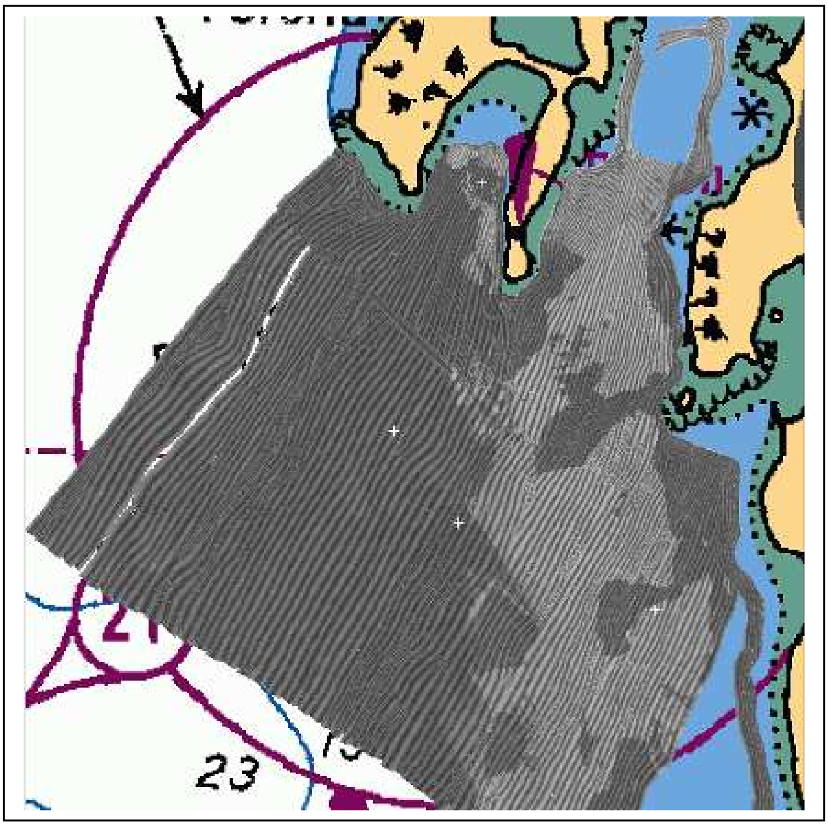
GEOLOGICAL SURVEY OF CANADA
OPEN FILE 4986

Cruise Hart 2003009 Geophysical Surveys near Yarmouth, NS, 17-30 April 2003



D.R. Parrott

2010

Natural Resources Canada / Ressources naturelles Canada

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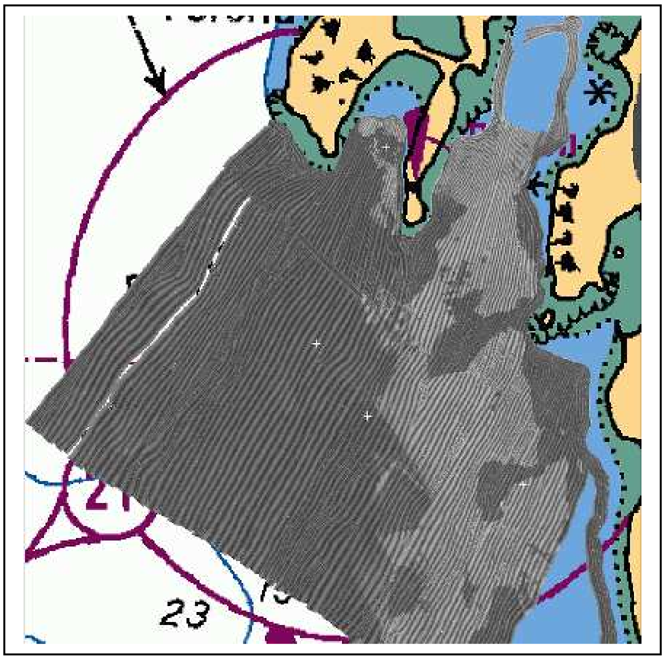

D.R. Parrott

2010

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Parrott, D.R. 2010. Cruise Hart 2003009 Geophysical Surveys near Yarmouth, NS, 17-30 April 2003; Geological Survey of Canada, Open File 4986, 59 p.

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Background

Canada's ports and harbours require routine dredging to maintain operational viability and allow passage of deep-draft vessels. Dredge spoils from these operations are often placed in offshore disposal sites. Monitoring of these disposal sites is required to understand the long-term fate of the dredged materials.

The Geological Survey of Canada (GSC), an agency of Natural Resources Canada (NRCan) have initiated a project "Assessing Marine Environmental Quality in coastal Waters of Eastern Canada", that is designed to assess the effects of human activities in marine environments. The project will provide decision makers with geoscience information to resolve user conflicts and balance competing demands for seafloor use and development with conservation. One of the project priorities is to assess the impact of marine disposal of dredge spoil. Conceptual models will be developed for the behaviour of material in disposal sites under various marine environments, ranging from quite sheltered areas to exposed sites with high tidal and current stress. The project focuses on sites with differing degrees of human impact, management, and user conflict. The project will provide outputs, consisting of maps conforming to new marine-mapping protocols, databases in high-priority areas, conceptual models and reports. The primary outcome of this project will be that ocean-management decisions made by stakeholders will be based on sound scientific information collected by NRCan.

Environment Canada (EC) is mandated with the responsibility to administrate the Disposal at Sea Regulation under Part 7 of the Canadian Environmental Protection Act (CEPA). CEPA requires the Minister of Environment to monitor disposal sites.

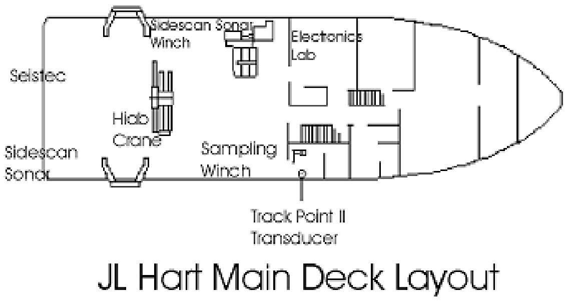
NRCan and EC have formed a joint program to study the effects of offshore disposal of dredged material with the intention that collaborative efforts will contribute to, and accelerate, objectives of both departments.

During 2003, several sites were selected for monitoring which provide an opportunity for case studies of the effects of disposal activities in unique environments: a sheltered coastal environment in Summerside, PEI; a partially protected site in Yarmouth, NS; a tidal estuary in Miramichi, NB; and a high energy site in Saint John, NB. The result of the monitoring will be used to compare and contrast the impact of disposal activities in these sites.

Survey Hart 2003009 was conducted from 17-30 April 2003, to provide information on the character and distribution of seafloor sediments near offshore disposal sites in Yarmouth Harbour and approaches. Since 1991 about 185,000 m^3 of material has been dredged from the shipping channels and inner harbour of Yarmouth, NS and placed in an offshore disposal site near the mouth of Outer False Harbour, adjacent to Yarmouth Sound. Other disposal sites, located in Yarmouth Outer Channel, had been used prior to the mid 1980's. Sites in the outer channel would be exposed to strong tidal currents that occur in the area. All sites would be exposed to large waves when the winds blow from a southerly direction.

A multidisciplinary suite of data was collected from the CCGS JL Hart (Figure 1) and hydrographic survey launch Plover. Geophysical and multibeam bathymetry surveys were performed in to determine if any material had been transported from the disposal area. Seafloor photographs, underwater video transects and seafloor samples were taken to provide additional information of the character and composition of the sediments on the seafloor.

a) 
b) 



c)

Figure 1. a) The geophysical survey and seafloor sampling program were performed using the CCGS JL Hart shown in a) above. b) Multibeam bathymetry data were collected with the hydrographic launch Plover equipped with a Simrad EM3000 sytem. c) The survey and sampling equipment were deployed and operated from the main deck of the JL Hart.

Geophysical equipment used during the survey consisted of a Simrad MS992 dual frequency (120 and 330 kHz) sidescan sonar system, IKB Seistec sub-bottom profiler and a Track Point II acoustic positioning system. Geophysical data were collected in over an offshore disposal site in False Harbour (west of Yarmouth), and in the approaches to Yarmouth as shown in Figure 2.

Multibeam bathymetry surveys were performed using a Simrad EM3000 system installed on the hydrographic survey launch Plover. Sediment samples were collected with a 0.1 m^3 van Veen grab sampler. Images of the seafloor were obtained with a 35 mm camera and an underwater video system.

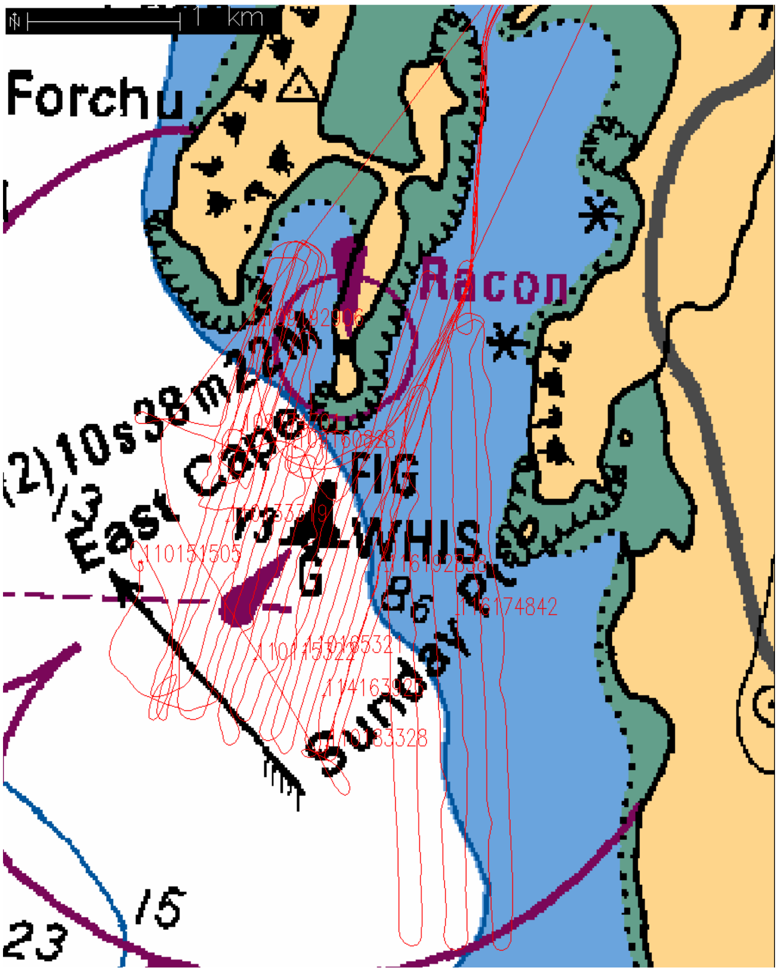


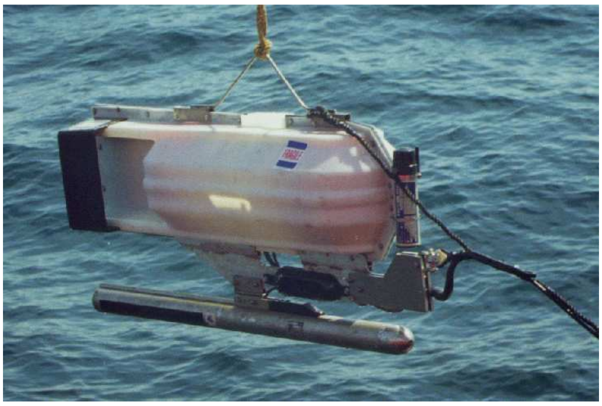
Figure 2. Survey tracks where sidescan sonar and Seistec data were collected in the approaches to Yarmouth, NS during survey Hart 2003009.

Data Acquisition and Processing

The following geophysical and sampling equipment was used during survey Hart2003009:

- Simrad MS992 sidescan sonar system in a neutrally-buoyant tow configuration
- IKB Seistec® high resolution sub-bottom profiler
- AGCDIG 4 channel digital geophysical data acquisition system
- ORE TrackPoint II ultra short baseline towfish positioning system
- Regulus survey navigation package with input from differential GPS
- Simrad EM3000 multibeam bathymetry system
- Linux workstations running GRASS with GSCA extensions
- Caris HIPS multibeam bathymetry data cleaning software running on Windows NT
- GSCA icehole camera
- van Veen grab sampler
- Scorpio video/still camera
- Small gravity corer

Sidescan Sonar
High-resolution, acoustic images of the seabed were produced with a Simrad MS992 dual frequency (120 and 330 kHz) sidescan sonar system. The towfish was deployed about 50 metres behind the vessel and run over the track lines shown in Figure 2. The system consisted of a neutrally-buoyant towbody and deployed 13 metres behind a dead weight depressor (a 120 kg. iron blister weight on a swivel) as shown in Figure 3. This configuration was chosen to reduce artifacts seen on the sidescan sonar records due to vessel-induced heave. The sidescan sonar system was capable of resolving objects down to a size of about 0.15 m. An ORE TrackPoint II acoustic position system was used to position the towfish. A hardcopy graphic record of the 330 kHz portion of the sidescan sonar data was produced on an Alden 9315CTP thermal recorder.



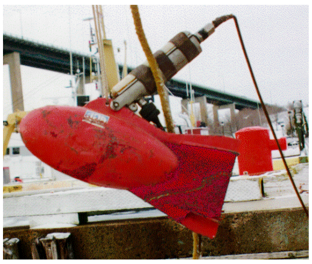


Figure 3. Neutrally buoyant sidescan sonar towfish (shown on the left) and deadweight depressor used by GSCA. The towfish was towed about 13 metres behind the deadweight depressor. The TrackPoint II tow fish positioning beacon is visible on the front of the towfish.

The sidescan sonar data were collected at 100 metre range for all lines providing a swath of 200 metres. The lines were typically run 75 metres apart, with deviations from the survey line as required to avoid fishing gear present in the area.

Sidescan sonar data from survey Hart 2003009 (both 120 and 330 kHz) were collected digitally using an AGCDIG digitizer with version 2.3 software. A sample interval of 80 microseconds was used. 1700 samples per ping were collected at the nominal 100 metre range setting. Digital gain settings for the sidescan sonar system and digitizers were logged on field sheets. During the survey, data were imported into a Linux workstation at a resolution of 0.35 metres (across track). The seafloor was detected and slant range and beam corrections were applied to the raw data to remove geometric distortions present in sidescan sonar data. The data were integrated with navigation and imported into the GRASS GIS system at 0.5 metre resolution. The sidescan sonar data from adjacent survey lines were integrated to produce a sidescan sonar mosaic at 0.5 metre resolution.

IKB Technologies Seistec® Sub-bottom profiler
An IKB Technologies Seistec® high-resolution, sub-bottom profiler system was used to map the thickness and structure of materials on the sea floor and provide information on the genesis of the sediments. The system uses an electro-dynamic (boomer) source to produce a repeatable impulse-like output providing a vertical resolution of 0.25 metre or better. The Seistec system was equipped with an internal line-and-cone array and an external streamer. The boomer and line-and-cone array are contained in a small catamaran as shown in Figure 4.

