W00503

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	W00503

LOCALITY

State(s):	New Hampshire
General Locality:	Coastal Waters of New Hampshire
Sub-locality:	Seabrook Beach to Rye Ledge

2015

CHIEF OF PARTY
Semme Dijkstra and Andy Armstrong

LIBRARY & ARCHIVES

Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00503

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:	**Coastal Waters of New Hampshire**
Sub-Locality:	**Seabrook Beach to Rye Ledge**
Scale:	**10000**
Dates of Survey:	**06/10/2015 to 06/29/2015**
Instructions Dated:	**N/A**
Project Number:	**ESD-PHB-20**
Field Unit:	**University of New Hampshire**
Chief of Party:	**Semme Dijkstra and Andy Armstrong**
Soundings by:	**Kongsberg Maritime EM 2040** (**MBES**)
Imagery by:	**Kongsberg Maritime EM 2040** (**MBES Backscatter**)
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Survey Personnel: Daishi Horiuchi, Ramli Mohd, Nilton Sanchez, Katrina Wyllie Gustavo Crespo, Ricardo Freire, Bo Lawson, Ravi Runghen Cesar Borba, Tomer Ketter, Kelly Nifong

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 WGS84 19N, MLLW. 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

June 24, 2020

MEMORANDUM FOR: Pacific Hydrographic Branch

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

SUBJECT: Submission of Survey W00503

The data were acquired as part of hydrographic survey operations for the Summer Hydro Course 2015 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 World Geodetic System (WGS) 1984. The projection used for this project is Universal Transverse Mercator (UTM) Zone 19.

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

All data were reviewed for DTONs and none were identified in this survey.

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

All significant findings are discussed in the accompanying Descriptive Report.

Bottom Samples- Due to different naming conventions among the images, videos, logs, and Final Feature File, no images or videos were able to be correlated to the samples. Only the four retrieved samples were retained in the FFF with no images or videos attached.

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

University of New Hampshire

Type of Survey:	Navigable Area

LOCALITY

States(s):	New Hampshire
General Locality:	Coastal Waters of New Hampshire
Sub-Locality:	Rye Ledge to Great Boars Head

2015

Group Members:	Massimo Di Stefano Onni Irish Amon Kimeli Hirokazu Kurita Damian Manda Maxlimer Vallee-Anziani	John Kidd Roshini Nilupa Mudiyanselage Kumari Samarakoon Anderson Pecanha Indra Prasetyawan Jaya Roperez
Chief of Party:	Semme Dijkstra and Andy Armstrong	

Survey

Dates:	June 10th – June 29th 2015

UNIVERSITY OF NEW HAMPSHIRE CENTER FOR COASTAL AND OCEAN MAPPING JOINT HYDROGRAPHIC CENTER	GROUP NAME:

HYDROGRAPHIC TITLE SHEET	GROUP NAME

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	Coastal Waters of New Hampshire
Sub-Locality:	Rye Ledge to Great Boars Head
Scale:	1:10,000
Dates of Survey:	10 June – 29 June
Instructions Date:	
Field Unit:	CCOM *R/V Coastal Surveyor*
Soundings by:	Kongsberg EM2040 Multibeam Echo Sounder
Imagery by:	Kongsberg EM2040 Backscatter Imagery
Soundings Acquired in :	Meters at WGS84

Remarks:

DESCRIPTIVE REPORT

HYDROGRAPHIC TITLE SHEET

Type of Survey: Navigable Area

LOCALITY

State(s):	New Hampshire
General Locality:	Coastal Waters of New Hampshire
Sub-locality:	Rye Ledge to Great Boars Head

SURVEY

Year:	2015
Dates of Survey:	6/10/2015-06/29/2015
Project:	Unknown
Field Unit:	CCOM/JHC: R/V Coastal Surveyor
Chief of Party:	Semme Dijkstra and Andrew Armstrong
Soundings by:	Multibeam Echo Sounder
Imagery by:	Multibeam Echo Sounder Backscatter
Soundings Acquired in:	meters at Mean Lower Low Water

University of New Hampshire
Center for Coastal and Ocean Mapping
Joint Hydrographic Center

Descriptive Report

Rye Ledge to Great Boars Head, NH

Project: Unknown
Locality: Atlantic Ocean
Sublocality: Rye Ledge to Great Boars Head
Scale: 1:10000
June 2015 - July 2015
CCOM/JHC
Chief of Party: Semme Dijkstra and Andrew Armstrong

2015 Summer Hydrographic Field Course

R/V Coastal Surveyor

Prepared by:

Massimo Di Stefano
Onni Irish
Amon Kimeli
Hirokazu Kurita
Damian Manda
Maxlimer Vallee-Anziani
John Kidd
Roshini Nilupa Mudiyanselage Kumari Samarakoon
Anderson Pecanha
Indra Prasetyawan
Jaya Roperez

Submitted

July 2015

A. Area Surveyed

The survey area extends from Rye Ledge, Rye, NH to just north of Great Boar's Head, Hampton, NH (Figure 1). The inshore limit of the survey is defined by the boat captain's judgment for safety of equipment and personnel with 12 ft (4 m) as the conventional depth limit. The survey junctions to the north with the 2014 Summer Hydro survey data and to the east with 2014 NOAA Ship Hassler survey H12696. Additionally, the survey junctions to the Northwest with 2005 FUGRO Lidar data (H11296). The survey covers a total area of 3.2nm^2.

A.1. Survey Limits

Data were acquired within the survey limits specified in table 1.

Table 1. Survey Limits

Northeast Limit		Southwest Limit	
Inshore	**Offshore**	**Inshore**	**Offshore**
70^o 45' 25" W	70^o 44' 43" W	70^o 47' 32" W	70^o 46' 26" W
42^o 58' 19" N	42^o 58' 06" N	42^o 55' 27" N	42^o 55' 09" N

A.2. Survey Purpose

The primary purpose of this survey is to educate the students enrolled in the UNH Center for Coastal and Ocean Mapping Joint Hydrographic Center's (CCOM/JHC) Summer Hydrographic Field Course in the planning, acquisition, and processing of a hydrographic survey. The data and deliverables are prepared to NOAA National Ocean Service 2015 specifications and are deemed suitable for nautical chart updates.

This hydrographic survey is geared towards obtaining high resolution bathymetry and backscatter data for the purposes of preparing and/or updating the existing nautical charts. Safety of navigation requires that existing nautical charts be updated regularly because of the inevitable changes in bottom geomorphology mainly due to sedimentation and action of bottom currents.

In addition, the survey area comprises a region where CCOM/JHC actively carries out research work and therefore provided a good synergy with currents projects.

A.3. Survey Quality

The entire survey is adequate to supersede previous data. Based on the junction analysis, it is has less than 0.10m mean difference from the junction surveys conducted by NOAA. This survey was conducted in accordance with the best practices listed in the *2014NOAA Field Procedures Manual*. The data and deliverables that accompany this package have been prepared in order to meet the requirements of the *2014 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.4 Survey Coverage

Survey Limits were acquired in accordance with the requirements in the Project Instructions and the Hydrographic Survey Specifications and Deliverables (HSSD). Figure 1 shows extend and location of the survey area.

Numerous small coverage holidays exist in this survey and are discussed in section B.2.8 of this DR.

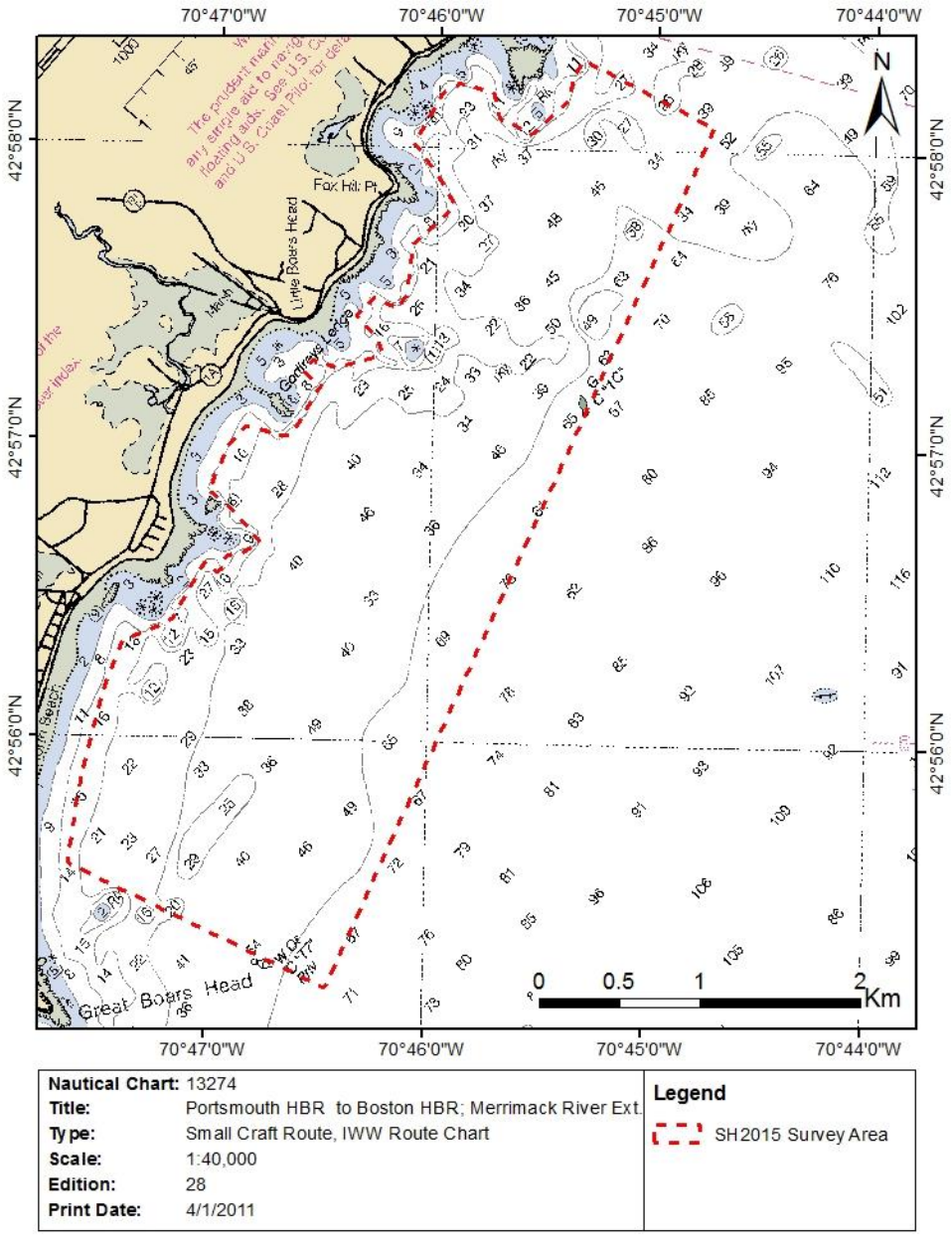


Figure 1. Summer Hydrographic Course 2015's outline of survey area off of Rye, NH.

A.5 Survey Statistics

Table 2. Hydrographic Survey Statistics expressed in linear nautical miles (LNM)

Vessel	R/V Coastal Surveyor (LNM)	Total (LNM)
SBES Mainscheme	0	0
MBES Mainscheme	152.26	152.26
Lidar Mainscheme	0	0
SSS Mainscheme	0	0
SBES/MBES Combo mainscheme	0	0
SBES/SSS Combo Mainscheme	0	0
MBES/SSS Combo Mainscheme	0	0
SBES/MBES Combo Crosslines	11.76	11.76
Lidar Crosslines	0	0
Number of Bottom Samples	10 (collected on the Galen J)	0
Number AWOIS Items Investigated		0
Number Maritime Boundary Points Investigated		0
Number of DPs		0
Number of Items Investigated by Dive Ops		0
Total Number of SNM		0

Table 3 Dates of data acquisition during the survey and sample collection

Survey Date	Julian Day Number	Type of Data Acquisition
06/10/2015	161	MBES
06/11/2015	162	MBES
06/12/2015	163	MBES
06/15/2015	166	MBES
06/16/2015	167	MBES
06/17/2015	168	MBES
06/18/2015	169	MBES
06/19/2015	170	MBES
06/23/2015	174	MBES
06/24/2015	175	MBES
06/25/2015	176	MBES
06/30/2015	181	Grab Samples
07/01/2015	182	Grab Samples
07/02/2015	183	Grab Samples

**Note that on June 22, 2015 the Captain of the RVCS was ill and out sick and therefore no data was collected.

B. Data Acquisition and Processing

B.1. Equipment and Vessels

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 data processing methods. Information to supplement sounding and survey data, and any deviations from the DAPR are discussed in the following sections.

B.1.2. Equipment

The following major systems were used for data acquisition during this survey:

Table 4. Major systems used during data acquisition.

Manufacturer	Model	Type
Odom	Digibar-Pro	Sound Speed System
AML	SV&P	Conductivity, Temperature and Depth Sensor
Applanix	POS/MV 320 V4	Positioning and Attitude System
Kongsberg	EM 2040	MBES

B.2 Quality Control

B.2.1 Crosslines

A total of 11.76 nautical miles of crosslines were acquired during the survey (fig.2). This accounts for 7.73 % of main scheme distance, which satisfies NOS Specifications and Deliverables (2015) of ~4%. To evaluate crossline agreement, two 1m surfaces were created; one from crossline soundings and one from main scheme soundings. A difference surface was performed in CARIS HIPS and the average difference between the surfaces is 0.0 m with a standard deviation of 0.1 m (Figures 3 & 4, Table 8), which means that there is not statistically significant difference between the crosslines and the main scheme.

