

**W00307**

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

**DESCRIPTIVE REPORT**

Type of Survey: Navigable Area

Registry Number: W00307

**LOCALITY**

State(s): Massachusetts

General Locality: Buzzards Bay

Sub-locality: Offshore of Mattapoissett Harbor

**2010**

CHIEF OF PARTY  
USGS

LIBRARY & ARCHIVES

Date:

**HYDROGRAPHIC TITLE SHEET**

**W00307**

**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: **Offshore of Mattapoisett Harbor**

Scale: **10000**

Dates of Survey: **06/16/2009 to 05/20/2010**

Instructions Dated: **N/A**

Project Number: **OSD-USGS-16**

Field Unit: **USGS**

Chief of Party: **USGS**

Soundings by: **SEA SwathPlus-M (Interferometric)**

Imagery by: **Klein Marine Systems System 3000 (SSS)**

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 W00307	
Project	OSD-USGS-16
Survey	W00307
State	Massachusetts
Locality	Buzzards Bay
Sub Locality	Offshore of Mattapoissett Harbor
Scale of Survey	1:10,000
Sonars Used	SEA SwathPlus (234kHz) Klein 3000 (132kHz)
Horizontal Datum	World Geodetic System of 1984 (WGS 84)
Vertical Datum	Mean Lower Low Water (MLLW)
Vertical Datum Correction	TCARI Tidal Model
Projection	Latitude-Longitude (WGS84) - UTM Zone 19N
Field Unit	United States Geologic Survey at Woods Hole
Survey Dates	06/16/2009 - 05/20/2010
Chief of Party	USGS and MCZM

### A. Area Surveyed

W00307 was surveyed by the US Geological Survey (USGS) with a SEA SwathPlus interferometric sonar with a towed Klein 3000 side scan onboard the 108 foot M/V Megan T. Miller. The survey area was covered over the course of two one-month periods (05/27/09 - 06/18/09, 05/14/20 – 06/04/10) in 2009 and 2010. The data were not collected in accordance with NOS Hydrographic Surveys Specifications and Deliverables and the Field Procedures Manual 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 W00307 survey is within the following limits:

NE Corner	41-40-27.63 N	70-39-15.44 W
SE Corner	41-30-17.71 N	70-38-58.48 W
SW Corner	41-30-09.28 N	70-48-24.57 W
NW Corner	41-40-20.12 N	70-48-41.61 W

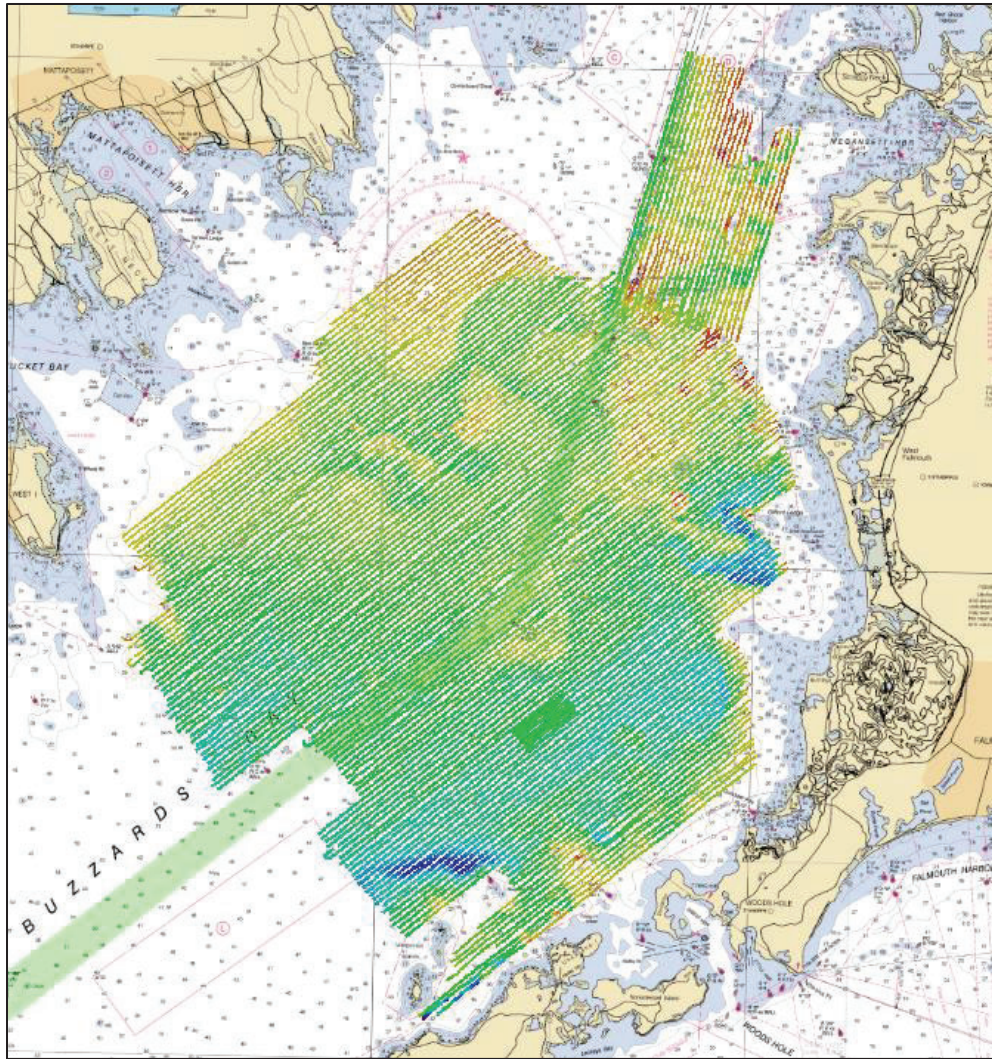


Figure 1: Survey W00307 1m CUBE surface overlaying Charts 13230\_1.

## B. Survey Purpose

Data were acquired by the United States Geologic Survey (USGS) in cooperation with the Massachusetts Office of Coastal Zone Management (MCZM). W00307 was part of a larger survey project for the USGS/MCZM to map the whole of Buzzards Bay, and surrounding coastal Massachusetts waters. The results of their efforts were published publicly under Open-File Report 2012-1002. NOAA learned of these data in early 2015 when NOAA Ship *Thomas Jefferson's* survey areas were being selected. Communication between NOAA and USGS lead to sharing of these data for charting evaluation. In response to the potential for charting, NOAA adjusted the *Thomas Jefferson* 2015 survey plans so as not to cover the same area twice (Figure 2).



