W00318

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

DESCRIPTIVE REPORT

Type of Survey:	External Source Data
Registry Number:	W00318

LOCALITY

State(s):	Massachusetts
General Locality:	Buzzards Bay
Sub-locality:	Vicinity of Cuttyhunk Harbor

2010

US Geological Survey (USGS)

LIBRARY & ARCHIVES

Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00318

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):	**Massachusetts**
General Locality:	**Buzzards Bay**
Sub-Locality:	**Vicinity of Cuttyhunk Harbor**
Scale:	**10,000**
Dates of Survey:	**09/10/2010 to 09/16/2010**
Project Number:	**W00318**
Data Source:	**US Geological Survey**
Chief of Party:	**US Geological Survey**
Soundings by:	**SEA SwathPlus-M interferometric sonar**
Imagery by:	**Klein 3000 Side Scan Sonar**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**Meters at Mean Lower Low Water**

Remarks:

The purpose of this survey is to provide contemporary data to update National Oceanic and Atmospheric Administration (NOAA) nautical charts. 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 surveyed features 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, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

DR Summary

Descriptive Report Summary to Accompany W00318	
Project	OSD-USGS-16
Survey	W00318
State	Massachusetts
Locality	Buzzards Bay
Scale of Survey	1:10,000
Sonars Used	SEA SwathPlus-M Klein 3000
Horizontal Datum	World Geodetic System of 1984 (WGS 84)
Vertical Datum	Mean Lower Low Water (MLLW)
Vertical Datum Correction	TCARI Tide Model
Projection	WGS84 - UTM Zone 19N
Field Unit	US Geologic Survey
Survey Dates	September 10-16, 2010
Chief of Party	US Geological Survey
Vessel	R/V Rafael

A. Area Surveyed

W00318 was surveyed by the United States Geological Survey (USGS) with a SEA SwathPlus-M interferometric sonar (234 kHz) onboard a 25 foot R/V Rafael. The survey area was covered over the course of one week (09/10 through 09/16) in 2010. The data were not collected in accordance with NOS Hydrographic Surveys Specifications and Deliverables, the Field Procedures Manual requirements, or IHO requirements but were post-processed by the Joint Hydrographic Center (JHC) IOCM Team in 2016 to meet the standards to the highest degree possible.

The survey is within the following limits:

NE Corner	41-27-40.10 N	70-50-56.27 W
SE Corner	41-23-16.99 N	70-50-56.28 W
SW Corner	41-23-16.95 N	70-59-36.18 W
NW Corner	41-27-40.10N	70-59-36.18 W

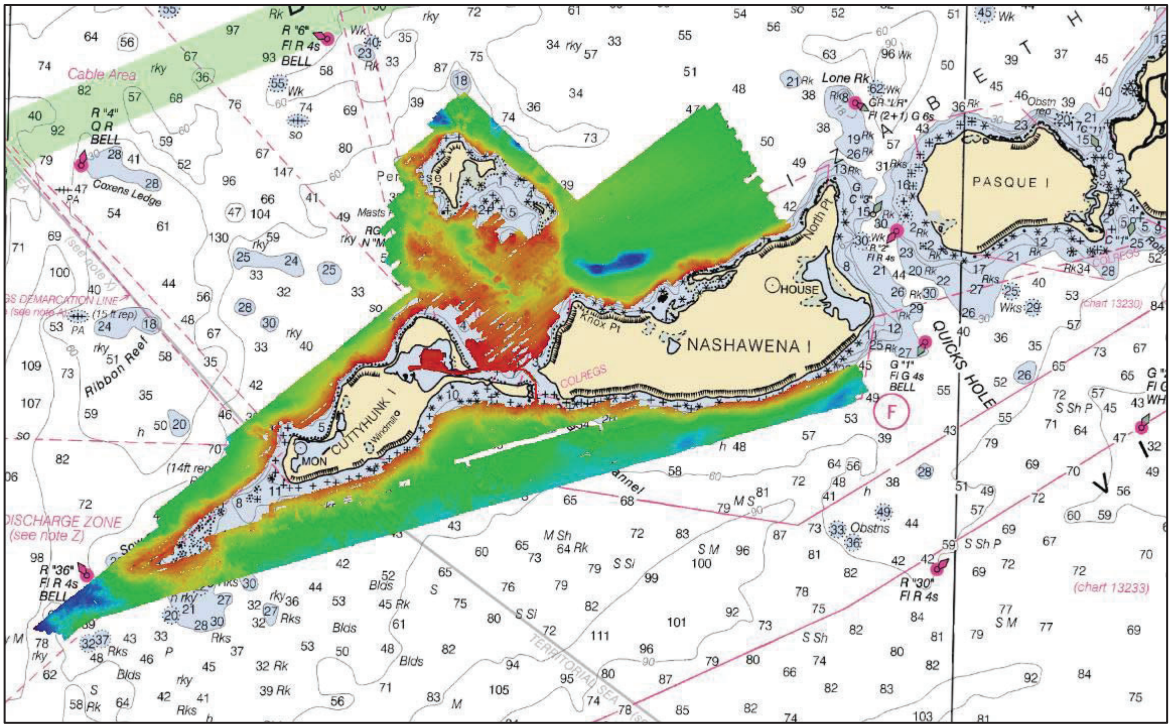

Figure 1: Shows USGS 1m W00318 grid over top NOAA chart 13218.

B. Survey Purpose

Data were acquired by the United States Geologic Survey (USGS) in collaboration with the Massachusetts Office of Coastal Zone Management (MCZM) to collect geophysical data in order to determine the geological processes that formed the Elizabeth Islands. This survey was part of a multi-year study (2009-2013) to map the inner shelf of southern Massachusetts waters and focused primarily on data such as seismics, grab samples, and side scan sonar (Pendleton et al).

Refer to the USGS Open-File Report 2011-1184 written by Pendleton et al. submitted with this data for more information on survey purpose and acquisition.

C. Intended Use of Survey

The southern half of W00318 (south of Cuttyhunk Island) is not recommended to supersede currently charted data (see F.1 for more information). However, the northern half of these data are recommended to supersede currently charted soundings and will be discussed in this document. The northern half of these bathymetric data (henceforth referred to as W00318) is suitable for chart compilation with additional coverage needed over shoals and sidescan identified targets.

D. Data Acquisition and Processing

D.1 USGS Acquisition and Processing

Survey data were collected by the USGS/MCZM in 2010 with a pole-mounted SEA SwathPlus first-generation interferometric sonar for bathymetry and a towed 100 and 500 kHz Klein 3000 sidescan sonar. These data were RTK navigated, referenced to Mean Lower Low Water (MLLW), and used an average offset of 2.9m for tidal corrections obtained from HYPACK scripts and DGPS calculations. Sound speed was collected continuously with an AML Oceanographic Micro SV velocimeter at the sonar head. Bathymetric data were collected and initially processed with the SEA SWATHPlus acquisition software and subsequently processed in CARIS 7.0 by the USGS. Sound speed profiles were obtained periodically using an AM SV plus V2 hand-deployed velocimeter and were applied during USGS post-processing (Figure 5).

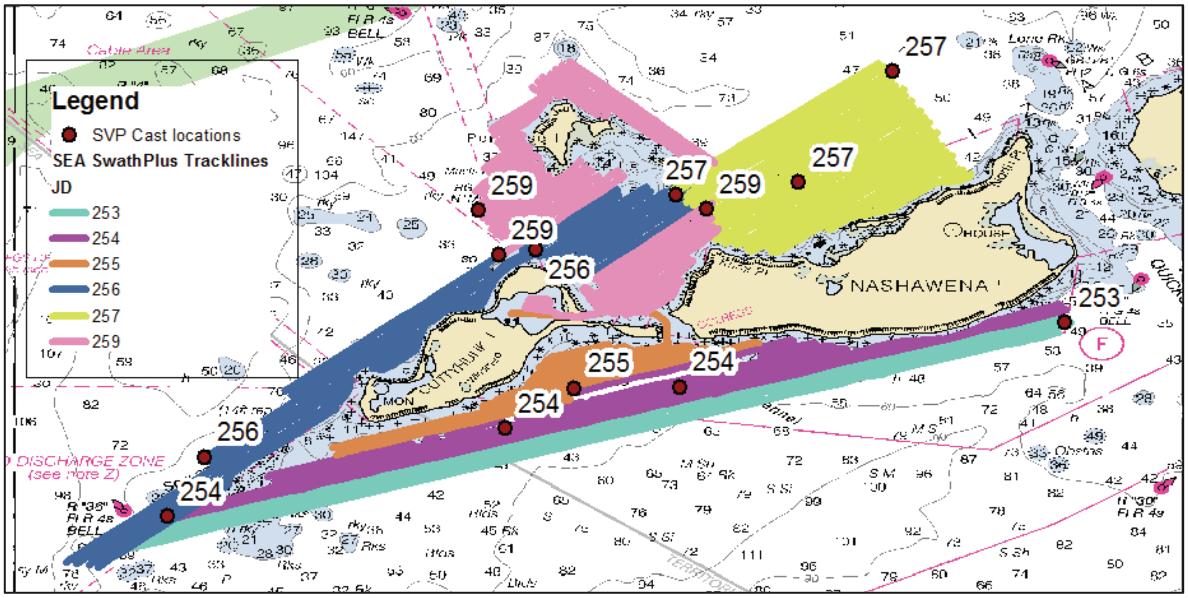

Figure 2: The USGS tracklines color coded by Julian Day for W00318 and red dots indicate the location of their applied SVP casts.

