W00501

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	W00501

LOCALITY

State(s):	New Hampshire
General Locality:	Atlantic Ocean
Sub-locality:	Coastal Waters of Rye, New Hampshire

2013

CHIEF OF PARTY
Semme Dijkstra

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00501

INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State(s):	**New Hampshire**
General Locality:	**Atlantic Ocean**
Sub-Locality:	**Coastal Waters of Rye, New Hampshire**
Scale:	**10000**
Dates of Survey:	**05/30/2013 to 07/05/2013**
Instructions Dated:	**05/30/2013**
Project Number:	**ESD-PHB-20**
Field Unit:	**University of New Hampshire**
Chief of Party:	**Semme Dijkstra**
Soundings by:	**Kongsberg Maritime EM 2040 (MBES)**
Imagery by:	**N/A**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 19N, Mean Lower Low Water. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

DESCRIPTIVE REPORT MEMO

April 09, 2020

MEMORANDUM FOR: Pacific Hydrographic Branch

FROM: Report prepared by PHB on behalf of field unit
Kurt Mueller
Physical Scientist, Pacific Hydrographic Branch

SUBJECT: Submission of Survey W00501

The data were acquired as part of hydrographic survey operations for the Summer Hydro Course 2013 at the University of New Hampshire to fill in a gap in modern multibeam coverage along the coast of New Hampshire. The primary objective of the survey were to meet the requirements of the Hydrographic Field Course as part of the completion of the GEBCO/NIPPON Foundation Graduate Certificate in Ocean Mapping and Engineering curriculum at the University of New Hampshire.

Products include a collection of processed grids, metadata, and associated reports for archive at NCEI.

All soundings were reduced to Mean Lower Low Water using Discrete Zoning. The horizontal datum for this project is North American Datum of 1983 (NAD 83). The projection used for this project is Universal Transverse Mercator (UTM) Zone 19.

Additional horizontal and vertical control information are described in Section C of the Descriptive Report.

All survey systems and methods utilized during this survey are described in the Data Acquisition and Processing Report.

Four (4) Dangers to Navigation were submitted after review at the Pacific Hydrographic Branch.

University of New Hampshire Joint Hydrographic Center acquired the data outlined in this report.

All significant findings are discussed in the accompanying Descriptive Report.

This survey does meet charting specifications and is adequate to supersede prior data.

University of New Hampshire

Center for Coastal and Ocean Mapping

Joint Hydrographic Center

Descriptive Report

Type of Survey:	Navigable Area

LOCALITY

States(s):	New Hampshire
General Locality:	Atlantic Ocean
Sub-Locality:	Coastal Waters of Rye, New Hampshire New Castle Island to Concord Point

2013

Group Members:	Derek Sowers	Sionhui Lim	Fang Yao
	Eunice Tetteh	Ashley Norton	Xinh Le
	Qian Yin	Takafumi Hashimoto	Josh Humberston
	Han Hu	Karolina Chorzewska	Htike Htike
Chief of Party:	Semme Dijkstra	Andrew A. Armstrong	

Survey

Dates:	May 30th – July 5rd

UNIVERSITY OF NEW HAMPSHIRE CENTER FOR COASTAL AND OCEAN MAPPING JOINT HYDROGRAPHIC CENTER	GROUP NAME:
HYDROGRAPHIC TITLE SHEET	UNH JHC/CCOM Summer Hydro
INSTRUCTIONS: The hydrographic sheet should be accompanied by this form, filled in as completely as possible when it is forwarded to the office	

State(s):	New Hampshire
General Locality	Atlantic Ocean
Sub-Locality:	Coastal Waters of Rye, New Hampshire
Scale:	1:10,000
Dates of Survey:	30 May – 05 July
Instructions Date:	May 30th June 2013
Field Unit:	CCOM/JHC *R/V Coastal Surveyor*
Soundings by:	EM2040 (MBES)
Imagery by:	EM2040 (MBES)
Soundings Acquired in :	Meters at NAD83

Remarks:

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Acronyms and abbreviations

AML	Applied Microsystems Ltd.
AWOIS	Automated Wreck and Obstruction Information System
BAG	Bathymetric Attributed Grid
CCOM/JHC	Center for Coastal and Ocean Mapping/Joint Hydrographic Center
CO-OPS	Center for Operational Oceanographic Products and Surfaces
CTD	Conductivity, Temperature, Depth sensor
CUBE	Combined Uncertainty and Bathymetry Estimator
DN	Day Number
DTON	Danger to Navigation
ENC	Electronic Navigational Chart
FIG	International Federation of Surveyors
FPM	Field Procedures Manual
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSSD	Hydrographic Survey Specifications and Deliverables
ICA	International Hydrographic Association
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
MLLW	Mean Lower Low Water
NAD 83	North American Datum of 1983
NGDC	National Geophysical Data Center
NOAA	National Oceanographic and Atmospheric Administration
NM	Nautical Miles
NOS	National Ocean Service
OPUS	Online Positioning User Service
PCS	Position Compute System
POS/MV	Position and Orientation System for Marine Vessels
RP	Vessel's Reference Point
SIS	Seafloor Information Systems
SVP	Sound Velocity Profiler
TPU	Total Propagated Uncertainty
TVU	Total Vertical Uncertainty
WGS 84	World Geodetic System of 1984

A. INTRODUCTION

This report accompanies the multibeam sonar data collected off the coast of Rye, New Hampshire between New Castle Island and Concord Point by the 2013 summer hydrographic field course run through CCOM/JHC at the University of New Hampshire. The survey was conducted to comply with the standards set forth for an IHO S-44 Special Order survey.

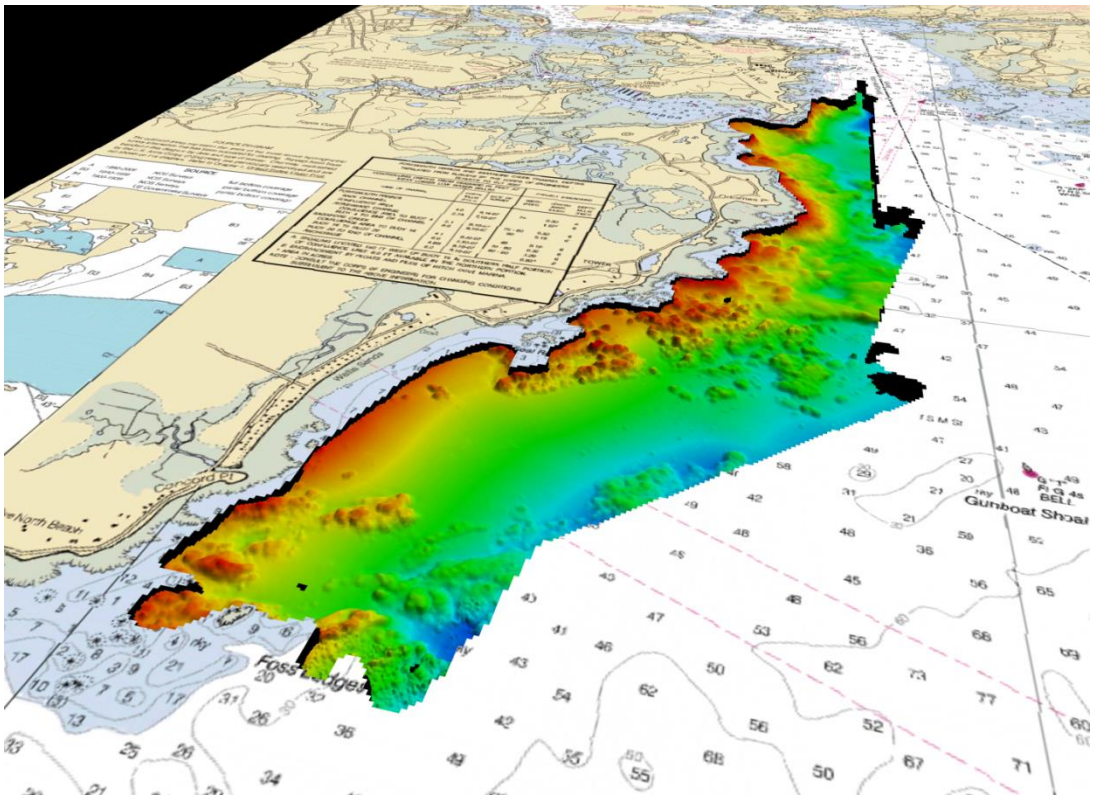


Figure 1 - Overview of Survey Area with chart (3-D view)

A.1. AREA SURVEYED

The hydrographic survey operations of the Summer Hydro Course 2013 were conducted in the area offshore the New Hampshire coast from the entrance to the Little Harbor (north from the entrance to Portsmouth Harbor) to the Foss Ledges, north from the Rye Harbor (Figure 1 & 2). The northernmost land marker was New Castle Island and the southernmost was Concord Point. The shore side limits of the area were defined by the most landward survey lines possible to run at high tides while maintaining the safety of the vessel.

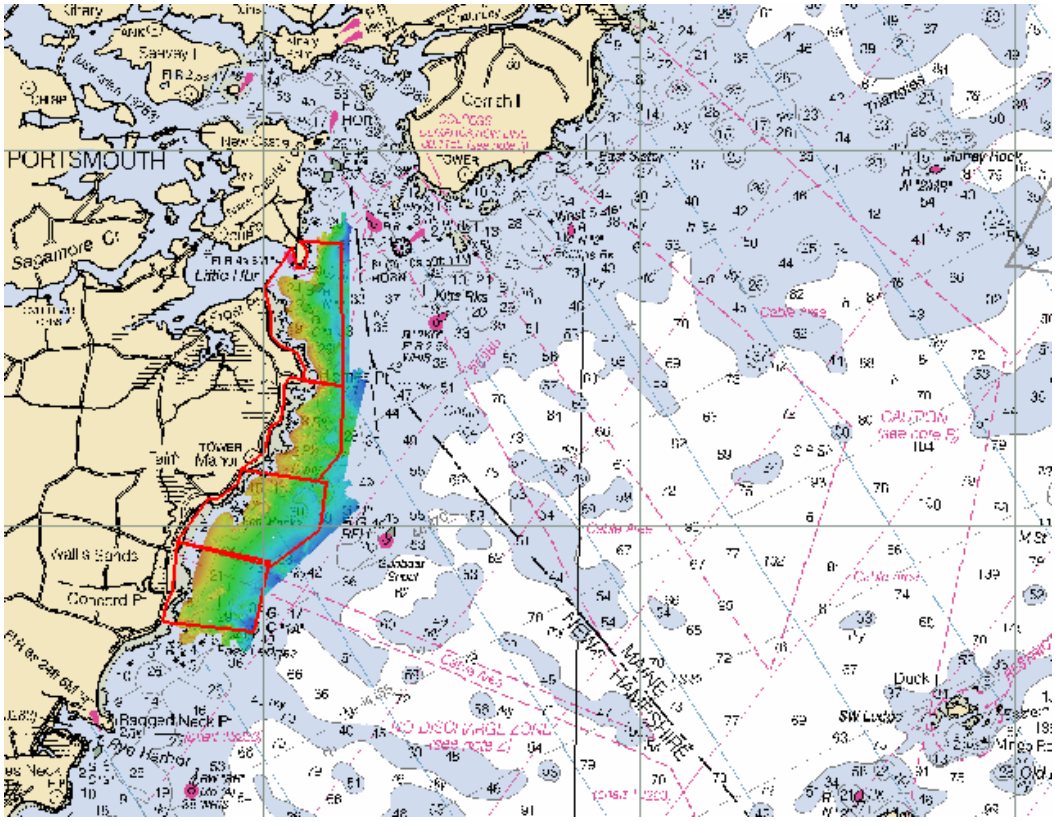


Figure 2 - The location of the survey area over the nautical chart number 13278 'Portsmouth to Cape Ann; Hampton Harbor'.

A.2. SURVEY LIMITS

The offshore limits of the area were planned to achieve a measureable overlap with the area surveyed in 1997 by the NOAA Vessel *Rude.* The most extended points of the covered area are listed in Table 1.

Table 1 - Covered area extents.

Minimum Latitude	43° 00' 18.30'' N
Minimum Longitude	070° 44' 28.60'' N
Maximum Latitude	43° 03' 47.15'' N
Maximum Longitude	070° 41' 30.26'' N

Figure 1 presents the location of the survey area over the nautical chart number 13278, 'Portsmouth to Cape Ann; Hampton Harbor'. The planned survey extents are marked by solid red lines. Color-coded semitransparent bathymetry surface marks the area covered during the survey operation. Details are presented in Figure 3.

