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): Maine

General Locality: Atlantic Ocean

Sub-Locality: Coastal Waters of York Harbor (Maine)

2019

Group Members: Casey O'Heran, Mekayla Dale, Jeffrey Douglas, Victor Chilamba, Keshav Sauba, Victoria Obura, Anne Hartwell, Rafeq Paimin, Kemron Beache

Chief of Party: Semme Dijkstra

Survey

Dates: June 3rd – July 3rd

UNIVERSITY OF NEW HAMPSHIRE CENTER FOR COASTAL AND OCEAN MAPPING JOINT HYDROGRAPHIC CENTER	GROUP NAME:
HYDROGRAPHIC TITLE SHEET	UNH JHC/CCOM Summer Hydro

INSTRUCTIONS: The hydrographic sheet should be accompanied by this form, filled in as completely as possible when it is forwarded to the office

State(s):	Maine
General Locality	Atlantic Ocean
Sub-Locality:	Coastal Waters of York Harbor (Maine)
Scale:	1:5,000
Dates of Survey:	03 June – 03 July
Instructions Date:	3 June 2019
Field Unit:	CCOM/JHC *R/V Gulf Surveyor*
Soundings by:	R2Sonic 2026 (MBES) Edgetech 6205 (MBES)
Imagery by:	
Soundings Acquired in :	Meters at WGS84

Remarks:

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A. Area Surveyed

The area surveyed during the Summer 2019 Hydrographic Field Course was north of Gerrish Island, ME and south of the Cape Neddick lighthouse. Also included were two offshore areas south east of the coastline around York Harbor. The main survey area comes within 1.17 nautical miles of Gerrish Island at its southwestern most extent and continues north to 0.86 nautical miles from the Cape Neddick Lighthouse. The offshore area comes within about 2.1 nautical miles offshore of Gerrish Island at the southeastern most extent and continues north to 2.1 nautical miles offshore of Brave Boat Harbour at the northwestern most extents. This area extends to about 2.52 nautical miles offshore of Gerrish Island at the western extents (**Figure 1**). Survey operations using a strut mounted R2Sonic 2026 occurred from June 3rd to June 28th 2019. Bottom samples were acquired on June 28th 2019

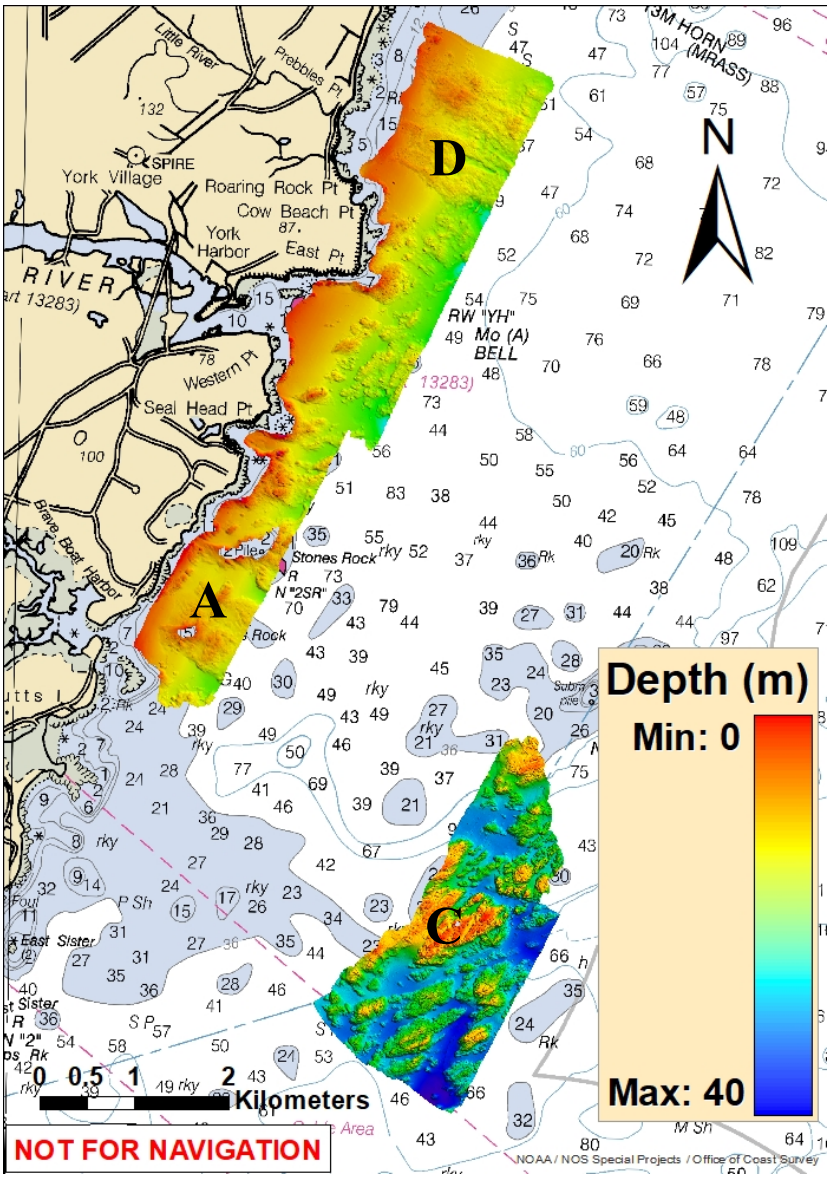

Figure 1: Survey Outline of area's A, C and D and final bathymetry gridded at 1 m

A.1 SURVEY LIMITS

The offshore limits of all survey areas and inshore limits of area C were defined by existing multibeam surveys. The inshore limits of areas A and D were defined by the local coastline. The survey data was collected in a planned polygon. The full extents of the data can be seen below in **Table 1**.

Table 4: Survey Limits

Areas A & D		*Area C*	
Direction	*Limit*	*Direction*	*Limit*
North	*43.152 N*	*North*	*43.090 N*
South	*43.092 N*	*South*	*43.054 N*
East	*70.598 W*	*East*	*70.595 W*
West	*70.650 W*	*West*	*70.627 W*

A.2 SURVEY PURPOSE

The primary objective of the data and deliverables that accompany this hydrographic survey are to meet the requirements of the Hydrographic Field Course as part of the completion of the GEBCO / NIPPON Foundation Graduate Certificate in ocean Mapping and Ocean Engineering curriculums at the University of New Hampshire. Data collected was a continuation of acquisition started by students in the 2018 Summer Hydrographic Field Course (SH2018).

A.3 SURVEY QUALITY

Data was collected to provide high-resolution multibeam echo sounder coverage supporting safe navigation for mariners off the southern coast of Maine. This survey was conducted in accordance with the best practices listed in the *2017 NOAA Field Procedures Manual*. The data and deliverables that accompany this package have been prepared in order to meet the requirements of the *2017 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

Complete multibeam coverage according to 2017 HSSD was acquired over the area shown in **Figure 1**.

A.5 SURVEY STATISTICS

The line plan was created in HYPACK and carried out using a single head high resolution shallow water multibeams echo sounder (R2Sonic 2026). Below is a table (**Table 2**) outlining the total distance planned to be transited on the MBES main scheme and the crosslines for this survey. These statistics were calculated using HYPACK's Line Report Function. **Table 3** shows the number of line files created according to their day and the area covered in each area

Table 5: Survey statistics expressed in kilometers (km) for the planned line schemes

AREA	# of Lines	Distance (km)	Run Line time	Change Line time	Total time
Area A-1 Main Lines	10	31.736	2:26:53	0:27:00	2:53:53
Area A-2 Main Lines	30	95.208	7:20:39	1:27:00	8:47:39
Area A Cross Lines	7	5.444	0:25:12	0:30:00	0:55:12
TOTAL	40	132.388			12:36:44
Area D Main Lines	112	235.811	18:11:23	5:33:00	23:44:23
Area D Cross Lines	9	102.44	0:47:25	0:32:00	1:19:25
TOTAL		246.055			25:03:48
Area C Main Lines	40	91.902	7:05:20	1:57:00	9:02:20
Area C Cross Lines	8	7.585	0:35:06	0:28:00	1:03:06
TOTAL		99.487			10:05:26

Table 3: Survey statistics showing number of line files created each day and area covered (km^2) in each area

Survey Area	Day	# of Lines	Area (km^2)
A & D	2019-161	30	8168.662
	2019-165	56	
	2019-168	122	
	2019-169	43	
	2019-170	72	
	2019-171	116	
	2019-172	47	
	2019-176	24	
	TOTAL	**510**	
C	2019-172	20	4979.099
	2019-175	92	
	2019-176	36	
	TOTAL	**148**	

The following table (**Table 4**) lists the specific dates of data acquisition for this survey:

Table 4: Survey acquisition dates

Survey Date	***Year Day Number***	***Data Acquisition***
06/10/2019	161	Patch Test
06/11/2019	162	Roll error experiment
06/12/2019	163	Mobilization of AML MVP 30 and Test profiles in River
06/13/2019	164	Patch Test
06/14/2019	165	MVP test deployments, Survey Area A
06/17/2019	168	Survey Area A
06/18/2019	169	Survey Area A & D, Edgetech Mobilized but not used
06/19/2019	170	Survey Area A &D
06/20/2019	171	Survey Area D
06/21/2019	172	Survey Area D & C
06/24/2019	175	Survey Area C,
06/25/2019	176	Survey Area C
06/26/2019	177	MVP Profiles on shore orthogonal transect
06/27/2019	178	MVP 30 and R2Sonic 2026 demobilized
06/28/2019	179	Bottom Video & Grab Sampling

B. DATA ACQUISITION AND PROCESSING

B.1 EQUIPMENT AND VESSELS

The R/V Gulf Surveyor is a 48-foot, twin screw, geared diesel, propeller driven catamaran owned by CCOM/JHC at UNH. The survey described in this document was completed using a centerline strut mounted R2Sonic 2026 MBES. Sound speed profiles were collected using a manually deployed ODOM Digibar Pro SVP and stern-mounted moving vessel profiler, the AML Oceanographic, Ltd, MVP-30. A port-side strut-mounted .Tech 6205 PDES was installed to supplement the multibeam data acquisition, but was not used due to interference with the R2Sonicecho sounder. The data were collected in accordance to NOS HSSD specifications and meet IHO Special Order standards.

Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures, and processing methods. General specifications are as follows:

B1.1 VESSELS

The survey platform used during the 2019 Summer Hydrographic Field Course (SH2019) was the *R/V Gulf Surveyor* (**Figure 2**) and the specifications are in **Table 5**.

Figure 2: R/V Gulf Surveyor – Left: Starboard View Right: Front View

Table 5: R/V Gulf Surveyor specifications

Length	48 feet (14.6 m)
Beam	17 feet (5.18 m)
Maximum draft	5 feet 6 inches (1.68 m)
Flag	U.S
Top Speed	18 knots
GPS antennas	2 x Trimble Zephyr Antennas
RTK GPS receiver	Trimble Trimark 3
Positioning and attitude	Applanix PosMV 320 with IMU 200
Primary Echosounder	R2Sonic 2026

B1.2 EQUIPMENT

The systems in **Table 6** were used for data acquisition during SH2019:

Table 6: Major acquisition systems

Manufacturer	*Model*	*Type*
R2Sonic	2026	MBES
Edgetech	6205	MBES
Applanix	PosMV 320 V5	Positioning and attitude
AML	MVP 30	Moving Vessel Profiler
ODOM	Digibar Pro	Sound Speed Profiler
Trimble	Trimble 5700	GNSS Receiver

B.2 QUALITY CONTROL

B.2.1 CROSSLINES

Crosslines were planned and executed at approximately 500 m spacing, orthogonal to the main survey scheme (**Figure 3** & **Figure 5**).

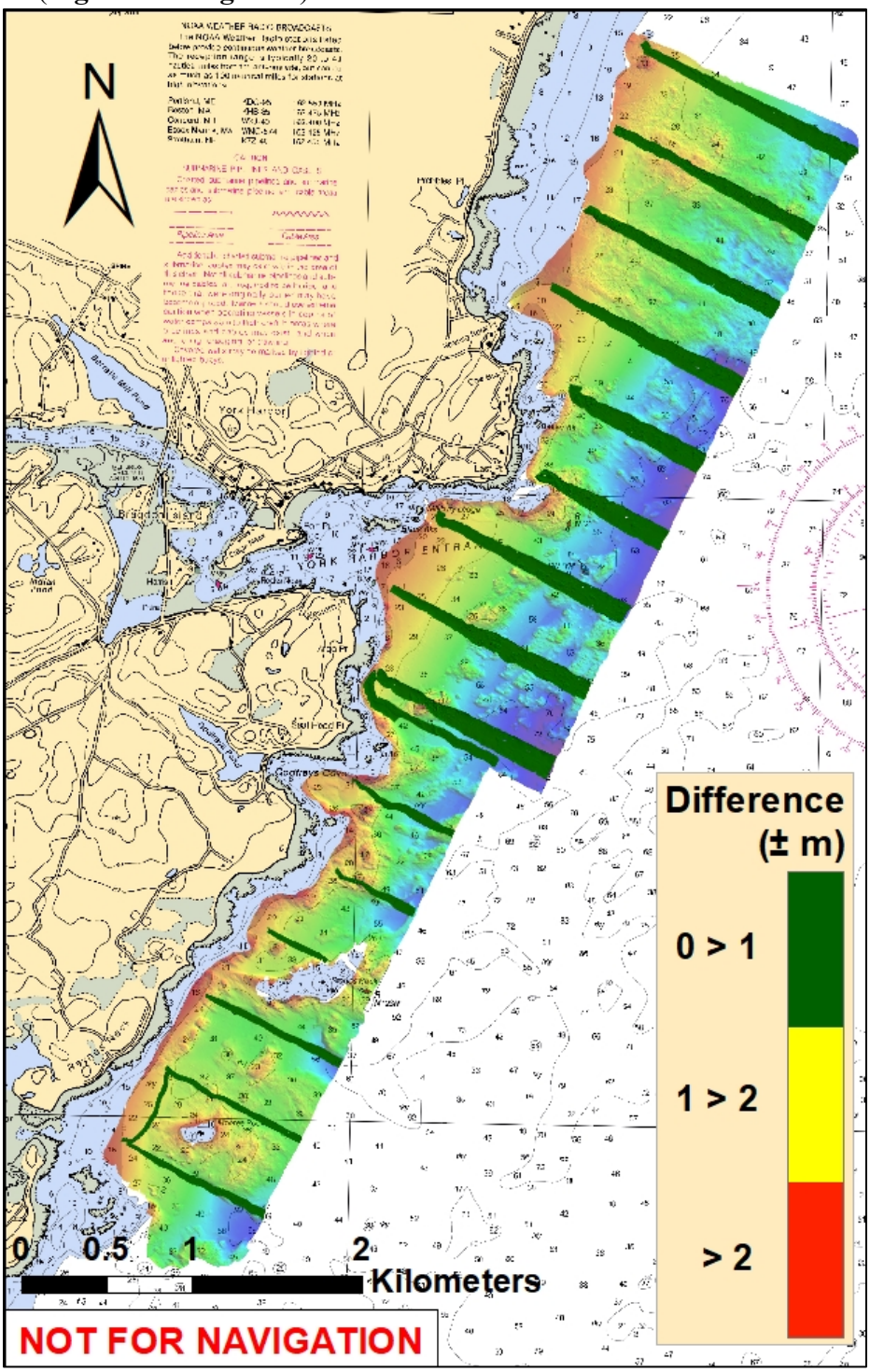

Figure 3: Crossline difference surface for survey area A & D overlaid on top of the bathymetry

The surface difference statistics can be seen in the **Figure 4**. Note these mostly fall within HSSD specifications.