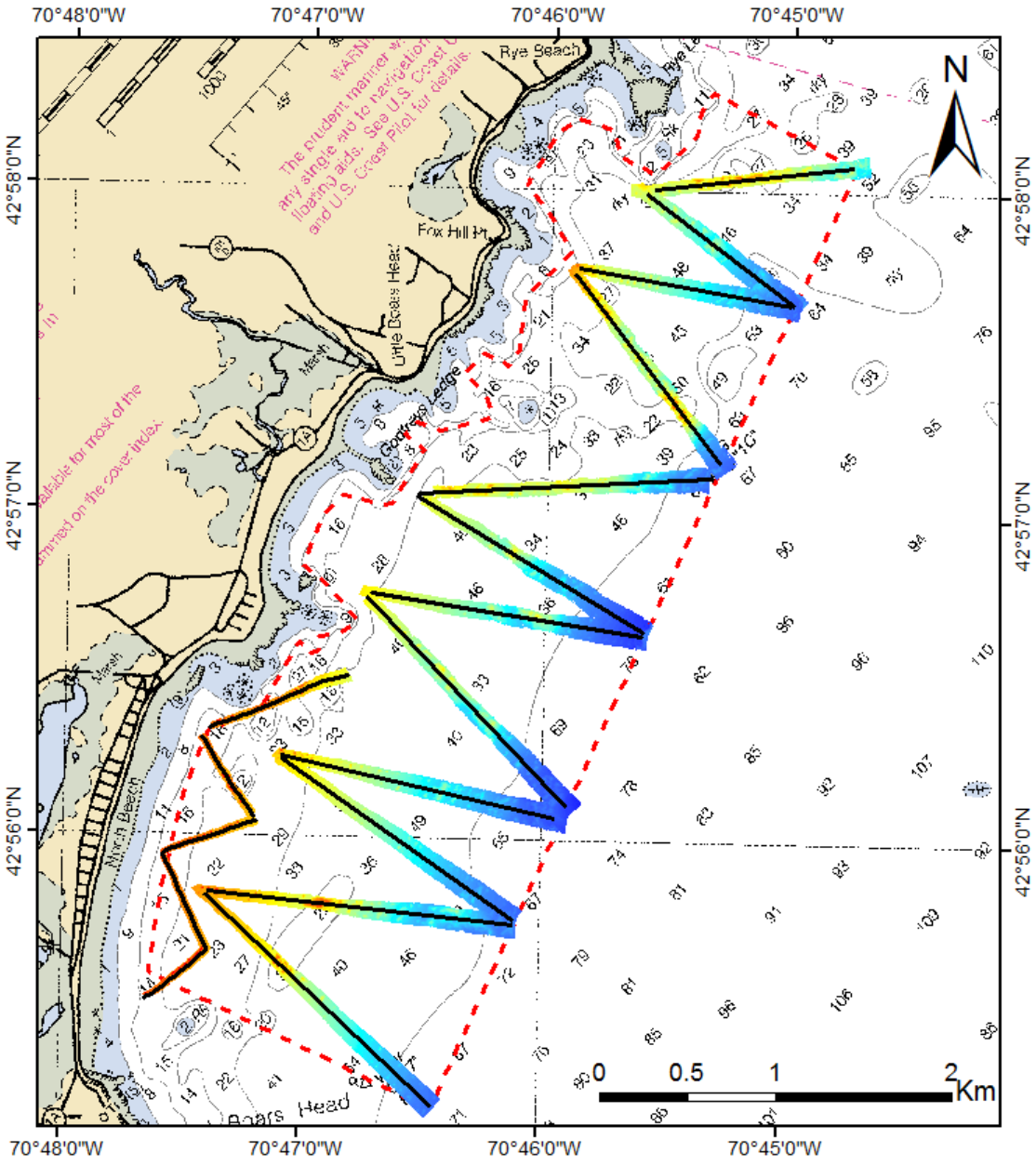


Figure 2. Overview of the acquired crosslines and corresponding surface generated with Caris HIPS & SIPS at 1.0 meter resolution. Coordinate System, WGS 1984 UTM zone 19N.

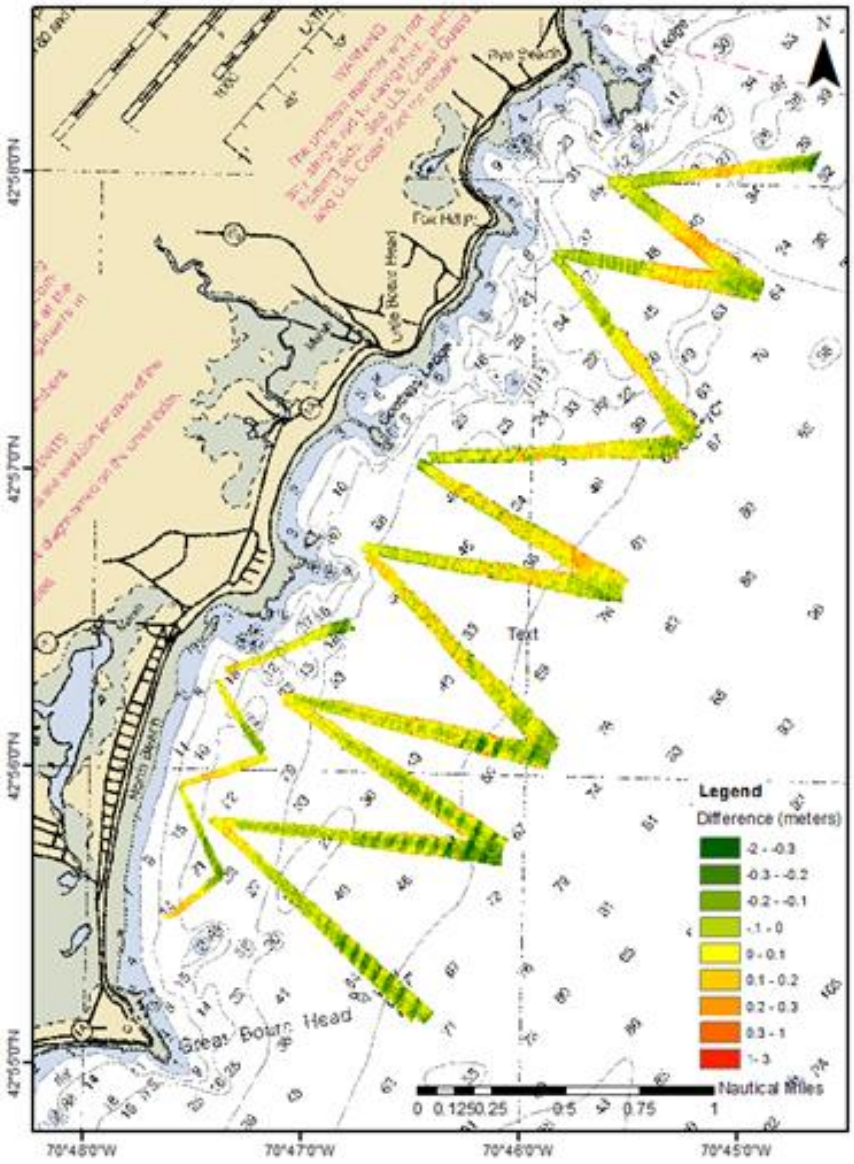


Figure 3: Crosslines* Difference Surface *(NOAA Chart13274_2)

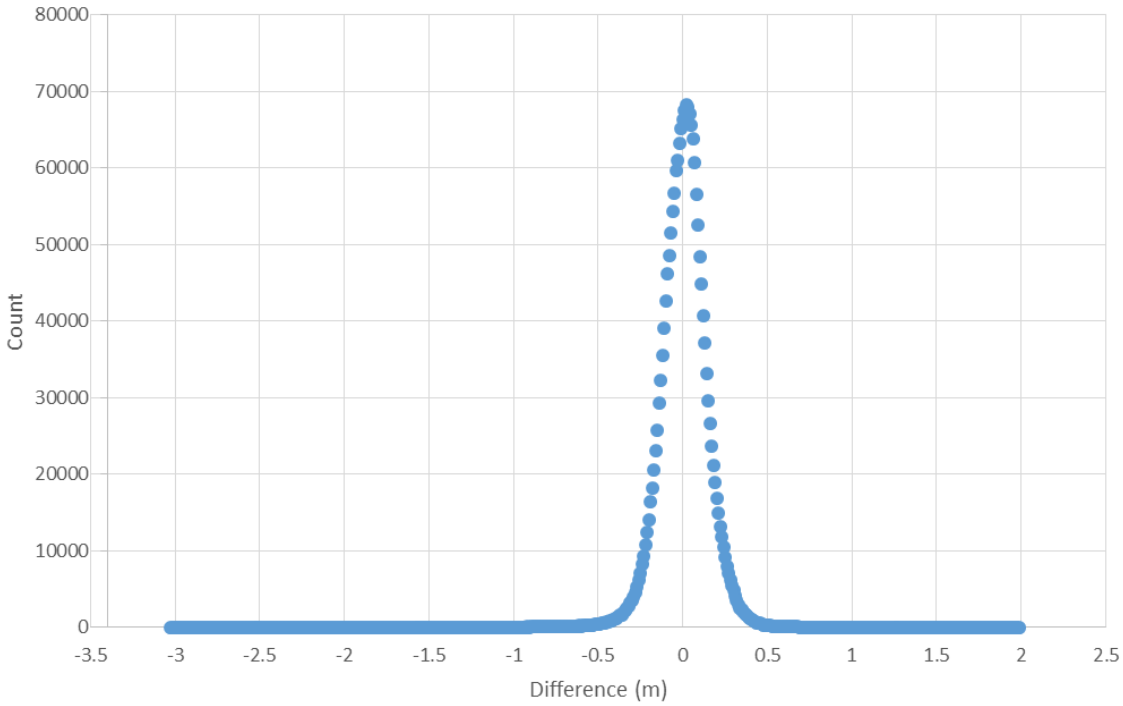


Figure 4. Difference between main scheme and crosslines

Table 5. Statistical information

Minimum	-3.00 m
Maximum	2.00 m
Mean	0.00 m
Area	N/A
Standard deviation	0.10 m
Total count	2,005,548

B.2.2 Uncertainty

Total Propagated Uncertainty values for this survey were derived from a combination of fixed values for equipment and vessel characteristics, as well as values for sound speed uncertainties. Tidal uncertainty values were also entered into the Tide Value section of the CARIS Compute TPU function. Uncertainty values of submitted finalized grids were calculated in CARIS using the "Greater of the Two" of uncertainty and standard deviation (scaled to 95%). To visualize the locations in which accuracy requirements were met for each finalized surface, a custom "IHO" layer was created, based on the difference between calculated uncertainty of the nodes and the allowable IHO uncertainty (Figure 5).

The total vertical uncertainty the following equation is used:

$$TVU = +/- \sqrt{(a)^2 + (b * d)^2}$$

Where ‘a’ represents the portion of the uncertainty that does not vary with depth, ‘b’ is a coefficient which represents that portion of the uncertainty that varies with depth and ‘d’ is the local water depth

In order to meet Special Order survey criteria, the maximum allowable horizontal uncertainty is 2m at 95% confidence while the maximum allowable vertical uncertainty is

$+/- \sqrt{(0.25)^2 + (0.0075 * d)^2}$ of a given depth (*d*) at 95% confidence.

The following survey specific parameters were used for this survey:

Table 6. Survey specific Tide TPU Values

Measured	Zoning
0.02 meters	0.10 meters

Table 7. Survey Specific Sound Speed TPU Values

Hull ID	*Measured - Digibar*	*Surface - AML*
RVCS	*0.3 meters/second*	0.025 *meters/second*

The finalized bathymetry surfaces have node uncertainty values estimated as the higher of either the standard deviation or total propagated uncertainty as suggested by the NOAA Field Procedures Manual (2014). The estimated uncertainty values were compared to the IHO Order1 Standards. Overall, 99.5% of the 1 m surface met the accuracy requirements stated in the specifications.

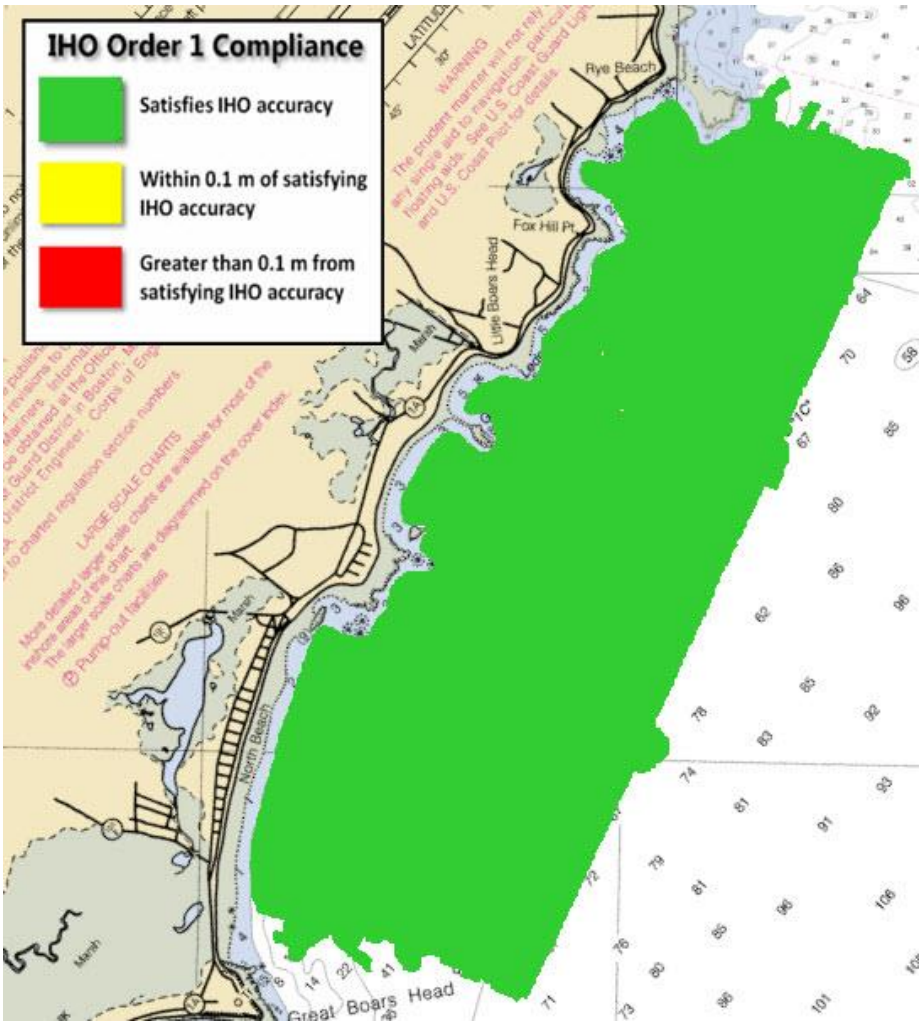


Figure 5. IHO layer of depth threshold 0.5 m and 1 m surfaces.

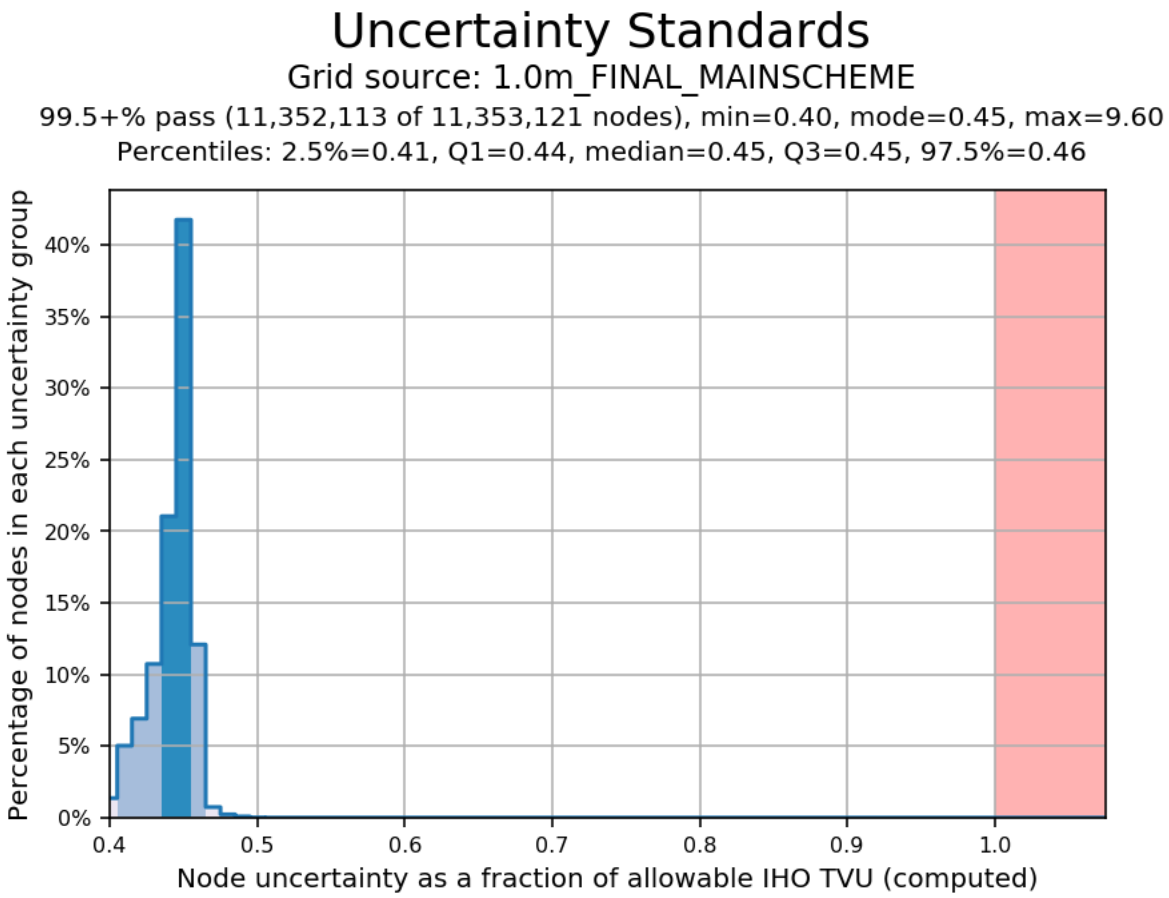


Figure 6: TPU from QC Tools.

