor replaced and multibeam system fully functioning. Forecast SE gales, captain advises against leaving the shelter of Milford Haven. Vessel anchors at the mouth of the Milford Haven for the night, wind 20-25 knots.

12th November: 05:45 raise anchor, permission from Milford Haven Port Authority to run line 68 inside estuary to calibrate TSS motion sensor. Transit to survey area and complete SV dip and deploy SSS prior to start of line 69, dir N. The priority now is to complete corridor 6 with multibeam and SSS and fill in the gaps of missing multibeam data. Weather sunny, large following swell, 1-2 m seas, wind 15-20 knots. 17:00 Forecast for gales later, which by 18:20 had changed to forecasting severe gale 9. Completed full coverage of corridor 6 with the last line (74) of the survey. Survey shortened by 16 hours due to weather forecast. At 22:30 all equipment had been secured with the multibeam pole brought to the horizontal position. Transit to Menai Bridge.

13th November: Transit to Menai Bridge, dock Menai Bridge at 16:00 after multibeam pole had been recovered to deck. Proceed to demob vessel, limited help from crew.

2.1.3 Demobilisation

The vessel tied up at Menai Bridge at 16:00 on the 13th November. The demobilisation of the vessel took place on the 13th and 14th of November. All light equipment was unloaded between 16:00 and 20:00, the heavy equipment unloaded between 08:00 and 10:00 on the 14th. All BGS staff left the vessel that day and returned to Edinburgh.

3 Equipment Used

3.1 MULTIBEAM BATHYMETRY

The multibeam system comprised of:

- Multibeam transducer - Reson Seabat 8101, pole mounted
- Multibeam power supply and transceiver – Reson 81-P, inboard
- Acquisition system - Quinsy7 QPS software
- QC and post processing system - Caris Hips and Sips offline

- Motion sensor - Applanix POS MV 320
- Motion sensor - TSS DMS-05 (QC for POS MV)
- SV Probe – Navitronics SVP15
- Differential GPS corrections – BGS Trimble NT300D receiver
- Over the side pole for transducer – manufactured and provided by vessel manager's, Vosper Thornycroft

The multibeam facility was provided by Netsurveys Ltd. Netsurveys do not own any multibeam systems or motion sensors and as such had in turn hired this equipment. Netsurvey did not wish to be involved in the installation of the transducer on the vessel, (pole or hull mounting) or insuring the equipment. In addition to the hired in equipment Netsurvey provided the acquisition, post processing and QC software plus two engineers to mobilise/demobilise and operate the multibeam system.

3.1.1 Transducer mounting

The vessel had an existing over the side pole to mount their Simrad HPR transducer. However it was known that this pole suffered from severe vibrations at speeds above 4 knots. Discussions prior to the survey between, BGS, Vosper Thornycroft, Bangor University and a local fabricator, were carried out to find a method of mounting a multibeam transducer on the vessel. The solution implemented was to use the existing pole and mounting position, to shorten and strengthen the pole and mount a support bracket at the water line. Trials were conducted on different methods to reduce vibration induced in the pole, the final version involved adding a tear drop shape to the pole from the water line to the transducer end.

A sub bracket to interface between the pole and the Reson transducer head had been manufactured by Bangor University, so it was a simple procedure to fit the transducer.

The pole and transducer were then wet tested but not mounted into the launch position. The captain decided it would be sensible to fit the pole while at sea and this was attempted off Llandudno. However the sea state was too rough for safe deployment and the vessel returned to Menai Bridge where the pole was mounted on the side of the vessel just off the pier. Several lines were run in the Menai Straits to test the functionality of the multibeam. However as the vessel can transit at a higher speed with the pole not in the water, the pole was raised and left in the horizontal position on passage to the survey area. As the multibeam could only be calibrated with the pole down and calibration is lost if the pole is raised, this meant that the calibration could not be carried out until the survey area.

3.1.2 Multibeam and motion sensor calibration

The POS MV motion sensor was calibrated as the vessel left the pier at Menai Bridge. This was a simple process of the vessel performing a series of figures of eight.

Pitch, roll, navigation error, static yaw and heave were calibrated. The procedure and sequences in which this was carried out is detailed in the 'Netsurvey Multibeam Report NSP040'. In practical term this required the transducer and the hence vessel has to transit along a course and reciprocal course over a flat sea bed to calibrate out roll errors. For navigation error run the same line, same course, twice at different speeds over a feature that has a sharp change/vertical height, usually found on wrecks. For pitch run a line and reciprocal line over a feature and for yaw two parallel lines offset from the centre of the feature and at a distance where the feature is at the outer extremities of the transducer beam range. The vessel than has to run the reciprocal course lines within an accuracy of 1m off track. Several features identified on the admiralty charts proved not

to have large enough features. Calibration was eventually performed over a rock out crop that had a large linear feature. The orientation of the feature meant that the vessel had to run lines NW and SE across the swell and tide. The vessel had great difficulty in running lines to the accuracy required. Setting up and calibration of the system took approximately 12 hours.

With the calibration completed there was still an artefact produced by a timing error between the transceiver of the Reson and the QPS acquisition software QiNSY 7.0 which could not be accounted for. Reinstalling a previous version of the QPS software solved the problem.

To maintain calibration, the pole was not raised until the end of the survey. This caused some concern at the port call at Milford Haven, however this was achieved without incident.

3.1.3 Operation

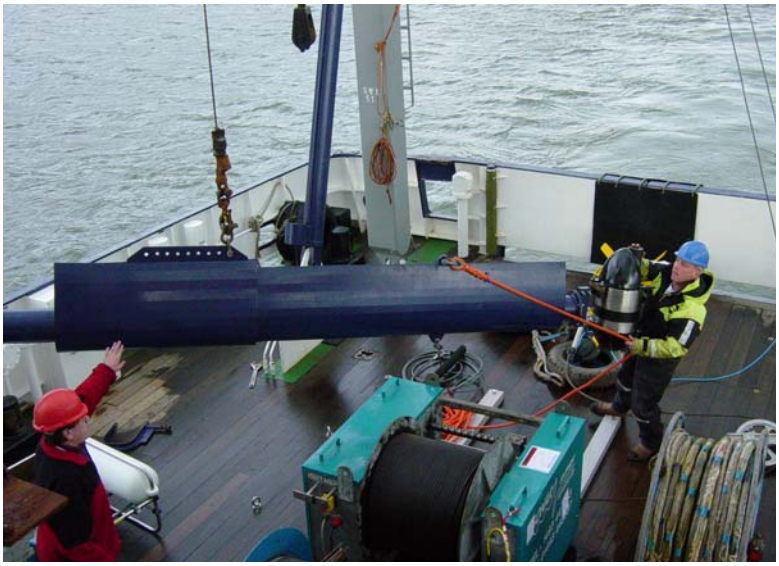
Overall the multibeam system performed very well and in some situations the survey was suspended due to the vessel not being able to handle the weather as opposed to the multibeam. Although the multibeam performed in poor weather conditions compromises were made with the quality, which BGS accepted in order to collect data in the continuing poor weather conditions.

Periodic checks were made of sound velocity of the water column. This was achieved by using a sound velocity probe.

The multibeam engineers were able to clean and process most of the data collected during the survey. This was achieved using Caris Hips and Sips on a separate processor in the spare time online and during weather down time.

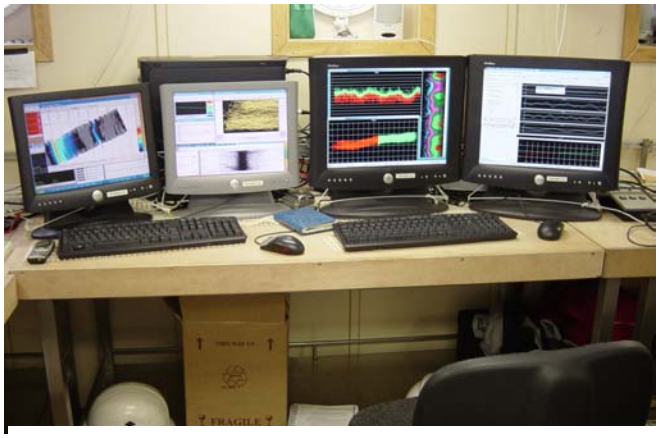
There were a few operational failures with the QPS acquisition system and the POS MV motion sensor. The QPS hung several times resulting in both loss of data and corrupting the database with the consequence that the data already collected could not be viewed on line. As the vessel was unable to steer straight lines it was impossible to predict the data coverage without viewing existing data, this resulted in running a less efficient line spacing to ensure 100% data coverage. The POS MV failed twice, each time there were no spares to fix the problems. The first failure was caused by water entering one of the GPS antenna connectors. As there were no spares BGS assisted in reworking the failed connector. Connectors are the chief cause of the majority of failures in this type of operation and this type of spare should be part of the equipment that is mobilised for a job. The second failure was at board level inside the POS MV processor, and without either a spare set of boards or a complete spare processor this failure could not have been rectified.