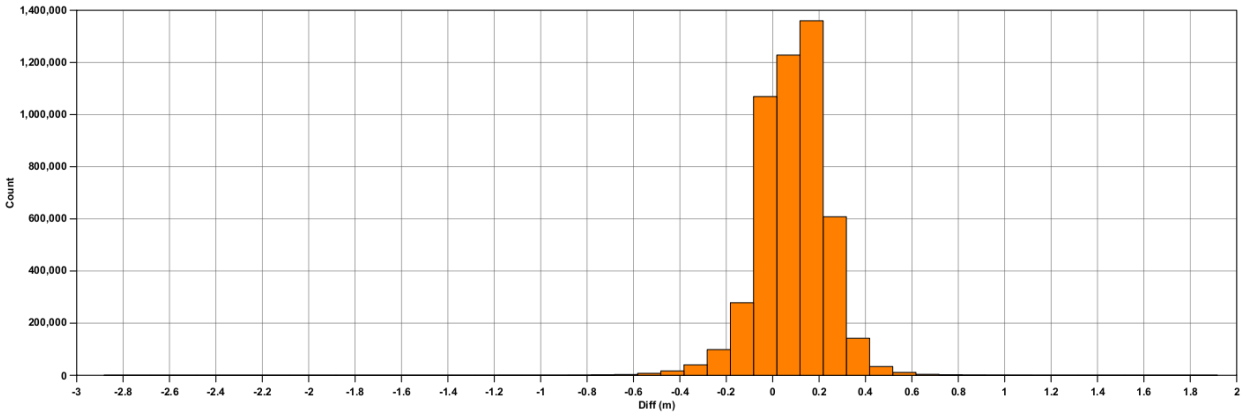

Figure 4: Statistical output for areas A & D crossline difference surface

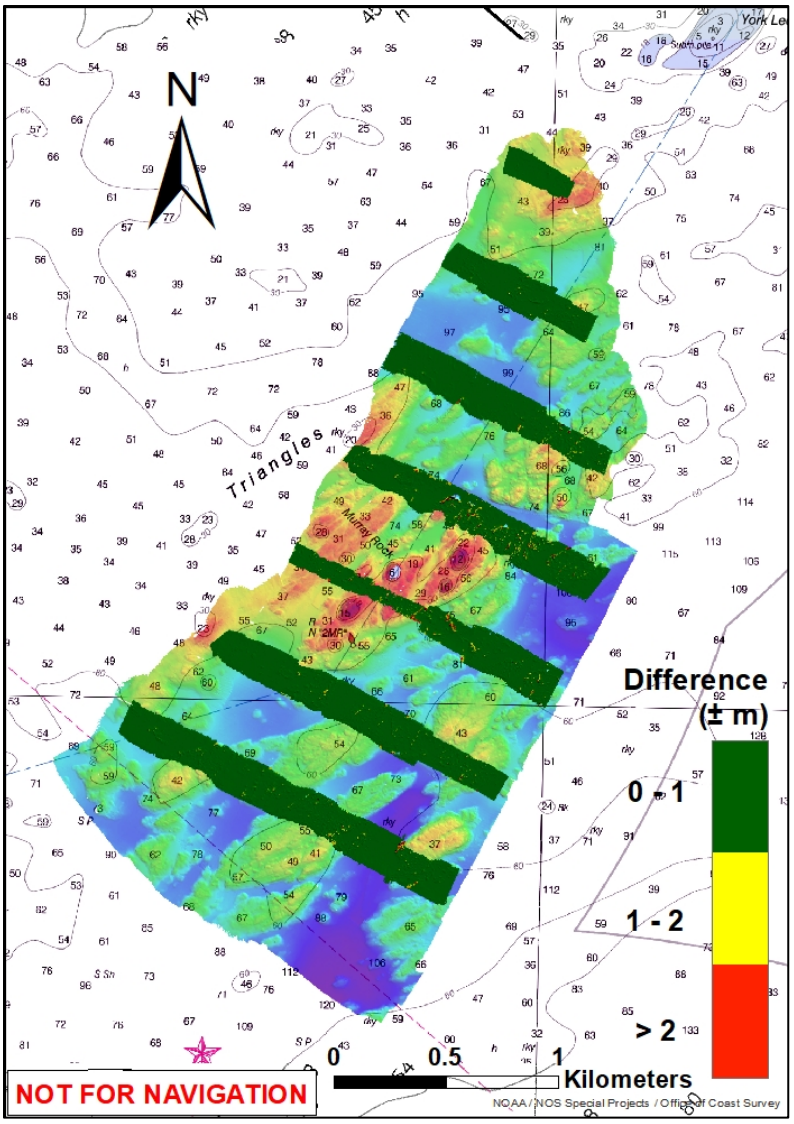

Figure 5: Crossline difference surface for survey area C overlaid on top of the bathymetry

The surface difference statistics can be seen in **Figure 6**. Note these fall within HSSD specifications.

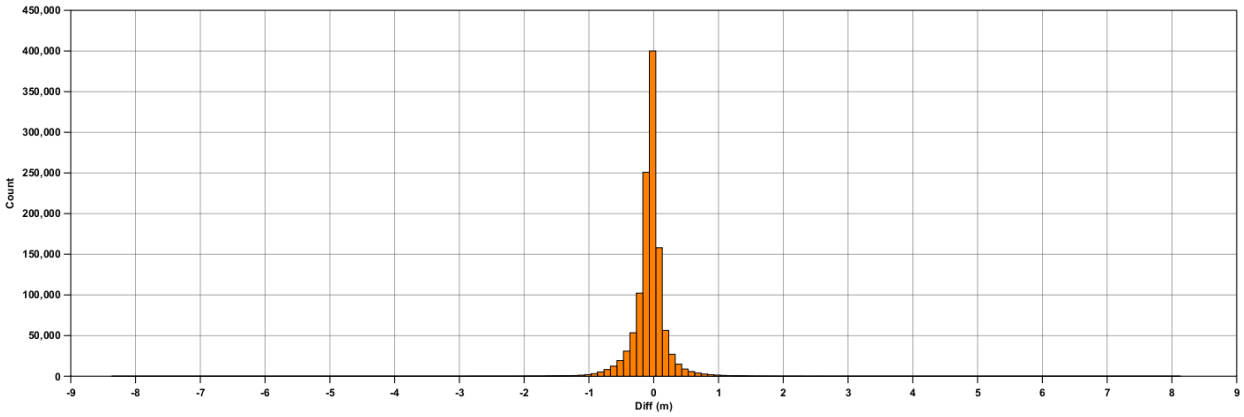

Figure 6: Statistical output for area C crossline difference surface

B2.2 UNCERTAINTY

Total propagated Uncertainty values (**Table 7**)for this survey were derived from a combination of fixed values for equipment and vessel characteristics, as well as values for sound speed uncertainties.

Table 6: TPU values used in processing MBES data

EQUIPMENT	**FEATURE**		**TPU**
R2Sonic 2026	*Echosounder*	*Pulse Length*	0.015 ms
		Sampling Length	0.02 m
	Offsets	*Roll*	0.05 º
		Pitch	0.05 º
		Heading	0.05 º
	Sound Velocity (AML MVP-30)	*Surface Sound Speed*	0.05 m/s
	Stabilization	*Roll stabilization*	0.00 m
		Pitch stabilization	0.00 m
		Heave compensation	0.00 m
Beam width		*Along*	1 º
		Across	0.50 º
Edgetech 6205	*Echosounder*	*Pulse Length*	
		Sampling Length	
	Offsets	*Roll*	
		Pitch	
		Heading	
	Sound Velocity (AML MVP-30)	*Surface Sound Speed*	
	Stabilization	*Roll stabilization*	
		Pitch stabilization	

		Heave compensation	
		Pitch offset	
		Heading offset	
APPLANIX POS/MV 320 V5	*Motion*	*Roll*	0.05º
		Pitch	0.05º
		Heading	0.05º
		Heave Fixed	0.05 m
		Heave Variable	5 %
		Roll Offset	0.05º
		Pitch Offset	0.05º
		Heading Offset	0.05º
	Position (IARTK mode, base station up to 15 km away)	*Horizontal*	0.5 m
		Vertical	1 m
AML MVP30	*Temperature / Conductivity*	*Temperature*	0.005ºC
		Conductivity	0.01 ms/cm
AML Smart SV&P	*Sound Velocity*	*Sound Velocity*	0.05 m/s

For this survey Special Order specifications requires the maximum allowable horizontal uncertainty to be 2 m at 95 % confidence. For vertical uncertainty the following equation is used at 95 % confidence:

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

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.

The 2019 Summer Hydro survey varied in depths from~ 6 - 38 m meters. With these values, the range of maximum allowable total vertical uncertainty is +/- 0.25 m to +/- 0.38 m at 95% confidence level.

For Area A-D, an uncertainty analysis in CARIS yielded a range between 0.03 and 0.22 meters, with an average uncertainty of 0.07 m and a standard deviation of 0.03 m (Figure 16). The maximum uncertainty is per 1m cell is less than the maximum allowable total vertical uncertainty for Special Order specifications.

For Area C, an uncertainty analysis in CARIS yielded a range between 0.03 and 0.33 meters, with an average uncertainty of 0.11m and a standard deviation of 0.05 m (Figure 17). The upper limit is within and the average is less than the allowable total vertical uncertainty according to the Special Order specifications.

In Area A-D, the greatest uncertainty is in the deeper sections of Area D.

In Area C, the greatest uncertainty is along the edges of the survey area and in the NE section of the survey Area.

Below can be seen an image of the total range of uncertainty for the 1m grid. **Figure 7** & **Figure 9** show that all of survey areas meet the requirements for Special Order maximum uncertainty. The statistical outputs can be seen in **Table 8** (visualized in **Figure 8**) & **Table 9**.

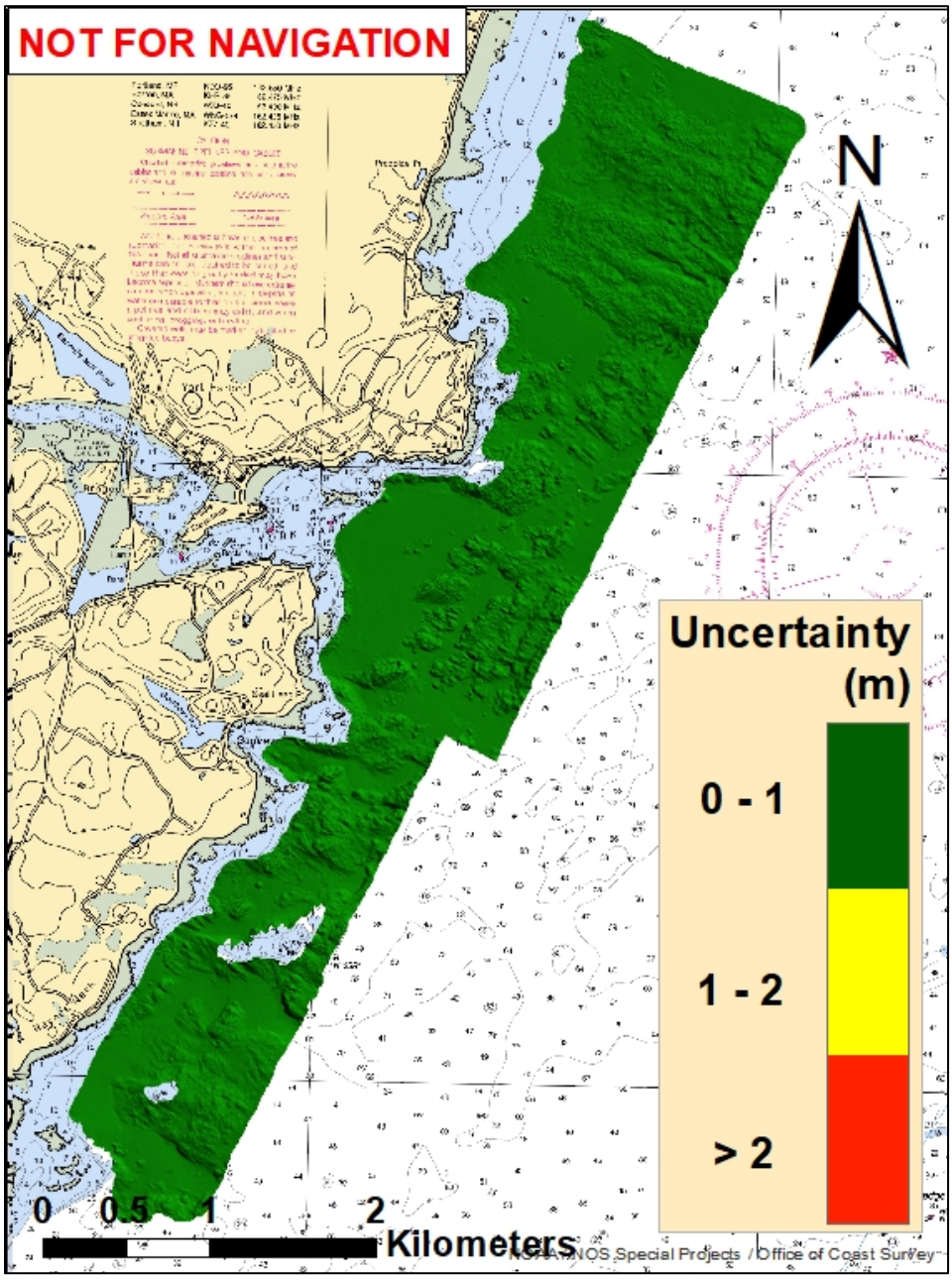

Figure 7: Full range of Uncertainty present in final surface of Area A & D gridded at 0.5m

Table 7: Statistics output for uncertainties associated to Area A & D

Statistical information:	
Minimum:	0.03 m
Maximum:	0.22 m
Mean:	0.07 m
Area:	N/A
Std_dev:	0.03 m
Total count:	31,582,943