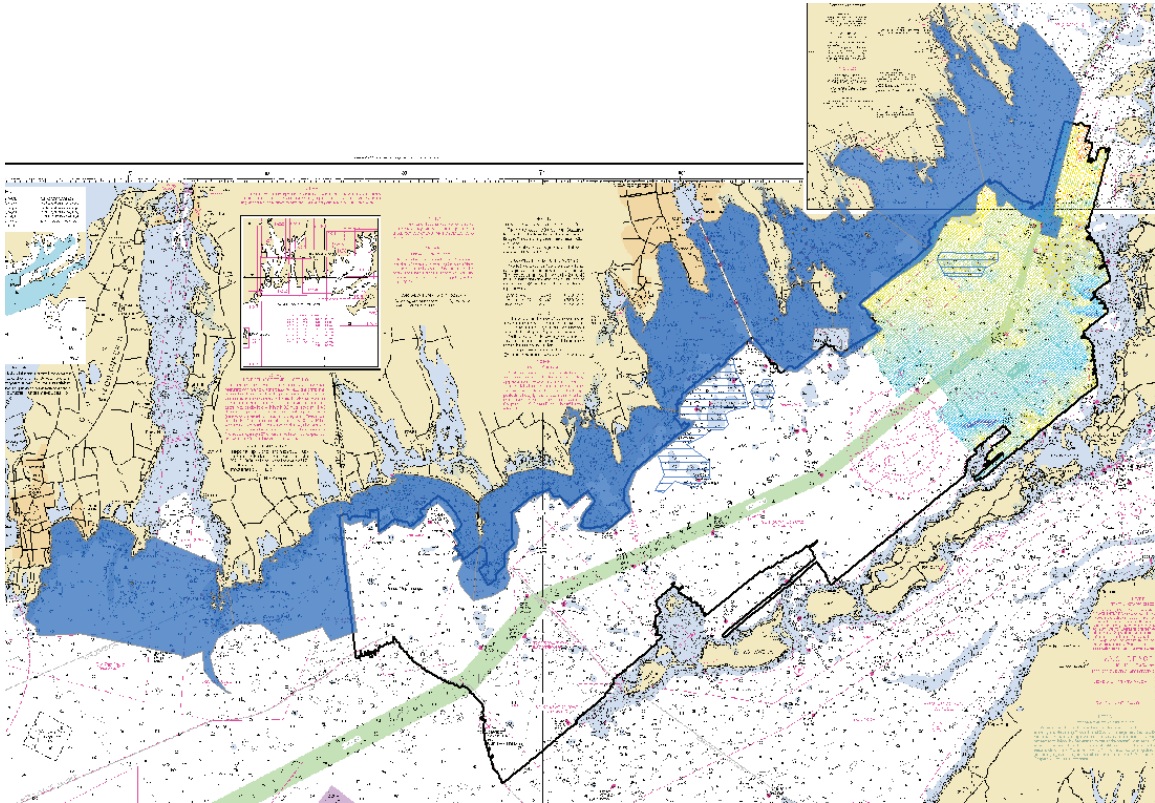


Figure 2: The USGS/MCZM survey area outlined in black with the NOAA Ship *Thomas Jefferson's* survey areas in blue. The boxed areas with blue lines are the areas assigned to the *TJ* for additional investigation. W00307 (North) 1m CUBE surface is shown over charts 13218 and 13229\_11.

Refer to the USGS Open-File Report 2012-1002 written by Ackerman et al submitted with this data for more information on the survey purpose and acquisition.

### C. Intended Use of Survey

These re-processed data are adequate to supersede prior sounding data and are intended for chart compilation. The analysis of these data have determined that they meet the horizontal and vertical requirements for CATZOC A2 but coverage and feature measurements of CATZOC B. With additional coverage over sidescan identified targets and shoals, CATZOC A2 could be achieved.

### D. Data Acquisition and Processing

#### D.1 USGS Acquisition and Processing

Survey data were collected by the USGS/MCZM in 2009-2010 with an EdgeTech Geo-Star FSSB and SB-0512i towfish for seismic profiling, a pole-mounted first-generation interferometric SEA SwathPlus sonar for bathymetry with concurrent side scan, and a towed Klein 3000 for supplementary side scan (Ackerman et al. 2012). These data were RTK navigated, referenced to Mean Lower Low Water (MLLW), and had an average tidal offset applied (Ackerman et al. 2012). The interferometric data were collected with the SEA SWATHPlus acquisition software and processed in CARIS 6.1-7.1 by the USGS.

Instrument	X	Y	Z
Transducer 1	-0.110	-0.019	0.158
Transducer 2	-0.110	-0.019	0.158

Table 1: Table represents the offset values in the received CARIS vessel files.

Bathymetric filters were applied to these data by the USGS in attempts to reduce the size of the data and remove inaccurate soundings. The filters applied to these data included low amplitude (100%), range (0-4m), box (3-50m depth, 1.5-75m horizontal), median (window size 5), along-track 1 (depth difference of 5-m, window size 5-m, and learn rate of 0.7), along-track 2 (depth difference of 1.5-m, window size 1m, and learn rate of 0.9), and mean filters (0.25m) (Ackerman et al. 2012).

The data package received by the IOCM center included the raw interferometric files .sxr, CARIS projects using the processed interferometric files .sxp, raw Klein side scan .XTFs, and detailed daily survey logs with records of ship speed, navigation failures, and side scan feature identifications.

Refer to the USGS Open-File Report 2012-1002 (Ackerman et al) for more complete information on data acquisition, vessel configuration, processing hardware and software, data quality and offsets.

## D.2 IOCM Post Processing

The W00307 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 option. This was done at the suggestion of JHC/CCOM Researcher Val Schmidt who pointed out the CARIS sonar algorithm is not applicable for interferometric systems.

The NOAA TCARI 2015 tidal model for Buzzards Bay was applied to these data using PYDRO to replace the tides applied by the USGS.

Also from the recommendation of Val Schmidt, these full-swath interferometric data were trimmed to limit the amount of noisy data included in surface creation by applying the CARIS across track distance filter. The across track distance CARIS filter of 1.73x water depth on either side of nadir was applied (Figure 3).

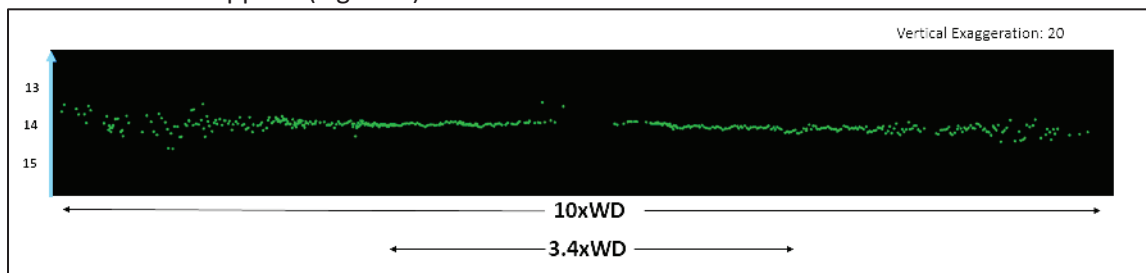


Figure 3: A single full swath of data at a depth of 14m. While there is data up to 10x water depth, only the data up to 3.4x water depth was kept after the CARIS filter was applied as it had less noise and less uncertainty.

This application limited the swath to ~50m at a depth of 14m and created ~50m data gaps between each swath. The resulting surface is of a similar nature to that of a "skunk-stripe" multibeam survey.

## 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 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).

Sound-speed profiles were collected approximately every four hours using a hand-casted Applied MicroSystems SV Plus sound velocimeter during the 2009 survey and with an ODIM MVP30 moving vessel profiler during the 2010 survey (Ackerman et al). These profiles were applied to the data in real time. Sound speed was not reapplied during post processing. Figure 5 shows the values that were used to calculate TPU based on the USGS/MCZM raw SVP documentation.

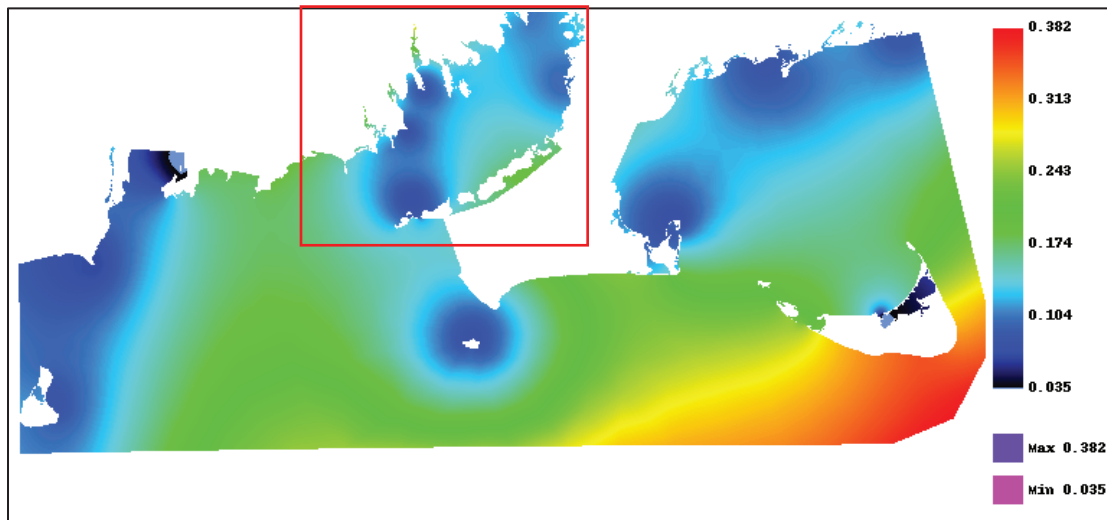


Figure 4: TCARI Tidal Error for the Buzzards Bay and surrounding area produced in PYDRO. The red box denotes where the survey area is located.