B.2.3 Junctions

This survey junctions with one NOAA survey conducted aboard NOAA Ship Hassler in 2014, one UNH survey conducted by the 2014 Summer Hydro class, and one FUGRO Lidar survey conducted in 2005 (fig. 4). The junction surfaces were differenced in CARIS BDB using the corresponding grid resolution used for the junctioning survey.

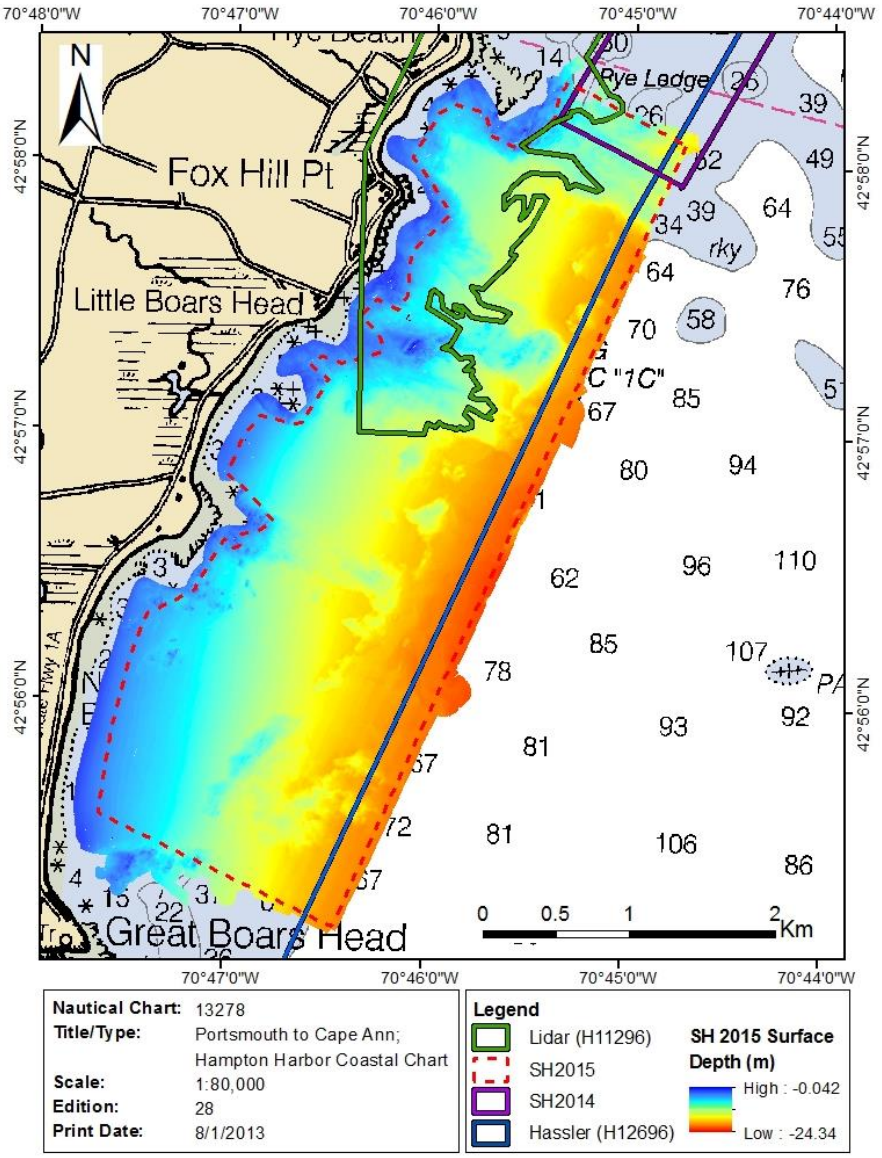


Figure 7. Overview of the junctions with previous data.

B.2.3.1 H11296 (LADS LIDAR)

The mean difference between the Summer Hydro 2015 survey and the LIDAR H11296 data set is 0.100 m with a standard deviation of 0.438m (fig.5). The LIDAR data is overall shoaler than the bathymetry collected in this 2015 survey. The larger differences are seen in in the rocky and deeper areas.

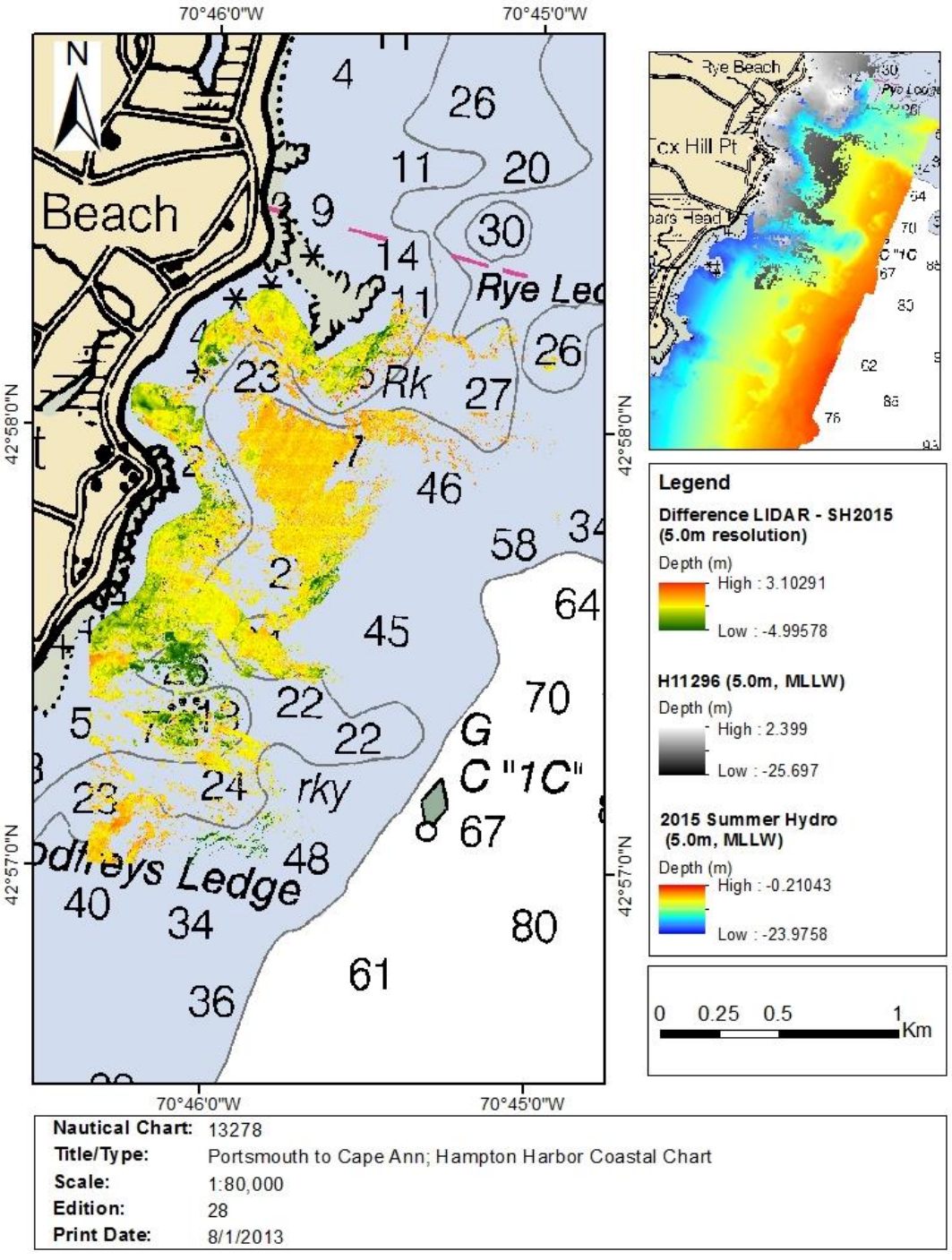


Figure 8. Surface difference between SH2015 and LIDAR data sets (left). Overview of raster surfaces overlap (top right).

B.2.3.2. H12696 (HASSLER MBES)

Survey H12696 was conducted by the NOAA Ship Hassler. The Hassler MBES data was gridded at 4.0m and therefore a 4.0m DTM was created of the 2015 Summer Hydro survey area to conduct a difference analysis. The mean difference was -0.0688 m with a standard deviation of 0.150 m.

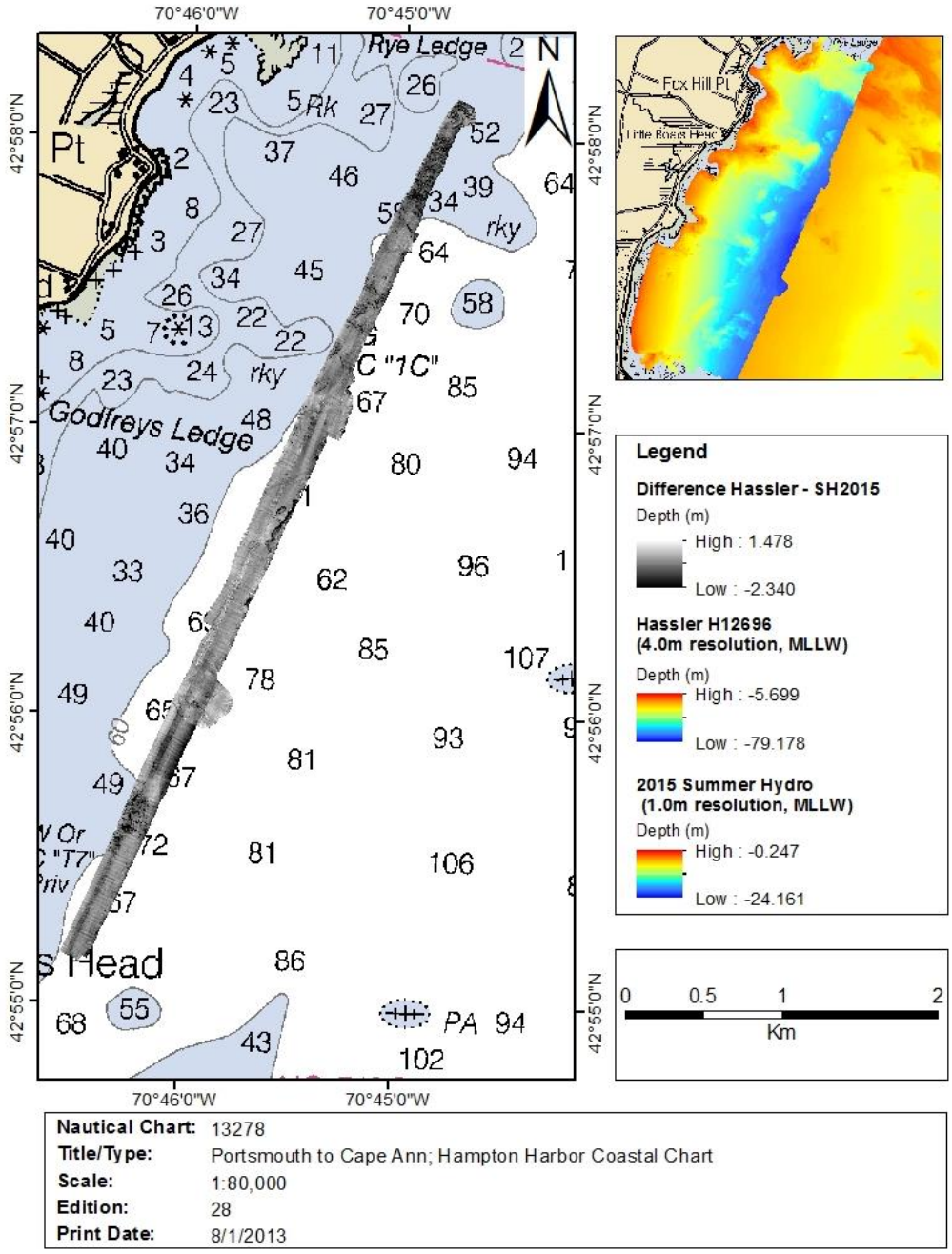


Figure 9. Surface difference between SH2015 and Hassler data sets (left). Overview of raster surfaces overlap (top right).

B.2.3.3. SH2014 (MBES Summer Hydro Survey)

The mean difference between this survey and the 2014 Summer Hydro survey (fig.7) is 0.28 m with a standard deviation of 0.16 m.

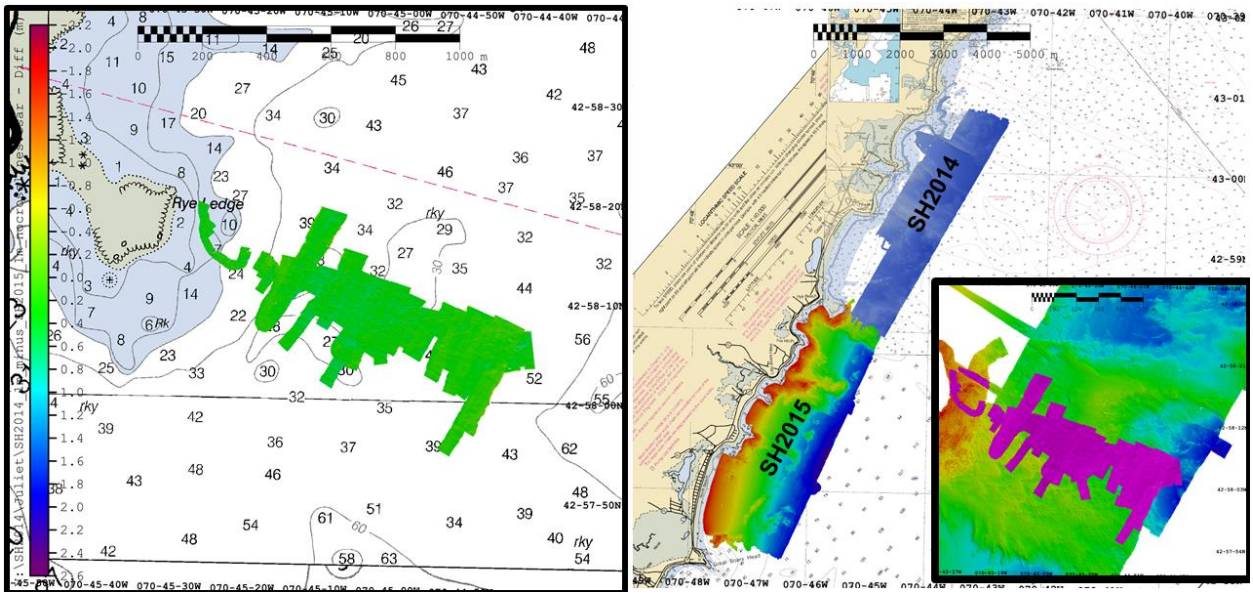


Figure 10. Surface difference between SH2015 and SH2014 data sets with RNC (left). Overview of raster surfaces overlap, pink is overlap area (right inset). Coverage SH2014 and SH2015 (right).