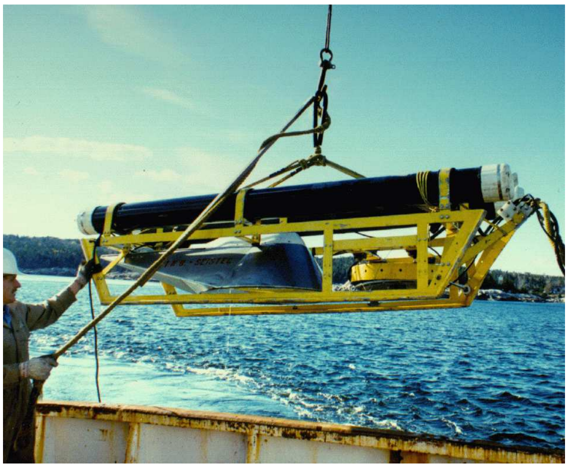


Figure 4. Seistec sub-bottom profiler showing the surface-towed catamaran used to support the boomer and line-and-cone array. Power and signals are contained in the tow cable bundle on the front of the catamaran.

The external streamer was attached to the front of the catamaran, so that the lead-in section of the streamer was positioned under the boomer and line-and-cone array with the receiving elements trailing behind the catamaran. The catamaran was deployed by crane and towed on the port side at the surface. The system was fired 2 times per second, or faster, and graphic records were displayed on a thermal graphic recorder. The power supply to the boomer was operated at a nominal setting of 175 Joules. Graphic records were printed on an EPC9802 recorder set for 125 millisecond scans in two channel mode. Data were sampled at a 38 microsecond interval for 124 milliseconds to provide 3845 samples per channel. Bandpass filtered signals were recorded. External steamer data were filtered at 1000 to 7000 hertz.

Digital Data Acquisition
The sidescan sonar and sub-bottom profiler data were digitized and logged on an AGCDIG digital data recorder, developed by the Geological Survey of Canada (Atlantic), running version 2.3 software. The clock in the AGCDIG was synchronized to the GPS time signal. No gains or corrections were applied by the digitizer to the raw logged data. Channel configurations for the logged data were:

Sidescan sonar - 80 microseconds sample interval

Channel	Use
0	120 kHz port
1	120 kHz starboard
2	330 kHz port
3	330 kHz starboard

Sub-bottom profiler – IKB Seistec - 38 microseconds sample interval

Channel	Use
0	STB Seistec line cone receiver
1	STB GF10/15P streamer hydrophone

Navigation

Navigation was provided by a Global Positioning System utilizing differential corrections broadcast by the Canadian Coast Guard. Accuracy of the navigation was about 4 m. Tracks and survey lines were run with the Regulus navigation package by ICAN Limited, Mount Pearl, NF.

Multibeam Bathymetry

Multibeam bathymetric data were collected using a Simrad EM3000 multibeam bathymetry system mounted in the hydrographic survey launch Plover (Figure 1b). The EM3000 system uses 300kHz transducer with 127 beams with a beamwidth of 1.5^o x 1.5^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.

The Plover 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 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.

Survey lines were run throughout the survey area to provide 200 percent coverage of the seafloor in water depths greater than about 20 metres. During the survey, data were processed using version 5.0 of the HIPS data cleaning program (CARIS by Universal Systems Limited, Fredericton, NB) on a Windows NT workstation to remove spurious soundings and navigation data and to correct for tidal variations. Data were also imported into a Linux based workstation and processed using the MBTools software developed by the Lamont-Doherty Institute. The processed data were imported into the GRASS GIS system where shaded-colour relief images were generated and overlaid on bathymetry maps of the area.

Multibeam Backscatter

The strength of an echo from the seafloor is known as the acoustic backscatter intensity. Acoustic backscatter intensity values are controlled by the physical properties of the seafloor sediments such as the velocity of sound, the density and roughness of the sediment. Backscatter generally increases as the sediments on the seafloor become denser and less porous, and increase in grain size. Mapping the distribution of backscatter provides valuable information on the character and distribution of sediments within an area. Backscatter data were processed using the MBTools software developed by the Lamont-Doherty Institute. The processed data were imported into the GRASS GIS system, where shaded-colour relief images were generated and overlaid on bathymetry maps of the area.

Seafloor Grab Samples

Figure 5. Seafloor samples were collected during with a van Veen grab sampler.

A 0.1 square metre van Veen grab sampler was used to collect sediment samples in the survey area (Figure 5). The sample locations are shown in Figure 6 and are provided in Appendix IV. Digital images were taken of most of the grabs and are incorporated as 'hotlinks' in an ArcView GIS data base to provide geographically referenced access to the images. Low-resolution copies of all available grab sample images are presented in this report in Appendix V.

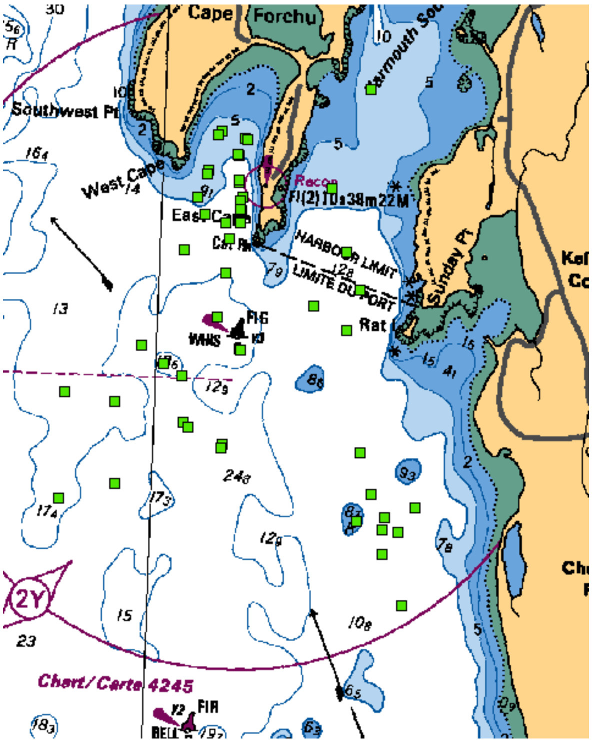


Figure 6. Location of grab samples (shown by the green squares) taken during survey Hart 2003009 in April 2003. The sample positions are provided in Appendix IV.

Seafloor Photographs

Figure 7. Icehole camera used to collect seafloor photographs during Hart 2003015.

Seafloor photographs were taken with the Icehole camera developed by GSCA (Figure 7). Images were obtained on transects through the disposal site and surrounding area using 200 ASA colour print film. The prints were digitally scanned and stored on CD-ROM. The digital images were incorporated into an ArcView GIS project as a series of "hotlinks" to enable viewing of the images in a geographically referenced context. A list of photograph locations is provided in Table 2 and shown in Figure 8. Thumbnails of the photographs are provided in Appendix IV.

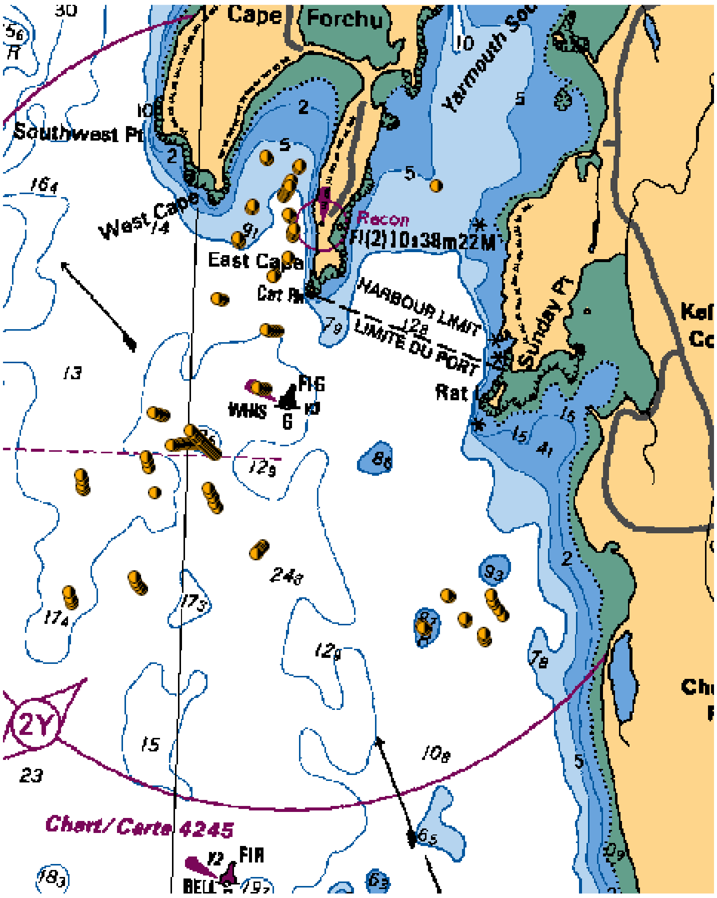


Figure 8. Location of seafloor photographs, shown by the yellow circles, taken during survey Hart 2003009 in April 2003. The sample positions are provided in Appendix IV.

Digital Video and Still Photographs

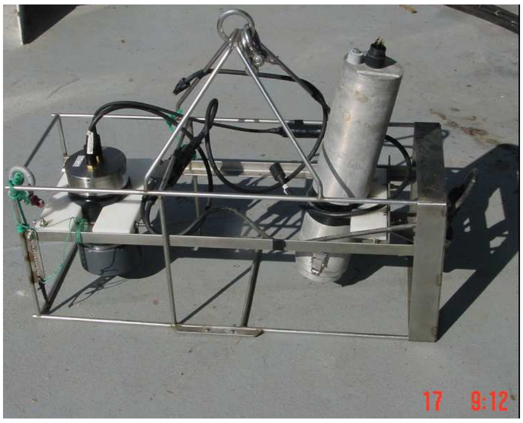


Figure 9. Digital video system used to collect video and digital still images during Hart 2003009.

Digital video and still images of the seafloor photographs were obtained with a Scorpio model 6kM camera which consists of a Nikon E995 model camera in a pressure housing rated for 6000 metre. In Figure 9, the Scorpio camera is shown on the left of the frame, with the flash and flood light on the right of the frame. Images and video obtained on transects through the disposal site and surrounding area. Video was recorded on a SONY DSR-20 Digital Videocassette Recorder. Still Images were recorded internally in the Nikon digital camera and downloaded to a computer at the end of the day.

The digital images were incorporated into an ArcView GIS project as a series of “hotlinks” to enable viewing of the images in a geographically referenced context. A list of video transects and photograph locations is provided in Table 2 and shown in Figure 10. Thumbnails of the photographs are provided in Appendix IV.

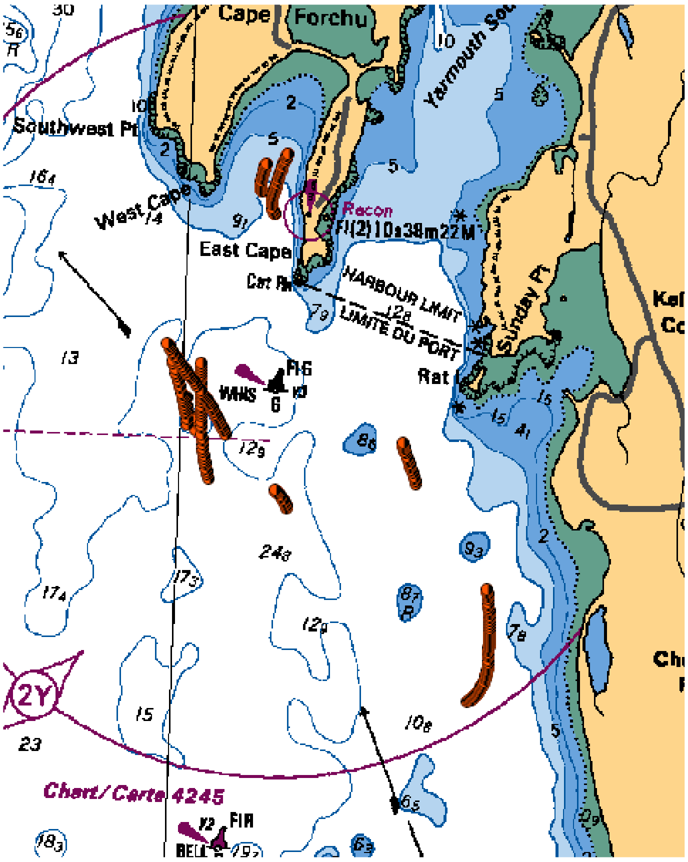


Figure 10. Location of digital video transects taken during survey Hart 2003009 in April 2003. The position of each of the red circles indicates where digital still images were obtained. The positions are provided in Appendix IV.

Tides and Currents

During 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 Figure 11, a tidal range of about 4-5 metres was predicted for Yarmouth NS during the period of the survey. A listing of the predicted tides is provided in Appendix V. Times are shown in Atlantic Daylight Time and tide heights are shown in centimeters.

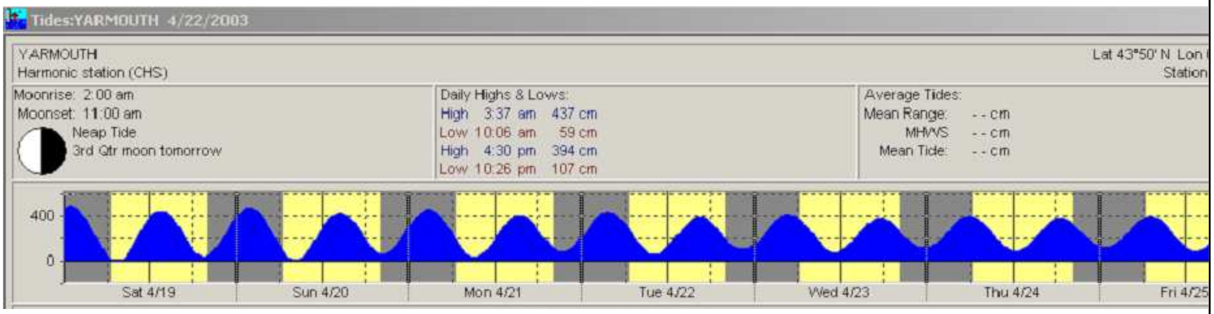


Figure 11. Predicted tides for Yarmouth from the program Tides and Currents.

Tidal data for the period 17-28 April 2003 were downloaded from the Canadian Hydrographic Service (CHS) tide gauge located on the government wharf in Yarmouth, NS. The tide gauge data, shown in Figure 12, were used to correct the multibeam bathymetry data.