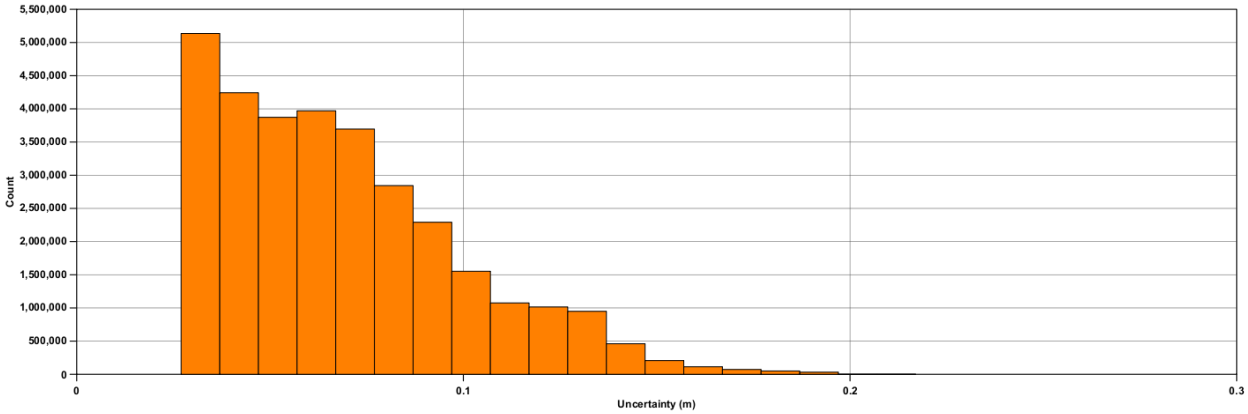

Figure 8: Statistics output for areas A & D uncertainty

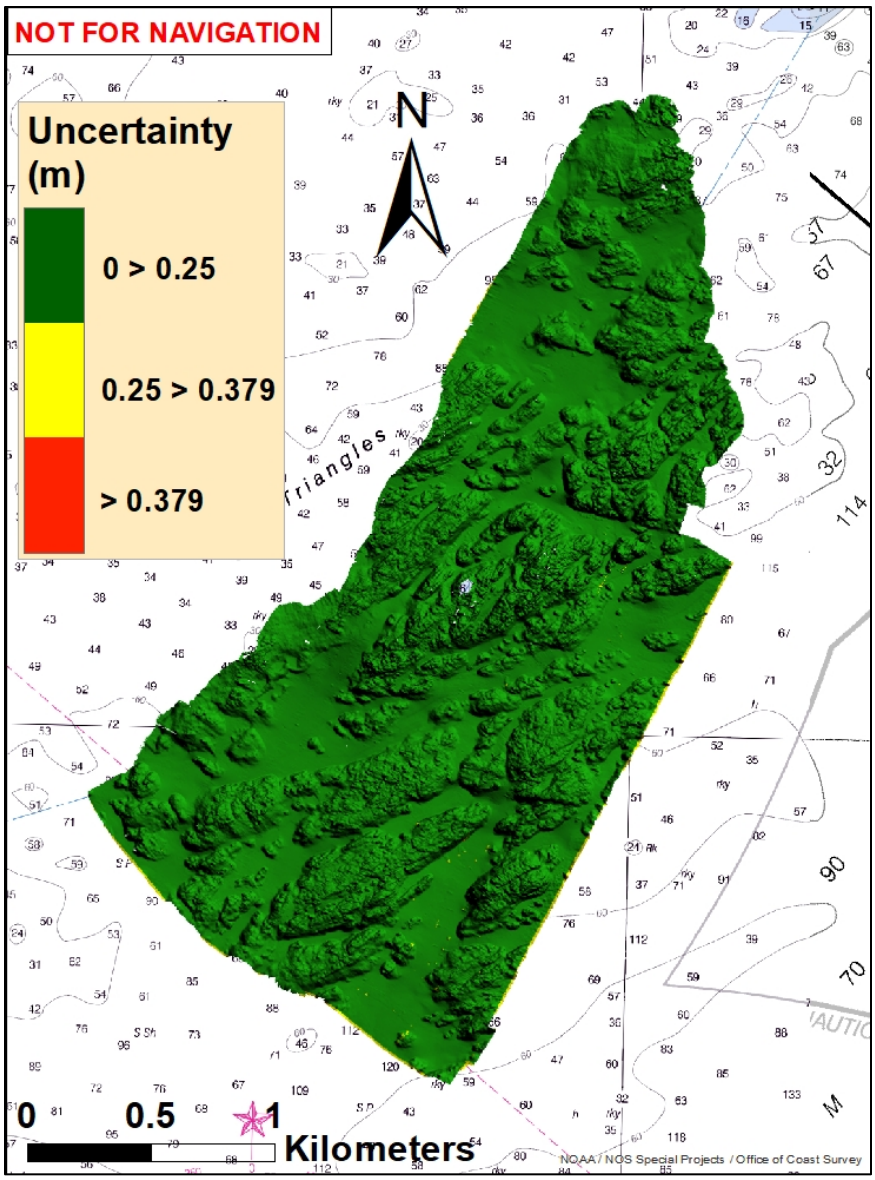

Figure 9: Full range of Uncertainty present in final surface of Area C gridded at 0.5m

Table 9: Statistics output for uncertainties associated to Area C

Statistical information:	
Minimum:	0.03 m
Maximum:	0.33 m
Mean:	0.11 m
Area:	N/A
Std_dev:	0.05 m
Total count:	4,932,098

B2.3 JUNCTIONS

The MBES surveys in **Table 10** junction with survey areas A and D (**Figure 10**):

Table 10: Junctioning Surveys (with Areas A and D)

Survey code	Year	Vessel	Agency	Relative location
H12615	2013	NOAA Ship Ferdinand R. Hassler	NOAA	North-east
W00244	2012	UNH R/V Coastal Surveyor / NOAA R/V Cocheco	UNH / NOAA	South-west
SH2018	2018	UNH R/V Gulf Surveyor	UNH	South-east

The MBES surveys in **Table 11** junction with survey area C (**Figure 10**):

Table 11: Junctioning Surveys (with Area C)

Survey code	Year	Vessel	Agency	Relative location
H03032	2017	UNH R/V Gulf Surveyor	UNH	North
H12613	2013	NOAA Ship Ferdinand R. Hassler	NOAA	North-east
W00244	2012	UNH R/V Coastal Surveyor / NOAA R/V Cocheco	UNH / NOAA	South-west

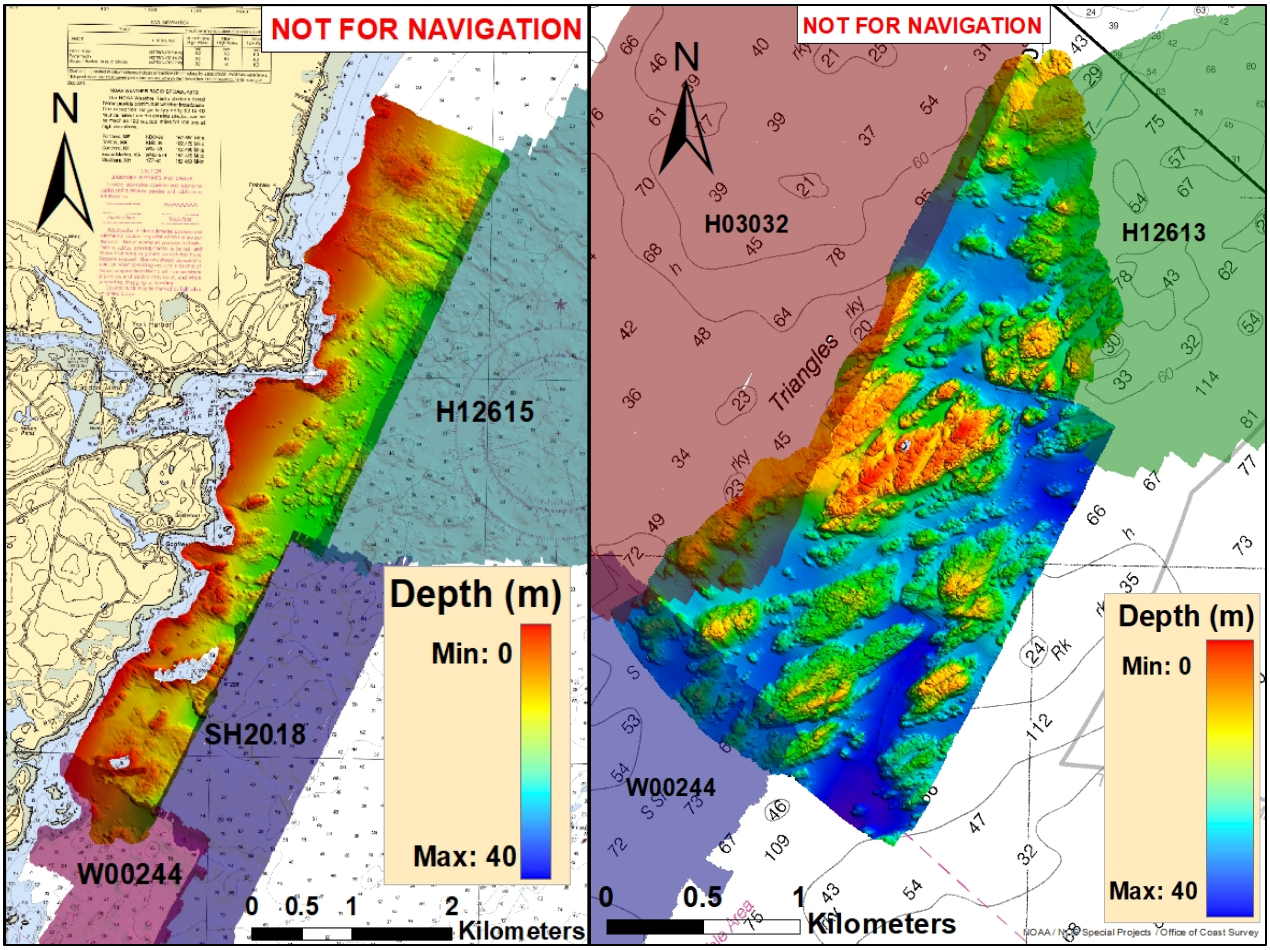

Figure 10: Surveys that junction with both survey areas

B.2.3.1. NOAA Survey H12615

This survey was conducted by NOAA Ship Ferdinand R. Hassler in 2013 and partially overlaps the north eastern limits of survey area A & D. A CUBE 4 m surface of H12615 was compared to the 0.5 m final surface of survey Area A & D (**Figure 12**). **Table 12** below shows associated statistics (**Figure 11**).

Table 12: Statistics about junction between SH2019 Area A & D and H12615

Statistical information:	**SH2019 Area A & D vs H12615**
Minimum:	-2.70 m
Maximum:	2.65 m
Mean:	-0.33 m
Area:	N/A
Std_dev:	0.22 m
Total count:	1,938,413

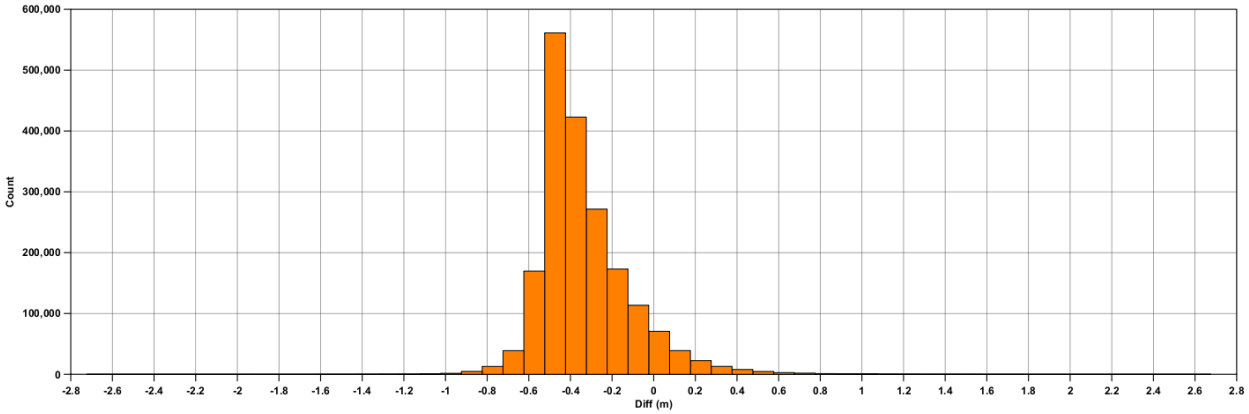

Figure 11: Statistics output from junction between SH2019 Area A & D and H12615

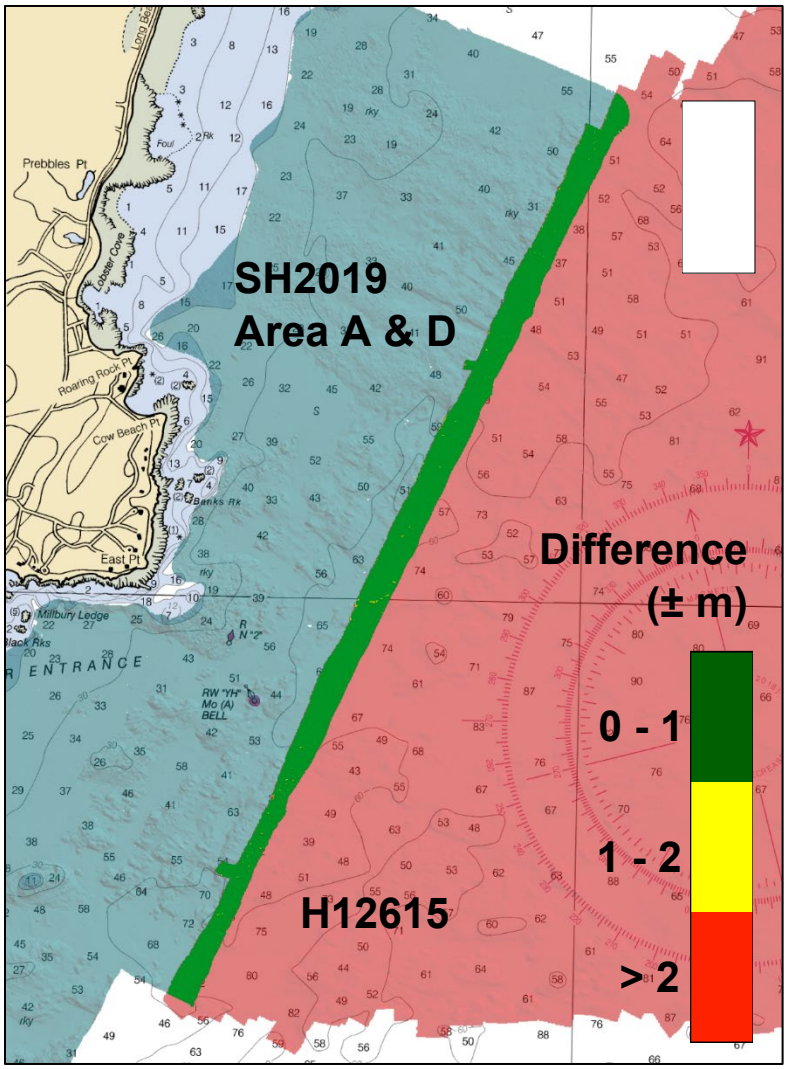

Figure 12: Difference surface between SH2019 Area A & D and H12615

B.2.3.2. UNH / NOAA Survey W00244

This survey was conducted by UNH R/V Coastal Surveyor / NOAA R/V Cocheco in 2012 and partially overlaps the south western limits of survey area A & D. A CUBE 2 m surface of W00244 was compared to the 0.5 m final surface of survey Area A & D (**Figure 14**). **Table 13** below shows associated statistics (**Figure 13**).

