2020 Descriptive Report of Seafloor Mapping: Vicinity of Casco Bay, Mid-coast Maine, Vicinity of Matinicus Island

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For an overview of the Maine Coastal Mapping Initiative (MCMI) information products, including maps, data, imagery, and reports visit: <u>https://www.maine.gov/dmr/mcp/planning/mcmi/index.htm</u>.

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Maine Coastal Mapping Initiative Maine Coastal Program Department of Marine Resources					
	DESCRIPTIVE REPORT				
Type of Survey:	Navigable Area				
Registry Number:					
	LOCALITY				
State(s):	Maine				
General Locality:	Gulf of Maine				
Sub-Localities:	Vicinity of Casco Bay, Mid-coast Maine, Vicinity of Matinicus Island				
	2020				
CHIEF OF PARTY Benjamin Kraun, Hydrographer, Contractor to the State of Maine					
	LIBRARY & ARCHIVES				
Date:					

	MAINE COASTAL MAPPING INITIATIVE	REGISTRY NUMBER:
HYDRO		
INSTRUCTIONS: The hyd	Irographic sheet should be accompanied by this form, filled in as completely as possible, v	when the sheet is forwarded to the Office.
State(s):	Maine	
General Locality:	Gulf of Maine	
Sub-Locality:	Vicinity of Casco Bay, Mid-coast Maine, Vici	nity of Matinicus Island
Scale:		
Dates of Survey:	04/15/2020 to 11/19/2020	
Instructions Dated:		
Project Number:		
Field Unit:	Amy Gale	
Chief of Party:	Benjamin Kraun, Hydrographer, Contractor	to the State of Maine
Soundings by:	Multibeam Echo Sounder	
Imagery by:	Multibeam Echo Sounder Backscatter	
Verification by:		
Soundings in:	meters at Mean Lower Low Water	
Remarks		
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ABSTRACT

During the survey season (April - November) of 2020 the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic surveying using a multibeam echosounder (MBES) in the waters off Casco Bay, mid-coast Maine, and Penobscot Bay, Maine. The surveying was conducted in part to support the Maine Department of Marine Resources' (DMR) efforts to enhance coastal resiliency through identification, characterization, and protection of fisheries critical to the state's marine environment and economy. The surveys also coincide with state and federal efforts to update coastal data sets and increase high resolution bathymetric coverage for Maine's coastal waters. A total of approximately 45 mi² (117 km²) of high-resolution multibeam data were collected. 39 mi² (101 km²) were collected in the "mainscheme" area of federal (18 mi²) and state (21 mi²) coastal marine waters. Approximately 6 mi² (16 km²) were collected in nearshore waters for the purposes of assessing nearshore and riverine sand movement. During the 2020 survey season the MCMI also collected sediment samples, water column data, and video in 42 locations, 30 samples of which coincide with areas summarized in this report.

1.0 Area Surveyed

The 2020 mainscheme survey areas were located off Maine's southern and mid-coast regions in the Gulf of Maine, with sub-localities of the vicinity of Casco Bay, west of Monhegan Island, west of Matinicus Island, and sections of the Sheepscot River and Back River, Maine as shown in Figures 1 through 5. The approximately 45 mi² (117 km²) combined survey areas adjoin the eastern and northeastern extents of the areas mapped by MCMI in 2017 and 2019 (2017 MCMI data accepted by NOAA, who lists the surveys as W00450) as well as the southern extent of NOAA survey H12477 (mapped in 2012 by Williamson & Associates, Inc. in 2012) (Figures 9-12). These data were not collected in direct accordance with the *NOS Hydrographic Surveys Specifications and Deliverables* and the *Field Procedures Manual* requirements; however, both documents were referenced during acquisition for guidance.

Survey limits of each main sub-locality are listed in Table 1. Specific dates of data acquisition for the mainscheme survey are listed in Appendix A.

Table 1 – 2020 mainscheme survey limits

Casco Bay

Southwest Limit	Northeast Limit		
43° 29' 13" N	43° 33' 13" N		
69° 59' 5" W	69° 50' 38" W		
Mid-coast Region, Inshore			
Southwest Limit	Northeast Limit		
43° 50' 57" N	44° 0' 4" N		
69° 43' 57" W	69° 39' 32" W		
Monhegan Island			
Southwost I imit	Northoast Limit		

Southwest Linit	Northeast Linnt	
43° 43' 59" N	43° 47' 52" N	
69° 23' 3" W	69° 19' 55" W	

Matinicus Island

Southeast Limit	Northwest Limit
43° 49' 27" N	43° 53' 5" N
68° 53' 53" W	68° 57' 30" W



Figure 1 – General localities of 2020 mainscheme and inshore survey coverage off southern, mid-coast, and Penobscot Bay, Maine.



Figure 2 – General locality of survey coverage off Casco Bay, Maine, shown in box A in figure 1. Shaded relief bathymetry is overlain on NOAA nautical chart 13290.



Figure 3 – General locality of inshore survey coverage within sections of the Sheepscot River and Back Rivers in mid-coast Maine, shown in box B in figure 1. Shaded relief bathymetry is overlain on NOAA nautical chart 13260.



Figure 4 – General locality of survey coverage off Monhegan Island, Maine. Area is shown in box C in figure 1. Shaded relief bathymetry is overlain on NOAA nautical chart 13301.



Figure 5 – General locality of survey coverage off Matinicus Island, Maine. Area is shown in box D in figure 1. Shaded relief bathymetry is overlain on NOAA nautical chart 13303.

1.1 Survey Purpose

This survey was conducted by the Maine Coastal Program's Maine Coastal Mapping Initiative (MCMI) as part of a multi-agency cooperative agreement partially funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Management, the Maine Department of Marine Resources (DMR), The Nature Conservancy (TNC), Maine Inland Fisheries & Wildlife's State Wildlife Grant, and the Maine Outdoor Heritage Fund. The purpose of this project was to help inform policy decision-making related to Maine's coastal waters by increasing the volume of available high-quality bathymetric, benthic habitat, geochemical, and geologic datasets as well as providing new data in the areas covered by several NOAA nautical charts: 13286, 13288, 13290, 13293, 13296, 13301, 13302, and 13303. These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and were shared with the NOAA Office of Coast Survey (OCS) for review.

1.2 Survey Quality

The entire survey should be adequate to supersede previous data.

1.3 Survey Coverage

Numerous small holidays (gaps in MBES coverage) exist within the surveyed area, and normally occurred as sonic shadows in areas of locally high relief and/or highly irregular bathymetry. Analyses of bathymetric data show that the least depths were achieved over all features, and that holidays have not compromised data integrity.

2.0 Data Acquisition

The following sub-sections contain a summary of the systems, software, and general operations used for acquisition and preliminary processing during the 2020 survey season.

2.1 Survey Vessel

All data were collected aboard the Research Vessel (R/V) Amy Gale (length = 10.7 m, width = 3.81 m, draft = 0.93 m) (Figure 6), a former lobster boat converted to a survey vessel and contracted to the MCMI. The vessel was captained by Caleb Hodgdon of Hodgdon Vessel Services. Surveys were based out of ports in Boothbay Harbor and South Portland, ME. The EM2040C transducer, motion reference unit (MRU), AML MicroX surface sound speed probe, and dual GNSS antennas were pole-mounted to the bow; pole raised (for transit) and lowered (for survey) via a pivot point at the edge of the bow. The main cabin of the vessel served as the data collection center and was outfitted with four display monitors for real time visualization of data during acquisition.