B.2.3.3. Junctions summary

Table 11 summarizes the differences between the 2015 Summer Hydro's survey area and its three junctions. The first two junctions were performed as SH2015 minus (-) Junction using Raster Calculator in ArcGIS where both surfaces had the same gridding. SH2015 minus SH2014 was calculated in CARIS BDB.

Table 8. Comparison between 2015 Summer Hydro surface and prior data surfaces.

Junction	H11296 (Lidar)	*H12696 (Hassler)*	SH2014
Resolution	5.0 m	*4.0m*	1.0m
Mean (m)	0.100	*-0.0688*	*0.46*
Standard Deviation (m)	0.438	*0.150*	*0.17*

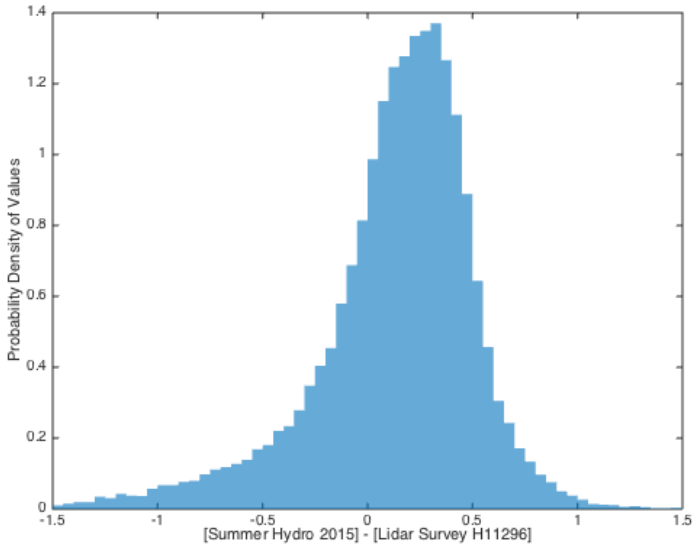


Figure 11. Histogram of surface difference between SH2015 and LIDAR data.

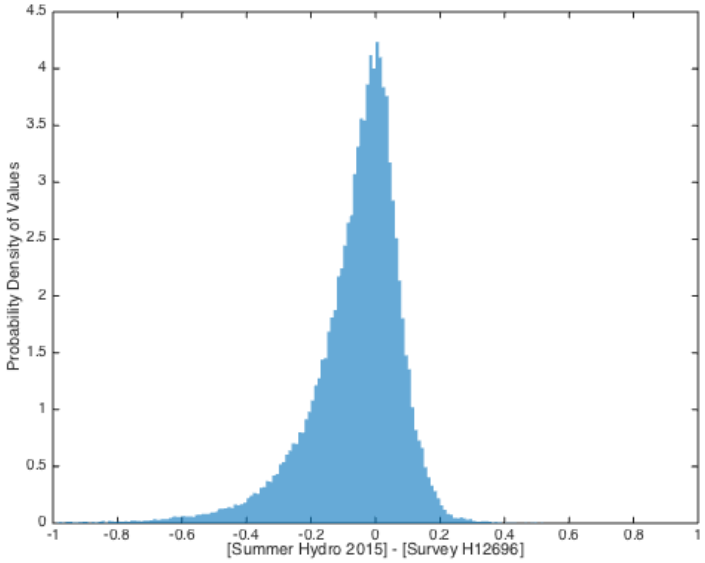


Figure 12. Histogram of surface difference between SH2015 and Hassler Data.

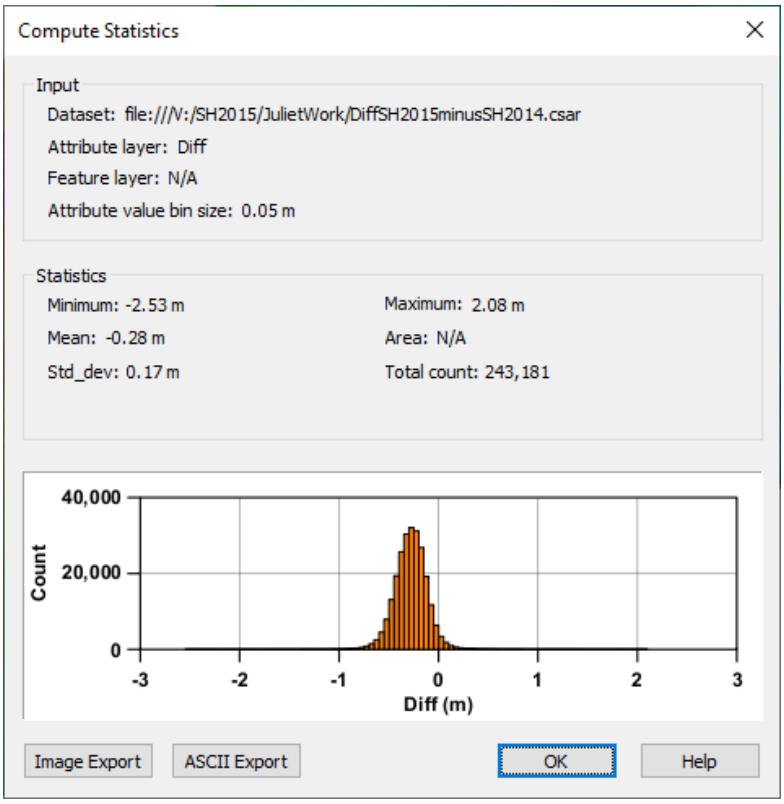


Figure 13. Histogram of surface difference between SH2015 and SH2014.

One of the major reasons why the 2015 Summer Hydro group surveyed off of Rye and North Hampton, NH was because the last two surveys in this region were conducted in 1953 and 1954 (fig.11). Both data sets are single beam derived datasets found on NOAA NOS Hydrographic Survey website (https://data.noaa.gov/dataset). Figure 11 outlines these surveys in relation to this 2015 survey. Further comparison with the chart and these surveys is in section D.

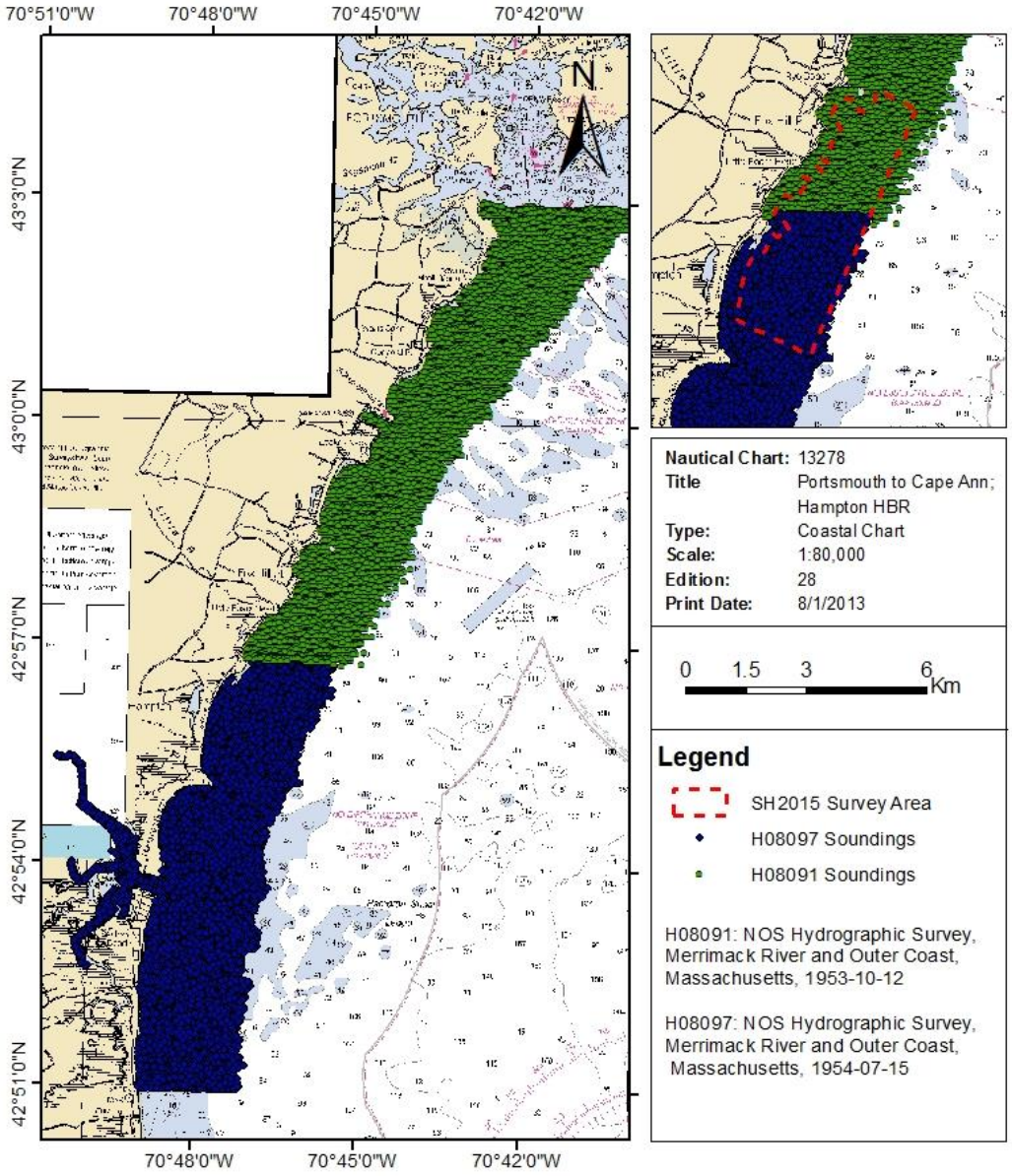


Figure 14. Overview of the location of the NOS Hydrographic Surveys carried out in 1953 and 1954.

Registry Number	Scale	Date of Survey	Field Unit	Sounding Derived From	Relative Location
H-7140	1 : 40,000	3 June - 29 Sept 1947	US CGS Ship Lydonia	808 Depth Recorder and Dorsey Fathometer	E
H-8091	1 : 10,000	20 Aug - 12 Oct 1953	East Coast Field Party	Echosounder, sounding pole, and leadline	N

H-8097	1 : 10,000	20 Aug - 14 Oct 1953 & 29 June - 15 July 1954	East Coast Field Party	Echosounder, sounding pole, and leadline	S

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the quality control section of the DAPR.

B.2.5 Equipment Effectiveness

There were no conditions or deficiencies that affected equipment operational effectiveness.

B.2.6 Factors Affecting Soundings

B.2.6.1. Dynamic Draft

A dynamic draft survey was not completed for this survey. Instead, the same values used for the last several years were applied to the data. These values are from a 2006 dynamic draft survey completed by CCOM/JHC where 18 measurement runs at varying speeds were conducted to determine the ellipsoid height vs ship speed through water referenced to IMU. The dynamic draft values are entered into the RVCS hvf file and applied on the Merge step in CARIS HIPS.

Table 9. Dynamic Draft Values Entered

Speed (knts)	Draft (m)
0	0
0.999136	-0.025
2.000216	-0.04
2.999352	-0.043
4.000432	-0.035
4.999568	-0.017
6.000648	0.012
6.999784	0.053
8.000864	0.104
9.000000	0.166
9.999136	0.239

B.2.7 Sound Speed Methods

An Odom Digibar Pro sound speed profiler was used to acquire profile measurements of the water column. The digibar was lowered over the side by hand at an approximate rate of 1 m/s. The ASCII serial data, downloaded from the Digibar, was saved to a .txt file and processed using the executable (W2COM.exe) found under COM in HYPACK support. The processed file was saved as an .asvp file format. The .asvp file was immediately uploaded into the SIS machine and applied real-time to the data acquisition. At least three sound speed profiles (SSP) were acquired each day and more were acquired when the surface sound velocity from the AML varied more than 3 m/s from the Digibar. This happened more frequently in shallow areas where sound velocity is more variable. Data was also processed in real time and evaluated for any sound velocity

concerns that would warrant additional CTD casts. Locations of the acquired SSP are shown in figure 16.

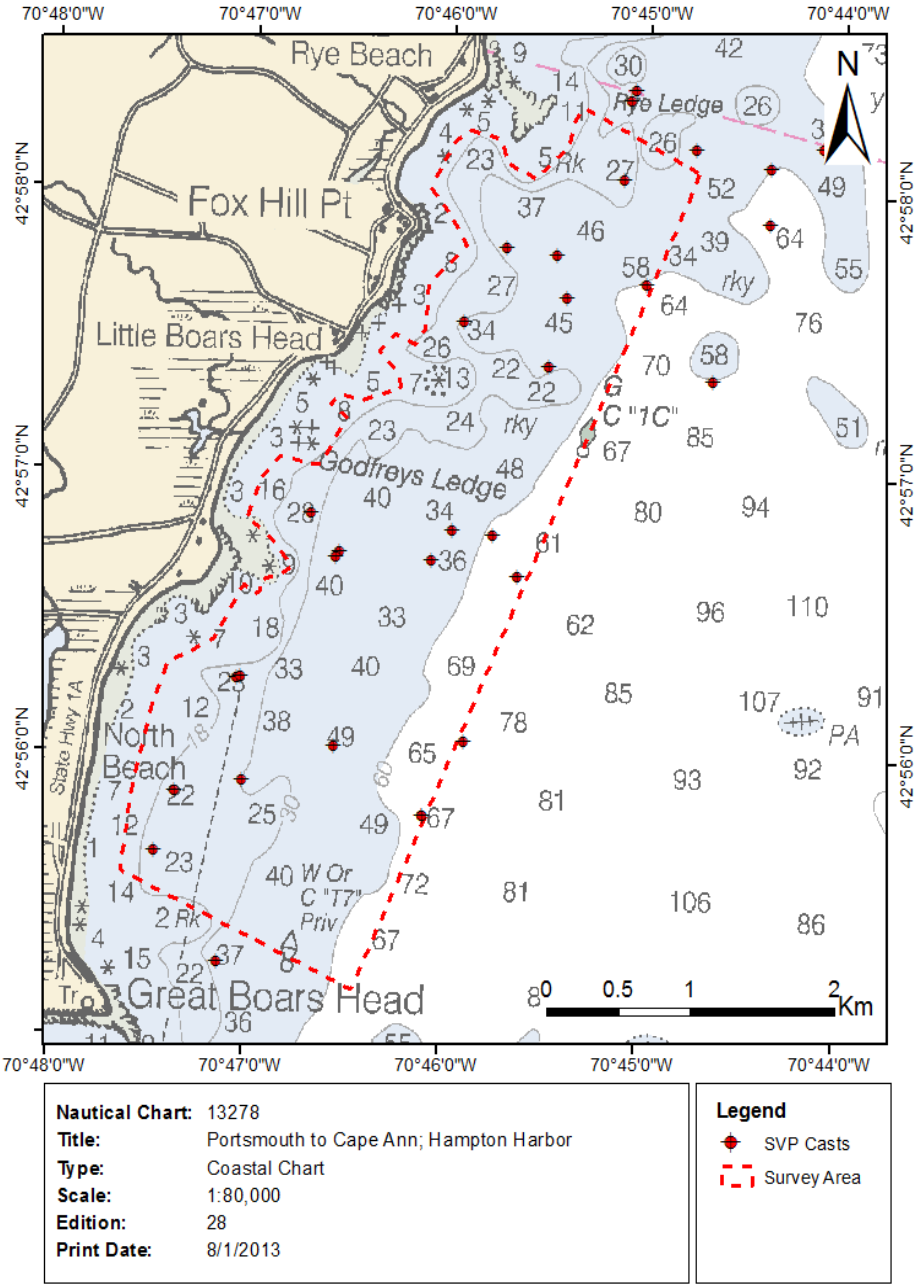


Figure 15. Locations of SSP acquired using an ODOM Digibar.