Before modification

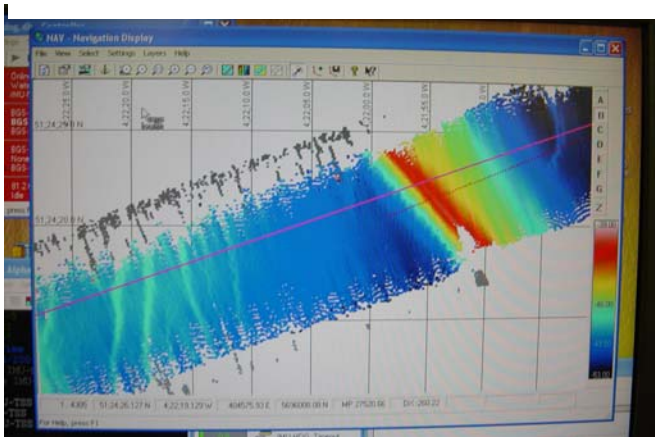


After modification

Reson 8101 Transducer

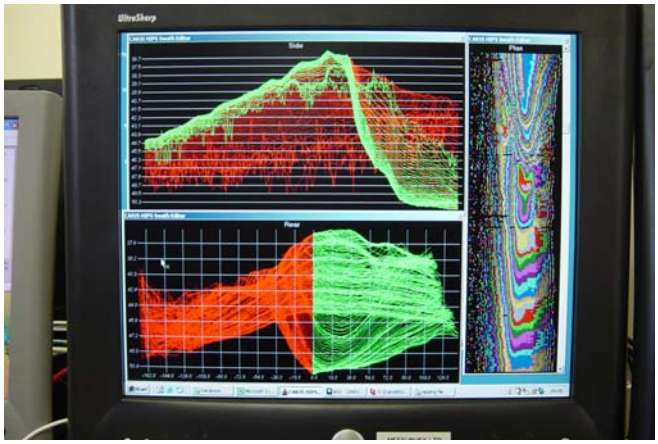


QPS Acquisition & Caris post processing/QA

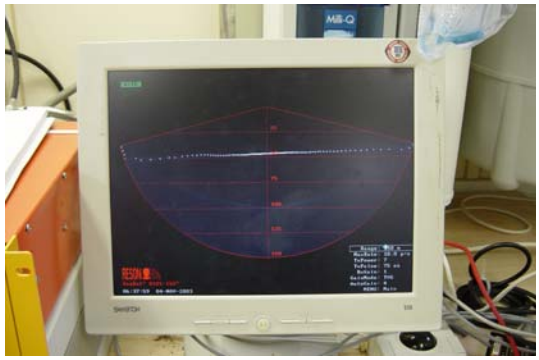


Online display of multibeam data

POS MV motion sensor



Caris Hips data cleaning display



GPS correction, POS MV processor and Reson transceiver and processor

3.2 SIDESCAN SONAR – EDGETECH MP-X

The Sidescan Sonar system comprised of:

Towfish - Edgetech MP-X

Winch & Cable – SES electric winch and slipring and 1000m of armoured co-axial cable

Block – SES block and electronic radio metering facility

Transceiver – Edgetech Starmux

Processor - Edgetech processor running Discover software

Acquisition – CODA DA200 with Edgetech MP-X interface

Paper record – BGS owned Ultra 120 TLR

Navigation data – BGS Trac C

This sidescan was chosen for this project as it claimed to be able to collect high resolution data at high vessel speed to match the speed that the multibeam can run at. Existing MP-X data had also been examined from the Bristol Channel area. At the time of the survey the only system available for rent was from Edgetech in the USA. Edgetech could not directly supply a winch and cable and also recommended using a CODA acquisition system to record the data instead of their own recording system. Edgetech have links with Sonar Equipment Services (SES) in Gt Yarmouth and set up the supply of a suitable winch. Edgetech also arranged for a loan of a CODA recording system with a digital MP-X interface. In addition a snatch block with a metering facility was hired from SES.

Both the Edgetech SSS and the CODA recording system were delivered directly to SES, who integrated them with their winch system, and provided set up instructions.

3.2.1 Mobilisation

Mobilisation was straight forward, although the winch (the single heaviest piece of equipment mobilised) was on the size and weight limit of the small tractor unit employed to ferry the equipment from the dockside across the jetty to the pier.

3.2.2 Operation

The deployment and retrieval proved successful in most situations. The block was attached to the A frame by a wire, the height of which could be adjusted by one of the vessel's winches operated by a member of the crew, who were very familiar with SSS deployments. This meant that all deployments and retrievals could be performed close to deck level, which reduced swinging of the tow fish.

The SES electric winch despite only having one speed proved very successful as the remote control allowed the SSS operator instant control of the towfish. Like wise the radio linked turns counter proved essential for this operation and allowed layback information to be input into the CODA with no delay. Although this layback data was captured by the Trac C, this information was input to the CODA manually due to a technical difficulty in adding this field to Trac C-CODA navigation string.

The MP-X required approximately 4 mins from switch on to establish a communication link between towfish and the Starmux interface. The Edgetech manual was extremely poor and did not match the Discover software program run on the Edgetech processor. Occasionally, usually after approximately the first 15 minutes of operation, the system would hang. The first time this happened it was thought the fish had been lost and the system was hauled in. Subsequently it was a

matter of switching off and on the system and waiting four minutes to re-establish communication, the cause of this was never established.

Another Ethernet port on the Starmux transferred the digital data to the CODA system for recording. This portable loaned system from CODA included a digital driver specific for this SSS system. Notes provided by SES on this interfacing proved essential and reduced setup time. The CODA system suffered from several problems. The first problem involved recording data to the DAT recorder, which could not keep up with the acquisition data rate of the SSS. This created an ever-increasing buffer that eventually made the CODA hang. CODA's initial response was that DAT drive was either faulty or could not handle the transfer rates. To date it has not been established what the problem was. The solution, in the short term, was to record to the CODA hard disk. The hard disk provided enough storage for 17 hours of continuous data collection. Due to weather conditions this proved to be enough storage before the port call when a DVD writer was installed. Data was transferred to DVD during the port call and on the transit to Menai Bridge at the end of the survey.

Post cruise problems with the navigation data stored on the CODA system were discovered by CODA when trying to mosaic the SSS data. The CODA system interpolates the one second navigation update sent from the Trac C and gives each ping of SSS (approximately 18/secound) a unique time stamp for which it uses as the primary field for referencing all subsequent processing. At the time of writing, BGS have found that the Trac C outputs the one-second navigation data string on average, exactly once a second but with a dither of up to 200msec. CODA do not to date, believe this to be cause of the anomaly found and are currently investigating other avenues including the data link to the Edgetech Starmux system.

The MP-X towfish is large and was difficult to operate in shallow water with a short rough sea. The towing arm proved insufficient to support the fish in these conditions and failed on the start of the second line of SSS operations, (3rd November). The towing arm was a standard unit that looked to have the standard Edgetech weak link fitted. Edgetech were contacted and admitted that they had disabled the weak link by installing larger bolts, the result being that the aluminium towing arm sheared at the head, the weakest part of the assembly. They dispatched another towing arm from the USA which arrived on the vessel on the 6th November minus several parts. The chief engineer quickly and expertly manufactured these parts on board. There was concern that we were installing an identical towing arm that had failed and measures were put in place to limited the sea conditions which the MP-X was operated in, namely not to tow in shallow water with short steep seas. Edgetech have since redesigned the towing bracket for this towfish. The problem may well have been compounded in that the SES co-axial tow cable was terminated in a large heavy stainless steel towing bracket which was then attached to the Edgetech bracket.

With the problems encountered with this system and the sea conditions the MP-X was only used on six of the survey days and then not all the time, with approximately 470 km of data collected out of a total of 1560 km carried out.

Paper records of the SSS were not produced on line as the hard copy output to the Ultra 120 printer could not keep up with the data throughput from the SSS system, although by sub sampling the data a reduced resolution record may have been have been produced.

Despite all the technical and weather difficulties good quality SSS data was collected.

MP-X tow fish with SES & MP-X tow brackets

Failed MP-X tow bracket

Setup of control and recording systems for Edgetech SSS system

Deployment of MP-X SSS

3.3 SIDESCAN SONAR – WAVERLEY SONAR 3000

The Waverley Sidescan Sonar system comprises of:

Towfish – Sonar 3000

Winch & Cable – BGS diesel/hydraulic winch with slipring and 600m of armoured 7 core cable

Block – SES block and electronic radio metering facility

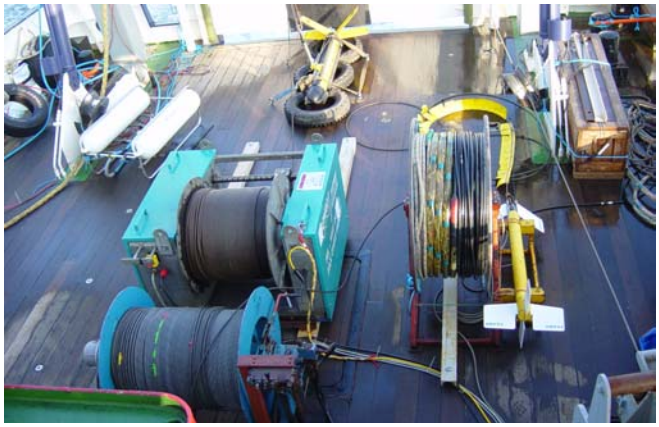
Transceiver – Waverley

Acquisition – BGS CODA DA200

Navigation data – BGS Trac C

This system, owned by BGS was taken as a backup to the MP-X SSS and used on one occasion after the towing bracket of the MP-X had failed. The Waverley was not routinely used while the MP-X was down, as the priority was to collect multibeam data, which was collected at speeds up to 9 knots outside the capabilities of the light weight Waverley system. The one line run did provide a comparison between the two systems showing that although it was thought that the Waverley system produced good results, the new technology of higher frequencies and ping rates showed how things have progressed since the developments of the 30 year old Waverley.