Figure 6 - R/V Amy Gale shown with pole-mounted dual GPS antennas, Kongsberg EM2040C multibeam sonar, MRU (not visible), and surface sound speed probe (not visible) in acquisition mode

2.2 Acquisition Systems

The real-time acquisition systems used aboard the R/V Amy Gale during the 2020 surveys are outlined in Table 2. Data acquisition was performed using the Quality Positioning Services (QPS) Qinsy (Quality Integrated Navigation System; v.8.18.2 to start season and v.9.2.2 later) acquisition software. The modules within Qinsy integrated all systems and were used for real-time navigation, survey line planning, data time tagging, data logging, and visualization.

Sub-system	Components			
Multibeam Sonar	Kongsberg EM2040C and processing unit			
Position, Attitude, and Heading Sensor	Seapath 330 processing unit, HMI unit, dual GPS/GLONASS antennas, MRU 5 motion reference unit (subsea bottle), Fugro 3610 Receiver and AD-341 antenna			
Acquisition Software and Workstation	Qinsy software v.9.2.2 and 64-bit Windows 10 PC console			
Surface Sound Velocity (SV) Probe	AML Micro X with SV Xchange			
Sound Velocity Profiler (SVP)	Teledyne Odom Digibar S sound speed profiler			
Ground-truthing/Sediment Sampling Platform	Ponar grab sampler, GoPro Hero 3+ video camera, dive light, dive lasers, YSI Exo I sonde			

Table 2 - Major systems used aboard R/V Amy Gale

2.3 Vessel Configuration Parameters

In 2017, the MCMI contracted Doucet Survey, Inc. to perform high-definition (precision \pm 5mm) 3D laser scanning of the Amy Gale and all external MBES system components (e.g. MRU, GPS antennas, and EM2040C) (Figures 6 and 7). The purpose of the laser scan survey was to refine and or verify the precision of hand-made vessel reference frame measurements for future surveys. All points were referenced to the center point of the base of the MRU (mounted inside the pole and directly atop the EM2040C transducer) (Figure 8), which served as the origin (e.g. 0,0,0), where 'x' was positive forward, 'y' was positive starboard, and 'z' was positive down. The laser scan survey results only differed from hand-made measurements by \leq 3mm for all nodes of interest. Reference measurements for each component were entered into the Seapath 330 Navigation Engine (Table 3) and converted so all outgoing datagrams would be relative to the location of the EM2040C transducer (e.g. EM2040C was used as the monitoring point for all outgoing datagrams being received by Qinsy during acquisition). Additional configuration and interfacing of all systems were established during the creation of a template database in the Qinsy console.

These offset values were not changed for the 2020 survey season. See appendices for specific settings as entered in the Seapath 330 Navigation Engine (Appendix B) and for the template database (Appendix C) used during data acquisition while online in Qinsy. Configuration settings of the EM2040C were assigned in the EM Controller module of Qinsy (Appendix D).

Equipment	x (m)	y (m)	z (m)
MRU	0.000	0.000	0.00
Antenna 1 (port)	0.158	-1.245	-3.000
Antenna 2 (starboard)	0.158	1.252	-3.035
EM2040C	0.036	0.000	0.133

Table 3 – 2017 equipment reference frame measurements for Seapath 330



Figure 7 – Amy Gale RGB color images generated from 3D laser scan survey (GPS antennas and external cabling not included in survey) data (.pts file converted to .las for visualization)



Figure 8 – Amy Gale origin (point 201 in RGB images) for vessel reference frame(s); origin is center point within the base of the pole (center point of base within internally-mounted motion reference unit (MRU) point 201 in images above)

2.4 Survey Operations

The following is a general summary of daily survey operations. Once the survey destination was reached, the sonar pole mount was lowered into survey position and its bracing rods were fastened securely to the hull of the ship via heavy-duty ratchet straps. Electric power to all systems was provided by a 2000-watt Honda eu2000i generator. Occasionally two eu2000i generators were simultaneously used if any auxiliary equipment needed additional electricity. Immediately following power-up, all interfacing instruments were given time to stabilize (e.g. approximately 30-45 minutes for Seapath to acquire time tag for GPS). Next, the desired Qinsy project (e.g. mainscheme, inshore, etc.) was selected for data acquisition. All files (e.g. raw sonar files, sound speed profiles, grid files, etc.) were recorded and stored within their respective project subfolders on a local drive. Prior to surveying, a sound speed cast was taken and imported into the 'imports' folder of the current project. After confirming a close match between the upcast and downcast data, the profile was applied to the sonar (EM2040C) in the Qinsy Controller module. Data were gridded at 0.5 to 4 meters for real-time visualization, depending on expected water depth range. Raw sonar files were logged in the Qinsy Controller module in .db format and saved directly onto the hydrographic workstation computer. All data were backed up daily on an external hard drive. At the end of each day's survey, sonar and navigation systems were powered down and the pole mount was raised and fastened for transit back to port. Upon arriving at the dock, all external instruments/hardware were visually inspected and rinsed with freshwater to prevent corrosion.

2.5 Survey Planning

Line planning and coverage requirements were designed to meet requirements for NOAA hydrographic standards (NOAA Field Procedures Manual, 2017). In the mainscheme area, parallel lines were mostly planned several days prior to surveying and run in a NE-SW or E-W pattern, depending on the location. Lines were spaced at consistent intervals to obtain a minimum of 20% overlap between full swaths. Soundings from beam angles outside of ± 60 degrees from the nadir were blocked from visualization during acquisition, thus increasing the true minimum full-swath overlap. This online blocking filter was recommended by QPS field engineers with the intent of eliminating noisy outer beams from the final product, thereby increasing the overall contribution of higher quality soundings. All data was acquired at approximately 6 - 6.5 knots, although some areas required slower speeds to ensure safe operation of the vessel around obstructions (e.g. fishing gear, docks, ledges, etc.).

2.6 Calibrations

Several patch tests were conducted aboard the R/V Amy Gale at the beginning of the 2020 survey season to correct for alignment offsets. After an initial application of patch test values data not tide-corrected, a second patch test was applied once verified tide data was available from NOAA. During the test, a series of lines were run to determine the latency, pitch, roll, and heading offset. The patch test data were processed using the Qimera (v.2.1.1) patch test tool. After calibration was complete, offsets (Tables 4) were entered into the template database in Qinsy. Full built-in self-tests (BIST) were performed at semi-regular intervals throughout the season to determine if any significant deviations in background noise were present at the chosen survey frequency of 300KHz.

Table 4 - 2020 patch test calibration offsets for EM2040C

Туре	Offset
Roll (degrees)	0.332
Pitch (degrees)	0.279
Heading (degrees)	-0.181

3.0 Quality Control

3.1 Crosslines

Due to unforeseen scheduling conflicts, crosslines were not run during the 2020 field season. For other quality control information, see section 3.2 of this report regarding 2020 data junctions with past MCMI and NOAA surveys.

3.2 Junctions

The following junctions were made with this survey. The Maine Coastal Program's Mapping Initiative conducted ongoing surveys in the areas of Saco Bay and Monhegan Island aboard the R/V Amy Gale from 2018 to 2019. The areas of overlap between the 2020 survey and the 2018-2019 junction survey were evaluated for sounding agreement by performing surface (4-meter resolution) difference tests in Fledermaus (v.7.8.6, 64-bit), where the junctioning surface (2018-2019) was subtracted from the new 2020 surface. A summary of surface details is shown in Table 5. Surface difference test results are shown in Table 6. The extents of overlap

between the 2018-2019 base surface and the corresponding 2020 junction surface are illustrated in Figures 9 and 10. The surfaces used for these tests are submitted with the data in these surveys.

Survey ID W00450 was conducted by the Maine Coastal Program's Mapping Initiative aboard the R/V Amy Gale in 2017 and accepted by NOAA. The areas of overlap between the 2020 survey and the 2017 junction survey were evaluated for sounding agreement by performing surface (4-meter resolution) difference tests in Fledermaus (v.7.8.6, 64-bit), where the junctioning surface (2017) was subtracted from the new 2020 surface. A summary of surface details is shown in Table 5. Surface difference test results are shown in Table 6. The extent of overlap between the 2017 base surface and the corresponding 2020 junction surface is illustrated in Figure 10. The surfaces used for these tests are submitted with the data in these surveys.