Bathymetric filters were applied by the USGS during acquisition to reduce the amount of data and filter out erroneous data. Bathy filters included a low amplitude (100%), range (1-m below the surface), box (2-m to avoid nadir), alongtrack 1 (depth difference of 10-m, window size 10-m, and learn rate of 0.6), alongtrack 2 (depth difference of 1-m, window size 1-m, and learn rate of 0.9), and a mean filter (0.1-m). These filters were used for the majority of the survey except in very shallow water. Several lines (l91f1-l100f1) were in such shallow waters between Nashawena and Cuttyhunk, so in those areas all filters except the low amplitude and mean filter were turned off to allow more data into the processed file. This procedure resulted in more editing later in CARIS, but it preserved more good data as well (USGS bathy XML file, Pendleton et al).

The data package received by the IOCM center included the raw interferometric files .sxr, a CARIS project using the processed interferometric files .sxp, SVP casts, and detailed daily survey logs with records of ship speed, navigation failures, and sidescan feature identifications. Raw SSS files were received.

Refer to the USGS field Open-File Report 2011-1184 and XML Documentation submitted with these data for more complete information on data acquisition, vessel configuration, processing hardware and software, data quality and offsets.

D.2 IOCM Post Processing

The W00318 supplied CARIS project was post-processed by NOAA IOCM with CARIS HIPS and SIPS 9.0. The provided CARIS HVF (HIPS Vessel File) was altered to have the sonar system be “UNKNOWN” instead of the “SEA SWATHPlus –M” option (Figure 3). This was done at the suggestion of JHC/CCOM Researched Val Schmidt who pointed out the CARIS sonar uncertainty algorithm is not applicable for interferometric systems.

	Date	Time	Time Correctio...	X (m)	Y (m)	Z (m)	Pitch (deg)	Roll (deg)	Yaw (deg)	Manufacturer	Model
1	2009-158	00:00	0.000	0.000	0.000	0.000	0.000	0.000	0.000		Unknown
2		00:00									

Figure 3: The HIPS Vessel File (HVF) of the R/V Rafael after the sonar model was changed to “Unknown” from “SEA SWATHPlus –M” option.

The NOAA TCARI 2016 tidal model for Buzzards Bay was applied to these data using PYDRO to replace the tides applied by the USGS.

E. Uncertainty

E.1 Total Propagated Uncertainty (TPU)

The USGS/MCZM CARIS projects included all imported .SXP files with their associated HIPS Vessel Files (HVF) and offsets already applied. In the CARIS HVFs, the SEA SwathPlus sonar option was selected in the given project. However, this is not the best option. While a SEA SwathPlus interferometric sonar is what was used to collect these data, CARIS does not currently have a correct interferometric algorithm for the Total Propagated Uncertainty (TPU) calculation. By selecting the SEA SwathPlus option, the TPU will be calculated with a multibeam algorithm and will produce incorrect “Uncertainty” values upon surface creation. The solution to this problem is to choose “Unknown” as the sonar in the vessel file, and was done in IOCM post-processing for this project.

NOAA TCARI tides were used to replace the USGS/MCZM tidal model. The TCARI tide errors were applied to each HDCS line file in CARIS. For the TPU calculation, the tidal uncertainty source was set to “Realtime” to accommodate the location of stored tidal error data. One sigma tidal uncertainty estimate of 0.15m from the TCARI tidal error surface generated in PYDRO (Figure 4).

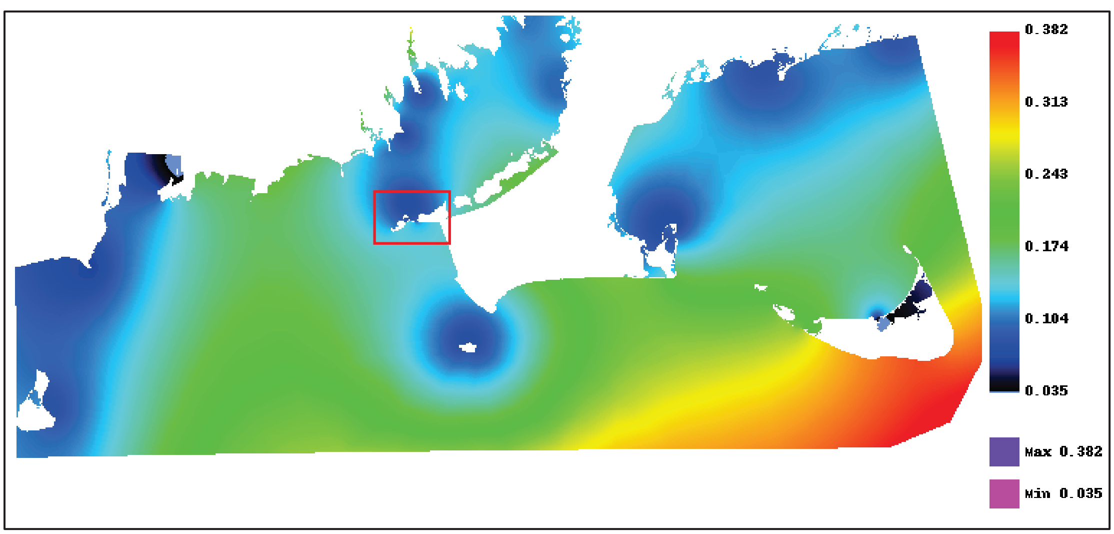

Figure 4: TCARI Tidal Error for W00318 and surrounding area produced in PYDRO. The red box denotes where the survey area is located.

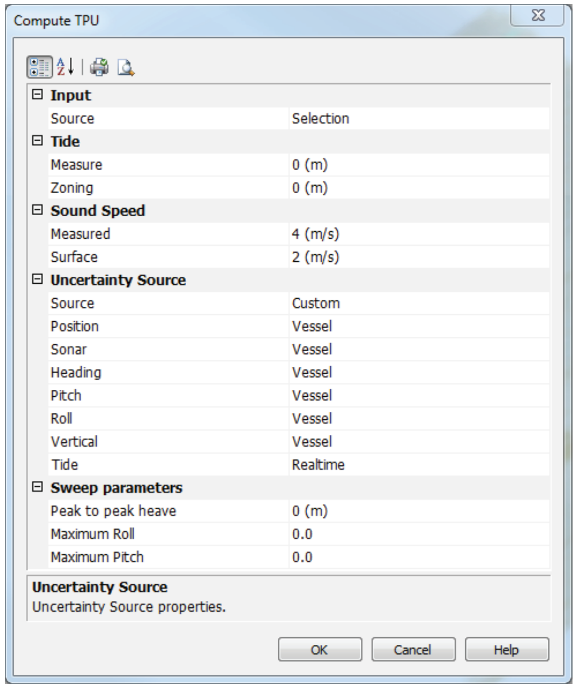

Figure 5: Shows the TPU values used to calculate W00318 CUBE surfaces

E.2 Estimated Uncertainty

As discussed previously, specifying “unknown” as the sonar model in CARIS results in an incomplete computation of the uncertainty layer that is generated upon CUBE surface creation. Instead, the standard deviation layer of each surface was used to empirically estimate the uncertainty of these data. Once biases were identified, a more comprehensive “worst-case scenario” uncertainty calculation was created as a new layer in the CSAR file called the Estimated_Uncertainty.

The standard deviation of measurements in each 1 m grid cell were combined with tide, heave, and draft in a root-mean-square sum (Equation 1). No biases were identified, so no additional components were needed in the calculation.

EQUATION 1:

$$\sigma_{estimated} = \sqrt{{\sigma_{Sonar}}^2 + {\sigma_{Tide}}^2 + {\sigma_{Heave}}^2 + {\sigma_{Draft}}^2}$$

$$\sigma_{Sonar} = Standard\ Deviation$$

$$\sigma_{Tide} = TCARI\ error\ estimate = 0.15$$

$$\sigma_{Heave} = 0.05$$

$$\sigma_{Draft} = 0.05$$

The average depth of W00318 is 10.99m and was used as the depth component to estimate the IHO order 1a 2σ total vertical uncertainty (TVU) requirement. For areas shoaler than 100m, the IHO Order 1a parameters are the following: a = 0.5m and b = 0.013.

IHO Order 1a TVU Requirement:

$$\sqrt{(a)^2 + (b*d)^2} = \sqrt{(0.5)^2 + (0.013*10.99)^2}$$

Using the above equation, the total allowable vertical uncertainty is < 0.52m for W00318. The 2σ average uncertainty calculated for W00318 is **0.3772m** as seen in Figure 6. The USGS/MCZM data meets IHO order 1a depth criteria based on these uncertainty calculations. For more information on why the uncertainty was calculated only for North portion of the bathymetry, see section F.1 of this DR Summary.