Table 13: Statistics about junction between SH2019 Area A & D and W00244

Statistical information:	**SH2019 Area A & D vs W00244**
Minimum:	-1.20 m
Maximum:	1.89 m
Mean:	-0.04 m
Area:	N/A
Std_dev:	0.19 m
Total count:	1,765,388

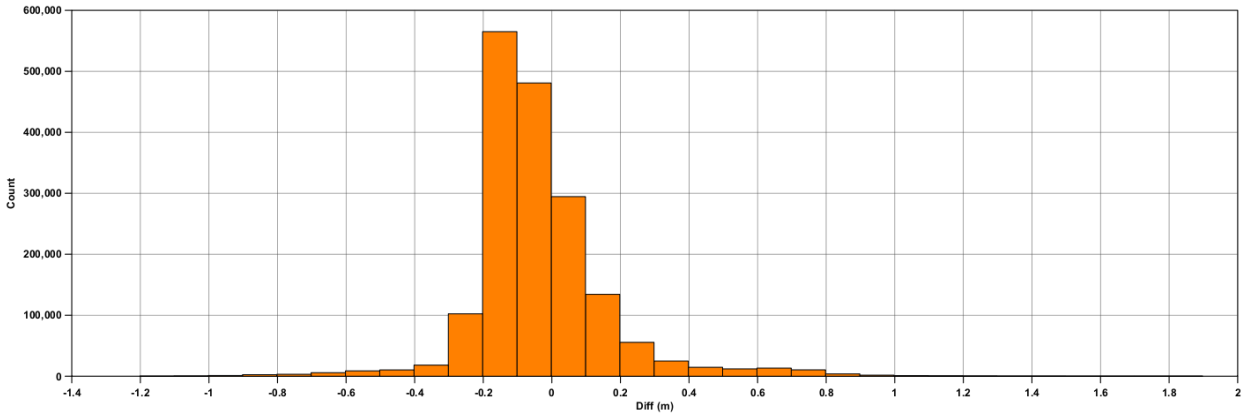

Figure 13: Statistics output from junction between SH2019 Area A & D and W00244

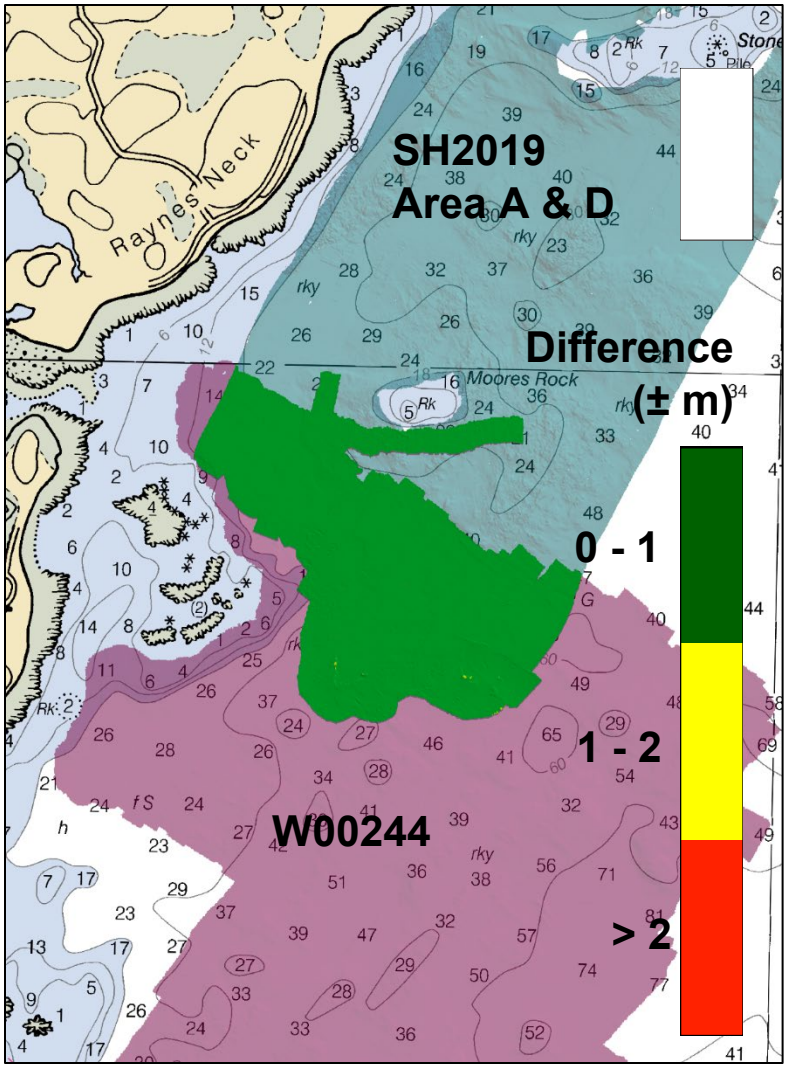

Figure 14: Difference surface between SH2019 Area A & D and W00244

B.2.3.3 SH2018

This survey was conducted by UNH R/V Coastal Surveyor in 2018 and partially overlaps the southern limits of survey area C. A CUBE 2 m surface of SH2019 was compared to the 0.5 m final surface for survey area C (**Figure 16**). **Table 14** below shows associated statistics (**Figure 15**).

Table 14: Statistics about junction between SH2019 Area A & D and SH2018

Statistical information:	**SH2019 Area A & D vs SH2018**
Minimum:	-6.82 m
Maximum:	0.61 m
Mean:	-1.37 m
Area:	N/A
Std_dev:	0.12 m
Total count:	752,956

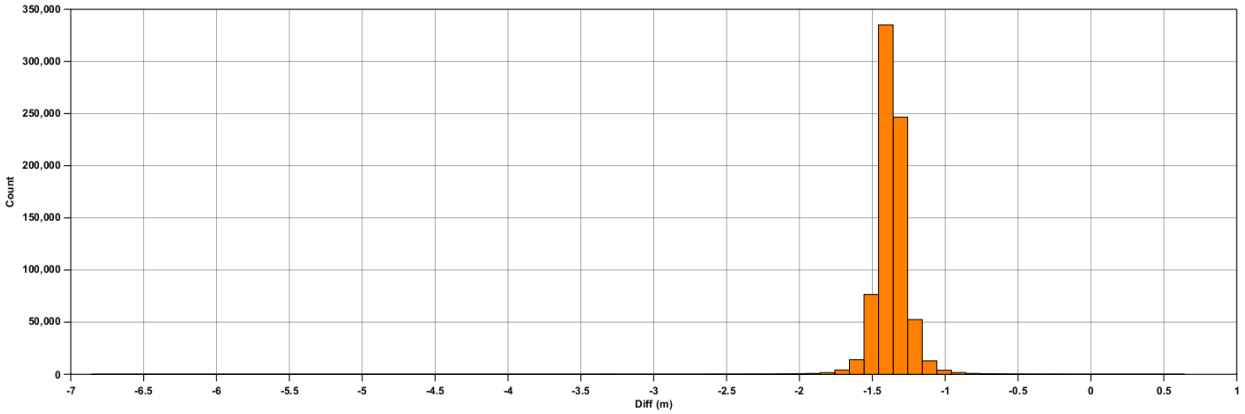

Figure 15: Statistics output from junction between SH2019 Area A & D and SH2018

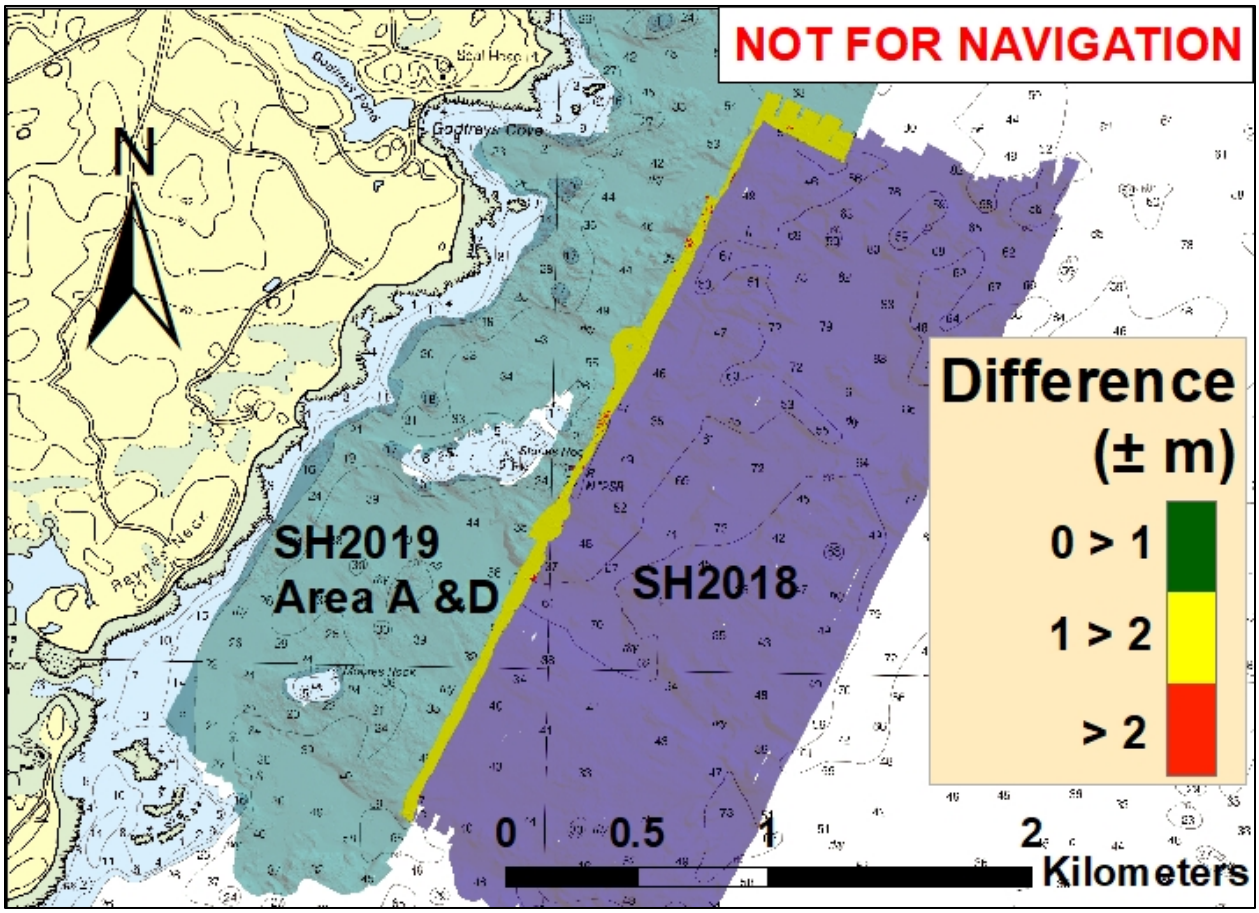

Figure 16: Difference surface between SH2019 Area A & D and SH2018

It is known that the SH2018 dataset has a consistent 1.31 m offset. By considering this, the difference appears as it does in **Figure 17**.

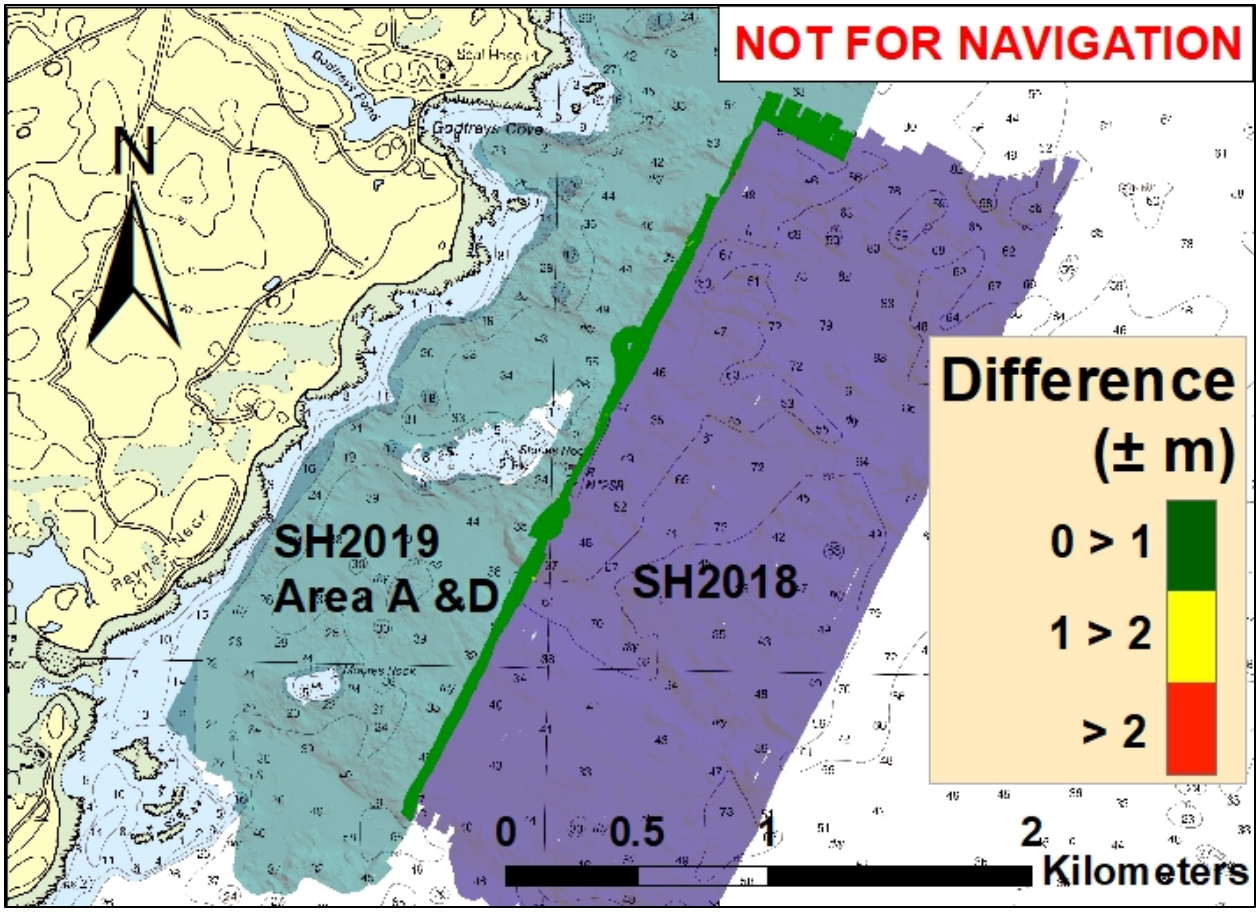

Figure 17: Difference surface between SH2019 Area A & D and SH2018 (corrected for the 1.31 m offset present the SH2018)

B.2.3.4 NOAA Survey H03032

This survey was conducted by UNH R/V Coastal Surveyor and partially overlaps the northern limits of survey area C. A CUBE 0.5 m surface of H03032 was compared to the 0.5 m final surface for survey area C (**Figure 19**). **Table 15** below shows associated statistics (**Figure 18**).