Survey ID W00448 was conducted by the Maine Coastal Program's Mapping Initiative aboard the R/V Amy Gale in 2016 and accepted by NOAA. The areas of overlap between the 2020 survey and the 2016 junction survey were evaluated for sounding agreement by performing surface (2-meter resolution) difference tests in Fledermaus (v.7.8.6, 64-bit), where the junctioning surface (2016) was subtracted from the new 2020 surface. A summary of surface details is shown in Table 5. Surface difference test results are shown in Table 6. The extent of overlap between the 2016 base surface and the corresponding 2020 junction surface is illustrated in Figure 11. The surfaces used for these tests are submitted with the data in these surveys.

Survey ID H12477 was conducted by Williamson & Associates, Inc in 2012 and accepted by NOAA. The areas of overlap between the 2020 survey and the 2012 junction survey were evaluated for sounding agreement by performing surface (8-meter resolution) difference tests in Fledermaus (v.7.8.6, 64-bit), where the junctioning surface (2012) was subtracted from the new 2020 surface. A summary of surface details is shown in Table 5. Surface difference test results are shown in Table 6. The extent of overlap between the 2012 base surface and the corresponding 2020 junction surface is illustrated in Figure 12. The surfaces used for these tests are submitted with the data in these surveys.

Registry Number/Surface Name	Grid Resolution	Area	Year	Field Unit	Relative Location(s)
MCMI	4 meters	Casco Bay	2018- 2019	R/V Amy Gale	W and S
MCMI	4 meters	Monhegan Island	2018- 2019	R/V Amy Gale	W
MCMI (NOAA W00450)	4 meters	Monhegan Island	2017	R/V Amy Gale	W and N

Table 5 – 2020 Survey Junctions

MCMI (NOAA W00448)	2 meters	Inshore (Sheepscot River)	2016	R/V Amy Gale	S
NOAA H12477	8 meters	Matinicus Island	2012	M/V Nooit Volmaakt R/V Resolution	Ν

Table 6 – Summary of surface difference test results for overlapping (junction) surveys

Junction Surface ID	New (2020) Surface ID	Median (m)	Mean (m)	Std. Dev. (m)
MCMI_2018_2019_SacoBay _4m_mllw	MCMI_2020_CascoBay_4m_mllw	0.15	0.16	0.44
MCMI_2018_2019_Monhega n_4m_mllw	MCMI_2020_Monhegan_4m_mllw	-0.05	-0.06	0.25
MCMI_2017_mainscheme_4 m_mllw	MCMI_2020_Monhegan_4m_mllw	-0.03	-0.04	0.65
MCMI_2016_inshore_2m_ml lw	MCMI_2020_Inshore_2m_mllw	-0.01	0.04	0.46
H12477_MB_8m_MLLW_C ombined	MCMI_2020_Matinicus_8m_mllw	-0.46	-0.38	0.17

Several factors are thought to contribute to the high standard deviation in several of the overlapping surveys (particularly the Monhegan Island area): poor agreement in rocky areas, filtering procedures, and survey conditions (e.g. weather and sea state). The most disagreement between surfaces was in areas with a steep, rocky seabed.



Figure 9 – Junctioning area between 2020 survey and MCMI 2018-2019 Saco Bay survey (top pane). 4-meter surfaces shown as surface difference results in lower pane.



Figure 10 – Junctioning areas between 2020 survey and NOAA OCS survey W00450 (orange) and MCMI 2018-2019 Monhegan Island survey (yellow). 4-meter surfaces shown as surface difference results in right pane.



Figure 11 – Junctioning areas between 2020 survey and NOAA OCS survey W00448 (top pane). 2-meter surfaces shown as surface difference results in middle and bottom panes.



Figure 12 – Junctioning area between 2020 survey and NOAA OCS survey H12477 (top pane). 8-meter surfaces shown as surface difference results in lower pane.

3.3 Equipment Effectiveness

Sonar

Sonar data were acquired with a Kongsberg EM2040C set to a survey frequency of 300 kHz, high-density beam forming, with 400 beams per ping. Although the EM2040C allowed full swath widths at this frequency, lines from previous year's survey run at comparable depths contained considerable noise in outer beams (> ± 60 degrees from the nadir as identified by QPS engineers). As a result (and as per QPS recommendation), soundings greater than ± 60 degrees from the nadir were not included in final bathymetric surfaces.

3.4 Sound Speed Methods

Sound speed cast frequency: A total of 107 sound speed casts were taken within the boundaries of the 2020 surveys. All sound speed cast measurements were collected using the Teledyne Odom Digibar S profiler. Sound speed casts were taken as needed throughout the survey, which was generally when the observed surface sound speed (monitored and visualized in real-time using the AML MicroX SV sensor) differed from the surface sound speed in the active profile by more than 2 meters per second. In certain instances, supplemental casts were taken when there was reason to suspect significant changes in the water column (e.g. change in tide, abrupt changes in seafloor relief, etc.). During the collection of sound speed casts, logging was stopped to download and apply the new cast and was resumed when the boat circled around and came back on the survey line. Throughout the duration of the survey, the surface sound speed was observed in real-time (by the AML Micro X SV probe). Although sound speed data were recorded in raw sonar files, the raw sound velocity profiles (.csv) were also submitted with the survey data.

A quality comparison between the AML Micro X SV sensor and the Teledyne Odom Digibar S profiler was not performed. However, real-time comparisons between surface sound speed observed by the AML Micro X SV and the surface sound speed entry in the Digibar S profile suggested these instruments agreed.

4.0 Data Post-processing

The following is a summary of the procedures used for post-processing and analysis of survey data using Qimera (v.2.1.1, 64-bit edition) and Fledermaus (v.7.8.6, 64-bit edition) software.

4.1 Horizontal Datum

The horizontal datum for these data is WGS 84 projected in UTM zone 19N (meters).

4.2 Vertical Datum and Water Level Corrections

The vertical datum for these data is mean lower-low water (MLLW) level in meters. A tidal zoning file ("Maine_Tide_Zoning.zdf") containing time and range corrections for verified tide station data was provided by NOAA OCS to MCMI in May 2020. This file was used to apply time corrections, tide height offsets, and tide scale (range) for collected data in each zone listed in Table 7.

Survey Area	Tide Station	Zone ID	(mins.)	Tide Scale
Casco Bay	8419317	NA7	-12	0.99
Monhegan Island	8418150	NA6	-6	0.96
	8418150	ME30	18	1.0
		ME31	6	0.99
Inshore		ME38	36	0.99
		ME61	6	1.0
		ME65	6	0.99
		ME70	12	0.96
		ME74	30	0.96
		ME84	6	0.96
		ME86	0	0.98
		ME96	18	0.96
Matinicus Island	8418150	NA17	-6	0.98

Table 7 – Tide zones and corrections referenced to verified Wells, ME (8419317) and Portland, ME (8418150) tide station data

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4.3 Processing Workflow

The general post-processing workflow in Qimera was as follows:

- 1. Create project
- 2. Add raw sonar files (e.g. metadata extracted and processed bathymetry data converted to .qpd, including vessel configuration and sound velocity)
- 3. Add tide zoning file (.zdf) and associated tide data and integrate into raw files
- 4. Create dynamic surface with NOAA CUBE settings enabled for desired resolution (e.g. 2-meter, 4 meter)
- 5. Review and edit soundings/clean surface with slice editor tool, 3D editor tool, and available filters
- 6. Duplicate surfaces at other grid sizes, if desired
- 7. Export final surface to .BAG file and CUBE surface
- 8. Export processed data in. GSF format for backscatter processing

<u>CUBE</u>

A CUBE (Combined Uncertainty and Bathymetry Estimator) surface was created for editing and as a starting point for final products. The corresponding NOAA cube setting (e.g. "NOAA_4m" configuration, Figure 13) was selected for each surface depending on the grid size of the surface.