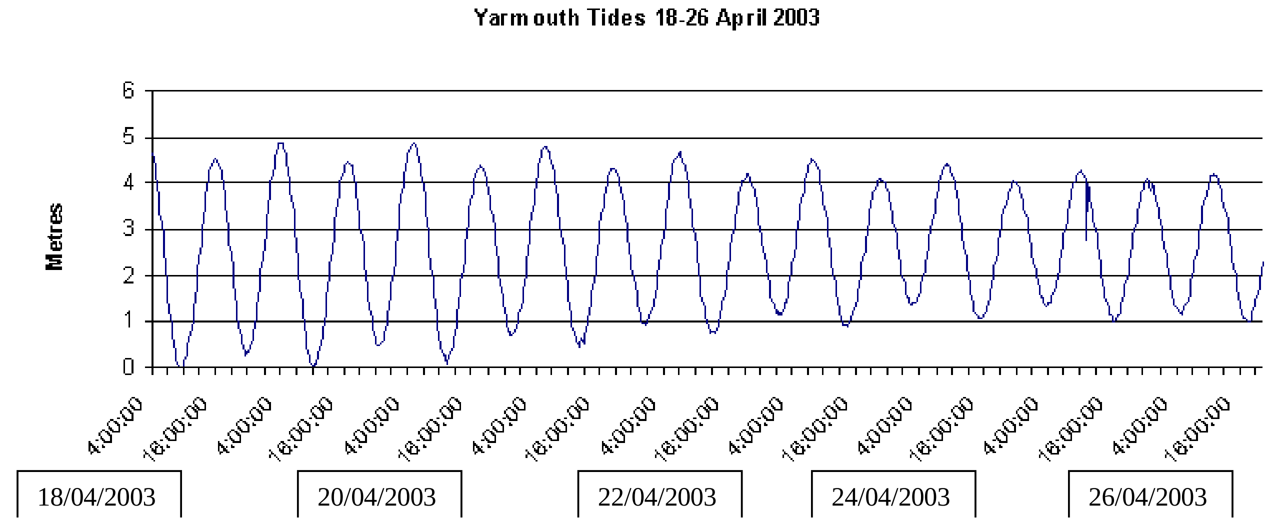
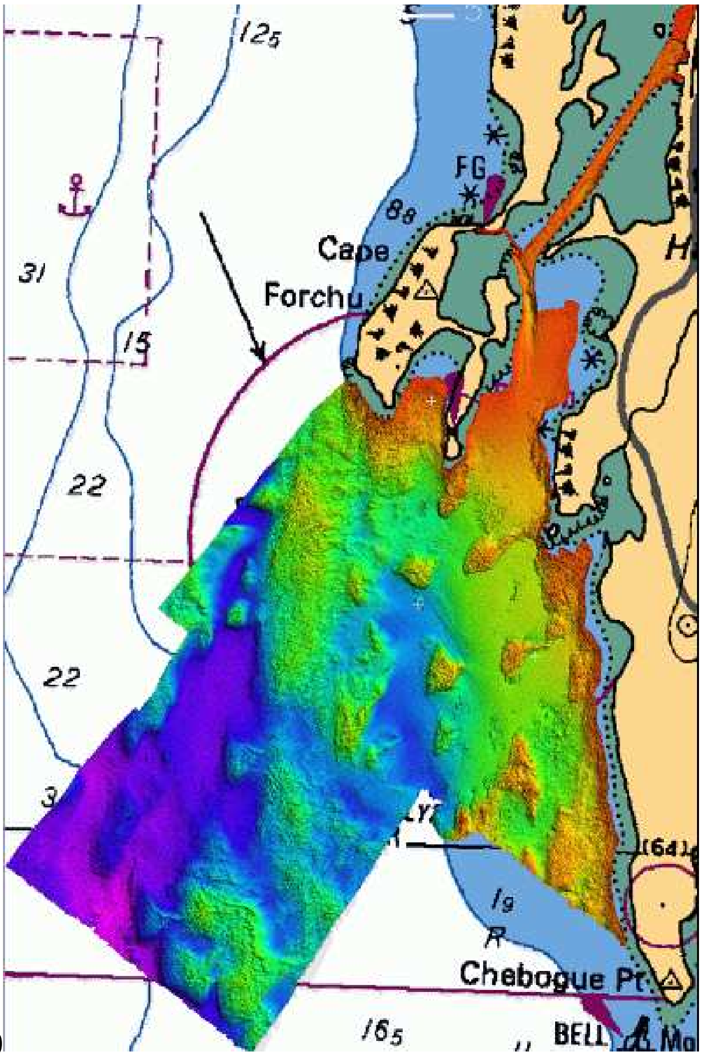


Figure 12 Measured tides for 17-28 April 2003 from the Canadian Hydrographic Service (CHS) tide gauge in Yarmouth, NS

Preliminary Results

A suite of data consisting of sidescan sonar, multibeam bathymetry, sub-bottom profiler, seafloor photographs, underwater video, and grab samples were collected in the area around an offshore disposal site in False Harbour, and in the approaches leading to Yarmouth NS.

a) 

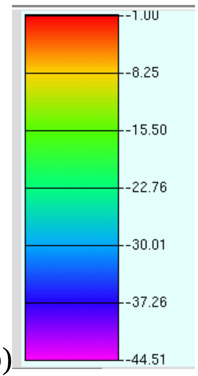
b) 

Figure 13. a) Coloured shaded relief image of multibeam bathymetry data from the Simrad EM3000 multibeam bathymetry system for the outer harbour and approaches of Yarmouth, NS. b) Colour bar associated with the data.

A shaded, colour-relief image generated from the multibeam bathymetry data shows the overall morphology of the seafloor in the area surveyed (Figure 13). Depths of about 45 metres were encountered in the deepest zone surveyed. The multibeam bathymetry data show that a large portion of the seafloor consists of areas of bedrock and coarse sediment infilled by finer sediment. Closer inspection of the data shows the presence of a large number of parallel ridges of coarse material on the western side of the surveyed area. These features are similar to parallel ribbed moraines observed on other multibeam bathymetry data in both the nearshore and offshore regions of Nova Scotia. (Parrott 1999).

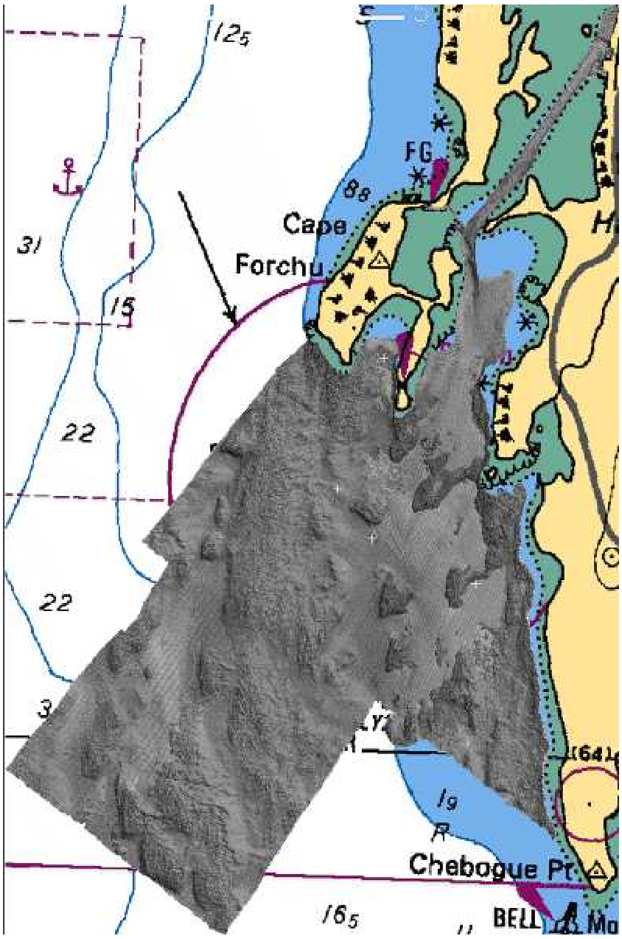


Figure 14. Acoustic backscatter intensity values, draped over bathymetry from the Simrad EM3000 multibeam bathymetry system, for the outer harbour and approaches of Yarmouth, NS.

A mosaic of the backscatter data from the Simrad EM3000 multibeam was produced at 2.0 metre resolution and displayed in Figure 14. The dark colour indicates the presence of coarse sediments and bedrock on the seafloor. Areas with lighter colour represent zones where finer sediments overlay the coarse material. Much of the eastern side of the approaches to the harbour show an accumulation of finer sediments.

Sidescan sonar data collected in the area, were processed and used to generate a mosaic (shown in Figure 15). The dark colour indicates the presence of coarse sediments and bedrock on the seafloor. Areas with lighter colour represent zones where finer sediments overlay the coarse material. The dredge spoils deposited in False Harbour are visible in the upper left portion of the mosaic. Much of the eastern side of the approaches to the harbour show an accumulation of finer sediments.

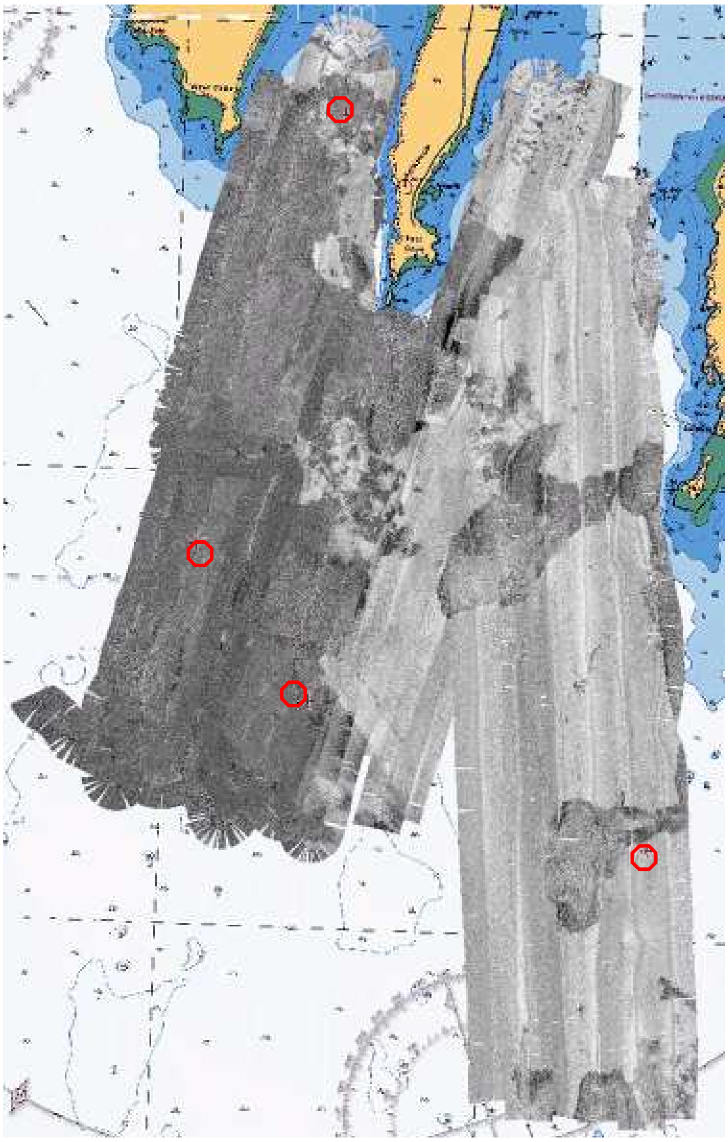
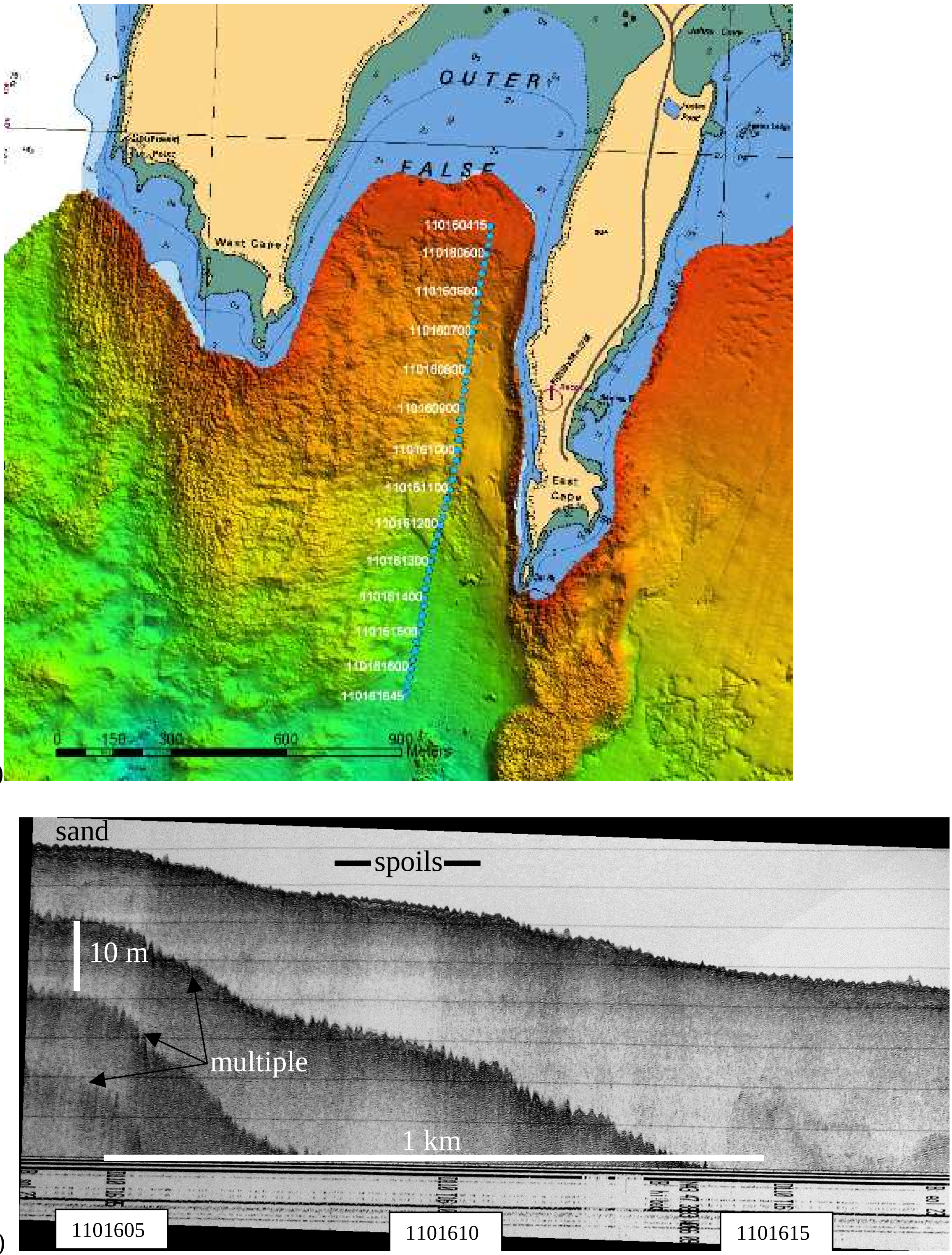


Figure 15. Sidescan sonar mosaic for the outer harbour and approaches of Yarmouth, NS generated from the April 2003 survey. The mosaic was produced at a cell resolution of 0.5 metres. Disposal site positions are shown by the red circles.