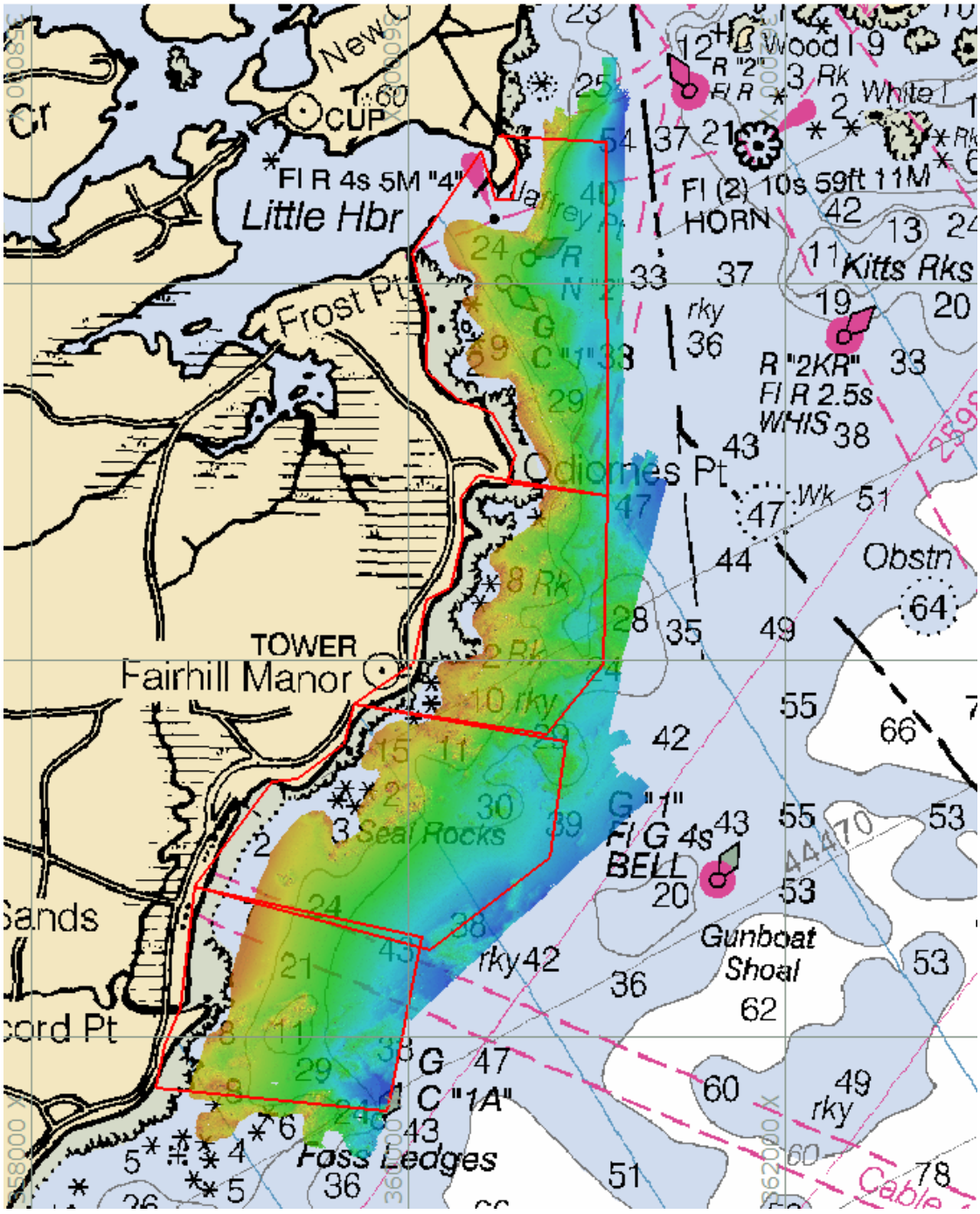


Figure 3 - Planned vs. covered area, displayed over the nautical chart number 13278 'Portsmouth to Cape Ann; Hampton Harbor'

A.3. SURVEY PURPOSE

The primary objective of the data and deliverables that accompany this hydrographic survey are to meet the requirements of the Hydrographic Field Course as part of the completion of the GEBCO / NIPPON Foundation Graduate Certificate in ocean Mapping and Ocean Engineering curriculums at the University of New Hampshire. The survey was conducted to comply with the standards set forth for an IHO S-44 Special Order survey. And fills in a gap in modern multibeam coverage along the Coast of New Hampshire.

A.4. SURVEY QUALITY

Data was collected to provide high-resolution multibeam echo sounder coverage supporting safe navigation for mariners off the southern coast of New Hampshire. This survey was conducted in accordance with the best practices listed in the NOAA Field Procedures Manual. The data and deliverables that accompany this package have been prepared in order to meet the requirements of the 2013 NOS Hydrographic Surveys and Specifications and Deliverables Manual (HSSD). As such the survey deliverables have been submitted to the NOAA Office of Coast Survey for the purpose of updating the nautical chart.

A.5. SURVEY COVERAGE

Complete multibeam coverage according to 2013 HSSD was acquired over the area shown in Figures 2 & 3.

A.6. SURVEY STATISTICS

Table 2 presents the total mileage of the whole survey operation. The daily survey statistics and other activities carried out are presented in Table 3.

Table 2 - Survey statistics - total operation

Line length	Mainscheme (nm)	119.2
	Crosslines (nm)	3.3
	Total (nm)	122.5
Coverage	Total (nm^2)	1.5

Table 3 - Survey statistics by day

Day	Mainscheme	Crosslines	Ground truth
June 17 - 168	11.7 nm	0.7 nm	-
June 18 - 169	19.3 nm	-	-
June 19 - 170	10.2 nm	1.7 nm	-
June 21 - 172	11.5 nm	-	-
June 24 - 175	11.8 nm	0.9 nm	-
June 25 - 176	22.7 nm	-	-
June 26 - 177	10.9 nm	-	5 grab samples, 6 sea bottom videos
June27 - 178	21.1 nm	-	4 grab samples, 6 sea bottom videos

B. DATA ACQUISITION AND PROCESSING

B.1. Equipment

The Research Vessel Coastal Surveyor was used for survey acquisition with a Kongsberg EM 2040 multibeam echo sounder. The AML Smart-X sound speed sensor was mounted to the EM 2040 sonar head to provide continuous surface sound speed measurements to SIS for real-time beam steering and ray tracing. Sound speed profiles were collected with a manually deployed Seabird SeaCAT Profiler CTD - SBE 19. The data were collected in accordance to NOS HSSD specifications and meet IHO Special Order standards. Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures, and processing methods.

B.1.1. *Survey Vessels*

The Research Vessel (R/V) Coastal Surveyor was used as the acquisition platform for this multibeam survey. The vessel specifications for R/V *Coastal Surveyor* is in the DAPR and equipment for surveying is also below.

The research vessel (R/V) Cocheco was used as data acquisition platform for bottom samples. Specifications for the R/V *Cocheco* are listed in the DAPR.

B.1.2. *Echo Sounding Equipment*

The inventory of equipment used is displayed in Table 4.

Table 4 - Hardware Inventory

Survey Hardware		
	Equipment	Manufacturer & Model
Echo Sounding	Multibeam Echo sounder	Kongsberg EM 2040
	Hydrographic Work Station	Kongsberg HWS 14
	Processing Unit	Kongsberg 358141
Attitude/ Positioning	Position Compute System	Applanix 320 V.4 POS/MV
	Inertial Motion Unit	Applanix IMU-200 POS/MV
	GPS Primary Antenna (Port)	Trimble/Zephyr
	GPS Secondary Antenna (Starboard)	Trimble/Zephyr

Horizontal Positioning	GPS Base Station Receiver	Trimble 5700
	2 Radio Modems	Trimble Trimark 3
Sound Speed	Surface Sound Speed Sensor	AML Smart X
	Sound Speed Profilers	Seabird SeaCAT Profiler CTD - SBE 19
Bottom Sampling	Grab Sampler	Wildco Shipek Grab Sampler

A Kongsberg EM 2040 multibeam echo sounder was used for this survey. The box housing the transmit and receive transducers was mounted firmly onto a secured arm at the bow of the vessel. The EM 2040 consists of a transmit transducer and a receive transducer which communicate to a processing unit via Ethernet and a workstation running SIS for data acquisition. The EM 2040 can be operated at 200, 300 or 400 kHz with roll, pitch and yaw stabilization. All data for this project was acquired using the sonar setting parameters defined in Table 5.

Table 5 - Setting parameters in SIS.

Parameters	Setting selected	Remarks
Operating mode	Normal Mode	3 sectors were used during data acquisition to provide a more uniform data distribution within each swath.
Frequency	300 kHz	This option provided sufficient resolution and a more efficient swath width (140^0) than allowed by the 400 kHz operating mode (120^0).
Beam Spacing	High density equidistant	This option provided a uniform distribution of soundings on the seafloor within each swath.
Bottom Detection Mode	Normal	Normal bottom detection mode was used.

Parameters	Setting selected	Remarks
Pulse length	Short CW (FM disabled)	A short pulse length was used to obtain high resolution data.
Dual Swath Mode	Off	A single swath was used.

B.1.3. *Software*

Note: CARIS 10 has been used to open the older CARIS 8 project.

Table 6 - Acquisition Software Details

Acquisition Software	Version	Purpose
SIS (Kongsberg)	3.8.4	real time EM 2040 MBES data monitoring and processing
Applanix POSView	3.4.0.0	monitor and log POS MV data
Hypack 2012	12.0.0.1	pre-survey line planning and for real-time vessel navigation
Seacast (SBE)	1.5.7	download and process sound speed profile data

Table 7 - Processing Software Details

Processing Software	Version	Purpose
CARIS HIPS and SIPS	8.0	real time EM 2040 MBES data monitoring and processing
Fledermaus FMGT	7.3.2b	process and create backscatter mosaics

B.2. Quality Control

B.2.1. *Cross-lines*

Two cross-lines were run within each of the four survey areas and totaled 3.3 nm, approximately 3 percent of the total lines run (Figure 4). The mean difference between the crossline's surface and the surveyed area is -0.08 m and had the standard deviation was 0.10 meters. The distribution of the differences throughout the survey area is shown in Figure 5 and the distribution of the differences as a function of magnitude of the difference is shown in Figure 6. Some differences are attributed to the limited applicability of the tidal zoning scheme used.

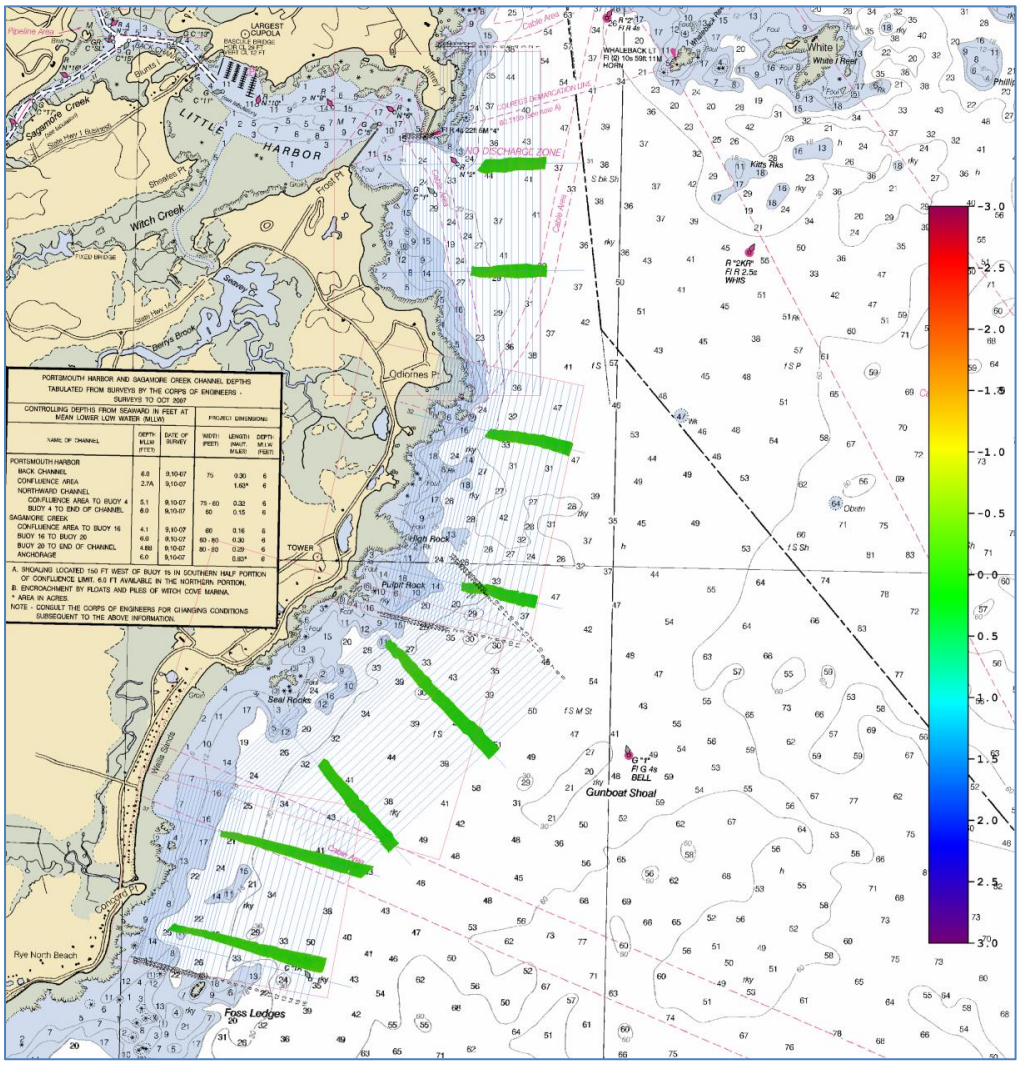


Figure 4 - Cross lines with mainscheme lines

National Ocean Service Hydrographic Specifications and Deliverables (NOAA, 2013) Section 5.2.4.3 specifies that "lineal mileage of crosslines shall be at least 4% of main scheme mileage in