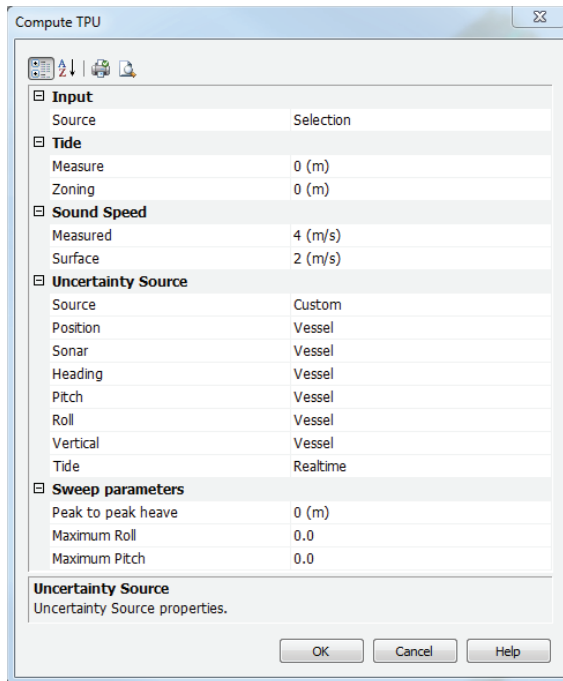


Figure 5: Shows the TPU values used to calculate W00307 CUBE surfaces

## E.2. Cross-line Comparison

As part of a 2015 reconnaissance effort directed in the OPR-B367-TJ-15 project instructions, the NOAA ship *Thomas Jefferson* (TJ) ran cross-lines as part of field sheet F00659 through the body of the survey area (Figure 6). The 1m W00307 surface was compared with a 0.5m surface from the *TJ* cross-lines. The surfaces had a mean difference of **0.41m** with a standard deviation of **0.18m**. The TJ data were found to be consistently shoaler.



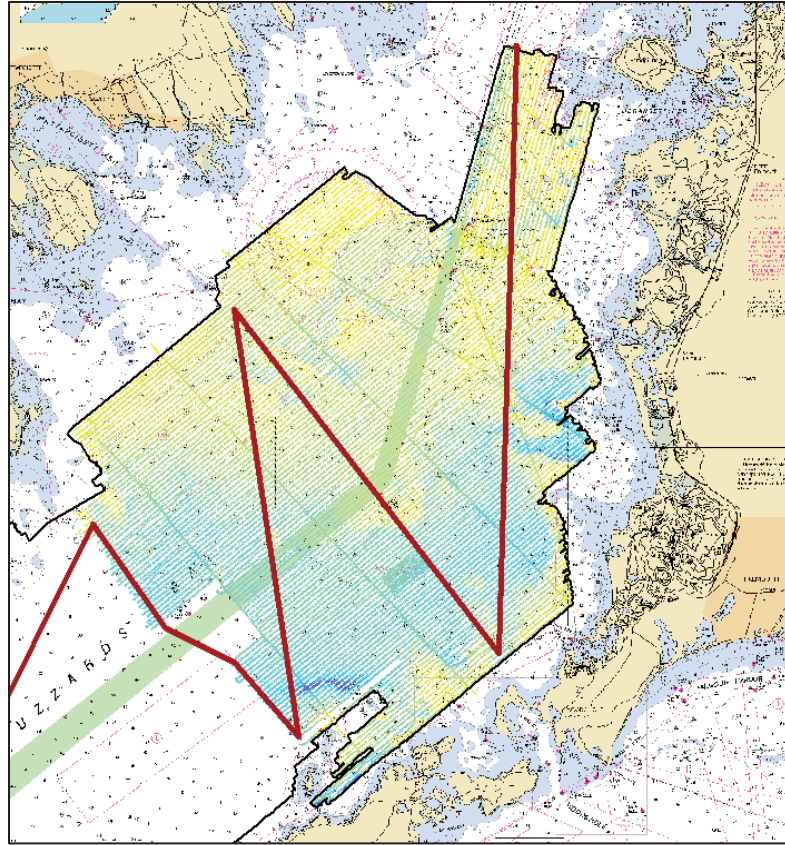


Figure 6: NOAA Ship *Thomas Jefferson* cross-lines (F00659) on top of the W00307 1m CUBE survey and Chart 13230\_1.

The TJ cross-line comparison identified a residual 30cm bias in the 2009 data with respect to the 2010 data. In comparison with W00308 (the central region), there was a 20cm difference between the overlapping 2009 data from W00308 and W00307. As there is no other 2010 data in the other Buzzards Bay surveys, we cannot confirm that there is a consistent 30cm difference between 2009 and 2010 USGS data. Instead, a 20cm change to the z-value was applied to the 2009 HVF in W00307 to match with the 2009 W00308 overlapping data (Figure 7.1-7.2). The implementation of this 20cm vertical correction changed W00307's overall agreement with the TJ crosslines to be **0.331m** (Figure 7.3), leaving the TJ data to still be shoaler but by less than before.

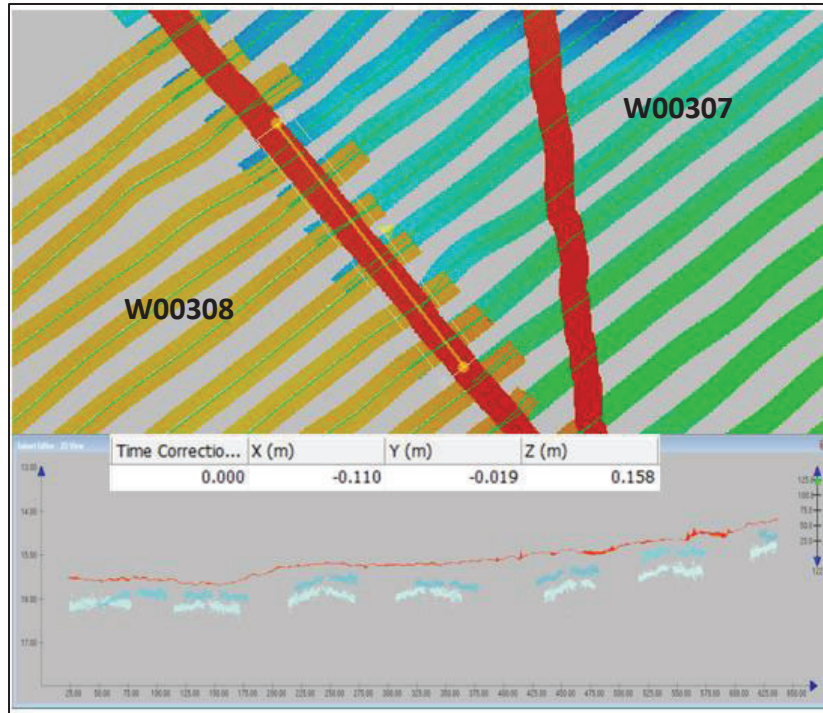


Figure 7.1: The top image shows the overlapping area between W00307, W00308, and the TJ crosslines. The middle image is a snapshot of the original W00308 2009 HVF file. The bottom image shows the subset area from the top image. The light blue soundings are from the W00307 2009 data, while the dark blue soundings are from the W00308 2009 data with the red solid line being the TJ crossline. There is a clear ~20 cm difference between the two USGS surveys.

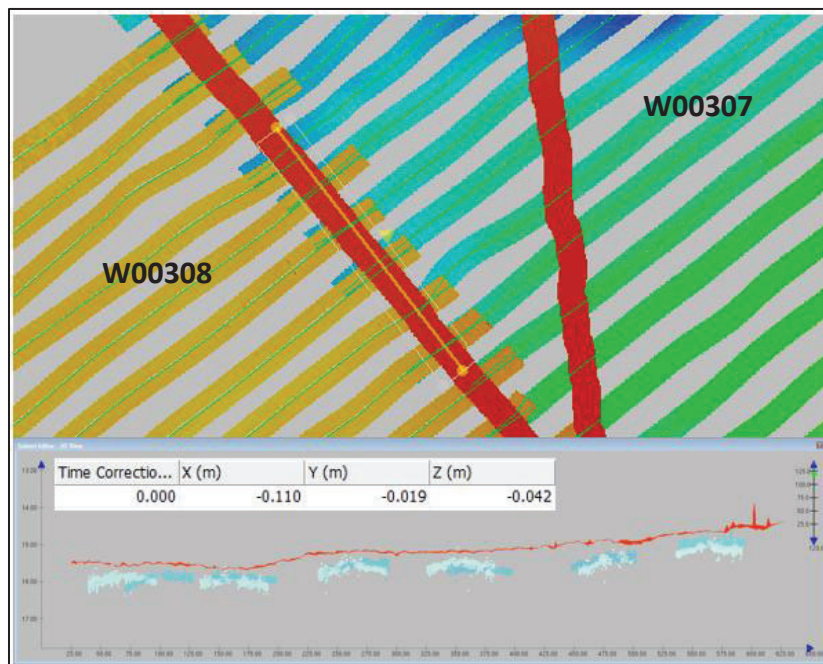


Figure 7.2: The top image shows the same overlapping area between W00307, W00308, and the TJ crosslines. The middle image is a snapshot of the W00308 2009 HVF file after a 20cm shift. The bottom image shows the subset area from the top image. The light blue soundings are from the W00307 2009 data, while the dark blue soundings are from the W00308 2009 data with the red solid line being the TJ crossline. Clearly, the two data sets more closely align post-shift.