Seistec sub-bottom profiler data were collected on several transects in Outer False Harbour. The transect shown in Figure 16 ran from the shallow water in the inner part of the bay to deeper water outside the bay. Note how the character of the seafloor, as seen on the multibeam bathymetry data, changes over the Seistec transect (shown in Figure 16a) and includes areas of smooth and rough seafloor. The Seistec data provides information on the thickness of these sediments. A smooth seafloor can be seen on the multibeam bathymetry data at time 1101604 on the Seistec transect in Figure 16a (1604 universal time on Julian day 110). The Seistec data show a 1-2 metre thick deposit of sand overlying coarser sediments (Figure 16b). The seafloor photograph shown in Figure 17a, provides additional insight into the nature of the seafloor, and shows that it is composed of rippled sand. The rough seafloor seen in both the multibeam bathymetry and Seistec data at 1101606 in Figure 16 appears to be due to the presence of coarse grained dredge spoils and debris. Seafloor photographs (Figure 17b) show the presence of angular cobbles and boulders with very little marine growth, the steel cable and the partially buried scallop shells, indicating that the material has been recently placed.

The area of smooth seafloor on the multibeam bathymetry data at 1101608 in Figure 16a appears as a lighter colour on the Seistec data in Figure 16b indicating 1-2 metres of sand overlaying coarser material. The seafloor photograph shown in Figure 17c confirms the presence of rippled sand. Another area of smooth seafloor can be seen in the multibeam bathymetry data at 1101612 in Figure 16a. The Seistec data in Figure 16b shows a dark colour extending to the seafloor, indicating the presence of coarser sediments. The seafloor photograph (Figure 17d) shows a seafloor composed of mixture of fine-grained sediments, gravel and well rounded cobbles, which probably represents a lag veneer overlying till. The seafloor photograph shown in Figure 17e shows an areas of the seafloor west of the transect (See Figure 16a for location). Note the abundance of marine growth on the rounded cobbles, compared to the lack of much growth material at the disposal site in Figure 17b, indicating that the material has been in place for a considerable time a)



b)

Figure 16. Seistec sub-bottom profiler data collected through the False Harbour disposal site a), showing b) the accumulated dredge spoil overlying the naturally deposited

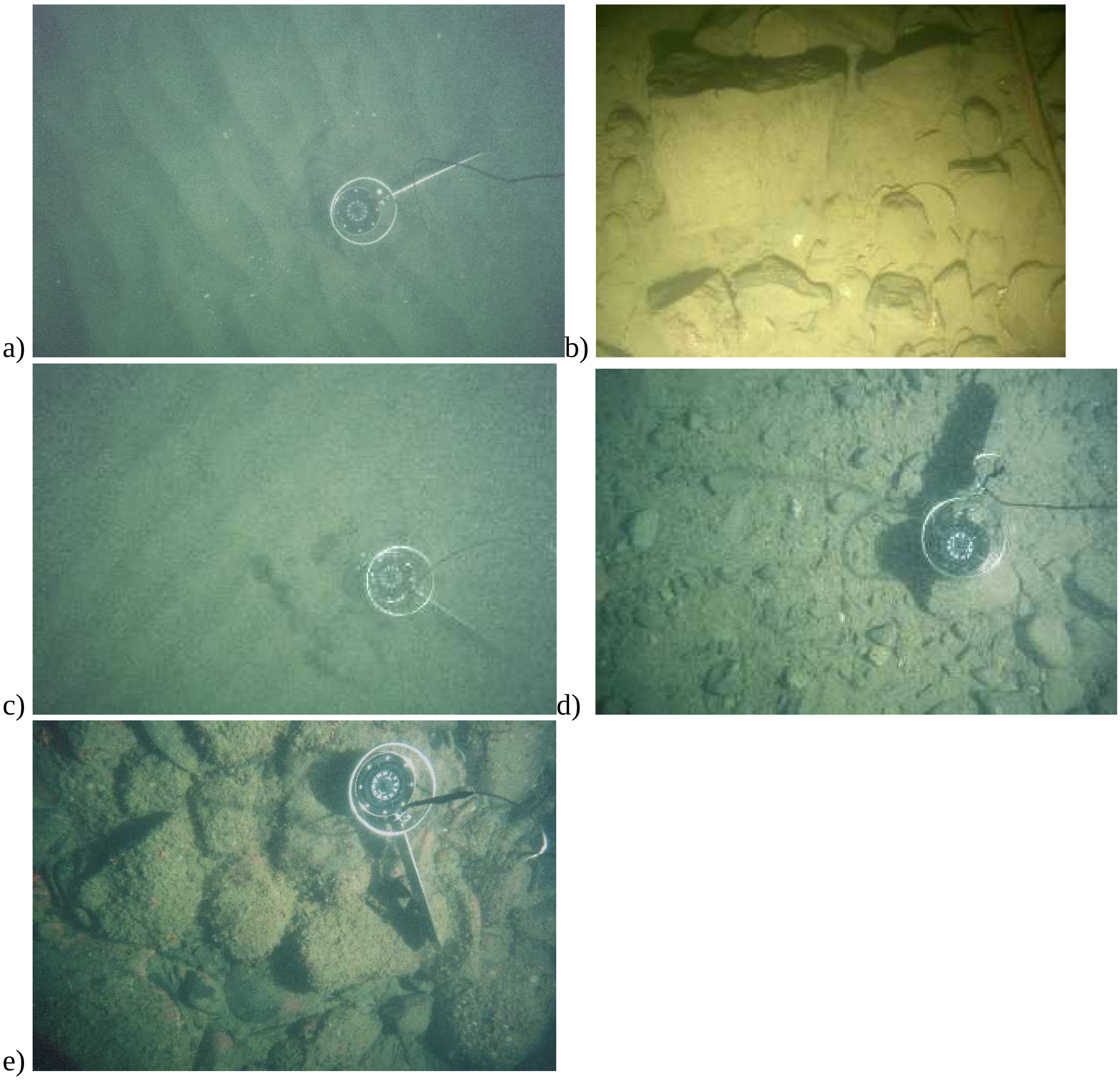


Figure 17 Seafloor photographs from near the False Harbour offshore disposal site.a) 21-5 b) 17-34 c) 24-1 d) 29-2 e) 28-3

Access to Data and Samples

The sidescan sonar, sub-bottom profiler and grab samples collected during this survey are archived at the Geological Survey of Canada Atlantic, in Dartmouth Nova Scotia. For access to the geophysical 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). Graphical records for the sidescan sonar and subbottom profiler, digitally processed sidescan sonar mosaics, ExaByte tapes containing the sidescan sonar data in SEG-Y format, CD-ROMs containing the sidescan sonar and sub-bottom profiler data in SEG-Y format, ExaBytes tapes of the raw data of a CDROM with the seafloor images and grab sample photographs are available for viewing. For some data, access can be achieved 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/.

References

Canadian Geoscience Knowledge Network internet site at http://cgkn.net/

CARIS HIPS hydrographic data cleaning software, CARIS,264 Rookwood Avenue Fredericton, New Brunswick, CANADA, E3B 2M2. http://www.caris.com

Geological Survey of Canada Atlantic internet site at http://gsca.nrcan.gc.ca

Nautical Software Inc, Tides and Currents 4.2, http://www.tides.com

Parrott, D.R. 1999, Cruise MA98-074 Geophysical and Multibeam Bathymetric Surveys of the Liverpool Offshore Dumpsites 13-19 October 1998. Geological Survey of Canada Open File report.

Tables

Table 1 Location of van Veen Grab Samples

CRUISE_NO.	STATION_NO	LATITUDE	LONGITUDE
2003009	1	44.757892	-66.751295
2003009	2	44.754307	-66.749570
2003009	6	44.759373	-66.749868
2003009	7	44.760808	-66.750712
2003009	8	44.759463	-66.749012
2003009	9	44.759788	-66.747597
2003009	10	44.759052	-66.746667
2003009	11	44.760663	-66.748828
2003009	12	44.761315	-66.748897
2003009	13	44.750172	-66.740688
2003009	14	44.739362	-66.737495
2003009	15	44.735275	-66.736623
2003009	16	44.733837	-66.735402
2003009	17	44.751390	-66.754527
2003009	27	44.761140	-66.748205
2003009	28	44.761025	-66.747912
2003009	29	44.760723	-66.747883
2003009	30	44.761308	-66.747433
2003009	31	44.761052	-66.747540
2003009	33	44.761207	-66.747718
2003009	34	44.760850	-66.747701
2003009	35	44.760395	-66.747905
2003009	36	44.753905	-66.743706
2003009	37	44.758473	-66.733088
2003009	38	44.757145	-66.729363

Table 2 Location of Seafloor Photographs

STATION	TYPE	EXPOSURE_N	NUMERIC_TI	WATER_DEPT	LATITUDE	LONGITUDE
1	Camera	2	111112540	10	0.000000	0.000000
1	Camera	3	111112656	10	0.000000	0.000000
1	Camera	4	111112746	10	0.000000	0.000000
1	Camera	5	111112833	10	0.000000	0.000000
2	Camera	1	111113623	17	0.000000	0.000000
2	Camera	2	111113704	17	0.000000	0.000000
2	Camera	3	111113752	17	0.000000	0.000000
2	Camera	4	111113838	17	0.000000	0.000000
2	Camera	5	111113918	17	0.000000	0.000000
2	Camera	6	111114000	17	0.000000	0.000000
3	Camera	1	111114727	19	0.000000	0.000000
3	Camera	2	111114808	19	0.000000	0.000000
3	Camera	3	111114849	19	0.000000	0.000000
3	Camera	4	111114934	19	0.000000	0.000000
3	Camera	5	111115025	19	0.000000	0.000000
4	Camera	1	111115940	27	43.782160	-66.168242
4	Camera	2	111120028	27	43.782203	-66.168438
4	Camera	3	111120111	27	43.782238	-66.168603
4	Camera	4	111120200	27	43.782288	-66.168795
4	Camera	5	111120245	27	43.782350	-66.169072
5	Camera	1	111122644	23	43.780493	-66.164638
5	Camera	2	111122735	23	43.780512	-66.164797
5	Camera	3	111122825	23	43.780525	-66.165010
5	Camera	4	111122917	23	43.780532	-66.165273
5	Camera	5	111123007	23	43.780533	-66.165547
5	Camera	6	111123050	23	43.780532	-66.165707
5	Camera	7	111123130	23	43.780528	-66.165823
5	Camera	8	111123215	23	43.780520	-66.165988
5	Camera	9	111123259	23	43.780508	-66.166142
5	Camera	10	111123339	23	43.780497	-66.166287
5	Camera	11	111123413	23	43.780483	-66.166415
5	Camera	12	111123458	23	43.780462	-66.166613
5	Camera	13	111123545	23	43.780443	-66.166763
5	Camera	14	111123635	23	43.780427	-66.166937
5	Camera	15	111123735	23	43.780408	-66.167138
5	Camera	16	111123821	23	43.780392	-66.167297
5	Camera	17	111123914	23	43.780375	-66.167477
6	Camera	1	111124803	20	43.779917	-66.163630
6	Camera	2	111124845	20	43.779960	-66.163725
6	Camera	3	111124925	20	43.780027	-66.163850
6	Camera	4	111125007	20	43.780113	-66.164000
6	Camera	5	111125050	20	43.780203	-66.164150
6	Camera	6	111125133	20	43.780280	-66.164273
6	Camera	7	111125209	20	43.780377	-66.164432
6	Camera	8	111125248	20	43.780448	-66.164542
6	Camera	9	111125325	20	43.780535	-66.164673
6	Camera	10	111125406	20	43.780630	-66.164815
6	Camera	11	111125448	20	43.780715	-66.164940
6	Camera	12	111125536	20	43.780820	-66.165097
6	Camera	13	111125622	20	43.780945	-66.165293
6	Camera	14	111125707	20	43.781077	-66.165497
6	Camera	15	111125745	20	43.781183	-66.165653
6	Camera	16	111125822	20	43.781332	-66.165883
7	Camera	1	111134414	21	43.777388	-66.174903
7	Camera	2	111134448	21	43.777473	-66.174923
7	Camera	3	111134526	21	43.777693	-66.174962
7	Camera	4	111134612	21	43.778007	-66.175038
7	Camera	5	111134650	21	43.778293	-66.175128
8	Camera	1	111135442	29	43.771395	-66.169580
8	Camera	2	111135522	29	43.771493	-66.169715
8	Camera	3	111135558	29	43.771658	-66.169898

8	Camera	4	111135639	29	43.771832	-66.170067
8	Camera	5	111135723	29	43.772083	-66.170277
9	Camera	1	111140302	23	43.770272	-66.175447
9	Camera	2	111140341	23	43.770432	-66.175540
9	Camera	3	111140429	23	43.770655	-66.175660
9	Camera	4	111140553	23	43.771030	-66.175818
10	Camera	1	111141428	30	43.776607	-66.163382
10	Camera	2	111141516	30	43.776897	-66.163613
10	Camera	3	111141605	30	43.777208	-66.163817
10	Camera	4	111141650	30	43.777495	-66.163988
10	Camera	5	111141735	30	43.777787	-66.164140
11	Camera	1	111142836	20	43.777350	-66.168680
11	Camera	2	111143157	20	43.778907	-66.169363
11	Camera	3	111143245	20	43.779265	-66.169523
11	Camera	4	111143333	20	43.779603	-66.169677
18	Camera	1	111181813	10	43.796832	-66.158188
18	Camera	2	111181846	10	43.796873	-66.158172
18	Camera	3	111181926	10	43.796940	-66.158150
18	Camera	4	111182006	10	43.797075	-66.158107
18	Camera	5	111182037	10	43.797130	-66.158090
19	Camera	1	111182606	0	43.796132	-66.158635
19	Camera	2	111182642	0	43.796178	-66.158583
19	Camera	3	111182721	0	43.796248	-66.158523
19	Camera	4	111182800	0	43.796325	-66.158467
19	Camera	5	111182840	0	43.796388	-66.158420
19	Camera	6	111182912	0	43.796478	-66.158370
19	Camera	7	111182947	0	43.796532	-66.158337
19	Camera	8	111183026	0	43.796602	-66.158300
19	Camera	9	111183108	0	43.796683	-66.158260
19	Camera	10	111183132	0	43.796732	-66.158238
19	Camera	11	111183215	0	43.796823	-66.158200
20	Camera	1	111183627	10	43.798348	-66.160108
20	Camera	2	111183658	10	43.798367	-66.160153
20	Camera	3	111183735	10	43.798402	-66.160213
20	Camera	4	111183815	10	43.798457	-66.160278
20	Camera	5	111183857	10	43.798530	-66.160337
21	Camera	1	111184348	10	43.797945	-66.157527
21	Camera	2	111184425	10	43.797970	-66.157467
21	Camera	3	111184457	10	43.797987	-66.157427
21	Camera	4	111184530	10	43.798017	-66.157382
21	Camera	5	111184620	10	43.798088	-66.157297
22	Camera	1	111190000	0	43.795337	-66.161350
22	Camera	2	111190032	0	43.795333	-66.161327
22	Camera	3	111190138	0	43.795355	-66.161285
22	Camera	4	111190219	0	43.795390	-66.161282
22	Camera	5	111190256	0	43.795432	-66.161293
22	Camera	6	111190326	0	43.795473	-66.161308
23	Camera	1	111190801	17	43.794878	-66.158092
23	Camera	2	111190827	17	43.794890	-66.158100
23	Camera	3	111190904	17	43.794930	-66.158112
23	Camera	4	111190945	17	43.794982	-66.158130
23	Camera	5	111191020	17	43.795037	-66.158152
24	Camera	1	111191459	10	43.793682	-66.157788
24	Camera	2	111191538	10	43.793820	-66.157742
24	Camera	3	111191618	10	43.793915	-66.157715
24	Camera	4	111191700	10	43.794028	-66.157675
24	Camera	5	111191738	10	43.794143	-66.157630
25	Camera	1	111192255	15	43.792232	-66.158040
25	Camera	2	111192328	15	43.792233	-66.158057
1	Camera	1	111112453	10	0.000000	0.000000
25	Camera	3	111192408	15	43.792257	-66.158080
25	Camera	4	111192446	15	43.792302	-66.158098
25	Camera	5	111192524	15	43.792383	-66.158105
26	Camera	1	111192937	17	43.791125	-66.159215
26	Camera	2	111193025	17	43.791110	-66.159217
26	Camera	3	111193058	17	43.791113	-66.159220