Figure 16 depicts survey lines colored according to the applied SSP. Some of the last sound speed casts collected at the end of the day were not entered into the Kongsberg SIS and were collected to use for sound speed corrections in post-processing.

For the inshore region many apparent refraction artifacts remained after applying sound speed profiles, be it during data acquisition or in post processing. These errors are due to the highly

locally dependent warming of the water as a result of the incident solar energy at the end of the day. Although this effect is systematic the magnitude of the depth uncertainty associated to it was deemed not too warrant the necessity of acquiring more bathymetric data and sound speed profiles.

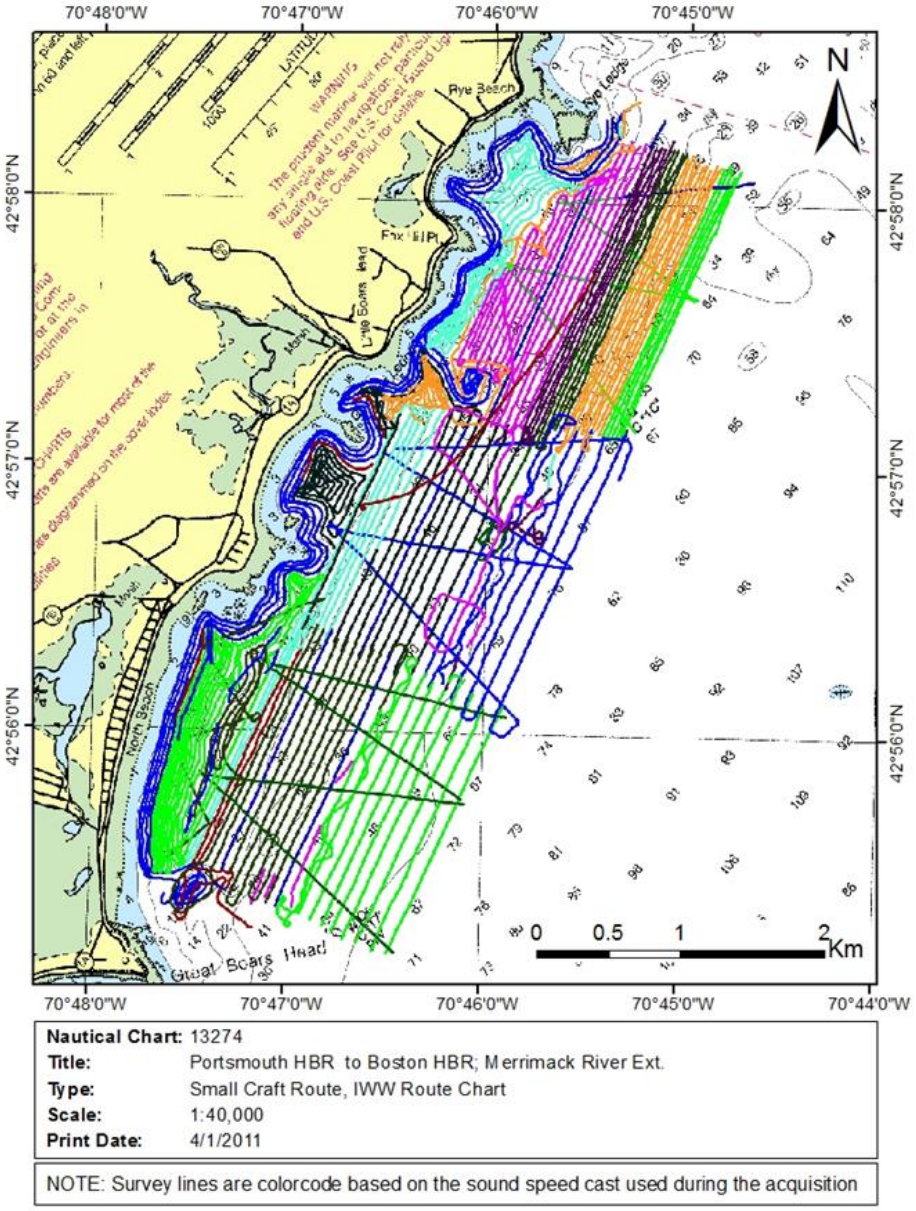


Figure** 16**. Survey lines colored by sound speed cast applied.

B.2.8 Coverage Equipment and Methods

A density analysis was run to calculate the number of soundings per surface node (table 12). Both final surfaces met the 2015 NOS Hydrographic Specifications and Deliverables requirement of a density of at least 95.0% of the nodes having five or more soundings. For the 0.5m surface, 98.12% of the nodes retained five or more soundings and for the 1.0m surface, 99.60% of the nodes met this same requirement. Note that this survey contained numerous small coverage holidays and are from acoustic shadowing from the rocky terrain.

Figure 17. Overview of the density analysis surface. Green => 5 sounding per cell, Red < 5 sounding per cell.

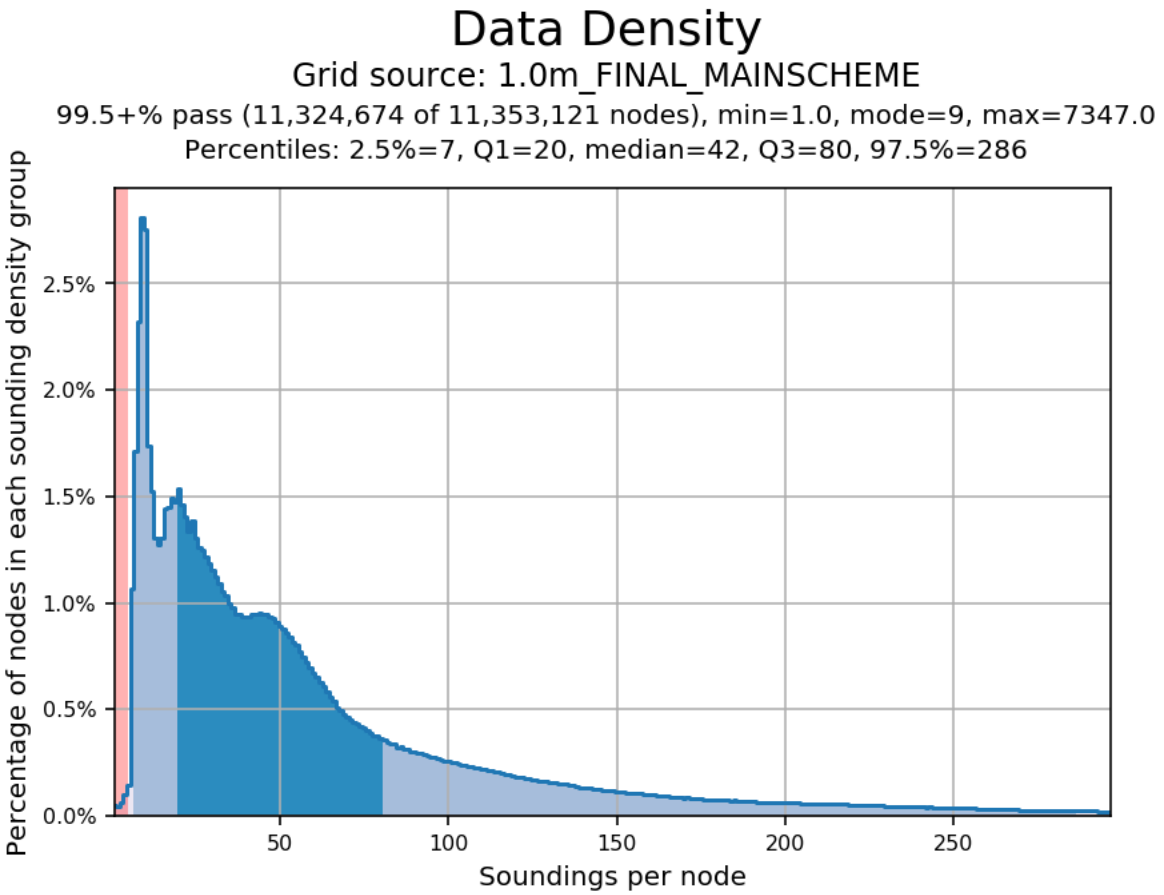


Figure 18: QC Tools data density, percentage of nodes in each density group 1m surface plot

Table 10. Summary of the results from the density analysis.

Resolution (m)	Depth Range (m)	Number of Nodes	Number of nodes with five soundings or more per node	Percentage of nodes with five or more soundings per node
0.5	0-10	16,562,295	16,250,919	98.12%
1.0	8-30	8,505,913	8,472,695	99.60%

In terms of holidays, a total of 49 locations were found that met NOAA specifications for holidays.

Table 11. List of holiday locations

ID	Longitude	Latitude
1	-70.774	42.97517
2	-70.763	42.96979
3	-70.7648	42.96967
4	-70.7615	42.96902
5	-70.7592	42.96882
6	-70.7599	42.96801
7	-70.7674	42.96707
8	-70.7685	42.96709
9	-70.767	42.96487
10	-70.7653	42.96319
11	-70.7676	42.96206
12	-70.7702	42.95953
13	-70.7704	42.95932
14	-70.7705	42.959
15	-70.7698	42.95899
16	-70.7702	42.95895
17	-70.7699	42.95887
18	-70.7714	42.95841
19	-70.7725	42.95795
20	-70.7688	42.95696
21	-70.7724	42.9555
22	-70.768	42.95549
23	-70.7685	42.95515
24	-70.7761	42.95424

ID	Longitude	Latitude
25	-70.7725	42.95409
26	-70.7672	42.95383
27	-70.7788	42.95368
28	-70.7738	42.95336
29	-70.7713	42.95332
30	-70.7695	42.95333
31	-70.7724	42.95335
32	-70.7762	42.95322
33	-70.7761	42.95312
34	-70.7694	42.95313
35	-70.7816	42.9483
36	-70.7633	42.94485
37	-70.7808	42.94393
38	-70.7694	42.94412
39	-70.783	42.94332
40	-70.7828	42.94328
41	-70.7917	42.9382
42	-70.7654	42.93269
43	-70.7909	42.92993
44	-70.7949	42.92526
45	-70.7926	42.92465
46	-70.7946	42.92417
47	-70.7925	42.92414
48	-70.7877	42.92292
49	-70.7886	42.92272

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

All vessel offsets and angular mounting biases were entered into the multibeam echo sounder software (SIS) in order to apply real-time correction to the soundings.

B.3.2 Calibrations

Prior to the acquisition, a total of 3 patch tests were carried out onboard the RV Coastal Surveyor, one per group, to ensure that each student in the class got experience performing a patch tests. The acquired data was processed in CARIS HIPS calibration editor and QPS Qimera calibration editor to estimate and verified calibration values (Table 14).

Table 12. Calibrations not discussed in the DAPR.

Calibration Type	Date	Reason	Location
Patch Test 1	2015-06-08	SIS calibration	Green 5 Buoy in Portsmouth Harbor
Patch Test 2	2015-06-09	SIS calibration	Green 5 Buoy in Portsmouth Harbor
Patch Test 3	2015-06-10	SIS calibration	43º 2.23" N 70º 39.78" W

The first two patch tests were conducted on the Green 5 Buoy in Portsmouth Harbor on June 8th and 9th. The third patch test was conducted at the original planned site on June 10th, over a feature located at 43º 2.23" N and 70º 39.78" W. Hydra team members participated in two of these patch tests, one at the Green buoy and at the original location.

Results from the patch test conducted on June 08 were consistent after processing the data with both software, Caris HIPS and QPS Qimera. The yaw value obtained from June 09 was incongruent with the other two patch tests because the acquired lines did not have sufficient overlap to estimate the yaw offset. The calibration values introduced into SIS configuration correspond to the values obtained from the Patch Test carried out on the 8th of June. Results are presented in table 15.

Table 13. Patch Test Values for all three exercises

Test	Patch Test 1: June 8	Patch Test 2: June 9	Patch Test 3: June 10
Latency (Timing)	0.00	0.00	0.00
Pitch	1.83	1.75	0.6
Roll	0.81	0.82	0.01
Yaw	-1.20	-0.58	-0.2

** Patch test values from June 8 were entered into SIS before the survey on June 10.*

B.3.2.1. Patch Test 1: June 8

A patch test was performed on June 08, 2015 onboard the RV Coastal Surveyor over a feature located at 43°04' 29.445'' N and 70°42'45.27'' W, northwest of the UNH pier in New Castle. The lines for time bias correction were run first. The first line was run at 5 knots and the second line, was run at the same position and direction but at 10 knots. The pitch and roll lines were run next at a speed of 5 knots. The lines for the yaw bias correction were run last, at the same speed of 5 knots, parallel to each other in the outermost sides of the target. The calibration was carried out in Caris, HIPS 9.0. The estimated values were entered into the Kongsberg

acquisition software (SIS) allowing real-time data correction. The values introduced into SIS configuration are presented in the following table.