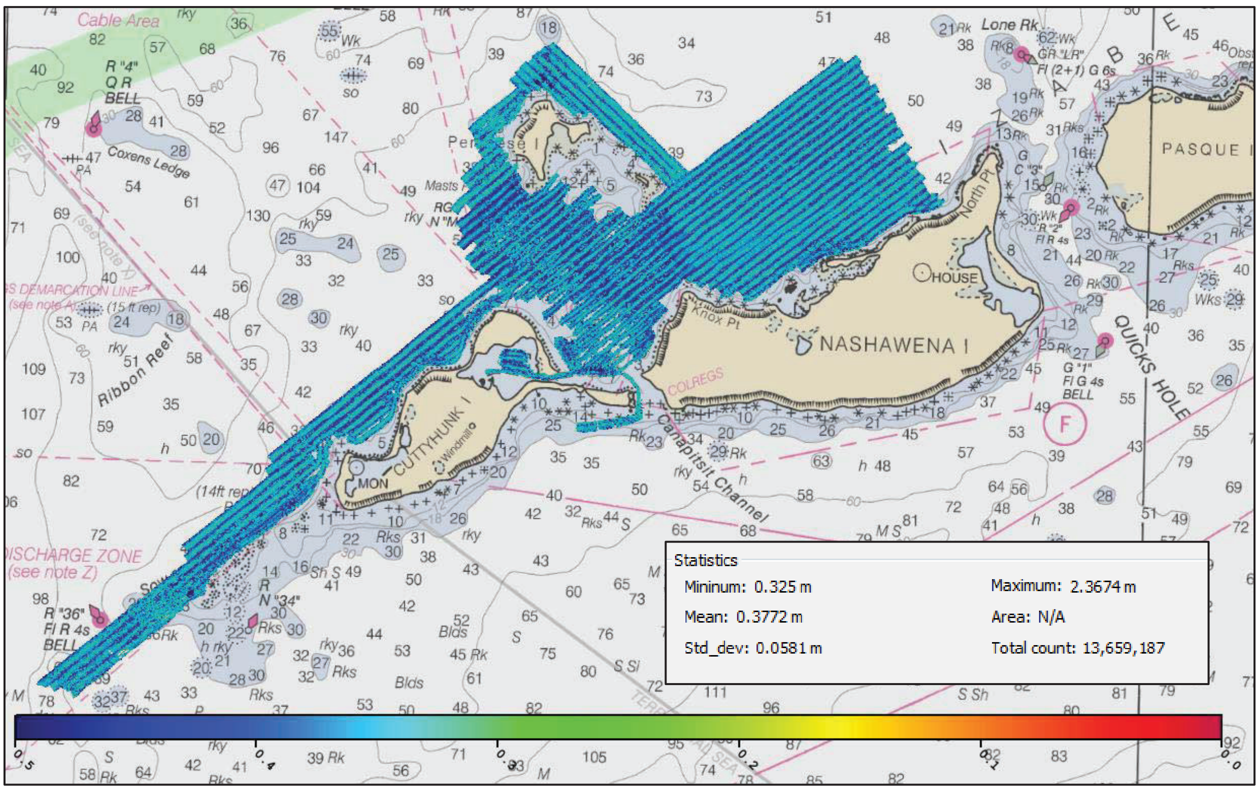

Figure 6: Uncertainty map of W00318 1m CUBE surface with the estimated uncertainty statistics. There is an average uncertainty of 0.37772m.

These uncertainty layers were not put through PYDRO for analysis.

F. Results and Recommendations

The following surfaces were created from the processed data:

Surface Name	Surface Type	Resolution (m)	Depth Range (m)
Cuttyhunk_swath_1m	Swath Angle Surface	1	0-28
Cuttyhunk_swath_2m	Swath Angle Surface	2	0-28
W00318_CUBE_1m	CUBE Surface	1	0-28
W00318_CUBE_2m	CUBE Surface	2	0-28
W00318_1m_CUBE_0to20m	CUBE Surface	1	0-20
W00318_2m_CUBE_18to36m	CUBE Surface	2	18-28

Table 1: List of surfaces and mosaics created for this project.

Table 2 does not include the 1m SSS mosaic created by the USGS which was used for analysis and feature identification. As backscatter was one of the USGS' main priorities during survey operations, recreation of the mosaic was not performed. SSS contact identifications were made from the raw SSS files provided by USGS/MCZM (Sections F.4 and F.5).

F.1 Junction Surveys

NOAA Ship *Thomas Jefferson* (TJ) survey H11921 of 2008 junctions completely with the southern half of these data (Figure 7). As the H11921 survey has already contributed to the chart and is of better overall quality (Figure 8), the southern half of the USGS/MCZM collected bathymetry data will not be submitted for charting and only the northern portion (W00318) will be discussed for charting purposes.

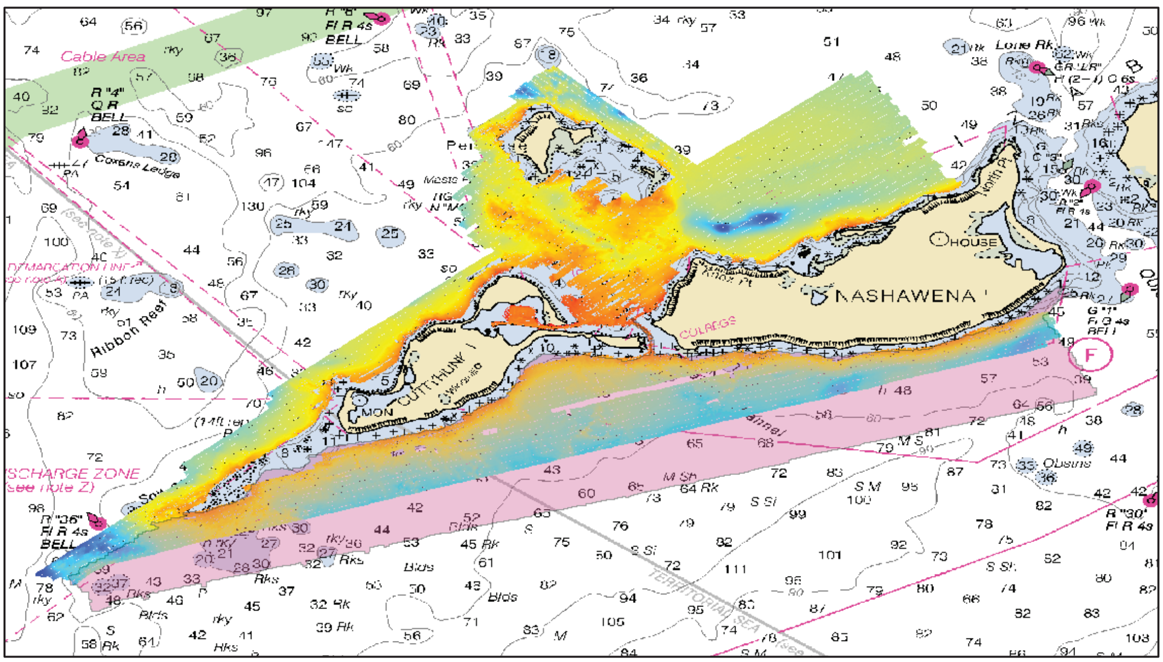

Figure 7: Shows the USGS/MCZM 1m swath angle surface over Chart 13218_1. The pink transparent polygon represents the coverage area of the NOAA Ship *Thomas Jefferson*'s H11921 survey. It is clear that the entire southern half of these Cuttyhunk data were covered by the TJ in 2008.

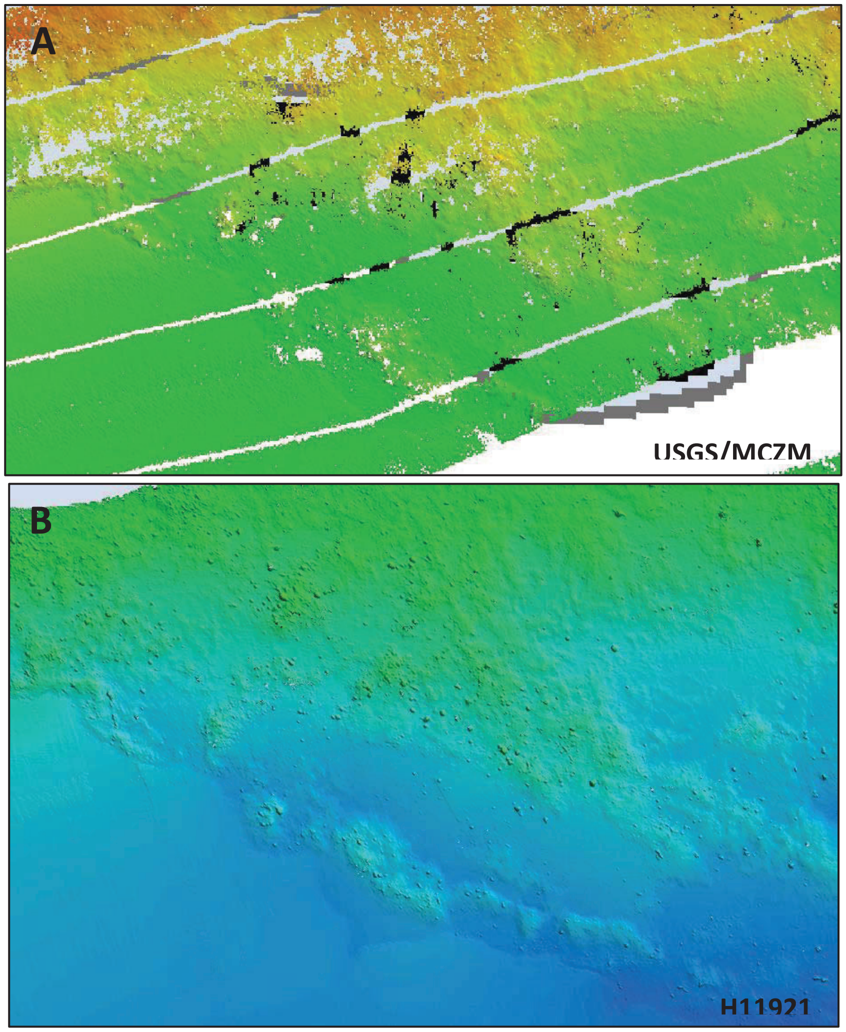

Figure 8: A. A subset of the southern half of Cuttyhunk surface over a particularly rocky area. B. The same area as in A is shown in the H11921 50cm surface. Clear and complete coverage was achieved over all rocks in the H11921 survey, the same cannot be said for the southern half of Cuttyhunk.