areas surveyed to meet object detection or complete bathymetric coverage requirements." The original line plan for this survey complied with the specification. The planned survey had 186,382 meters of main scheme lines and 9,550 meters of cross-lines, meaning that cross-lines represented 5.12% of main scheme lines. However, due to the many survey lines that were run parallel to the complex shoreline and required maneuvering the vessel to avoid hazardous areas, many of the shallow survey lines had to deviate from the original line plan to avoid running vessel aground.

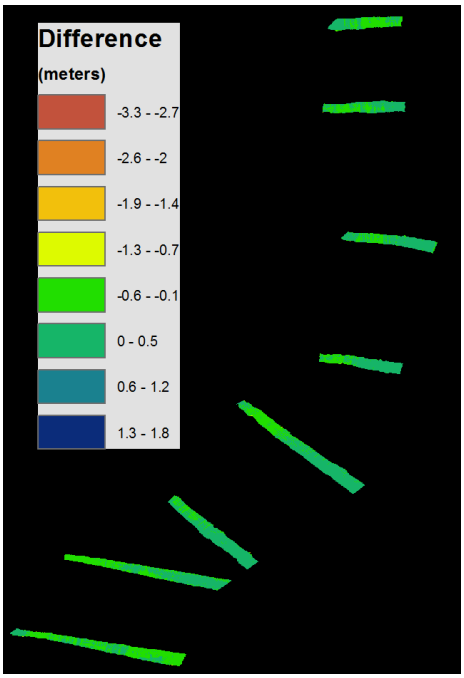


Figure 5 - Difference between main survey surface and cross lines

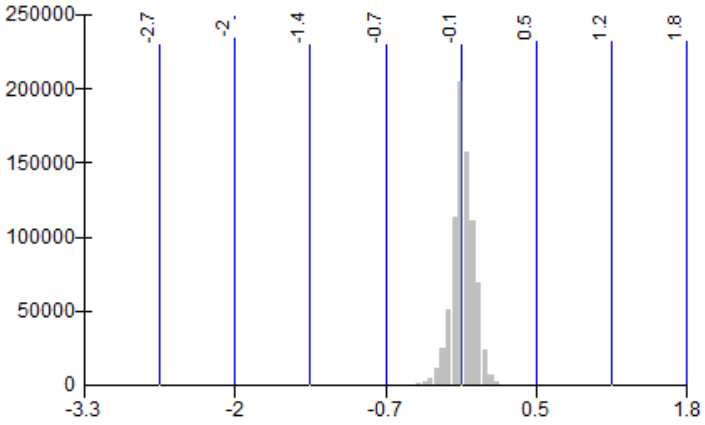


Figure 6 - Distribution of differences based on number of nodes

B.2.2. *Uncertainty*

The uncertainties associated with this survey were determined using the published values from the CARIS website and entered into the HVF file for the CARIS project. These values are presented in Table 8.

Table 8 - Standard deviation values

TPU Standard	Value Entered in HVF
Motion Gyro (deg)	0.020
Heave %	5.000
Heave (m)	0.050
Roll (deg)	0.020
Pitch (deg)	0.020
Position Nav (m)	1.000
Timing Trans (s)	0.010
Nav Timing (s)	0.010
Gyro Timing (s)	0.010
Heave Timing (s)	0.010
Pitch Timing (s)	0.010
Roll Timing (s)	0.010
Offset X (m)	0.010
Offset Y (m)	0.010
Offset Z (m)	0.010
Vessel Speed (m/s)	0.300
Loading (m)	0.010
Draft (m)	0.010
Delta Draft (m)	0.010
MRU Align StdDev gyro	0.000
MRU Align StdDev R/P	0.000

Tide values and sound speed values also had uncertainties that were incorporated in the calculation of TPU (Table 9). A 0.5 m CUBE surface was created based on the TPU values and critiqued using the IHO S-44 Special Order standards. 95.51% of nodes fell within the standards of a special order survey based on standard deviations and 100% fell within the standards of a Special Order survey based on uncertainty (Table 10).

Table 9 - Tide and Sound Speed Uncertainties used to compute TPU

Parameter	Uncertainty
Tide Values - Measured	0.0200 m
Tide Value - Zoning	0.100 m
Sound Speed - Measured	0.5 m/s
Sound Speed - Surface	0.200 m/s

Table 10 - Surface statistics of final CUBE surface from CARIS

	Error Values from	Error Values from
Number of nodes processed:	20,435,888	20,435,888
Number of nodes populated:	20,410,988 (99.88%)	20,410,988 (99.88%)
Number of holidays detected:	73	73
IHO S-44 Special Order:		
Number of nodes considered:	20,409,909	20,409,909
Number of nodes within Special	20,409,909 (100.00%)	19,492,796 (95.51%)
Residual mean:	Residual mean: -0.034	-0.153

Figure 7 shows a representation of the TPU throughout the survey area based on all vessel configuration, tide, and sound speed parameters. Higher TPU values exist in the deeper sections and in areas where the vessel was turning while collecting data.

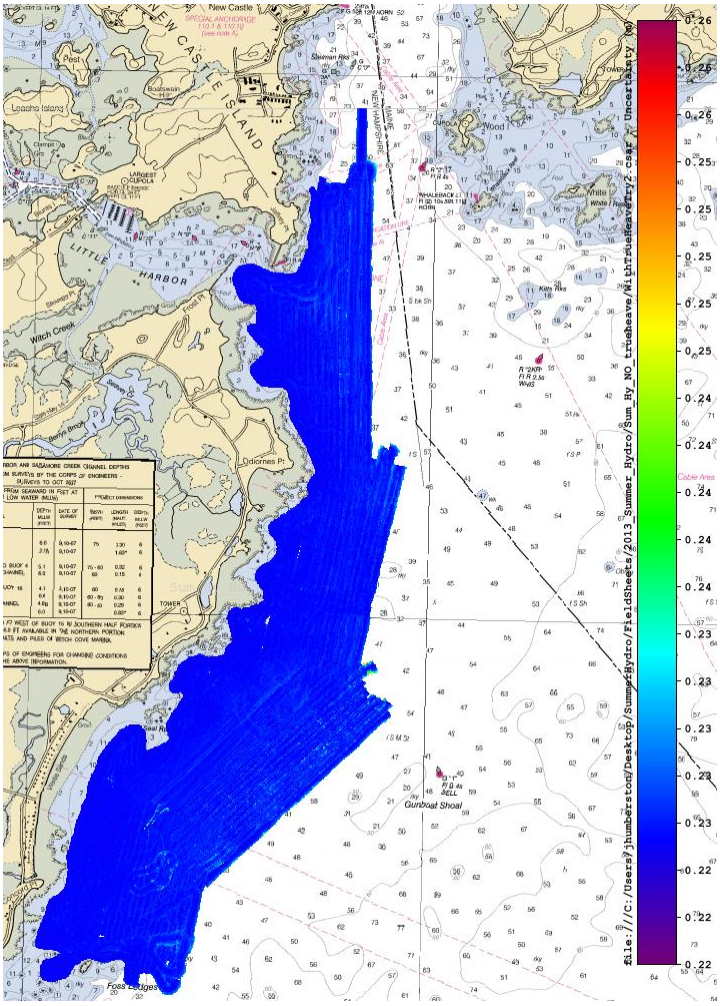


Figure 7 - TPU values throughout the survey area.

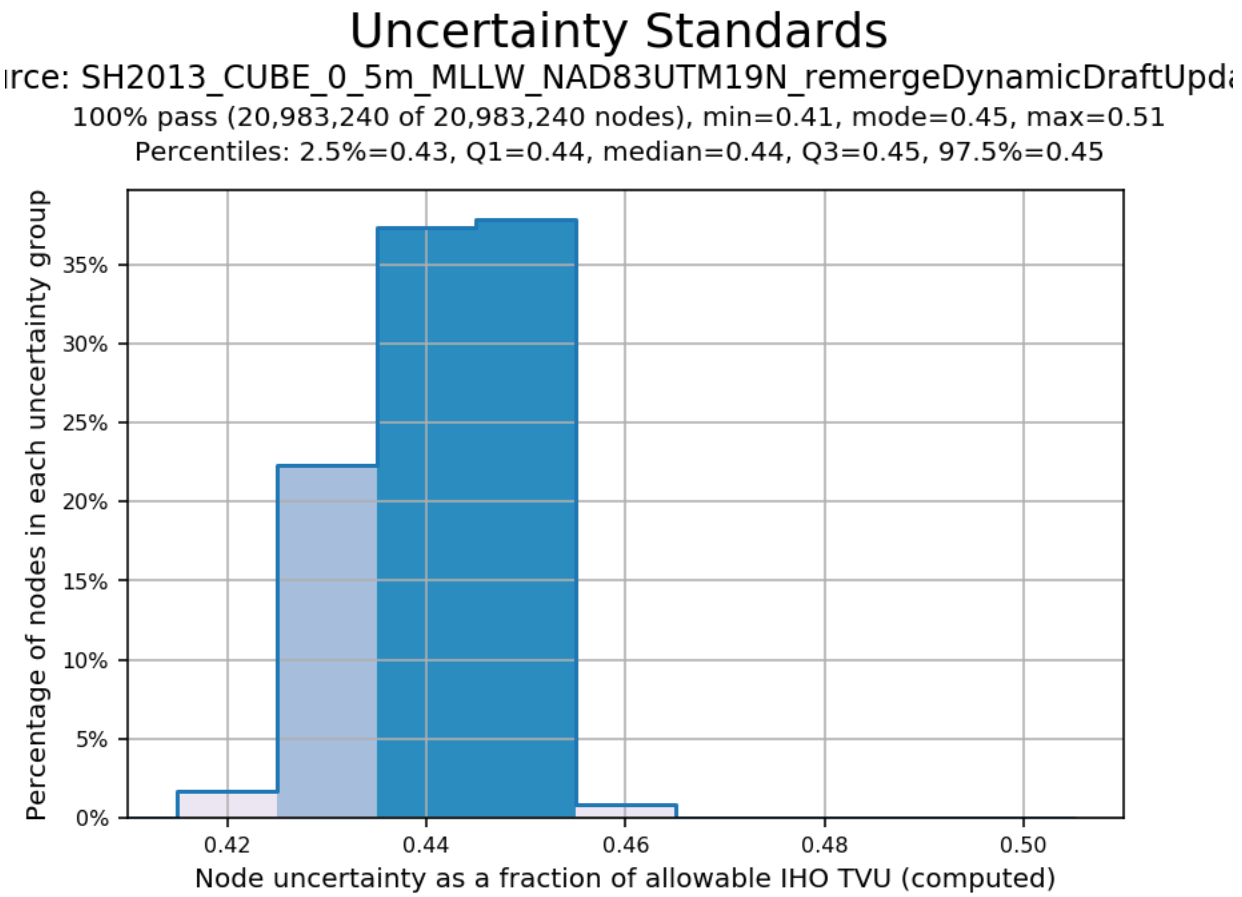


Figure 8 - TVU from QC tools

According to the NOS standards for survey of special order, the maximum allowable Total Vertical Uncertainty at the 95% confidence level is determined using this formula:

$$\mp\sqrt{a^2 + (bxd)^2}$$

Where:

a is the portion of the uncertainty that does not vary with depth.

b is the coefficient that represents the portion of the uncertainty that varies with depth

d is the depth

bxd is the portion of the uncertainty that varies with depth.