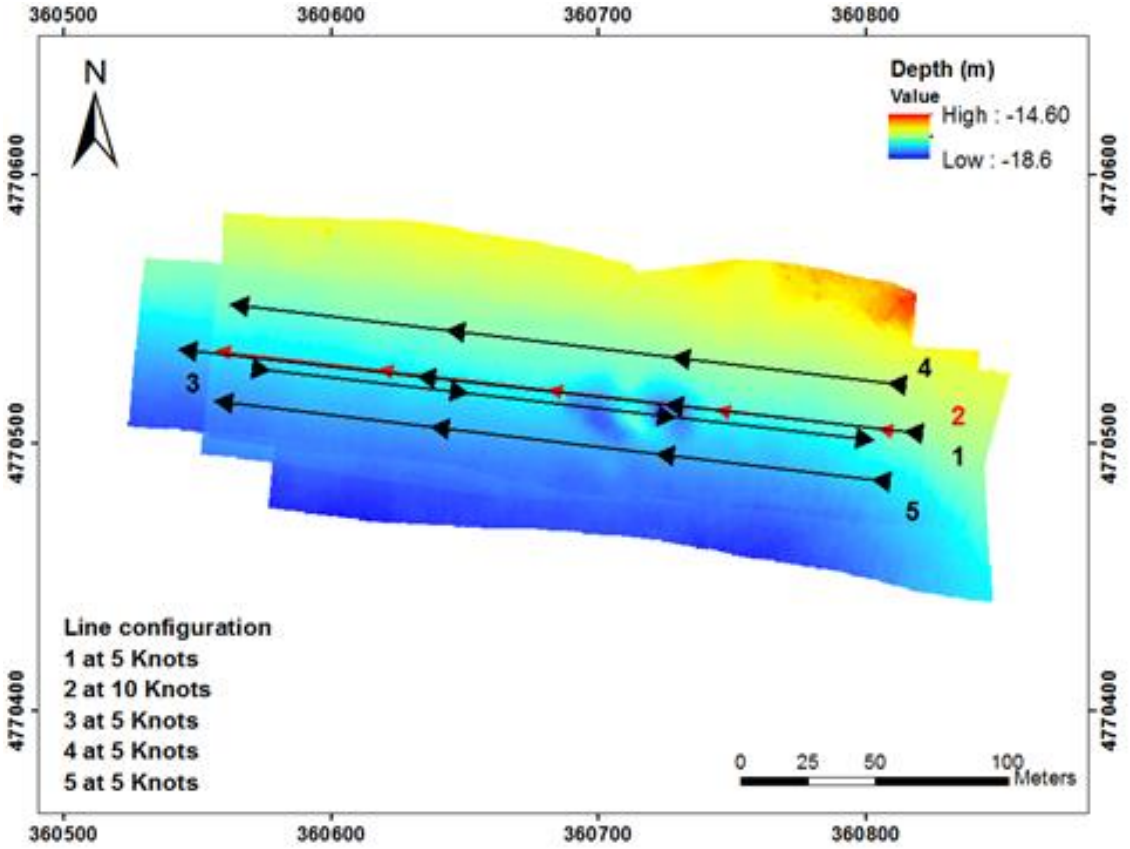


Figure 19. Overview of the Patch Test area conducted on June 8th, line configuration and bathymetry data. Coordinate System, WGS 1984 UTM zone 19N. The selected target is the buoy block of G"5".

B.3.3 Waterline

Waterline (static draft) values were taken before survey lines were acquired each day and entered into the SIS acquisition computer for real-time application. Both groups worked together to ensure that the waterline measurements were taken in relatively the same location each day, for the morning and afternoon readings. All waterline measurements were taken at the entrance to Portsmouth Harbor. It is important to note that the water masses between Portsmouth Harbor and the survey area off of Rye/North Hampton are different and this introduced a level of uncertainty to our results, but taking a waterline measurement in the survey area would introduce even more uncertainty given variable sea states.

This results in a few centimeter differences between days. Table 16 lists the waterline values; only the morning values were applied in SIS. Figure 17 lists an example of the offset seen between days. The average morning waterline was 0.523 m and the average afternoon waterline measurement was 0.509 m, respectively. The average of all waterline measurements was 0.518 and the average difference between morning and afternoon measurements was 0.0149 m.

Table 14. Lists the waterline values taken during the survey.

Date (2015)	Julian Day (DN)	Group	Waterline(m)		
			Morning	Afternoon	Average
June 08	159	Vega	0.509	0.555	0.532
June 09	160	Hydra/Vega	0.461	0.461	0.461
June 10	161	Hydra	0.507	0.488	0.4975
June 11	162	Vega	0.535	0.490	0.5125
June 12	163	Hydra	0.498	0.524	0.511
June 15	166	Vega	0.533	0.497	0.515
June 16	167	Hydra	0.525	0.519	0.522
June 17	168	Vega	0.579	0.504	0.5415
June 18	169	Hydra	0.550	0.510	0.53
June 19	170	Vega	0.513	0.505	0.509
June 23	174	Vega	0.531	0.500	0.5155
June 24	175	Hydra/Vega	0.545	0.554	0.5495
June 25	176	Hydra/Vega	0.55	0.535	0.5425

**Note on June 22nd, the RVCS did not collect data, therefore no waterline measurements were taken

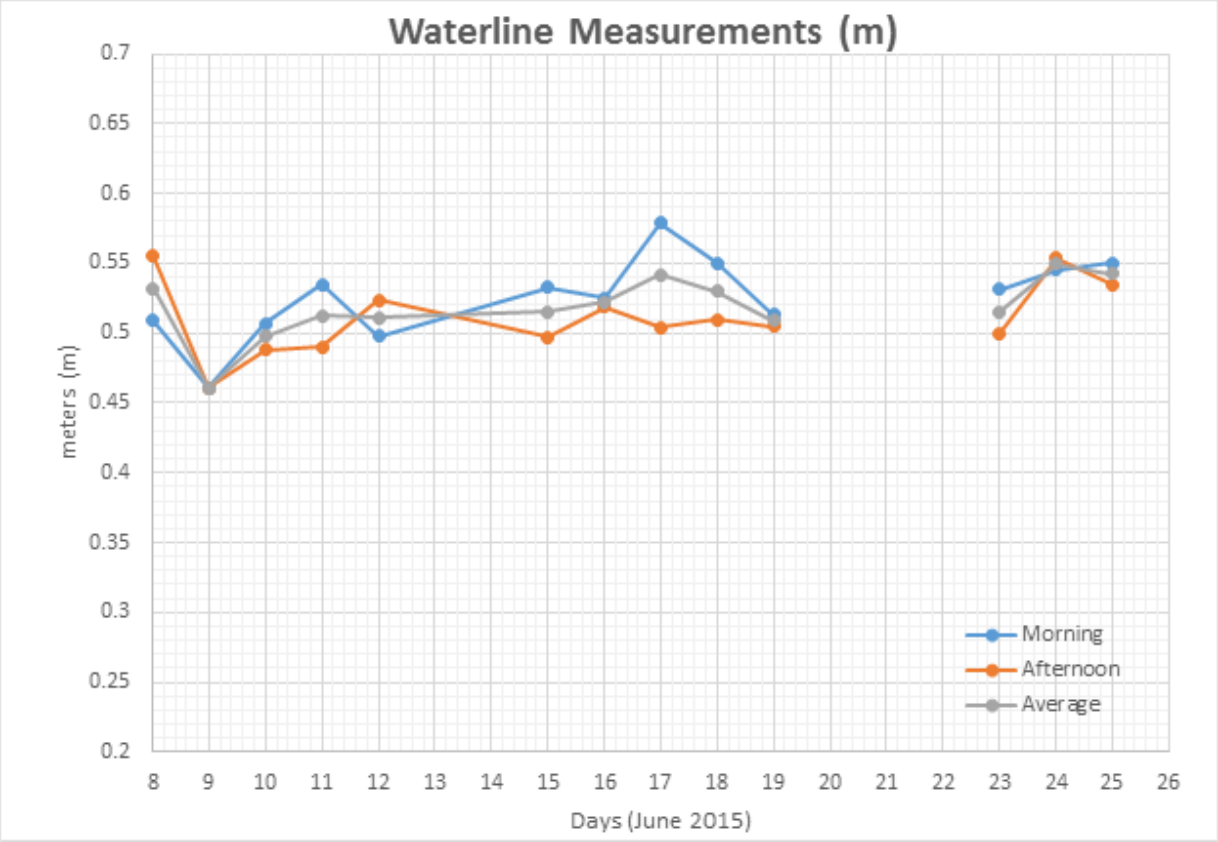


Figure 20. Plot of the waterline values taken during the survey.

B.4 Backscatter

From the raw .all files, including main scheme and some turns, a 0.75 m backscatter mosaic was generated using FMGT.

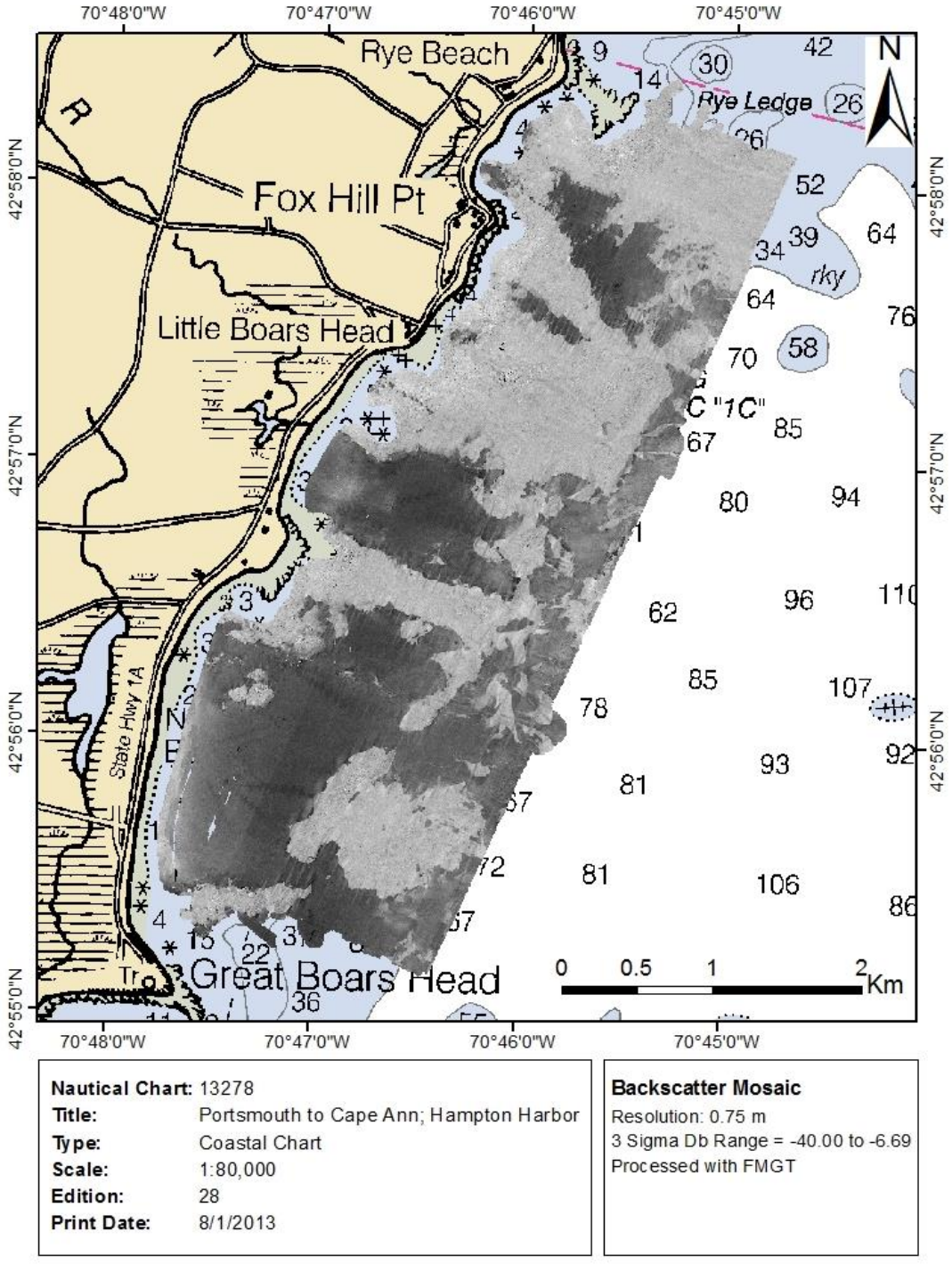


Figure 21. Backscatter mosaic at 0.75m resolution. Coordinate System, WGS 1984 UTM zone 19N.

B.5 Data Processing

B.5.1. Software Updates

There were no software configuration changes after the DAPR was submitted.

B.5.2. Surfaces

Table 17 shows a list of the surfaces and/or BAGs submitted to the Processing Branch.

Table 15. Submitted Surfaces

Surface Name	Surface Type	Resolution (m)	CUBE Parameter	File Extension	Purpose
MB_0.5m_MLLW_Final	CUBE	0.5	NOAA_0.5 m	.csar	Complete MBES
MB_1m_MLLW_Final	CUBE	1.0	NOAA_1 m	.csar	Complete MBES
MB_1m_MLLW_Combined	CUBE	1.0	NOAA_1 m	.CSAR	Complete MBES
SH2015_1m_MLLW_Combined	CUBE	1.0	Combined surfaces (NOAA 1m & 0.5m)	.bag	Complete MBES
SH2015_Backscatter_0_5m_FINAL	Backscatter	0.5	N/A	.tiff	Mosaic

The guidance put forth in the 2014 HSSD for complete coverage is 1m for 0-20m and 2m for 18-40m. Because of the nature of the rocky seafloor and to reduce the number of designated soundings, a 50cm resolution surface was created for depths 0-10m and a 1m-resolution surface was created for depths 8-22m. These selected resolutions exceed the recommended complete coverage resolutions. The combined 1m surface was created with a rule file with the attribute depth least.

C. Vertical and Horizontal Control

Additional information discussing the vertical or horizontal control for this survey can be found in the accompanying HVCR.

C.1 Vertical Control

- The vertical datum for this project is Mean Lower Low Water.
- Standard Vertical Control Methods Used:
- Discrete Zoning

The following National Water Level Observation Network (NWLON) stations served as datum control for this survey:

Table 16. NWLON Tide Stations

Station Name	Station ID
Fort Point	8423898

Table 17. Water Level Files (.tid)

File Name	Status
8423898.tid	Observed

The entire survey area fell within one tide zone, NA169, provided by CO-OPS, NOS. This zone is based off the primary station of Fort Point, NH with no subordinate gauge. The time correction is -6mins and the range ratio is 1x. The tide file applied to the data is the observed data from Fort Point, NH with the -6 minute time correction applied.

C.2 Horizontal Control

- The horizontal datum for this project is WGS84.
- The projection used for this project is UTM zone 19N.

For precise positioning, two GNSS base stations were established in the survey area for broadcasting RTK corrections to the R/V Coastal Surveyor via Trimble Trimmark 3 radio Modems in CMR+ format. One base station was located on the roof of the Seacoast Science Center at Odiorne State Park, New Hampshire. This base station was used for one of the patch tests and some of the transit lines. The second base station was established at the Rye Harbor State Park to provide RTK corrections for the whole survey area. The reference point used was an orange stake hammered in the grass. The coordinates of the reference point (Lat 43º 00' 5.73129" N, Long 70º 44' 38.77763" W and Elevation Height of -22.887 m) were derived from 6 hours of observations on June 8, 2014 processed by the Online Positioning User Service (OPUS, http://www.ngs.noaa.gov/OPUS/).

D. Results and Recommendations

D.1 Chart Comparison.