However, the temporal difference between these two datasets is significantly smaller (almost negligible) than any newly acquired data would be, so the NOAA survey H11921 was used instead to validate processed depths. NOAA Ship *Thomas Jefferson* (TJ) survey H11921 data was downloaded from NCEI/NGDC data portal. The downloaded 50cm resolution .BAG files were combined in CARIS BDB 4.1 using an “at least” z-value rule and the “override ambiguity check” on.

A comparison of H11921 50cm combined surface with the USGS Cuttyhunk data resulted in a mean offset of **0.229m** - the TJ data being consistently shoaler than the USGS-collected data. This number is consistent with other USGS PMBS data and TJ comparisons with data obtained around the same time. For this survey, most of the significant differences can be attributed to lack of coverage over extremely rocky areas (Figures 9.1 and 9.2) with only a small contribution coming from actual changes in the seafloor. An example of a true change is shown in Figure 9.3.

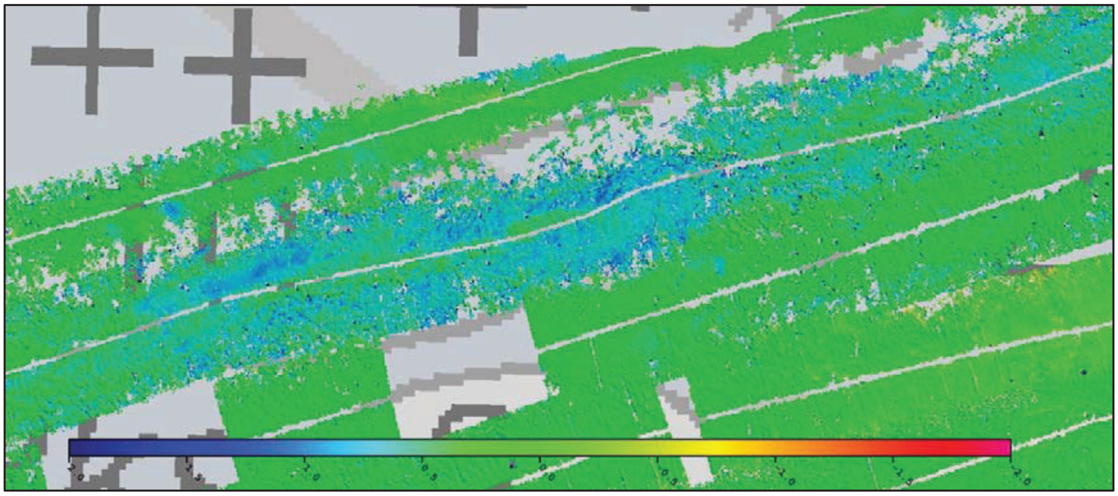

Figure 9.1: Area of significant change on the difference surface between USGS South Cuttyhunk and the NOAA H11921 survey.

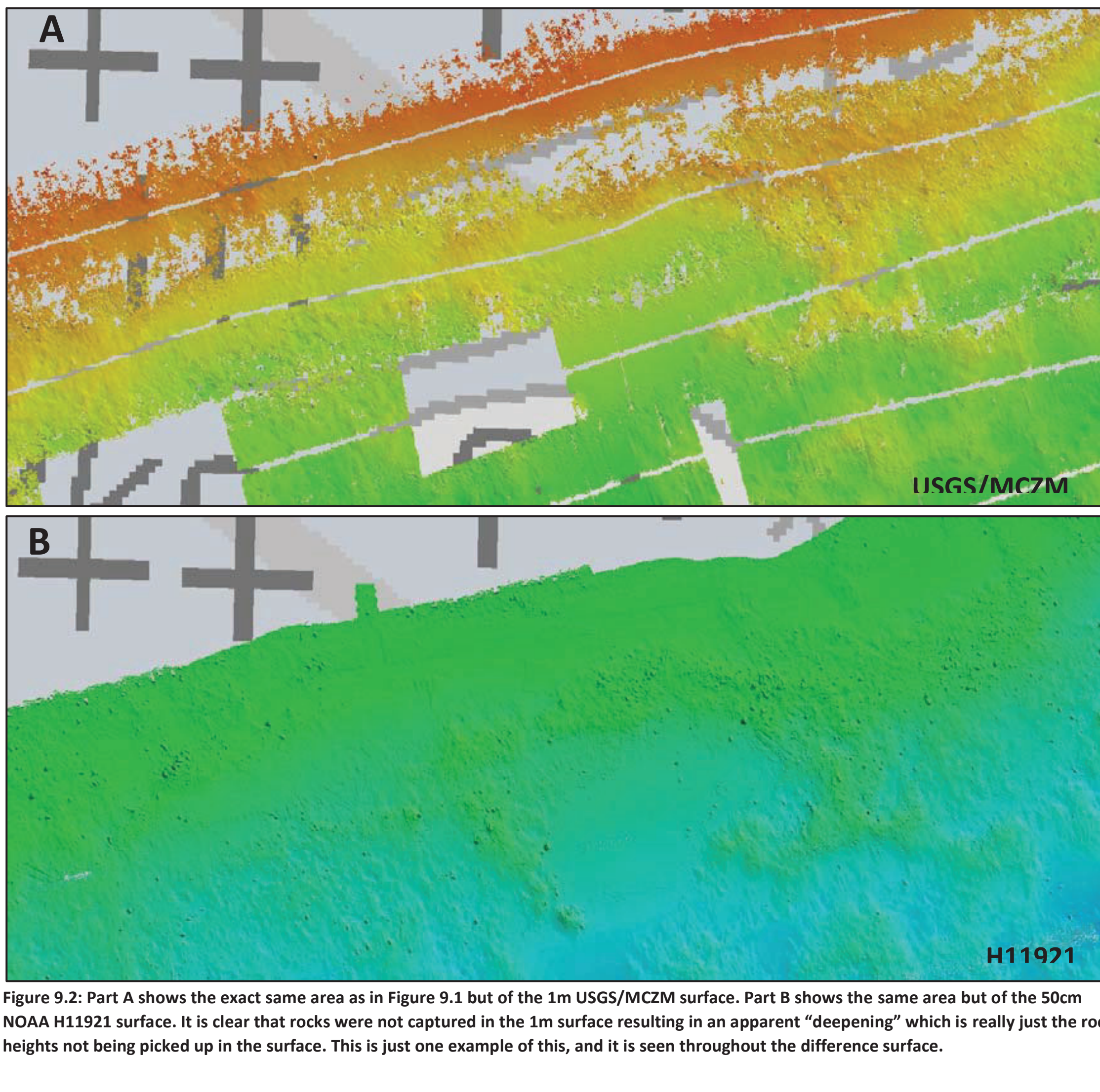

Figure 9.2: Part A shows the exact same area as in Figure 9.1 but of the 1m USGS/MCZM surface. Part B shows the same area but of the 50cm NOAA H11921 surface. It is clear that rocks were not captured in the 1m surface resulting in an apparent "deepening" which is really just the rock heights not being picked up in the surface. This is just one example of this, and it is seen throughout the difference surface.

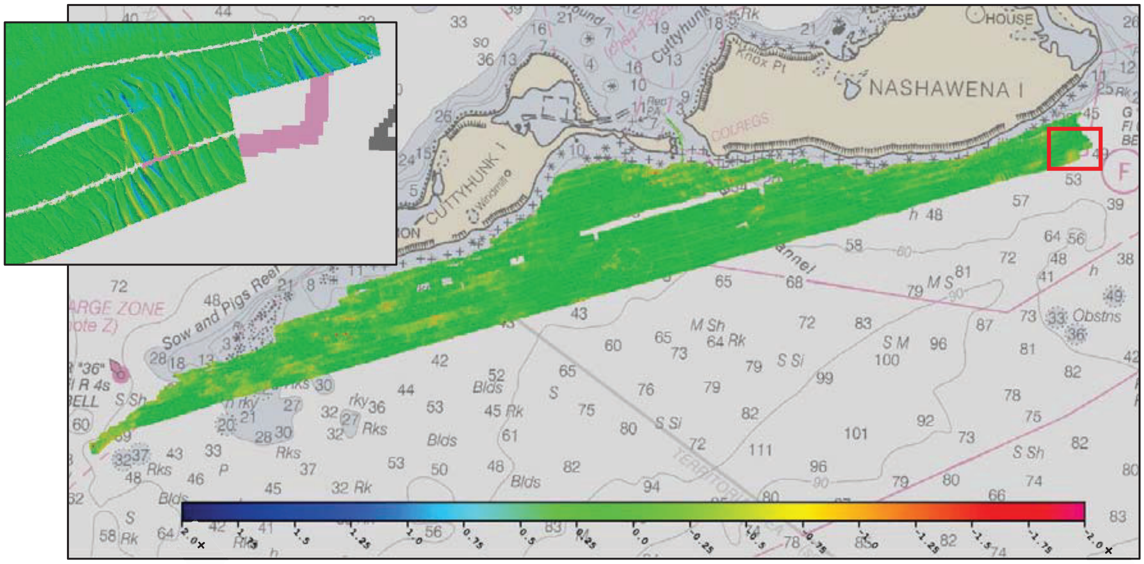

Figure 9.3: The difference surface between the USGS Cuttyhunk 1m swath surface and H11921 50cm combined surface. Most of the differences are attributed to the rocky areas as seen in Figure 7A-B. The most significant differences not related to rocks are those related to changes in sand wave location as seen in the subset to the top right of the red box. Differences in this area are upwards of 3m. *Note: color bar was shortened on either end (denoted with a +) to highlight areas of significant change.