Table 15: Statistics about junction between SH2019 Area C and H03032

Statistical information:	**SH2019 Area C vs H03032**
Minimum:	-3.87 m
Maximum:	5.28 m
Mean:	0.46 m
Area:	N/A
Std_dev:	0.46 m
Total count:	2,294,504

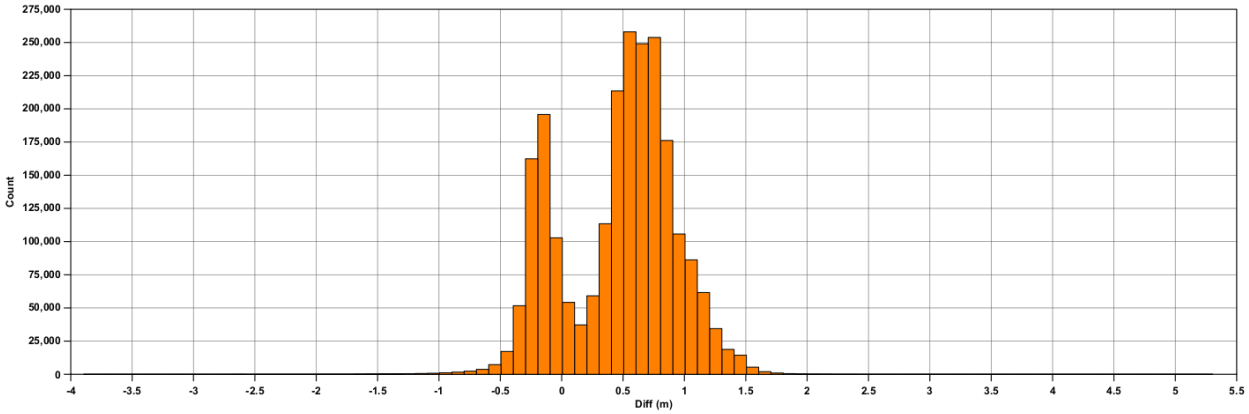

Figure 18: Statistics output from junction between SH2019 Area C and H03032

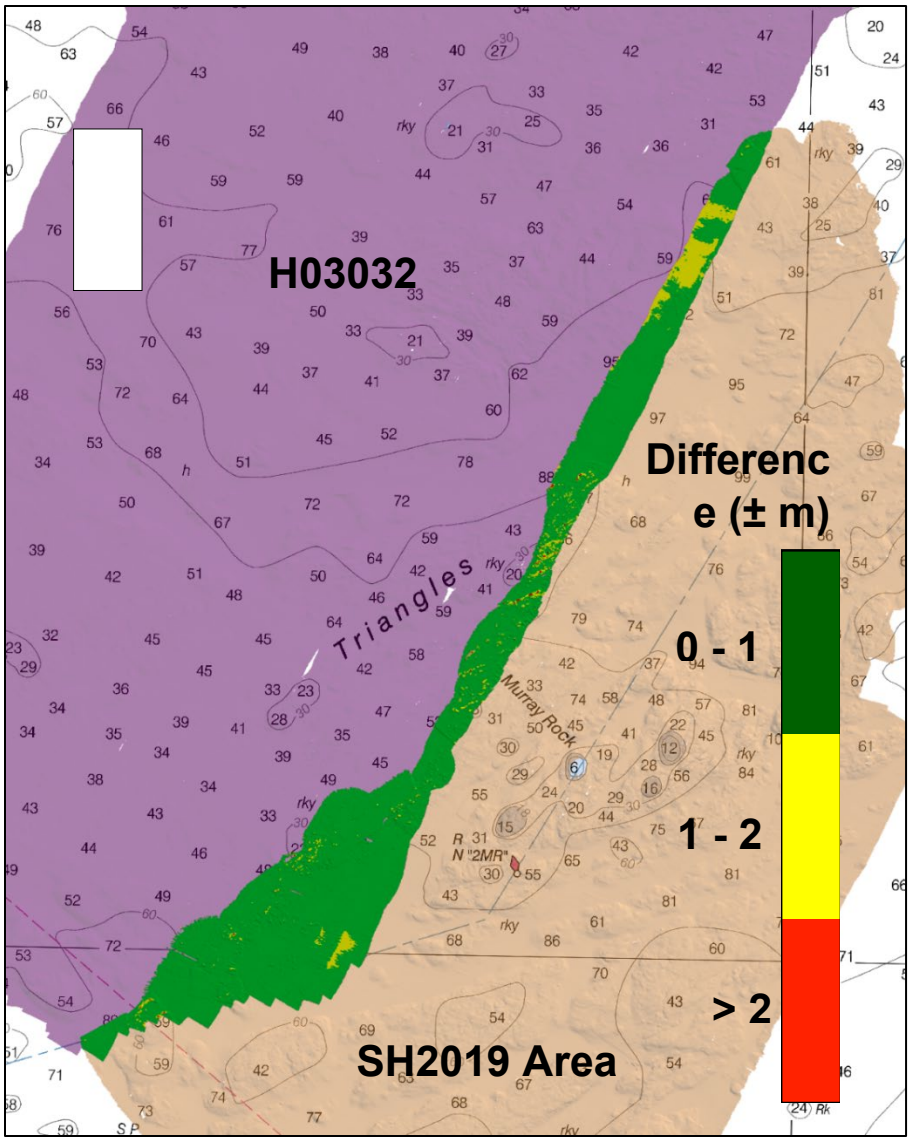

Figure 19: Difference surface between SH2019 Area C and H03032

B.2.3.5. NOAA Survey H12613

This survey was conducted by NOAA Ship Ferdinand R. Hassler in 2013 and partially overlaps the northern limits of survey area C. A CUBE 4 m surface of H12613 was compared to the 0.5 m final surface of survey Area C (**Figure 21**). **Table 16** below shows associated statistics (**Figure 20**).

Table 16: Statistics about junction between SH2019 Area C and H12613

Statistical information:	**SH2019 Area C vs H12613**
Minimum:	-6.50 m
Maximum:	10.89 m
Mean:	0.49 m
Area:	N/A
Std_dev:	0.55 m
Total count:	1,515,593

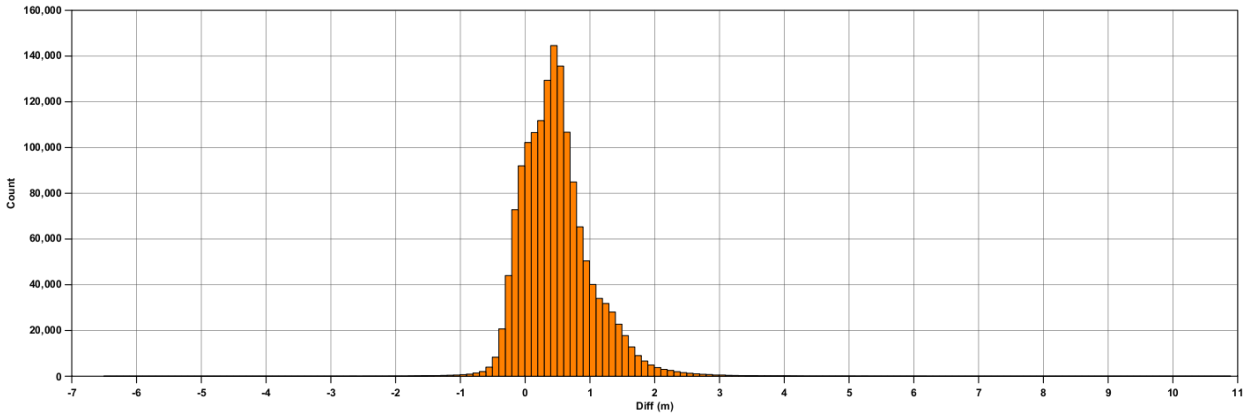

Figure 20: Statistics output from junction between SH2019 Area C and H12613

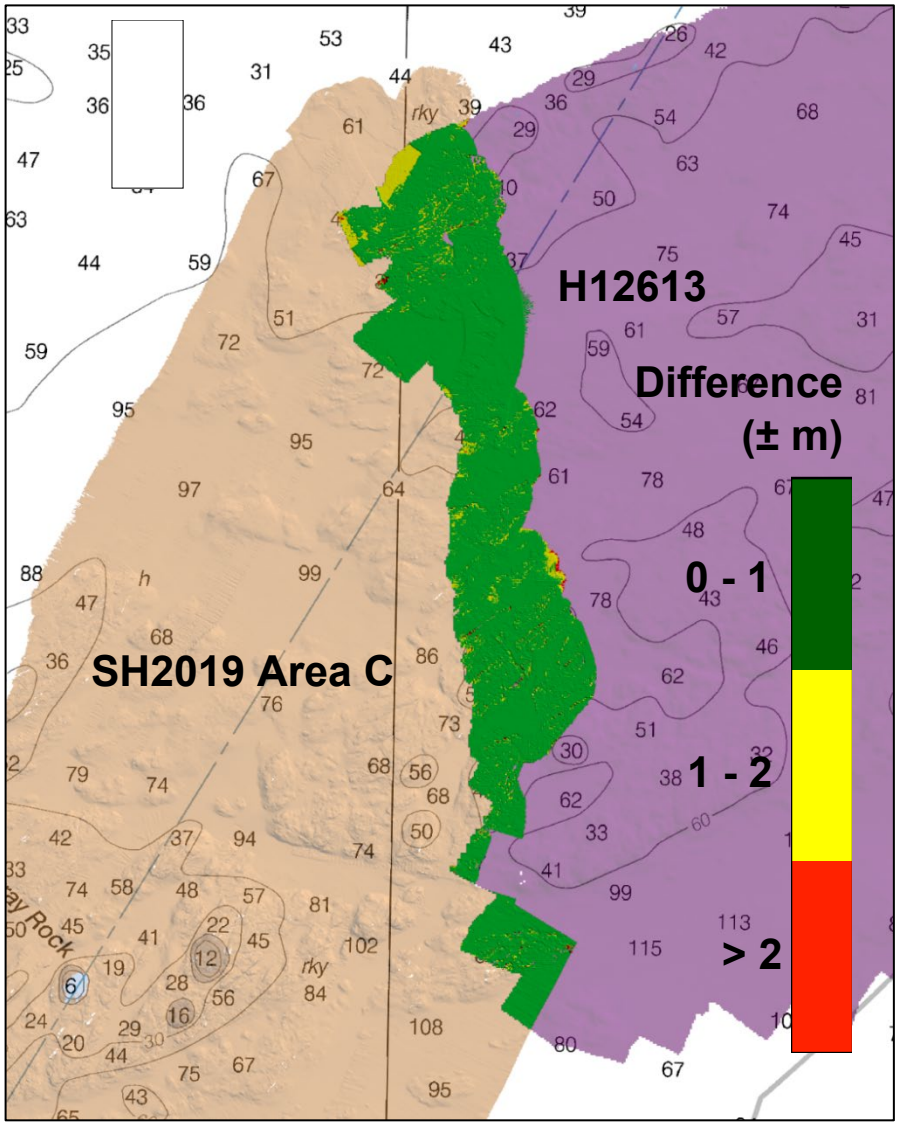

Figure 21: Difference surface between SH2019 Area C and H12613

B.2.3.6. NOAA Survey W00244

This survey was conducted by UNH R/V Coastal Surveyor and NOAA R/V Cocheco in 2012 and partially overlaps the northern limits of survey area C. A CUBE 2 m surface of W00244 was compared to the 0.5 m final surface of survey C (**Figure 23**). **Table 17** below shows associated statistics (**Figure 22**).

Table 17: Statistics about junction between SH2019 Area C and W00244

Statistical information:	**SH2019 Area C vs W00244**
Minimum:	-3.46 m
Maximum:	4.71 m
Mean:	0.11 m
Area:	N/A
Std_dev:	0.39 m
Total count:	1,350,583