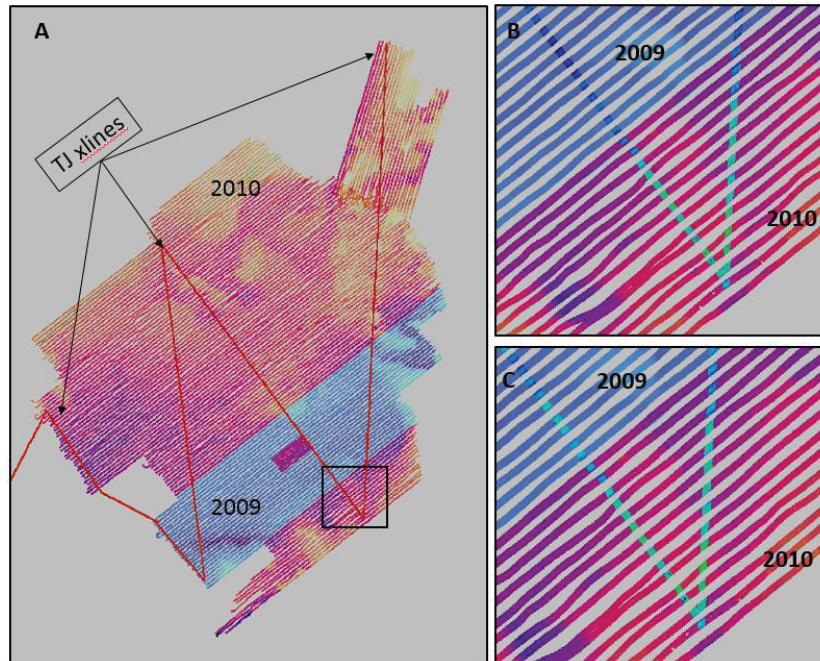


Figure 7.3: A. W00307 broken up by collection year 2009 and 2010 and shown in different color schemes with the TJ crosslines on top. B. Close up of the black box from 7A shows that the change in the difference surface aligns perfectly with the acquisition years. The 2009 data averages a difference with the crosslines of ~45cm while it's ~15cm in 2010. The TJ data is always shoaler. C. Close up of the same area in 7B with a difference surface that was created after the HVF was edited. Clearly the differences between 2009 and 2010 are significantly less – on the order of ~10-15cm.

A standard offset value was not applied to these data in regards to the overall crossline difference as the time between acquisition of the W00307 and F00659 was too great and could potentially cause more errors than corrections. A portion of the overall difference values can be attributed to natural changes over the 5-6 year period.

### E.3 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 as well as a separate component to accommodate the identified roll bias (more evident in W00309) in a root-mean-square sum (Equation 1). A fixed value for the roll bias error at 60° was used to simulate a worst-case scenario for these across-track filtered interferometric data. The roll bias itself was estimated to be 0.7° due to the ~1m depth difference on the starboard side found during the TJ crossline comparison with W00309. The areas affected by the roll bias appeared deeper than the rest of the swath (see W00309 DR Summary for more information on the roll bias). Equation 1 was used to calculate the uncertainty for each CUBE surface.

**EQUATION 1:**

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

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

$$\sigma_{Tide} = \text{TCARI error estimate} = 0.15 \quad \text{*Estimated average value based on Figure 4}$$

$$\sigma_{Heave} = 0.05$$

$$\sigma_{Draft} = 0.05$$

$$\sigma_{Depth} = \text{Depth}^2 \times \tan(60^\circ) \times \sigma_{Roll}^2$$

$$\sigma_{Roll} = \frac{0.7}{180} \pi$$

The average depth of W00307 is 12.85m and was used as the depth component to estimate the IHO order 1a 2 $\sigma$  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:*

$$\sqrt{(a)^2 + (b * d)^2} = \sqrt{(0.5)^2 + (0.013 * 12.85)^2}$$

Using the above equation, the total allowable vertical uncertainty is < 0.53m for W00307. The 2 $\sigma$  average uncertainty calculated for W00307 is **0.6328m** as seen in Figure 8. The USGS/MCZM Buzzards Bay data did not meet IHO order 1a based on these uncertainty calculations.



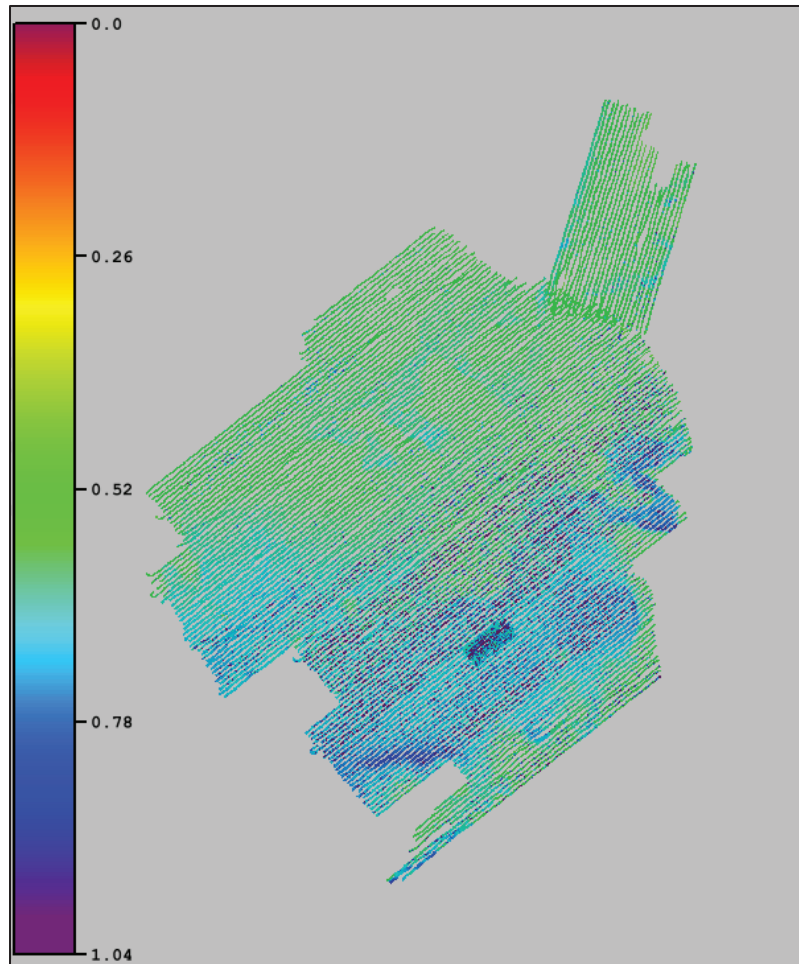


Figure 8: Uncertainty map of W00307 1m CUBE surface with the estimated uncertainty statistics. There is an average uncertainty of 0.6328m.

Without the roll bias contribution to the uncertainty calculation W00307 would meet IHO Order 1a requirements with an average vertical uncertainty of **0.3348m** (Figure 9). A layer was added to the W00307 CUBE surface with the same uncertainty calculation but without the roll bias contribution and is named "Uncertainty\_NoRollBias".



