Cruise Matthew 2002066 Geophysical Surveys and Sampling Operations in the Middle Shoal Area, Cape Breton Island, NS, 19 -30 October 2002

D.R. Parrott

2010
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Background
Survey Matthew 2002066 was conducted from 19-30 October 2002 near Middle Shoal, in the approach to Great Bras d’Or, which forms the northern entrance to the Bras d’Or Lakes of Cape Breton Island. Geophysical data, seafloor samples, and seafloor photographs and videos were collected from the CCGS Matthew (Fig. 1a). Multibeam bathymetry data were collected with a Simrad EM3000 system, mounted in the survey launch Plover (Fig. 1b). These data were used to provide information on the character and distribution of seafloor sediments, and the geological and oceanographic processes which have affected the seafloor over three offshore marine disposal sites which received material from dredging the channel through Middle Shoal. The three offshore disposal sites were located near Table Head, Bird Islands, and Little River as shown in Figure 2. During times of inclement weather in the Middle Shoal area, operations were shifted to Sydney Harbour and the Baddeck area in the Bras d’Or Lakes.

Figure 1. The geophysical survey and seafloor sampling program were performed using (a) the CCGS Matthew. Multibeam bathymetry was conducted using the survey launch Plover (b) equipped with a Simrad EM3000 multibeam bathymetry system.

Geophysical equipment used during the survey consisted of a Simrad MS992 dual frequency (120 and 330 kHz) sidescan sonar system, and an IKB Seistec sub-bottom profiler. Sediment samples were collected with a vanVeen grab sampler and a small gravity corer, and bottom photographs were taken along transects through the survey area. A track plot showing lines where geophysical data collected, in the Middle Shoal area and in Sydney harbour during survey Matthew 2002066 is shown in Figure 2.
Figure 2. Trackplot showing lines where geophysical data were collected a) in St. Ann’s Bay and near Middle Shoal in the approach to Great Bras d’Or channel and b) in Sydney harbour, during survey Matthew 2002066.
Data Acquisition and Processing
The following geophysical and sampling equipment was used during survey Matthew 2002066:
• 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
• vanVeen grab sampler
• 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 mounted in 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 4. The towfish was deployed about 50 metres behind the vessel. This configuration was chosen to reduce artifacts seen on the sidescan sonar records due to vessel-induced heave, and thereby improve resolution. The sidescan sonar system was capable of resolving objects as small as 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 set at a fixed speed of 1.7 knots. This produced records with a 2 to 1 aspect ratio at the slowest survey speeds of 3.5 knots. A hardcopy graphic record of the 120 kHz portion of the sidescan sonar data was produced on an EPC Labs GSP1086-2 thermal recorder.

Figure 4 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 beacon is visible on the front of the towfish.

The sidescan sonar data were collected at 100 metre range for lines near the disposal sites and at 200 metre range for lines outside the primary disposal sites. This provided swaths of 200 and 400 metres respectively. Lines run at the 100 m range were typically 75 or 100 metres apart, with a 300 metre spacing used for the 200 metre range lines.
Sidescan sonar data from survey Matthew 2002066 (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. 3400 samples per ping were collected at 200 metre range and 1700 samples 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 for data near the disposal site and 1.0 metre resolution for regional data. The sidescan sonar data from adjacent survey lines were integrated to produce a sidescan sonar mosaic. A variable layback, based on towfish positions from the TrackPoint II positioning system, was applied to the sidescan sonar data.

**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 electrodynamic (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 5. 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 on the starboard side of the vessel 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 EPC9800 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 streamer data were filtered at 1000 to 7000 hertz.

![Figure 5. Seistec sub-bottom profiler showing the catamaran used to tow the boomer and line-and-cone array at the surface. Power and signals are contained in the tow cable bundle on the front of the catamaran.](image-url)
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 to the raw logged data during digitization. Channel configurations for the logged data were:

<table>
<thead>
<tr>
<th>Channel</th>
<th>Use</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>120 kHz port</td>
</tr>
<tr>
<td>1</td>
<td>120 kHz starboard</td>
</tr>
<tr>
<td>2</td>
<td>330 kHz port</td>
</tr>
<tr>
<td>3</td>
<td>330 kHz starboard</td>
</tr>
</tbody>
</table>

Sidescan sonar - 80 microseconds sample interval

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

<table>
<thead>
<tr>
<th>Channel</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>STB Seistec line cone receiver</td>
</tr>
<tr>
<td>1</td>
<td>STB GF10/15P streamer hydrophone</td>
</tr>
</tbody>
</table>

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° x 1.5°. 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 m² at 50 metres water depth.