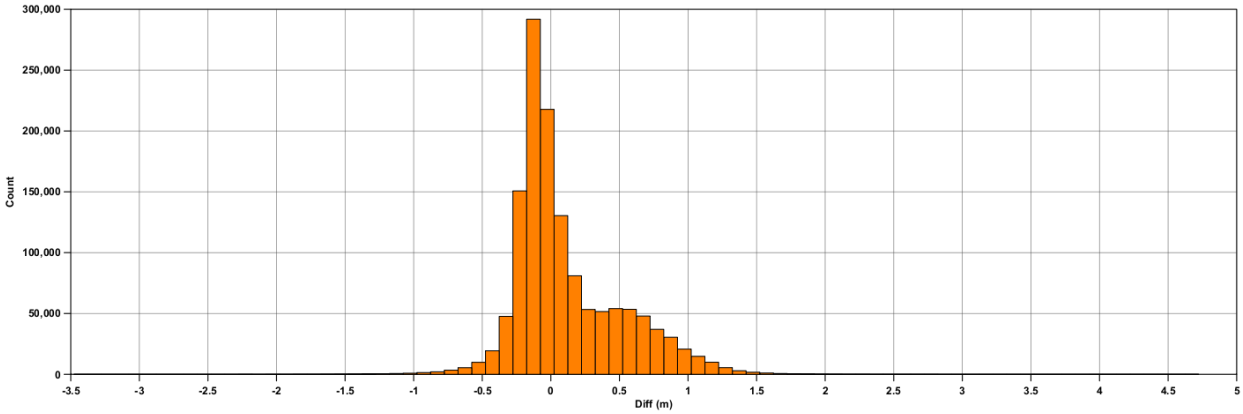

Figure 22: Statistics output from junction between SH2019 Area C and W00244

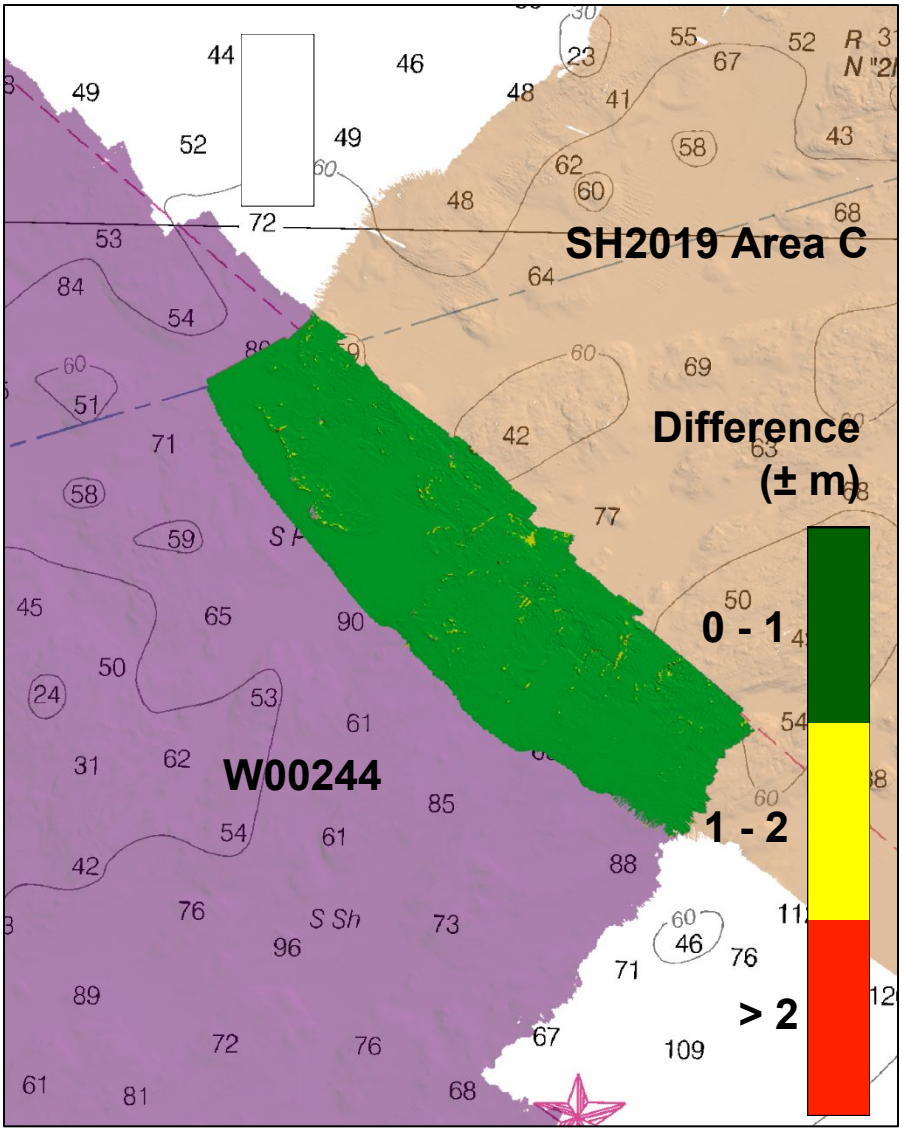

Figure 23: Difference surface between SH2019 Area C and W00244

B2.4 SONAR QC CHECKS

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

B.2.5 EQUIPMENT EFFECTIVENESS

The base station at the Seacoast Science Center at Odiorne State Park was not able to provide corrections throughout the duration of the survey. Therefore, POSPac was used to produce .SBET files using the NUNH CORS station as a base station. These files were then applied in post processing of the .xtf files in Caris.

The Edgetech 6205 interfered with the R2Sonic 2026 (primary sonar system). For this reason, it was not used to acquire data during surveying, but instead was used as a mobilizing / demobilizing exercise for both groups, including integrating it with the on board computers.

B.2.6 FACTORS AFFECTING SOUNDINGS

The AML MVP30 created surface profiles starting at an incorrect depth (approximately 1.2 m too high). This resulted in the sonar being placed in the wrong part of the profile. There were strong sound velocity gradients in this area so the surface sound speed probe often showed that there was greater than a ± 3 m/s difference between it and the profile being used. Each profile was therefore adjusted (depths increased by 1.2 m) and reapplied to the data.

B.2.7 SOUND SPEED METHODS

Sound speed measurements were made by manually deploying an ODOM Digibar Pro SVP from June 3rd to June 12th. Then the AML MVP30 was installed and was used from June 13th to the end of the survey on July 3rd. The AML MVP30 is a moving vessel profiler. See the DAPR section for more information regarding procedures.

Another ODOM Digibar Pro was installed at the base of the strut above the R2Sonic 2026 to be used as a surface sound speed probe.

B.2.8 COVERAGE EQUPMENT AND METHODS

Complete coverage requirements as dictated in the NOS HSSD were met by maintaining survey speed at about 7 knots and utilizing high-density equidistant operating mode on the R2Sonic 2026. Finalized CUBE surfaces of 0.5m and 1m were produced from this data

B.2.8.1 Sounding Density Analysis

The sounding density per grid node of a 0.5 m and 1m surface can be seen in **Figure 24** & **Figure 26**. The number of soundings per m^2 required to meet the IHO Special Order minimum requirements is 3.59. Associated statistics are in **Table 18** & **Table 19** (**Figure 25** & **Figure 27**).

Area C gridded at 1m meets the 5m nodes per cell for 95% of cells requirement of the NOAA HSSD. Area A-D

Area A-D's final surface is gridded at 1m in order to meet the NOAA density requirements. (An 0.5 grid is also being submitted to archive.)

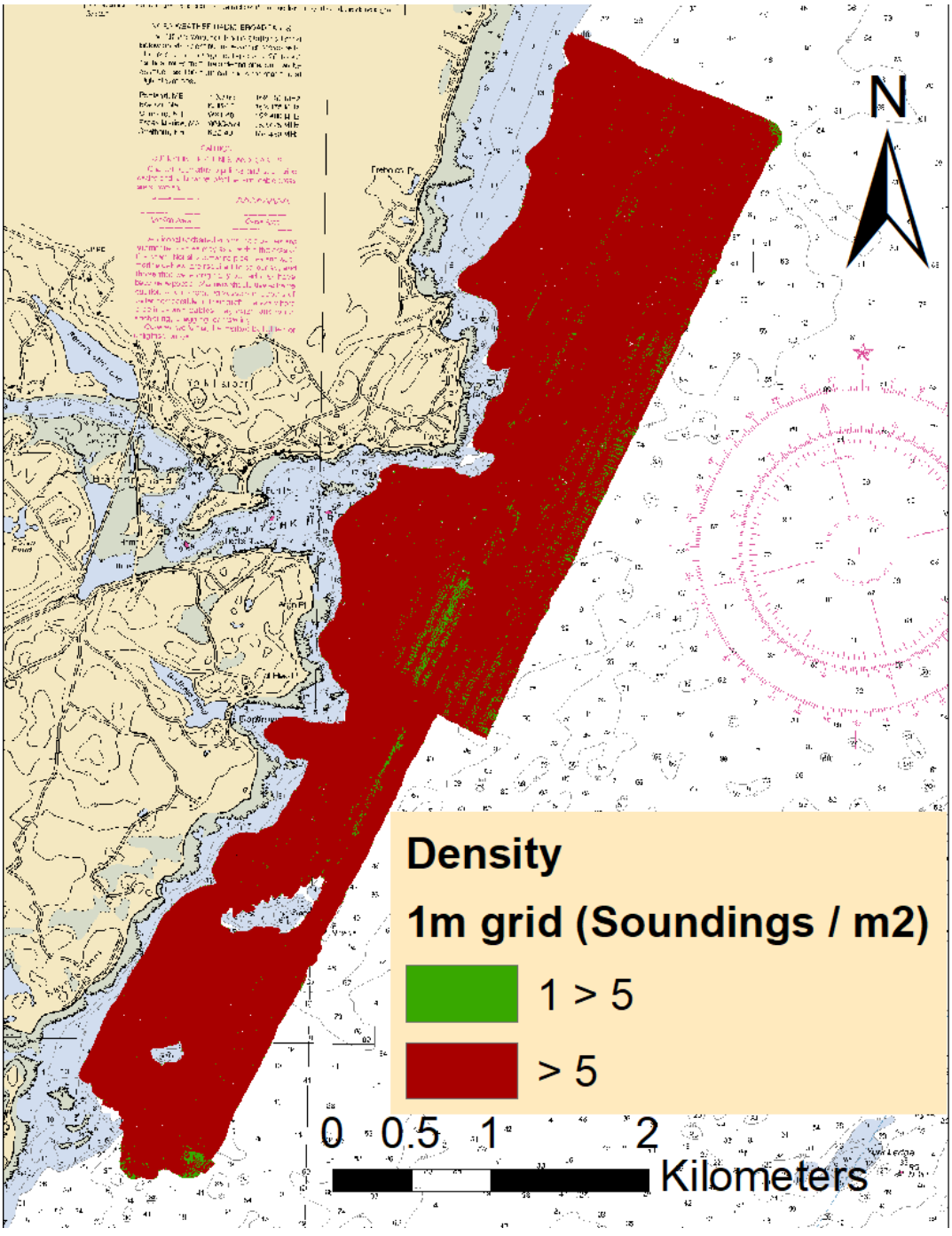

Figure 24: Sounding Density of SH2019 Area A & D 1m grid

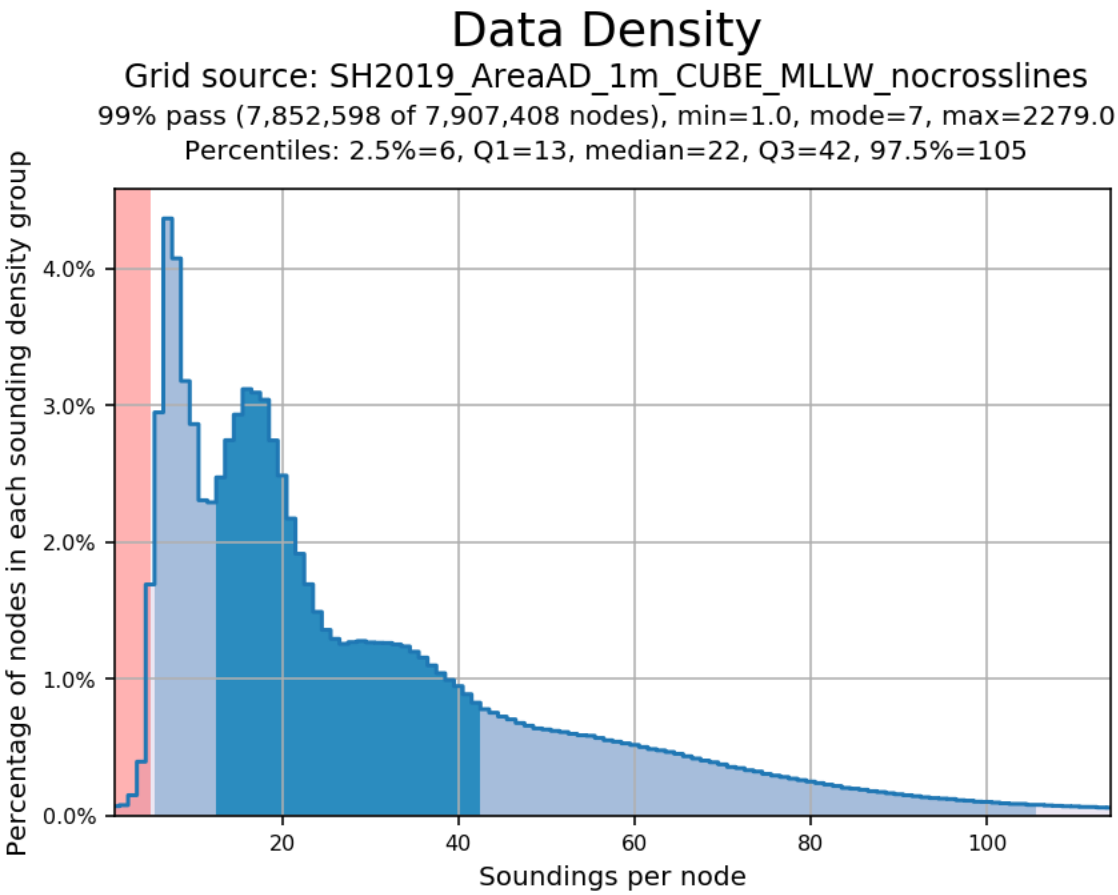

Figure 25: Statistics output for the Density of Area A & D 1m grid

Table 18: Statistics about sounding density of Area A & D using 0.5m

Statistical information:	
Minimum:	1.000
Maximum:	1036.000
Mean:	15.947
Area:	N/A
Std_dev:	14.571
Total count:	31,582,943

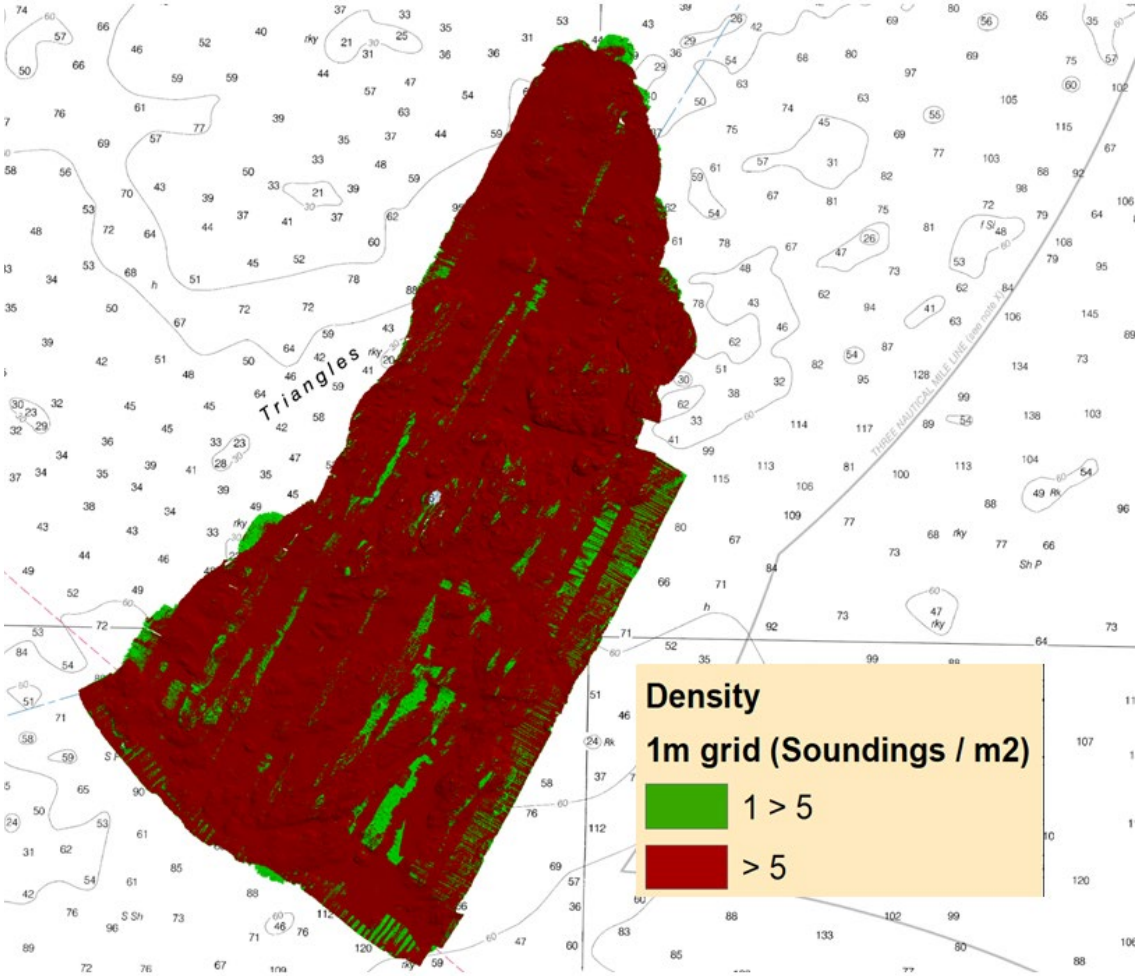

Figure 26: Sounding Density of SH2019 Area C where 5 nodes per cell at the 95% level is the NOAA HSSD specification.