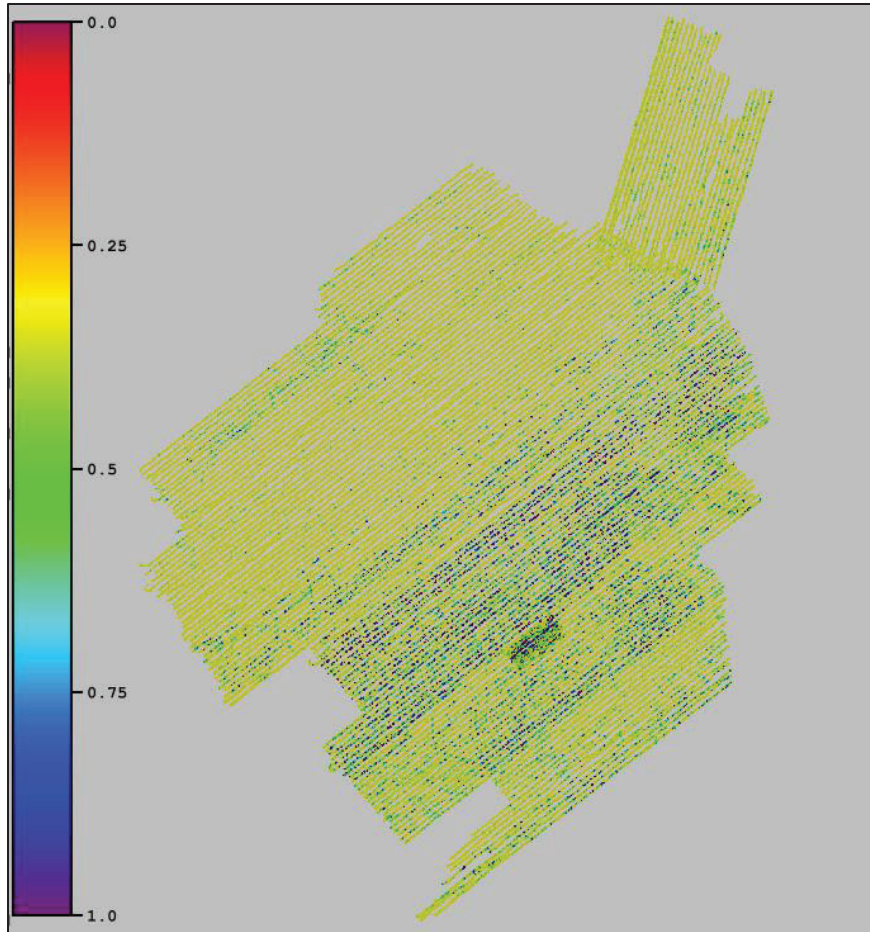


Figure 9: Uncertainty map of W00307 1m CUBE surface with the estimated uncertainty statistics without the roll bias contribution. There is an average uncertainty of 0.3348 m. 99.78% of these data would meet IHO Order 1a with this calculation.

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)
W00307_north_1m_0to20	CUBE Base Surface	1	0-20
W00307_north_2m_18to40	CUBE Base Surface	2	18-40
W00307_north_1m	CUBE Base Surface	1	0-21m
W00307_north_2m	CUBE Base Surface	2	0-21m

Table 2: List of surfaces created for this project.

Table 2 does not include the 1m SSS mosaic created by the USGS that 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 (F.5).

### F.1 Chart Comparisons

A soundings layer of the USGS/MCZM Buzzards Bay data was made in order to directly compare with the soundings on the current charts (Table 3). Soundings from W00307 were selected by the depth layer in CARIS BASE Editor 4.0. Shoal biased soundings were selected using a single-defined radius of 15mm at a map scale of 1:10,000.

W00307 was compared with the following RNC and ENC, which cover the survey area:

Chart	Scale	Edition	Edition Date	NM Date
13228	1:20,000	12	11/1/2009	5/23/2015
13232	1:20,000	5	11/1/2009	5/23/2015
13236	1:20,000	31	4/1/2012	5/23/2015
13229	1:40,000	32	6/1/2013	5/19/2015
13230	1:40,000	51	4/1/2014	1/31/2015
13218	1:80,000	42	7/1/2013	6/27/2015
13246	1:80,000	40	10/1/2013	10/22/2015
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
US5MA27M	1:20,000	24.4	9/30/2014	5/11/2015
US5MA26M	1:20,000	15.4	7/23/2014	4/16/2015
US5MA24M	1:20,000	12.0	12/16/2014	12/16/2014
US5MA25M	1:40,000	20.0	9/24/2014	9/24/2014
US4MA14M	1:80,000	25.7	2/18/2014	5/11/2015
US4MA23M	1:80,000	27.17	11/7/2013	5/4/2015
US3EC09M	1:400,000	10.0	10/26/2015	10/26/2015
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 3: List of ENCs and RNCs that include W00307

In comparison to current NOAA RNCs and ENCs, it is clear that W00307 is fairly comparable to the charted soundings – generally within a meter (+/- 1-3 feet) as shown in Figure 11. However, there are a few areas where W00307 is considerably shoaler than currently charted soundings. An example of which is shown in Figure 12.

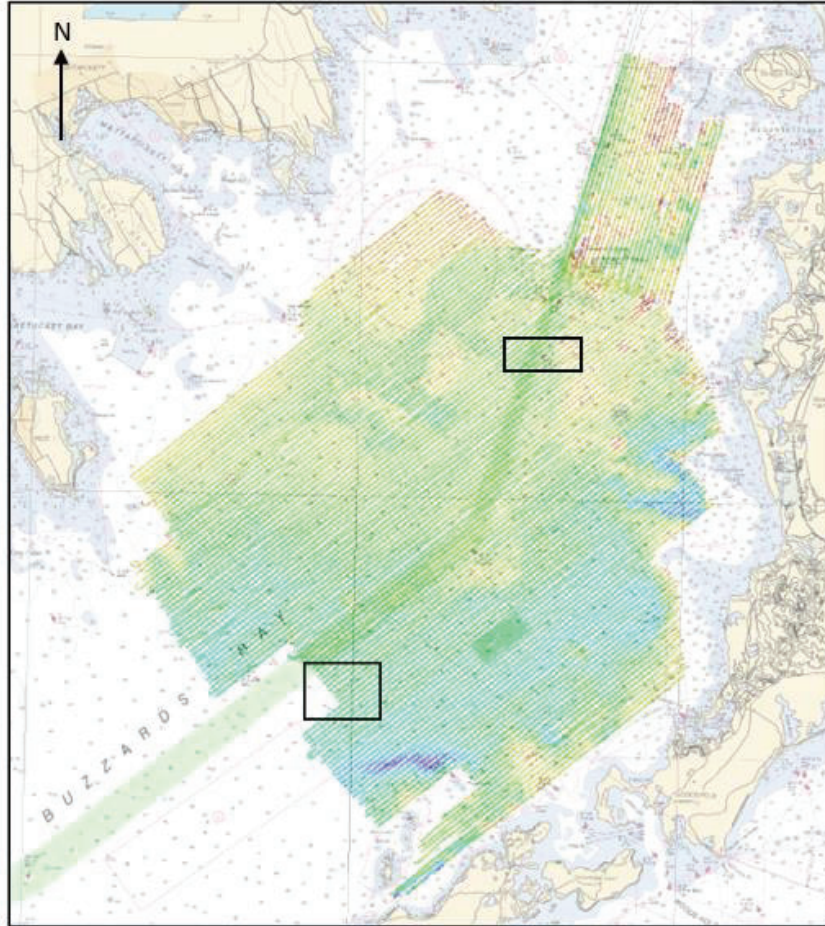


Figure 10: Top image is Chart 13230 over W00307 1m CUBE surface with two subsets identified in black boxes.

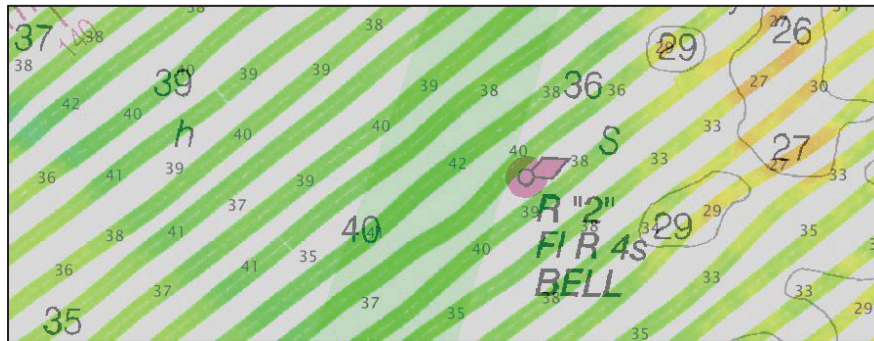


Figure 11: The northernmost subset from Figure 10 is enlarged to show selected soundings from W00307 at 15mm spacing at map scale 1:10,000. The W00307 soundings are the smaller sized numbers and are clearly within +/- 1-3 feet of each charted sounding.