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 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° - 0.5° can be obtained from the raw GPS data. A Kalman filter is used to improve the heading estimate to 0.05° - 0.1°. Vessel attitude is measured using an inertial measurement unit to provide an accuracy of 0.0003° for pitch, roll and heading. More information on this system can be found at www.applanix.com.

Survey lines were run at a various spacing 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 scanned bathymetry maps of the area.

Tidal corrections were made using predicted tides for Table Head and measured tides from the tide gauge in Sydney, NS provided by the Canadian Hydrographic service.

**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.

**Seafloor Photographs**

Photographs were taken at 47 camera stations near Middle Shoal, and in Sydney Harbour (about 300 photographs in total) with the Icehole camera developed by GSCA (shown in Figure 6). Images were obtained on transects through the disposal site and surrounding area using 200 ASA colour print film. The photographs were processed, digitized, and stored on CD-ROM. Locations for all camera stations are and provided in Appendix IV. The photographs are shown in Appendix VI. A copy of a CDROM with the images was archived at the Geological Survey of Canada offices in Dartmouth, NS.
Seafloor Grab Samples

A 0.1 cubic metre van Veen grab sampler was used to collect sediment samples in the survey area (Figure 7). The sample locations are provided in Appendix IV. Digital images of the grabs, are incorporated as ‘hotlinks’ in an ArcView GIS database 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. A copy of a CDROM with the images was archived at the Geological Survey of Canada offices in Dartmouth, NS.

Figure 7. Samples were collected during Matthew 2001030 with a VanVeen grab sampler.

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 Figures 8 and 9, a tidal range of about 1 metre was predicted for Table Head, near Middle Shoal, during the survey with currents of about 0.4 knots predicted for Big Bras D’Or. A tidal range of about 1 metre was predicted for North Sydney.

Figure 8. Predicted tides for Table Head, near Middle Shoal, Cape Breton Island for October 2002.
Figure 9. Predicted currents for Great Bras d’Or area during the Matthew 2002066 survey.

Figure 10. Predicted tides for North Sydney, Cape Breton Island for October 2002.
Preliminary Results

Middle Shoal, Cape Breton Island, Nova Scotia
A suite of data consisting of sidescan sonar, sub-bottom profiler, seafloor photographs, and grab samples were collected in St. Anns Bay and near Middle Shoal in the approach to Great Bras d’Or channel over disposal sites A, B and C during cruise Matthew 2002066. Multibeam bathymetry and backscatter data were collected over Sites A and B. A shaded colour-relief image generated from the multibeam bathymetry data shows a large cluster of dredge spoils near the centre of Site A in about 27 metres water depth, and a long linear accumulation of spoils in about 8 metres water depth in Site B (Figure 11). These dredge spoils were dumped in approved offshore disposal sites.

Figure 11. Coloured shaded relief image generated from multibeam bathymetry data collected near Middle Shoal in the approach to Great Bras d’Or channel over disposal sites A and B during October 2002 on survey Matthew 2002066.
Multibeam bathymetry data were processed to extract backscatter intensity values and used to generate a mosaic (shown in Figure 12). The dredge spoils are visible in the central portion of Site A and along the southeast edge of Site B.

Figure 12. Backscatter intensity calculated from multibeam bathymetry collected near Middle Shoal in the approach to Great Bras d’Or channel over disposal sites A and B during October 2002 on survey Matthew 2002066.
Sidescan sonar data collected over disposal sites A, B, and C were processed and used to generate mosaic (shown in Figure 13). The dredge spoils are visible in the near the center of the mosaic collected over area A and along the southeast side of the mosaic over site B. Only a small amount of material was dumped in Site C, and a small area of dredge spoil was detected.