While the South Cuttyhunk bathymetry will not be considered for charting, the sand waves identified (along with any other features) in these data will be included in the feature file submitted for this area (for more information see sections F.4 and F.5 of this DR Summary).

F.2 Chart Comparisons

A soundings layer of the W00318 data was made in order to directly compare with the soundings on the current charts (Table 2). Soundings from W00318 were selected by the depth layer in CARIS BASE Editor 4.0. Shoal biased soundings were selected using a single-defined radius of 10mm at a map scale of 1:10,000.

W00318 was compared with the following RNC and ENC, which cover the survey area:

Chart	Scale	Edition	Edition Date	NM Date
13229	1:12,000	32	6/1/2013	7/28/2016
13229	1:40,000	32	6/1/2013	5/19/2015
13218	1:80,000	42	7/1/2013	6/27/2015
12300	1:400,000	49	6/1/2012	6/13/2015
13200	1:400,000	38	9/1/2012	6/06/2015
13009	1:500,000	36	5/1/2014	6/13/2015
13006	1:675,000	36	7/1/2012	6/13/2015
5161	1:1,058,400	14	3/1/2016	5/30/2015
13003	1:1,200,000	52	10/1/2015	6/13/2015
US5MA25M	1:40,000	20.0	9/24/2014	9/24/2014
US5MA20M	1:40,000	8.11	2/2/2015	7/20/2016
US4MA23M	1:80,000	27.17	11/7/2013	5/4/2015
US3NY01M	1:400,000	32.21	1/24/2013	5/06/2015
US2EC04M	1:675,000	19.0	6/11/2015	6/11/2015

Table 2: List of ENCs and RNCs that include W00318

In comparison to current NOAA RNCs and ENCs, it is clear that W00318 is fairly comparable to the charted soundings – generally within a meter (+/- 1-3 feet) as shown in Figure 10.

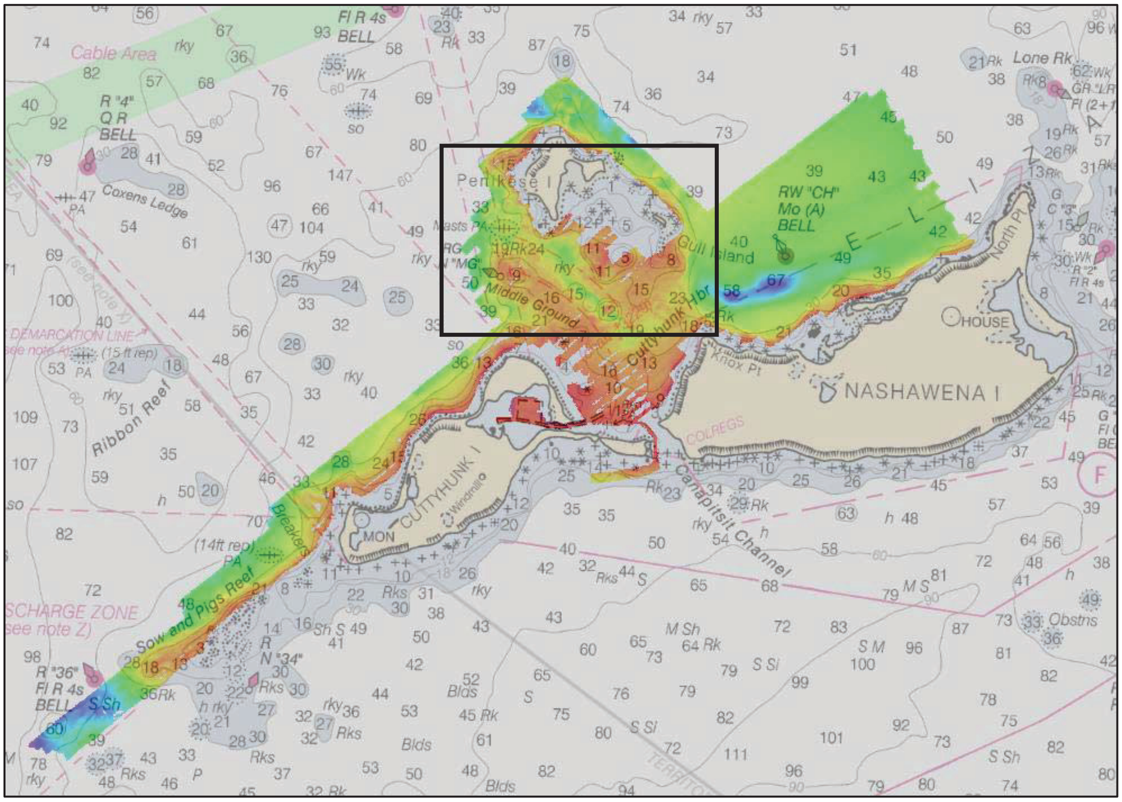

Figure 10: W00318 1m CUBE surface over Chart 13218_1 with a subset outlined in black.

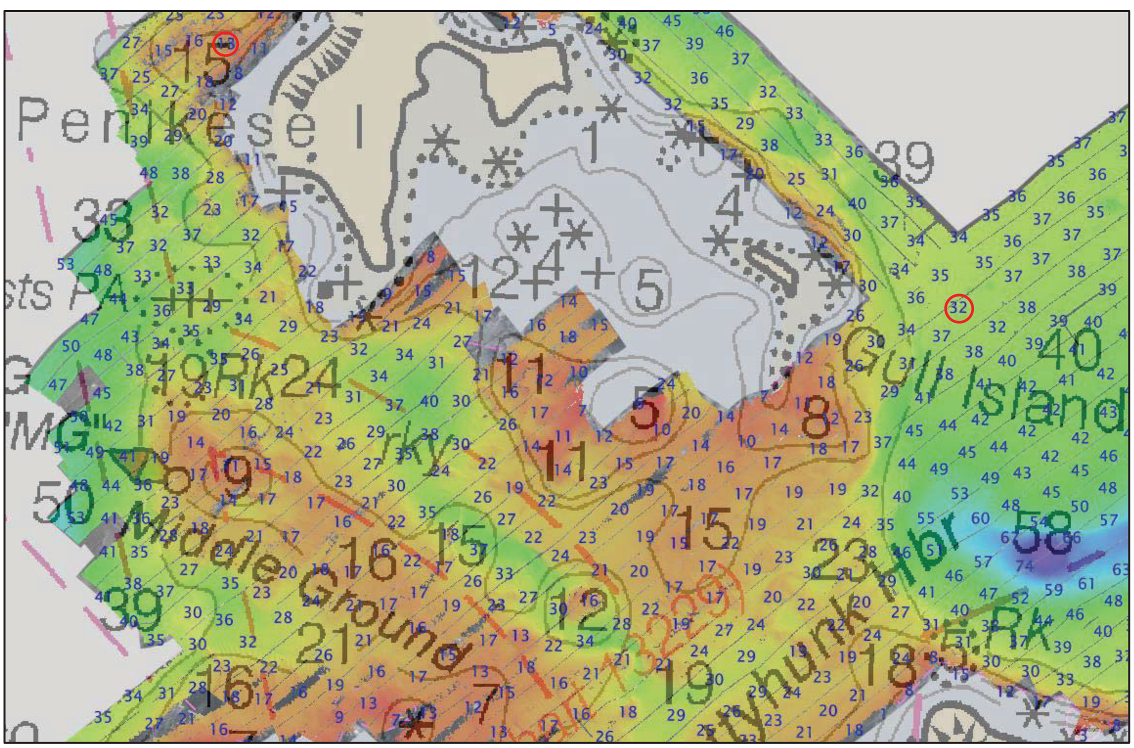

Figure 11: The subset from Figure 10 is enlarged to show selected soundings from W00318 at 10mm spacing at map scale of 1:10,000. The W00318 soundings are the smaller sized blue colored numbers and are generally within +/- 1-3ft of each charted sounding. Only two W00318 soundings are circled in red. The northernmost because even though it is within the 1-3ft standard, it is shoaler than what is charted and could be considered cartographically significant. The easternmost because it is shoaler than both the surrounding charted soundings as well as W00318 soundings.

An interpolated surface was created from the charted soundings covering the W00318 survey area. The difference between the interpolated surface and the 1m CUBE surface helped identify areas of shoaling relative to the chart. As the entire survey is in < 25m of water, all such shoaler areas are found to be notable (Figure 12). This difference surface is included in the data package.