Based on IHO S-44 (5th Edition), a = 0.25 meters and b = 0.0075 in depths less than 100 meters. The depth (d) varied from 1 m to 30 m within our survey area.

The uncertainty values of the finalized surface was compared with the maximum allowable Total vertical Uncertainty prescribed by the IHO S-44 (5th Edition) for survey of special order shows the results which indicate that 95.51% (for the 0.5 m surface) of grid nodes fall within the allowable TVU.

B.2.3. *Junctions*

The perimeter of the survey area was planned to overlap with two existing surveys for depth comparison (Figure 9). There was a particularly large overlap planned between this survey and the 1997 survey by the NOAA research vessel Rude. This overlap was designed to fill in data gaps existing in the 1997 survey. There was also an overlap planned with existing data from a lidar survey to explore the reliability of the lidar data. The differences between the surfaces are reported in Table 11 and difference surfaces are shown in Figure 9.

Table 11 - Differences with previous surveys

Compared Surfaces	Mean Difference	Standard Deviation	Difference Range
Summer Hydro Survey and Rude survey	0.52 m	1.65 m	-6.845 m to 9.664 m
Summer Hydro Survey and Lidar Survey	0.26m	0.53 m	-2.646 m to 4.923 m

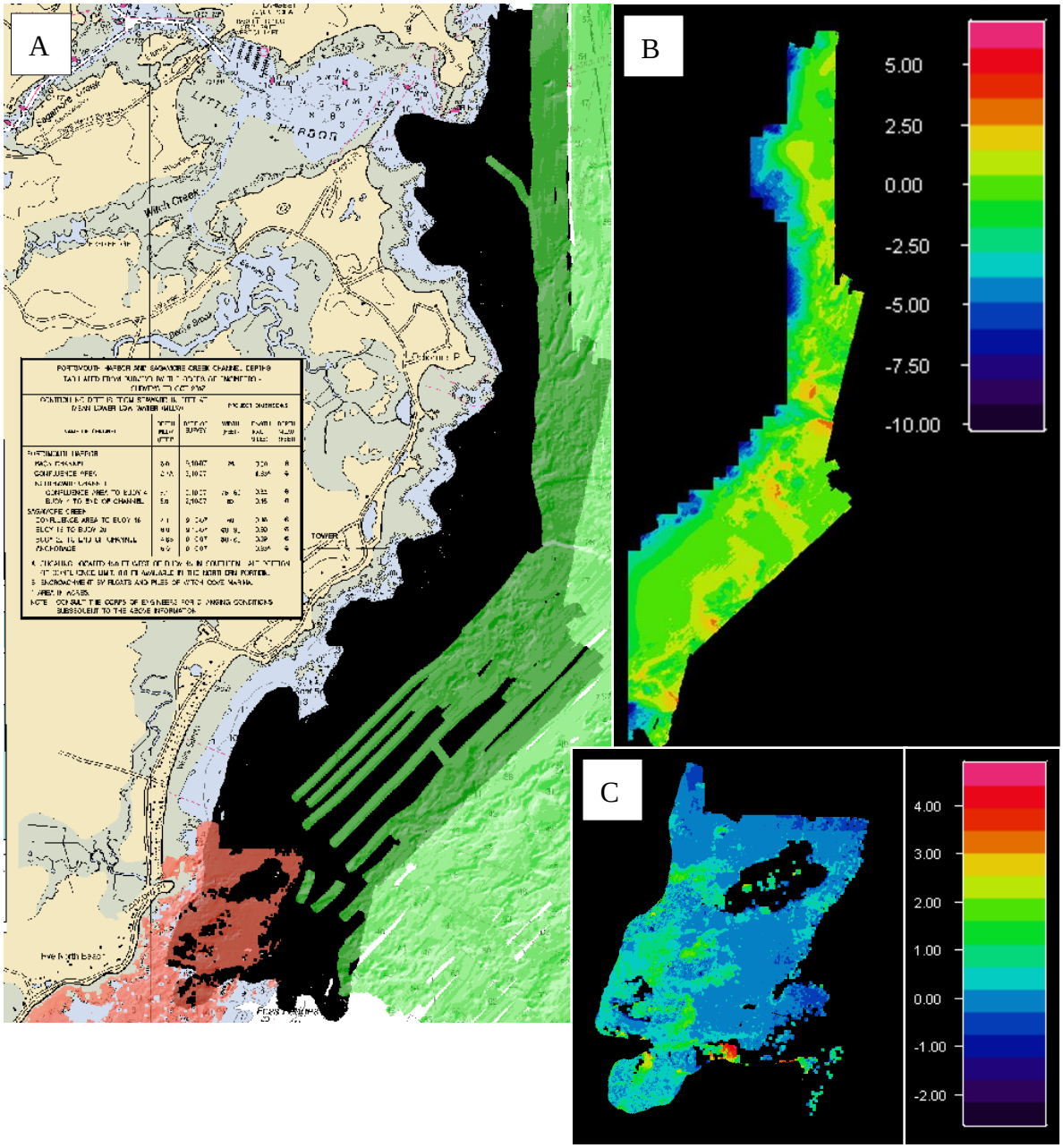


Figure 9 - Junctions

In A, the green semi-transparent data represents the 1997 Rude survey, the red semi-transparent data represents the 2005 lidar survey, and the solid black represents this Summer Hydro's survey area. B shows the difference surface between this Summer Hydro's survey results and the Rude survey results. C shows the difference surface between this Summer Hydro's survey results and the lidar survey results.

B.2.4. *Object detection and coverage requirements*

The final CUBE surface at 0.5 m resolution ranged from depths of 0.31 meters to 21.73 meters with a mean depth of 10.62 meters. Of the 20,410, 988 nodes populated by the final surface, 95. 51% meet IHO S-44 Special Order based on their standard deviation and 100% meet IHO S-44 Special Order based on their uncertainty. The final surface density has a mean of 32.34 measurements per node and the distribution can be seen in Figure 10. This survey therefore meets resolution and coverage requirements of an IHO S-44 Special order survey.

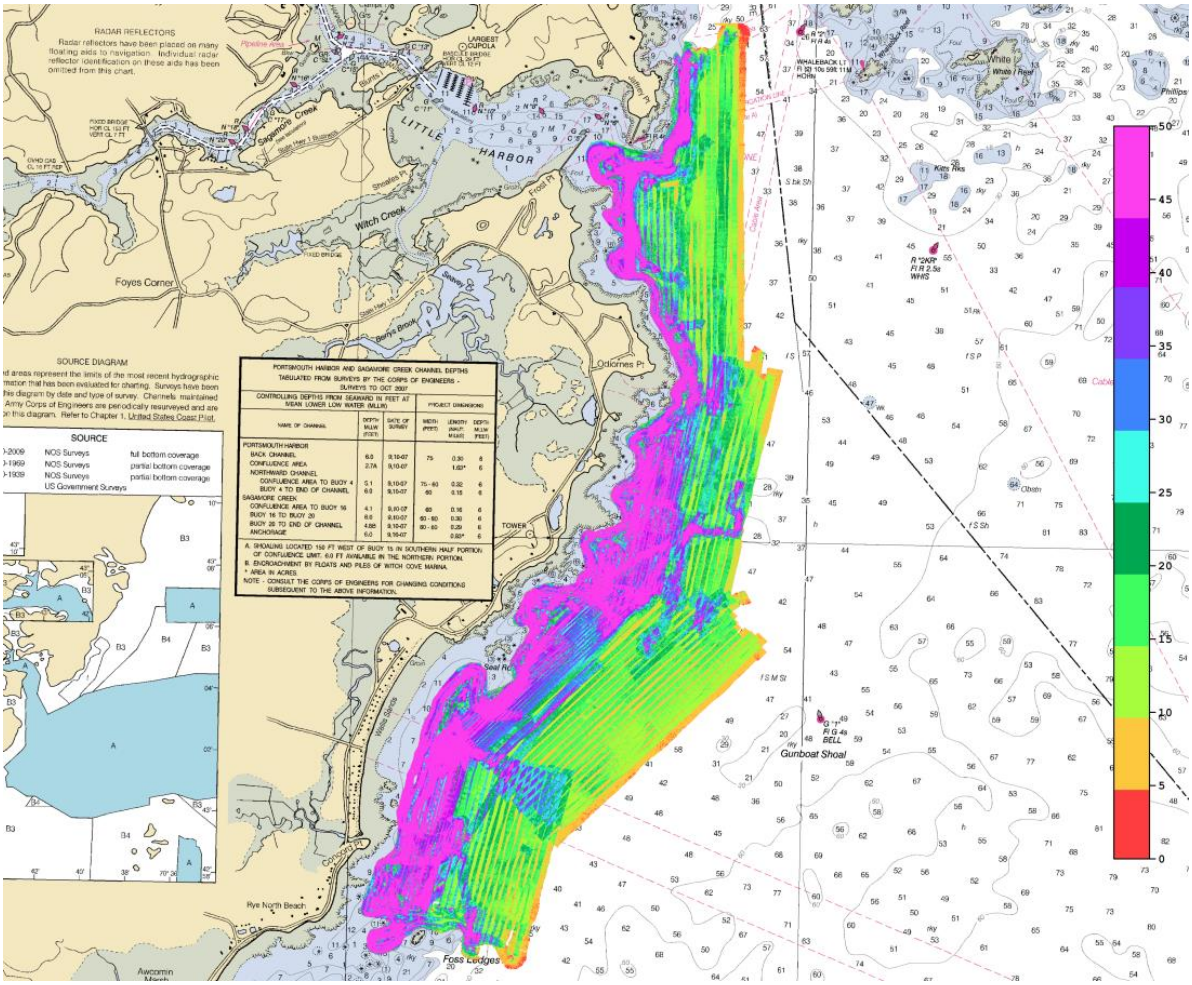


Figure 10 - Soundings per node throughout survey area.

There were 9 holidays that met the NOAA specification for holiday.

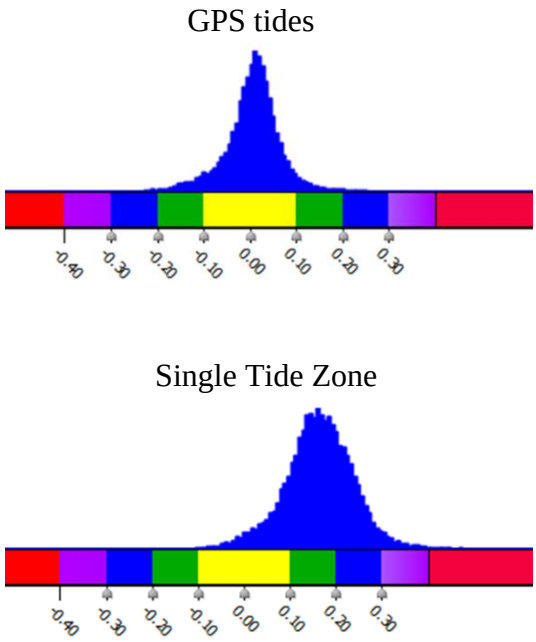
ID	Feature ID		Latitude	Longitude
1	4U 0000000001 00001		43.033384N	070.713805W
2	4U 0000010002 00001		43.045369N	070.709621W
3	4U 0000020003 00001		43.013421N	070.726637W
4	4U 0000030004 00001		43.012942N	070.727078W
5	4U 0000040005 00001		43.016860N	070.724341W
6	4U 0000050006 00001		43.017638N	070.717803W
7	4U 0000060007 00001		43.020514N	070.712484W
8	4U 0000070008 00001		43.019890N	070.728537W
9	4U 0000080009 00001		43.011181N	070.721433W

Table 12 - Holiday location

B.2.5. *Observed Data Artifacts*

Some surface artifacts were present in the initial CUBE surface, but reprocessing the data with true heave eliminated or reduced many of these artifacts. While minor artifacts are still present through the survey area, they do not significantly affect the results of the survey. Applying GPS tides also helped to remove some artifacts in shallow water where the tide files were unable to account for the tidal variations due to shallow water. Figure 11 shows the differences in the cross-line to main scheme line correlation associated with using GPS tides and a single tide zone, respectively. The .hvf file was updated to have the correct dynamic draft values after this analysis was done. GPS tides should take dynamic draft into account and may account for some of the variation.