D.1.1 Raster Charts

The following are the largest scale raster charts, which cover the survey area:

Table 18. Largest Scale Raster Charts

Chart	Title	Scale	Edition	Edition Date	LNM Date	NM Date
13274	Portsmouth Harbor to Boston Harbor; Merrimack River Extension	1:40,000	28	4/1/2011	LNM 17/15	5/28/2015
13278	Portsmouth to Cape Ann; Hampton Harbor Coastal Chart	1:80,000	28	8/1/2013	LNM 47/14	5/28/2015
13260	Bay of Fundy to Cape Cod	1:378,838	41	8/1/2012	LNM 23/15	5/14/2015
13009	Gulf of Maine and Georges Bank	1;500,000	36	5/1/2014	LNM 18/15	5/14/2015

13006	West Quoddy Head to New York	1:675,000	36	7/1/2012	LNM 23/15	5/14/2015
13003	Cape Sable to Cape Hatteras	1:1,200,000	51	9/1/2012	LNM 23/15	5/14/2015

A comparison between prior soundings and the SH2015 bathymetric surface was carried out by creating a Triangular Irregular Networks (TIN) of up-to-date charted soundings and separately from the full data collected in the prior 1950s surveys. Figures 19 and 20 show the difference between the surfaces derived from prior soundings and SH2015. In both cases, the newer survey resulted in shallower depths in some locations. The charted sounding comparison in Figure 19 shows the charted data to generally be shoal biased as would be expected; however a few rocky red (survey shallower) areas stick out in the northern section.

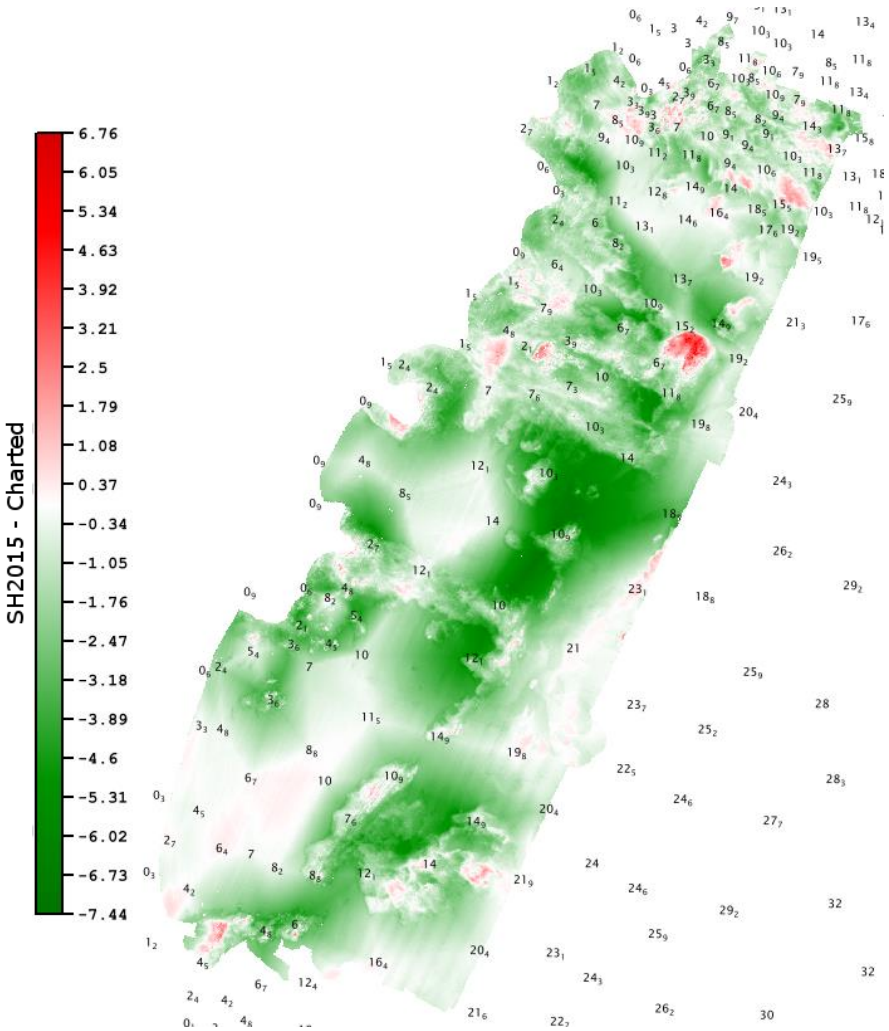


Figure 22. Depth differences between charted soundings and SH2015 data set.

The comparison to full 1950s surveys in Figure 20 shows closer agreement and a more varied pattern of differences. The most notable shoal from the charted soundings comparison, on the east side about 1/3 of the way from the northern end of the survey is not as prominent,

indicating that this may have been a cartographic decision or error in not placing an additional sounding on this portion of the rocky shoal. The most notable feature in Figure 20 is that the sandy area in the southern portion of the survey appears to have gotten shallower since the 1950s.

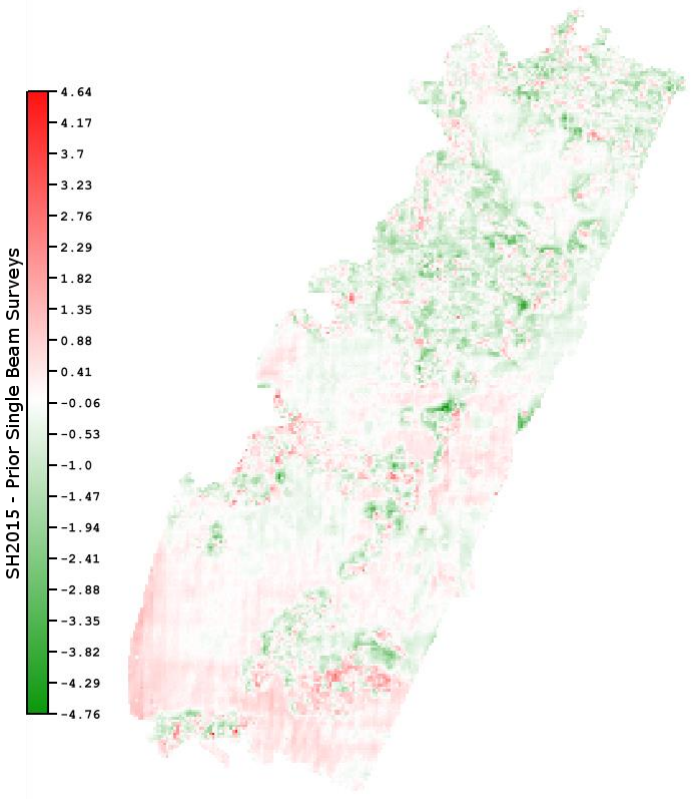


Figure 23. Depth differences between the surface derived from the 1950s surveys and SH2015 data set.

D.1.2 Electronic Navigational Charts.

The following are the largest scale ENCs, which cover the survey area.

Table 19. Available ENC in the area of interest.

ENC	Title	RNC	Scale	Edition	Update Application Date	Preliminary?
US5MA01M	Newburyport Harbor and Plum Island Sound	13282	1;20,000	7.2	2/2/2015	No
US5NH02M	Portsmouth Harbor Cape Neddick Harbor to Isles of Shoals;Portsmouth Harbor	13283	1:20,000	19.7	4/1/2015	No
US5MA19M	Merrimack River Extension	13274	1;40,000	4.6	11/25/2014	No
US4MA04M	Portsmouth to	13278	1:80,000	23.10	5/27/2015	No

	Cape Ann					
US3EC10M	Bay of Fundy to Cape Cod	13260	1;378,838	36.8	5/18/2015	No
US2EC04M	West Quoddy Head to New York	13006	1:675,000	18.9	06/23/2015	No

D.1.3 AWOIS Items.

No AWOIS items were assigned for this survey.

D.1.4 Charted Features

No charted features exist for this survey..

D.1.5 Uncharted Features

There are no uncharted features for this survey.

D.1.6 Dangers to Navigation

Danger to Navigation Reports are included in Appendix II of this report.

D.1.7 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey.

D.1.8 Channels

No channels exist for this survey. There are no designated anchorages, precautionary areas, safety fairways, traffic separation schemes, pilot boarding areas, or channel and range lines within the survey limits.

D.1.9 Bottom Samples

Nine stations for sample and video collection were selected prior to field work, based on the backscatter mosaic and ship-time availability (fig. 21). The acquisition was carried out onboard the Galen J. The samples were collected using a Stainless Steel Grab, with 9" Steel-Plated Arms (WILDCO Standard Ponar). The sampler was lowered manually by the starboard side of the ship and recovered using a small drive pulley. Very little or no sample was recovered in most of the stations due to technical issues, probably related to the size and mechanism of the sampler and in some cases, due the rocky nature of the seafloor (fig.22). The underwater video captures were done with Ocean Systems Delta Vision HD Underwater Video Camera. The integrated system consisted on a camera mounted in a frame with 10-12 LED light bulbs, connected to a PC interface and power supply. Technical issues with the camera system and the lack of sediment samples did not allow conducting a proper seafloor characterization however, by comparing screen captures from the videos and the backscatter surface (fig. 24) a general description could be done.

In general, there was a very good correlation between the sediment characteristics observed in the videos and the backscatter data. The survey area is composed of alternated patches of hard substrate cover with shelf fragments (stations 0702-02, 0702_06, 0702_14), and soft substrate ranging from very fine sediment, mud (station 0702_05) to sand with ripples (stations 0702-08, 0702_13,).

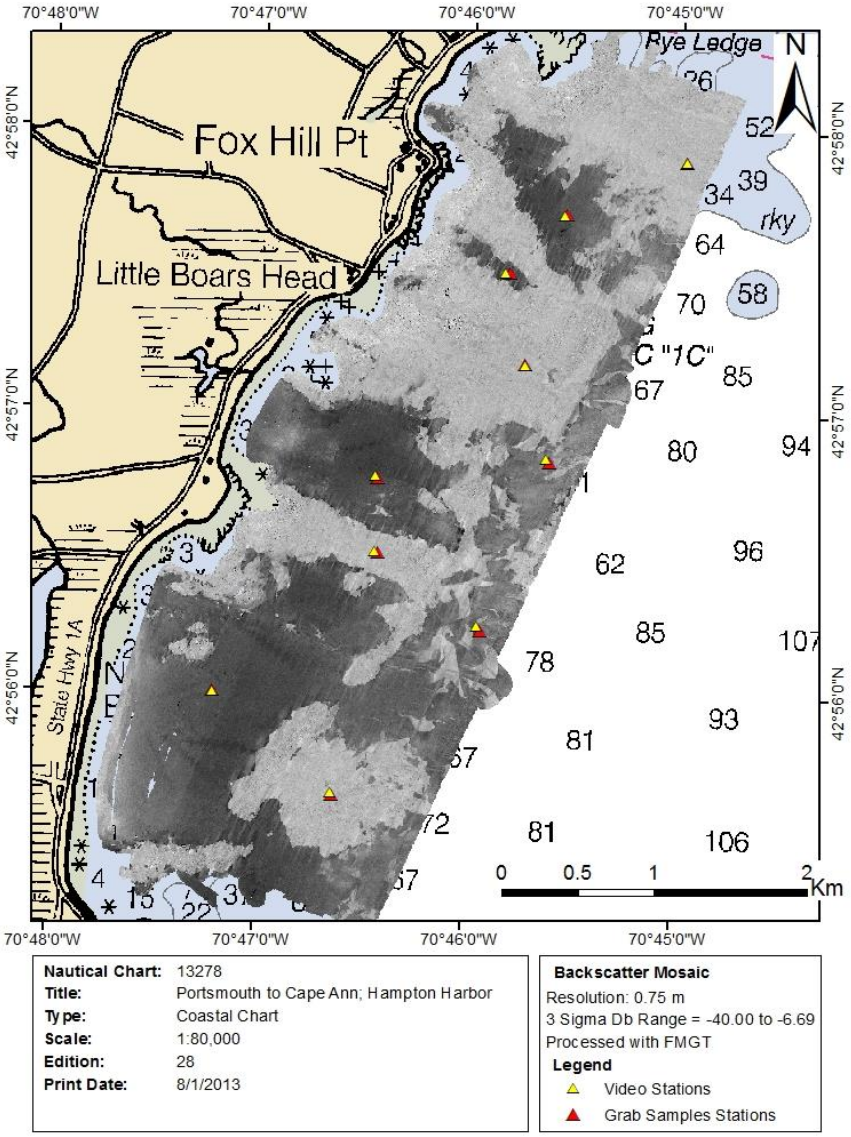


Figure 24. Locations of the station for sample and video collection. Coordinate System, WGS 1984 UTM zone 19N

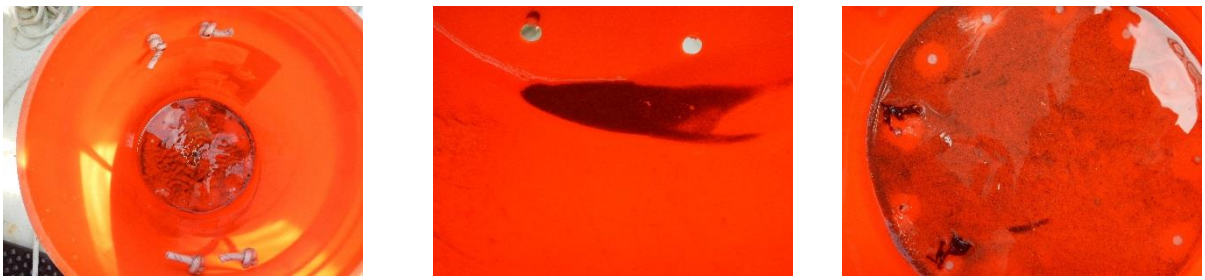


Figure 25. Sediment samples collected in some of the stations.