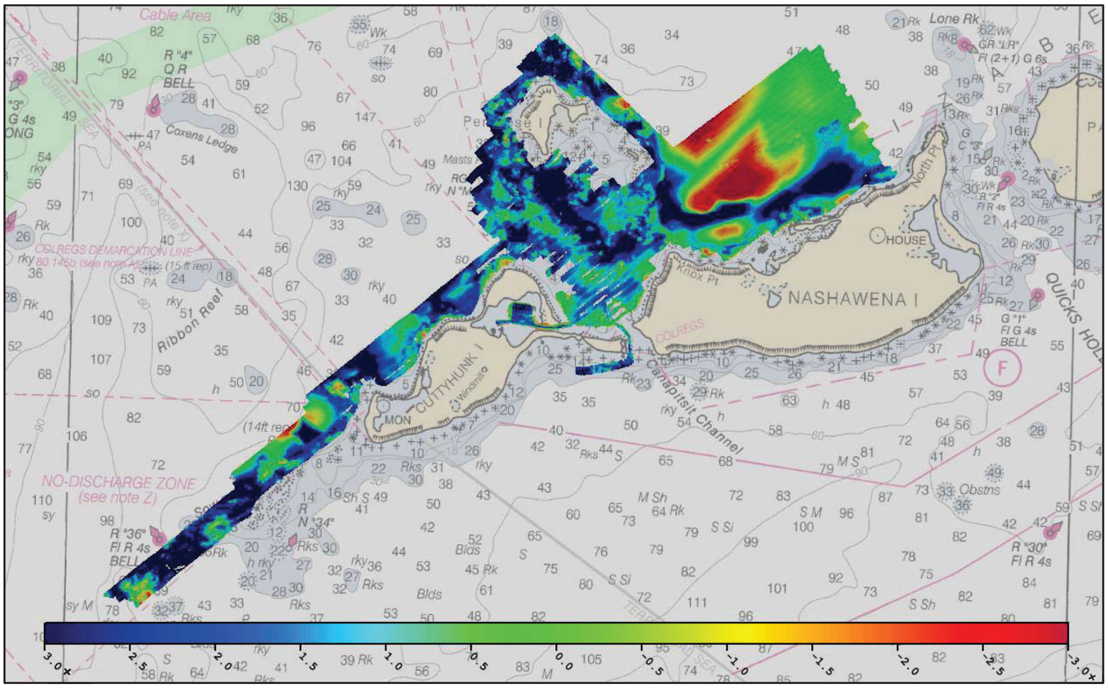

Figure 12: The difference surface created by differencing an interpolated surface of the currently charted soundings and the 1m CUBE W00318 surface. Cooler colors indicate areas where W00318 is deeper than currently charted soundings. The warmer colors indicate areas where W00318 is shoaler than currently charted data. *Note: color bar was shortened on either end (denoted with a +) to highlight areas of significant change.

F.3 Density

The current NOS complete coverage density requirement coverage states that 80% of all surface nodes having 5 soundings per node. W00318 surpasses the standard with 89.5% of all nodes in the survey having at least 5 soundings, with the majority having between 9-12 soundings (Figure 13). The average sounding density for these data is 11.

Upon further inspection, it becomes clear that nodes with sounding densities that do not meet NOS standards are primarily found along the nadir gap and along the outer edges of the swath in very shallow areas (Figure 14).

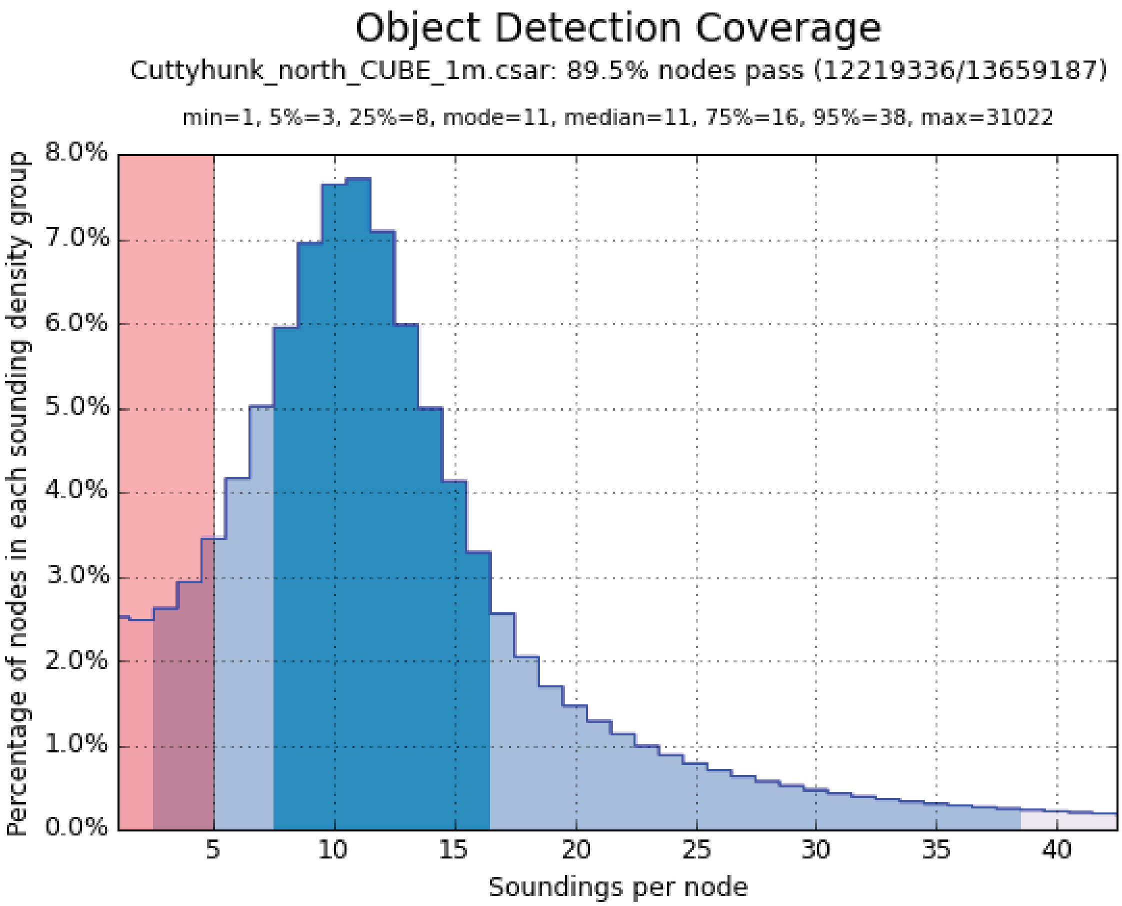

Figure 13: Graph created in PYDRO of W00318 1m CUBE surface stating 89.5% of the survey meets NOS specifications of 5 soundings per node.

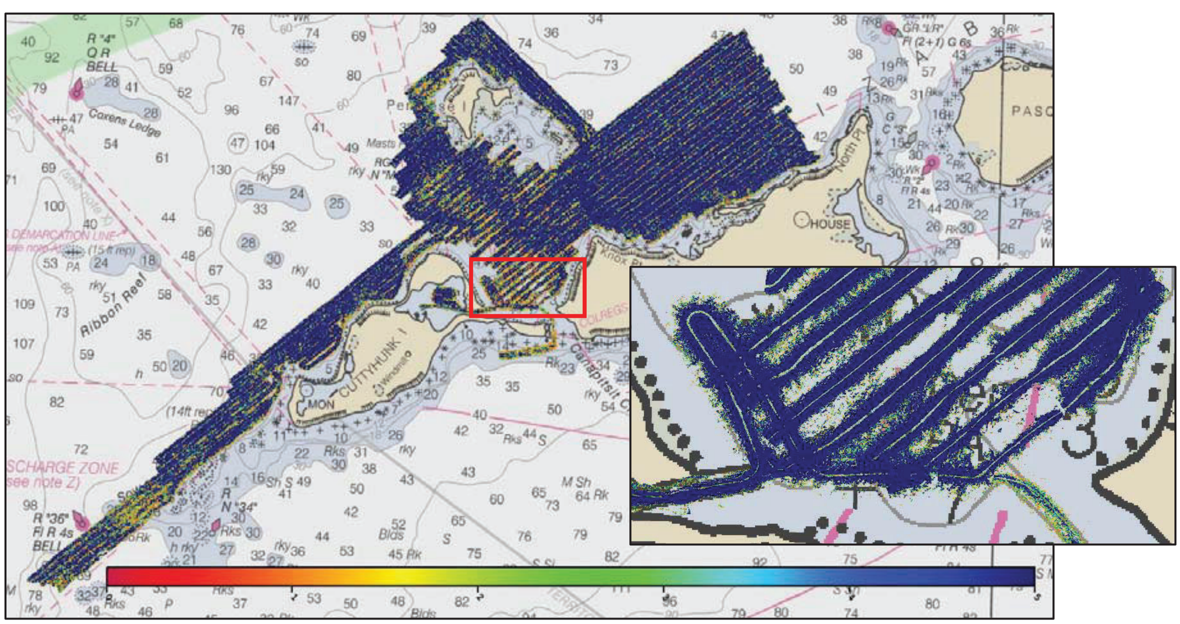

Figure 14: W00318 density with the scale bar from 0-5 soundings per node. The dark blue areas indication places where nodes have more than the NOS requirement. A red box indicates an area where there is a larger area of nodes with less than the NOS standard. The image to the lower right is a closer look at that subset. It is clear that the problem nodes are those on the outer edges of the swath and nearest the nadir gap.

F.4 Features

These data were not collected for charting purposes and feature investigations were not performed by the USGS/MCZM during data collection.

W00318 features were identified through the 0.5m side scan published mosaic created by the USGS, the 1m CUBE bathymetric surfaces created through IOCM post-processing, and verified in the SSS waterfall view. One uncharted wreck has been identified in this survey (Table 3). This feature (Figure 15) is included in the final feature file submitted along with this project.

Latitude	Longitude
41-24-00.49N	70-58-16.51W

Table 3: Uncharted wreck locations in W00318.