A.



B.

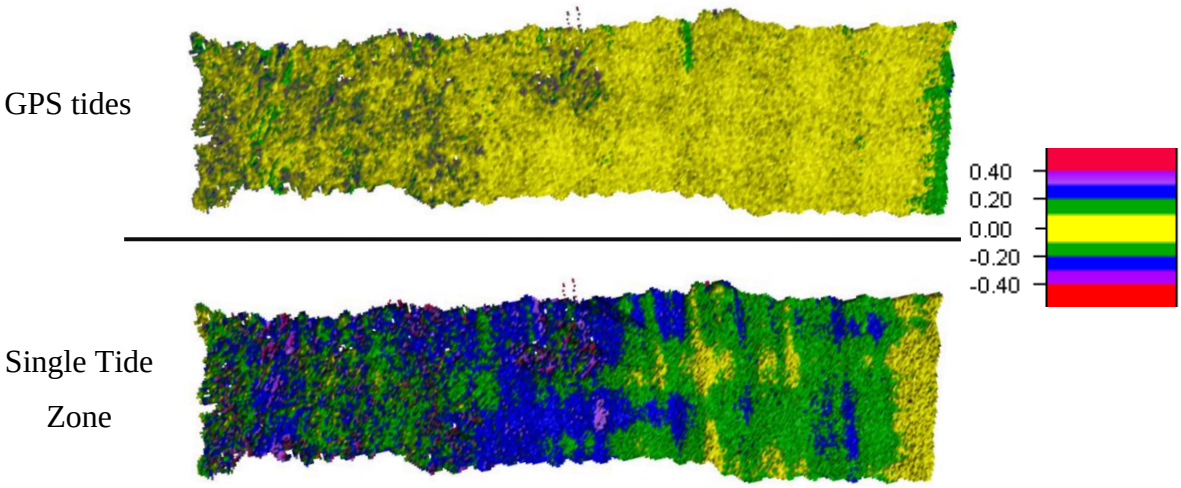


Figure 11 - Crossline to main scheme line correlation

A. shows histograms of the differences between main scheme lines and a cross line. The concentration around 0 when using GPS tides suggest a better temporal correlation with the true tides than the single tide zone which is concentrated around 0.15 meters difference. B. shows the distributions of the differences for each methods.

B.3. Corrections to Echo Soundings

B.3.1. *Vessel Offsets*

See the DAPR for more information.

B.3.2. *Patch Tests*

Patch tests were conducted on June 14th, June 18th, and June 26th. The initial patch test was examined in SIS and the calibration was applied in SIS. Subsequent patch test calibrations were applied in CARIS during post processing.

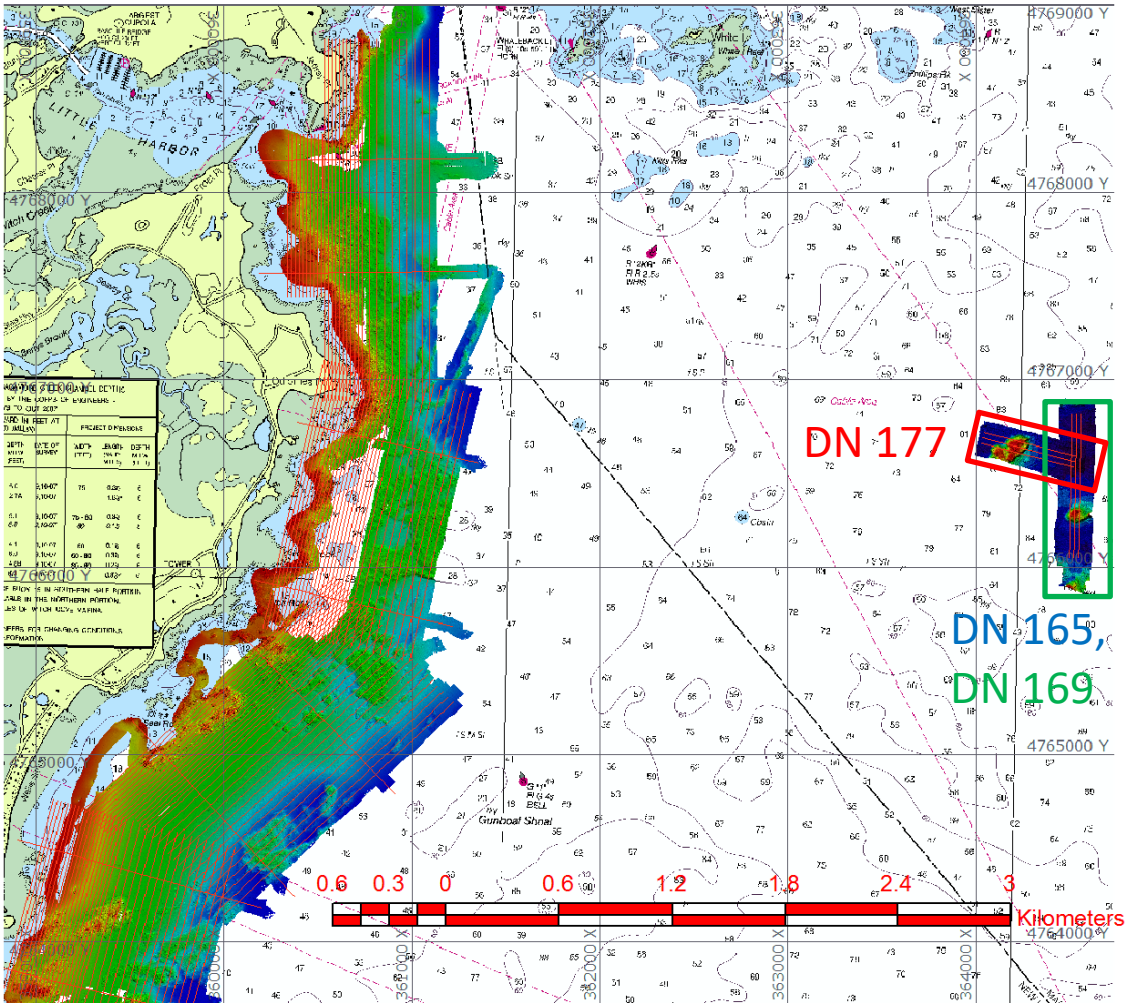


Figure 12 - Patch Test Areas.

The patch test results conducted were analyzed and the resulting surfaces compared. All data were collected using the following calibration values (Roll: -1.45, Pitch: 1.5, Heading: -1.7, Timing: 0) and further corrected in CARIS using (Roll: -1.37, Pitch: 1.5, Heading: -1.7, Timing: 0). The selected calibration values are shown in Table 13 with the final calibration values used as the bottom.

Table 13 - Student Group Patch Test Results

Group	Timing	Roll	Pitch	Heading
Blue	0	-1.45	1.5	-1.7
Green	0	-1.37	1.5	-1.7
Red	0	-1.40	1.25	-1.58
AVERAGE	0	-1.41	1.42	-1.66
SD	0	0.04	0.14	0.07
Final	**0**	**-1.37**	**1.5**	**-1.7**

Static draft measurements were taken daily while the vessel was stationary in the survey area and noted in the daily data acquisition and processing logs which are available digitally. An inboard clear draft tube located inboard of the vessel provided visual access for measurement of the water level to the vessel reference point on the IMU. A value of 0.5 m was applied in SIS for real-time processing, and daily variations in draft measurements were recorded for calculating the uncertainty due to static draft (Table 14).

Table 14 - Static Draft

Day Number	Draft (m)
168	0.495
169	0.54
170	0.498
172	0.516
175	0.55
176	0.516
177	0.545

178	0.505
Mean	**0.521**
Standard deviation	**0.022**

B.3.3. *Dynamic Draft*

The settlement and squat characteristics of R/V *Coastal Surveyor* were documented in a 2006 survey conducted by CCOM/JHC during which 18 measurement runs at varying speeds were performed in order to obtain ellipsoidal height vs. ship-speed-through-the-water referenced to the IMU. The full report is attached in Appendix B of the DAPR. The dynamic draft corrections for R/V Coastal Surveyor were entered in the CARIS HVF for application during post processing. Heights shown in Table 16 follow the CARIS convention of positive down for height (z-value). (Notes the HVF file when opened as text saves the values in knots, but the vessel editor may show units in m/s.)

Table 15 - Dynamic Draft Values used in the hydrographic vessel file (HVF) for R/V Coastal Surveyor

Speed (m/s)	Error (m/s)	Height (m)	Error (m)
0.000	+/- 0.406	-0.000	+/- 0.0448
0.514	+/- 0.406	-0.025	+/- 0.0448
1.029	+/- 0.406	-0.040	+/- 0.0448
1.543	+/- 0.406	-0.043	+/- 0.0448
2.058	+/- 0.406	-0.035	+/- 0.0448
2.572	+/- 0.406	-0.017	+/- 0.0448
3.087	+/- 0.406	0.012	+/- 0.0448
3.601	+/- 0.406	0.053	+/- 0.0448
4.116	+/- 0.406	0.104	+/- 0.0448
4.630	+/- 0.406	0.166	+/- 0.0448
5.114	+/- 0.406	0.239	+/- 0.0448

B.3.4. *Vessel Attitude*

Vessel attitude measurements (heave, pitch, roll, and heading) were supplied to SIS from the POS/MV via a TSS serial data stream set at a baud rate of 19200. Attitude corrections were made in SIS real time, and were preserved in the CARIS HDCS format.

B.3.5. *Sound Speed Corrections*

One to four sound speed profile measurements were made each day during data acquisition. Immediately after each profile cast was taken, the .log raw sound speed measurement file was downloaded from the instrument, converted to SIS .asvp file format using Seacast software, edited for any SIS formatting errors using the SIS SV Editor tool, and loaded in to SIS. The sound speed measurement profile input into SIS from the AML profiler during real-time acquisition was used by SIS for real-time ray tracing in conjunction with the real-time surface sound speed input. The SVP was not applied in CARIS was not used during post-acquisition data processing since it has previously been applied in SIS; however, all .asvp files that were used for data acquisition were converted to CARIS .svp format for GIS display in CARIS HIPS. Figure 13 is a map of the geographical locations of the sound speed profile casts which are labeled by month, day, and daily cast number.

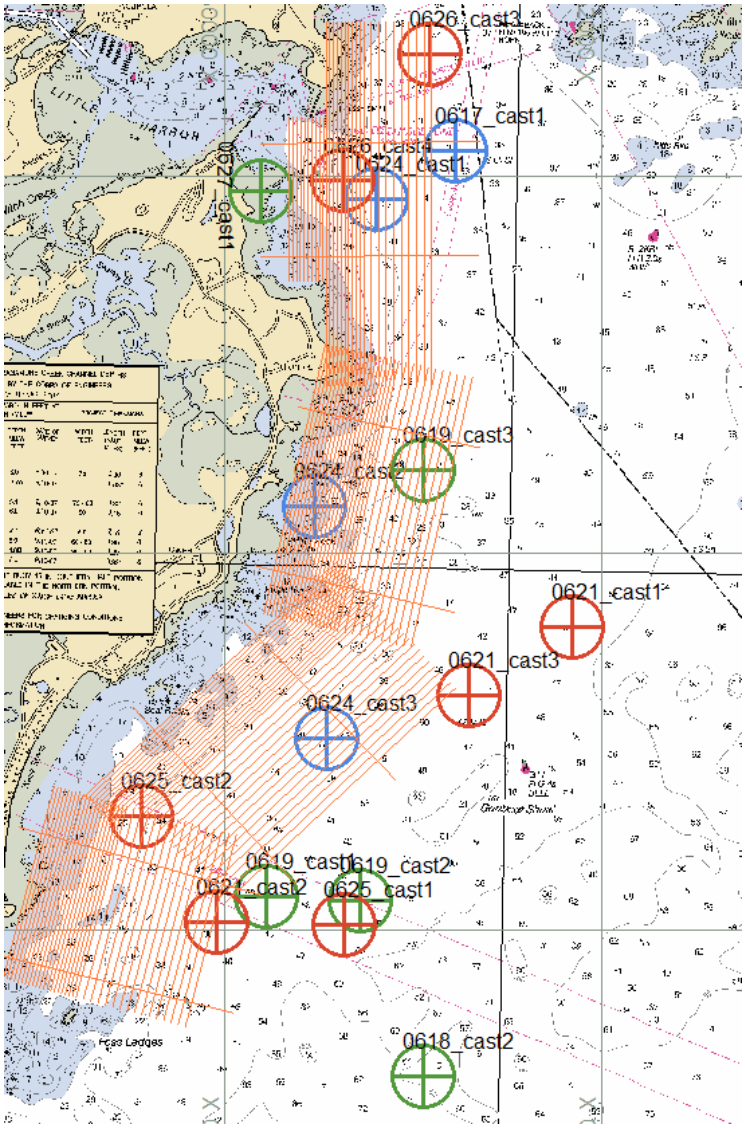


Figure 13 - Sound Speed Profile Cast Locations labeled by month, day, and daily cast number.

