GEOLOGICAL SURVEY OF CANADA
OPEN FILE 6474

Cruise Report *Matthew* 2007006 and 2007016: Bay of Fundy 3 May – 16 June 2007

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Publications in this series have not been edited; they are released as submitted by the author.

Background

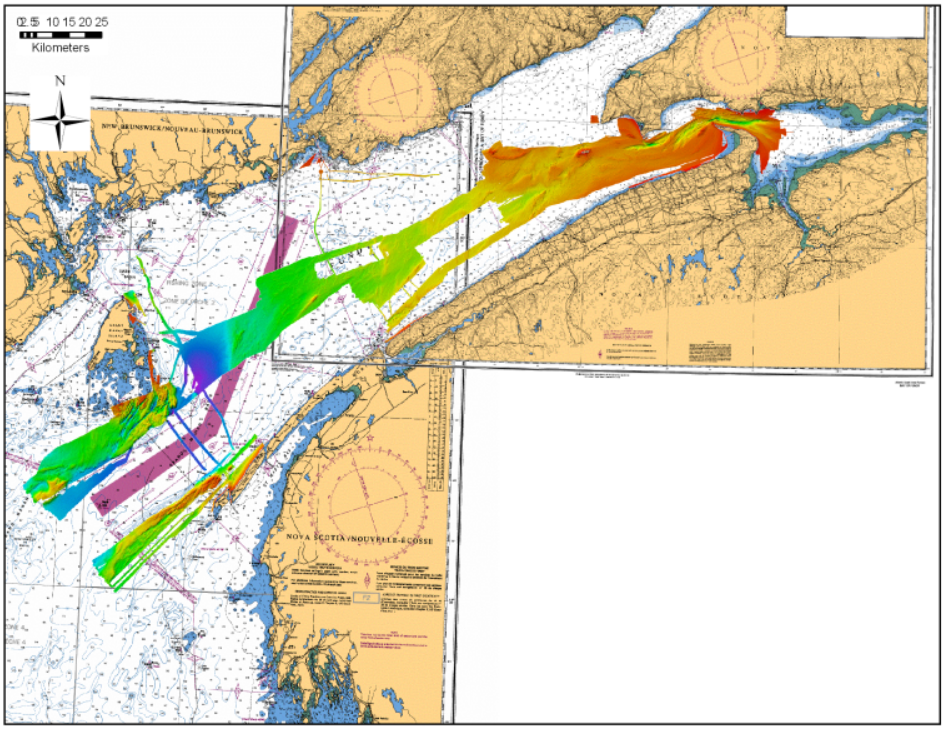
The Geological Survey of Canada (GSC), a division of Natural Resources Canada (NRCan), has initiated a project to produce a series of maps showing the bathymetry, seafloor backscatter, and surficial geology throughout the Bay of Fundy. Matthew 2007006 and 2007016, the second of a series of cruises planned to the area, was conducted as a joint project between the Geological Survey of Canada and the Canadian Hydrographic Service of the Department of Fisheries and Oceans, Canada.

Matthew 2007006 was conducted from 25 April to 23 May 2007 and Matthew 2007016 was conducted from 23 May to 15 June 2007 using the CCGS Matthew (Figure 1). The vessel, equipped with a Kongsberg Simrad EM710 multibeam bathymetry system and a Knudsen 3.5 kHz sounder, collected multibeam bathymetry, multibeam backscatter and sub-bottom profiler data. The Matthew carried two hydrographic launches, each equipped with a Kongsberg Simrad EM3002 multibeam bathymetry system, which were deployed for daytime operation. The vessel operated out of Saint John, NB and expanded on previous data collected throughout the Bay of Fundy, as shown in Figure 2. The surveys were designed to take advantage of previously collected data in the area. Selected areas were re-surveyed to determine if changes had occurred in the seafloor.

Previous surveys in the Bay of Fundy (Fader et al., 1977; Amos et al., 1992; Parrott et al., 2000, Parrott et al., 2007) have collected a variety of geophysical and multibeam bathymetry data, samples, and photographs. These data will be integrated with the multibeam bathymetry coverage from this survey to generate new surficial geology maps for the bay.

Figure 1. Multibeam bathymetry and sub-bottom profiler data were collected using the CCGS *Matthew* equipped with a Kongsberg Simrad EM710 multibeam bathymetry system and two hydrographic launches equipped with Kongsberg Simrad EM3002 multibeam bathymetry systems. Photo courtesy of J. Shaw.

a)



b)

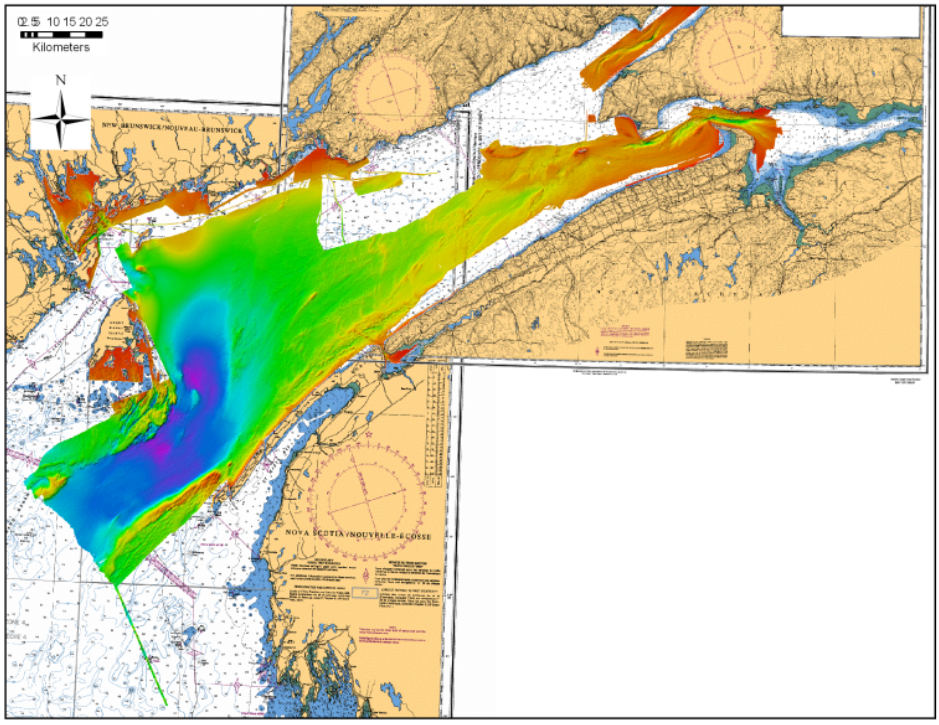


Figure 2. a) Multibeam bathymetry coverage in the Bay of Fundy collected during Matthew 2007006 and 2007016. b) Compilation of all multibeam bathymetry coverage in the Bay of Fundy available to June 2007.

Vessel Characteristics

CCGS Matthew is an inshore hydrographic survey vessel with the following particulars:

Length overall	51.25 m
Breadth	10.50 m
Displacement (light)	745 tonnes
Displacement (loaded)	950 tonnes
Speed	12 knots
Range	4000 nautical miles
Crew	12 persons
Scientific staff	8 persons

The P-class hydrographic launches Plover, and Pipit can be deployed from the CCGS Matthew for operations away from a home port or can operate independently from a shore base. Plover and Pipit were equipped with Kongsberg Simrad EM3002 multibeam bathymetry systems.

Length overall	10 m
Breadth	3 m
Speed	12 knots
Crew	1 persons
Scientific staff	1-2 persons

Survey procedures

During this survey, the CCGS *Matthew* was used for multibeam bathymetry and sub-bottom profiler surveys. The systems consoles for the multibeam bathymetry and sub-bottom profiler were located on the bridge level, in the hydrographic control room. A data processing facility of work stations equipped with five Caris Hips licenses was established in the hydrographic plotting room. A central disk stored a backup copy of the raw multibeam bathymetry data, as well as the processed data. All computers and storage drives were connected by a high speed network. Staff generally divided their time between data acquisition and processing. The surveys were designed to take advantage of previously collected data in the area as shown in Figure 2. Selected areas were re-surveyed to determine if changes had occurred in the seafloor.

The launches, Plover and Pipit were carried aboard the Matthew, and deployed for daytime operations. Georeferenced images of existing coverage and areas to be surveyed were provided to the launches each morning. Areas to be surveyed were generally divided equally between the launches. When necessary the launches would exchange coverage plots at midday to ensure that the survey block was completely surveyed, with no unnecessary duplication.

Often, at the start of a survey block, the survey vessels would run a baseline along a preplanned course, along a contour line, or along the edge of existing coverage. The coverage plots provided by the multibeam bathymetry logging systems, were then used to run a series of offset lines from the baseline, to ensure that all the seafloor was surveyed.

Data Acquisition and Processing

The following equipment and software was used during surveys Matthew 2007006 and 2007016:

- Kongsberg Simrad EM710 and EM3002 multibeam bathymetry systems
- SEA Submetrics interferometric sidescan sonar system
- Knudsen 320M echo sounder
- Brooke Ocean Technology Moving Vessel Profiler MVP200
- Caris HIPS multibeam bathymetry data cleaning software running on Windows XP

Multibeam Bathymetry

The Kongsberg EM710 system on the CCGS *Matthew*, uses a 70 to 100 kHz transducer with 200 or 400 beams to provide a beamwidth of 1^{o}. The system provides coverage to depths in excess of 2000 metres, and across-track coverage of up to 5.5 times deep water. The system provides a depth resolution of 1 cm with an accuracy of 5 cm RMS. A nadir beam ensonifies an area of approximately 2.25 m^2 at 50 metres water depth. Information on the multibeam bathymetry systems can currently be found on the company website at http://www.kongsberg.com.

Multibeam bathymetric data were also collected using Simrad EM3002 multibeam bathymetry systems mounted in the hydrographic survey launches Plover and Pipit (Figure 1). The EM3002 systems use 300 kHz transducers with 254 beams with a beamwidth of approximately 0.5^{o}. The system provides a depth resolution of 1 cm with an accuracy of 5 cm RMS. Each beam insonifies an area of approximately 1.35 m^2 at 50 metres water depth.

Survey lines were run to provide overlapping swaths with the previous line with 120% to 200% percent coverage of the seafloor. The multibeam swath width was set at the maximum allowable angle by the conditions at the time of the survey. Generally beam angles of 60-70 degrees either side of nadir were used. The multibeam bathymetry coverage is shown in Figure 2.

During the survey, data were processed using version 6.0 of the CARIS HIPS data cleaning program (by Universal Systems Limited, Fredericton, NB) on Windows XP workstations to remove spurious soundings and navigation data and to apply the OmniStar tidal corrections and TrueHeave (logged separately on the POS-MV computer). CARIS HIPS was also used to grid survey lines immediately after they were completed to check data quality especially for motion and refraction artifacts. Both 5-metre and 10-metre grids were constructed using the "swath-angle" option for weighting soundings in the gridding process. The colour coding of depths generally set for a 0-225 metre range, illuminated from an azimuth of 315 degrees and at an angle of 45 degrees. A vertical exaggeration of 10 was applied to the data.

Navigation and Attitude

Each vessel used an Applied Analytics Corporation POS-MV 320 attitude sensing system with integrated differential GPS navigation system to determine the position and attitude. The systems integrate data from an inertial measurement unit and differential GPS signals. A positional accuracy of 0.5 to 4 metres can be obtained using the phase differential of the GPS carrier frequency when using DGPS, and of 0.02-0.10 metres when using an RTK source. This survey was performed using DGPS data for an accuracy of 0.5 to 4 metres. A heading aiding accuracy of 0.1^{o} - 0.5^{o} can be obtained from

the raw GPS data. A Kalman filter is used to improve the heading estimate to 0.05^{o} - 0.1^{o}. Vessel attitude is measured using an inertial measurement unit to provide an accuracy of 0.0003^{o} for pitch, roll and heading. More information on this system can be found at www.applanix.com.