CUBE Settings			? ×	
Configuration NOAA_4	m 💌			
CUBE Capture Distance:) Distance Sca	le: 5.00		
	Distance Mir	1: 2.828		
CUBE Hypothesis Resolution Algorithm : Number of Samples 💌				
Estimate Offset:		4.00		
Horizontal Error Scale:		1.96		
Advanced <<				
Distance Exponent:	2.00			
Queue Length:	11			
Quotient Limit:	255.00			
Discount Factor:	1.00			
Bayes Factor Threshold:	0.135			
Run Length Threshold:	5			
		ОК	Cancel	

Figure 13 – CUBE settings parameters window shown with settings for NOAA 4-meter grid resolution

4.4 Final Surfaces

The following surfaces and BAGs were submitted with the survey data.

Table 8 - Surfaces submitted with 2020 survey data

Surface Name	Resolution (m)	Depth Range (m)	Surface Paramete r
MCMI_2020_CascoBay_2m_mllw	2	51.8 - 134.0	N/A
MCMI_2020_CascoBay_4m_mllw	4	51.9 – 133.5	N/A
MCMI_2020_CascoBay_8m_mllw	8	52.0 - 132.8	N/A
MCMI_2020_Monhegan_2m_mllw	2	43.6 - 97.4	N/A
MCMI_2020_ Monhegan _4m_mllw	4	43.7 – 97.2	N/A
MCMI_2020_ Monhegan _8m_mllw	8	43.9 - 97.2	N/A
MCMI_2020_Inshore_2m_mllw	2	0.1 - 45.8	N/A

MCMI_2020_Inshore_4m_mllw	4	0.1 - 45.6	N/A
MCMI_2020_Matinicus_1mgrid_0_to_30m _clip_mllw	1	0.8 - 30.0	N/A
MCMI_2020_Matinicus_2m_mllw	2	3.0 - 56.9	N/A
MCMI_2020_ Matinicus _4m_mllw	4	3.1 - 56.8	N/A
MCMI_2020_ Matinicus _8m_mllw	8	3.3 - 56.7	N/A

4.5 Backscatter

Backscatter was logged in the raw .db files. The .db files also hold the navigation record and bottom detections for all lines of surveys. Processed sonar files containing multibeam backscatter data (snippets and beam-average) were exported from Qimera v.2.1.1. in .GSF format. QPS Fledermaus Geocoder Toolbox (FMGT; v.7.8.6, 64-bit edition) was used to import, process, and mosaic time-series backscatter data. Default backscatter processing settings were used to create the mosaic, except for the Angle Varied Gain (AVG) filter and AVG window size, which were set to 'Adaptive' and '100', respectively. Backscatter mosaics of the data were gridded at 2-meter and 4-meter resolution and exported in greyscale (files ending in "gs") and floating-point (files ending in "db") GeoTIFF format. The mosaics are shown in Table 9 and Figures 14 through 17. The GSF files containing the extracted were submitted with the data in this survey.

Table 9 - Backscatter mosaics submitted with 2020 survey data

Mosaic Name	Pixel Size (m)
MCMI_2020_CascoBay_backscatter_2m_db	2
MCMI_2020_CascoBay_backscatter_4m_db	4
MCMI_2020_Monhegan_backscatter_2m_db	2
MCMI_2020_Monhegan_backscatter_4m_db	4
MCMI_2020_Inshore_backscatter_2m_db	2
MCMI_2020_Inshore_backscatter_4m_db	4
MCMI_2020_Matinicus_backscatter_2m_db	2
MCMI_2020_Matinicus_backscatter_4m_db	4



Figure 14 – Backscatter mosaic (4-meter pixel size) of 2020 Casco Bay survey area.



Figure 15 – Backscatter mosaic (2-meter pixel size) of 2020 Inshore survey area.



Figure 16 – Backscatter mosaic (4-meter pixel size) of 2020 Monhegan Island survey area.



Figure 17 – Backscatter mosaic (4-meter pixel size) of 2020 Matinicus Island survey area.

5.0 Results

5.1 Charts Comparison

The hydrographer conducted a qualitative comparison of reclassified bathymetry data and depth contours from the surveyed area to the charted soundings and contours. The largest scale (i.e. greater than 1:100,000) raster navigational charts which cover the survey areas are listed in Table 10. Prior hydrographic surveys in the vicinity were conducted by NOAA between 1854 and 1954 and some consisted only of partial bottom coverage. These data were not compared with data collected by the MCMI.

Chart	Scale	Source Edition	Source Date	Most Recent NTM Date	
13286	1:80,000	34	3/1/2019	10/15/2020	
13288	1:80,000	44	2/1/2016	5/6/2021	
13290	1:40,000	41	10/1/2019	5/6/2021	
13293	1:40,000	36	3/1/2016	4/1/2021	
13296	1:15,000	26	1/1/2012	6/25/2020	
13301	1:40,000	22	12/1/2018	5/20/2021	
13302	1:80,000	25	4/1/2019	1/21/2021	
13303	1:40,000	15	3/1/2017	6/18/2020	

Table 10 - Largest scale raster charts in survey area

Chart 13286

The entire Casco Bay survey area coincides with chart 13286. Charts with scales 1:80,000 (and smaller) inherently contain very generalized contours. As shown in Figure 18, the agreement between chart contours and new survey data (reclassified at 60 feet intervals; same as chart) is generally good at depths less than 360 feet (110 meters).

Chart 13288

The entire Casco Bay, Monhegan Island, and inshore survey areas coincide with chart 13288. The majority of the inshore survey area is generalized beyond comparison, however. Charts with scales 1:80,000 (and smaller) inherently contain very generalized contours. As shown in Figures 19 through 20, the agreement between chart contours and new survey data (reclassified at 60 feet intervals; same as chart) is generally good at depths less than 300 feet (91 meters). Agreement becomes increasingly poor at depths beyond 300 feet throughout the surveyed areas, particularly in the Monhegan Island area (Figure 21). This disagreement is likely due to the low resolution and lack of full bottom coverage during prior surveys rather than over

generalization. It is recommended that contours within the survey area be revised; though since only a relatively small total surface area deeper than 300 feet exists in the survey area, this disagreement could also be considered negligible.

Chart 13290

The majority of the Casco Bay survey area coincides with chart 13290. As shown in Figure 22, the agreement between chart contours and new survey data (reclassified at 60 feet intervals; same as chart) is generally good at depths less than 360 feet (110 meters).

Chart 13293

The entire inshore survey area coincides with chart 13293. Surveyed depths have good overall agreement with charted contours and soundings (Figure 23), although individual soundings may disagree at any given location.

Chart 13296

The majority of the inshore survey area coincides with chart 13296. Surveyed depths have good overall agreement with charted contours and soundings (Figure 24), although individual soundings may disagree at any given location.

Chart 13301

The entire Monhegan Island survey area coincides with chart 13301. As shown in Figure 25, the agreement between chart contours and new survey data (reclassified at 60 feet intervals; same as chart) is generally good at depths less than 300 feet (91 meters).

Chart 13302

The entire Matinicus Island survey area coincides with chart 13302. Charts with scales 1:80,000 (and smaller) inherently contain very generalized contours. As shown in Figure 26, the agreement between chart contours and new survey data (reclassified at 60 feet intervals; same as chart) is generally good at depths less than 120 feet (37 meters). Agreement becomes increasingly poor at depths beyond 120 feet throughout the surveyed area. This disagreement is likely due to the low resolution and lack of full bottom coverage during prior surveys rather than over generalization. It is recommended that contours within the survey area be revised.