B.3.6. *Tide and water level corrections*

The verified water level values from the NOAA water level gauge at Fort Point, NH (station ID: 8423898) were used to reduce soundings to the Mean Lower Low Water (MLLW) datum during post processing in CARIS. The whole survey area is located within the one tidal zone. A minus 6 minute time correction was applied to the verified tide tidal data to conform to the tidal zoning information obtained from CO-OPs. Refer to DAPR Appendix C for the e-mail correspondence regarding tidal zoning.

B.4. Data Processing

CARIS HIPS and SIPS version 8.0 was used for all post-acquisition data processing.

B.4.1. *Project Creation and Data Import*

A unified CARIS project with the additional calibration values in the vessel file was created for culminating all of the data collected during the survey. The .all files produced during data acquisition were imported into the project using CARIS's conversion wizard. Tide and true heave files were applied before computing TPU.

B.4.2. *Data Analysis and Data Cleaning*

The data was analyzed and cleaned using CARIS's swath and subset editors. There were relatively few soundings to be cleaned. Multiple soundings were removed in one area where the vessel's wake is believed to have caused false readings.

B.4.3. *Surfaces Finalization*

Once the data was cleaned and the TPU was calculated, a final 0.5 m CUBE surface was created using the NOAA cube specifications for a Special Order Survey.

B.4.4. *Final Products*

The final surface was exported from CARIS as a.bag file for viewing in other software.

C. Vertical and Horizontal Control

C.1. Vertical Control

The Center for Operational Oceanographic Products and Services (CO-OPS) of the National Ocean Service (NOS) provided vertical control and tidal zoning specifications for this project **(**Figure 14**)**. The primary water level station at Fort Point (8423898), New Hampshire, was used for the local water levels control. The tidal datum of Mean Lower Low Water Level (MLLW) was used as vertical reference datum for water level corrections for the entire hydrographic survey. The water level from the verified tide was downloaded from the NOAA website (http://opendap.co-ops.nos.noaa.gov/axis/text.html) for the survey period (June 14 ~ June 27, 2013). Tide station information and tidal zoning specifications are described in Table 16 and Table 17, respectively.

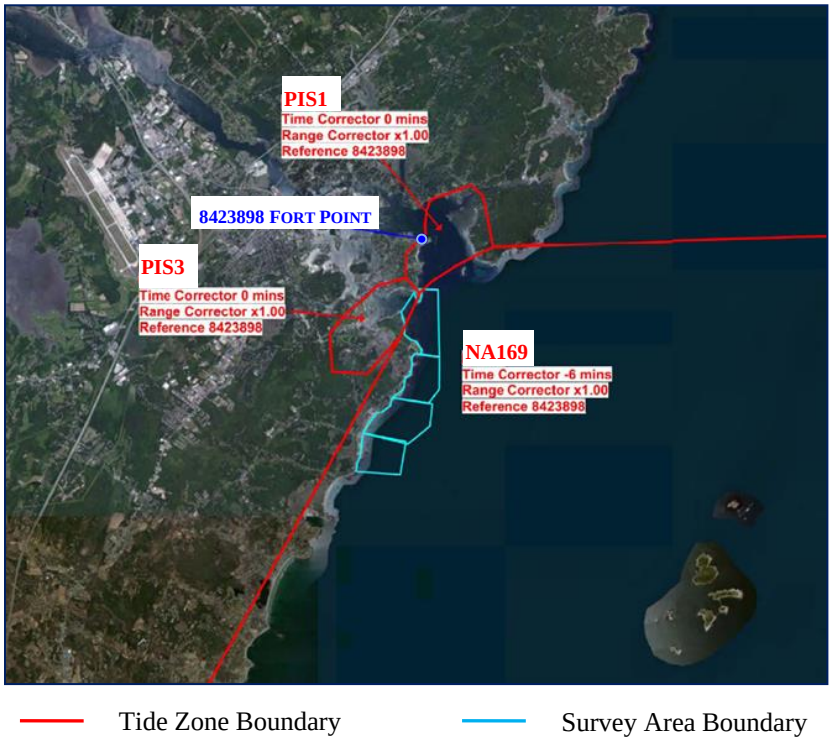


Figure 14 - Description of the location of survey area and tide zone boundary

Table 16 - Tide Station Information

Station ID & Name	Position	Data Source	Data retrieval date		Datum	Unit	Time Zone
			Begin Date	End Date			
8423898 Fort Point, NH	43°4.3' N 70°42.7' W	USDOC/NOAA/ -NOS/COOPS	2013/06/14	2013/06/27	MLLW	Meters	GMT

Table 17 - Tidal zoning specifications provided by CO-OPS, NOS

Name of Zone	Time Corrector (min)	Range Corrector	Reference Tidal Station
PIS1	0	x1.0	Fort Point, NH (8423898)
PIS3	0	x 1.0	Fort Point, NH (8423898)
NA169	-6	x 1.0	Fort Point, NH (8423898)

C.2. Horizontal Control

The North American Datum of 1983 (NAD-83) is used as the horizontal datum for this project. Real Time Kinematic (RTK) navigation with GPS base station and rover station were used for the horizontal control. The GPS based station was established by CCOM/JHC on the roof of the Seacoast Science Center at Odiorne Point, in New Castle, New Hampshire (43º02’43.37944”N, 70º42’49.73612” W) . To locate the vessel position, the Trimble 5700 GPS receiver and the Trimble TRIMMARK 3 radio modern were installed on the vessel (RV Coastal Surveyor) to acquire the GPS data and the corrections transmitted from the base station,

respectively. The vessel position was applied to the POS/MV and combined with attitude from IMU to establish the horizontal control. All positions are projected to the Universal Transverse Mercator (UTM) Zone 19N.

C.3. Environmental conditions impacting the quality of survey

Artifacts shown in Figure 15 are apparent in data acquired for survey line No. 5 in Priority Area-1 due to the rough weather on June 17, 2013 around 19:00:00(GMT). Resurvey of this line was done on the next day, June 18, 2013.

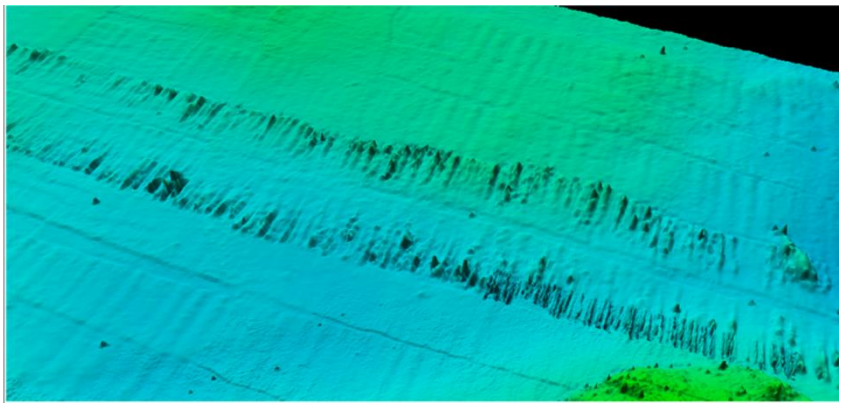


Figure 15 - Artifacts appeared in data acquired due to rough weather.

D. RESULTS AND RECOMMENDATIONS

D.1. Chart comparison

Table 18 - Nautical charts in region of survey area.

	Number	Title	Scale
1.	13283	Portsmouth Harbor Cape Neddick Harbor to Isles of Shoals; Portsmouth Harbor	1: 20,000
2.	13274	Portsmouth Harbor to Boston Harbor; Merrimack River Extension	1:80,000
3.	13278	Portsmouth to Cape Ann; Hampton Harbor	1:80,000

D.1.1. *Bottom Samples*

Bottom samples and underwater videos were taken from the RV *Cocheco* June 26th 2013 within the priority 1 area. Bottom sampling sites were chosen based on the results of the analysis of backscatter mosaic, to ensure that the parts of the sea bottom with different reflectivity characteristics will be sampled. Locations of bottom sampling sites are presented in Figure 16.

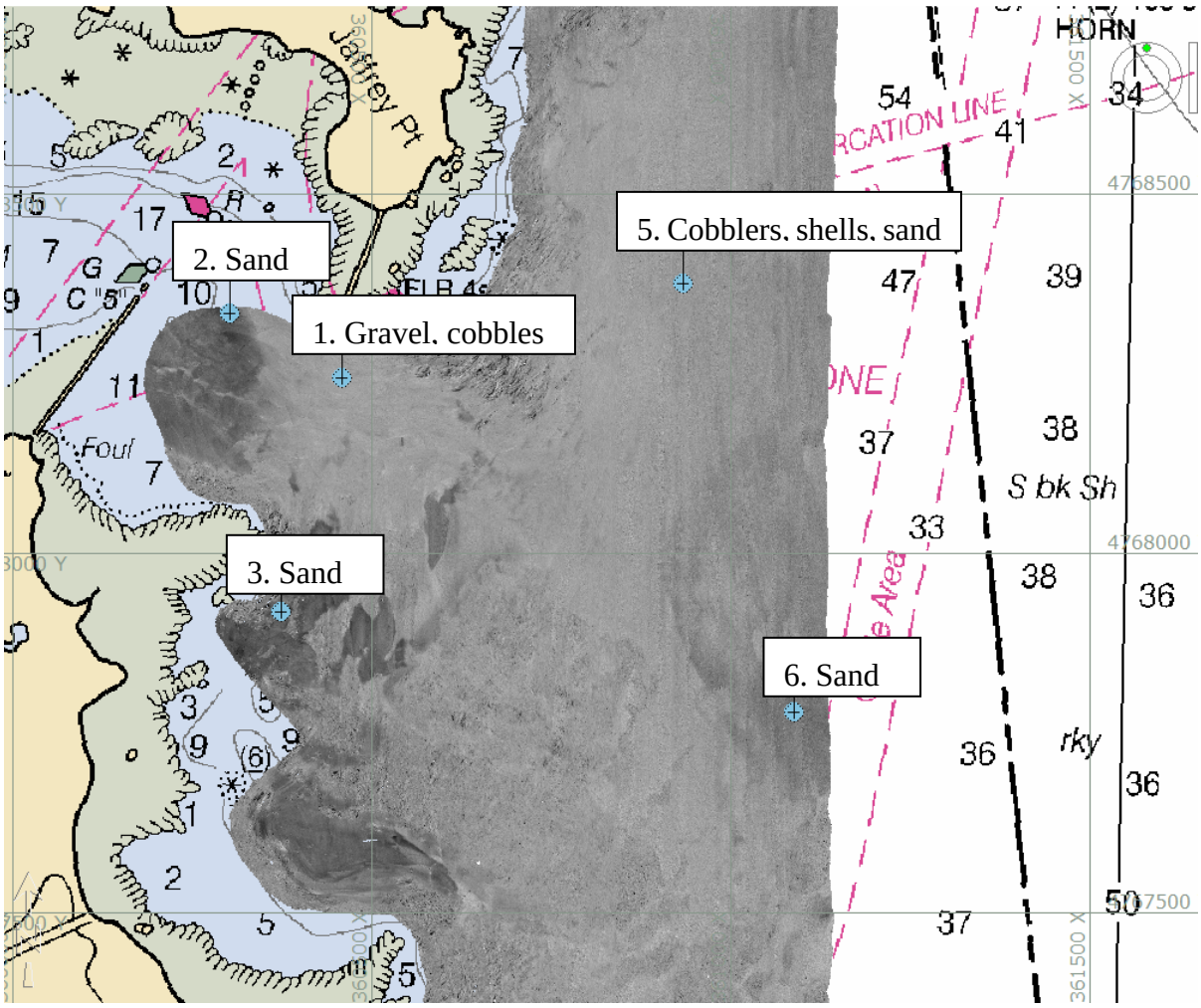


Figure 16 - Locations of samples with short descriptions.