26	Camera	4	111193214	17	43.791173	-66.159208
26	Camera	5	111193130	17	43.791130	-66.159220
27	Camera	1	113111612	10	43.797118	-66.145530
27	Camera	2	113112644	10	43.793165	-66.162258
27	Camera	3	113112727	10	43.793250	-66.162345
27	Camera	4	113112803	10	43.793322	-66.162417
27	Camera	5	113112836	10	43.793388	-66.162488
28	Camera	1	113113510	0	43.789515	-66.163557
28	Camera	2	113113542	0	43.789532	-66.163612
28	Camera	3	113113705	0	43.789583	-66.163877
28	Camera	4	113113740	0	43.789597	-66.163970
28	Camera	5	113113818	0	43.789612	-66.164085
29	Camera	1	113114450	17	43.787692	-66.158655
29	Camera	2	113114534	17	43.787685	-66.158773
29	Camera	3	113114611	17	43.787682	-66.158905
29	Camera	4	113114704	17	43.787697	-66.159238
29	Camera	5	113114754	17	43.787743	-66.159505
29	Camera	6	113114834	17	43.787792	-66.159685
30	Camera	1	113115409	20	43.784073	-66.159555
30	Camera	2	113115455	20	43.784072	-66.159653
30	Camera	3	113115532	20	43.784082	-66.159883
30	Camera	4	113115607	20	43.784118	-66.160128
30	Camera	5	113115645	20	43.784178	-66.160342
31	Camera	1	113121417	0	43.774348	-66.159257
31	Camera	2	113121521	0	43.774115	-66.159510
31	Camera	3	113121608	0	43.774017	-66.159633
31	Camera	4	113121649	0	43.773958	-66.159707
31	Camera	5	113121726	0	43.773890	-66.159792
31	Camera	6	113121814	0	43.773810	-66.159905
32	Camera	1	113123925	18	43.769748	-66.145423
32	Camera	2	113123018	18	43.770122	-66.141608
32	Camera	3	113123100	18	43.770190	-66.141625
32	Camera	4	113123137	18	43.770260	-66.141663
32	Camera	5	113123212	18	43.770332	-66.141718
33	Camera	1	113123548	15	43.769568	-66.145047
33	Camera	2	113123635	15	43.769567	-66.145103
33	Camera	3	113123712	15	43.769578	-66.145162
33	Camera	4	113123753	15	43.769610	-66.145237
34	Camera	1	113124620	15	43.770595	-66.138475
34	Camera	2	113124721	15	43.770928	-66.138908
34	Camera	3	113124818	15	43.771282	-66.139205
34	Camera	4	113124908	15	43.771500	-66.139348
34	Camera	5	113124956	15	43.771783	-66.139575
35	Camera	1	113125435	15	43.771648	-66.143118
35	Camera	2	113125511	15	43.771652	-66.143177
35	Camera	3	113125554	15	43.771673	-66.143267
35	Camera	4	113125635	15	43.771712	-66.143365
36	Camera	1	113130325	19	43.769000	-66.139942
36	Camera	2	113130349	19	43.769147	-66.139988
36	Camera	3	113130424	19	43.769288	-66.140017
36	Camera	4	113130503	19	43.769393	-66.140038

Table 3 Start Point of Seafloor Video Transects

Station Number	Exposure Number	Numeric Time	Water Depth (m)	Latitude	Longitude	Comments
12	1	111153000	0	43.780802	-66.165357	Large Rocks
12	2	111153100	0	43.781352	-66.165422	
12	3	111153154	0	43.781837	-66.165512	Cobbles/Boulders
12	4	111153254	0	43.782355	-66.165597	Cobbles/Boulders
13	1	111154100	23	43.780302	-66.164717	
13	2	111154212	23	43.780707	-66.164583	
13	3	111154236	23	43.780822	-66.164568	

13	4	111154318	23	43.781040	-66.164580	
14	1	111161300	0	43.780640	-66.165488	
14	2	111161339	0	43.780965	-66.165537	Cobbles/Boulders
14	3	111161419	0	43.781323	-66.165603	Boulders
14	4	111161433	0	43.781450	-66.165633	
14	5	111161451	0	43.781613	-66.165682	Cobbles/Gravel
14	6	111161505	0	43.781740	-66.165718	Cobbles/Gravel
14	7	111161522	0	43.781892	-66.165763	Cobbles/Gravel
14	8	111161545	0	43.782100	-66.165833	
14	9	111161556	0	43.782200	-66.165872	
14	10	111161614	0	43.782363	-66.165933	Well-Rounded Boulders
14	11	111161630	0	43.782502	-66.165990	Well-Rounded Boulders
14	12	111161646	0	43.782640	-66.166057	Well-Rounded Boulders
14	13	111161726	0	43.782965	-66.166203	Well-Rounded Boulders
14	14	111161740	0	43.783078	-66.166257	Well-Rounded Boulders
14	15	111161822	0	43.783397	-66.166410	Well-Rounded Boulders
14	16	111161830	0	43.783462	-66.166442	Well-Rounded Boulders
14	17	111161910	0	43.783758	-66.166570	Well-Rounded Boulders
14	18	111161925	0	43.783888	-66.166623	Well-Rounded Boulders
14	19	111161958	0	43.784155	-66.166722	Well-Rounded Boulders
14	20	111162050	0	43.784577	-66.166887	Well-Rounded Boulders
14	21	111162110	0	43.784748	-66.166953	
15	1	111164417	20	43.777138	-66.163403	Shell Hash, Gravel
15	2	111164445	20	43.777398	-66.163473	Well-Rounded Gravel, Shell Hash
15	3	111164510	20	43.777625	-66.163550	Well-Rounded Gravel, Shell Hash
15	4	111164533	20	43.777825	-66.163617	Well-Rounded Gravel, Shell Hash
15	5	111164600	20	43.778048	-66.163695	Well-Rounded Gravel, Shell Hash
15	6	111164615	20	43.778173	-66.163735	Well-Rounded Gravel, Shell Hash
15	7	111164630	20	43.778303	-66.163778	Well-Rounded Gravel, Shell Hash
15	8	111164650	20	43.778468	-66.163827	Well-Rounded Gravel, Shell Hash
15	9	111164710	20	43.778642	-66.163872	Well-Rounded Gravel, Shell Hash
15	10	111164740	20	43.778895	-66.163935	Slightly Angular Gravel
15	11	111164805	20	43.779098	-66.163975	Well-Rounded
15	12	111164840	20	43.779370	-66.164023	Well-Rounded
15	13	111164906	20	43.779612	-66.164060	Well-Rounded
15	14	111164920	20	43.779720	-66.164075	Cobbles
15	15	111165000	20	43.780042	-66.164112	Cobbles
15	16	111165045	20	43.780453	-66.164150	Cobbles
15	17	111165055	20	43.780527	-66.164157	Boulders
15	18	111165128	20	43.780800	-66.164172	Boulders
15	19	111165213	20	43.781165	-66.164202	Boulders
15	20	111165237	20	43.781370	-66.164218	Bou lders, Angular
15	21	111165308	20	43.781602	-66.164230	Boulders, Rounded
15	22	111165329	20	43.781775	-66.164238	Boudlers, Cobbles, Gravel
15	23	111165345	20	43.781895	-66.164240	Boudlers, Cobbles, Gravel
15	24	111165413	20	43.782122	-66.164262	Boudlers, Cobbles, Gravel
15	25	111165436	20	43.782293	-66.164267	Boudlers, Cobbles, Gravel
15	26	111165450	20	43.782395	-66.164272	Boudlers, Cobbles, Gravel
15	27	111165513	20	43.782588	-66.164283	Boudlers, Cobbles, Gravel
15	28	111165600	20	43.782942	-66.164295	Large Boudlers, Cobbles, Gravel
15	29	111165627	20	43.783140	-66.164302	Boudlers, Cobbles, Gravel
15	30	111165648	20	43.783277	-66.164307	Boudlers, Cobbles, Gravel
15	31	111165700	20	43.783355	-66.164312	Boudlers, Cobbles, Gravel
15	32	111165735	20	43.783652	-66.164350	Boudlers, Cobbles, Gravel
15	33	111165751	20	43.783745	-66.164357	Boudlers, Cobbles, Gravel
15	34	111165813	20	43.783887	-66.164367	Boudlers, Cobbles, Gravel
15	35	111165836	20	43.784040	-66.164383	Boudlers, Cobbles, Gravel
15	36	111165901	20	43.784218	-66.164400	

15	37	111165930	20	43.784470	-66.164438	Boudlers, Cobbles, Etc.
15	38	111165954	20	43.784628	-66.164438	
16	1	111170941	0	43.795895	-66.159475	Gravel/Sand/Silt
16	2	111171021	0	43.795925	-66.159530	Sand Ripples
16	3	111171040	0	43.795940	-66.159555	Sand Ripples
16	4	111171114	0	43.795973	-66.159597	Sand Ripples
16	5	111171131	0	43.795990	-66.159615	Sand Ripples
16	6	111171154	0	43.796017	-66.159637	Sand Ripples
16	7	111171220	0	43.796052	-66.159658	Sand Ripples
16	8	111171240	0	43.796093	-66.159673	Rubble/Cobbles
16	9	111171320	0	43.796170	-66.159690	Boulders
16	10	111171340	0	43.796202	-66.159695	Wire Rope, Boulders
16	11	111171420	0	43.796295	-66.159700	Rounded Boulders
16	12	111171440	0	43.796330	-66.159698	Cobbles, Boulders
16	13	111171500	0	43.796368	-66.159695	Sand Ripples
16	14	111171520	0	43.796408	-66.159690	Sand Ripples
16	15	111171535	0	43.796438	-66.159685	Sand Ripples
16	16	111171553	0	43.796477	-66.159680	Sand Ripples
16	17	111171625	0	43.796572	-66.159663	Sand Ripples
16	18	111171730	0	43.796728	-66.159623	Sand Ripples
16	19	111171805	0	43.796805	-66.159600	Sand Ripples
16	20	111171840	0	43.796897	-66.159570	Sand Ripples
16	21	111171944	0	43.797063	-66.159512	Boulders, Cobble, Gravel, Seaweed
16	22	111172000	0	43.797098	-66.159500	Boulders, Cobble, Gravel, Seaweed
16	23	111172040	0	43.797205	-66.159462	Boulders, Cobble, Gravel, Seaweed
16	24	111172104	0	43.797258	-66.159440	Boulders, Cobble, Gravel, Seaweed
16	25	111172128	0	43.797358	-66.159402	Boulders, Cobble, Gravel, Seaweed
16	26	111172148	0	43.797408	-66.159382	Boulders, Cobble, Gravel, Seaweed
16	27	111172155	0	43.797422	-66.159377	Boulders, Cobble, Gravel, Seaweed
16	28	111172219	0	43.797470	-66.159357	Large Boulders, Cobbles, Gravel, S
16	29	111172230	0	43.797492	-66.159347	Sand, Gravel, Shells, Seaweed
16	30	111172254	0	43.797542	-66.159327	Sand, Gravel, Shells, Seaweed
16	31	111172313	0	43.797598	-66.159302	Sand, Gravel, Shells, Seaweed
16	32	111172330	0	43.797633	-66.159285	Sand, Gravel, Shells, Seaweed
16	33	111172348	0	43.797670	-66.159268	Sand, Gravel, Shells, Seaweed
17	1	111173048	0	43.794458	-66.158255	
17	2	111173130	0	43.794463	-66.158285	
17	3	111173200	0	43.794475	-66.158313	
17	4	111173230	0	43.794500	-66.158347	
17	5	111173306	0	43.794550	-66.158398	
17	6	111173323	0	43.794617	-66.158442	
17	7	111173350	0	43.794643	-66.158465	
17	8	111173420	0	43.794663	-66.158487	
17	9	111173507	0	43.794707	-66.158520	
17	10	111173545	0	43.794772	-66.158557	
17	11	111173610	0	43.794818	-66.158580	
17	12	111173640	0	43.794848	-66.158598	
17	13	111173915	0	43.795073	-66.158638	
17	14	111173937	0	43.795102	-66.158618	
17	15	111173950	0	43.795118	-66.158607	
17	16	111174015	0	43.795152	-66.158588	
17	17	111174030	0	43.795173	-66.158578	
17	18	111174154	0	43.795318	-66.158552	
17	19	111174225	0	43.795358	-66.158555	
17	20	111174255	0	43.795400	-66.158560	
17	21	111174346	0	43.795497	-66.158570	
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70	46	114160429	0	43.785485	-66.167197	
70	47	114160443	0	43.785632	-66.167312	
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Appendices

Appendix I - Survey Particulars

Name of Vessel:	J.L. Hart
Dates	17-30 April 2003
Vessel captains:	Dean Robinson 14-28 April 2003
	David Pink, 28-30 April 2003
Area of Operation	Yarmouth, NS
Senior Scientist:	Russell Parrott

List of Participants

<u>Geological Survey of Canada Atlantic</u>

Russell Parrott	Senior Scientist
Darrell Beaver	Navigation + Simrad EM3000 multibeam
Robert Murphy	Sampling and seafloor photography
Anthony Atkinson	Electronics

Other

Eric Patton	GIS and navigation

Appendix II - Cruise Log (all times in GMT)

17 April 2003 Thursday

13:00 CSL Plover lifted from water and placed on a SeaLand Industries trailer for transport to Yarmouth, NS.

14:00 Beaver, Murphy and Reid depart BIO and drive to Yarmouth.

19:00 Launch lifted from trailer and placed in Yarmouth Harbour. Dock space provided by Coast Guard Canada in a fenced and locked area on a floating dock. Equipment mobilized and all systems tested. Problems encountered with sound velocity profiler (SVP) system.