An Applied Analytics Corporation POS-MV 320 attitude sensing system with integrated differential GPS navigation system was used to determine the position and attitude. The systems integrate data from an inertial measurement unit together with differential GPS using Coast Guard RTCM Type 9 corrections. This survey was performed using DGPS corrections resulting in a typical accuracy of 0.5 metres (1 sigma). Typical heading accuracy was 0.015^{o} (1 sigma) with a baseline GPS antenna length of 2.6 m. Vessel attitude is measured using an inertial measurement unit to provide an accuracy of 0.02^{o} for pitch, roll and heading. More information on this system can be found at www.applanix.com.

In regions where no previous multibeam coverage existed, survey lines were run with the Regulus navigation package by ICAN Limited, Mount Pearl, NF. Otherwise, survey lines were run in the Geographic Display module of Kongsberg Seafloor Information System (SIS) in the manner described in the previous section.

OmniSTAR

With recent advancements in GPS positioning precision, a vessel's height above mean sea level can be determined for any point during transit. The multibeam bayhymetry data collected during this survey were corrected for tidal heights using OmniSTAR, a wide-area differential GPS service provided by the Fugro group of companies. More information is available at www.omnistar.com.

Knudsen 320M echo sounder

Sub-bottom profiler data were collected with a Knudsen 320M sounder operating a four element 3.5 kHz transducer array installed in a ram near the keel, on the starboard side of the Matthew. More information on the sounder is available on the company website at http://www.knudsenengineering.com/ASP/Products/Products.asp. Data were stored in KEB (Knudsen Extended Binary) and SEG-Y formats and viewed using the Knudsen PostSurvey program available. Information of the format and the program are available at http://www.knudsenengineering.com/ASP/Support/Download.asp.

The timestamp in the headers of the data recorded by the Knudsen echo sounder was synchronized to UTC using the NMEA ZDA string output from the POS-MV. The PC clock on the recording computer was manually synchronized to GPS time.

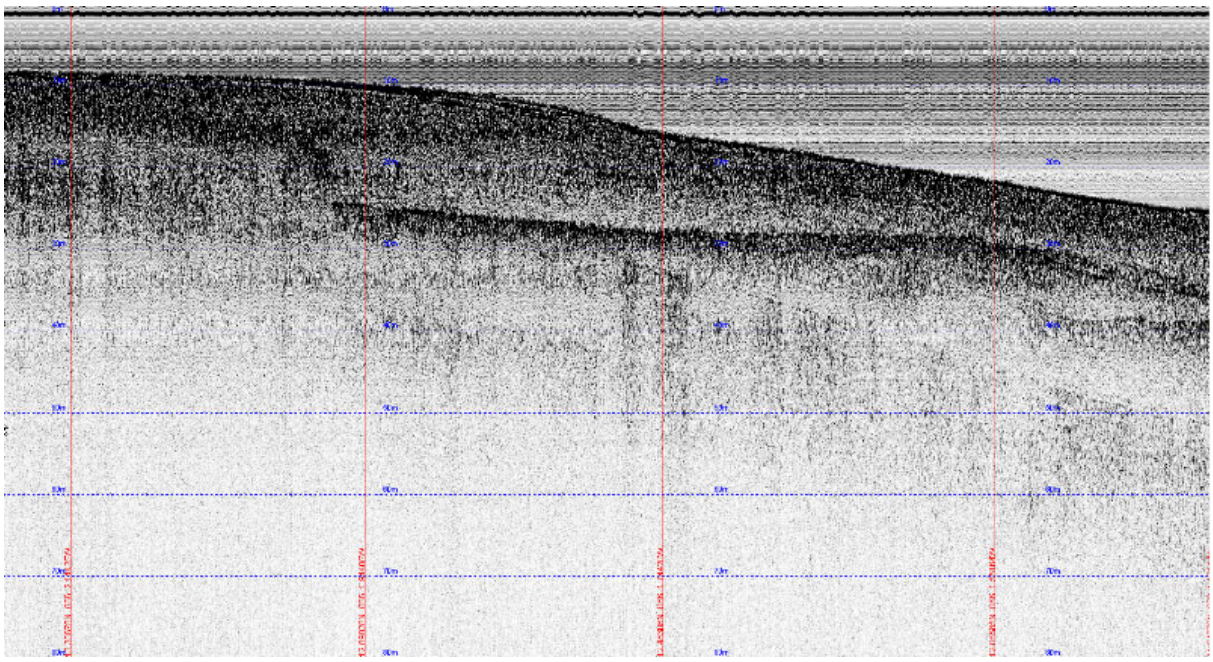


Figure 3. Sub-bottom profile, of the approach to Saint John Harbour, of 3.5 kHz data collected with the Knudsen 320B sounder. The horizontal lines are spaced at 10 metres, and the vertical lines have about 250 m spacing.

Brooke Ocean Technology Moving Vessel Profiler MVP200

Measurements of the velocity of sound in the water column were made with a Brooke Ocean Technology Moving Vessel Profiler MVP200 equipped with an Applied Microsystems Limited Smart Probe CTD probe. The system was used to provide data for correction of calculated water depths from the Kongsberg Simrad EM710 multibeam bathymetry data. More information on the MVP is available at http://www.brookeocean.com and for the velocimeter at http://www.appliedmicrosystems.com.

Tides and Currents

Bathymetry surveys in the Bay of Fundy must accommodate the largest recorded tides in the world. Prior to the survey, tides and currents for the survey area were calculated using the program Tides and Currents Pro by Nautical Software Inc. As shown in Appendix III, a tidal range of about 10 metres was predicted for Digby, NS, during the period of the 2007 survey. Times are shown in Atlantic Daylight Time and tide heights are shown in centimetres. Tides were also calculated using the program WebTides, developed by the federal Department of Fisheries and Oceans (DFO), and used in post-processing to provide control for the real time GPS corrections. The program is available from the DFO website at
http://www.mar.dfo-mpo.gc.ca/science/ocean/coastal_hydrodynamics/WebTide/webtide.html.

For the duration of the survey, tide gauges were installed at the Lighthouse Cove lighthouse on Brier Island, in North Head on Grand Manan Island, and at the privately owned public wharf in Digby, NS to supplement the permanent gauge in Saint John, NB. Data were also downloaded from the gauge in Eastport, Maine, USA.

For the Minas Passage survey, tide gauges were installed at Cape Sharp, Cape Split, Blomidon, Spencers Island and Port Greville to provide a 1-2 month record of tidal elevations in the restricted waters of the passage. The gauges at Cape Sharp and Spencers Island were left in place to provide a long term record.

Access to Data and Samples

The multibeam bathymetry and sub-bottom profiler data collected during this survey are archived by both the Canadian Hydrographic Service and the Geological Survey of Canada, Atlantic, in Dartmouth Nova Scotia. For access to the data and samples contact the senior scientist for the survey, Russell Parrott (902-426-7059) or Susan Merchant of the GSCA Curation group (902-426-3410). Data can be accessed by logging on to the Geological Survey of Canada Atlantic site at http://gsca.nrcan.gc.ca and the Canadian Geoscience Knowledge Network http://cgkn.net/.

Acknowledgements

The captains and crews of the CCGS *Matthew* provided valuable assistance with data collection. This project was jointly funded by Natural Resources Canada through the Geoscience for Ocean Management program of the Earth Sciences Sector, and the Canadian Hydrographic Service of the Department of Fisheries and Oceans Canada. R.O. Miller and V. Kostylev reviewed the manuscript.

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Appendices

Appendix I - Survey Particulars

Name of Vessel:	*Matthew*
Dates:	25 April – 15 June 2007
Vessel captains:	Rick Smith, Roy Lockyear and Michael Hameon
Area of Operation:	Bay of Fundy
Senior Scientist:	Russell Parrott
Senior Hydrographers:	Michael Lamplugh, Jon Griffin

List of Participants – Matthew 2007006 - 25 April – 23 May 2007

Geological Survey of Canada Atlantic

Russell Parrott	Senior Scientist
Scott Hayward	GIS, navigation, multibeam bathymetry

Canadian Hydrographic Service

Michael Lamplugh	Senior Hydrographer
Jon Griffin	Senior Hydrographer
Michael Collins	Hydrographer
Christian LeBlanc	Hydrographer
David Street	Hydrographer
David Sinnot	Hydrographer
Andrew Craft	Hydrographer
Kelly Sabadash	Student Hydrographer
Morley Wright	Electronics

List of Participants – Matthew 2007016 - 23 May - 15 June 2007

Geological Survey of Canada Atlantic

Russell Parrott	Senior Scientist
Paul Fraser	GIS, navigation, multibeam bathymetry

Canadian Hydrographic Service

Jon Griffin	Senior Hydrographer
Glen King	Hydrographer
Christian Solomon	Hydrographer
Joe Manning	Hydrographer
Steve Nunn	Hydrographer
Michael Nickerson	Hydrographer
David Levy	Electronics

Appendix II - Activities

All times are shown in UTC Universal Time Code (Atlantic Daylight Savings Time + 3 hr).

25 April 2007 Wednesday - Day 115 – crew change mobilization

Crew change CCGS *Matthew*.

16:00 Meeting scheduled with Lamplugh and Costello (CHS), Parrott (GSC) and vessel captain to discuss status of vessel and launches. Launch Pipit will not fit properly into the davits after the recent modifications. Project manager for company doing launch refit, CHS, and captain discuss methods to remedy problem. Vessel departure delayed.

26 April 2007 Thursday - Day 116– mobilization

Vessel has fire and safety inspection and certification scheduled for early afternoon.
Launch Pipit at shipyard to remove material from the bow and to move the lifting hook forward in order to shift the launch back in the davit.
Problems encountered with Kongsberg Simrad multibeam bathymetry system.
Vessel departure delayed.

27 April 2007 Friday - Day 117 – mobilization

Launch Pipit returns from shipyard. Modification to retaining chocks for Pipit required.
Seaworthiness certificate still required for Pipit
Problems still encountered with Kongsberg Simrad multibeam bathymetry system. Patch test not completed.
Matthew encounters problems with variable pitch propeller system such that the vessel still has 1 degree pitch in reverse on the propeller when the indicator shows that there should be zero pitch on the propeller. The controller had just been refit at a cost of about $30,000 by a west coast company.
Vessel departure delayed.

28 April 2007 Saturday - Day 118 – mobilization

Port side chocks modified to accept launch Pipit.
Vessel departure delayed.

29 April 2007 Sunday - Day 119 – mobilization

Vessel departure delayed.

30 April 2007 Monday - Day 120 – mobilization

15:50 Start trials of engine room controls. A local company was called in to perform the calibration of the system to set the propeller to zero pitch. Apparently, this is a fairly simple procedure involving adjusting a collar on a shaft to get the desire angle. The local company sent one of their junior technicians to perform the task.

16:50 Trials completed and system calibrated.
Seaworthiness certificate still required for Pipit. Still having problems with the multibeam bathymetry system on the Matthew. Discussions being held with Fugro re cost of OmniStar service for high resolution GPS signals.
Vessel departure delayed.

1 May 2007 Tuesday - Day 121 – mobilization

Continue with trials in Bedford Basin. Problems encountered with the Brooke Ocean Technology (BOT) MVP which result in erroneous values for the velocity. These problems prevent completion of the patch test.