Chart 13303

The entire Matinicus Island survey area coincides with chart 13303. As shown in Figure 27, the agreement between chart contours and new survey data (reclassified at 60 feet intervals; same as chart) is generally good at depths less than 120 feet (37 meters). Agreement becomes increasingly poor at depths beyond 120 feet throughout the surveyed area, though less so than for chart 13302.



Figure 18 – Comparison between surveyed depth in Casco Bay area (reclassified at 60-feet intervals, by color) and chart 13286 (scale: 1:80,000, 60-feet contour intervals).



Figure 19 – Comparison between surveyed depth in Casco Bay area (reclassified at 60-feet intervals, by color) and chart 13288 (scale: 1:80,000, 60-feet contour intervals).


Figure 20 – Comparison between surveyed depth in inshore area (reclassified at 60-feet intervals, by color) and chart 13288 (scale: 1:80,000, 60-feet contour intervals).



Figure 21 – Comparison between surveyed depth in Monhegan Island area (reclassified at 60-feet intervals, by color) and chart 13288 (scale: 1:80,000, 60-feet contour intervals).



Figure 22 – Comparison between surveyed depth in Casco Bay area (reclassified at 60-feet intervals, by color) and chart 13290 (scale: 1:40,000, 60-feet contour intervals).



Figure 23 – Comparison between surveyed depth in inshore area (reclassified at 60-feet intervals, by color) and chart 13293 (scale: 1:40,000, 60-feet contour intervals).



Figure 24 – Comparison between surveyed depth in inshore area (reclassified at 60-feet intervals, by color) and chart 13296 (scale: 1:15,000, 60-feet contour intervals).



Figure 25 – Comparison between surveyed depth in Monhegan Island area (reclassified at 60-feet intervals, by color) and chart 13301 (scale: 1:40,000, 60-feet contour intervals).



Figure 26 – Comparison between surveyed depth in Matinicus Island area (reclassified at 60-feet intervals, by color) and chart 13302 (scale: 1:80,000, 60-feet contour intervals).



Figure 27 – Comparison between surveyed depth in Matinicus Island area (reclassified at 60-feet intervals, by color) and chart 13303 (scale: 1:40,000, 60-feet contour intervals).

5.2 Uncharted Features

An uncharted wreck was found in the Sheepscot River off Birch Point in/near the town harbor of Wiscasset, Maine (Figure 28). The object was identified in real-time by the hydrographer on November 4, 2020. An additional 0.5-meter surface was created to visualize and illustrate the feature at finer resolution (insets of Figures 28 and 29).

The depth of this feature was approximately 0 to 8 meters. A mast is clearly visible coming out of the water from the wreck (Figure 29). Coordinates and additional attributes are listed in Table 11. The wreck was surveyed through normal line coverage, and two additional lines were run over the wreck with water column data collection enabled in Qinsy (Table 12). The suspected wreck is oriented northeast (bow)-southwest (stern) and appears to be upright but slightly listing to port.



Figure 28 – Location of suspected uncharted wreck located in 2020 survey area, off Birch Point in the Sheepscot River. Inset shows 50-cm gridded data overlain on 2-meter gridded bathymetry data.



Figure 29 – Suspected uncharted wreck mapped in 2020 survey area. Photograph of exposed mast (left) taken in the field on day of survey. Qimera soundings view window (right panes) show clear structure of boat.

Table 11 - Coordinates and summary attributes of suspected uncharted wreck

Latitude	Longitude	Length (m)	Width (m)	Orientation
43° 59' 39.195" N	69° 41' 52.447" W	20.1	6.5	NE-SW

Table 12 – Additional storage file names containing wreck

Database filename

1417_110420_Amy Gale - 0001.db 1418 110420 Amy Gale - 0001.db

5.3 Bottom Samples

A total of 42 bottom samples, 30 in area summarized in this report and 12 outside the scope of this report, were collected in state waters to supplement existing sediment data collected previously by other agencies (Maine Geological Survey and University of Maine) in the Matinicus Island survey area (Figure 30). The results of grain-size and video analyses will be used to calibrate, refine, and digitize interpretations of

seafloor substrate. These data are also used to investigate how these data relate to benthic infauna in the survey area.

Additional details on the bottom samples are provided in Table 13. More detailed analysis of grain size composition of these samples and benthic fauna composition will be determined after laboratory processing is complete for the collected samples.



Figure 30 – Bottom sample locations collected near Matinicus Island.

Table 13 – Grab Sample Information

Site Name	Date	Latitude (decimal degrees N)	Longitude (decimal degrees W)	Depth (m)	Grain Size (field observation)	Backscatter Intensity (dB)	Kelp Present?
MT-01	7/21/20	43.877150	-68.952083	27.8	shell hash, trace fine gravel	-13.63	
MT-02	7/21/20	43.880817	-68.946200	26.5	shell hash	-12.37	
MT-03	7/21/20	43.875767	-68.934850	26.6	rock	-12.05	Y
MT-04	7/21/20	43.872050	-68.928767	46.3	mud with shell hash and some fine gravel	-8.27	
MT-05	7/21/20	43.862450	-68.927767	24.4	large rock in ponar	-9.85	
MT-06	7/21/20	43.862117	-68.935600	31.9	several cobbles 10-20 cm in length	-10.48	
MT-07	7/21/20	43.849800	-68.942617	38.7	mud with shell hash and some fine gravel	-9.53	
MT-08	7/21/20	43.849400	-68.953517	28.5	shell hash mixed with gravel, some mud	-11.74	
MT-09	7/24/20	43.850500	-68.913017	23.3	pebble-sized gravel and shell hash	-15.83	Y
MT-10	7/24/20	43.845283	-68.909667	16.2	rock with kelp	N/A	Y
MT-11	7/24/20	43.854183	-68.871617	27.4	mix of cobbles and shell hash, some gravel	N/A	
MT-12	7/24/20	43.864717	-68.877367	17.5	fine shell hash	N/A	Y
MT-13	7/24/20	43.864017	-68.865817	23.8	shell hash	N/A	Y
MT-14	7/24/20	43.868283	-68.868117	31.2	shell hash, trace mud	N/A	
MT-15	7/24/20	43.881933	-68.865817	22.6	rock	N/A	Y
MT-16	7/28/20	43.873833	-68.913333	29.3	muddy gravel and intact shells, some shell hash	-9.85	
MT-17	7/28/20	43.868083	-68.947483	13.3	rock with kelp	-8.90	Y
MT-18	7/28/20	43.835217	-68.931600	47.2	fine sandy mud, some shell fragments	-16.46	
MT-19	7/28/20	43.835167	-68.924350	43.7	mud	-15.83	
MT-20	7/28/20	43.836183	-68.910517	27.4	rock	-12.68	
MT-21	7/28/20	43.825633	-68.850583	79.6	mud	N/A	
MT-22	7/28/20	43.843083	-68.853067	63.1	mud with pebble-sized gravel intermixed	N/A	
MT-23	8/6/20	43.876467	-68.852133	38.7	sandy mud, some fine gravel	N/A	
MT-24	8/6/20	43.876450	-68.869467	25.1	gravel with shell hash, some mud	N/A	
MT-25	8/6/20	43.857050	-68.851250	46.0	rock	N/A	
MT-26	8/6/20	43.836133	-68.864750	48.2	rock	N/A	
MT-27	8/6/20	43.830500	-68.870300	54.1	muddy shell hash	N/A	
MT-28	8/6/20	43.845550	-68.931067	43.0	gravelly mud	-10.48	
MT-29	8/6/20	43.859000	-68.949300	34.2	mud with some shell hash	-8.27	
MT-30	8/6/20	43.883817	-68.901317	39.4	gravelly mud, some sand intermixed	-11.42	

6.0 Summary

From April to November of 2020, MCMI collected a total of approximately 45 mi² (117 km²) of highresolution multibeam data. 39 mi² (101 km²) were collected in the "mainscheme" area of federal (18 mi²) and state (21 mi²) coastal marine waters. Approximately 6 mi² (16 km²) were collected in nearshore waters. Except for numerous small holidays, multibeam coverage was 100% in all areas surveyed. Survey data were processed with 4-meter grid resolution, although 2-meter and 8-meter surfaces were also generated for submission with this report. Comparisons between these survey data and the largest scale nautical charts in the immediate vicinity show good overall agreement except for in surveyed areas at depths greater than 120 feet (locality off Matinicus Island) and 300 feet (all other localities). Overall, these data are of sufficient quality to supersede previous data collected in the vicinity. It is recommended that the corresponding charts be updated to reflect these data.