Waverley Sonar 3000 Tow Fish



Deck layout of winches

3.4 SURFACE TOW BOOMER

This system comprises of:

Source 1 - BGS catamaran and EG&G 500J plate

Source 2 – Applied Acoustics catamaran and plate

Receiver - Teledyne 7 channel hydrophone

Power source – Applied Acoustics CSP3000

Signal Conditioning – BGS amplifier and filter unit

Recording system – CODA DA200

Printer – Ultra 3710 TLR

Navigation data – BGS Trac C

The above system owned by BGS was mobilised with a loaned boomer plate and power cable. Source 2 catamaran had been purchased to replace the existing elderly heavy BGS catamaran and the plate and power cable had been loaned by Applied Acoustics for trial purposes. This provided a complete spare source for the project.

The weather conditions encountered on the project dictated that the boomer was only deployed once and even this line was in marginal sea conditions for this system. Weather down time also impacted on the number of available survey days resulting in prioritising on collecting multibeam data. This resulted in excluding any other reasonably calm days for boomer operations as boomer could only be run at 3-4 knots.

The catamaran was towed on the starboard side and the hydrophone on the port side at the end of a 2m pole.

BGS EG&G S.T.Boomer

Above: 7 Channel, 10m Hydrophone

Left: Applied Acoustics S.T.Boomer

3.5 NAVIGATION, PROCESSING AND DATA LOGGING

For everything except the multibeam system the positioning of the vessel used the vessel's survey DGPS system, (Trimble NT300D). The multibeam was independently positioned using the POS MV 320 system.

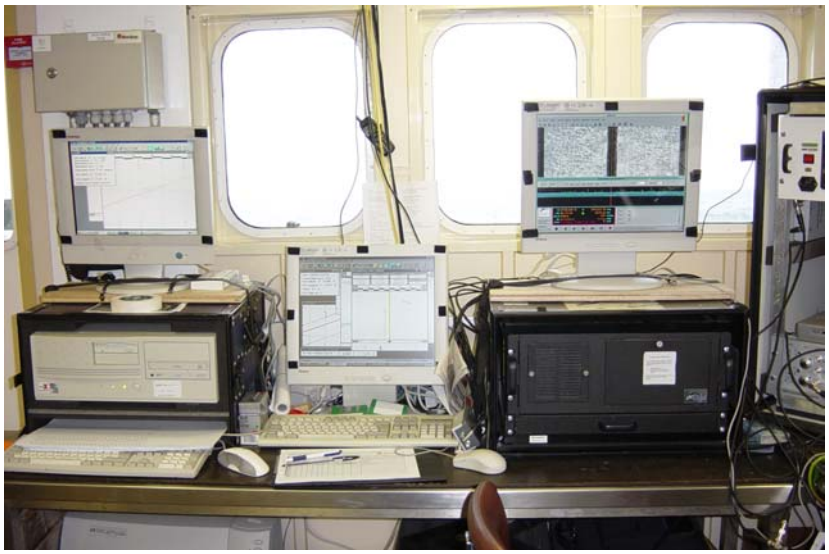
Prior to the project the BGS had thought, wrongly, that the Bridge would also be using the vessel DPGS for running survey lines. It became evident that the bridge only had uncorrected GPS into

their charting system, which also proved inadequate to run accurate straight survey lines. BGS brought the Trac C as backup and mobilised this system providing the Bridge with a clear positioning and run line displays. All survey lines being setup and controlled by BGS from the Wet Lab.

The Trac C was also used to provide navigation strings to the 2 CODA systems, monitor the lines run and log the navigation data.

The Trac C performed well, apart from occasionally loosing the displayed time stamp when the GPS signal was lost and there was dither on the navigation data string to the CODA, (see 3.2.2).

Data was logged at 5 sec intervals.



Wet Lab Trac C positioning system and S.T.Boomer recording system

3.6 VESSEL

The vessel performed well in that it had no equipment down time and was found to be very economical with fuel, both would be expected from a relatively new vessel.

3.6.1 Steering

The vessel did have a great deal of problems steering survey lines of the ideal +/-5m from the projected line. In fact the majority of lines were no better than +/-40m, with some +/-100m. Whilst it is acknowledged that the weather was less than ideal, even on the calmer days the vessel was unable to steer the lines within the desired tolerances. Unfortunately it could not be established at the time the exact cause of this problem, as there were many factors that could contribute to this problem, e.g. weather, vessel shape, over the side multibeam pole, auto pilot, helmsman, tide and currents. The only thing that could be dismissed is the helmsman display as this was provided by the Trac C. The survey was adapted to mitigate this failing by reducing the line spacing, however this caused inefficiencies in the survey and ultimately the amount of usable data collected. It was acknowledged by the master that the vessel had not been asked before to steer to such tolerances. The mate Alun Price had, on the day BGS visited the vessel prior to the survey, suggested that the vessel would find it difficult to steer straight lines. BGS queried this with the Nick Martin and Bill Page of VT, who said there was not a problem. A post cruise meeting including Nick Martin, Bill Page and Alun Price concluded that there are three possible

factors, excluding wind and sea conditions which could have affected the ability to steer straight lines, auto pilot, helmsman and vessel shape, all will be investigated by VT and reported back to BGS.

3.6.2 Other

The vessel appears to have good laboratory space, with the clean laboratory above the main deck and the wet laboratory on deck level. However for surveys that use predominately their own equipment the clean lab becomes almost useless as it is laid out with permanent equipment. The vessel has been designed for Bangor University use and not particularly for other general-purpose projects. The wet lab has a reasonable space and good access to the back deck, an ideal position for geophysical surveys. However there is very little bench space provided due to sinks, water filters and 'Corian' worktops. VT adapted the Wet Lab by providing removable worktops (plywood) to most of the surfaces thus creating enough worktops to mount all the equipment. These wooden surfaces proved effective for the survey.

The vessel was very comfortable, but all survey personnel found both the accommodation and the wet lab very noisy, something surprising for a new build vessel. A few complained of headaches, which may be attributed to the noise. Communication between the Bridge and the Wet lab proved difficult via internal phone due to the noise levels. The wet lab also became quite stuffy and hot. The vessel acknowledged that there was no air conditioning, which may make using the vessel in a warmer time of year even more uncomfortable.

The officers and crew are highly experienced, and it was good to work with crew that know how to handle over the side equipment.

4 Recommendations for future work of this type

4.1 MULTIBEAM

There has been many discussions pre and post cruise on whether BGS should look to either

- purchasing and operating or
- renting and operating

a high resolution multibeam system that could be mounted on vessels of opportunity.

From the experiences of this operation it is the opinion of the author that it would not be either practical or make economic sense to currently have this facility in house for the following reasons:

- The knowledge required to mobilise, calibrate, QC and operate a system would have to be acquired and maintained. Although there are staff that could acquire this knowledge unless there are projects amounting to 100 days at sea a year this knowledge would be difficult to retain. This coupled with the diversity of work projects and knowledge marine operations staff are expected to have and retain and the limited number of staff available the quality of multibeam surveys would be put at risk.
- The cost of purchasing a system would have to written off against use, currently this is 10 days a year at best which would not show value for money.
- Purchasing would sterilise the technology we use. It is the author's opinion that unlike echosounders, multibeam systems are not a mature product. There are developments taking

place that would make any purchase obsolete in a few years. By renting, the most up to date system can be used.

For any future work, the subcontractor selected for the multibeam operations should be tasked to provide at least basic spares, so as to reduce down time of common failures, e.g. connectors.

The above recommendations would need to be reviewed if BGS say had for instance, a 5 year programme to collect multibeam data.

4.2 SIDESCAN SONAR

The Edgetech system had a few problems both with the over the side and the inboard equipment.

The tow fish is large and heavy and although produced great records and showed good stability in rough conditions, there is concern about using this system in shallow waters with the associated short steep swells. Other systems should be reviewed prior to future operations of this type.

Edgetech have reviewed the MP-X towing bracket and have designed a new bracket. Any changes to the towing bracket should be checked and assessed prior to any future use.

The onboard system worked well, though the lack of useful manuals for both the Edgetech and CODA system need to be addressed for future work using this system.

There is still concern about the data transfer from the Edgetech to the CODA, any further use of these systems together needs to be reviewed prior to any further operations.

It is recommended that due to the large volumes of data collected from the MP-X tow fish that removable hard drives be used to store the data. If these are not available then use DVD. DAT and Exabyte tapes, although they should work, produce difficulties in importing and using the data in the office and with the associated extra staff time.

Due to the high data rates of 18/sec a more precise time stamped data string is required to the CODA recording system. Prior to any further operations a formal method to provide positioning, time, layback, line number data etc, to the CODA in a timely manner needs to be set up.

It is recommended that the BGS CODA recording system be upgraded to address the problems of using hard drives and DVD to store data, including an additional serial port for additional navigation data input and the ability to accept a digital interface for SSS etc.

Consideration should be given to the purchase of a light-weight block for SSS operation with a wireless turns counter with serial and digital display output.