23:00 JL Hart departs BIO jetty in Dartmouth NS to transit to Yarmouth NS.

18 April 2003 Friday

11:00 Parrott, Atkinson and Patton load computer workstations into van, depart BIO and drive to Yarmouth.

Plover continues to have problems with SVP.

15:00 GSCA staff arrive Yarmouth, check into hotel and commence setup of computers and workstation.

22:00 JL Hart arrives in Yarmouth after a 20 hour transit. Ship docks at the government wharf and ties up to a floating barge. Staff check laboratory to ensure that no gear was damaged in transit. SVP system functioning properly on Plover.

23:00 Complete setup of computers and workstation in hotel.

19 April 2003 Saturday

10:00 Mobilize survey gear on JL Hart. Connect all graphic recorders, digitizers, video displays etc. Plover departs Yarmouth and commences multibeam bathymetry survey of the False Harbour disposal site.

15:30 JL Hart departs Yarmouth and commences a sidescan sonar and Seistec survey of the outer harbour disposal sites. A large number of lobster pots are present in the area. The pots are generally laid in strings of approximately 10 pots with a buoy at either end. Survey lines are runs as strait as possible, with deviations from the line as necessary to avoid snagging any fishing gear.

16:30 Start line into False Harbour. The False Harbour disposal site is located near the head of a small bay, in an area with shallow water and restricted maneuverability. Several lobster pots were present in the area. In order to perform the survey in False Harbour all operations are conducted at high tide.

20:00 Recover survey gear and return to Yarmouth

20:30 JL Hart secure at dock.

21:00 Plover returns to Yarmouth.

22:00 Start processing of sidescan sonar and multibeam bathymetry data.

20 April 2003 Sunday

10:00 Plover departs for survey site and continues with survey of outer channel.

10:40 Arrive JL Hart.

10:50 JL Hart departs Yarmouth and continues with a sidescan sonar and Seistec survey of the outer harbour disposal sites. Survey lines are runs as strait as possible, with deviations from the line as necessary to avoid snagging any fishing gear.

Run additional lines into False Harbour at high tide. A lobster buoy becomes tangled in the Seistec catamaran. The gear is untangled with no damage to the lobster gear or the Seistec system.

19:00 Start line to survey up the shipping channel in Yarmouth Harbour.
19:45 Recover gear near the government wharf.
19:55 JL Hart secure at wharf.
20:00 Plover returns to base.
22:00 Start processing of sidescan sonar and multibeam bathymetry data.

21 April 2003 Monday

10:00 Plover departs for survey site and continues with survey of outer channel.
10:40 Arrive JL Hart.
10:50 JL Hart departs Yarmouth and commences camera stations to obtain seafloor photographs of disposal sites and surrounding areas.
11:30 Logging of navigation system data enabled.
15:00 Test digital video and still photographs system over an old disposal sites in the outer harbour. A gravel seafloor with boulders, and shell hash and sand, were encountered.
16:00 Test the digital video and still photographs system over the False Harbour disposal site (at high tide). Two transects were obtained near the site. One transect shows a boulder and cobble seafloor that quickly graded to a sandy seafloor. Another shows a sandy seafloor that changes to angular gravel with boulders and debris and back to sand.
18:00 Continue with camera stations in False Harbour.
19:36 Recover camera and return to base.
20:00 Secure at dock.
22:00 Continue processing of sidescan sonar and multibeam bathymetry data.

22 April 2003 Tuesday

10:00 Plover departs for survey site and continues with survey of outer channel.
10:40 Maintenance day for JL Hart. Personnel from shipyard arranged to arrive at 10:00 to evaluate work required to repair the hydraulic control station used to operate the vessel's large winches and to replace the rescue spot light. Shipyard personnel were delayed until 15:00. After removal of the old spotlight, it is decided that it would be more efficient to completely replace the unit while the personnel were on board the vessel, than to return and replace the light on another date. No survey operations are performed.
12:00 A brief report on conditions at the False Harbour disposal site is prepared, and e-mailed to Environment Canada.

Photographs taken on 21April are printed by a "1 hour photo" service. The photographs show a large amount of fine suspended material in the water, resulting in reduced resolution of the seafloor. The camera is adjusted to trigger at 1.3 metres above the seafloor, rather than the 1.7 metres used previously.

Digital still images from the Scorpio system are downloaded. The software provided with the system appears have some problems with controlling the hardware and several attempts were required to download all the images.

Continue processing of sidescan sonar and multibeam bathymetry data.

23 April 2003 Wednesday

10:00 Plover departs for survey site and continues with survey of outer channel.
10:40 Arrive JL Hart.
10:50 JL Hart departs Yarmouth and commences camera stations to obtain seafloor photographs of disposal sites and surrounding areas.

15:00 Take grab samples of disposal sites and surrounding areas with a van Veen grab.
19:36 Recover grab sampler and return to base.
20:00 Secure at dock. Arrange to send cdrom to Environment Canada by courier.
22:00 Continue processing of sidescan sonar and multibeam bathymetry data.

24 April 2003 Thursday
10:00 Plover departs for survey site and continues with survey of outer channel.
10:30 Arrive JL Hart.
10:45 JL Hart departs Yarmouth and commences grab samples of disposal sites and surrounding areas with a van Veen grab.
13:00 Perform video transects on east side of the harbour with the digital system, over an older disposal site. The transect shows a sandy seafloor that changed to gravel with boulders and back to sand.
14:10 Regulus navigation computer crash. No input strings are seen on the serial port. The computer and all hardware were rebooted.
Continue with video transects.
16:10 Recover video equipment.
16:30 Deploy Seistec and sidescan sonar and continue survey of outer harbour.
18:00 Tangle a free floating buoy and rope on the Seistec system. Recover the survey equipment and return to base.
18:45 Secure at dock.
22:00 Continue processing of sidescan sonar and multibeam bathymetry data.

25 April 2003 Friday
10:00 Plover departs for survey site and continues with survey of outer channel.
10:30 Arrive JL Hart.
10:45 JL Hart departs Yarmouth and steams to False Harbour. Heavy swell is encountered that resulted in equipment being dumped from counter tops. Conditions are not safe for deck work. Return to base.
Digital still images from the Scorpio system are downloaded. The software provided with the system is still having some problems with controlling the hardware and several attempts are required to download all the images.
Make arrangements to demobilize the geophysical gear on Monday.
Continue processing of sidescan sonar and multibeam bathymetry data.

26 April 2003 Saturday
10:00 Plover departs for survey site and continues with survey of outer channel.
10:20 Arrive JL Hart.
10:30 JL Hart departs Yarmouth and steams to False Harbour and commences grab samples of disposal sites and surrounding areas with a van Veen grab.
16:10 Deploy Seistec and sidescan sonar and continue survey of the eastern side of the outer harbour.
19:30 Recover gear and return to base.
20:00 Secure at dock.
22:00 Continue processing of sidescan sonar and multibeam bathymetry data.

27 April 2003 Sunday
10:00 Heavy winds and rain. No survey or sampling operations.
11:00 Start to disconnect hydraulic lines and survey gear in preparation for complete demobilization of gear on Monday morning.

15:00 Launch Plover continues with multibeam survey operations. Problems encountered with the Uninterruptible Power Supply (UPS) overheating on the launch causing the system to halt and loose data.
18:00 Launch returns to base.

28 April 2003 Monday

The JL Hart will remain in port today until the vessel has been handed over to the new crew. Plans were made with the new captain (David Pink) for the JL Hart to transit to Grand Manan to complete photographic work started during survey Hart2002012. GSC personnel will drive to Digby, take the ferry to Saint John and continue on to Grand Manan to rejoin the vessel.
10:00 Welder arrives to cut winches free from deck of JL Hart.
Lift winches and heavy survey gear unto jetty using boom truck.
13:00 Coast Guard truck arrives to load winches and heavy gear.
15:00 Jodrey arrives from Dartmouth with rental van. Start to load lighter gear into van.
17:00 Jodrey and Patton with loaded van leave for Dartmouth.
17:30 Parrott, Atkinson and Murphy leave Yarmouth to catch ferry to Saint John – to transit to Grand Manan and rejoin JL Hart.
19:00 Contact JL Hart before boarding ferry. Winds have increased and forecast calls for strong winds for next 2-3 days. JL Hart unable to depart for Grand Manan. GSC personnel return to Yarmouth.
21:00 GSC personnel back in Yarmouth.

29 April 2003 Tuesday

12:00 GSC personnel arrive JL Hart to discuss procedure for unloading remaining gear.
Tide is too low to allow unloading of gear using ship's crane.
15:00 Vessel unloaded at high tide, and gear stowed into GSC van.
17:30 Murphy, Beaver and Reid remain in Yarmouth with launch Plover. Atkinson and Parrott leave Yarmouth to transit to Dartmouth.
22:00 Atkinson and Parrott arrive Dartmouth.

30 April 2003 Wednesday

12:00 Crane arrives to load Plover on launch.
12:45 Truck arrives, Plover loaded and secured.
14:00 Truck departs for Dartmouth.
15:30 Beaver, Murphy and Reid arrive Dartmouth and help unload Plover.

Appendix III - Grab Samples Photographs

Hart 2003009 Grab Samples

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2003009_39.gif

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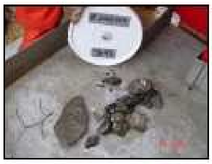

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Hart 2003009 Grab Samples

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Appendix IV - Seafloor Photographs

Hart 2003009 Seafloor Photographs


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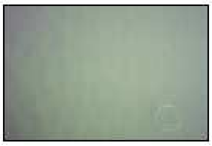
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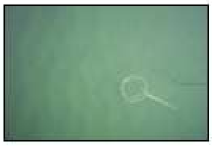
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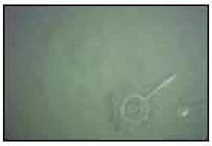
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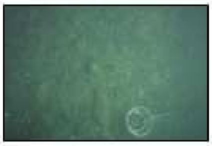
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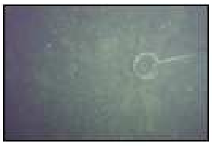
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Hart 2003009 Seafloor Photographs


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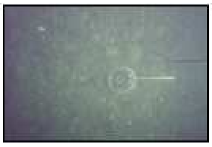
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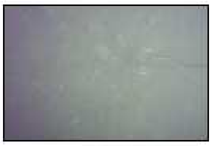
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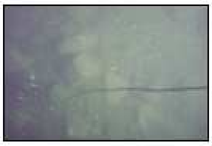
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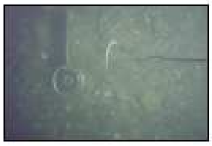
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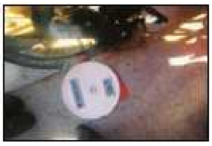
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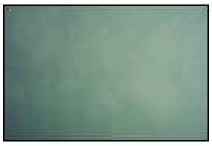
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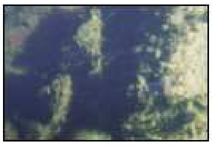
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Hart 2003009 Seafloor Photographs


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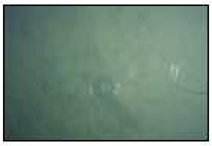
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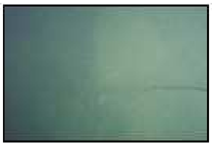
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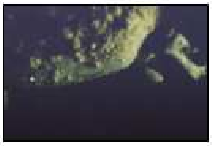
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Hart 2003009 Seafloor Photographs


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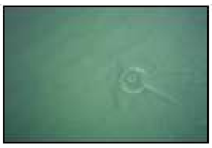
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Hart 2003009 Seafloor Photographs


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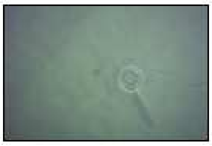
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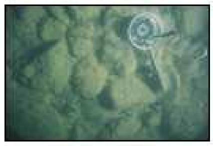
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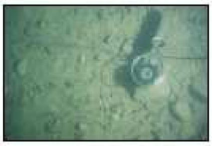
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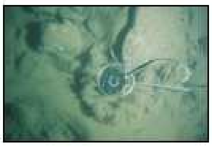
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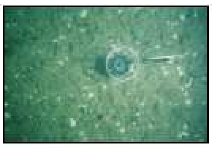
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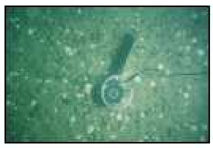
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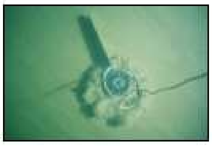
Hart 2003009 Seafloor Photographs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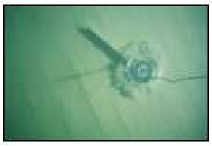
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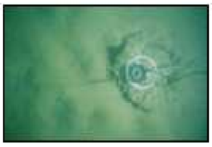
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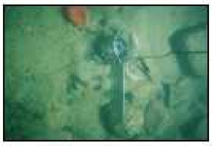
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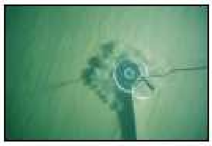
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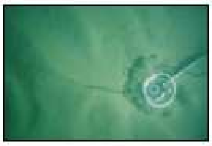
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Appendix V - Digital Seafloor Images