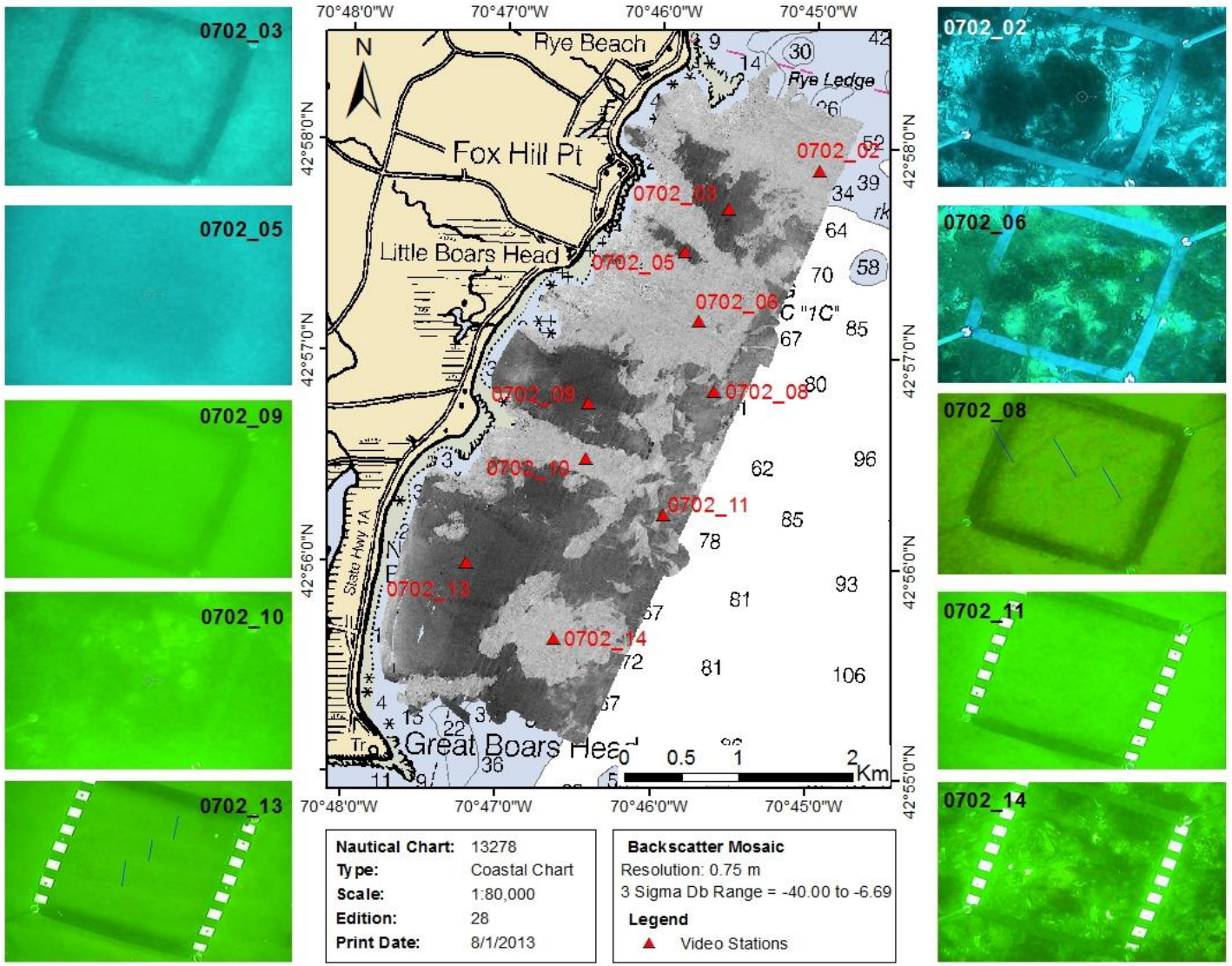


Figure 26. Locations of the station for sample and video collection. Coordinate System, WGS 1984 UTM zone 19N

D.2 Additional Results

D.2.1 Shoreline

No shoreline data was collected.

D.2.2 Prior Surveys

Prior survey comparisons were discussed in the junction analysis section of this DR.

D.2.3 Aids to Navigation

Aids to navigation (ATONs) exist for this survey, but were not investigated.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

No submarine features exist for this survey.

D.2.6 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.7 Platforms

No platforms exist for this survey.

D.2.8 Significant Features

No significant features exist for this survey.

D.2.9 Construction and Dredging

No present or planned construction or dredging exist within the survey limits.
D.2.10

D.2.10 New Survey Recommendations

Additional data between the 2005 FUGRO LIDAR data and this survey was not collected due to time constraints and is recommended to be surveyed.

D.2.11 New Inset Recommendations

No new insets are recommended for this area.

E. Approval Sheet

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

All field sheets, this Descriptive Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch.

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys and Specifications Deliverables Manual, Field Procedures Manual, Letter Instructions,

and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

F. Table of Acronyms

Acronym Definition
AHB Atlantic Hydrographic Branch
AST Assistant Survey Technician
ATON Aid to Navigation
AWOIS Automated Wreck and Obstruction Information System
BAG Bathymetric Attributed Grid
BASE Bathymetry Associated with Statistical Error
CO Commanding Officer
CO-OPS Center for Operational Products and Services
CORS Continually Operating Reference Staiton
CTD Conductivity Temperature Depth
CEF Chart Evaluation File
CSF Composite Source File
CST Chief Survey Technician
CUBE Combined Uncertainty and Bathymetry Estimator
DAPR Data Acquisition and Processing Report
DGPS Differential Global Positioning System
DP Detached Position
DR Descriptive Report
DTON Danger to Navigation
ENC Electronic Navigational Chart
ERS Ellipsoidal Referenced Survey
ERZT Ellipsoidally Referenced Zoned Tides
FFF Final Feature File
FOO Field Operations Officer
FPM Field Procedures Manual
GAMS GPS Azimuth Measurement Subsystem
GC Geographic Cell
GPS Global Positioning System
HIPS Hydrographic Information Processing System
HSD Hydrographic Surveys Division
HSSD Hydrographic Survey Specifications and Deliverables
HSTP Hydrographic Systems Technology Programs
HSX Hypack Hysweep File Format
HTD Hydrographic Surveys Technical Directive
HVCR Horizontal and Vertical Control Report
HVF HIPS Vessel File
IHO International Hydrographic Organization

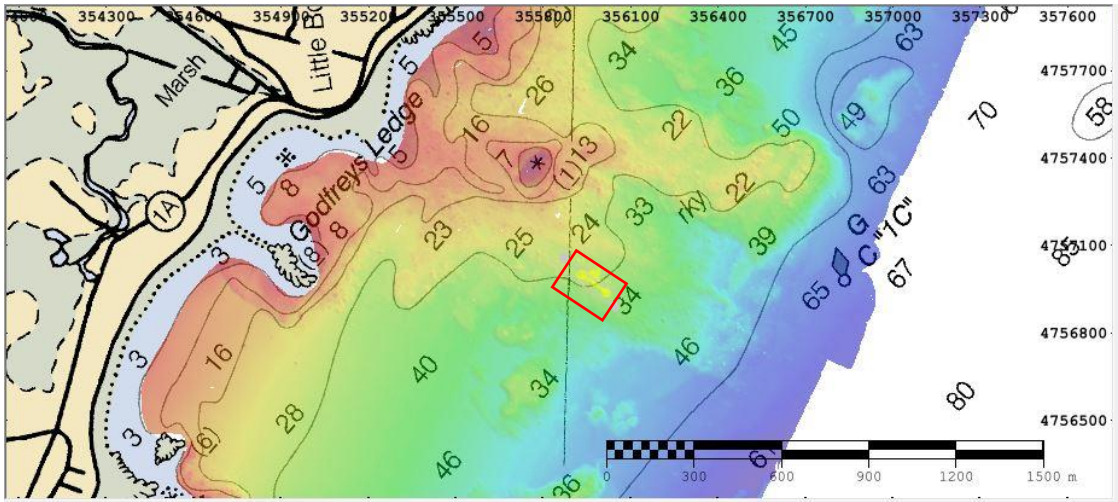
IMU Inertial Motion Unit
ITRF International Terrestrial Reference Frame
LNM Local Notice to Mariners
LNM Linear Nautical Miles
MCD Marine Chart Division
MHW Mean High Water
MLLW Mean Lower Low Water
NAD 83 North American Datum of 1983
NAIP National Agriculture and Imagery Program
NALL Navigable Area Limit Line
NM Notice to Mariners
NMEA National Marine Electronics Association
NOAA National Oceanic and Atmospheric Administration
NOS National Ocean Service
NRT Navigation Response Team
NSD Navigation Services Division
OCS Office of Coast Survey
OMAO Office of Marine and Aviation Operations (NOAA)
OPS Operations Branch
MBES Multibeam Echosounder
NWLON National Water Level Observation Network
PDBS Phase Differencing Bathymetric Sonar
PHB Pacific Hydrographic Branch
POS/MV Position and Orientation System for Marine Vessels
PPK Post Processed Kinematic
PPP Precise Point Positioning
PPS Pulse per second
PRF Project Reference File
PS Physical Scientist
PST Physical Science Technician
RNC Raster Navigational Chart
RTK Real Time Kinematic
SBES Singlebeam Echosounder
SBET Smooth Best Estimate and Trajectory
SNM Square Nautical Miles
SSS Side Scan Sonar
ST Survey Technician
SVP Sound Velocity Profiler
TCARI Tidal Constituent And Residual Interpolation
TPU Total Porpagated Error
TPU Topside Processing Unit
USACE United States Army Corps of Engineers
USCG United Stated Coast Guard
UTM Universal Transverse Mercator

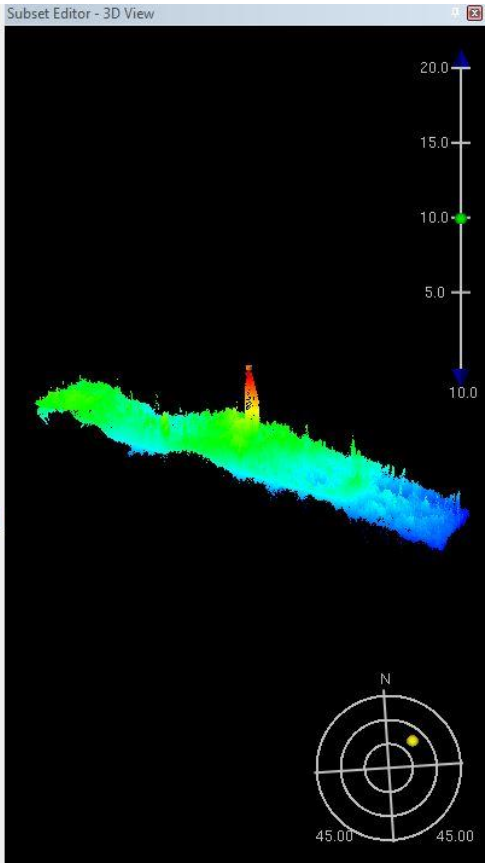
XO Executive Officer
ZDA Global Positiong System timing message
ZDF Zone Definition File

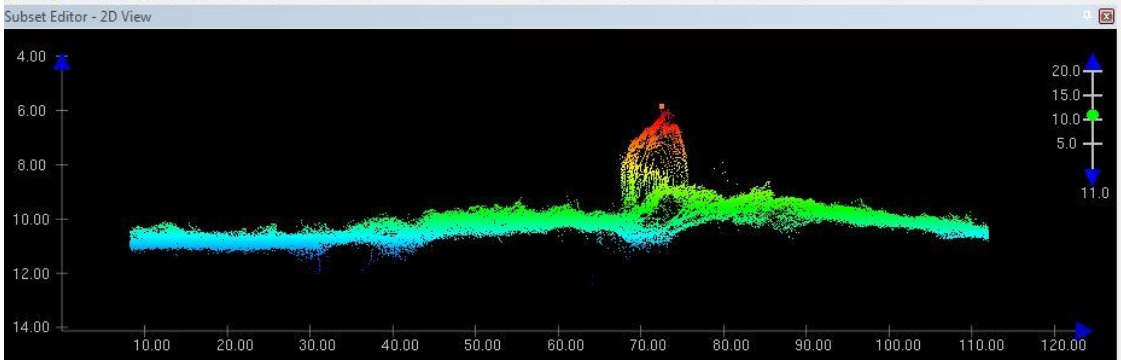
Appendix II: Dangers to Navigation

DTON #1

Latitude	42° 57' 06.38''
Longitude	70° 45' 56.60''
Depth (m)	5.7
Charted Depth (m)	~ 9
Survey Day	2015-166
Line	0167_20150615_155120
Nautical Chart	13274 - Portsmouth Harbor to Boston Harbor; Merrimack River Extension

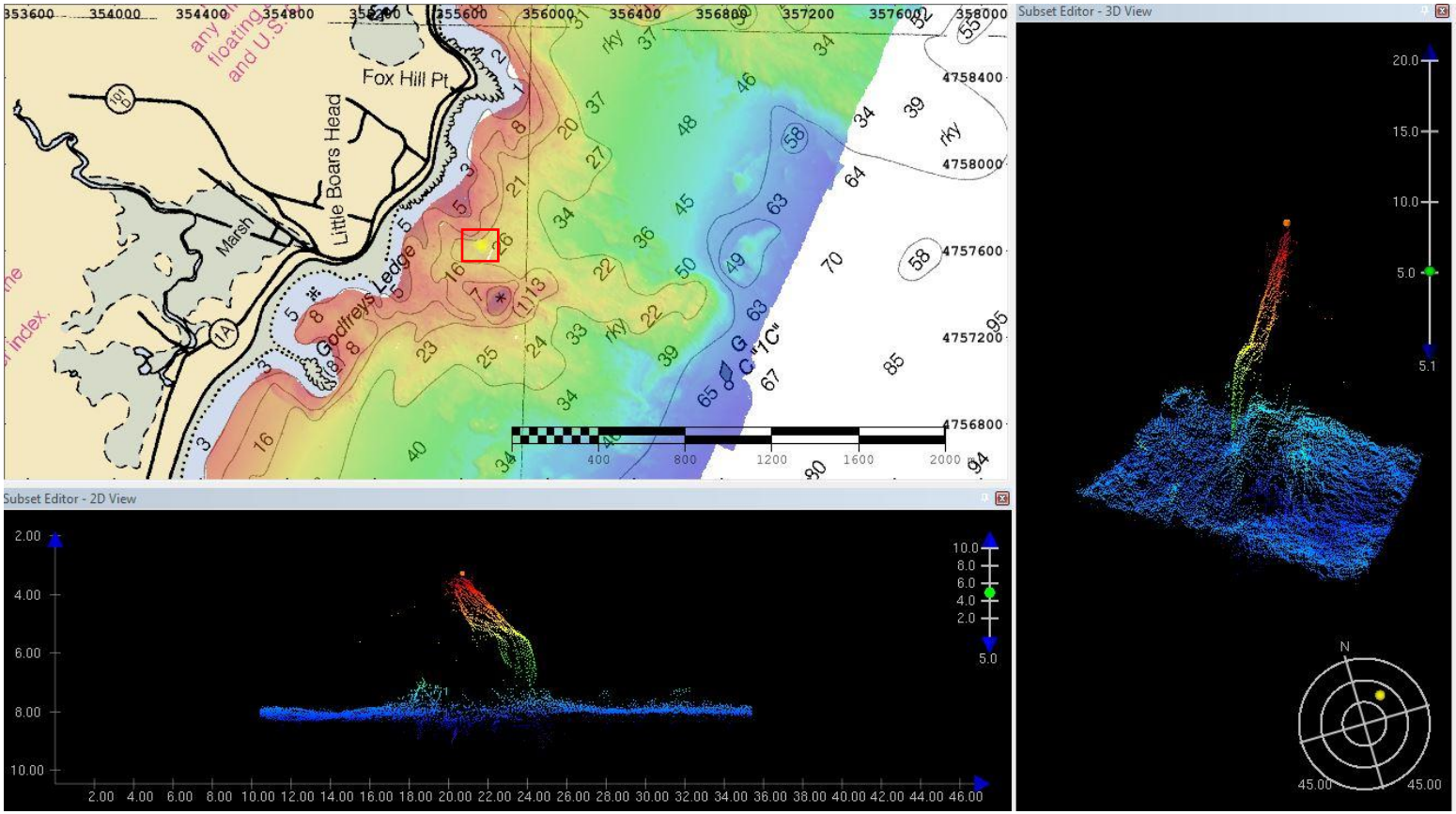






DTON #2

Latitude	42° 57' 27.03''
Longitude	70° 46' 09.32''
Depth (m)	3.2
Charted Depth	~ 6
Survey Day	2015-169
Line	0370_20150618_191046
Nautical Chart	13274 - Portsmouth Harbor to Boston Harbor; Merrimack River Extension



APPROVAL PAGE

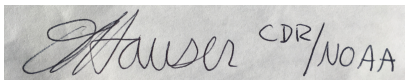
W00503

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
- 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.



HAUSER.OLIVIA.A.1275636009
2020.08.03 16:34:18 -07'00'

Approved:_____

Commander Olivia Hauser, NOAA
Chief, Pacific Hydrographic Branch