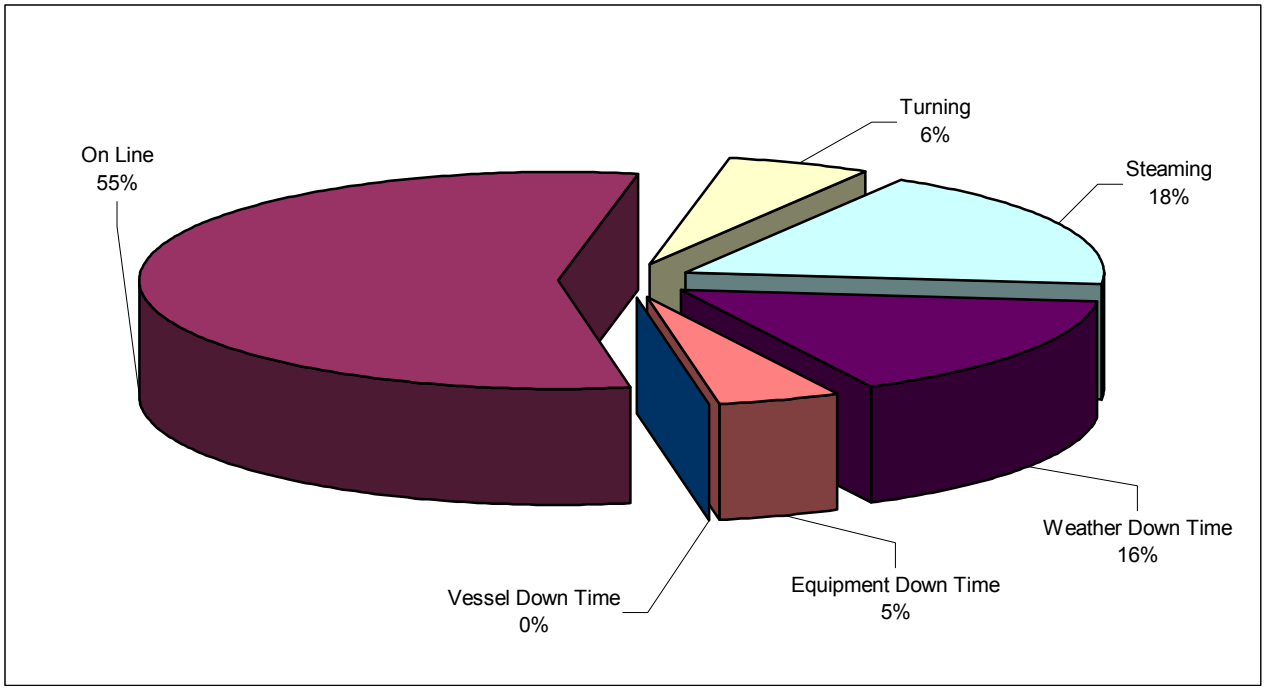
4.3 VESSEL

Before any further operations utilising the RV Prince Madog, BGS will need to be satisfied that:

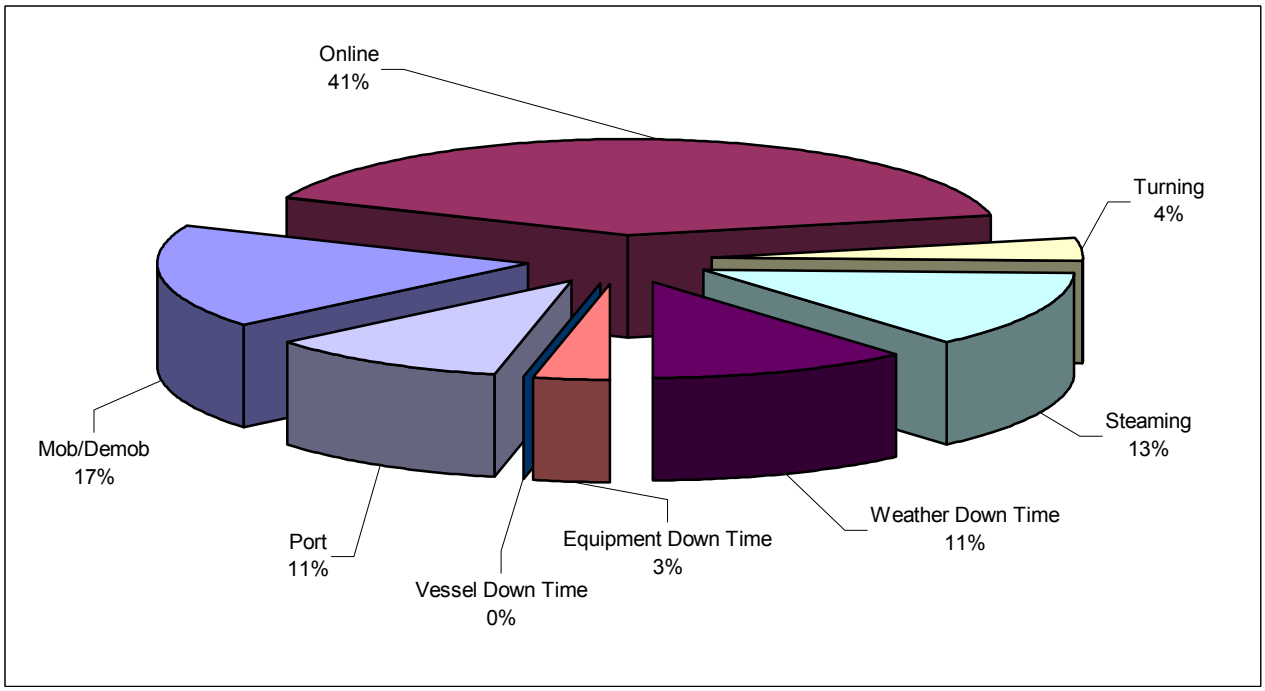
- The vessel can run survey lines to the accuracy required
- Additional measures have been taken to reduce vibration on the over the side pole mount for the multibeam transducer, e.g. support bracket closer to the bottom of the pole.

Appendix 1 Time Utilisation Diagrams

TIME UTILISATION IN THE SURVEY AREA



TIME UTILISATION FOR TOTAL SHIP TIME



Appendix 2 Summary Daily Log

All Times quoted are GMT

Project 03/03 Summary Daily Log

Date: 29th October

Time

08:30 Travel BGS Edinburgh to Menai Bridge

15:30 Arrive at Vessel, unable to start mob until next morning

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/Demob, setting up		0.0
On line		0.0
Turning		0.0
Steaming		0.0
Weather downtime		0.0
Equipment downtime		0.0
Vessel downtime		0.0
Port		0.0

Project 03/03 Summary Daily Log

Date: 30 Oct

Time

08:00 Join vessel and start mobilisation

16:00 Multibeam attached to over the side pole and wet tested, OK

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	24	24
On line		
Turning		
Steaming		
Weather downtime		
Equipment downtime		
Vessel downtime		
Port		

Project 03/03 Summary Daily Log

Date: 31 Oct

Time

08:30 Wet test MP-X SSS over the stern, OK

09:20 Wet test AA Surface Tow Boomer over the stern, OK

09:50 Sail

11:30 Great Orme for shelter too rough to mount multibeam pole over the side

12:00 Calibrate POS MV320 motion sensor by carrying out figure of 8, OK

12:30 Head back to Menai Bridge to attempt to mount pole

13:45 Mount mutlibeam pole just north of vessel berth

Multibeam and SSS trials 2 lines, calm sea state, vessel speed 6-9knots

15:00 Recover SSS and articulate multibeam pole into transit position

15:15 Drop off Applanix and university engineers at Menai Bridge

15:30 Head for Bristol Channel

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	15.5	39.5
On line		
Turning		
Steaming	8.5	8.5
Weather downtime		
Equipment downtime		
Vessel downtime		
Port		

Project 03/03 Summary Daily Log

Date: 1 Nov

Time

00:00 Steaming to survey area

06:30 Arrive on site and deploy Multibeam pole

08:00 Deploy SV probe

08:30 Attempt to run series of lines across charted wreck, to calibrate multibeam could not find wreck, 2nd wreck did not have any significant height. Moved to reef and found steep sided gully. Ran series of lines perpendicular to gully, vessel found it difficult to run straight lines.

12:30 Processing calibration data found timing error for heave information. This resulted in banding in multibeam data. Investigate cause

19:30 Install previous version of QPS-Quincy software, data acceptable, though still banding.

21:56 SOL 1 Dir NE, Multibeam only, weather force 8 (47 knots).

23:28 EOL 1, Data from swath no longer acceptable, head for shelter – Caldey Island. Wind 32 knots, gusting 48 knots.

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	15.5	55.0
On line	1.5	1.5
Turning		
Steaming	6.5	15.0
Weather downtime	0.5	0.5
Equipment downtime		
Vessel downtime		
Port		

Project 03/03 Summary Daily Log

Date: 2 Nov

Time

00:00 Hove to, east of Caldey Island

00:30 At anchor, east of Caldey Island

08:15 Weigh anchor and head for last fix on line 1, sea state rough 1-2m swell wind 30 knots

09:40 Stop for end SV probe dip, seastate 3-4m SW swell, 32 knots

10:00 SOL 2, Dir NE, multibeam only

11:15 Course varying to avoid pots

12:05 EOL 2

12:09 SOL 3, Dir SW, multibeam only

16:15 Weather deteriorating all afternoon, wind 30-40 knots, seastate 3-5m

16:30 EOL 3, Abort line due to weather.