Problems were encountered when the ship's second generator tried to synchronize with the operating generator, causing circuit breakers to open and a shutdown in the second generator.

Vessel departure delayed.

2 May 2007 Wednesday - Day 122 – mobilization

12:00 Jim Etter from Strictly Hydraulics is on board to diagnose the problems with the generators.
Personnel from BOT on board to diagnose problem with MVP.
OmniStar installation and testing continues.

18:45 The generator problem has been diagnosed and repaired by J. Etter, who found several wires out of place on the control panel which caused feedback loops between the generators. He recommends synchronizing the generators manually if the problem re-occurs.

19:00 Matthew departs BIO to test MVP in Bedford Basin. Still encountering problems with the MVP resulting in erroneous velocities being calculated.

22:00 Matthew returns to BIO.
Vessel departure delayed.

3 May 2007 Thursday - Day 123 and depart Halifax

12:00 Depart BIO for trials in Bedford Basin. The MVP deployment was successful. Perform patch tests on Matthew and Pipit to calibrate multibeam bathymetry system.

15:00 Offsets from patch test determined and entered into system.

16:00 Patch tests repeated on Matthew and Pipit to confirm offsets. OmniStar high precision GPS and tidal height system installation completed on Matthew. Steve Parsons reviews operation of system with CHS staff. OmniStar licenses for Pipit launch had been arranged earlier in the week and has been activated. The license for the Plover and will be activated while the Matthew is in transit.

19:00 Gerard Costello (regional hydrographer) on board to address scientific staff about the upcoming survey, and pass out CHS hats.

20:00 CHS personnel not required for the upcoming survey returned to BIO using the launch Pipit. Pipit returns to the Matthew and is secured in the chocks. Mike Collins departs to drive the CHS vehicle to Digby and rejoin the survey there. Plover returns to the Matthew and is secured.

21:00 Safety meeting for scientific staff. A brief familiarization with the vessel was followed by all scientific staff struggling into the survival suits.

21:30 Matthew departs Bedford Basin for transit to the Bay of Fundy.

4 May 2007 Friday - Day 124 – In transit

11:00 In transit from Halifax to the Bay of Fundy.
Geotiffs of existing coverage generated for use in the Regulus navigation systems on the Matthew, Plover and Pipit.

17:00 OmniStar license activated for the launch Plover. An external antennae was installed temporally on the hangar deck to received the signal and activate the service.
En route Digby to pick up Mike Collins.

21:30 Approaching Digby. Deploy SVP in shipping lane on approach to Digby.

22:30 Deploy the launches Plover and Pipit to collect soundings near the ferry terminal and at the privately-owned public wharf. Both launches collected data in the shipping channel

approaching the wharf, followed by the Matthew. All 3 data sets will be compared to ensure that all systems are calibrated the same.

23:59 Continue with soundings.

5 May 2007 Saturday - Day 125

00:30 Launch Pipit recovered. Mike Collins returns to the Matthew on the launch.

00:50 Launch Plover recovered. Sounding data from both launches transferred to the processing team.

01:30 Transit from Digby to outer edge of the data collected by the Creed in 2006 to extend existing coverage. The overnight survey will be performed by the Matthew only. Launches will be prepared for planned operations in the morning.

02:30 MVP near start of survey lines.

03:00 Start line running southwest towards Grand Manan overlapping the coverage completed by the Creed in 2006.

10:30 Deploy launches south of Grand Manan. Wait for tanker transiting through area to leave survey area.

11:30 Problems with Regulus navigation system on the launch Pipit. Updated software installed.

12:30 Software updated – launch away to start survey.

13:00 MVP while underway. Matthew and both launches surveying. Matthew infilling large gap in data near Grand Manan. Launches working to extend coverage into shoals adjacent to 2006 survey.

16:00 Discussions held with Lamplugh and Wright to move the Knudsen logging computer from the present location in the lower lab to the plotting room behind the bridge to allow watchkeepers to monitor the system and make file changes at the end of the lines.

17:00 Multibeam bathymetry lines are presently being run with 100% overlap. Discussions held with Lamplugh to increase the offset between lines to improve coverage. Some artifacts are currently present in the data, that could effect data quality. It is decided to process the most recent data to ensure that line spacing can be increased, without compromising data quality – too much.

18:00 Regulus navigation computer reboots itself. The system is on an uninterruptible power supply so that power glitches should not be a problem.

The multibeam bathymetry data appears to be quite acceptable – even in the outer beams. Survey line spacing increased to improve coverage.

18:15 John Hughes Clarke calls to discuss joining the vessel.

21:45 Recover the launches Plover and Pipit, and download data.

22:00 Move the control computer for the Knudsen sounder to the plotting room. The network connection was moved to feed the location at the back of the plotting room, and the ARC and Knudsen computers placed on the same small table. The watchkeeper can now monitor the Knudsen sounder, make file changes etc.

22:30 Regulus navigation computer reboots itself again.

23:00 JHC was unable to arrange rental of a car that can be driven by another driver, without the driver being present in the rental office to sign a rental agreement. He will arrange for his own transport to Parrsboro.

23:00 Recover launches.

23:30 Data from the launches imported into the SIS system. Layout a line that expands the coverage from today's launch survey, near the Murre Ledges off Grand Manan, and extends to Cape Split.

6 May 2007 Sunday - Day 126

00:00 Continue line from the Murre Ledges.
11:00 Continue on transit line from Grand Manan to Minas Passage. Repeat line run through Margaretsville dune field survey (performed by UNB in 1993).
12:50 Launches away to commence survey of Minas Passage.
13:15 Matthew starts survey of Minas Passage on line through centre of Passage. The tide was just starting to flood, adding about 3 knots to the vessel speed.
15:00 Run line parallel to centre line. Vessel doing 10.9 knots through water – 2.5 to 3 knots over the ground. Long features on seafloor parallel to ship's track.
22:00 Recover launches and continue survey.

7 May 2007 Monday - Day 127

00:00 Continue lines in Minas Passage
10:45 Launches away to survey off Cape Blomidon
10:50 Matthew continues long lines through Passage with a speed of 18 kt SOG when going with the tide, and 6 kt when going against.
17:43 Break offline to recover Plover.
18:04 Picking up Plover sue to a vibration problem. The problem was caused by a section of rope on the prop. The rope was cut and the launch redeployed.
20:30 J. Hughes Clarke notices that the serial GPS navigation string was not input to the Knudsen system.
21:30 Problem solved. The navigation data was being input on a network cable rather than on the serial cable labeled as the input to the system. The network cable with the GPS feed had been removed the previous day and connected to another piece of equipment. The system functioned properly when the network cable was plugged back in (1 MVP cast completed today).
22:21 Recover launches and continue survey.

8 May 2007 Tuesday - Day 128

10:00 Sea state 2-3m winds 30-35 knts, Continue lines in Minas Passage
10:39 Pipit non-operational due to generator overheating. The digital temperature readout shows about 240F while the analogue system shows about 160F. The coxwain reports that the oil on the dipstick was warm (not hot) to the touch.
12:20 Sounding East side of Cape Blomidon due to high winds.
13:39 Pipit repaired onboard and deployed.
19:00 The captain leaves vessel to assume duties on the CCGS *Cornwallis*. Roy Lockyer assumes command. A new deckhand is picked up in Wolfville using the rescue boat (a Rigid hull Inflatable Boat or RIB).
21:57 Recover launches. Continue survey

9 May 2007 Wednesday - Day 129

10:00 Sea state <1m winds 5-10 kts, sunny- continue lines in Minas Passage (Parrsboro side)
10:45 Both launches in the water working near Parrsboro.
15:40 Snag lobster float line, stop sounding off Parrsboro, moving south to coverage off Blomidon.
17:00 JHC making modifications to offset levers in POS-MV system because of heave problems
17:34 Pipit calls in with generator problems, Matthew moves west to recover.
20:00 Senior engineer departs Matthew in RIB.
21:00 R. Parrott and Cameron Conrad (new senior engineer) board Matthew from FRC.
22:30 Recover launch Plover near Parrsboro.
23:00 Commence survey of large sand wave field in Minas Basin.

10 May 2007 Thursday - Day 130

10:00 Sea state <1m winds <5 kts, sunny- continue lines in Minas Passage
10:50 Both launches are deployed with the engineer onboard Pipit. Plover having SIS problems, Pipit having fuel problems.
11:15 Standing by on launches, nothing underway. Pipit recovered and engineer looks at engine and generator.
12:45 Redeploy Pipit for further tests.
13:15 Fuel supply problems persist on Pipit, the launch is recovered.
15:45 Problems encountered synchronizing the Matthew's first and second generators. Chief engineer recommends that the generators not be synchronized manually but the vessel return to port (probably Saint John NB) to have someone diagnose the system.
15:54 Ship wide power failure.
19:00 Chief engineer contacts the Coast Guard Halifax based mechanic that had been on the vessel last year to check on the best course of action for the launch Pipit. It is recommended that the fuel filters be checked to see if any dirt has collected. The filter is removed, found to contain dirt from the fuel tanks and cleaned.
20:00 Launch Pipit deployed for further trials.
21:40 Recover launches.

11 May 2007 Friday - Day 131

03:00 Matthew departs Minas Channel for Saint John to meet generator electrician.
10:20 Tied up Saint John Coast Guard Station.
14:00 Food stores, fuel and engineering parts taken on board.
16:00 Plover surveys all day. Pipit encounters more trouble with fuel system caused by very dirty fuel in the tank.
16:50 Launch Pipit under tow by Plover.
17:42 Plover returns to survey.
17:48 Launch Pipit is recovered for tests on the generator and returned to survey.
23:00 Depart Saint John. Both launches brought back on board before transiting back to survey area in Minas Passage.

12May 2007 Saturday – Day 132

00:01 Survey en route to Minas Channel.
00:20 MVP.
00:30 MVP secured on deck.
02:30 MVP.
02:35 MVP secured on deck.
10:36 Plover deployed for nearshore survey. Pipit remains on board to get fuel system cleaned.
11:25 FRC deployed to transport Jodi Delong, a reporter from the Chronical Herald who is returning to the vessel to do more detailed interviews for an article for the paper.
13:12 FRC secured on deck.
19:00 Launch Pipit deployed.
23:00 FRC with R. Parrott and Jodi Delong departs the vessel.
23:37 FRC secured on deck.

13 May 2007 Sunday – Day 133

00:01 Continue survey in the Minas Channel. Launch Plover recovered.
00:07 Launch Pipit recovered.

10:39 Launch Plover deployed.
07:59 Launch Pipit deployed.
11:21 MVP cast.
11:33 MVP secure on deck.
14:46 FRC departs the Matthew with M. Lamplugh.
15:06 FRC returns to the Matthew with J. Griffin who joins the vessel as HIC.
22:18 Recover launches Plover and Pipit.
Start transit line towards Brier Island to expand coverage from the 2006 Creed survey.

14 May 2007 Monday – Day 134

00:00 Transit to Brier Island.
02:24 MVP cast.
03:03 MVP recovered.
09:45 MVP cast.
10:44 Launches deployed in shoal area from missed 2006 Creed coverage. Sunny, calm, sea state less than 1 m. J. Griffin HIC.
13:08 MVP cast.
15:00 Slow down to recover Pipit after she encountered fishing gear in the survey area.
15:24 Deploy Pipit.
20:00 Matthew snags fishing gear. Due to the amount of fishing gear close to Brier Island the survey is moved east of Grand Manan.
21:32 Slow vessel to recover launches.
22:35 Launches recovered.
22:47 MVP cast.
23:38 MVP recovered. Continue survey.