Figure 13. Sidescan sonar mosaic of data collected in St. Ann’s Bay and near Middle Shoal in the approach to Great Bras d’Or channel over disposal sites A, B and C during survey Matthew 2002066.
Sydney, Cape Breton Island, Nova Scotia
During times when it was not possible to survey in Middle Shoal because of weather conditions, a suite of data consisting of sidescan sonar data, multibeam bathymetry and backscatter, sub-bottom profiler data, and seafloor photographs were collected in Sydney harbour. Figure 14a shows the ships tracks where sidescan sonar and sub-bottom profiler data were collected. The sidescan sonar data were processed to correct for geometric factors, combined into a mosaic, and overlaid on a chart. Figure 14b shows the sidescan sonar mosaic and locations where seafloor photographs were taken in Sydney. Locations for all camera stations are provided in Appendix IV. The photographs are shown in Appendix VI.

Figure 14. Location of a) ship’s tracks and b) a mosaic of sidescan sonar data showing seafloor photograph locations in Sydney Harbour taken during October 2002 on survey Matthew 2002066.
Multibeam bathymetry and backscatter intensity data were collected in the shallow water portions of Sydney harbour to complement data previously collected by the Canadian Hydrographic Service. The new data were integrated with previously collected data the the amalgamated data set shown in Figure 15.

Figure 15. Multibeam bathymetry data were collected during October 2002 on survey Matthew 2002066 and integrated with existing data
Bras d’Or Lakes, Cape Breton Island, Nova Scotia
Also, during times when it was not possible to survey in Middle Shoal because of weather conditions, a suite of data consisting of sidescan sonar, sub-bottom profiler, seafloor photographs, and gravity core samples were collected near Baddeck, in the Bras d’Or Lakes. Multibeam bathymetry and backscatter data were collected in Baddeck Harbour and along a transit through St Patricks Channel to complement data previously collected by the Canadian Hydrographic Service. A shaded colour-relief image generated from the multibeam bathymetry data (Figure 16). A large sinkhole, with a depth of about 30 metres, is evident in the northeast corner of the data.

Figure 16. Coloured shaded relief image generated from multibeam bathymetry data collected in Baddeck Harbour and along a transit through St Patricks Channel during October 2002 on survey Matthew 2002066.
Sidescan sonar data and sub-bottom profiler data were collected along a transect through St. Andrews channel to Iona and back to Baddeck as shown in Figure 17. Core samples were taken in St Patricks channel.

Figure 17. Sidescan sonar and sub-bottom profiler data were collected a transect through St. Andrews channel to Iona and back to Baddeck during survey Matthew 2002066.
Access to Data and Samples
The sidescan sonar, sub-bottom profiler, multibeam bathymetry, photographs, 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. 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, and ExaBytes tapes of the raw data are available for viewing.

Acknowledgements
We would like to thank the officers, crew onboard the CCGS Matthew for their assistance in the various surveys and in collecting and delivering the sediment samples.

References
Appendices

Appendix I - Survey Particulars
Name of Vessel: CCGS Matthew
Vessel captain: Robert Gray
Dates of Survey: 19-30 October 2002
Area of Operation: Middle Shoal Area, Cape Breton Island, Nova Scotia
Senior Scientist: Russell Parrott, GSC

Appendix II - Survey Personnel

Geological Survey of Canada Atlantic
Russell Parrott Senior Scientist
Anthony Atkinson Electronics Technologist
Robert Murphy Sampling/photography
Darrel Beaver Multibeam bathymetry data collection/multibeam data processing
Paul Girouard Navigation/database entry/computers
Angus Robertson Navigation/database entry/sampling
John Shaw Marine Geologist

Others
Walli Rainey Geophysical watckkeeping and record keeping
Lori Cook Geophysical watckkeeping and record keeping
Appendix III - Summary of Activities (all times in GMT)

Day 290 – Thursday 17 October 2002 – Mobilization
GSC personnel commence mobilization of gear on CCGS Matthew at BIO.

Day 291 – Friday 18 October 2002 – Mobilization
GSC personnel continue with mobilization of gear on CCGS Matthew at BIO.

Day 292 – Saturday 19 October 2002 – Mobilization and Transit to survey site
11:00 GSC personnel continue with mobilization of gear on CCGS Matthew at BIO.
16:00 CCGS Matthew departs BIO en route to North Sydney, NS.