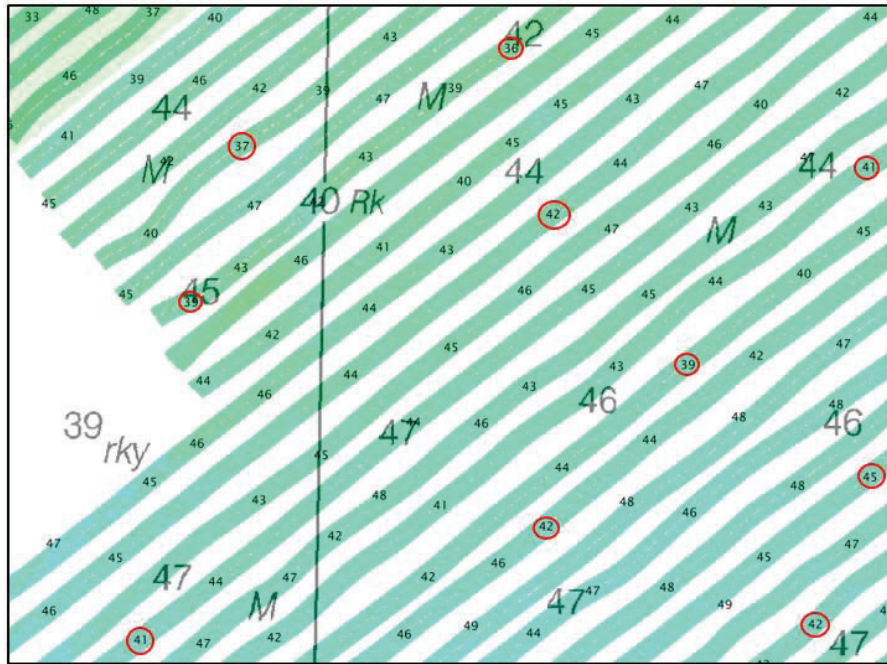


Figure 12: The southernmost subset from Figure 10 is enlarged to show selected soundings at 15m spacing at map scale 1:10,000. The W00307 soundings indicated with a red circle are shallower than the nearest charted sounding.

An interpolated surface was created from the charted soundings covering the W00307 survey area. The difference between the interpolated surface and the 1m CUBE surface helped identify areas of relative shoaling. Only a few areas were identified although most were in shallow enough waters (less than 35ft) to be of significance (Figure 13). This difference surface is included in the data package.



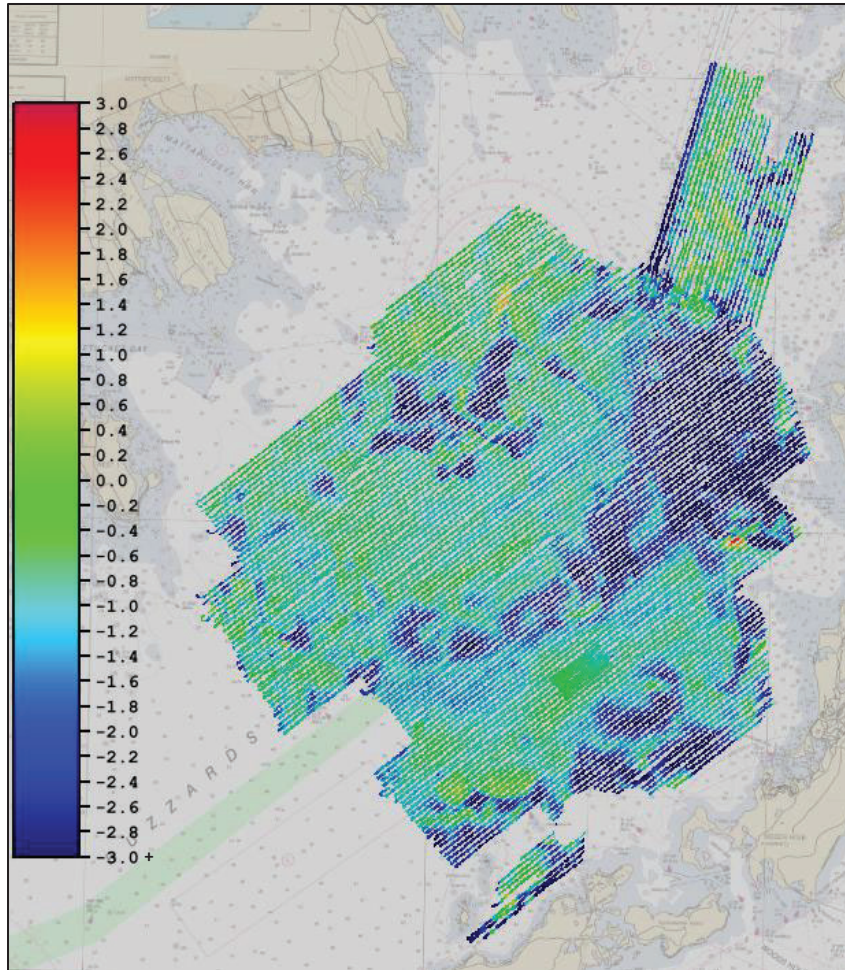


Figure 13: The difference surface created by differencing an interpolated surface of the currently charted soundings and the 1m CUBE W00307 trimmed surface. Cooler colors indicate areas where W00307 is deeper than currently charted soundings. The warmer colors indicate areas where the USGS data is shallower than currently charted soundings. No areas of shoaling exceed more than a 3m difference. \*Note: color bar was shortened on deep end (denoted with a +) to highlight areas of significant change.

## F.2 Features

These data were not collected for charting purposes and feature investigations were not performed by USGS/MCZM during data collection. That said, a number of features were identified throughout the post-processing of W00307-W00309 that are not currently identified on the charts. Features were confirmed as wrecks by their appearances on CUBE surfaces and intensity differences in the 1m backscatter mosaic, and were confirmed in the SSS waterfall view (Figures 14). One uncharted wreck has been identified in this survey (Table 4). A feature file has been created and submitted along with this project. It was not identified as DTON. This feature was further investigated during the NOAA Ship *Thomas Jefferson's* reconnaissance effort in Buzzards Bay as part of field sheet F00654.

For more information on the identified features, please see the TJ report and submission of F00654. For more information on the TJ investigations, please see the Visual Report Appendix included with these data.

Latitude	Longitude
41-35-19.5367N	70-40-00.7871W

Table 4: Uncharted wreck locations in W00307.



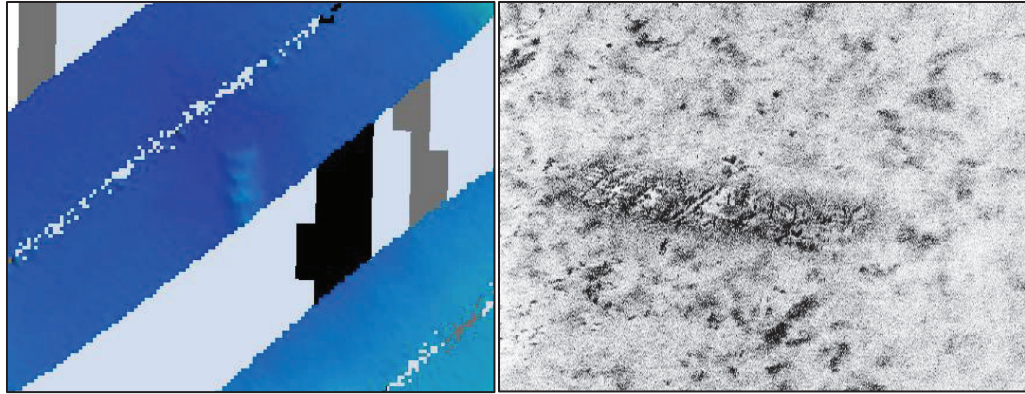


Figure 14: Left image depicts the wreck in the 1m CUBE surface and the right image is of the same wreck in the side scan waterfall view in CARIS.

It is also recommended that the remaining presently charted features 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.

Bottom samples were collected with these data and a surficial geology map released for the Buzzards Bay area. Both can be found in more detail in the USGS Open-File Report 2014-1220 submitted with this report.

### **F.3 Junction Surveys**

In the summer of 2015, NOAA Ship *Thomas Jefferson* survey H12643 junctioned with W00307 (Figure 15). While the overlap was small, the survey data were used to further validate the USGS processed depths. Comparison of the 50cm CUBE H12643 surface with the 1m CUBE W00307 surface reveals an average 35cm difference with the most notable differences occurring over rocky areas (Figure 16). As was with the TJ cross-lines, the NOAA collected data were consistently shallower than the USGS PMBS data.