15 May 2007 Tuesday – Day 135

00:00 Surveying south East of Grand Manan. Seas 2 m, winds 20 kts from SW, cloudy, gale warning.
04:18 MVP cast.
10:00 The captain is concerned about getting too far away from launches. Currently running short North-South lines to infill 2006 Creed coverage.
10:46 Slow to deploy launches.
11:04 Both launches deployed.
11:08 MVP run in continuous autocast mode.
12:04 Recover MVP.
Operations on the Matthew southeast of Grand Manan terminated due to the high density of fishing gear and poor visibility. The survey area is moved.
21:00 Launches recovered.
Running lines East-West after pick up of the launches. Due to the amount of fishing gear in the Brier Island area it was decided to return to the Minas Channel to continue the survey there.
22:45 MVP cast.

16 May 2007 Wednesday- Day 136

00:00 Run long line to Scots Bay and Minas Channel. Foggy with winds.
11:15 Both launches deployed for surveys.
14:15 The cook departs the vessel to tend to family matters.
18:30 Replacement cook arrives on the vessel and is injured within 45 minutes of being on the Matthew.
19:00 Hydrographers M. Lamplugh and A. Kraft join the vessel. J. Griffin departs.

20:00 Continue lines in Scots Bay.
22:08 Slow vessel to recover launches.
22:28 Both launches ecovered and secured. Steam towards anchorage.
23:00 Anchor for the night in Scots Bay.

17 May 2007 Thursday- Day 137

00:00 At anchor in Scots Bay. Overcast, foggy, winds 15 kts.
09:00 Anchor up, headed to Advocate Bay to drop off launches.
10:20 Launches deployed for near shore surveys.
11:00 New cook arrives.
12:00 Continue surveys in Scots Bay.
13:00 Continue surveys in Minas Channel.
21:54 Slow vessel to recover launches.
22:12 Both launches secured. Continue survey.

18 May 2007 Friday –Day 138

00:00 Transit to Saint John for an inspection by a diver, to determine if any fishing gear is fouled in the propellors.
11:00 The Omnistar RTK signal was lost several times throughout day. The problem appears to be more prevalent at night.
12:00 Survey a wreck in Anchorage C in the approaches to Saint John harbour in high resolution mode on the multibeam.
12:30 Pipit deployed for survey in Saint John harbour.
14:00 Matthew secured at the Saint John Coast Guard base. Waiting for divers.
16:45 Pipit recovered.
18:00 Depart Saint John. En route Scots Bay to continue survey.
19:00 Trouble with Knudsen sounder. An error message stating 'no SCSI or socket found' is displayed.

19 May 2007 Saturday- Day 139

00:00 Surveying in near Isle Haute. Weather calm, overcast, winds 10-20 knots. Matthew surveys the southern extent of Scots Bay and Cape d'Or.
11:00 Launches deployed near the shoreline near Baxters Harbour.
The Knudsen system is still non-operational. A call is placed to Bruce Wile (presently in Rimouski).
13:00 Wile conveys the procedure for restarting the Knudsen 3.5 kHz.
22:04 Slow vessel to recover launches.
22:23 Both launches recovered and secured. Continue survey.

20 May 2007 Sunday- Day 140

00:00 Surveying in the central portion of the bay, north of Parkers Cove coverage collected on the Creed in 2006. Weather - foggy, poor visibility, light winds, calm, sea state less than 1 m.
00:44 MVP cast.
11:00 Omnistar coverage problems throughout the day. The problem is more prevalent at night.
12:30 Launches deployed to survey for the day in an area due south of the Matthew.
Knudsen back on line.
21:57 Slow vessel to recover launches.
22:28 Both launches recovered and secure. Continue survey.

21 May 2007 Monday Day 141

00:00 Working north of Parkers Cove south of previously surveyed "Mussel" area from 1999 survey on the CCGS *Frederick G.Creed.*

10:30 Launches deployed.

11:00 Omnistar coverage problems throughout the day. The problem is more prevalent at night. Launches expand to coverage near where the Matthew is surveying. Calm, overcast with light breezes.

21:38 Slow vessel to recover launches.

22:01 Launches secured.

22:20 Resume survey.

22:34 MVP cast.

22 May 2007 Tuesday - Day 142

00:01 Surveying to expand coverage north of Digby, south of previously surveyed "Drumlin" area (Creed 1999). Calm, overcast with light breezes.

10:45 Launches deployed and working in the same block as the Matthew. Well defined sharp crested sandwaves observed on the multibeam bathymetry data.

13:30 The Kongsberg Simrad SIS computer locks up for first time this survey. Restart system.

14:30 Recover launches and steam to Saint John to exchange crew.

17:30 Alongside at the Saint John Coast Guard base.
A 1000 hour check was required on the ship's engines. The chief engineer estimates that 2 days alongside would be required for the oil change and check.

20:00 S. Hayward departs vessel to return to BIO.

23 May 2007 Wednesday- Day 143 – Saint John Coast Guard Base

Crew change day. Remain at Saint John Coast Guard base.

10:20 Hydrographers depart BIO en route to CCGS Matthew in Saint John NB.

10:30 S. Hayward and R. Parrott meet at BIO to discuss operations to date on the Matthew.

11:00 R. Parrott departs BIO en route to CCGS Matthew.

14:00 The senior engineer and technician report that the oil change and 1000 hour check have been completed.

14:30 Hydrographers arrive from BIO.

15:10 R. Parrott arrives from BIO.
S. McCavour and M. Monahan from the Port of Saint John arrive for a tour of the vessel and to discuss operational procedures used by GSC and CHS on the EM3002 launches. The Port has an identical multibeam bathymetry system as used by CHS (an EM3002) installed in one of the old CHS H-class launches (Helldiver?). McCavour and Monahan were invited for a visit to discuss ways to optimize operation of the launches. Existing coverage of Saint John was discussed. Siltation problems were encountered in the shipping lanes in Saint John last year resulting in a doubling of the amount of material that required dredging. Potential techniques for predicting the amount of infill to be expected were briefly discussed.

16:00 Coast Guard personnel arrive for crew change, after transferring from the original bus that broke down outside Saint John.

16:30 S. Parsons from CHS arrives to study the Omnistar RTK GPS. Tests run on systems in launches and on the Matthew.

18:00 CHS personnel depart for BIO.

18:30 Coast Guard personnel depart for BIO.

19:00 The captain reports that the vessel will remain alongside overnight to allow fueling operations and to give time for the engineers and mates to familiarize with the vessel.

Taking on fuel.

22:00 Fueling completed. Milk ordered for delivery in the morning. Apparently the milk supplied by the dairy was in the wrong type of container for the refrigeration units available on board.

24 May 2007 Thursday- Day 144

09:00 Milk arrives in different containers – but are still not the correct type. The delivery was not accepted.

12:00 The milk truck is returning to the deport an will return to the vessel with different containers.

14:00 Depart Saint John Coast Guard Base and start to transit to the survey area near the middle of the bay. Apparently the milk truck had not yet arrived and it was decided to improvise on containers and use the milk delivered yesterday.

14:10 Multibeam bathymetry system turned on.

14:30 Knudsen transducer extended on the ram. Knudsen 320B sounder on and recording. Homogenous sediments overlying stratified sediments overlying rough surface. (Holocene clays, glaciomarine sediments and till?) Settings – Gain = 20, AGC = off, Power level = 3, Pulse type = .75 ms chirp, TVG = off.

15:50 MVP test and casts.

16:40 MVP recovered. Continue with transit lines.

17:10 Start to deploy launches near survey site.

17:25 Deployment complete. Transit to start of line.

17:55 Start of survey lines. Infilling a block of data west of 1999 Creed survey.

18:18 Launch Pipit encounters problems with MVP system and cannot deploy sensor. A quick mechanical check does not diagnose the problem. The Pipit comes alongside to download a velocity profile taken in the area by the Matthew.

18:34 Pipit away. Resume survey line.

22:30 Recover launches and continue survey. Ship's technician checks MVP to diagnose potential problems. Apparently the switch is in an awkward position which could potentially be stepped on by anyone entering the launch.

25 May 2007 Friday- Day 145

00:01 Continue survey using Matthew.

09:00 An MVP cast is taken by *Matthew* and loaded into memory sticks for use by the launches.

11:00 Deploy launches to complete southern section of survey block.

12:30 Launch Pipit reports engine problems which limit speed to 6 knots. Speeds above 6 knots cause the engine to lose power after a short time. The manufacturers' representative is contacted and recommends use of a special diagnostic tool designed for that engine. The tool is carried on the Matthew and located by the engineers and technician.

13:10 Over thirty metres of penetration into smooth-surfaced soft sediments are observed on the Knudsen 3.5 kHz sounder, tapering to a rough surfaced hard sediment at 13:15.

13:50 Reflector at 8-10 metres on Knudsen.
The launch Pipit is still having engine problems and running at 6 knots. The launch will be recovered at the end of this line.

15:03 Recover the launch Pipit. The engineer and technician commence diagnosis of the engine problems. The error code was cleared from the display but re-occurred as soon as the engine was started. The mechanic in Dartmouth recommended contacting the mechanic in Yarmouth to arrange a service call.

16:10 Launch Plover passes on starboard side, showing overlapping coverage between Matthew and the launch. Plover to come alongside to transfer coverage plot to Matthew, and to receive a geotiff of the next survey area.

16:50 Launch Plover steaming alongside.
16:57 Data transferred to Plover.
17:22 Restart Knudsen sounder.
18:31 Launch Pipit still on board. Arrangements have been made to have the diesel mechanic meet the launch at the wharf in Digby at 08:00 AST to diagnose and repair the problem. Arrangements are being made to have a Brooke Ocean technician perform a service call on the MVP at the same time. Contact P. Fraser to inform him of planned rendezvous at 08:00.
Apparently the coxain's sounder on the Pipit had been turned on causing interference with the EM3000 system. A previous visual check of the system did not indicate that the system was active. Apparently the display did not show any activity even though the sounder was running.
19:30 On line. Launch Plover surveying area south of Matthew.
20:00 Start long MVP transect taking casts every 2 minutes.
21:40 End of MVP transect. Recover MVP.
21:50 Recover Plover, and return to survey lines.
23:50 Continuing survey.

26 May 2007 Saturday- Day 146

00:01 Continue survey using Matthew.
08:05 End of survey lines in area. Start transit to Digby to rendezvous with diesel mechanic. Data was logged during transit.
09:00 Launch Pipit deployed just outside Digby Gut to transit to Digby.
09:20 Deploy launch Plover to extend previous coverage between Parkers Cove and Digby.
09:25 Series of MVP casts taken to determine water conditions in area.
09:45 Matthew commences survey to extend coverage north of Parkers Cove. Some confusion existed over the extent of the survey coverage during the first leg of the Matthew survey this year. Not all of the survey lines had been migrated to the new project started for this leg of the survey. A significant offset was noticed on the Regulus display of the existing coverage when compared to the Global Mapper project used to assemble data from various sources. The Global Mapper project was confirmed by loading the previous lines into the Kongsberg Simrad SIS computer and comparing the results. This raises the question – why is there a discrepancy with Regulus?
15:50 Temporary repairs to launch Pipit have been completed, and the launch is returning to the Matthew. Some of the electronic sensors had been connected across a 24 volt supply, even though they were rated for 12 volts. A switch was installed to allow the coxain to override the sensor and keep the fuel pump running.
Launch Plover is at the western end of the survey line (near Digby).
Large sandwaves (17 metre amplitude) on 3.5 kHz. Sandwaves on multibeam bathymetry system. Need to check amplitude.
16:00 End of local survey. Sounders off. Launches returning to Matthew. System cleanup started on the Simrad SIS computer.
16:10 Launches back on board. Paul Fraser from GSCA joins the vessel.
Transit back to previous survey area adjacent to Grand Manan.
18:02 Start Knudsen 3.5 kHz sounder and log data. Settings – Gain = 20, AGC = off, Power level = 3, Pulse type = .75 ms chirp, TVG = off.
18:15 Deploy launch Plover.
18:55 Deploy launch Pipit. MVP streamed. SIS computer restarted and then subsequently crashed.
19:15 On line and recording.
19:25 Recover MVP and start line running.
21:47 Stop vessel to recover launches. Logging off.