MCMI has utilized final data products for high-resolution backscatter and bathymetry to refine existing seafloor sediment maps. When combined with existing geophysical (e.g. seismic reflection profiles and side-scan sonar) data, these data may also be used to refine interpretations of coastal/nearshore geomorphology and three-dimensional assessments of potential sediment resources/valley fill in the region. In addition, these data are a critical component of benthic habitat classification and modeling performed by MCMI. Overall, these data have a variety of applications and are an invaluable resource to public and private agencies who wish to manage and understand coastal and marine resources more effectively.

These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and were shared with the NOAA Office of Coast Survey for review.

Please contact the Maine Coastal Program's Research Coordinator for additional information or data requests.

References

NOAA, 2017. NOS hydrographic surveys specifications and deliverables: U.S Department of Commerce National Oceanic and Atmospheric Administration. 162 Pages.

U.S. Department of the Interior, 2014. Proposed geophysical and geological activities in the Atlantic OCS to identify sand resources and borrow areas north Atlantic, mid-Atlantic, and south Atlantic-Straits of Florida planning areas, *final environmental assessment*. OCS EIS/EA BOEM 2013-219 U.S. Department of the Interior Bureau of Ocean Energy Management Division of Environmental Assessment Herndon, VA, January 2014.

Mainscheme	Inshore
4/16/20	4/15/20
5/6/20	5/11/20
5/26/20	5/14/20
6/1/20	5/18/20
6/17/20	5/25/20
6/18/20	6/2/20
6/23/20	6/4/20
6/26/20	6/8/20
7/6/20	6/9/20
7/7/20	6/16/20
7/14/20	8/13/20
7/22/20	8/14/20
7/23/20	8/19/20
7/27/20	8/25/20
7/30/20	8/27/20
8/7/20	9/3/20
8/10/20	10/5/20
8/20/20	10/21/20
9/4/20	10/22/20
9/7/20	10/26/20
9/8/20	10/28/20
9/10/20	11/4/20
10/19/20	11/9/20
10/20/20	11/10/20
	11/12/20
	11/13/20

Dates (mm/dd/yy) of Data Acquisition for 2020 Surveys*

Appendix A – Specific dates of data acquisition for surveys

*Dates of surveys not summarized in this report not listed

Appendix B – 2020 Configuration settings for Seapath 330



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HP/XP/G2						
L- BTK						
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Input/Output						
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connected to Seapath 330						



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	TelegramOut13			NONE	Telegram Out #13	
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Appendix C – Template database settings in Qinsy (for acquisition)

Note: All template databases used for surveying in the 2020 season are identical except for EM2040C calibration offsets (e.g. pitch, roll, and heading). These differences are summarized in table 4 of report's main text.

Template database name: AmyGale_2020_Patch1_nonverifiedtides_2.db

Note: Disregard template database name. Verified tide files were used to run the patch test and update EM2040C offsets, however the template name was not properly changed to reflect this.

Qinsy uses the following reference frame conventions (these differ from those used by Seapath 330):

Pitch rotation: + bow up Roll rotation: + heeling to starboard Heave: + upwards

X: + to starboard Y: + towards bow Z: + up

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🖨 🌑 Datums	Line sequence number: 1	
WGS84		
🛱 🛣 Heights	Line description: N/A	
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Geodetic		Predefined system:	Not Defined
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			"20210225T035001.424000"]]
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		DTM file:	N/A		
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	Conversion factor to metres:	1.000000000000	 	
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Survey	Sound Velocity Profile		
General Ge	Sound Velocity Profile Profile ID: 1383 Profile latitude: 43;31;56:02287 N Profile longitude: 70;20;08:36092 W Profile date: 2020-06-04 Profile time: 1307 Depth unit: Meters / Second SD depth data: 0.100 m SD velocity data: 0.050 m/s Number of entries: 17		
Qinsy 9 For Help, press F1			