16:37 SOL 4, run multibeam line while running for shelter behind Caldey Island

17:52 EOL 4

18:30 At anchor, Caldey Island

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up		55.0
On line	7.5	9.0
Turning		
Steaming		15.0
Weather downtime	13:45	13.95
Equipment downtime		
Vessel downtime		
Port		

Project 03/03 Summary Daily Log

Date: 3 Nov

Time

00:00 At anchor, wind gusting to 60 knots throughout the night.
08:00 Weigh anchor and head for last fix on line 4
08:30 No GPS/Nav signal for multibeam, turn and head for shelter
11:50 Connector repaired in STB GPS antenna, Multibeam GPS/Nav OK
Head for line 5
12:20 SOL 5, Dir NE
12:38 SSS MP-X deployed
14:01 EOL 5
14:08 SOL 6, Dir SW
14:14 SSS towing bracket failed
14:22 Recovered SSS
16:03 EOL 6
16:04 SOL 7, Dir SW
18:25 EOL 7
18:55 Heading lost on multibeam, abort start of line and circle
19:05 Multibeam OK
19:10 SOL 8, Dir NE
21:20 EOL
21:21 Trac C crash
21:44 SOL 9, Dir SW

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up		55.0
On line	10.75	19.75
Turning	1.25	1.25
Steaming	0.5	15.5
Weather downtime	8.0	21.95
Equipment downtime	3.5	3.5
Vessel downtime		
Port		

Project 03/03 Summary Daily Log

Date: 4 Nov

Time

00:00 Online 9
01:37 EOL 9
01:49 SOL 10, Dir NE
02:00 Waverley Sonar 3000 SSS deployed
05:15 SSS recovered, shallow water
05:25 EOL 10
06:37 SOL 11, Dir SW
08:30 Wind 28 knots, S, Seastate 2-4m, confused sea
10:07 EOL 11
10:08 SV probe dip
11:53 SOL 12, Dir NE
14:18 EOL 12
14:22 SOL 13, Dir SW
15:49 Multibeam acquisition software froze, abort line, turn and go back
16:10 Back on line, multibeam acquisition froze, turn vessel
16:59 Multibeam running, grid file hangs system., new grid file
19:06 EOL 13
19:16 SOL 14, Dir NE
22:12 EOL 14
23:00 SOL 15, Dir SW

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	0.15	55.15
On line	22.7	42.45
Turning	1.0	2.25
Steaming		15.5
Weather downtime		21.95
Equipment downtime	0.15	3.65
Vessel downtime		
Port		

Project 03/03 Summary Daily Log

Date: 5 Nov

Time

00:00 Online 15

02:44 EOL 15

02:49 SOL 16, Dir NE

04:58 EOL 16, Multibeam acquisition PC froze, abort line, turned and restarted

05:20 SOL 17, Dir NE

08:00 Wind 25-30 knots, dir S/SE, swell confused, SW, S, N, occasionally large deep swells

08:17 EOL 17

08:28 SOL 18, Dir SW

09:19 EOL 18

10:07 SOL 19, Dir NE, wind picked up, strong gale 43 knots SE

12:23 EOL 19

12:29 Deploy SV Probe

12:41 SOL 20, Dir SW

15:01 EOL 20

15:14 SOL 21, Dir NE, gale 8, confused sea

15:41 Abort line 21, multibeam data too noisy, weathered off

18:05 SOL 22, Dir SW

19:47 EOL 22

19:57 SOL 23, Dir NE

22:13 EOL 23

22:23 SOL 24, Dir SW

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	0.15	55.3
On line	21.7	64.15
Turning	1.8	4.05
Steaming		15.5
Weather downtime		21.95
Equipment downtime	0.35	4.0
Vessel downtime		
Port		

Project 03/03 Summary Daily Log

Date: 6 Nov

Time	
00:00	On line 24
01:14	EOL 24
01:40	SOL 25, Dir NE
03:43	EOL 25
03:50	SOL 26, Dir SW
06:03	EOL 26
06:14	SOL 27, Dir NE
08:23	EOL 27, head for Ilfracombe to pickup new tow bracket for MP-X SSS
09:50	Leave Ilfracombe
10:15	Deploy S.T.Boomer
10:36	SOL 28, Dir SW
14:20	EOL 28, recover S.T.Boomer, deploy MP-X SSS
14:35	SOL 29, Dir NE
15:37	EOL 29
15:55	SOL 30, Dir SW
16:31	EOL 30
16:38	SOL 31, Dir NE
16:51	EOL 31
17:02	SOL 32, Dir SW
17:15	EOL 32
17:36	SOL 33, Dir NE
19:44	EOL 33
20:22	SOL 34, Dir SW
22:31	EOL 34
22:41	SOL 35, Dir NE
23:14	MP-X SSS and multibeam systems hung
23:16	EOL 35
23:25	MP-X SSS and multibeam OK
23:37	SOL 36, Dir NE

Project 03/03 Summary Daily Log

Date: 6 Nov - continued

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	0.3	55.6
On line	18.8	82.95
Turning	3.1	7.15
Steaming	0.8	16.3
Weather downtime		21.95
Equipment downtime		4.0
Vessel downtime		0.0
Port	1.0	1.0

Project 03/03 Summary Daily Log

Date: 7 Nov

Time	
00:00	On line 36
00:09	Problems with recording SSS data to DAT tape on loaned CODA system
01:19	EOL 36
02:31	SOL 37, Dir SW, Still problems with CODA recording
05:37	EOL 37
05:59	SOL 38, Dir NE
09:45	Wind 33 knots from E/SE
10:21	EOL 38
10:38	SSS recovered, transit to corridor 9, sea state rough, short steep swell
12:47	SV probe dip, NE end of corridor 9
13:04	SOL 39, Dir SW
14:37	EOL 39
14:41	SOL 40, Dir NE
17:16	EOL 40
17:45	SOL 41, Dir SW
18:38	EOL 41
18:45	SOL 42, Dir NE
19:55	EOL 42
20:06	SOL 43, Dir SW
22:08	EOL 43
21:16	SOL 44, Dir NE
22:16	EOL 44
22:21	SOL 45, Dir SW
23:04	EOL 45
23:14	SOL 46, Dir NE
23:30	Difficulty in holding vessel on course due to wind/tide/swell. Multibeam data poor, wind >40 knots, dir 120 deg

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	0.25	55.85
On line	21.25	104.2
Turning	1.75	8.9
Steaming	0.75	17.05
Weather downtime		21.95
Equipment downtime		4.0
Vessel downtime		0.0
Port		1.0

Project 03/03 Summary Daily Log

Date: 8 Nov

Time

00:00 On line 46

00:18 EOL 46, proceed to sheltered location to north of 'Worms Head, W.O.W.

07:45 SOL 47, Dir SW, re-run of line 46, with wind and swell

08:15 Manorbier firing range firing west of 4 deg 40''. Run line to 4 deg 36'' west

Wind gusting to 43 knots outside lee of Worms Head

09:06 EOL 47

09:13 SOL 48, Dir NE, into wind and swell

09:29 EOL 48, abort line due to poor multibeam data

09:58 SOL 49, Dir 130 deg across survey area towards Ilfracombe, sheltered coast. Multibeam data OK as pole is on sheltered side of vessel in this direction

12.53 EOL 49

12:58 SOL 50, Dir SW, Corridor 3

15:22 EOL 50, try reciprocal course NE, multibeam data to noisy, head for corridor 2, east of Lundy

17:24 SOL 51, Dir NE, start approx. 9km from SW end, multibeam system hung

17:36 Multibeam OK, grid file corrupt, but cannot view existing data. Offset vessel to make sure of data coverage.

20:00 Wind gusting to 40 knots

20:06 EOL 51

20:44 SOL 52, Dir SW

22:00 Wind 30-35 knots

22:38 EOL 52, transit around west side of Lundy to most sheltered corridor (1)

23:50 SOL 53, Dir SW

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up		55.85
On line	12.5	116.7
Turning	1.2	10.1
Steaming	3.3	20.35
Weather downtime	7.0	28.95
Equipment downtime		4.0
Vessel downtime		0.0
Port		1.0

Project 03/03 Summary Daily Log

Date: 9 Nov

Time	
00:00	On line 53
02:05	EOL 53
02:13	SOL 54, Dir NE, wind 20 knots
03:01	EOL 54
03:13	SOL 55, Dir SW
03:17	EOL 55
03:46	SOL 56, Dir NE
04:05	EOL 56
04:17	SOL 57, Dir SW
05:00	EOL 57
05:10	SOL 58, Dir NE , wind 27 knots, SE
05:49	EOL 58, wind 30 knots, SSE
05:55	SOL 59, Dir SW
06:31	EOL 59
06:47	SOL 60, Dir NE
08:08	EOL 60
08:30	SSS Deployed
08:43	SOL 61, Dir SW
09:01	EOL 61, wind 30+ knots
09:11	SSS recovered
09:25	SOL 62, Dir SE, across horse rocks
09:45	EOL 62
11:51	SV Probe dip
11:58	SSS deployed
12:10	SOL 63, Dir SW, wind decreasing, small Atlantic swell, easterly swell decreasing
12:25	Multibeam system hung
12:33	Multibeam OK, lost 1282m of data
15:50	EOL 63
15:57	SOL 64, Dir NE
19:15	EOL 64
19:32	SOL 65, Dir SW

22:16 EOL 65

22:31 SOL 66, Dir NE

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	0.5	56.35
On line	18.35	135.05
Turning	2.85	12.95
Steaming	2.3	22.65
Weather downtime		28.95
Equipment downtime		4.0
Vessel downtime		0.0
Port		1.0

Project 03/03 Summary Daily Log

Date: 10 Nov

Time

00:00 On line 66

00:02 EOL 66

00:12 SOL 67, Dir SW, wind 17 knots, 200 deg

01:50 EOL 67

02:10 SSS recovered

02:30 Head for port call at Milford Haven

06:55 Tied up at Milford Haven

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	0.33	56.68
On line		135.05
Turning	0.13	13.08
Steaming	4.5	27.15
Weather downtime		28.95
Equipment downtime		4.0
Vessel downtime		0.0
Port	19.24	20.24

Project 03/03 Summary Daily Log

Date: 11 Nov

Time

00:00 Milford Haven

06:38 Depart Milford Haven

07:35 POS-MV failed, head for calibration site to calibrate newly installed TSS motion sensor

08:20 Castle Martin firing range informed vessel to move out of firing range, which also calibration site, POS-MV still down

08:50 Head back to Milford Haven to await Applanix engineer and spare processor

09:54 At anchor in Milford Haven Roads

13:55 Weigh anchor and head for Milford Haven

15:02 Applanix engineer on board

15:46 Applanix engineer leaves, multibeam system OK

16:03 Forecast SE gale 8, captain refuses to leave Milford haven

16:40 Vessel at anchor at mouth of Milford Haven.