2003009 Digital Images


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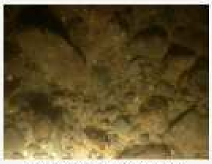
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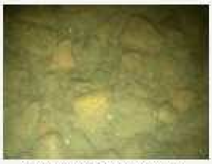
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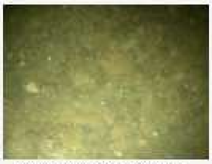
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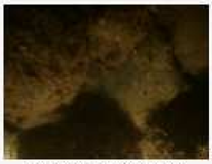
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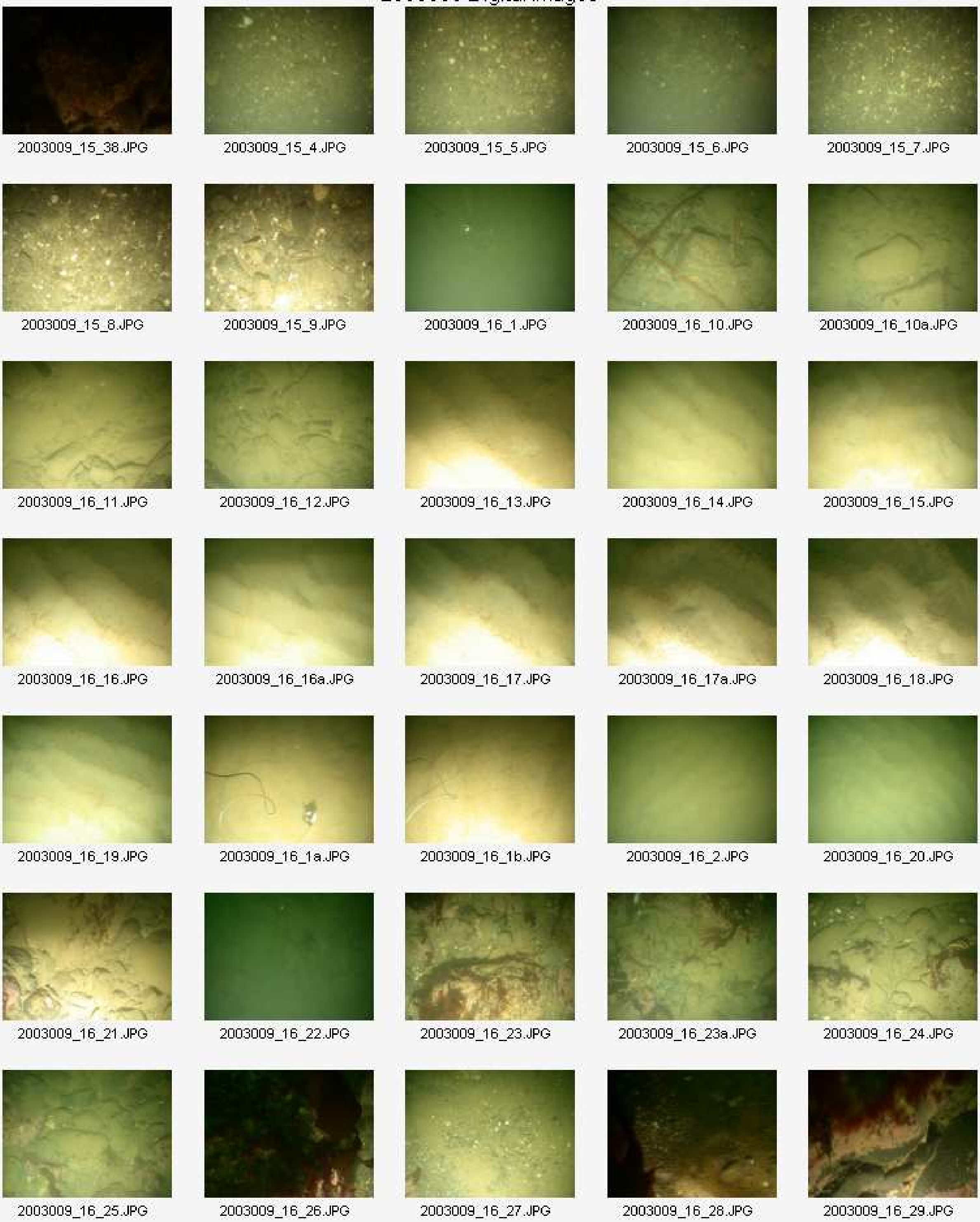
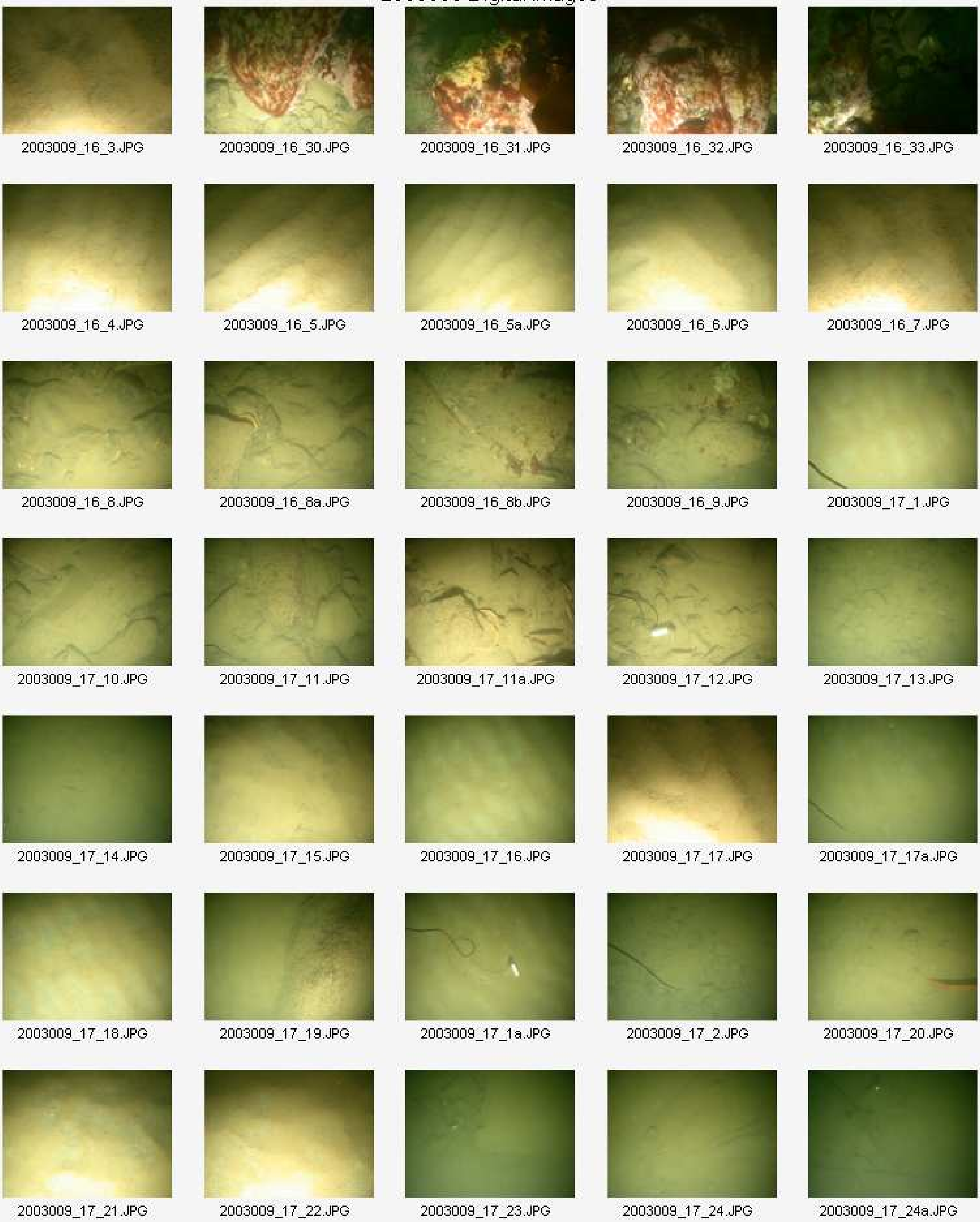
Digital Seafloor photographs

2003009 Digital Images



Digital Seafloor photographs

2003009 Digital Images



Digital Seafloor photographs

2003009 Digital Images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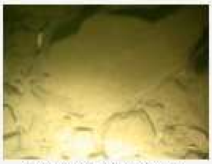
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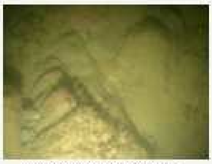
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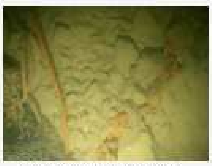
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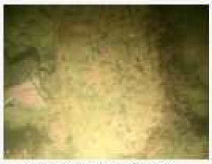
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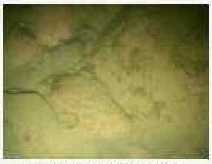
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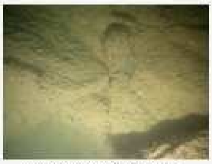
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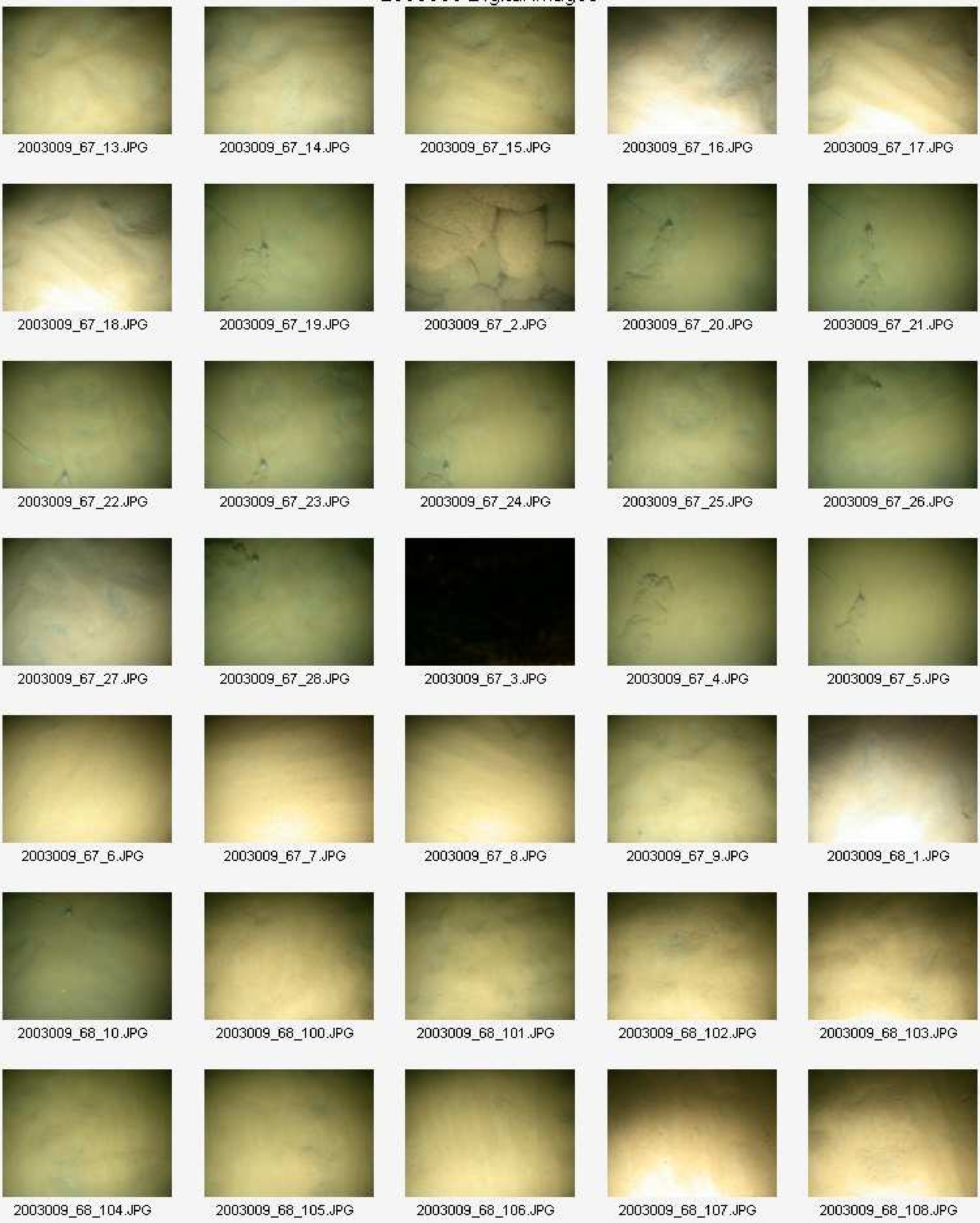
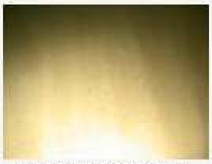
Digital Seafloor photographs

2003009 Digital Images



Digital Seafloor photographs

2003009 Digital Images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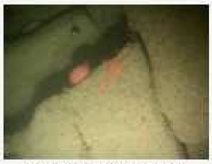
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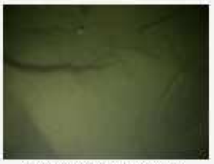
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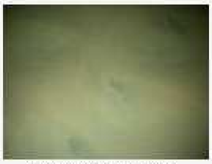
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Digital Seafloor photographs

2003009 Digital Images


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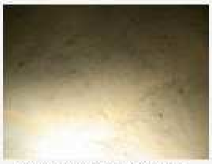
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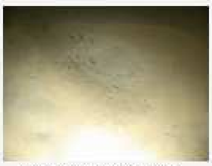
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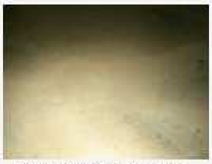
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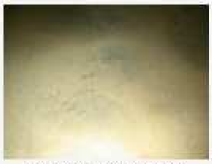
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Digital Seafloor photographs

2003009 Digital Images


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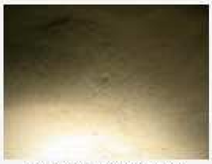
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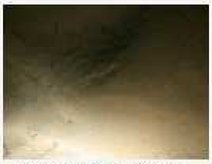
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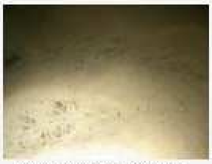
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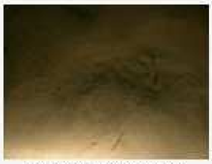
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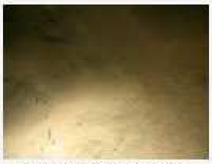
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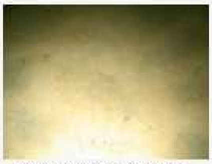
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2003009_69_12.JPG

Digital Seafloor photographs

2003009 Digital Images


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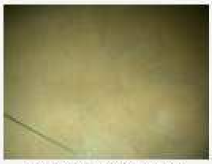
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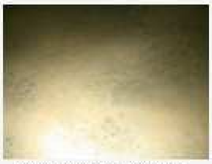
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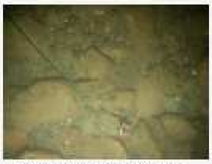
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2003009_70_20.JPG


2003009_70_21.JPG

Digital Seafloor photographs

2003009 Digital Images


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2003009_70_24.JPG


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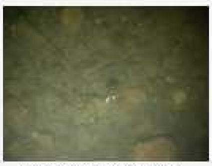
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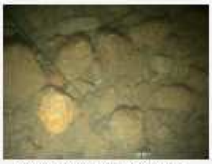
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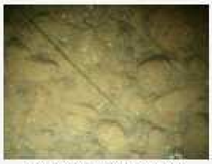
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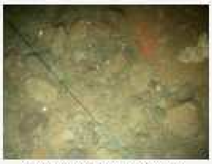
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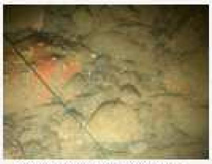
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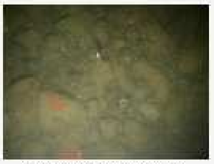
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Digital Seafloor photographs

2003009 Digital Images


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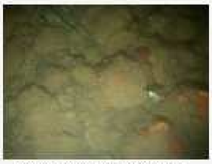
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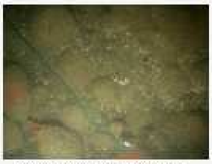
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2003009_70_7.JPG


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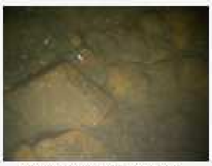
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2003009_70_9.JPG