Day 293 – Sunday 20 October 2002 – Mobilization and start surveys
10:00 GSC personnel depart BIO en route to North Sydney, NS.
13:00 CCGS Matthew arrives North Sydney, NS.
17:00 GSC personnel arrive North Sydney, NS and join CCGS Matthew. Complete connection of survey equipment in laboratory and set up computer network.
23:30 Lab set up complete.

Day 294 – Monday 21 October 2002 – Geophysical surveys
08:00 CCGS Matthew departs North Sydney, NS for survey site.
11:10 Deploy launch Plover for Survey of near shore area near Table Head - Site B.
11:45 Deploy sidescan sonar, Seistec sub-bottom profiler and TrackPoint system and run a series of lines on Site B, near Table Head, east of the dredged channel in Middle Shoal, Great Bras D’Or. 100 metre range (each side), 150 metre line spacing.
14:09 Recover launch for lunch. Continuing with geophysical surveys.
15:36 Deploy launch.
20:13 End of survey at Site B. Recover geophysical gear.
20:26 Recover launch.
21:31 Deploy geophysical gear for survey of Site C.
23:59 Continuing with sidescan sonar and sub-bottom profiler survey of Site C.

Day 295 – Tuesday 22 October 2002 – Survey and sampling Middle Shoal
00:01 Continuing with sidescan sonar and sub-bottom profiler survey of Site C.
11:17 Deploy multibeam launch for continuation of survey of disposal Site B – Table Head
12:28 Recover geophysical gear and steam to Site B.
13:57 Commence seafloor photographs and grab stations at Site A B near Table Head in Great Bras D’Or channel. Digital pictures taken at of samples at grab sites.
14:45 Recover multibeam launch for lunch.
15:26 Deploy multibeam launch. Continue with samples and photography.
20:15 Recover multibeam launch.
21:00 Finish sampling. Anchor behind Bird Island for night.

Day 296 – Wednesday 23 October 2002 – Survey and sampling
10:37 Deploy multibeam launch for continuation of survey of disposal Site B – Table Head.
10:45 Deploy geophysical gear for survey of site A – near Bird Islands.
11:18 Plover recovered. Problems with the velocimeter.
16:52 Deploy launch after re-termination of velocimeter cable
20:17 Recover multibeam launch.
22:35 Recover geophysical gear and steam towards Middle Shoal.
23:30 Proceed through Great Bras D’Or channel and anchor for night.

**Day 297 – Thursday 24 October 2002 – Survey and sampling, Sydney Harbour**

10:30 Deploy multibeam launch for continuation of survey of disposal Site A.
10:45 Proceed through Great Bras d’Or channel to survey site. Strong northerly winds make site unsuitable for survey operations.
11:30 Recover multibeam launch and transit to Sydney.
13:04 Deploy multibeam launch to collect data near Muggah Creek.
14:58 Recover launch for lunch.
15:49 Deploy launch.
20:10 Recover multibeam launch. Continue with geophysical surveys in Northwest Arm Sydney.
22:45 Recover geophysical gear.
23:00 Tie up at government wharf in North Sydney (near Newfoundland Ferry Terminal) for the night.

**Day 298 – Friday 25 October 2002 – Survey and sampling, Sydney Harbour**

11:00 Discuss bathymetry coverage available for Sydney Harbour with Jon Griffin of CHS currently surveying in Sydney harbour with the CCGS Creed.
12:30 Deploy multibeam launch for continuation of survey near Muggah Creek
12:42 Commence camera stations in South Arm for a series of stations between Muggah Creek and the steel mill.
14:45 Recover launch.
15:34 Deploy launch – continue with photograph stations in South Arm and Northwest Arm.
17:00 Deploy geophysical gear for survey in Sydney Harbour. Run sidescan sonar and sub-bottom profiler lines in Northwest Arm.
20:30 Recover multibeam launch. Continue with geophysical surveys in Northwest Arm Sydney.
22:30 Recover geophysical gear and transit to Middle Shoal disposal Site C.
23:00 Tie up at government wharf in North Sydney (near Newfoundland Ferry Terminal) for the night.