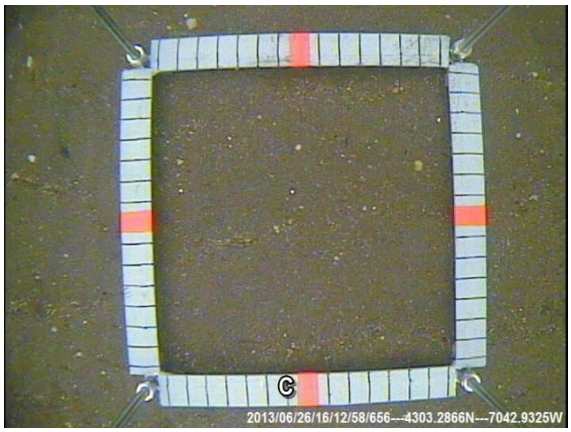
Positions and descriptions of samples are presented in Table 19. Five grab samples and six underwater video records were taken that day (June 26th). Representative frames from underwater video records are presented in Table 19

Table 19 - Positions and descriptions of samples taken on June 26th.

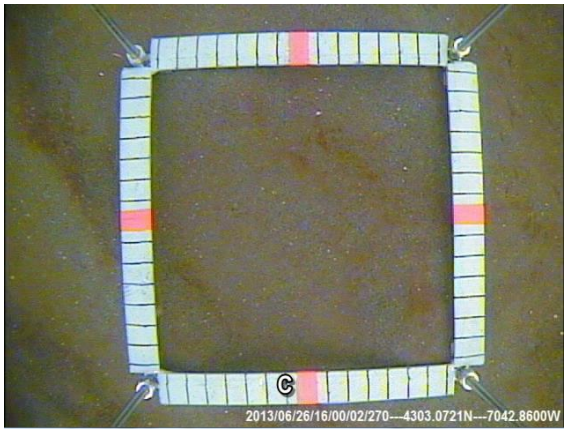
Site number	Latitude	Longitude	Description of grab sample
1	43 03 14.652 N	070 42 48.5102 W	Gravel, cobbles,
2	43 03 17.4682 N	070 42 55.4683 W	Sand
3	43 03 4.034 N	070 42 51.9854 W	Sand
4	43 03 15.678 N	070 42 39.102 W	N/A
5	43 03 19.236 N	070 42 27.642 W	Cobbles, shells, sand
6	43 02 59.98 N	070 42 20.2899 W	Sand

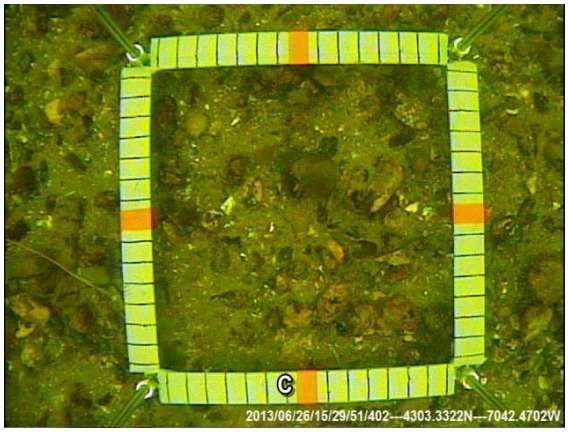
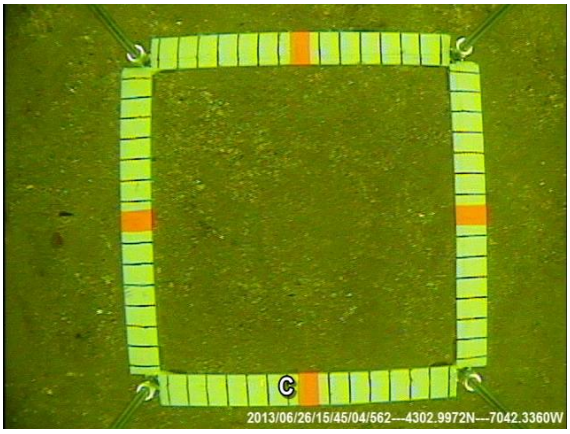
Figure 17 - Frames from underwater videos taken on the sites as specified in Table 19.

Site 1



Site 2



Site 3	Site 4
	
Site 5	Site 6

D.2. Dangers To Navigation (Dton)

All possible dangers to navigation observed within the survey area are reported in Appendix 1.

Summer Hydrography 2013 Bottom Samples Report

Bottom characteristics:

A total of 11 bottom samples were obtained in priority areas 1 and 2. Bottom sampling sites were chosen based on the results of the analysis of backscatter mosaic, to ensure that the parts of the sea bottom with different reflectivity characteristics will be sampled. The collected samples in the relatively high backscatter areas are sample 177-1, 177-5, 178-1, 178-2, 178-5, and 178-6 while the relatively low backscatter areas are sample 177-2, 177-3, 177-6, 178-3, and 178-4.

The exact position of each sampling location and each sample characteristics (NATSUR (Nature of Surface) and NATQUA (Nature of Surface - Qualifying Terms)) which described according to S-57 feature file are shown in Table 1.

SAMPLE #	LATITUDE (°)	LONGITUDE (°)	COLOR	NATSUR	NATQUA
177-1	43 03 14.652 N	070 42 48.5102 W	pink-brown, brown	pebble, gravel	coarse, medium
177-2	43 03 17.4682 N	070 42 55.4683 W	grey	sand	fine
177-3	43 03 4.034 N	070 42 51.9854 W	N/A	seaweed	seaweed
177-5	43 03 19.236 N	070 42 27.642 W	pink-brown, black, grey	shell, sand, pebble	broken, coarse
177-6	43 02 59.98 N	070 42 20.2899 W	brown	shell, sand	broken, fine
178-1	43 00 52.313 N	070 43 38.326 W	brown	Sand	fine
178-2	43 00 48.748 N	070 43 11.727 W	Grey-brown, grey-brown, white	gravel, cobbles, shell	Medium, coarse, broken
178-3	43 01 00.764 N	070 43 36.396 W	grey	sand	fine
178-5	43 01 9.351 N	070 43 28.675 W	brown	sand	fine
178-6	43 00 57.378N	70 43 16.74W	Grey, red	Rocky, cobbles, No Sample, seaweed	coarse, coarse, seaweed
178-7	43 00 58.8812 N	070 43 44.4551 W	Grey, red	Rocky, cobbles, seaweed	coarse, coarse, seaweed

Table 1: Bottom Characteristics with Lat/Long, NATSUR, NATQUA based on grabs & photos

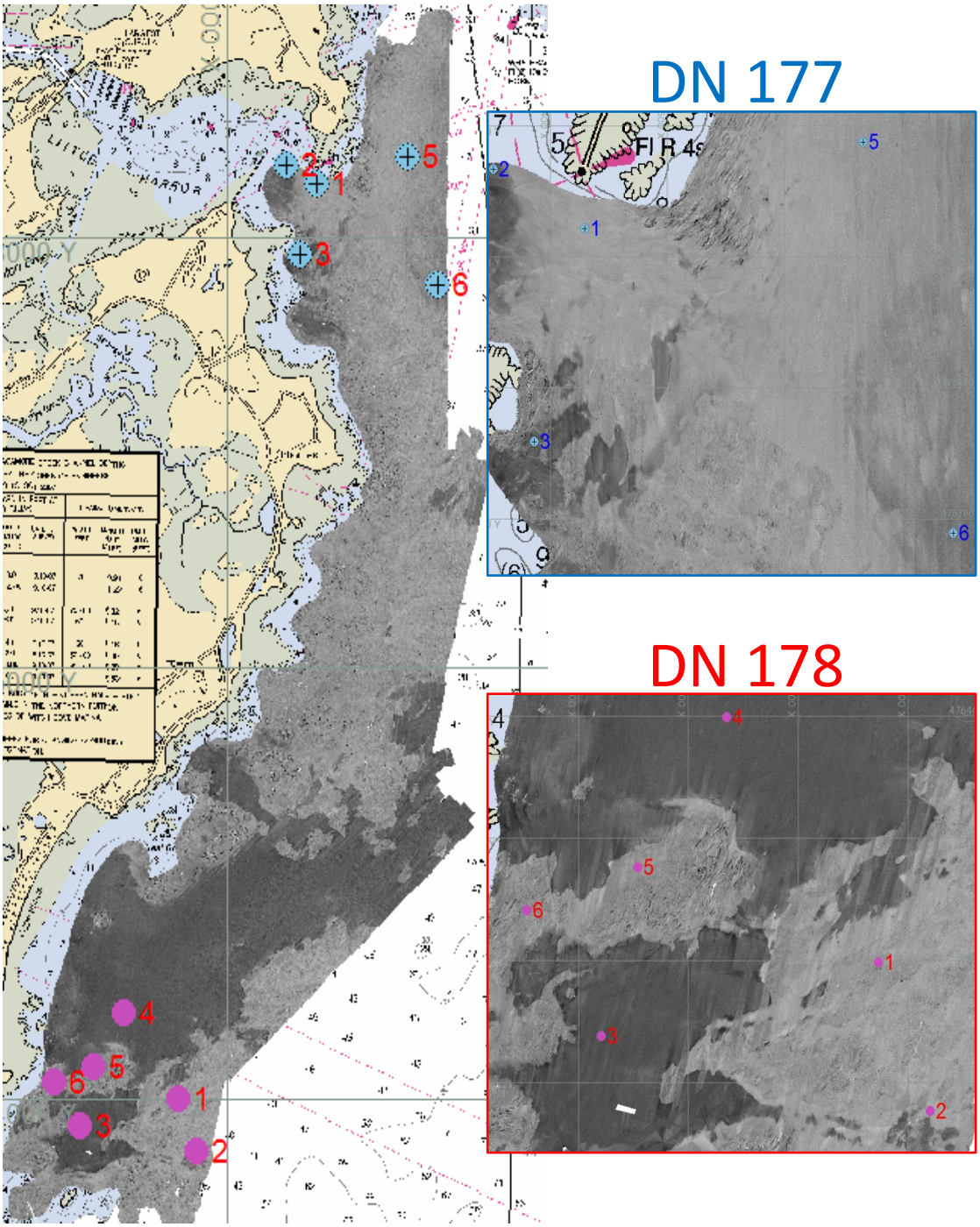


Figure 1: Bottom Grab Sampling Positions

Bottom samples and underwater videos were taken from the RV *Cocheco* June 26th 2013 within the priority 1 area. Locations of bottom sampling sites are presented in Figure 1.

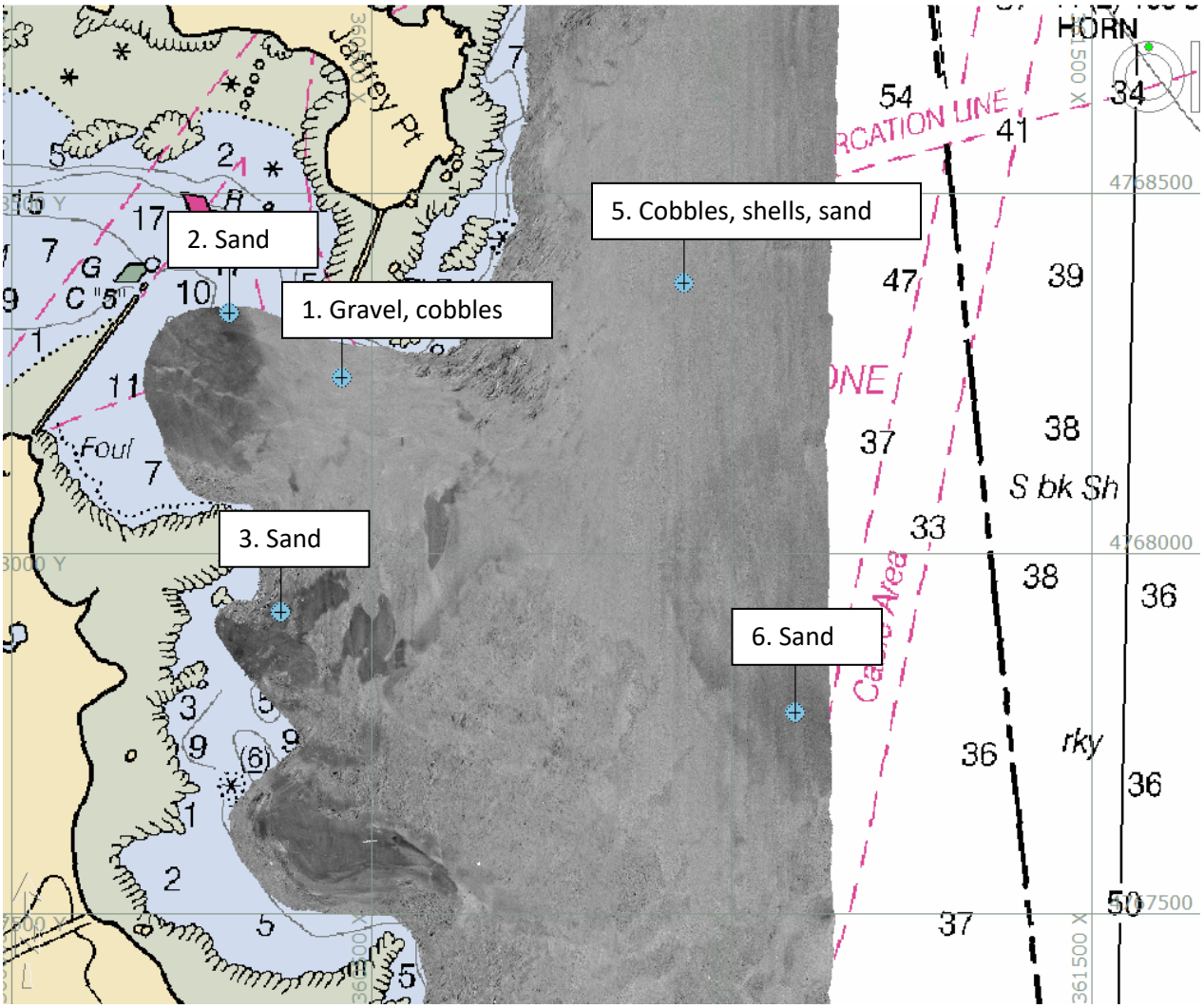


Figure 2: Locations of samples with short descriptions.