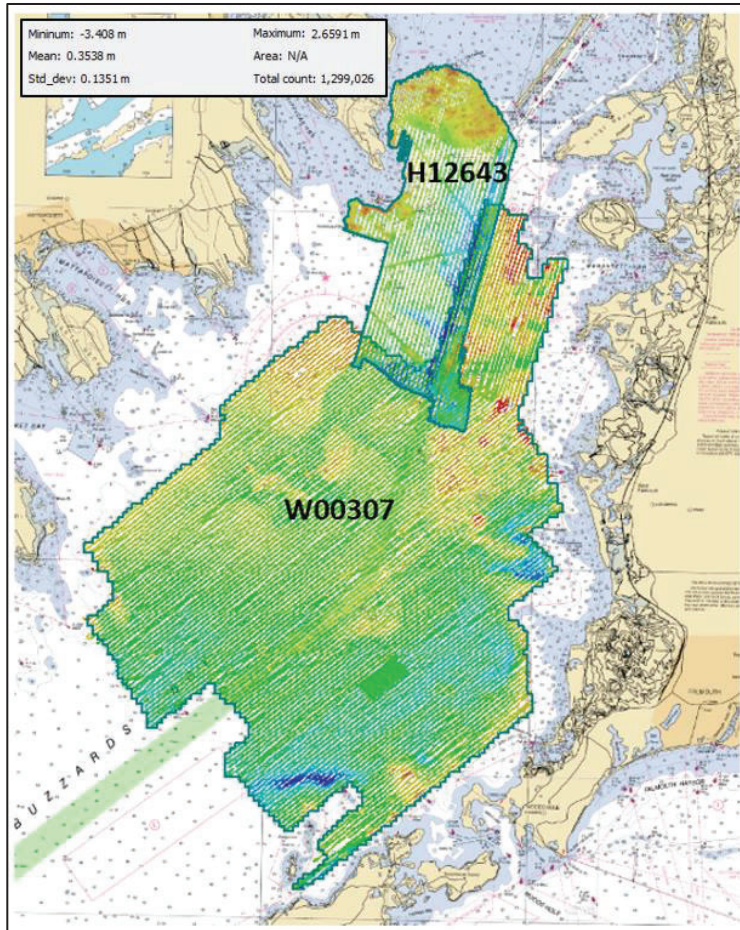


Figure 15: NOAA Ship *Thomas Jefferson* survey H12643 overlap with W00307 survey area.

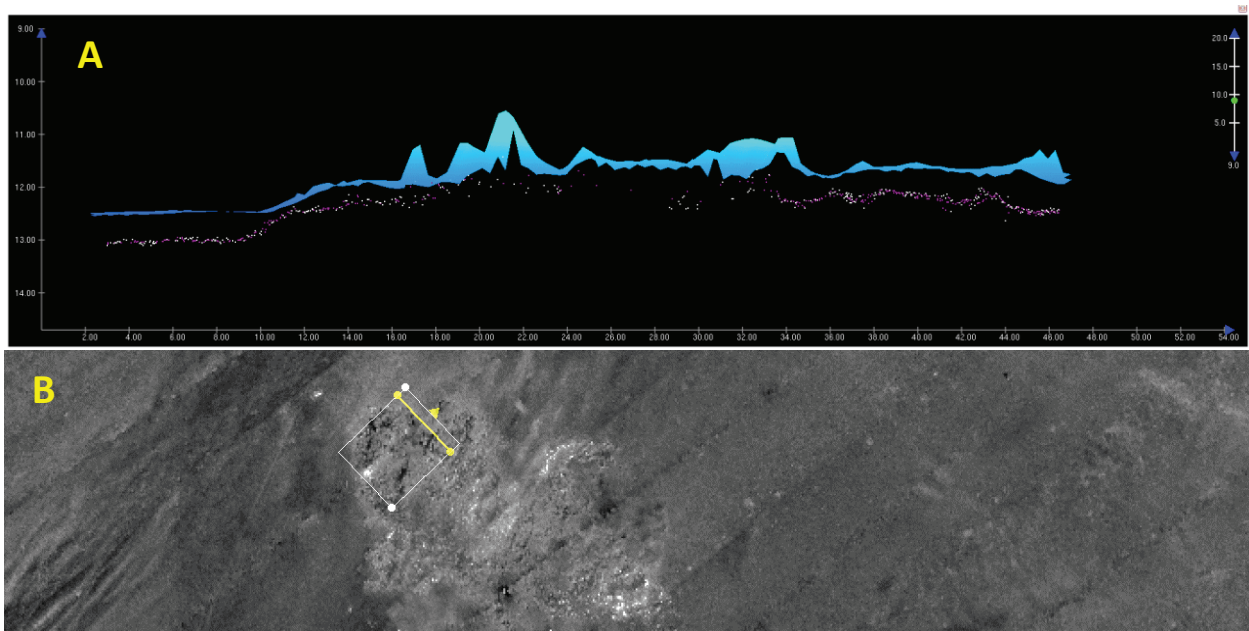


Figure 16: A. Subset of an area of larger difference between both W00307 and TJ H12643. Single swath of USGS data points in pink with the H12643 CUBE reference surface overtop. B. The subset and swath location over the USGS SSS 1m mosaic (see F.5) – shows it's a rocky location.

#### F.4 Density

Within the trimmed surfaces, the W00307 survey meets the NOS density standard for complete coverage requiring 80% of all surface nodes having 5 soundings per node (Figure 17). 85.8% of all nodes in the survey have at least 5 soundings, with the majority having between 7-15 soundings.

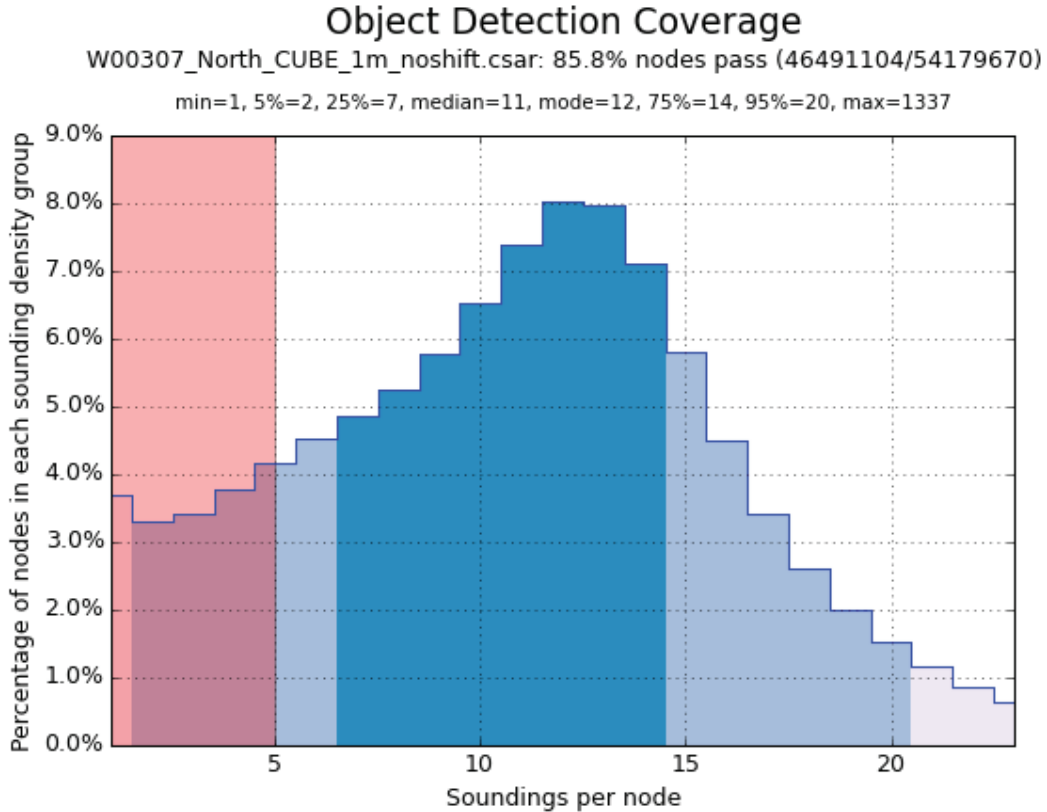


Figure 17: Graph created in Pydro of W00307 1m CUBE surface statistics stating 85.8% of the survey meets NOS specifications of 5 soundings per node.

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 very outer edges of the trimmed swath (Figure 18). Both of these areas are expected as they are known trouble spots for the sonar.