**Day 299 – Saturday 26 October 2002 – Survey and sampling, Middle Shoal**

00:00 Continue with sampling and photographs.
03:05 Finish sampling and photographs of Site C.
10:41 Deploy multibeam launch to start survey of Site A near Bird Island at Middle Shoal.
10:53 Start photographs of Site A, including a transect through the disposal pile.
14:15 End camera transects, start grab samples at Site A.
14:32 Recover launch Plover.
15:23 Deploy launch.
15:29 Continue with grabs.
17:16 Start camera stations at Site B.
19:51 Finish camera stations.
22:00 Arrive Baddeck and tie to wharf. John Shaw arrives and come aboard
22:30 Creed arrives. Disconnect Track point transducer from starboard side to allow Creed to tie up alongside.
**Day 300 – Sunday 27 October 2002 – Standby in Baddeck**
00:00 Tied to wharf in Baddeck due to forecast winds of 45-50 knots.
11:00 Murphy and Beaver to Sydney and retrieve van, then to BIO to get 3 metre core barrels for corer. Heavy seas overtopping causeway encountered when crossing Canso Causeway by van. Shaw picks sample sites.

**Day 301 – Monday 28 October 2002 – Survey and sampling**
12:07 Plover deployed for survey of Baddeck Bay.
12:37 Start gravity core program in St Patrick’s Channel.
14:40 Recover launch Plover.
15:15 Deploy launch. Continue with gravity cores.
19:45 Finish gravity core program and steam to Baddeck. Shaw picks survey lines.

**Day 302 – Tuesday 29 October 2002 – Survey and sampling**
11:35 Plover deployed for survey of Baddeck Bay. Steam to St. Andrew’s Channel.
13:08 Deploy sidescan and Seistec to determine nature of features identified on multibeam bathymetry. 30-40 knot winds. Heave on Seistec records. Much of seafloor in shallow water is quite hard with little penetration. Pockets present filled with surficial sediment. Sidescan sonar kept about 7 metres below surface to provide records on bank tops only.
20:00 Recover launch Plover in Baddeck.
21:00 Tie up at wharf in Baddeck.
22:00 Creed tied up alongside Matthew. Fred Jodrey arrives with passenger van for return trip to Halifax.

**Day 303 – Wednesday 30 October 2002 – Transit from Baddeck to Halifax**
11:35 Load van with computers and grab samples.
   Depart Baddeck. CCGS Matthew departs Baddeck for Kelly’s Cove to wait for favourable weather conditions for transit around Cape Breton Island.
   Arrive BIO and unload gear.

**Day 305 – Friday 2 November 2002 – Demobilize gear**
   CCGS Matthew arrives Halifax. GSC personnel demobilize geophysical gear.
## Appendix IV - Sample and Camera Station Locations

### Camera Stations

<table>
<thead>
<tr>
<th>Station</th>
<th>Type</th>
<th>Exp.</th>
<th>Day/Time</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Depth</th>
<th>Geographic Location</th>
</tr>
</thead>
<tbody>
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<td>Camera 1</td>
<td>1</td>
<td>295135800</td>
<td>46.322168 -60.373733</td>
<td>11.1</td>
<td>Middle Shoal, Gulf of St. Lawrence</td>
<td></td>
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</tr>
<tr>
<td>Camera 2</td>
<td>2</td>
<td>295140000</td>
<td>46.322353 -60.37487</td>
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<td>Middle Shoal, Gulf of St. Lawrence</td>
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<tr>
<td>Camera 3</td>
<td>3</td>
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<td>46.322633 -60.37253</td>
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<tr>
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<td>295142600</td>
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<td>Middle Shoal, Gulf of St. Lawrence</td>
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<td>295142810</td>
<td>46.322227 -60.376657</td>
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<td>Middle Shoal, Gulf of St. Lawrence</td>
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<td>Camera 9</td>
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<td>295143015</td>
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Appendix VI - Seafloor Photographs

Matthew 2002066 Seafloor Photographs
Matthew 2002066 Seafloor Photographs
Matthew 2002066 Seafloor Photographs
Matthew 2002056 Seafloor Photographs

Appendix VII - Geophysical Records and Tapes
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