23:30 Wind 20-25 knots

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up		56.68
On line		135.05
Turning		13.08
Steaming	1.0	28.15
Weather downtime	8.2	37.15
Equipment downtime	8.17	12.17
Vessel downtime		0.0
Port	6.63	26.87

Project 03/03 Summary Daily Log

Date: 12 Nov

Time	
00:00	At anchor, wind 15-20 knots
05:00	Weigh anchor
06:00	Permission received from port authority to perform calibration of TSS motion sensor inside Milford Haven shipping channel
06:13	SOL 68, SWcalibration line
06:35	EOL 68
06:40	Proceed to survey area, wind 15-20 knots
09:43	SV probe dip, water depth 63m
10:05	Deploy MP-X SSS
10:20	SOL 69, Dir NE, wind 3-4, 1-2m seas, sunny, large following swell producing vessel roll
13:13	EOL 69, 6 km short of 1st centre line
12:23	SOL 70, Dir SW, head to swell
16:37	EOL 70
16:44	SOL 71, Dir NE
17:00	Wind 26 knots, forecast gale later
18:10	Multibeam positioning lost track
18:22	Multibeam data OK
19:17	EOL 71, SSS recovered
19:39	SOL 72, Dir SW, multibeam fill in for corridor 6
19:59	EOL 72
20:29	SOL 73, Dir NE, multibeam fill in for corridor 6
20:38	EOL 73
21:16	SOL 74, Dir SW, multibeam fill in for corridor 6
21:57	EOL 74, end of survey, forecast severe storm 11
22:30	Multibeam pole raised and secured, head for Menai Bridge

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	1.0	57.68
On line	12.72	147.77
Turning	1.78	14.86
Steaming	3.5	31.65
Weather downtime	5.0	42.15
Equipment downtime		12.17
Vessel downtime		0.0
Port		26.87

Project 03/03 Summary Daily Log

Date: 13 Nov

Time

00:00 Proceeding to Menai Bridge

16:00 Dock Menai Bridge, start demob

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	4.0	61.68
On line		147.77
Turning		14.86
Steaming	16.0	47.65
Weather downtime		42.15
Equipment downtime		12.17
Vessel downtime		0.0
Port	4.0	30.87

Project 03/03 Summary Daily Log

Date: 14 Nov

Time

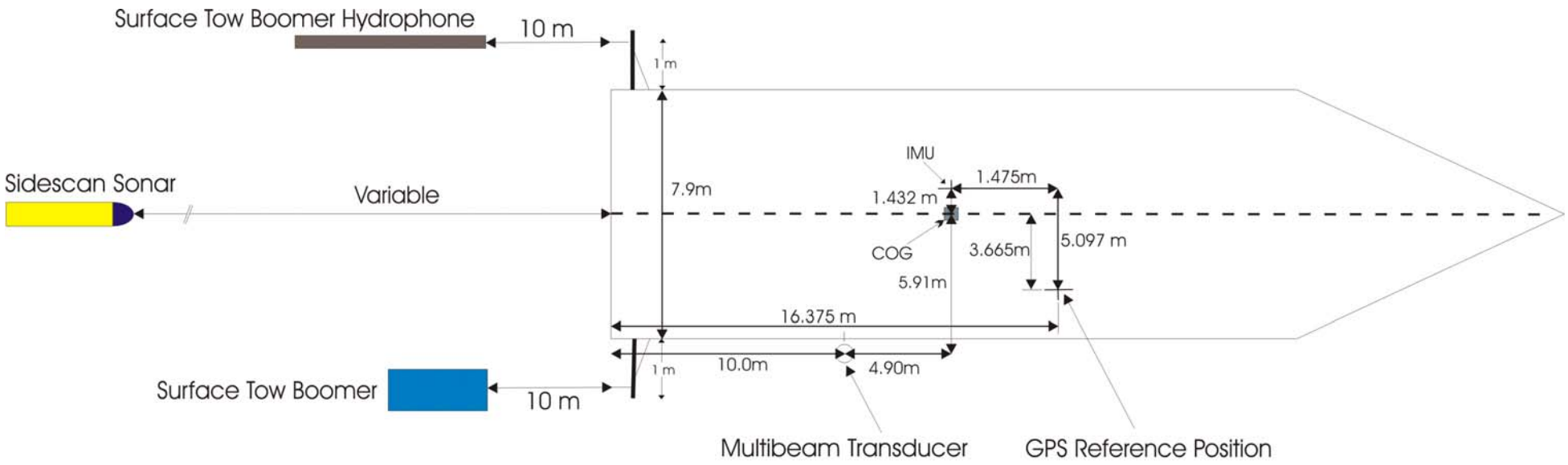
00.00 Menai Bridge

10:30 Depart vessel

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/Demob, setting up	2.5	64.18
On line		147.77
Turning		14.86
Steaming		47.65
Weather downtime		42.15
Equipment downtime		12.17
Vessel downtime		0.0
Port	8.0	38.87

Appendix 3 Equipment Layback Diagram



RV PRINCE MADOG - PROJECT BGS03/03

Appendix 4 Line Summary Sheets

British Geological Survey Marine Operations **Line Summary Log Sheet 1 of 3** **Vessel : RV Prince Madog**

PROJECT 03/03 **BRISTOL CHANNEL MARINE HABITAT STUDY - GEOPHYSICAL SURVEY 2003**

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Line	Start			End			Length	Total	Equipment Run				
No.	Date	J. Day	Time	Date	J. Day	Time	(km)	(km)	Multibeam	SSS	S.T.Boomer	Nav Data File	Comments
	1-Nov	305	21:56	1-Nov	305	23:08	11.18	11.18	X			BCLine1.txt	fixes 1 to 11, ss 1-2m, wind to 47 knots
2	2-Nov	306	10:00	2-Nov	306	12:05	24.80	35.98	X			BCLine2.txt	fixes 12 to 26, ss 3-4m, wind 32 knots
3	2-Nov	306	12:09	2-Nov	306	16:30	34.82	70.80	X			BCLine3.txt	fixes 27 to 54, ss 3-5m, 30-40 knots, abort line early
4	2-Nov	306	16:37	3-Nov	307	17:52	14.54	85.34	X			BCLine4.txt	fixes 55 to 64, ss 3-5m, 30-40 knots, abort line early
5	3-Nov	307	12:20	3-Nov	307	14:01	19.15	104.49	X	MP-X		BCLine5.txt	fixes 2 to 13, SSS from 14:22
6	3-Nov	307	14:08	3-Nov	307	14:28	1.86	106.35	X	MP-X		BCLine6.txt	fixes 14 to 17, SSS Edgetech, tow braket failed
4A	3-Nov	307	14:29	3-Nov	307	16:02	12.11	118.46	X			BCLine4A.txt	fixes 18 to 29, line numbering change
7	3-Nov	307	16:04	3-Nov	307	18:25	21.82	140.28	X			BCLine7.txt	fixes 30 to 45,
8	3-Nov	307	19:10	3-Nov	307	9:36	37.40	177.68	X			BCLine8.txt	fixes 46 to 62
9	3-Nov	307	21:44	4-Nov	308	1:37	36.79	214.47	X			BCLine9.txt	fixes 64 to 88
10	4-Nov	308	1:49	4-Nov	308	5:25	38.27	252.74	X	Wav3000		BCLine10.txt	fixes 89 to 114, SSS started 02:10, SSS stopped 05:15
11	4-Nov	308	6:37	4-Nov	308	10:07	40.75	293.49	X			BCLine11.txt	fixes 115 to 137
12	4-Nov	308	11:52	4-Nov	308	14:18	42.42	335.91	X			BCLine12.txt	fixes 138 to 153
13	4-Nov	308	14:22	4-Nov	308	19:06	41.26	377.17	X			BCLine13.txt	fixes 154 to 183, loop back?????
14	4-Nov	308	19:16	4-Nov	308	22:12	41.76	418.93	X			BCLine14.txt	fixes 184 to 203, timing error Trac C, SOL correct, EOL time +18 mins
15	4-Nov	308	23:00	5-Nov	309	2:44	37.07	456.00	X			BCLine15.txt	fixes 204 to 227
16	5-Nov	309	2:49	5-Nov	309	4:59	31.30	487.30	X			BCLine	fixes 228 to 243, swath computer crashed
17	5-Nov	309	5:20	5-Nov	309	6:17	7.77	495.07	X			16_17_18	fixes 244 to 250 continuation of line 16
18	5-Nov	309	6:28	5-Nov	309	9:19	37.13	532.20	X			.txt	fixes 251 to 269, ss 2-3m confused, wind 30+
19	5-Nov	309	10:07	5-Nov	309	12:23	32.59	564.79	X			BCLine19.txt	fixes 270 to 285, ss 2-3m confused, wind 30+
20	5-Nov	309	12:41	5-Nov	309	15:01	32.18	596.97	X			BCLine20.txt	fixes 286 to 301, ss 2-3m confused, wind 30+
21	5-Nov	309	15:14	5-Nov	309	15:45	6.03	603.00	X			BCLine21.txt	fixes 302 to 306, line aborted to much noise on swath
22	5-Nov	309	18:05	5-Nov	309	19:47	26.00	629.00	X			BCLine22.txt	fixes 1 to 12, TracC rebooted, DGPS jumped, timing out
23	5-Nov	309	19:57	5-Nov	309	22:14	26.36	655.36	X			BCLine23.txt	fixes 13 to 28
24	5-Nov	309	22:23	6-Nov	310	1:14	26.14	681.50	X			BCLine24.txt	fixes 29 to 47
25	6-Nov	310	1:40	6-Nov	310	3:43	29.58	711.08	X			BCLine25.txt	fixes 48 to 61
26	6-Nov	310	3:50	6-Nov	310	6:03	29.49	740.57	X			BCLine26.txt	fixes 62 to 76
27	6-Nov	310	6:14	6-Nov	310	8:23	29.40	769.97	X			BCLine27.txt	fixes 77 to 91