22:08 Launches on board. Logging restarted

27 May 2007 Sunday- Day 147

00:01 Continue survey using Matthew.
09:00 MVP cast.
10:15 Sounders off during launch deployment.
10:30 Launches Pipit and Plover deployed.
10:35 Restart Simrad SIS computer. Clean out old display files. J. Griffin starts a new project on SIS for this area.
10:44 Start logging on Knudsen system.
11:00 Restart Kongsberg SIS program again.
11:12 Continue a survey line to west along northern edge of existing coverage. Large sandwaves present on multibeam bathymetry and sub-bottom profiler, incised into stratified sediments.
12:00 Stratified sediments up to 15 metres thick.
12:16 Problems encountered with the POS-MV system, causing incorrect heading values. System shutdown and restarted. MVP deployed in preparation for cast. Navigation string not being received by the MVP computer or by the Global Mapper computer.
12:27 More problems with the POS-MV. OmniStar system not responding. SIS computer restarted to run on differential GPS. OmniStar manuals etc. consulted to determine problems with the sytem.
14:20 MVP recovered. No cast was taken.
14:41 OmniStar system back on line.
14:52 OmniStar glitch – altitude error.
14:56 Restart POS-MV. Sounders off. Loop to infill zone of bad data.
15:57 Stratified sediment coming near to surface. Change in backscatter and small train of sandwaves observed on multibeam bathymetry.
16:10 Large features on Knudsen 3.5 kHz (mainly features in the water column) and small sandwaves on multibeam bathymetry. Stratified sediments are present to west of sandwaves and may also be present under the sandwaves, but are difficult to map.
16:34 Change beam width on multibeam to 67/67 from 70/70 due to noise on outer beams.
19:30 SVP cast. A single cast was taken for the multibeam bathymetry data, followed by ½ hour of casts to look at variability in the water column.
19:37 Features seen in the water column in an area of sandwaves on the multibeam.
19:55 Logging water column data on multibeam system. Targets in water column and 20 metres of penetration into stratified sediments on 3.5 kHz.
MVP still running.
20:04 10 metre amplitude sandwave. Lee side on the western side of the feature indication potential sediment transport from within the bay.
20:05 MVP recovered.
21:09 Sand ribbons on backscatter plot.
21:40 End of line. Sounders off for recovery of launches.
22:00 Launches recovered.
22:18 Start series of lines through Margaretsville dunefield to determine changes in large features mapped in 1993.

28 May 2007 Monday- Day 148

00:01 Continue survey using Matthew.
00:30 Large sandwaves in an area of stratified sediments. Many echos are evident in the watercolumn. Many of the large sand waves are symmetrical, others are asymmetric with the

lee slope pointing out the bay and indicate potential sediment transport from the head of the bay.

09:40 MVP cast.

10:20 Deploy launches for survey near Isle Haute. Due to the previous engine problem and the temporary repairs made, it is necessary to remain in close proximity to the launches. The Matthew will survey between Isle Haute and Cape D'Or.

10:45 Start of survey south of Isle haute running to Cape D'Or.

11:10 Beam width changed to 70/70 from 67/67 on multibeam bathymetry.

11:39 Large erosional area on multibeam. Knudsen tracking multiple for 2-3 minutes.

12:10 POV-MV problems – system recovered by itself after performing some tight turns to get the systems attention.

12:28 Back on line and surveying. Slow down to let fishing vessel 'Fundy Breeze' out of Harbourville, NS pass.

15:45 Continuing with survey near Isle Haute.

16:44 End of line to Cape D'Or. Pulse length on Knudsen changed to 3.0 ms from 0.75 ms, Spreading = 20 LogR, Gain = 0, Power = 1.

17:35 End of Line. New file started.

19:09 Extending coverage down to Cape Spencer NS and mapping nearshore extent of the eastern banner bank associated with the cape.

19:20 Reflector seen at about 20 m below seafloor on the Knudsen sub-bottom profiler. Erosion in the channel near Cape Spenser extends down to and probably beyond this reflector.

21:15 Sounders off. Recover launches.

21:40 Resume survey line.

29 May 2007 Tuesday- Day 149

10:16 Stop logging sub-bottom and multibeam to drop off the launches for the day to survey near Isle Haute.

10:45 Hard drive on SIS computer cleaned up and defragmented to remove unnecessary files.

11:04 Start logging Knudsen.

11:07 Matthew back on line and continuing to run lines in an East-West direction. Working South towards Harbourville.

11:36 End of Line. Started a new file for the 3.5 kHz.

12:36 End of Line. Started a new file for the 3.5 kHz.

13:12 End of Line. Stopped logging multibeam and sub-bottom to launch the FRC to transport R. Parrott to Harbourville for his return to BIO.

13:17 FRC in the water. Matthew is turning to resume surveying.

13:19 Started logging data again

13:23 Multibeam lost bottom tracking. Stopped logging multibeam to turn around and pick up the line again.

13:33 Back on line and logging multibeam and sub-bottom data.

14:06 Stopped logging sub-bottom profiler and multibeam to recover FRC.

14:11 FRC back on board. Started collecting multibeam and 3.5 kHz again.

14:32 New Knudsen file. Beginning to turn.

14:34 New Knudsen file. Have finished the turn and are back online.

15:51 EOL. Starting to turn. New Knudsen file.

15:53 Finished turning. New Knudsen file started.

16:04 Survey speed slowed to avoid ship traffic that is crossing our bow.

16:23 Traffic cleared. Matthew brought back up to survey speed.

17:08 EOL. Starting to turn. New Knudsen file.

17:11 Start of next line. New Knudsen file.
17:26 Slowed to measure a new sound velocity profile. There was no problem with the data but we had been using the same profile since 09:44 of May 28. The water is well mixed so there hasn't been any significant change in the velocity profile.
20:00 Slow vessel to recover launches.
20:30 Resume survey.

30 May 2007 Wednesday- Day 150

10:15 Weather sunny and calm.
10:20 Stopped logging multibeam data off Digby. Still collecting sub-bottom data. Both launches will be dropped off at Digby so the Pipit can travel into Digby for repairs. Matthew and Plover will work between Digby and Young's Cove for the day.
10:25 Stopped logging sub-bottom as the launches Pipit and Plover are deployed.
10:36 Launch Plover is away.
10:40 Launch Pipit is away to transit to Digby.
10:46 The ship's officers are conducting a test of some equipment on the bridge before the survey resumes.
11:16 Start collecting sub-bottom. Steaming to pick up end of last line.
11:17 Start logging multibeam.
11:35 Slowing to perform a sound velocity cast. MVP going into the water.
11:41 Measured a new sound velocity profile. There was little change from the previous cast.
11:45 MVP back on board.
12:07 POS-MV lost RTK for a few seconds but is back online and logging okay.
12:25 End of Line. New file for sub-bottom profiler.
13:52 End of Line. New file for sub-bottom profiler.
14:54 End of Line. Turning to head back toward Digby to pick up both launches as the repairs on Pipit are complete.
15:49 Stop collecting multibeam and sub-bottom data to recover launches
16:07 Both launches back on board. Subsequent discussions with the ship's technician indicate that some of the sensor problems with the launch Pipit may have been caused by an improperly installed ground terminal. After installation of the new electronics module the factory representative noticed that the ground strap was connected to the starting motor, rather than to the grounding strip in the hull of the launch. When the ground strap was connected in the proper manner, the problems that had been noticed with the new control module and sensors disappeared.
16:11 Starting to steam toward Isle Haute where work will continue for the remainder of the day.
16:13 Start logging sub-bottom data for the transit to Ile Haute.
16:39 Stopped collecting multibeam. Still logging sub-bottom data on the steam to Isle Haute.
17:18 Matthew stopping to deploy launches. The launches will work to fill holes in the coverage while the Matthew will survey between Isle Haute and Quaco Ledge. Stopped logging sub-bottom data.
17:22 Both launches at the rail
17:25 Launch Pipit is in the water. There is a problem starting the launch Plover. Ship's engineers are working on the problem.
17:59 Launch Plover is brought back on board for more work. Matthew will start sounding again. The problem with Plover is a bad starter. The problem will be repaired by the ship's engineers and Plover will resume surveying tomorrow.
18:08 Start sub-bottom profiler.
18:12 Slowing down to perform a sound velocity cast.

18:21 Deployed MVP to measure a new sound velocity profile.
18:26 Started logging multibeam again.
18:47 Going off line to avoid some fishing gear.
20:30 Slow and recover launch Pipit
20:40 Resume survey

31 May 2007 Thursday- Day 151

00:01 Continue survey.
10:15 Weather is overcast with light winds and calm seas. This morning Matthew will be working north of Margaretsville. The launches will be working near Isle Haute. The plan for the remainder of the survey will be to have the launches ready to go earlier in the morning (6:45 – 7:00 am ADT) to maximize the amount of time they are able to survey each day.
10:18 Both launches going in the water
10:24 Launches Pipit and Plover are away.
10:26 Start logging sub-bottom profiler and multibeam data on steam towards the start of the survey for the day.
10:39 Start of survey lines for the day.
11:17 End of line. New files for sub-bottom profiler and multibeam
11:28 Multibeam outer beam angles changed from 67 degrees to 65 degrees as there were holes in the coverage where the outer beams were not tracking the bottom.
11:49 End of line. New files for sub-bottom profiler and multibeam.
11:58 POS MV lost its RTK solution for a few seconds. It's now back online and working correctly.
12:38 End of Line. New files for sub-bottom profiler and multibeam.
13:13 End of Line. New files for sub-bottom profiler and multibeam.
14:00 EOL. New files for sub-bottom profiler and multibeam.
14:37 EOL. New files for sub-bottom profiler and multibeam.
15:23 EOL. New files for sub-bottom profiler and multibeam.
16:03 EOL. New files for sub-bottom profiler and multibeam.
16:04 Wind has picked up to 13 kts out of the northeast. This is affecting the data quality on the launches so the Pipit and Plover will steam toward Advocate Harbour to collect data in that area.
16:50 Slowing down to avoid some traffic in the area.
17:07 EOL. New files for sub-bottom profiler and multibeam.
19:22 EOL. New files for sub-bottom profiler and multibeam.
21:15 Slow vessel to recover launches
21:30 Both launches recovered and secured.

1 June 2007 Friday- Day 152

00:01 Continue survey.
10:00 Deployed launches to survey for the day.
10:15 Weather is foggy with calm seas and light wind. Matthew will be working on the Northern end of the multibeam coverage this morning running lines to the south of Quaco Ledge.
11:00 Going off line to fill a hole in data collected last night.
11:30 EOL. New files for sub-bottom profiler and multibeam.
11:40 EOL. New files for sub-bottom profiler and multibeam. Called end of line early and turned around to avoid some fishing vessels.
11:52 EOL. New files for sub-bottom profiler and multibeam
11:56 Lost POS MV for close to a minute. Back online at 11:57. This left a hole in the data that will be filled on the next pass.