Table 19: Statistics about sounding density of Area C at 1m

Statistical information:	
Minimum:	1.000
Maximum:	1014.000
Mean:	15.674
Area:	N/A
Std_dev:	10.667
Total count:	4,932,098

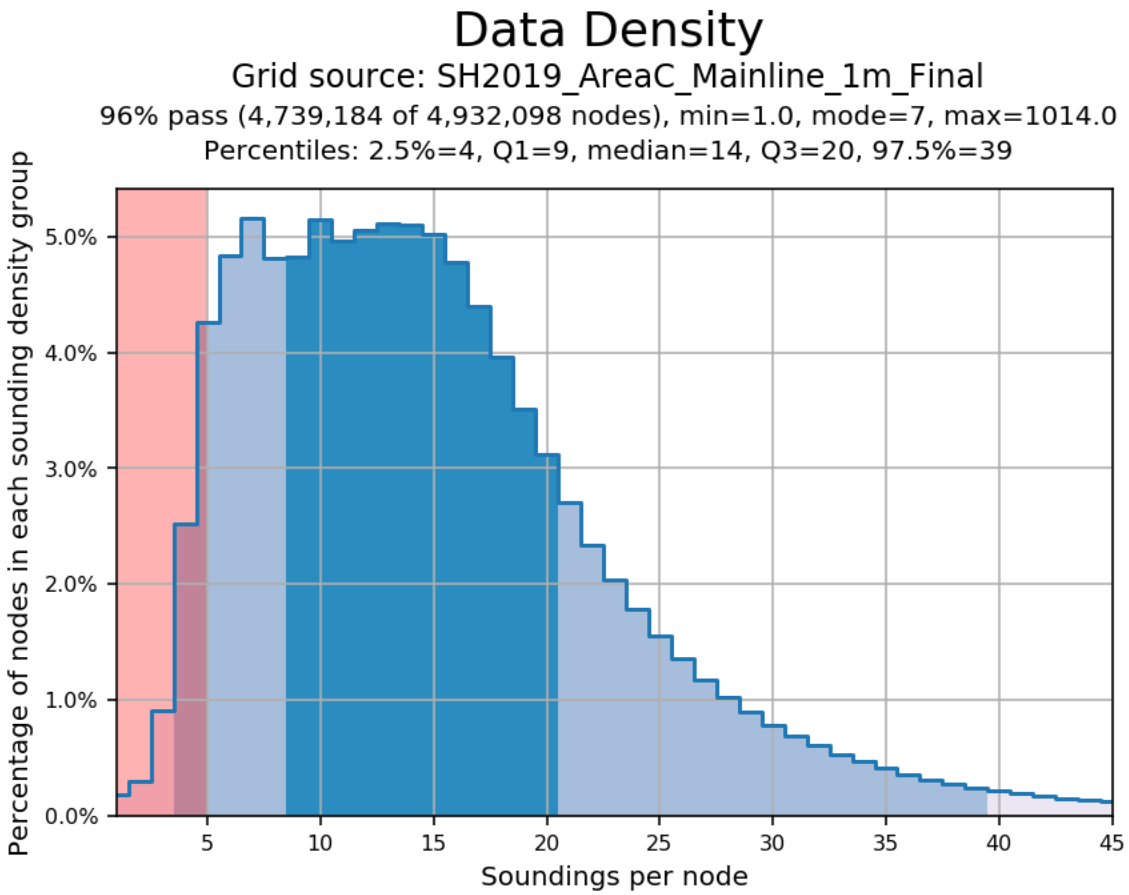

Figure 27: Statistics output for the Density of Area A & D

B.2.9 HOLIDAYS

Lines were run to fill in substantial holidays, except for areas where danger were present e.g, shoals. This survey contained numerous holidays, primarily due to acoustic shadowing in rocky terrain. QC tools was run on the 1m grid in order to generate a list holidays.

Table: Area AD Holidays from QC tools

FEATURE ID	LATITUDE	LONGITUDE
4U 0000000001 00001	43.129492N	070.622525W
4U 0000010002 00001	43.128615N	070.625969W
4U 0000020003 00001	43.128579N	070.629091W
4U 0000030004 00001	43.129637N	070.630705W
4U 0000040005 00001	43.130956N	070.622798W
4U 0000050006 00001	43.131679N	070.628325W
4U 0000060007 00001	43.131246N	070.625215W
4U 0000070008 00001	43.138776N	070.618676W
4U 0000080009 00001	43.143174N	070.620342W
4U 0000090010 00001	43.142320N	070.608146W
4U 0000100011 00001	43.147480N	070.610027W

4U 0000110012 00001	43.143487N	070.615370W
4U 0000120013 00001	43.147372N	070.614464W
4U 0000130014 00001	43.144339N	070.611838W
4U 0000140015 00001	43.147401N	070.614305W
4U 0000150016 00001	43.155291N	070.606493W
4U 0000160017 00001	43.154155N	070.614286W
4U 0000170018 00001	43.132350N	070.617806W
4U 0000180019 00001	43.154059N	070.611504W
4U 0000190020 00001	43.101425N	070.647713W
4U 0000200021 00001	43.103773N	070.647247W
4U 0000210022 00001	43.098577N	070.644749W
4U 0000220023 00001	43.118279N	070.632825W
4U 0000230024 00001	43.118288N	070.631547W
4U 0000240025 00001	43.123139N	070.627299W
4U 0000250026 00001	43.123098N	070.630826W
4U 0000260027 00001	43.122071N	070.632729W
4U 0000270028 00001	43.106249N	070.635307W

Table: Area C Holidays from QC tools

FEATURE ID	LATITUDE	LONGITUDE
FEATURE ID	Latitude	Longitude
4U 0000000001 00001	43.064474N	070.603014W
4U 0000010002 00001	43.069367N	070.611763W
4U 0000020003 00001	43.069766N	070.616048W
4U 0000030004 00001	43.070605N	070.608848W
4U 0000040005 00001	43.070330N	070.615584W
4U 0000050006 00001	43.070912N	070.608782W
4U 0000060007 00001	43.068304N	070.618761W
4U 0000070008 00001	43.071367N	070.607861W
4U 0000080009 00001	43.071796N	070.610009W
4U 0000090010 00001	43.071622N	070.608297W
4U 0000100011 00001	43.072458N	070.605187W
4U 0000110012 00001	43.072374N	070.604743W
4U 0000120013 00001	43.070541N	070.608945W
4U 0000130014 00001	43.072387N	070.597386W
4U 0000140015 00001	43.072969N	070.604697W
4U 0000150016 00001	43.073349N	070.603908W
4U 0000160017 00001	43.071203N	070.607979W
4U 0000170018 00001	43.073172N	070.604334W
4U 0000180019 00001	43.073427N	070.613098W
4U 0000190020 00001	43.074948N	070.612548W

4U 0000200021 00001	43.072685N	070.604370W
4U 0000210022 00001	43.076330N	070.596776W
4U 0000220023 00001	43.074270N	070.606291W
4U 0000230024 00001	43.077202N	070.609770W
4U 0000240025 00001	43.077973N	070.609974W
4U 0000250026 00001	43.086497N	070.598711W
4U 0000260027 00001	43.076457N	070.610856W

B.3 CORRECTIONS TO ECHO SOUNDING

B.3.1 CORRECTIONS

All data reduction procedures conform to those detailed in the DAPR.

B.3.2 CALIBRATIONS

B.3.2.1 PATCH TEST

A patch test was performed on June 10th onboard the RVGS on Cod Rock which is just north of the UNH Pier in New Castle (**Figure 28**). This area has a relatively flat seafloor with a rock outcrop at 70.690962° W, 43.045099° N and at a depth of 20m. Offsets were applied in Caris for the post processing. For more detailed information, see the DAPR C.3.2

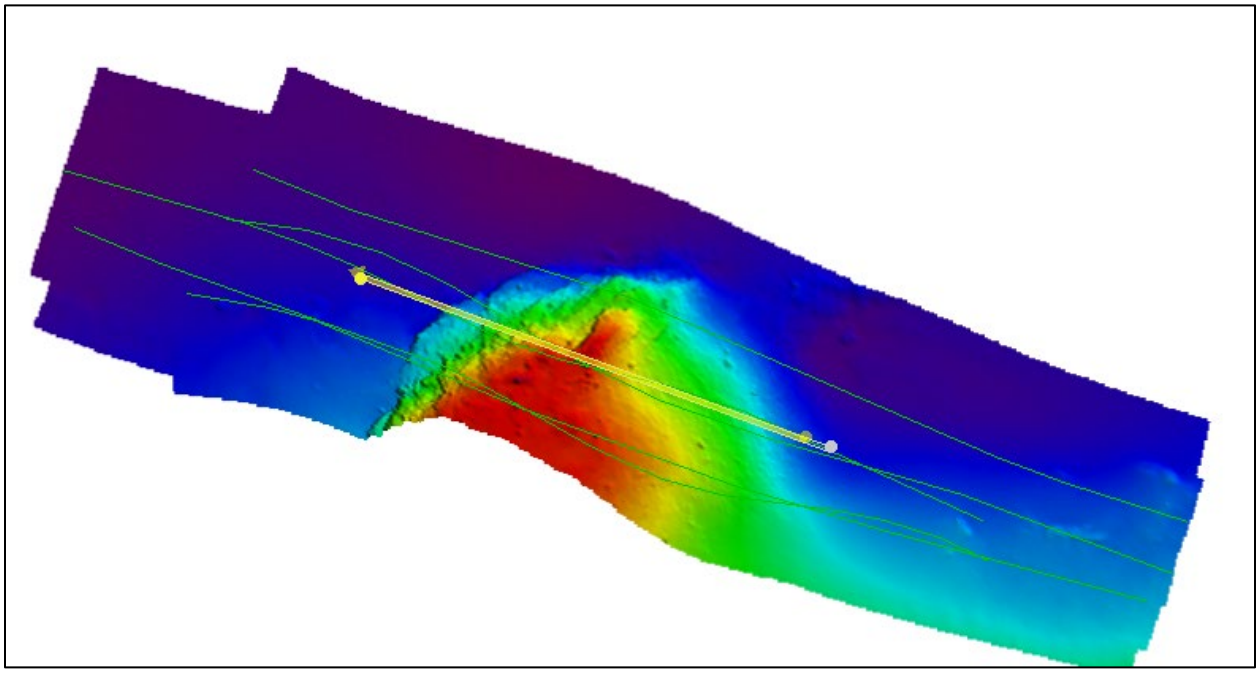

Figure 28: View of patch test in Caris HIPS & SIPS v11.1

B.3.3 WATER LINE

Water line measurements were taken daily with respect to the RVGS Reference Point (top of bolt above aft computer rack). The Height Above Draft Reference (HADR) point is the edge of the moon pool (15 cm below the RVGS RP). The water line was measured from this HADR point to

the water line and this value entered into the computation setup in Qinsy. See start of survey setup SOP for more information.

B.4 BACKSCATTER

Backscatter data was acquired by the R2Sonic 2026 MBES along with bathymetric data and logged as R2Sonic MBES 'snippets' in Qinsy. A 1 m backscatter mosaic was created in Caris from the survey main lines to plot bottom sample locations). The final backscatter mosaic was generated with FMGeocoder Toolbox- V7.8.10 using .db and .qpd file pairs at a grid resolution of 0.5 m (**Figure 29).**

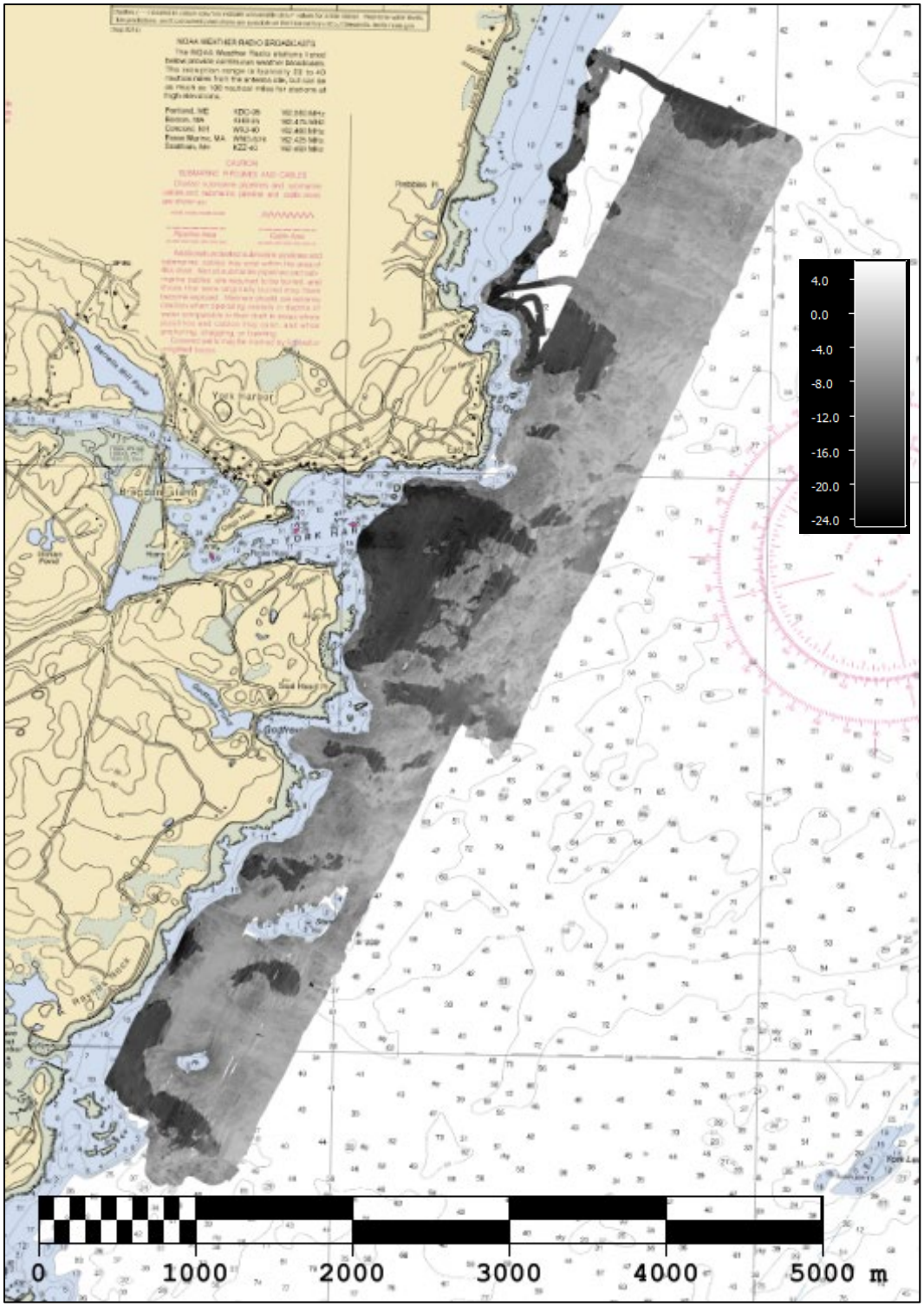

Figure 29: Final Mosaic of Area A & D Backscatter created in FMGT

B.5 DATA PROCESSING

B.5.1 SOFTWARE UPDATES

All software updates can be found in the DAPR.