2003009_71_57.JPG


2003009_71_58.JPG

Digital Seafloor photographs

Appendix VI - Predicted Tides

Tides generated by the program Tides and Currents Pro

Times are given in Atlantic Daylight Time and depths in centimeters

Year	Month	Day	Time	Tide	Time	Tide	Time	Tide	Time	Tide
2003	Apr	17	12:00a	477	1:00a	409	2:00a	302	3:00a	183
2003	Apr	17	4:00a	80	5:00a	15	6:00a	4	7:00a	52
2003	Apr	17	8:00a	151	9:00a	271	10:00a	379	11:00a	448
2003	Apr	17	12:00p	467	1:00p	430	2:00p	344	3:00p	230
2003	Apr	17	4:00p	120	5:00p	45	6:00p	21	7:00p	53
2003	Apr	17	8:00p	133	9:00p	247	10:00p	367	11:00p	459
2003	Apr	18	12:00a	498	1:00a	474	2:00a	396	3:00a	283
2003	Apr	18	4:00a	163	5:00a	62	6:00a	3	7:00a	2
2003	Apr	18	8:00a	61	9:00a	166	10:00a	286	11:00a	388
2003	Apr	18	12:00p	448	1:00p	457	2:00p	414	3:00p	325
2003	Apr	18	4:00p	212	5:00p	108	6:00p	43	7:00p	31
2003	Apr	18	8:00p	71	9:00p	158	10:00p	275	11:00p	390
2003	Apr	19	12:00a	470	1:00a	494	2:00a	460	3:00a	377
2003	Apr	19	4:00a	265	5:00a	148	6:00a	53	7:00a	4
2003	Apr	19	8:00a	13	9:00a	78	10:00a	183	11:00a	296
2003	Apr	19	12:00p	388	1:00p	438	2:00p	441	3:00p	395
2003	Apr	19	4:00p	306	5:00p	198	6:00p	105	7:00p	52
2003	Apr	19	8:00p	49	9:00p	95	10:00p	184	11:00p	296
2003	Apr	20	12:00a	400	1:00a	466	2:00a	479	3:00a	440
2003	Apr	20	4:00a	358	5:00a	250	6:00a	141	7:00a	56
2003	Apr	20	8:00a	17	9:00a	32	10:00a	99	11:00a	198
2003	Apr	20	12:00p	299	1:00p	379	2:00p	422	3:00p	422
2003	Apr	20	4:00p	376	5:00p	291	6:00p	192	7:00p	111
2003	Apr	20	8:00p	68	9:00p	72	10:00p	120	11:00p	204
2003	Apr	21	12:00a	307	1:00a	397	2:00a	450	3:00a	457
2003	Apr	21	4:00a	418	5:00a	341	6:00a	242	7:00a	143
2003	Apr	21	8:00a	68	9:00a	37	10:00a	55	11:00a	118
2003	Apr	21	12:00p	206	1:00p	295	2:00p	366	3:00p	405
2003	Apr	21	4:00p	404	5:00p	359	6:00p	281	7:00p	193
2003	Apr	21	8:00p	124	9:00p	90	10:00p	95	11:00p	139
2003	Apr	22	12:00a	215	1:00a	305	2:00a	384	3:00a	429
2003	Apr	22	4:00a	434	5:00a	399	6:00a	330	7:00a	241
2003	Apr	22	8:00a	152	9:00a	86	10:00a	59	11:00a	76
2003	Apr	22	12:00p	131	1:00p	207	2:00p	286	3:00p	352
2003	Apr	22	4:00p	389	5:00p	389	6:00p	348	7:00p	278
2003	Apr	22	8:00p	202	9:00p	141	10:00p	110	11:00p	112
2003	Apr	23	12:00a	149	1:00a	215	2:00a	295	3:00a	366
2003	Apr	23	4:00a	408	5:00a	414	6:00a	385	7:00a	326
2003	Apr	23	8:00a	247	9:00a	166	10:00a	104	11:00a	78
2003	Apr	23	12:00p	91	1:00p	136	2:00p	203	3:00p	277
2003	Apr	23	4:00p	340	5:00p	378	6:00p	379	7:00p	344
2003	Apr	23	8:00p	283	9:00p	215	10:00p	158	11:00p	124
2003	Apr	24	12:00a	121	1:00a	150	2:00a	208	3:00a	282
2003	Apr	24	4:00a	348	5:00a	390	6:00a	400	7:00a	379
2003	Apr	24	8:00a	329	9:00a	256	10:00a	178	11:00a	118
2003	Apr	24	12:00p	90	1:00p	97	2:00p	136	3:00p	199
2003	Apr	24	4:00p	270	5:00p	334	6:00p	373	7:00p	377
2003	Apr	24	8:00p	347	9:00p	291	10:00p	226	11:00p	168
2003	Apr	25	12:00a	129	1:00a	119	2:00a	143	3:00a	198
2003	Apr	25	4:00a	270	5:00a	335	6:00a	379	7:00a	395
2003	Apr	25	8:00a	380	9:00a	334	10:00a	262	11:00a	184
2003	Apr	25	12:00p	123	1:00p	93	2:00p	98	3:00p	135

2003	Apr	25	4:00p	197	5:00p	270	6:00p	335	7:00p	375
2003	Apr	25	8:00p	381	9:00p	353	10:00p	299	11:00p	231
2003	Apr	26	12:00a	168	1:00a	124	2:00a	110	3:00a	134
2003	Apr	26	4:00a	190	5:00a	262	6:00a	329	7:00a	376
2003	Apr	26	8:00a	396	9:00a	384	10:00a	336	11:00a	261
2003	Apr	26	12:00p	181	1:00p	120	2:00p	91	3:00p	97
2003	Apr	26	4:00p	136	5:00p	201	6:00p	277	7:00p	344
2003	Apr	26	8:00p	385	9:00p	390	10:00p	359	11:00p	300
2003	Apr	27	12:00a	226	1:00a	158	2:00a	111	3:00a	99
2003	Apr	27	4:00a	126	5:00a	187	6:00a	262	7:00a	331
2003	Apr	27	8:00a	381	9:00a	401	10:00a	385	11:00a	331
2003	Apr	27	12:00p	251	1:00p	170	2:00p	112	3:00p	87
2003	Apr	27	4:00p	98	5:00p	143	6:00p	214	7:00p	294
2003	Apr	27	8:00p	362	9:00p	400	10:00p	398	11:00p	358
2003	Apr	28	12:00a	290	1:00a	211	2:00a	139	3:00a	94
2003	Apr	28	4:00a	89	5:00a	125	6:00a	192	7:00a	271
2003	Apr	28	8:00a	342	9:00a	391	10:00a	405	11:00a	379
2003	Apr	28	12:00p	315	1:00p	232	2:00p	153	3:00p	101
2003	Apr	28	4:00p	85	5:00p	105	6:00p	159	7:00p	237
2003	Apr	28	8:00p	321	9:00p	386	10:00p	413	11:00p	398
2003	Apr	29	12:00a	346	1:00a	269	2:00a	186	3:00a	116
2003	Apr	29	4:00a	79	5:00a	85	6:00a	132	7:00a	207
2003	Apr	29	8:00a	289	9:00a	358	10:00a	400	11:00a	402
2003	Apr	29	12:00p	363	1:00p	291	2:00p	206	3:00p	134
2003	Apr	29	4:00p	93	5:00p	89	6:00p	121	7:00p	185
2003	Apr	29	8:00p	270	9:00p	353	10:00p	408	11:00p	420
2003	Apr	30	12:00a	387	1:00a	323	2:00a	239	3:00a	155
2003	Apr	30	4:00a	93	5:00a	69	6:00a	90	7:00a	150
2003	Apr	30	8:00a	230	9:00a	312	10:00a	375	11:00a	404
2003	Apr	30	12:00p	391	1:00p	338	2:00p	260	3:00p	179
2003	Apr	30	4:00p	116	5:00p	89	6:00p	99	7:00p	146
2003	Apr	30	8:00p	222	9:00p	310	10:00p	385	11:00p	424

Appendix VII - Measured tides for Yarmouth NS 18-27 April 2003

Tides downloaded ron the CHS tide gauge in Yarmouth NS

Times are given in GMT and depths in meters

Date	Time	Tide	Time	Tide	Time	Tide	Time	Tide
4/18/2003	4:00:00	4.611	5:00:00	3.948	6:00:00	2.84	7:00:00	1.505
4/18/2003	8:00:00	0.507	9:00:00	0.007	10:00:00	0.126	11:00:00	0.596
4/18/2003	12:00:00	1.507	13:00:00	2.641	14:00:00	3.717	15:00:00	4.404
4/18/2003	16:00:00	4.503	17:00:00	4.136	18:00:00	3.254	19:00:00	2.127
4/18/2003	20:00:00	1.104	21:00:00	0.442	22:00:00	0.35	23:00:00	0.731
4/19/2003	0:00:00	1.525	1:00:00	2.634	2:00:00	3.771	3:00:00	4.582
4/19/2003	4:00:00	4.874	5:00:00	4.612	6:00:00	3.783	7:00:00	2.659
4/19/2003	8:00:00	1.397	9:00:00	0.497	10:00:00	0.062	11:00:00	0.264
4/19/2003	12:00:00	0.832	13:00:00	1.747	14:00:00	2.85	15:00:00	3.787
4/19/2003	16:00:00	4.383	17:00:00	4.412	18:00:00	3.967	19:00:00	3.045
4/19/2003	20:00:00	1.951	21:00:00	1.04	22:00:00	0.536	23:00:00	0.566
4/20/2003	0:00:00	0.975	1:00:00	1.797	2:00:00	2.869	3:00:00	3.922
4/20/2003	4:00:00	4.643	5:00:00	4.852	6:00:00	4.511	7:00:00	3.655
4/20/2003	8:00:00	2.565	9:00:00	1.372	10:00:00	0.498	11:00:00	0.185
4/20/2003	12:00:00	0.341	13:00:00	0.974	14:00:00	1.882	15:00:00	2.929
4/20/2003	16:00:00	3.802	17:00:00	4.283	18:00:00	4.307	19:00:00	3.848
4/20/2003	20:00:00	3.007	21:00:00	2.074	22:00:00	1.239	23:00:00	0.785
4/21/2003	0:00:00	0.809	1:00:00	1.256	2:00:00	2.082	3:00:00	3.077
4/21/2003	4:00:00	4.003	5:00:00	4.632	6:00:00	4.763	7:00:00	4.449
4/21/2003	8:00:00	3.653	9:00:00	2.591	10:00:00	1.49	11:00:00	0.767
4/21/2003	12:00:00	0.463	13:00:00	0.662	14:00:00	1.227	15:00:00	2.088
4/21/2003	16:00:00	3.085	17:00:00	3.875	18:00:00	4.296	19:00:00	4.24
4/21/2003	20:00:00	3.817	21:00:00	3.056	22:00:00	2.147	23:00:00	1.366
4/22/2003	0:00:00	0.982	1:00:00	1.108	2:00:00	1.469	3:00:00	2.236
4/22/2003	4:00:00	3.103	5:00:00	3.928	6:00:00	4.529	7:00:00	4.663
4/22/2003	8:00:00	4.303	9:00:00	3.549	10:00:00	2.618	11:00:00	1.63
4/22/2003	12:00:00	1.007	13:00:00	0.797	14:00:00	0.923	15:00:00	1.415
4/22/2003	16:00:00	2.224	17:00:00	3.064	18:00:00	3.738	19:00:00	4.114
4/22/2003	20:00:00	4.112	21:00:00	3.766	22:00:00	3.022	23:00:00	2.271
4/23/2003	0:00:00	1.558	1:00:00	1.201	2:00:00	1.159	3:00:00	1.57
4/23/2003	4:00:00	2.232	5:00:00	3.1	6:00:00	3.848	7:00:00	4.357
4/23/2003	8:00:00	4.493	9:00:00	4.217	10:00:00	3.564	11:00:00	2.693
4/23/2003	12:00:00	1.85	13:00:00	1.195	14:00:00	0.941	15:00:00	1.06
4/23/2003	16:00:00	1.482	17:00:00	2.184	18:00:00	2.984	19:00:00	3.699
4/23/2003	20:00:00	4.053	21:00:00	4.074	22:00:00	3.745	23:00:00	3.136
4/24/2003	0:00:00	2.411	1:00:00	1.795	2:00:00	1.409	3:00:00	1.402
4/24/2003	4:00:00	1.675	5:00:00	2.244	6:00:00	2.991	7:00:00	3.737
4/24/2003	8:00:00	4.243	9:00:00	4.391	10:00:00	4.164	11:00:00	3.587
4/24/2003	12:00:00	2.813	13:00:00	1.97	14:00:00	1.358	15:00:00	1.065
4/24/2003	16:00:00	1.153	17:00:00	1.532	18:00:00	2.186	19:00:00	2.916
4/24/2003	20:00:00	3.571	21:00:00	3.945	22:00:00	3.988	23:00:00	3.714
4/25/2003	0:00:00	3.158	1:00:00	2.463	2:00:00	1.837	3:00:00	1.479
4/25/2003	4:00:00	1.417	5:00:00	1.613	6:00:00	2.127	7:00:00	2.852
4/25/2003	8:00:00	3.537	9:00:00	4.046	10:00:00	4.259	11:00:00	2.767
4/25/2003	12:00:00	3.523	13:00:00	2.822	14:00:00	1.999	15:00:00	1.377
4/25/2003	16:00:00	1.123	17:00:00	1.135	18:00:00	1.494	19:00:00	2.125
4/25/2003	20:00:00	2.846	21:00:00	3.508	22:00:00	3.878	23:00:00	3.924

4/26/2003	0:00:00	3.777	1:00:00	3.157	2:00:00	2.416	3:00:00	1.754
4/26/2003	4:00:00	1.261	5:00:00	1.13	6:00:00	1.41	7:00:00	2.019
4/26/2003	8:00:00	2.675	9:00:00	3.435	10:00:00	3.93	11:00:00	4.162
4/26/2003	12:00:00	3.985	13:00:00	3.468	14:00:00	2.762	15:00:00	1.973
4/26/2003	16:00:00	1.346	17:00:00	1.039	18:00:00	1.046	19:00:00	1.453
4/26/2003	20:00:00	2.099						
4/27/2003	0:00:00							
4/27/2003	4:00:00	1.767	5:00:00	1.272	6:00:00	1.191	7:00:00	1.51
4/27/2003	8:00:00	2.063	9:00:00	2.764	10:00:00	3.542	11:00:00	4.145
4/27/2003	12:00:00	4.308	13:00:00	4.121	14:00:00	3.592	15:00:00	2.865
4/27/2003	16:00:00	1.991	17:00:00	1.325	18:00:00	1.069	19:00:00	1.221
4/27/2003	20:00:00	1.66	21:00:00	2.357	22:00:00	3.151	23:00:00	3.822
4/28/2003	0:00:00	4.237	1:00:00	4.263	2:00:00	3.772	3:00:00	3.056
4/28/2003	4:00:00	2.261	5:00:00	1.534	6:00:00	1.11	7:00:00	1.073
4/28/2003	8:00:00	1.42	9:00:00	2.04	10:00:00	2.819	11:00:00	3.608
4/28/2003	12:00:00	4.086	13:00:00	4.211	14:00:00	3.961	15:00:00	3.327
4/28/2003	16:00:00	2.497	17:00:00	1.683				