12:13 EOL. New files. Poor visibility and heavy traffic in area.
12:41 EOL. New files for sub-bottom profiler and multibeam.
13:20 Changing course to avoid fishing traffic in the area. This will leave a hole in the data that will need to be filled later. There was also a problem with the outer beams losing bottom tracking. The beam angles were brought in to 65 degrees from 70 degrees to correct the problem.
13:30 Back on line after avoiding fishing traffic.
13:56 EOL. Start transit North to Quaco ledge to get away from the fishing vessels in this area. Continue logging both multibeam and sub-bottom during the transit.
14:06 Arrived at survey area near Quaco ledge. Start of line. Multibeam beam angles changed from 60 degrees to 70 degrees.
14:44 Multibeam beam angles changed from 70 to 65 degrees.
16:00 Lost OmniStar RTK corrections and CDGPS as well. Switched to Coast Guard RTCM DGPS for horizontal postion on POS MV. The loss of the OmniStar corrections means there will be no GPS tide for this line. Omnistar back online after 8 – 10 minutes and POS MV went down for a few seconds while it switched back to RTK mode.
17:09 Slowing down for traffic.
17:19 Surveying over large sandwaves. (15 – 20 m)
17:36 EOL. New files for sub-bottom profiler and multibeam.
18:39 EOL. New files for sub-bottom profiler and multibeam.
21:04 Steaming past Ile Haute to pick up launches. Stopped logging multibeam to reboot the SIS computer.
21:13 Slow to recover launches.
21:27 Launches recovered.

2 June 2007 Saturday - Day 153

00:01 Continue survey.
09:45 Deploy launches. Weather is foggy with poor visibility. Winds are light and seas are calm.
10:19 This morning Matthew has been working south of Quaco Ledge but will transit North because of heavy traffic and poor visibility. Work will continue off the Eastern side of Quaco Ledge running lines in an East-West direction.
11:30 EOL. New files for sub-bottom profiler and multibeam. Fog has lifted and visibility has improved.
11:45 Lost the OmniStar RTK corrections for a few seconds. POS MV has switched to Coast Guard RTCM DGPS.
11:48 Omnistar is back online. POS MV back in RTK mode.
11:50 Lost POS MV for a few seconds after it changed back to RTK mode.
12:28 EOL. New files for sub-bottom profiler and multibeam.
13:01 Altering course slightly to fill a hole in the coverage.
13:23 EOL. New files for sub-bottom profiler and multibeam.
14:33 EOL. New files for sub-bottom profiler and multibeam.
16:29 EOL. New files for sub-bottom profiler and multibeam.
17:28 EOL. New files for sub-bottom profiler and multibeam.
18:26 EOL. New files for sub-bottom profiler and multibeam.
19:07 EOL. New files for sub-bottom profiler and multibeam.
20:56 Stop logging multibeam and sub-bottom profiler to pick up launches.
21:07 Launch Pipit is on board.
21:14 Launch Plover is on board.

3 June 2007 Sunday - Day 154

00:01 Continue survey.
10:15 Weather is sunny and calm. Light winds.
10:34 Stop logging multibeam and Knudsen to drop off launches for the day near Ile Haute. The launches will steam to Advocate Harbour where they will survey for the day.
10:45 Both launches in the water.
10:47 Start logging multibeam. There are problems connecting to the sub-bottom profiler at this time.
11:14 Sub-bottom profiler is back online after restarting the Knudsen computer in the transducer room and following the procedures in the Knudsen Procedures.rtf document. J. Griffin suggested remotely connecting to the desktop of the Knudsen computer in the transducer room instead of running the Echo SCSI Server software.
11:14 Deployed MVP.
11:30 MVP set to autodeploy at 2 minute intervals while Matthew surveys a line heading North to connect the Isle Haute data to the Chignecto data collected on the Creed in 2006.
11:45 Lost POS MV for a few seconds.
12:06 slowing to recover MVP.
12:10 MVP on board.
12:14 EOL. New files for multibeam and sub-bottom profiler. Due to a large amount of fishing gear in the area Matthew will survey south to the Isle Haute coverage and continue to work in that area.
12:39 Slowed down and turned as Matthew has hooked onto some fishing gear.
12:42 Back online after shedding the fishing gear.
13:12 EOL. New files. Matthew has finished the line running south and is turning to the west to run the lines to the north of Isle Haute.
14:36 EOL. Stop logging multibeam to reboot SIS computer.
14:41 Start logging multibeam again.
16:42 EOL. New files for multibeam and sub-bottom profiler.
17:54 EOL. New files for multibeam and sub-bottom profiler.
19:07 EOL. New files for multibeam and sub-bottom profiler.
21:01 Lost connection to Sub-bottom profiler.
21:03 Stop logging multibeam data to pick up launches.
21:15 Launch Pipit onboard.
21:22 Launch Plover onboard. Preparing to take a sound velocity cast.
21:31 Sub-bottom profiler back up and running.

4 June 2007 Monday - Day 155

00:01 Continue survey.
10:15 Rain and moderate to high winds out of the South (15 Kts in Scots Bay, 20 - 25 Kts near Parkers Cove). Both launches are working in Scots Bay near the coast where they will have some shelter from the winds out of South. Matthew will survey lines along the coast from Scots Bay to Parkers Cove.
10:31 EOL. New files for the sub-bottom profiler and multibeam.
10:40 Slowing down to deploy MVP.
10:48 Measured a new sound velocity profile. Surface temperature is near 8 degrees C.
11:35 Lost Omnistar RTK corrections. POS MV has switched to RTCM differential.
11:40 Lost POS MV for a few seconds as it switched back to RTK mode. Back online and operating now.
13:32 Slowing down to deploy MVP.

13:38 Measured a new sound velocity profile. The water is significantly colder at the surface off Bridgetown than it was this morning in Scots Bay.
13:49 EOL. New files. Launch Plover is having some problems so we are turning to survey back towards Scots Bay.
16:53 EOL. Stop logging multibeam and sub-bottom profiler as we are stopped to pick up launch Plover.
17:02 The problem with the launch Plover was caused by some rope wrapped around the propeller. The rope will be removed and the Plover will be sent back out to continue surveying.
17:11 Launch Plover away.
17:18 Matthew back online and logging multibeam and sub-bottom profiler.
17:33 EOL. New files for multibeam and sub-bottom profiler.
20:50 Stop logging data to pick up launches.
21:06 Launch Plover on board.
21:15 Launch Pipit on board.

5 June 2007 Tuesday - Day 156

00:01 Continue survey.
09:45 Dropping off launches to survey for the day. Pipit will survey in Scots Bay while Plover will work on the coast between Baxters Harbour and Halls Harbour. Matthew will continue to run lines from Scots Bay to Margaretsville. Matthew will not survey further than Margaretsville to stay within 1.5 – 2 hours from the launches in case they have problems. Yesterday Matthew was 3 hours away when the Plover had its problem. Weather today is cloudy with periods of rain. Winds of 15–20 knots from the South. Winds are lighter in Scots Bay (7 – 10 knots).
10:21 EOL. Stop logging multibeam and sub-bottom profiler while stopped to measure the ship's freeboard.
10:28 Back online and logging again.
11:58 EOL. New files for multibeam and sub-bottom profiler.
12:12 EOL. New files. Running two short lines to fill a hole in the coverage.
12:24 EOL. New files. Back on the main survey line.
14:00 POS-MV is running in RTCM DGPS mode as we had lost the Omnistar RTK corrections for a few minutes. We are receiving the Omnistar corrections again but the POS MV will continue to run in RTCM mode until the Omnistar accuracy improves.
14:10 EOL. New file for the sub-bottom profiler. We did not start logging a new line for the multibeam as we will wait until the Omnistar accuracy improves so we will be able to calculate GPS tides for the start of the next line.
14:12 POS MV has switched back to RTK mode.
14:14 Lost POS MV for a few seconds.
14:15 POS MV is back operating correctly now. Multibeam line incremented automatically at this time. There will be no GPS tide measurements for the end of the previous line and the beginning of this line.
14:38 Omnistar vertical accuracy has improved to ~10 cm.
15:22 SIS has stopped drawing realtime coverages so we have stopped logging multibeam to reboot the SIS computer and clean out project files that aren't needed.
16:20 Sea state has increased. Swells of greater than one metre.
16:22 Lost Omnistar corrections. POS MV is operating in RTCM differential mode.
16:25 Receiving Omnistar corrections again. POS MV will continue to operate in RTCM mode until RTK accuracy improves.

16:29 SVP warning yellow. Surface water temperature seems to have cooled by a couple of degrees with the incoming tide.
16:42 POS MV is back operating in RTK mode. It is expected to lose positioning.
16:43 Stopped logging multibeam since we are at the end of the line and we anticipate losing the POS MV positioning. We will hold off making our turn until after the POS MV goes down.
16:47 Lost POS MV while it switched back to RTK mode. It is back in operation now.
16:48 POS MV is back online and multibeam logging has been restarted.
18:22 EOL. New files for multibeam and sub-bottom profiler.
21:10 Recover both launches and continue survey.

6 June 2007 Wednesday - Day 157 - Saint John NB

00:01 Continue survey.
09:30 Steaming to Saint John where we will tie up to take on fuel and provisions. Plan to sail again at 09:00 ADT on Thursday June 7. Visibilty is poor.
10:42 Stopped logging sub-bottom profiler for a few minutes to raise the ram before entering the harbour at St. John.
11:37 Lost POS MV for a few seconds as it changed modes back to RTK mode.
11:53 Sub-bottom profiler switched to a 6 ms chirp from 3 ms.
12:00 Pump in transducer room turned off.
12:01 Sub-bottom profiler switched back to 3 ms chirp. It has lost bottom tracking and is tracking the sub-bottom as bottom. Transducer blanking reduced to 10 m.
12:24 Stopped collecting multibeam and sub-bottom as we are entering Saint John harbour. Stopped the surface calculation on Olex as well.
13:05 Vessel tied up at the Coast Guard base in Saint John. R. Parrott will join the ship today.
17:00 R. Parrott joins the vessel.
19:30 John Hughes Clarke (jhc) and students from the Netherlands join the vessel for a comprehensive tour of the facilities to see the hardware and processing setup on the vessel. Discussion held about upcoming surveys of Grand Manan, display of multibeam bathymetry and sub-bottom profiler data as a webpage and in the ArcMap environment. A copy of the multibeam bathymetry and sub-bottom profiler data were provided to jhc on a portable drive
22:00 John Hughes Clarke and students depart Matthew. Copy of multibeam bathymetry and 3.5 kHz sub-bottom profiler data provided to John Hughes Clarke for experimentation with techniques for display of multibeam and 3.5 kHz.

7 June 2007 Thursday - Day 158

00:01 Secure in Saint John, NB.
14:30 Depart Saint John. Clear skies, light winds good visibility.
14:55 Extend transducer ram. Start logging Knudsen 3.5 kHz. Start pump in transducer room. Multibeam system operational.
15:10 Change Knudsen sounder to internal triggering while adjustments made to multibeam system.
15:15 Return Knudsen to external triggering from the multibeam bathymetry system.
15:20 Wedge of fine sediments seen in the harbour approaches thins. Glacial till (?) at surface.
16:20 Alter course to run line. Start lines on multibeam and sub-bottom profiler.
16:30 MVP cast.
16:35 Start series of MVP casts on a 5 minute interval. Water temperature varies from about 6.3 C at the surface to 5.6 C at 5 m from the seafloor. Velocity varies from 1472.5 at surface to 1470.5 at depth.
18:00 EOL. Start new line on reciprocal course.
18:15 End of MVP transect. Gear secured on deck.

20:00 EOL. Start new line on reciprocal course.
21:30 EOL. Stop to take draft measurement.
21:42 SOL on reciprocal course.
23:10 EOL/SOL on reciprocal course. Several fishing boats in the area about 1 nautical mile north of the present survey line.