Wav3000 = Waverley Sonar 3000 MP-X = Edgetech Multipulse AA = Applied Acoustics Boomer plate

British Geological Survey Marine Operations **Line Summary Log Sheet 2 of 3** **Vessel : RV Prince Madog**

PROJECT 03/03 BRISTOL CHANNEL MARINE HABITAT STUDY - GEOPHYSICAL SURVEY 2003

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Line	Start			End			Length	Total	Equipment Run				
No.	Date	J. Day	Time	Date	J. Day	Time	(km)	(km)	Multibeam	SSS	S.T.Boomer	Nav Data File	Comments
28	6-Nov	310	10:36	6-Nov	310	14:20	25.60	795.57	X		AA	BCLine28.txt	fixes 92-116
29	6-Nov	310	14:35	6-Nov	310	15:37	10.33	805.90	X	MP-X		BCLine29.txt	fixes 117-124, break off to do transects across video line
30	6-Nov	310	15:55	6-Nov	310	7:12	5.41	811.31	X	MP-X		BCLine30.txt	fixes 1-6
31	6-Nov	310	16:38	6-Nov	310	16:51	2.58	813.89	X	MP-X		BCLine31.txt	fixes 7-11
32	6-Nov	310	17:02	6-Nov	310	17:15	1.52	815.41	X	MP-X		BCLine32.txt	fixes 12-13
33	6-Nov	310	17:36	6-Nov	310	19:44	18.76	834.17	X	MP-X		BCLine33.txt	fixes 14-28 contiuation of line 29
34	6-Nov	310	20:22	6-Nov	310	22:31	29.08	863.25	X	MP-X		BCLine34.txt	fixes 29-43
35	6-Nov	310	22:41	6-Nov	310	23:16	6.91	870.16	X	MP-X		BCLine	fixes 44-48, Edgetech SSS system and Swath crash
36	6-Nov	310	23:37	7-Nov	311	1:19	23.15	893.31	X	MP-X		35_36_37	fixes 49-60, SSS US
37	7-Nov	311	2:31	7-Nov	311	5:37	37.03	930.34	X	MP-X		.txt	fixes 61-80
38	7-Nov	311	5:59	7-Nov	311	10:21	37.40	967.74	X	MP-X		BCLine38.txt	fixes 81-109
39	7-Nov	311	13:04	7-Nov	311	14:37	19.27	987.01	X			BCLine39.txt	fixes 110-120
40	7-Nov	311	14:41	7-Nov	311	17:16	19.16	1006.17	X			BCLine40.txt	fixes 121-136, TracC clock sync lost after track part way along line
41	7-Nov	311	10:48	7-Nov	311	18:38	10.05	1016.22	X			BCLine41.txt	fixes 1-7
42	7-Nov	311	18:45	7-Nov	311	10:48	10.25	1026.47	X			BCLine42.txt	fixes 8-16
43	7-Nov	311	20:06	7-Nov	311	21:08	8.68	1035.15	X			BCLine43.txt	fixes 17-24
44	7-Nov	311	21:16	7-Nov	311	22:16	9.61	1044.76	X			BCLine44.txt	fixes 25-32
45	7-Nov	311	22:21	7-Nov	311	23:04	9.76	1054.52	X			BCLine45.txt	fixes 33-38
46	7-Nov	311	23:14	8-Nov	312	0:18	10.76	1065.28	X			BCLine46.txt	fixes 39-46
47	8-Nov	312	7:45	8-Nov	312	9:06	18.71	1083.99	X			BCLine47.txt	fixes 47-56
48	8-Nov	312	9:13	8-Nov	312	9:29	1.35	1085.34	X			BCLine48.txt	fixes 57-59
49	8-Nov	312	9:58	8-Nov	312	12:53	29.20	1114.54	X			BCLine49.txt	fixes 62-81
50	8-Nov	312	12:58	8-Nov	312	15:22	33.79	1148.33	X			BCLine50.txt	fixes 82-98, Trac C time 36 secs ahead of PC time
51	8-Nov	312	17:24	8-Nov	312	20:06	19.33	1167.66	X			BCLine51.txt	fixes 99-116, Multibeam PC hyng at start of line
52	8-Nov	312	20:44	8-Nov	312	22:38	32.46	1200.12	X			BCLine52.txt	fixes 117-129
53	8-Nov	312	23:50	9-Nov	313	2:05	23.25	1223.37	X			BCLine	fixes 130-144
54	9-Nov	313	2:13	9-Nov	313	3:01	4.24	1227.61	X			53_54_55_56	fixes 145-151
55	9-Nov	313	3:08	9-Nov	313	3:17	0.93	1228.54	X			.txt	fixes 152-154

Wav3000 = Waverley Sonar 3000 MP-X = Edgetech Multipulse AA = Applied Acoustics Boomer plate

British Geological Survey Marine Operations **Line Summary Log Sheet 3 of 3** **Vessel : RV Prince Madog**

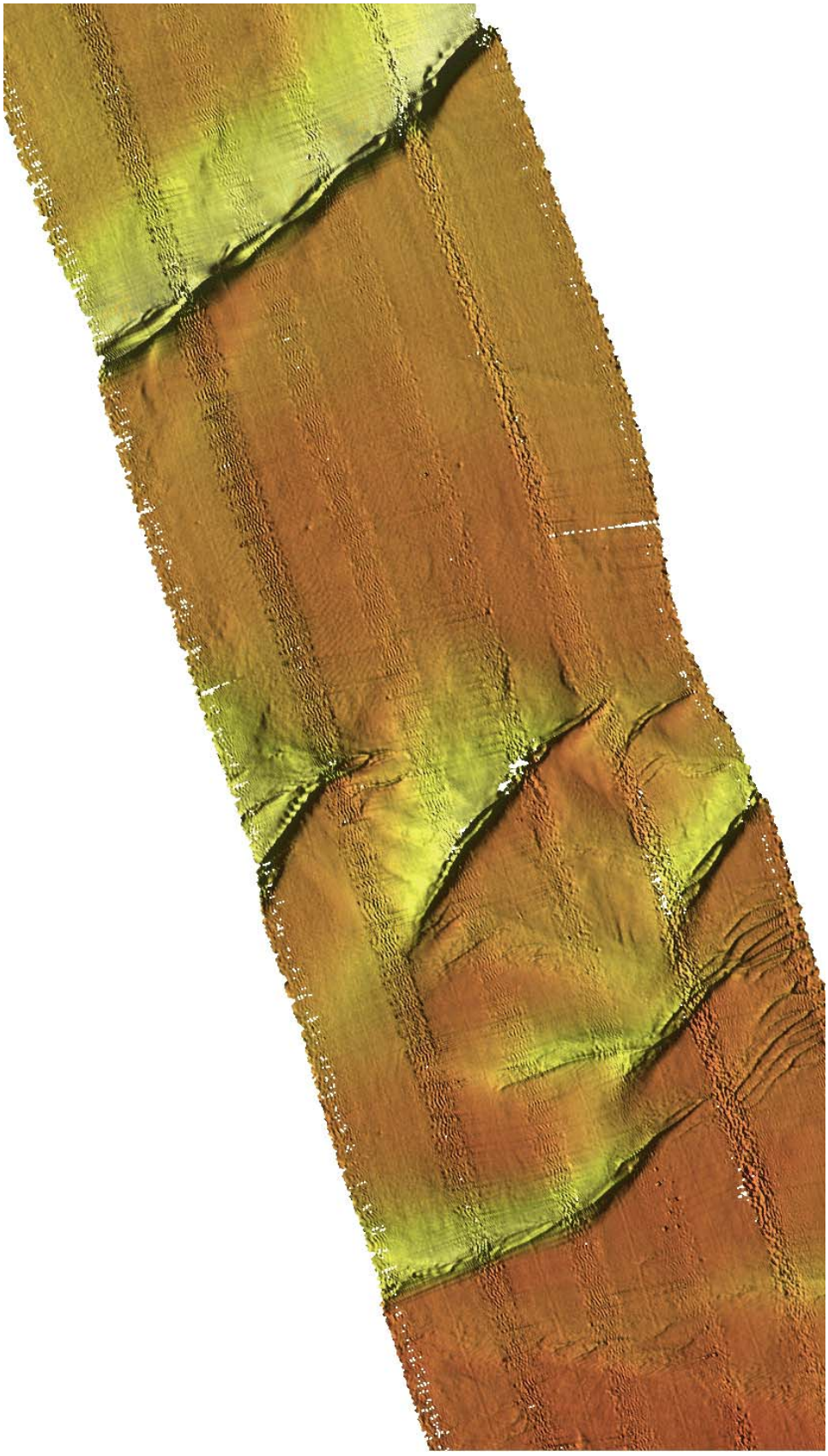
PROJECT 03/03 **BRISTOL CHANNEL MARINE HABITAT STUDY - GEOPHYSICAL SURVEY 2003**