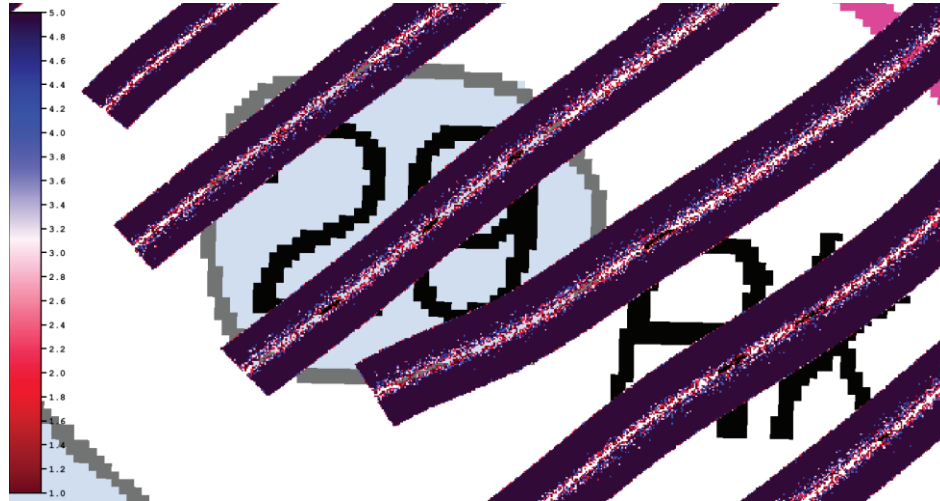


Figure 18: A closer look shows that the areas with a sounding density of less than 5 sounding per node are primarily found near the nadir gap.

### F.5 KLEIN Sidescan

The KLEIN 3000 sidescan data were processed by the USGS using Xsonar and ShowImage software. The USGS created a 1m mosaic of the entire Buzzards Bay area using PCI Geomatica (Figure 19). For more information on USGS sidescan acquisition and processing, refer to the USGS Open-File 2012-1002 Report (Ackerman et al).

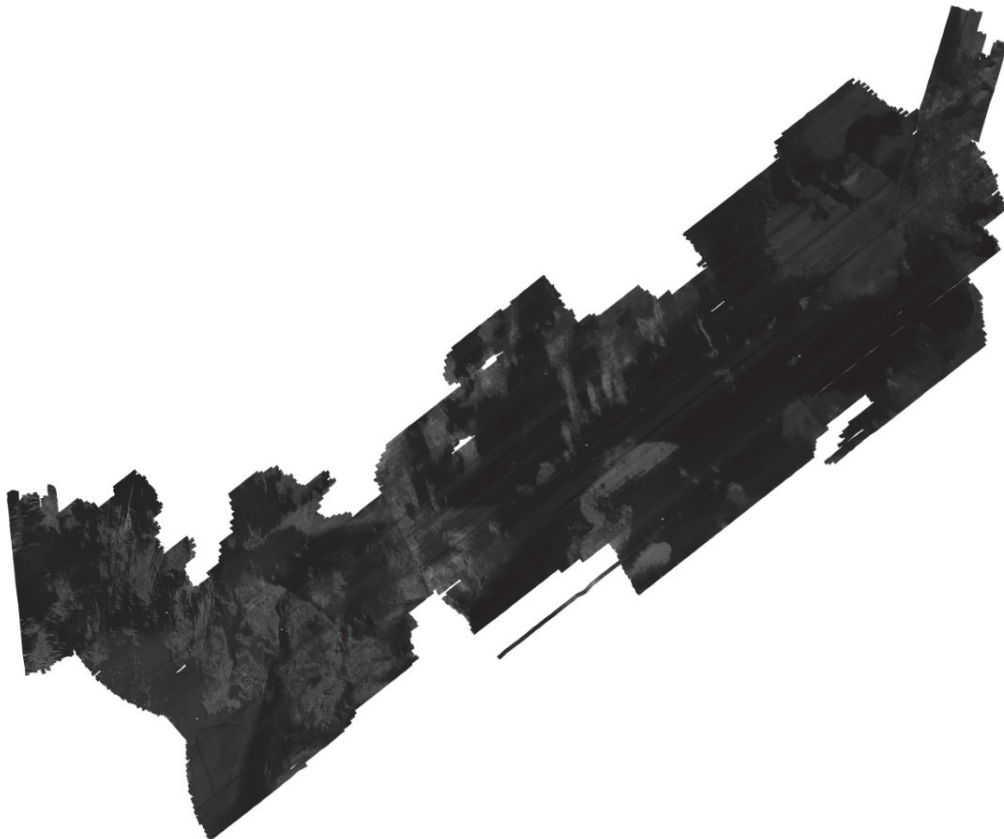


Figure 19: 1m combined sidescan mosaic of W00307, W00308, and W00309 created by USGS.

Initial IOCM post-processing efforts were focused on contact identification primarily north of the main channel throughout the USGS survey areas. Contacts with an estimated 1m or greater shadow height were identified for a general understanding of the area through the CARIS SIPS



9.0 sidescan waterfall. After the TJ reconnaissance effort was completed, a more thorough analysis of the sidescan was achieved. Contacts with 1m or greater shadow height were identified and recorded in accordance to NOS standards throughout the entire W00307 survey area and are included in various formats with the submission of this project. A number of significant contacts were identified from these and resurveyed during the TJ reconnaissance effort (see section F.2) for more accurate least depths.

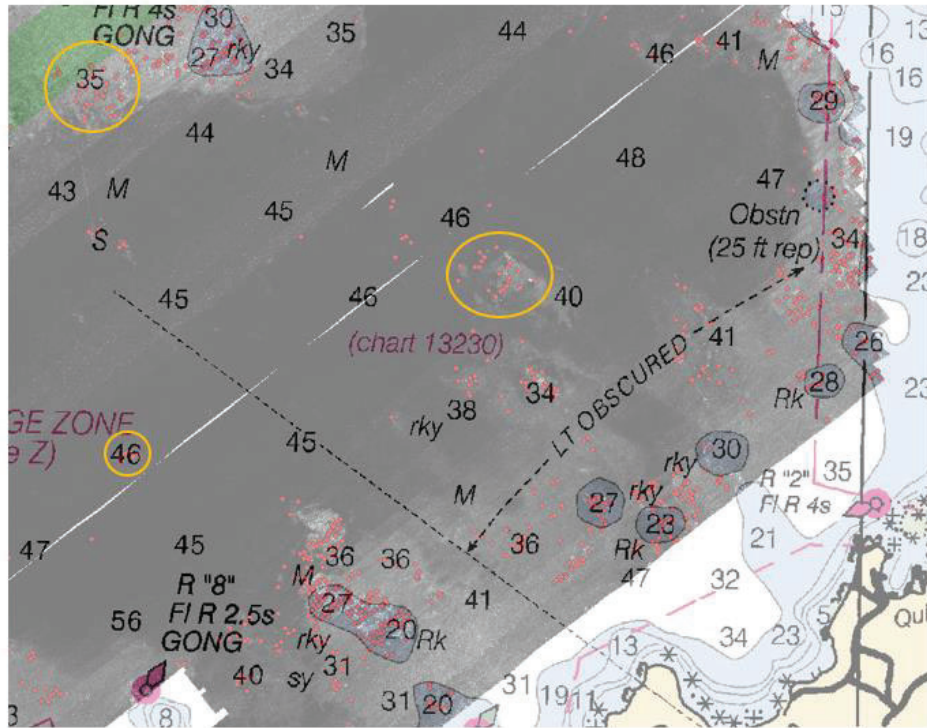


Figure 20: Close up of the Southeast corner of W00307 sidescan mosaic with contacts ( $\geq 1m$ ) in RED and the 13218 chart overlain. The YELLOW circles represent areas of the chart that could be updated with a "rocky, boulders" designation.

It is 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 20). 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." This particular body of water has had problems in the past with tugs with tows slacking their tow lines and getting caught on these boulders. 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
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Chappaquoit	8447685
Monument Beach	8447355
Piney 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 2015 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.

For more information, please reference the USGS Open-File Report 2012-1002 (Ackerman et al).

## H. Approval/Recommendations

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	08/16/2016	 <small>Digitally signed by Andrew A. Armstrong, III DN: cn=Andrew A. Armstrong, o=NOAA/USCGC USCGC, ou=USCGC, email=andrew.armstrong@noaa.gov, c=US</small>

**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 W00307 depths were shifted vertically by -0.366 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 W00307 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

W00307

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)
- Processed survey data and records
- Geospatial PDF of survey products

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

Approved: MCGOVERN.MEGHAN.ELIZABETH.1284020495 Digitally signed by  
MCGOVERN.MEGHAN.ELIZABETH.1  
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Date: 2020.01.22 10:19:11 -05'00'

**Commander Meghan McGovern, NOAA**  
Chief, Atlantic Hydrographic Branch