8 June 2007 Friday - Day 159

00:01 Continue survey in centre of bay.
01:17 End of line. Alter course to head further south towards NS side to keep away from fishing activity at other end of survey line.
01:40 Infilling holes in coverage in area of horse mussel reefs and sandwaves.
03:00 Start a long southwest trending survey line in transit to Brier Island.
09:22 MVP cast.
09:45 Deploy launches for a survey of a shoal near Brier Island. Light winds, calm, sunny.
Infill large wedge-shaped gap in coverage from 2006 Creed survey.
11:35 Problems with heading in POS-MV. Stop logging. Vessel turns in a slow circle to clear problem.
11:40 Restart logging.
12:00 End of line. Start new line on reciprocal course.
12:15 MVP cast.
12:30 Start transect of MVP cast at 5 minute intervals.
13:30 Gear in water – stop MVP
13:40 Continue MVP transect
13:50 MVP recovered.
14:14 End of line. Start new line on reciprocal course.
14:35 Simrad EM710 not tracking the seafloor properly. The seafloor had been quite rough and the system did not track the change from bedrock to sediment properly. The system has been reset. Returning to a point about 5 minutes back the line to resume surveying.
17:02 Start line to infill Creed coverage. Beam angle increased to 74 degrees each side as a test of coverage.
17:15 Beam angle returned to 70 degrees each side.
18:57 Start of line to southwest.
20:02 End of line.
20:08 Start new line on reciprocal course. Returning on survey line to rendezvous with launches.
21:00 Slow vessel to recover launches.
21:23 Start MVP cast
21:33 Recover MVP and resume survey.
23:20 End of line. Start new line on reciprocal course.

9 June 2007 Saturday - Day 160

00:01 Continue survey off Brier Island.
00:27 Start new line on reciprocal course. Turn for launches.
00:40 MVP out for profile collection, 5min interval.
00:45 New SVP used.
01:24 EOL/Start new line on reciprocal course (NE).
09:00 MVP cast
09:45 Deploy both launches near Brier Island. Calibrate ship's radio direction finder.
10:20 Start survey. Infill gaps in coverage near Brier Island. Sunny, no wind, flat calm.
10:40 End of southwest trending line.

10:42 Start of northeast trending line.
11:30 Loop to fix heading problem in POS-MV
11:33 Start logging Knudsen which had been left off at the last end of line.
12:10 Start logging true heave on POS-MV
12:20 Start MVP profile
12:44 Disable MVP profiles for turn and while near fishing gear.
12:53 End of southwest trending line. Slow vessel for turn.
12:58 On line, vessel back to survey speed of 10 knots.
13:11 Restart MVP profiles.
14:03 End of MVP transect. Slow for turn.
14:06 Restart survey line.
14:12 Restart MVP transect. Speed through the water 13 knots. MVP resets and brings the fish to surface.
15:00 End of MVP transect. Slow for turn.
15:07 Restart survey line heading northeast.
15:10 Restart MVP transect.
15:14 Disable MVP auto-deploy after one cast. Fishing gear ahead.
15:30 Restart MVP casts.
16:43 Slow for turn. Start line to southwest. Resume MVP cast.
18:08 End of MVP transect. Recover MVP fish.
18:10 MVP secured on deck. Resume survey line.
18:30 Slow for turn. Start line to northeast.
21:12 Stop logging data to pick up launches.
21:30 Launches secured on deck.
21:50 MVP cast. Leave fish in water for later casts.
Infill gap off Long Island from 2006 Creed survey.

10 June 2007 Sunday - Day 161

00:01 Continue survey off Brier Island.
Recover MVP and secure on deck.
09:15 MVP cast.
09:45 Deploy launches near Grand Manan. P. Fraser is on board the launch Pover to observe and participate in operations for the day.
10:00 Matthew starts running lines south of Grand Manan to expand previous coverage.
10:25 Problems with POS-MV heading. Turn vessel in a loop to clear problem. This has become a daily occurrence at about this time. The mate had noticed that it appears to occur about 5 minutes earlier each day, and had predicted the time for this problem.
12:30 MVP cast. End of line. Continue survey on reciprocal course.
Highly variable water column conditions. Successive MVP casts show large changes in properties. Surveying over Northeast Bank on Grand Manan Banks.
13:15 MVP cast. Set system for transect with a profile every 5 minutes.
15:10 End of line. Continue survey on reciprocal course heading southwest towards Northeast Bank.
15:15 MVP cast.
16:18 MVP cast.
16:38 MVP cast.
17:20 MVP cast at end of line.
17:25 End of line. Continue survey on reciprocal course heading northeast from Northeast Bank.
19:30 Start a series of short lines to infill coverage south of Proprietor Shoal.
20:42 Complete infill lines. Logging off to recover launches.

21:20 Launches recovered and secure.
21:22 Continue with survey south of Grand Manan. Lines will be about 50 km long, for a duration of 3 hours.
23:20 Start backup of 3.5 kHz data to portable drive.
23:30 MVP cast.
23:55 Slow to retrieve MVP.

11 June 2007 Monday - Day 162

00:01 Continue survey off Brier Island.
09:45 Deploy launches.
10:15 Transit to area east of Grand Manan to run line towards Blacks Harbour.
10:58 Slow to deploy MVP.
11:05 MVP cast stopped 2/3 of the way down. Press 'Recover' button to recover. After a visual inspection of the drum to ensure that there were no problems with the cable, the cast was repeated.
11:18 New SVP loaded into SIS
11:20 POS-MV heading problems. The duration was only 2-5 seconds, and the line was continued.
12:10 MVP cast. Recover and secure towfish.
12:31 Omnistar out. POS MV running in RTCM differential mode.
12:33 POS MV back in RTK mode
12:34 Lost POS MV position for a few seconds.
12:51 Stop logging multibeam and sub bottom profiler. Launching FRC to drop R. Parrott in Black's Harbour.
12:56 FRC deployed.
13:04 Start logging data again. Matthew on a slow steam towards Black's Harbour while waiting for FRC to return.
13:37 Stop logging to pick up FRC.
13:54 FRC back on board. Logging started.
14:41 Stop logging to reboot SIS computer.
14:46 Logging started again.
15:22 Knudsen lost bottom tracking for a few minutes.
16:08 Alter course to steam toward survey area South of Grand Manan.
16:32 Resume survey South of Grand Manan.
17:32 Slow down to deploy MVP.
17:40 New MVP cast.

12 June 2007 Tuesday - Day 163

10:30 Continue working South of Grand Manan. Launches working off Grand Manan North of Old Proprietor Shoal. Winds are from the Northeast at 10 – 15 knots with scattered showers and seas of 0.5 m to 1 m.
11:08 Lost Omnistar RTK corrections. POS MV operating in RTCM mode.
11:13 Omnistar back online. POS MV back in RTK mode. Have stopped logging data and the *Matthew* is performing a slow turn to avoid the heave problems that occur when the POS MV switches back to RTK mode.
11:16 POS MV lost it's positioning. Matthew still in a slow turn.
11:19 Back online. POS MV operating in RTK mode with Omnistar corrections. Restarted data logging.
16:01 Stop logging data. Rendezvous with launch Pipit to exchange coverage lines.

21:30 Changed sounder mode from ‘Very shallow’ to ‘Shallow’ to better track soft bottom in 130m depth.

13 June 2007 Wednesday - Day 164

00:00 Last night of sounding. Expected time of departure is 6:30am (local time).

10:30 Finishing last survey line before departing for Halifax.
11:03 Lost Omnistar corrections. Constellation problem?? POS MV has switched to RTCM mode.
11:10 POS MV switched back to RTK mode. EOL. Start steam to Halifax.
11:14 Stop logging Knudsen to raise ram.
11:16 Resume logging Knudsen.
11:33 Stop logging Knudsen data.
12:27 Lower ram and resume logging Knudsen data.
14:50 Matthew has hooked onto some fishing gear. Knudsen ram raised. Stopped to try to untangle gear.
14:56 Matthew is clear of the fishing gear and back underway. Knudsen ram lowered.
18:24 Stopped logging Knudsen. Seas have picked up and data quality is poor.

14 June 2007 Thursday - Day 165

13:15 Entering Halifax Harbour.

Appendix III - Predicted Tides for Digby

Hourly values in metres above chart datum – generated by the program Tides and Currents version 4.2 by Nautical Software Inc. Times are shown in Atlantic Daylight Time. Heights are metres above chart datum, with 12 hourly predictions per line.