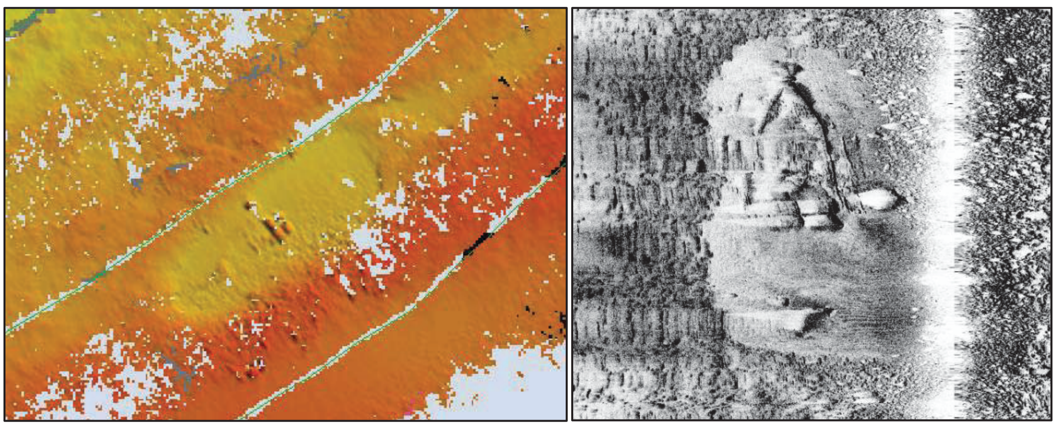

Figure 15: The left image depicts the uncharted wreck in the 1m CUBE W00318 surface. The right image is of the same wreck found in the sidescan waterfall view in CARIS.

It is recommended that the remaining charted features and identified rocky areas be developed/resurveyed for accurate and updated least depths. This is common practice for any NOAA survey and will be recommended to the USGS for future surveys. See the submitted **Feature Appendix** submitted with these data for a complete list of charted features and how they appear in these data.

F.5 KLEIN Sidescan

The Klein 3000 sidescan data were processed by the USGS in SonarPro, XSonar, and PCI Geomatica Software. The USGS created a half meter resolution mosaic of these data (Figure 16).

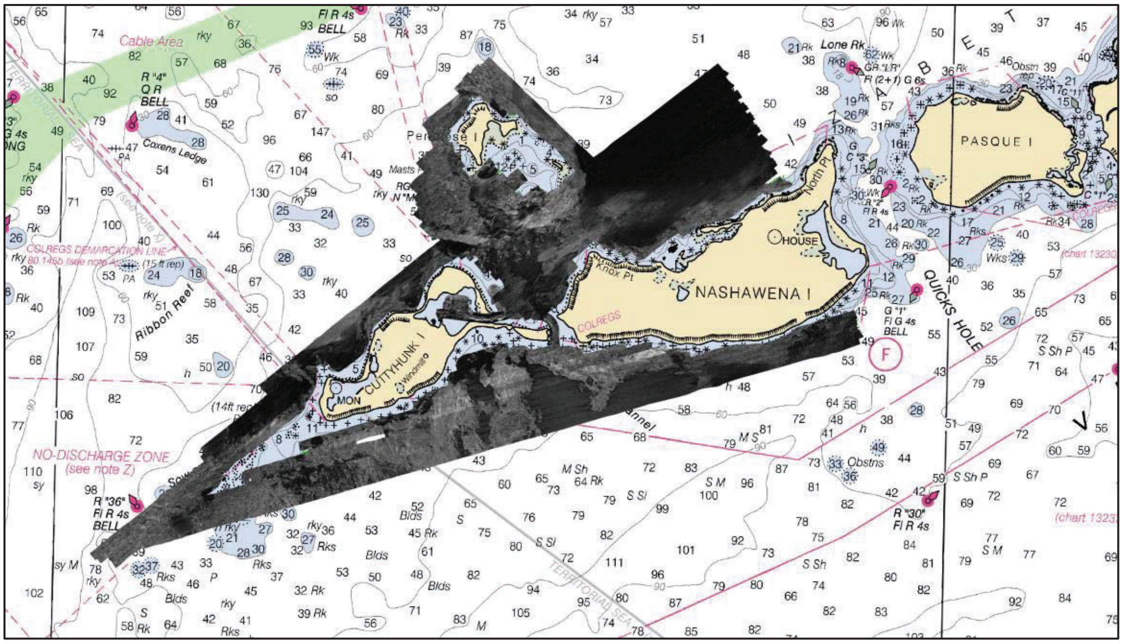

Figure 16: The USGS 50cm combined sidesscan mosaic of W00318.

For more information on USGS side scan practices, please see the submitted USGS XML documentation.

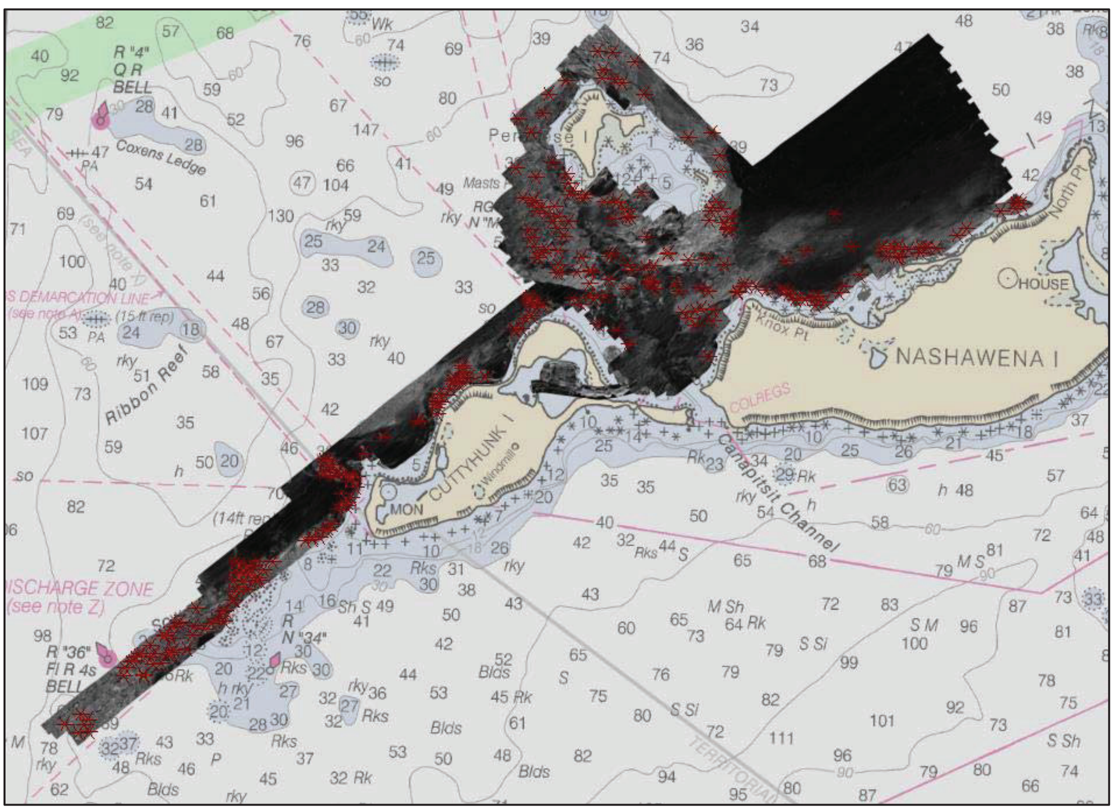

Figure 17: The W00318 sidescan mosaic over NOAA Chart 13218_1 with the 290 identified contacts in red.

Based on previous analysis of USGS/MCZM interferometric data in this general area, the determined best practice for contact identification in excessively rocky (filled with boulders) areas was to select the largest contact in each area on each trackline in the CARIS SIPS 9.0 sidescan waterfall view. Then come back through in the feature file to designate the areas surrounding said contacts as the S-57 “Caution Area” feature class. A textual description was also included in the S-57 feature attributes for each area to say something close to: “This area represents a seriously rocky area made up of a significant number of boulders all with heights 1m or greater.” This was the procedure for W00318 sidescan data and all identified contacts are included in various formats with the submission of this project.

As previously discussed in Section F.1 of this document, the portion of USGS/MCZM bathymetry south of Cuttyhunk Island is not being submitted. However, the sidescan is. This is because the NOAA survey H11921 did not include a backscatter component. Since the bathymetry covering the southern portion of Cuttyhunk has already been applied to the chart, a line by line analysis of the sidescan files was not performed. Instead, only the areas that included significant numbers of boulders were identified in the 50cm USGS SSS mosaic and designated using the S-57 “Caution Area” feature class as previously described. These identified areas were confirmed in the SSS waterfall view. In the entire sidescan coverage area of W00318, 17 Caution Areas were identified (Figure 18).

Additionally, six areas of sand waves /sand ripples were identified. A final feature file has been submitted with these data and includes all the caution areas identified through this process.