B.5.2 SURFACES

The final deliverable surfaces are listed in **Table 20**.

Table 20: Table of final surfaces to be submitted

Surface Name	Surface Type	Data Format	Resolution
SH2019_AD_1m_MLLW_CUBE_NAD83UTM19N.csar	CUBE	.CSAR	1 m
SH2019_AD_1m_MLLW_CUBE_Crosslines.csar	CUBE	.CSAR	1 m
SH2019_AreaC_1m_MLLW_CUBE_NAD83UTM19N.csar	CUBE	.CSAR	1 m
SH2019_C_1m_MLLW_CUBE_Crosslines.csar	CUBE	.CSAR	1 m

C. VERTICAL AND HORIZONTAL CONTROL

C.1 VERTICAL CONTROL

The vertical datum used for the project was Mean Lower Low Water (MLLW). Data was acquired with respect to the ellipsoid (WGS-84 datum) and transformed to MLLW using a static offset of 29.18 meters. The offset based on VDatum values was applied to entire survey area because all points tested in the survey area had offsets value indistinguishable from 29.18 when error was taken in to account. Vertical control was acquired using RTK GNSS techniques. The base station at the Seacoast Science Center in Odiorne State Park provided the RTK real time corrections for the survey.

C.2 HORIZONTAL CONTROL

The horizontal control was referenced to the WGS84 datum and the final products projections are in UTM19N. Final products were projected into UTM zone 19N. The reference used for the horizontal control and vertical control for post processing is the CORS network. Details are given in the HVCR.

Positions were acquired in the same manner as the vertical control (C.1). The reference for this survey for the corrections is a base station composed of GNSS satellites from the CORS network. For more details, refer to the HVCR.

D. RESULTS AND RECOMMENDATIONS

D.1 CHART COMPARISON

Below can be seen the results of the chart comparison (**Figure 30**). Chart comparisons were made for the RNCs and it was assumed the ENC would follow the same.

D.1.1 ELECTRONIC NAVIGATIONAL CHARTS

Table 21 summarizes the largest scale ENCs covering the survey area

Table 21: Available ENCs in the area

ENC	*Scale*	*Edition*	*Edition Date*	*NM Date*
US5NH02M	1:20,000	29	3/18/2019	

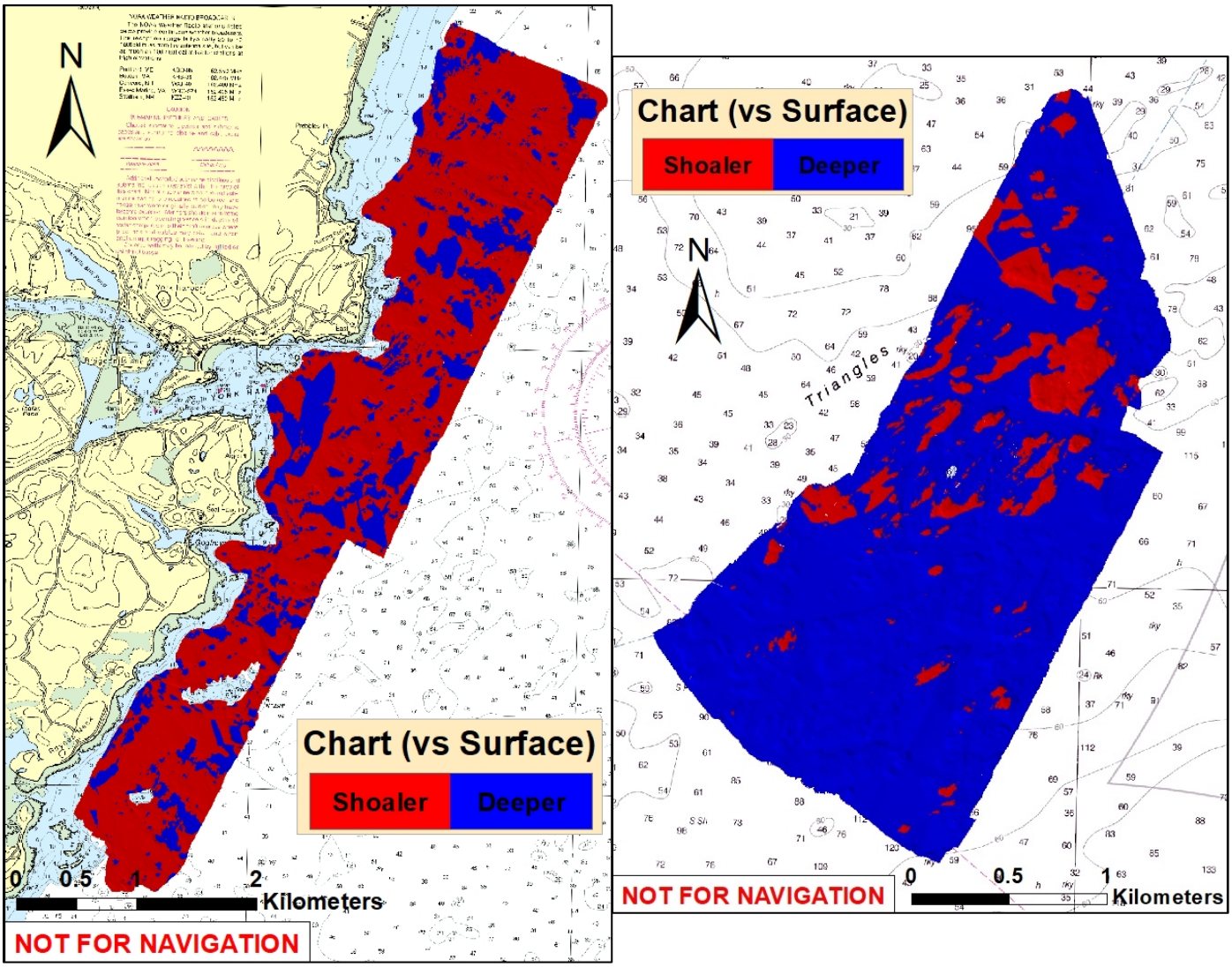

Figure 30: Chart comparison of Area A & D and C with US5NH02M ENC

Note that the ENC charts have good correlation with the RNCs. Therefore, an RNC chart comparison was not made. Look to section D.1.1 for information on chart changes.

D.1.2 RASTER CHARTS

Table 22 summarizes the largest scale RNCs covering the survey area

Table 22: Available RNCs in the Survey Area

RNC	*Scale*	*Edition*	*Edition Date*	*NM Date*
13283	1:20,000	23	12/1/2014	12/1/2014

D.1.3 AWOIS ITEMS

There are not AWOIS items assigned for the survey area.

D.1.4 CHARTED FEATURES

No charted features exist for the survey area.

D.1.5 UNCHARTED FEATURES

There are not uncharted features in the survey area.

D.1.6 DANGERS TO NAVIAGTION

Shoals were found in this area, please refer to the DTON report.

D.1.7 SHOAL AND HAZARDOUS FEATURES

Several shoals exist in the survey area

D.1.8 CHANNELS

No channels exist in the survey area.

D.1.9 BOTTOM SAMPLES

Using the backscatter mosaic, 14 locations were selected for bottom sampling. Each sample location was chosen to get a varied and representative sample of the bottom characteristics in survey area A and D. Video was acquired at sampling sites. One day was allotted to collect video and grab samples (June 28th 2019). One of the locations yielded no sediment sample and at two locations no sample grabs were performed.

Table 23 & **Table 24** below present the sampling station for each methods.

Table 23: Video Stations, date, time, latitude and longitude of first and last bottom arrival

Station	Fix	Date Acquired	Latitude	Longitude	Remarks
1	**First**	6/28/2019 14:53	43 05 54.7247 N	070 38 58.3531 W	Sample Taken
	Last	6/28/2019 15:02	43 05 54.3531 N	070 38 58.7642 W	
2	**First**	6/28/2019 15:15	43 06 0.78500 N	070 38 23.2020 W	Sample Taken
	Last	6/28/2019 15:18	43 06 0.27690 N	070 38 23.0490 W	
3	**First**	6/28/2019 15:24	43 06 15.1860 N	070 38 14.0414 W	Sample Taken
	Last	6/28/2019 15:33	43 06 14.8082 N	070 38 13.6686 W	
4	**First**	6/28/2019 15:43	43 06 37.5700 N	070 38 9.57030 W	Sample Taken
	Last	6/28/2019 15:48	43 06 38.0256 N	070 38 9.83110 W	
5	**First**	6/28/2019 15:56	43 06 51.2844 N	070 37 56.1684 W	*No Sample*
	Last	6/28/2019 16:02	43 06 51.5614 N	070 37 56.2280 W	
6	**First**	6/28/2019 16:09	43 06 53.1728 N	070 37 45.2436 W	*No Sample*
	Last	6/28/2019 16:10	43 06 53.6695 N	070 37 45.3280 W	
7	**First**	6/28/2019 16:17	43 07 1.65430 N	070 37 49.8211 W	Sample Taken
	Last	6/28/2019 16:21	43 07 2.19430 N	070 37 49.7125 W	
8	**First**	6/28/2019 16:27	43 07 15.2555 N	070 37 36.3520 W	Sample Taken
	Last	6/28/2019 16:32	43 07 15.5769 N	070 37 36.5929 W	

9	**First**	6/28/2019 16:39	43 07 8.88310 N	070 37 15.7500 W	Sample Taken
	Last	6/28/2019 16:44	43 07 9.96830 N	070 37 15.7817 W	
10	**First**	6/28/2019 16:55	43 07 45.2697 N	070 37 43.3372 W	Sample Taken
	Last	6/28/2019 16:59	43 07 45.5246 N	070 37 42.1919 W	
11	**First**	6/28/2019 17:07	43 07 43.6357 N	070 36 51.3891 W	Sample Taken
	Last	6/28/2019 17:14	43 07 44.9778 N	070 36 51.2292 W	
12	**First**	6/28/2019 17:20	43 08 2.69330 N	070 37 5.12100 W	*No Sample*
	Last	6/28/2019 17:21	43 08 3.33940 N	070 37 4.70690 W	
13	**First**	6/28/2019 17:29	43 08 47.9746 N	070 36 20.6946 W	Sample Taken
	Last	6/28/2019 17:35	43 08 48.9356 N	070 36 19.9653 W	
14	**First**	6/28/2019 17:42	43 09 13.8631 N	070 36 15.7799 W	Sample Taken
	Last	6/28/2019 17:46	43 09 14.4601 N	070 36 15.5830 W	

Table 24: Sample Stations and locations

Station	Latitude	Longitude
1	43 05 53.8192 N	070 38 58.2235 W
2	43 06 00.1720 N	070 38 22.7689 W
3	43 06 14.1699 N	070 38 13.9887 W
4	43 06 37.3194 N	070 38 09.8853 W
5	43 06 50.8565 N	070 37 57.1442 W
6	43 06 52.8650 N	070 37 45.6217 W
7	43 07 01.3493 N	070 37 50.0436 W
8	43 07 14.3843 N	070 37 36.5029 W
9	43 07 08.4481 N	070 37 15.7712 W
10	43 07 45.6143 N	070 37 44.0395 W
11	43 07 43.0937 N	070 36 51.4373 W
12	43 08 01.8174 N	070 37 05.1041 W
13	43 08 47.4230 N	070 36 22.2363 W
14	43 09 12.2917 N	070 36 17.1556 W

D.2 ADDITIONAL RESULTS

D.2.1 SHORELINE AND NEARSHORE FEATURES

No investigation was conducted.

D.2.2 PRIOR SURVEYS

Discussed in B2.3.

D.2.3 AIDS TO NAVIGATION

No damaged or uncharted aids to navigation were observed.

D.2.4 OVERHEAD FEATURES

No overhead features exist in the survey area.

D.2.5 SUMBARINE FEATURES

No features exist in this category

D.2.6 FERRY ROUTES AND TERMINALS

No ferry routes or terminals exist in the survey area

D.2.7 PLATFORMS

No structures exist in this category

D.2.8 SIGNIFICANT FEATURES

No significant features were found

D.2.9 CONSTRICTION AND DREDGING

No features exist in this category

D.2.10 NEW SURVEY RECOMMENDATIONS

No new survey recommendations were made for this survey

D.2.11 NEW INSET RECOMMENDATIONS

No new inset recommendations were made for this survey.

E. APPROVAL SHEET

The approval sheet shall contain the following statements

- Approval of the deliverable files, Descriptive Report, digital data, and all accompanying records. This approval constitutes the assumption of responsibility for the stated accuracy and completeness of the hydrographic survey.
- Indication of the completeness of the survey and adequacy for its intended purpose. Recommendation of additional work is required.
- The amount and degree of personal supervision of the work.
- Additional information or references helpful for verifying and evaluating the survey

Supervision Statement:

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.

Approval Statement:

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

Adequacy Statement: The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys and Specifications Deliverables Manual, Field Procedures Manual. Standing and Letters 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.

Any Additional Statements:

Signing Personnel		
Approver Name	Approver Title	Approval Date
Capt. Andrew Armstrong, Ret. NOAA	Chief of Party	
Semme Dijkstra	Chief of Party	

F. TABLE OF ACRONYMS

CCOM/JHC	Center for Coastal and Ocean Mapping/Joint Hydrographic Center
CMR	Compact Measurement Records
CTD	Conductivity Temperature Depth
CUBE	Combined Uncertainty and Bathymetric Estimator
DAPR	Data Acquisition and Processing Report
DP	Detached Position
ENC	Electronic Navigational Chart
GPS	Global Position System
HADR	Height Above Draft Reference
HSSD	Hydrographic Specifications and Deliverables
HVCR	Horizontal and Vertical Control Report
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
LNM	Linear Nautical Miles
MBES	Multibeam Echosounder
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
POS/MV	Position and Orientation System for Marine Vessels
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
RV	Research Vessel
SBES	Singlebeam Echosounder
SH	Summer Hydrographic Field Course
SNM	Square Nautical Miles
SSS	Side Scan Sonar
SVP	Sound Velocity Profiler
TPU	Total Propagated Error
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984