Site number	Latitude	Longitude	Sample # DN-Site	Description of grab sample
1	43 03 14.652 N	070 42 48.5102 W	177-1	Gravel, cobbles,
2	43 03 17.4682 N	070 42 55.4683 W	177-2	Sand
3	43 03 4.034 N	070 42 51.9854 W	177-3	Sand
4	43 03 15.678 N	070 42 39.102 W	177-5	N/A
5	43 03 19.236 N	070 42 27.642 W	177-6	Cobbles, shells, sand
6	43 02 59.98 N	070 42 20.2899 W	177-1	Sand

Table 2: Positions and descriptions of samples taken on June 26th.

Positions and descriptions of samples are presented in Table 2. Five grab samples and six underwater video records were taken that day (June 26th). Representative frames from underwater video records are presented in Figure 3.

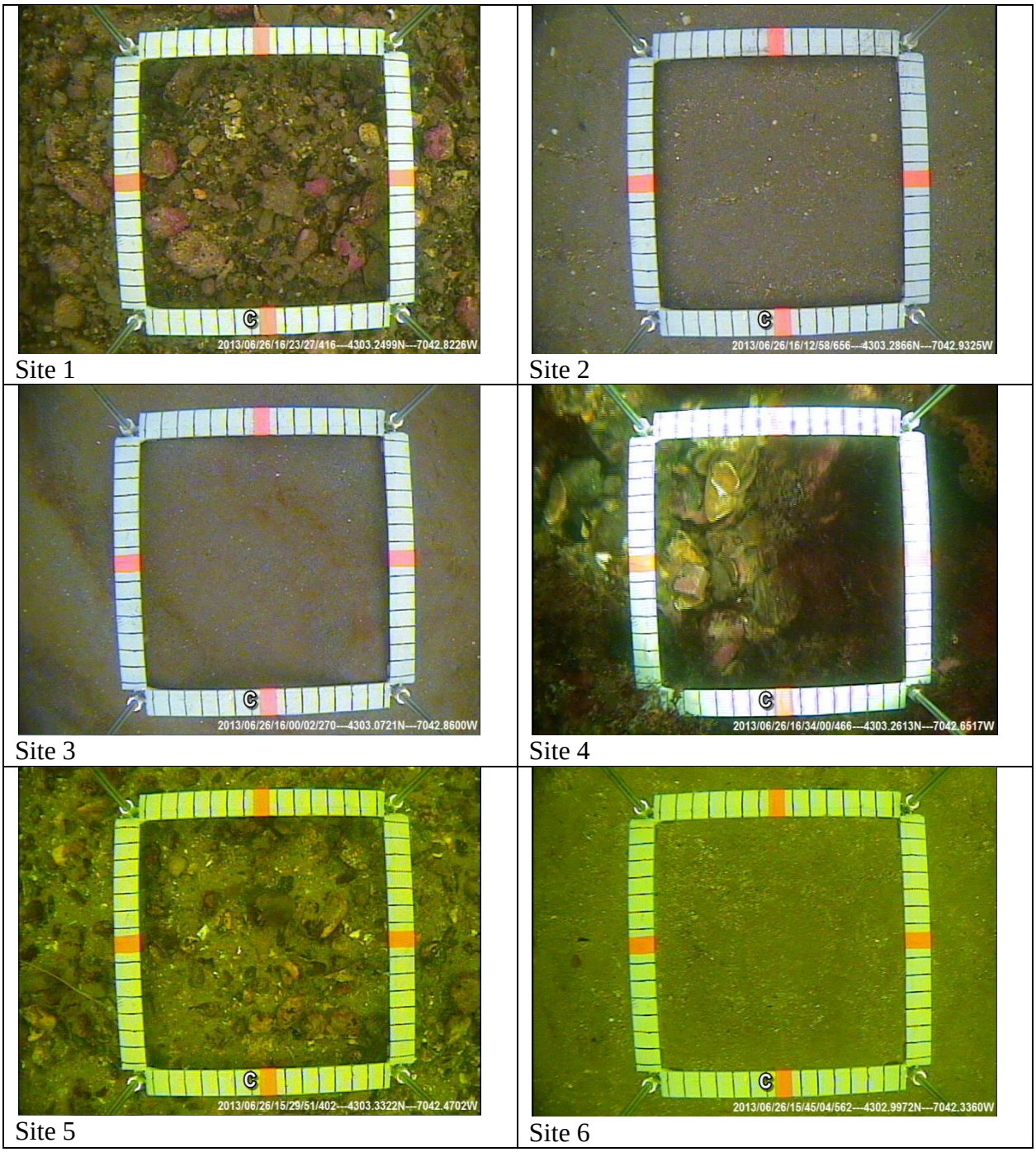


Figure 3: Chosen frames from underwater videos taken on the sites as specified in Table 2 DN177.

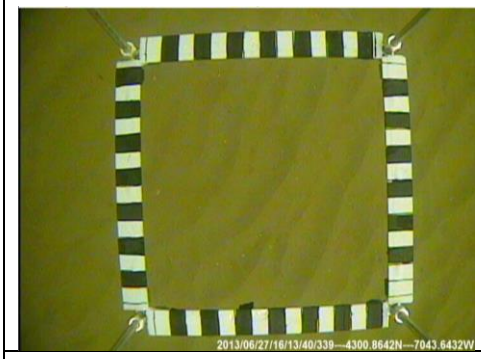
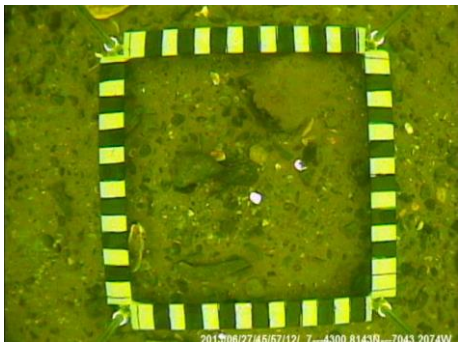
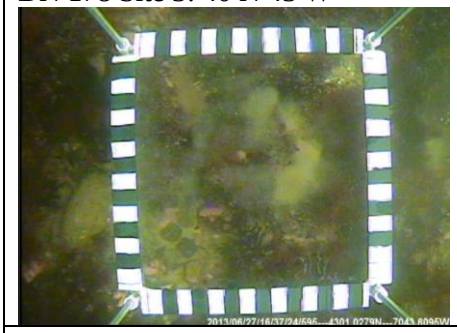
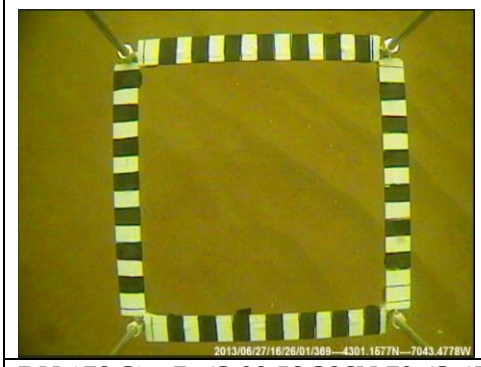
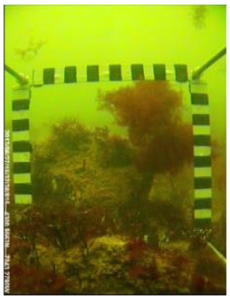
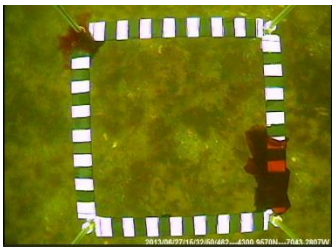
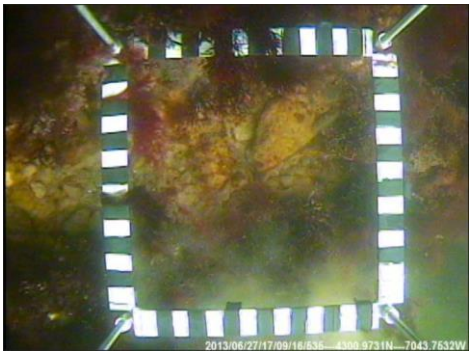
DN 178	06272013
DN 178 Site 1: 40 00 51.876N 70 43 38.466W 	DN 178 Site 2: 40 70 
DN 178 Site 3: 40 N 43 W 	DN
DN 178 Site 5: 43 01 9.462N 70 43 28.668W 	DN 178 Site 6 43 00 57.378N 70 43 16.74W  
DN 178 Site 7: 43 00 58.386N 70 43 45.192W 	

Figure 4: Bottom video stills from DN 178

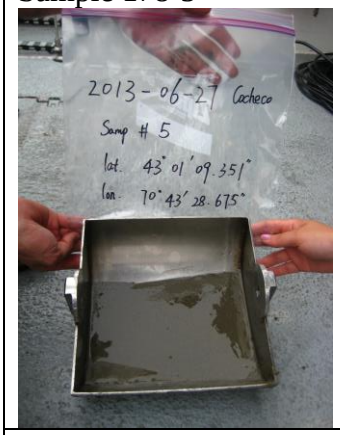
DN 178	06272013
Sample 178-1 	Sample 178 -2 
Sample 178-3 	Sample 178-4
Sample 178-5 	Sample 179-6
Sample 178-7	

Figure 5: Grabs on Deck from DN 17

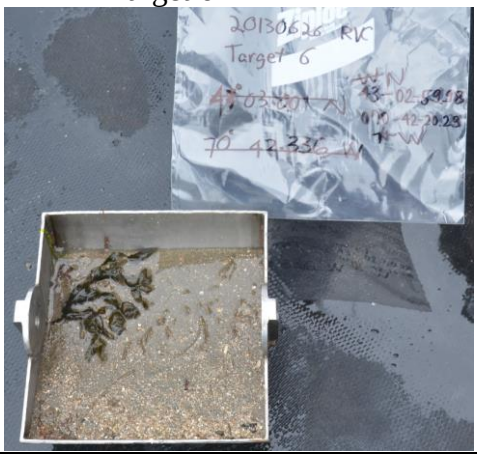
DN177	06262013
DN 177 Target 1 	DN177 Target 2 
DN177 Target 3 	N/A
DN177 Target 5 	DN177 Target 6 

Figure 7: Grabs on deck from DN177

APPROVAL PAGE

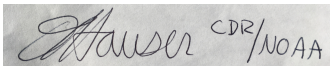
W00501

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NCEI for archive

- Descriptive Report
- Collection of Bathymetric Attributed Grids (BAGs)
- Collection of backscatter mosaics
- Processed survey data and records
- Bottom samples
- GeoPDF of survey products

The survey evaluation and verification has been conducted according current OCS Specifications, and the survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.



Digitally signed by HAUSER.OLIVIA.A.1275636009
Date: 2020.05.11 17:47:18 -07'00'

Approved:_____

Commander Olivia Hauser, NOAA
Chief, Pacific Hydrographic Branch