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😑 🏬 Survey	Object: Amy Cale			
- 🕜 General	Object: Any Gale			
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Datums	Object type:	Vessel		
WGS84	Description of reference point:	Amy Gale MRU		
	Height above draft reference:	0.000 m		
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Digital Tarrain Models	Squat model:	Not Defined		
	SD draft:	0.050 m		
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□·[™] Survey	System: EM2040C		
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⊟ đ Geodetic	Description:	EM2040C	
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Heights	Driver:	Kongsberg EM2040/EM710/EM302/EM122	
Chart Datum / Vertical Datum	Executable and Cmdline:	DrvKongsbergEM.exe	
Mean Water Level Model	Driver specific settings:	MANUFACTURER=2;MODEL=2045;RAW BATHY=1;RAW SNIP=1;RAW WCD=1;	
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	opulate rate.		
Local Construction Grid	Acquired by:	[Directly into Qinsy] (No additional time tags)	
- O UTC to GPS Correction	Observation time from:	N/A	
Sound Velocity Profile	Number of slots:	1	
e de Object	Manufacturer:	Kongsberg	
Amy Gale	Model:	EM2040C	
EM2040C	Object location:	Amy Gale	
D d Gvro	Node name:	RX	
Gvro	X (Stbd = Positive)::	0.000 m	
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- S Amy Gale MRU	P-W-ffort	0.000	
@ RX	Roll offset:	0.332	
⊥ ● TX	Pitch offset:	0.279	
Link	Heading offset:	-0.181	
Auxiliary Systems	Unit is roll stabilized:	No	
- Ime Sync	Unit is pitch stabilized:	No	
	Unit is heave compensated:	No	
- Fixed Node	Beam steering (flat transducer):	No	
	Beam angle width along:	1.500 m	
	Beam angle width across:	1.500 m	
	Maximum number of beams per ping:	800	
	Use sound velocity from unit:	Yes	
	Slot:	1	
	SD type:	Pulse, Sampling	
	SD pulse length:	0.150 ms	
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• Amy Gale MRU • RX • RX • TX • Maximum number of beams per ping: 800 • Maximum number of beams per ping: 800 • Use sound velocity from unit: Yes • Yes • Sound velocity from unit: Yes • Sound velocity from unit: Sound velocity from unit: Sound velocity from unit: Ves • Sound velocity from unit: Sound velocity from unit: Sound velocity from unit: Ves • Sound velocity from unit: Sound velocity from unit: Sound velocity from unit: Ves • Sound velocity from unit: Sound velocity from unit: Ves • Sound velocity from unit: Sound velocity from unit: Sound velocity from unit: Ves • Sound velocity from unit: Sound velocity from unit: Ves • Sound velocity: Ves • Sound ves • Sound ves • Sound ve	P Amy Gale MRU Beam angle width across: 1.500 m • TX Maximum number of beams per ping: 800 • Link Use sound velocity from unit: Yes • Stime Sync Slot: 1 • EM2040C Controller SD type: Pulse, Sampling • ASCIL Logger SD pulse length: 0.150 ms • SD controller SD sampling length: 0.050 ° • SD pitch offset: 0.050 ° • SD pitch offset: 0.050 ° • SD roll offset: 0.000 ° • SD pitch stabilization: 0.000 ° • SD pitch stabilization: 0.000 ° • SD pitch velocity: 0.050 m/s	□ ¥ Variable Node	Beam angle width along:	1.500 m	
Maximum number of beams per ping: 800 Auxiliary Systems Use sound velocity from unit: Yes Auxiliary Systems Slot: 1 S Time Sync SD type: Pulse, Sampling • ASCI Logger SD pulse length: 0.150 ms Fixed Node SD sampling length: 0.050 m SD roll offset: 0.050 ° SD pitch offset: 0.050 ° SD roll offset: 0.050 ° SD roll offset: 0.000 ° SD heading offset: 0.000 ° SD pitch tabilization: 0.000 m SD pound velocity: 0.050 m/s	• TX Maximum number of beams per ping: 800 • TX Use sound velocity from unit: Yes wuxiliary Systems Slot: 1 • Time Sync SD type: Pulse, Sampling • ASCIL Logger SD pulse length: 0.150 ms • ASCIL Logger SD sampling length: 0.050 m SD roll offset: 0.050 ° SD pitch offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 m SD beave compensation: 0.000 m SD sound velocity: 0.050 m/s	Amy Gale MRU	Beam angle width across:	1.500 m	
Image: Second velocity from unit: Yes Auxiliary Systems Slot: 1 Time Sync Slot: 1 EM2040C Controller SD type: Pulse, Sampling The Sync SD pulse length: 0.150 ms Dr ASCII Logger SD sampling length: 0.050 m SD roll offset: 0.050 ° SD pitch offset: 0.050 ° SD heading offset: 0.000 ° SD roll stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	State Use sound velocity from unit: Yes Suiliary Systems Slot: 1 Strime Sync SD type: Pulse, Sampling EM2040C Controller SD type: Pulse, Sampling ASCII Logger SD pulse length: 0.150 ms SD coll offset: 0.050 ° SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	e TY	Maximum number of beams per ping:	800	
Auxiliary Systems Slot: 1 Ime Sync SD type: Pulse, Sampling EM2040C Controller SD pulse length: 0.150 ms Dr ASCII Logger SD sampling length: 0.050 m Fixed Node SD roll offset: 0.050 ° SD pitch offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	Solar 1 Silot: 1 SD type: Pulse, Sampling ASCIL Logger SD pulse length: 0.150 ms SD roll offset: 0.050 ° SD pilch offset: 0.050 ° SD pilch offset: 0.050 ° SD roll stabilization: 0.000 ° SD pilch stabilization: 0.000 ° SD pound velocity: 0.050 m/s		Use sound velocity from unit:	Yes	
State File Image: State State	Time Sync Soc Pulse, Sampling EM2040C Controller SD type: Pulse, Sampling ASCII Logger SD pulse length: 0.150 ms ixed Node SD sampling length: 0.050 m SD roll offset: 0.050 ° SD heading offset: 0.050 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	Auxiliary Systems	Slot:	1	
Image: Provide Controller Do Specifie Controller Image: De ASCII Logger SD pulse length: 0.150 ms Image: Provide Provi	EM2040C Controller SD bype: For Help, press F1	- 👌 Time Sync	SD type:	Pulse Sampling	
Obs ASCII Logger SD pate tergin. 0.100 ms Fixed Node SD sampling length: 0.050 m SD roll offset: 0.050 ° SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD pate compensation: 0.000 m SD sound velocity: 0.050 m/s	ASCII Logger SD pampling length: 0.050 m SD sampling length: 0.050 m SD roll offset: 0.050 ° SD pitch offset: 0.500 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	EM2040C Controller	SD pulse length:	0.150 ms	
Fixed Node SD sampling length. 0.000 m SD roll offset: 0.050 ° SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	Ixed Node SD sampling length. 0.050 m SD roll offset: 0.050 ° SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD pitch stabilization: 0.000 m SD sound velocity: 0.050 m/s	De ASCII Logger	SD pulse length.	0.050 m	
SD roll offset: 0.000 ° SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	SD foll offset: 0.050 ° SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD heading offset: 0.000 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	Fixed Node	SD sampling length.	0.050 11	
SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	SD pitch offset: 0.050 ° SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s		SD roll offset:	0.050	
SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	SD heading offset: 0.500 ° SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s For Help, press F1		SD pitch offset:	0.050	
SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	SD roll stabilization: 0.000 ° SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s For Help, press F1		SD heading offset:	0.500 °	
SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	SD pitch stabilization: 0.000 ° SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s For Help, press F1		SD roll stabilization:	0.000 °	
SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s	SD heave compensation: 0.000 m SD sound velocity: 0.050 m/s		SD pitch stabilization:	0.000 °	
SD sound velocity: 0.050 m/s	For Help, press F1		SD heave compensation:	0.000 m	
	For Help, press F1		SD sound velocity:	0.050 m/s	
	For Help, press F1				

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ile Edit View Options Help				
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Survey	Observation	n: Gyro		
Geodetic Geodetic	Observation description: Observation type: 'At' node: Measurement unit code: System description:	Gyro Bearing (True) Amy Gale MRU Degrees Gyro		
	(C-O) option: Scale factor: Fixed system (C-O): Variable (C-O): A-priori SD:	(C-O) offsets applied first 1.00000000000 0.000000000 0.00000000 0.5000		
Gott Gott				
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Survey	ch Poll Heave Sensor
General System. Fit	cii Koli Heave Selisoi
Geodetic Description:	Pitch Roll Heave Sensor
Type:	Pitch Roll Heave Sensor
Driver:	Network - Seapath MRU Binary Format 11 (With UTC)
Chart Datum / Vertical Datum Executable and Cmdlir	E: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Mean Water Level Model Port:	13001
Ż Digital Terrain Models Update rate:	0.000 s
E Projections	0,000 s
- Universal Transverse Mercator (North Hemisphere)	[Directly into Oinsy] (No additional time tags)
Local Construction Grid	Lonectly into Qinsyl (No additional time tags)
- O UTC to GPS Correction	
Number of slots:	0
Object:	Amy Gale
PRH sensor reference r	umber: 1
EM2040C Rotation convention p	ch: Positive bow up
	I: Positive heeling to starboard
Gyro Angular variable meas	red: HPR (roll first)
Heave Sensor Angular measurement	inits: Degrees
Sign convention heave	Positive upwards
A Variable Node Measurement unit hear	e: Meters
Amy Gale MRU Conversion factor to d	grees decimal: N/A
Conversion factor to m	etres: N/A
Quality indicator type	itch and roll: No quality info recorded
Quality indicator type	eave: No quality info recorded
-	ndicator type: N/A
EM2040C Controller Object location:	Amy Gale
Viewed Node name:	Amy Gale MRU
X (Stbd = Positive)::	0.000 m
Y (Bow = Positive)::	0.000 m
Z (Up = Positive)::	0.000 m
A-priori SD:	0.000 m
(C-O) roll offset:	0.000 °
(C-O) pitch offset:	0.000 °
(C-O) heave offset:	0.000 m
Heave time delay:	0.000 s
Qinsy 9 For Help, press F1	