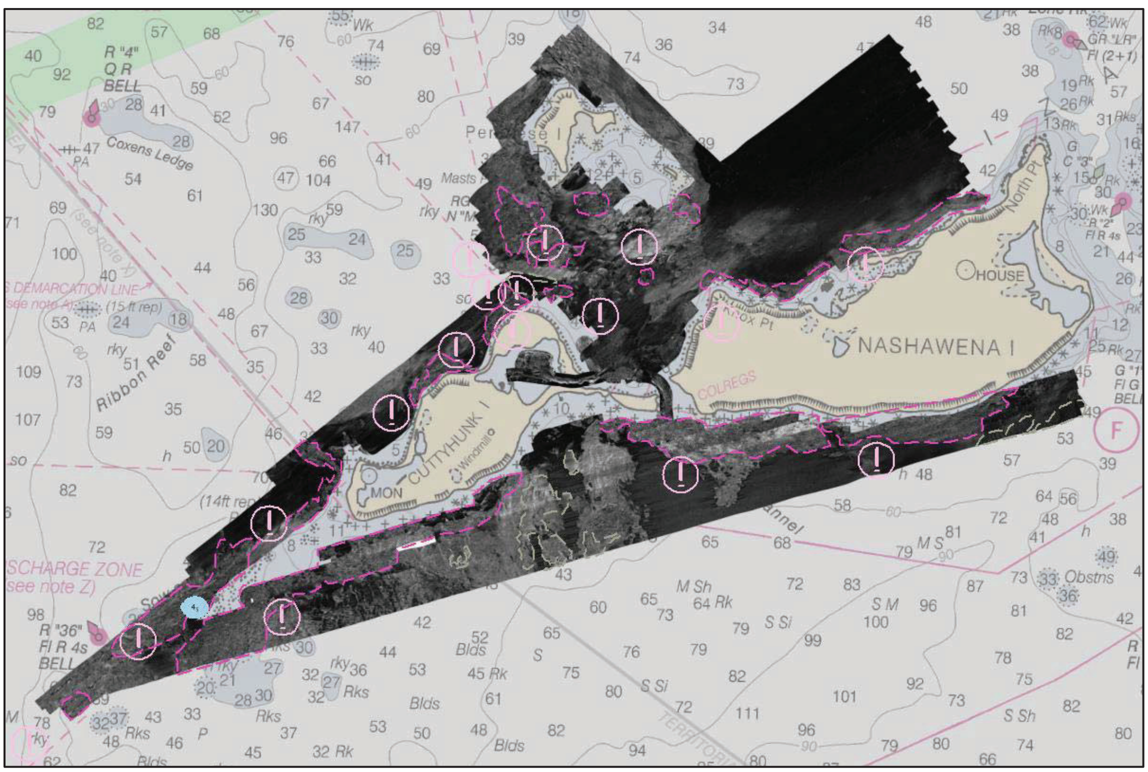

Figure 18: The entire 0.5m combined W00318 SSS mosaic over NOAA Chart 13218_1. Caution areas included in the feature file are outlined in pink, sand wave areas are outlined in grey, and the single uncharted wreck is identified by the blue circle.

As previously discussed, discrepancies between the NOAA data and USGS/MCZM occur primarily over rocky areas (section F.1 Figures 9.1-9.3) as a result of a variety of things including (but not limited to): the primary focus of the survey was not for hydrography and therefore additional feature investigations were not conducted, the least depths of the rocks were captured but buried in and amongst noise making it impossible to pick out without additional data, the data was filtered out during USGS acquisition and/or post-processing and now cannot be identified amongst the noise. For the reasons listed above and coupled with the location of these data (the shallow nature of this survey), it is recommended that significant sidescan targets identified in the contacts (Figure 19) be resurveyed for accurate least depths, as they are likely to be considered DTONs.

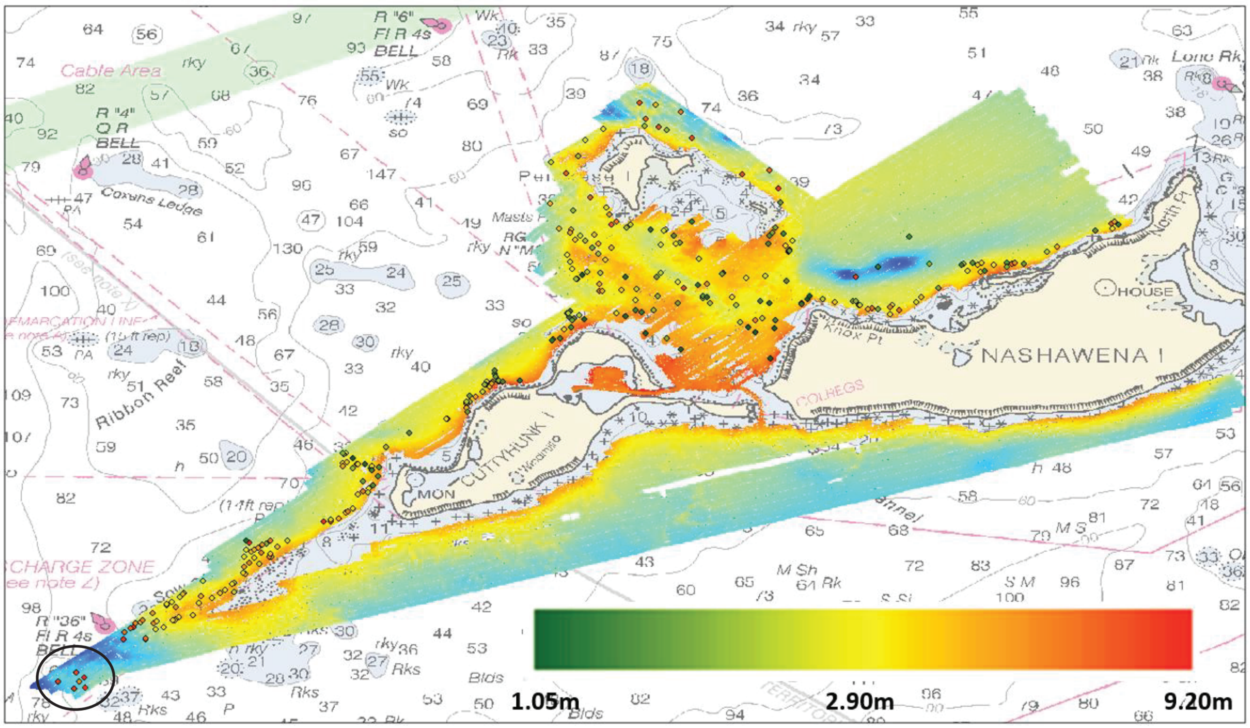

Figure 19: The SSS contacts identified for W00318 and colored by measured "height." The warmer colors indicating contacts of larger heights and cooler colors indicating those of smaller heights. It is important to also consider the depth of the area in which these contacts are found. For example, the group of six contacts found in black circle in the lower left (SW) corner of the data are measured to be extremely large rocks based on shadow height but are found in charted depths of 70+ feet and should probably not be resurveyed.

It is also recommended that the sidescan accompanied with these data be used as much as possible to update the chart – even simply updating the amount of areas designated "rky" (Figure). It is also important to note that these areas are boulder fields, and that is not necessarily conveyed in the traditional use of the charted term "rky." For this reason, it is suggested that a new chart designation of "rky, bldrs" be used to differentiate between rock outcrops and boulder fields.

G. Vertical and Horizontal Control

The vertical datum for this project is Mean Lower Low Water. Heights for these data were obtained by Real Time Kinematic Global Positioning System (RTK-GPS) and were referenced to the USGS Marine Operations Facility (MOF) in Falmouth, Mass. Revisions were communicated over a cellular modem and high frequency radio between the ship and base station. The USGS applied their own tidal model and referenced the following tidal benchmarks:

Station Name	Station ID
Chappaquoit	8447685
Monument Beach	8447355
Pine Point Wings Cove	8447416
Round Hill	8447842

To maintain consistency between the USGS interferometric and NOAA surveys, the USGS tidal model was removed upon arrival at the IOCM center. The NOAA 2016 TCARI model was applied to the CARIS HDCS data through PYDRO (E.1).

The horizontal datum for this project is World Geodetic System 1984 (WGS84) and is projected to Universal Transverse Mercator (UTM) Zone 19N. USGS horizontal positioning was acquired using a differential GPS and Wide Area Augmentation System (DGPS+WAAS).
For more information, please reference the USGS Open-File Report 2011-1184 (Pendleton et al) and the USGS XML documentation for their published bathymetry. Both are submitted with these data.

H. Approval

Following IOCM processing, the survey data do not fully meet the requirements as set forth in the NOS Hydrographic Surveys and Specifications Deliverables Manual, Field Procedures Manual, Standing and Letter Instructions, and all HSD Technical Directives. However, these data are adequate to supersede charted general sounding data in their common areas. This survey requires additional least-depth investigations over identified features, shoals, and rocky areas from both this survey and prior charted surveys.

Approver Name	Approver Title	Approval Date	Signature
Andrew A. Armstrong, III	Co-Director, Joint Hydrographic Center	9/23/2016	Digitally signed by Andrew A. Armstrong, III DN: cn=Andrew A. Armstrong, III, o=NOAA/NOS/OCS, ou=Joint Hydrographic Center, email=andy.armstrong@noaa.gov, c=US Date: 2016.09.23 05:25:11 Z

Note: Because there was an observed vertical offset between the depths in this survey with the depths of F00659 (2015 survey from a verified source, the NOAA Ship Thomas Jefferson), the W00318 depths were shifted vertically by -0.322 meters, which is the mean difference in the gridded depths between the two sources. Note that depths are positive down, so the vertical shift applied to W00318 was a shoal bias. This correction was performed in accordance with the External Source Data Vertical Alignment Policy in the NOAA Office of Coast Survey.

APPROVAL PAGE

W00318

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
- Data Acquisition and Processing Report
- Collection of Bathymetric Attributed Grids (BAGs)
- 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.

MCGOVERN.MEGHAN.E LIZABETH.1284020495 Digitally signed by MCGOVERN.MEGHAN.ELIZABETH.1284020495 Date: 2020.01.08 15:41:59 -05'00'

Approved:______________________________

Commander Meghan McGovern, NOAA
Chief, Atlantic Hydrographic Branch