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

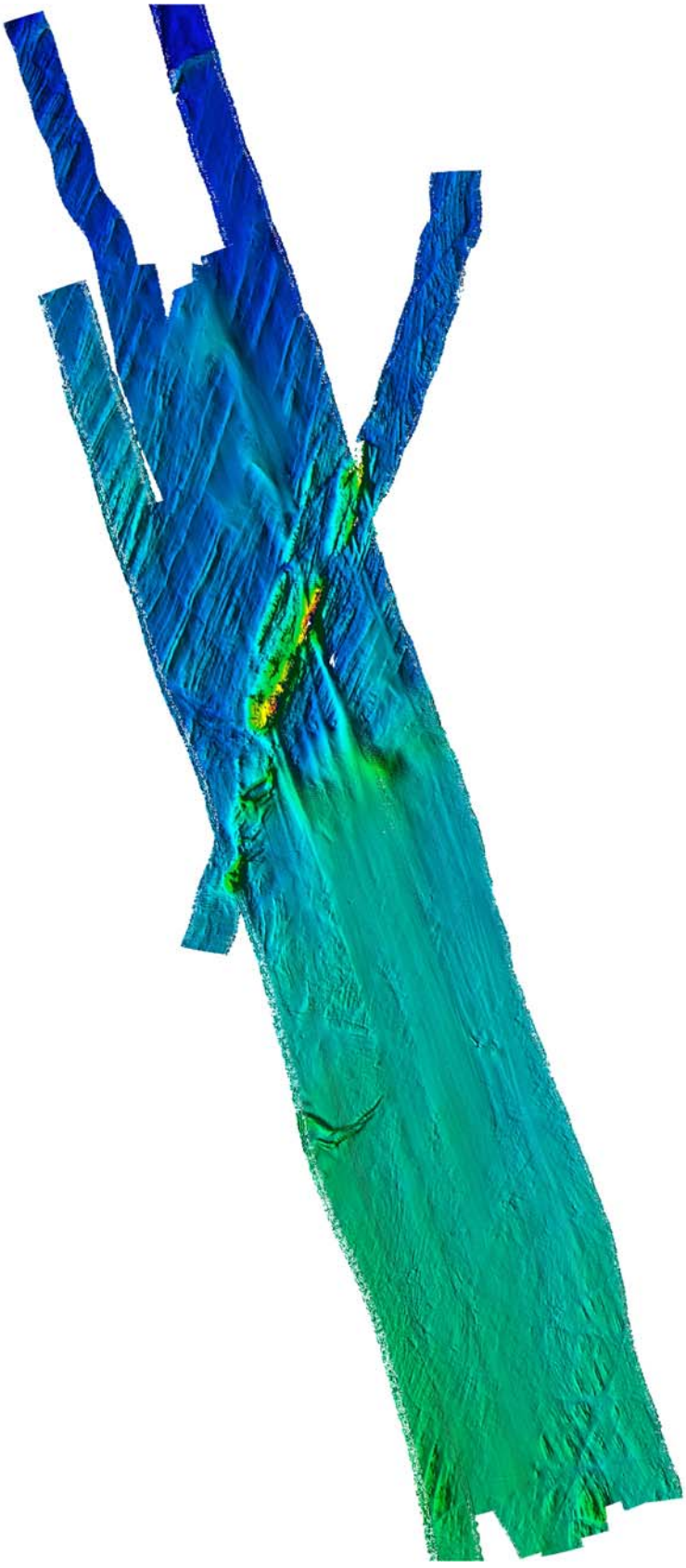
Line	Start			End			Length	Total	Equipment Run				
No.	Date	J. Day	Time	Date	J. Day	Time	(km)	(km)	Multibeam	SSS	S.T.Boomer	Nav Data File	Comments
56	9-Nov	313	3:46	9-Nov	313	4:05	4.19	1232.73	X			BCLine53_54_55_56.txt	fixes 155-158
57	9-Nov	313	4:17	9-Nov	313	5:00	6.15	1238.88	X			BCLine	fixes 159-164
58	9-Nov	313	5:10	9-Nov	313	5:49	3.77	1242.65	X			57_58_	fixes 165-169
59	9-Nov	313	5:55	9-Nov	313	6:31	6.43	1249.08	X			59_60	fixes 170-175
60	9-Nov	313	6:47	9-Nov	313	8:08	8.03	1257.11	X			.txt	fixes 176-185
61	9-Nov	313	8:42	9-Nov	313	9:01	5.33	1262.44	X	MP-X		BCLine61.txt	fixes 186-189
62	9-Nov	313	9:25	9-Nov	313	9:49	3.76	1266.20	X			BCLine62.txt	fixes 190-193
63	9-Nov	313	12:10	9-Nov	313	15:50	45.80	1312.00	X	MP-X		BCLine63.txt	fixes 194-217
64	9-Nov	313	15:57	9-Nov	313	19:15	40.38	1352.38	X	MP-X		BCLine64.txt	fixes 218-237
65	9-Nov	313	19:32	9-Nov	313	22:16	41.42	1393.80	X	MP-X		BCLine65.txt	fixes 238-255
66	9-Nov	313	22:31	10-Nov	314	0:02	17.48	1411.28	X	MP-X		BCLine66_	fixes 256-266
67	10-Nov	314	0:12	10-Nov	314	1:50	17.63	1428.91	X	MP-X		67.txt	fixes 267-278
68	12-Nov	316	6:13	12-Nov	316	6:35	1.16	1430.07	X			BCLine68.txt	fixes 1-4, calibration line at Milford Haven
69	12-Nov	316	10:20	12-Nov	316	13:13	39.32	1469.39	X	MP-X		BCLine69.txt	fixes 5-24
70	12-Nov	316	13:24	12-Nov	316	16:37	40.03	1509.42	X	MP-X		BCLine70.txt	fixes 25-45
71	12-Nov	316	16:44	12-Nov	316	19:17	38.27	1547.69	X	MP-X		BCLine71.txt	fixes 1-16 Nav clock error of 5 minutes at EOL
72	12-Nov	316	19:38	12-Nov	316	19:59	3.63	1551.32	X			BCLine	fixes 17-20
73	12-Nov	316	20:29	12-Nov	316	20:38	1.70	1553.02	X			72_73_74	fixes 21-23
74	12-Nov	316	21:16	12-Nov	316	21:57	7.64	1560.66	X			.txt	fixes 24-29, End of survey

Wav3000 = Waverley Sonar 3000 MP-X = Edgetech Multipulse AA = Applied Acoustics Boomer plate

Appendix 5 Swath Images



Example of unprocessed multibeam bathymetry data



Example of unprocessed multibeam bathymetry data

Appendix 6 Personnel on Board

Name	Position	On Board
BGS		
Dave Smith	*Electronic Engineer-* *Party Chief*	*30th Oct –14th Nov*
Neil Campbell	*Mechanical Engineer*	*30th Oct –14th Nov*
Ceri James	*Marine Geologist*	*30th Oct –10th Nov*
Sally Phillpot	*Marine Geologist*	*10th Oct –14th Nov*
Dave Wallis	*Electronic Engineer*	*30th Oct –14th Nov*
Michael Wilson	*Electronic Engineer*	*30th Oct –14th Nov*
Netsurvey		
Robert Bertram	*Multibeam Surveyor*	*30th Oct –14th Nov*
Paul Robertson	*Multibeam Senior Surveyor*	*30th Oct –14th Nov*
RV Prince Madog		
Steve Duckworth	*Master*	*30th Oct –10th Nov*
Alun Price	*Chief Officer* *Master*	*30th Oct –10th Nov* *10th Oct –14th Nov*
Hywel Owen	*Chief Engineer*	*30th Oct –10th Nov*
Arfon Williams	*Chief Engineer*	*10th Oct –14th Nov*
Neil Holmes	*2nd Engineer*	*30th Oct –14th Nov*
Phil Jones	*Bosun*	*30th Oct –10th Nov*
Tom Roberts	*Seaman* *Bosun*	*30th Oct –10th Nov* *10th Oct –14th Nov*
Dafydd Lloyd-Jones	*Seaman*	*30th Oct –14th Nov*
Dave Williams	*Seaman*	*10th Oct –14th Nov*
Mike Downey	*Chief Cook*	*30th Oct –10th Nov*
Eiffion Pritchard	*Chief Cook*	*10th Oct –14th Nov*

Appendix 7 Glossary

BGS	*British Geological Survey*
BMAPA	*British Marine Aggregate Producers Association*
EOL	*End of line*
GMT	*Greenwich Mean Time*
IT	*Information Technology*
MIRO	*Mineral Industry Research Organisation*
ODPM	*Office of the Deputy Prime Minister*
SOL	*Start of line*
SSS	*SideScan Sonar*
VT	*Vosper Thornycroft*