Date	Time	Tide	Tide	Tide	Tide	Tide	Tide	Tide	Tide	Tide	Tide	Tide	Tide
2007 Apr 25	12:00a	7.3	7.1	9	12.2	16.2	20.1	22.9	23.7	22.2	19.2	15.4	11.2
2007 April 25	12:00p	7.8	6.2	6.9	9.4	13	17	20.6	22.6	22.5	20.6	17.5	13.8
2007 April 26	12:00a	10	7.5	7.1	8.8	11.8	15.7	19.6	22.5	23.4	22.2	19.3	15.6
2007 April 26	12:00p	11.5	8	6.3	6.9	9.4	12.9	17	20.7	22.9	22.8	20.8	17.7
2007 April 27	12:00a	13.8	9.9	7.2	6.7	8.4	11.5	15.4	19.5	22.6	23.6	22.3	19.4
2007 April 27	12:00p	15.6	11.3	7.7	6	6.8	9.4	13.2	17.5	21.4	23.5	23.2	21
2007 April 28	12:00a	17.6	13.4	9.2	6.4	6.1	8	11.4	15.6	20	23.1	23.8	22.3
2007 April 28	12:00p	19.1	15.1	10.6	6.9	5.6	6.8	9.8	13.9	18.6	22.5	24.3	23.5
2007 April 29	12:00a	20.8	16.9	12.3	8	5.5	5.6	8	11.8	16.4	20.9	23.7	24
2007 April 29	12:00p	21.9	18.4	14	9.3	6	5.3	7.2	10.7	15.3	20.1	23.8	24.9
2007 April 30	12:00a	23.4	20.1	15.6	10.7	6.5	4.6	5.6	8.6	12.9	17.8	22.1	24.3
2007 April 30	12:00p	23.8	21.1	17.1	12.3	7.8	5.2	5.5	8.1	12.3	17.3	22	24.9
2007 May 1	12:00a	25.1	22.7	18.7	13.8	8.7	5.1	4.2	6.1	9.8	14.6	19.6	23.3
2007 May 1	12:00p	24.6	23.1	19.7	15.3	10.4	6.4	4.9	6.2	9.7	14.4	19.5	23.8
2007 May 2	12:00a	25.7	24.7	21.4	16.8	11.5	6.8	4.1	4.4	7.2	11.6	16.7	21.4
2007 May 2	12:00p	24.2	24.3	21.9	18	13.2	8.6	5.5	5.1	7.5	11.6	16.7	21.7
2007 May 3	12:00a	25.1	25.7	23.6	19.6	14.6	9.3	5.2	3.8	5.3	8.9	13.6	18.8
2007 May 3	12:00p	22.9	24.6	23.5	20.4	16.1	11.3	7.1	5.1	6	9.2	13.8	18.9
2007 May 4	12:00a	23.4	25.8	25.2	22.2	17.7	12.4	7.5	4.3	4.1	6.6	10.7	15.7
2007 May 4	12:00p	20.6	23.8	24.4	22.4	18.8	14.3	9.6	6.2	5.4	7.3	11.1	15.8
2007 May 5	12:00a	20.8	24.5	25.8	24.1	20.5	15.8	10.6	6.2	4.1	5	8.2	12.6
2007 May 5	12:00p	17.5	21.9	24.2	23.7	21.1	17.2	12.7	8.5	6	6.2	8.8	12.8
2007 May 6	12:00a	17.5	22.1	25	25.2	22.9	18.9	14.1	9.3	5.6	4.5	6.2	9.7
2007 May 6	12:00p	14.2	18.9	22.6	24	22.8	19.8	15.8	11.6	7.9	6.2	7.2	10.2
2007 May 7	12:00a	14.3	18.8	22.9	25	24.4	21.6	17.6	12.9	8.4	5.5	5.2	7.4
2007 May 7	12:00p	11.1	15.5	19.8	22.9	23.5	21.9	18.7	14.8	10.8	7.7	6.6	8.1
2007 May 8	12:00a	11.3	15.4	19.7	23.2	24.7	23.6	20.6	16.5	12	8	5.6	5.8
2007 May 8	12:00p	8.3	12	16.3	20.4	22.9	23.2	21.2	18	14.2	10.4	7.6	7
2007 May 9	12:00a	8.7	12	16	20.1	23.3	24.4	23.1	20	15.9	11.5	7.7	5.7
2007 May 9	12:00p	6.2	8.8	12.6	16.9	20.7	23.1	23.1	21	17.7	13.8	10.1	7.4
2007 May 10	12:00a	6.9	8.7	12.1	16.2	20.3	23.4	24.4	23	19.7	15.6	11.2	7.5
2007 May 10	12:00p	5.5	6.1	8.9	12.9	17.2	21.2	23.6	23.5	21.3	17.7	13.6	9.7
2007 May 11	12:00a	6.9	6.3	8.2	11.8	16.1	20.4	23.6	24.7	23.2	19.8	15.5	10.9
2007 May 11	12:00p	7	4.9	5.6	8.7	12.9	17.6	21.9	24.5	24.4	21.9	18	13.5
2007 May 12	12:00a	9.1	5.9	5.2	7.3	11.2	15.8	20.5	24.1	25.4	23.8	20.2	15.5
2007 May 12	12:00p	10.6	6.3	4	4.9	8.3	13	18.1	22.9	25.7	25.6	22.7	18.3
2007 May 13	12:00a	13.3	8.3	4.6	3.8	6.1	10.4	15.5	20.8	24.9	26.3	24.5	20.5
2007 May 13	12:00p	15.4	10.1	5.4	3	4.1	7.9	13.2	18.9	24.1	27.2	26.8	23.5
2007 May 14	12:00a	18.5	12.8	7.2	3.1	2.3	5	9.8	15.4	21.3	25.8	27.2	25.1
2007 May 14	12:00p	20.7	15.2	9.4	4.3	2	3.5	7.9	13.6	19.8	25.4	28.5	27.7
2007 May 15	12:00a	23.8	18.3	12.1	5.9	1.7	1.2	4.3	9.5	15.6	21.9	26.6	27.7
2007 May 15	12:00p	25.2	20.5	14.8	8.7	3.4	1.4	3.5	8.2	14.3	20.8	26.6	29.4
2007 May 16	12:00a	28.1	23.7	17.9	11.2	4.7	0.6	0.6	4.2	9.7	16.1	22.6	27.2
2007 May 16	12:00p	27.9	25	20.1	14.2	7.9	2.9	1.4	3.9	8.9	15.1	21.8	27.5
2007 May 17	12:00a	29.7	27.8	23.2	17.1	10.3	3.8	0.2	0.7	4.7	10.3	16.8	23.2
2007 May 17	12:00p	27.3	27.4	24.3	19.4	13.5	7.3	2.7	1.9	4.8	9.9	16.1	22.6

2007 May 18	12:00a	27.8	29.3	27	22.2	16.2	9.4	3.4	0.4	1.5	5.6	11.1	17.6
2007 May 18	12:00p	23.6	27	26.6	23.3	18.5	12.8	6.9	3	2.8	6	10.9	16.9
2007 May 19	12:00a	23.1	27.6	28.5	25.8	21.1	15.2	8.8	3.3	1.1	2.7	6.8	12.2
2007 May 19	12:00p	18.3	23.7	26.4	25.5	22.2	17.6	12.2	6.8	3.6	4	7.2	12
2007 May 20	12:00a	17.7	23.3	27	27.3	24.5	20	14.4	8.4	3.7	2.2	4.1	8.1
2007 May 20	12:00p	13.2	18.8	23.5	25.5	24.4	21.2	16.8	11.7	7	4.5	5.2	8.4
2007 May 21	12:00a	12.9	18.2	23.2	26.2	26.1	23.3	18.9	13.7	8.3	4.4	3.4	5.4
2007 May 21	12:00p	9.3	14.1	19.2	23.2	24.7	23.4	20.3	16.1	11.4	7.3	5.3	6.2
2007 May 22	12:00a	9.3	13.6	18.5	22.9	25.3	24.9	22.2	18	13.2	8.4	5.1	4.6
2007 May 22	12:00p	6.6	10.2	14.8	19.4	22.9	24	22.6	19.6	15.7	11.3	7.7	6.1
2007 May 23	12:00a	7	9.9	14	18.5	22.4	24.4	23.9	21.3	17.4	12.9	8.6	5.8
2007 May 23	12:00p	5.5	7.5	11	15.3	19.6	22.6	23.5	22.1	19.2	15.4	11.3	8
2007 May 24	12:00a	6.5	7.5	10.3	14.1	18.3	21.9	23.7	23.2	20.7	17	12.8	8.8
2007 May 24	12:00p	6.3	6.1	8.1	11.5	15.6	19.7	22.5	23.3	21.9	19	15.3	11.4
2007 May 25	12:00a	8.1	6.7	7.7	10.3	14	18	21.5	23.2	22.7	20.3	16.8	12.8
2007 May 25	12:00p	9	6.6	6.5	8.5	11.9	16	19.9	22.7	23.4	21.9	19	15.2
2007 May 26	12:00a	11.2	7.9	6.6	7.6	10.2	13.9	17.9	21.3	23	22.4	20	16.5
2007 May 26	12:00p	12.6	8.9	6.6	6.7	8.9	12.3	16.5	20.4	23.1	23.6	21.9	18.8
2007 May 27	12:00a	14.8	10.7	7.4	6.3	7.4	10.2	14	18.1	21.5	23	22.3	19.7
2007 May 27	12:00p	16.1	12.1	8.4	6.5	6.9	9.3	13	17.3	21.3	23.7	23.8	21.8
2007 May 28	12:00a	18.3	14	9.7	6.6	5.8	7.3	10.4	14.5	18.8	22	23.2	22.1
2007 May 28	12:00p	19.2	15.4	11.2	7.7	6.2	7.1	10	14	18.5	22.4	24.4	23.9
2007 May 29	12:00a	21.3	17.4	12.8	8.5	5.7	5.5	7.5	11.1	15.5	19.8	22.7	23.3
2007 May 29	12:00p	21.7	18.4	14.3	10.1	6.9	6	7.6	11	15.4	20.1	23.6	24.9
2007 May 30	12:00a	23.7	20.5	16	11.2	7	4.9	5.4	8.1	12.2	16.9	21.1	23.4
2007 May 30	12:00p	23.3	21	17.3	12.9	8.7	6.2	6.1	8.4	12.4	17.1	21.7	24.7
2007 May 31	12:00a	25.1	23.1	19.2	14.4	9.4	5.7	4.4	5.8	9.2	13.8	18.6	22.4
2007 May 31	12:00p	23.9	22.9	20	15.9	11.3	7.5	5.7	6.6	9.6	14	19	23.2
2007 June 1	12:00a	25.4	24.9	22	17.7	12.5	7.7	4.6	4.4	6.7	10.6	15.5	20.3
2007 June 1	12:00p	23.4	24	22.2	18.7	14.4	9.8	6.5	5.7	7.5	11.1	15.8	20.7
2007 June 2	12:00a	24.4	25.7	24.2	20.7	16	10.7	6.3	4.1	4.9	7.9	12.2	17.2
2007 June 2	12:00p	21.7	24	23.6	21.2	17.4	12.9	8.5	5.9	6.1	8.6	12.6	17.5
2007 June 3	12:00a	22.2	25.2	25.5	23.2	19.2	14.3	9.2	5.3	4.1	5.7	9.3	13.9
2007 June 3	12:00p	18.8	22.7	24.2	23	20	16	11.5	7.6	5.8	6.8	9.9	14.1
2007 June 4	12:00a	19	23.3	25.5	24.9	22	17.8	12.8	7.9	4.7	4.4	6.8	10.7
2007 June 4	12:00p	15.4	20.1	23.4	24.1	22.2	18.9	14.8	10.4	6.9	5.9	7.6	11.1
2007 June 5	12:00a	15.5	20.2	24	25.5	24.2	20.9	16.4	11.5	7	4.5	5	7.8
2007 June 5	12:00p	12	16.7	21.2	23.9	23.8	21.5	17.9	13.7	9.4	6.5	6.1	8.3
2007 June 6	12:00a	12.1	16.6	21.1	24.5	25.3	23.5	19.8	15.3	10.4	6.3	4.4	5.5
2007 June 6	12:00p	8.8	13.1	17.9	22.1	24.2	23.7	21	17.2	12.8	8.7	6.1	6.2
2007 June 7	12:00a	8.8	12.7	17.3	21.7	24.7	25.1	22.9	19	14.3	9.6	5.8	4.4
2007 June 7	12:00p	5.9	9.5	14	18.8	22.8	24.7	23.8	20.7	16.7	12.2	8.1	5.7
2007 June 8	12:00a	6	8.9	13	17.7	22	24.9	25	22.5	18.4	13.7	9	5.4
2007 June 8	12:00p	4.3	6.1	10	14.7	19.6	23.6	25.2	24.1	20.8	16.4	11.7	7.5
2007 June 9	12:00a	5.1	5.6	8.6	12.9	17.7	22.2	25	25	22.4	18.2	13.4	8.6
2007 June 9	12:00p	5	4.1	6.2	10.2	15.2	20.2	24.3	25.9	24.6	21	16.4	11.4
2007 June 10	12:00a	6.9	4.4	4.9	8	12.5	17.5	22.2	25.1	25.2	22.5	18.2	13.3
2007 June 10	12:00p	8.4	4.7	3.8	6	10.3	15.5	20.8	25	26.7	25.2	21.4	16.5
2007 June 11	12:00a	11.1	6.3	3.5	4	7.2	11.9	17.2	22.2	25.4	25.5	22.8	18.4
2007 June 11	12:00p	13.3	8.2	4.3	3.4	5.8	10.3	15.7	21.3	25.8	27.5	25.8	21.8
2007 June 12	12:00a	16.5	10.8	5.5	2.6	3.1	6.5	11.4	17	22.3	25.7	25.8	23
2007 June 12	12:00p	18.5	13.3	7.9	4	3.1	5.7	10.3	15.9	21.8	26.5	28.1	26.2
2007 June 13	12:00a	21.9	16.4	10.4	4.8	1.8	2.5	6.1	11.1	17	22.6	26	26

2007 June 13	12:00p	23.1	18.6	13.2	7.7	3.7	3	5.7	10.5	16.3	22.3	27	28.4
2007 June 14	12:00a	26.3	21.8	16.1	9.8	4.2	1.3	2.3	6	11.2	17.3	22.9	26.2
2007 June 14	12:00p	26	22.9	18.3	12.9	7.3	3.5	3.1	6.1	10.9	16.8	22.8	27.3
2007 June 15	12:00a	28.3	25.9	21.3	15.6	9.2	3.6	1.2	2.5	6.4	11.7	17.8	23.3
2007 June 15	12:00p	26.2	25.6	22.4	17.9	12.4	6.9	3.4	3.6	6.8	11.6	17.4	23.3