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File Edit View Options Help					
Survey	Latency:	0.000 s			^
General	Acquired by:	[Directly into Oinsy] (No additional time taos)		-	—
Geodetic	Observation time from:	N/A			
Datums ■ WGS94	Number of slots:	0			—
					—
Chart Datum / Vertical Datum	Object:	Amy Gale			
Amean Water Level Model	PKH sensor reference number:	1			
🛓 Digital Terrain Models	Rotation convention pitch:	Positive bow up			
E Projections	Rotation convention roll:	Positive heeling to starboard			
- Universal Transverse Mercator (North Hemisphere)	Angular variable measured:	HPR (roll first)			
Local Construction Grid	Angular measurement units:	Degrees			
- O UTC to GPS Correction	Sign convention heave:	Positive upwards			
Sound Velocity Profile	Measurement unit heave:	Meters			
Diject	Conversion factor to degrees decimal:	N/A			
Amy Gale	Conversion factor to metres:	N/A			
	Quality indicator type pitch and roll:	No quality info recorded			
EWIZO40C	Quality indicator type heave:	No quality info recorded			
Gvro	Description of quality indicator type:	N/A			
Heave Sensor	Object location:	Amy Gale			
L Position Navigation System	Node name:	Amy Gale MRLL			
⊨ 🔆 Variable Node	Y (Sthd = Bositive):	0.000 m			
	X (Stod = Positive)	0.000 m			
@ RX	Y (Bow = Positive)	0.000 m			
I III IIII IIII IIIII IIIIIIIIIIIIIII	Z (Up = Positive)::	0.000 m			
Enk Stranger	A-priori SD:	0.000 m			6
Auxiliary Systems	(C-O) roll offset:	0.000 °			
- © Time Sync	(C-O) pitch offset:	0.000 °			
	(C-O) heave offset:	0.000 m			
Fixed Node	Heave time delay:	0.000 s			
i hid hode	Heave filter length:	N/A			
	SD roll and pitch:	0.050 °			
	SD heave (fixed):	0.050 m			
	SD heave (variable):	5.000 %			
	SD roll offset:	0.050 °			
	SD pitch offset:	0.050 °			
	SD heave offset:	0.050 m			
					—
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E % 🔜 🙏 💿 🖉 🛛 🔢 📟 🖉 🗟 💷 🔒 🛈	8	
Image: Survey Image: Geodetic Image: Geodetic </th <th>System: Pos Description: Type: Driver: Executable and Cmdline: Port: Update rate: Latency: Acquired by: Observation time from: Number of slots:</th> <th>ition Navigation System Position Navigation System Position Navigation System Network - Seapath Binary Format 11 (With UTC) DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS 13001 0.000 s [Directly into Qinsy] (No additional time tags) N/A 0</th>	System: Pos Description: Type: Driver: Executable and Cmdline: Port: Update rate: Latency: Acquired by: Observation time from: Number of slots:	ition Navigation System Position Navigation System Position Navigation System Network - Seapath Binary Format 11 (With UTC) DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS 13001 0.000 s [Directly into Qinsy] (No additional time tags) N/A 0
Image: System Image: System <t< td=""><td>Satellite system name: Horizontal datum: Vertical datum: Height file: Height level: Height level: Height offset: SD latitude: SD latitude: SD latitude: SD height: Measurement unit: Receiver description: Receiver description: Node name: X (Stbd = Positive):: X (Stbd = Positive):: Z (Up = Positive):: A-priori SD:</td><td>WGS84 WGS84 N/A No Level Correction N/A 0.000 m 0.250 m 0.010 Navigation System 0 Amy Gale Amy Gale MRU 0.000 m 0.000 m 0.000 m 0.000 m 0.000 m</td></t<>	Satellite system name: Horizontal datum: Vertical datum: Height file: Height level: Height level: Height offset: SD latitude: SD latitude: SD latitude: SD height: Measurement unit: Receiver description: Receiver description: Node name: X (Stbd = Positive):: X (Stbd = Positive):: Z (Up = Positive):: A-priori SD:	WGS84 WGS84 N/A No Level Correction N/A 0.000 m 0.250 m 0.010 Navigation System 0 Amy Gale Amy Gale MRU 0.000 m 0.000 m 0.000 m 0.000 m 0.000 m
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AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Progra	am	– 🗆 X
File Edit View Options Help		
루- ^መ ' Survey	Noder Amy Cole MPU	
- 🖪 General	Node: Amy Gale MRO	
🖶 🗸 Geodetic	Object location: Amy Gale	
Datums	Node name: Amy Gale MRU	
WGS84	X (Stbd = Positive)" 0.000 m	
# Chart Datum (Matical Datum	Y (Bow - Positive) 0000 m	
Chart Datum / Vertical Datum	$T_{\rm c}(0) = \text{Positive}, 0.00 \text{ m}$	
	A-phon SD: 0.000 m	
Universal Transverse Mercator (North Hemisphere)		
Local Construction Grid		
- 💩 UTC to GPS Correction		
Sound Velocity Profile		
🖃 🔁 Object		
🖨 🏧 Amy Gale		
⊇- <mark>:</mark> System		
EM2040C		
I = 4 ^p Gyro		
K Dish Ball Hanna Cassar		
Prich Koll Heave Sensor A Desition Navigation System		
© TX		
Link		
Auxiliary Systems		
- Time Sync		
EM2040C Controller		
ASCII Logger		
└ _─ ↓ Fixed Node		
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AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Progr	ram	– 🗆 X
File Edit View Options Help		
E	Node: RX	
General Geodetic Datums Geodetic Datums Geodetic Datums Geodetic Datums General Geodetic Geodetic Geodetic Construction Level Model Digital Terrain Models Digital Terrain Models Digital Terrain Models Digital Terrain Models Digital Terrain Models Construction Grid Object Guide Construction Grid Object Gond Construction Grid Sound Velocity Profile Gond Construction Grid Geodetic Sound Velocity Profile Gond Construction Grid Geodetic Construction Grid Construction Grid Geodetic Construction Grid Construction Grid Construction Grid Geodetic Construction Grid Construction Grid	Object location: Amy Gale Node name: RX X (Stud = Positive): 0.000 m Y (Bow = Positive): 0.005 m Z (Up = Positive): 0.006 m A-priori SD: 0.010 m	
Qinsy 9 For Help, press F1	1	

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E 🔏 🔜 🙏 💿 🖉 🛛 🔢 📼 🛃 🗠 🔒 🛈			
Survey	Node: TX		
General			
Geodetic	Object location: Amy Gale		
Datums	Node name: TX		
WG584	X (Stbd = Positive):: 0.040 m		
Heights	Y (Bow = Positive): 0.004 m		
Mean Water Level Model			
Digital Terrain Models			
Universal Transverse Mercator (North Hemisphere)			
Local Construction Grid			
- Ö UTC to GPS Correction			
Sound Velocity Profile			
🖶 🖶 Object			
🖨 🏧 Amy Gale			
🖨 🔚 System			
B Ø Gyro			
L Ditch Dell Unever Concern			
Price Roll Heave Sensor			
• RX			
Link			
Auxiliary Systems			
- 💩 Time Sync			
ASCII Logger			
Fixed Node			
Qinsy 9 For Help, press F1]		

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File Edit View Options Help				
E % 🔜 🙏 💿 🖉 🛛 🔢 📟 🐼 🗟 💷 🔒 ()	8			
Survey	System: Time Sync			
🛱 🗸 Geodetic	Description:	Time Svnc		
Datums	Type:	Time Synchronization System		
Gor WGS84	Driver:	NMEA ZDA		
Chart Datum / Vertical Datum	Executable and Cmdline:	DrvPositionNMEA.exe		
Mean Water Level Model	Port:	2		
🚽 Digital Terrain Models	Baud rate:	9600		
🖻 🔛 Projections	Data bits:	8		
	Stop bits:	1		
Local Construction Grid	Parity:	None		
OUL to GPS Correction	Byte frame length (time):	10 bits (1.042 ms)		
Direct	Maximum data transfer rate:	960 bytes / second		
Amy Gale	Update rate:	0.000 s		
🖨 🏭 System	Latency:	0.000 s		
	Acquired by:	[Directly into Oinsy] (No additional time tags)		
⊖ \$° Gyro	Observation time from:	N/A		
	Number of elete	0		
T Pich Koll Heave Sensor T Position Navigation System	Number of slots.	0		
a Variable Node	Use QPS PPS Adapter:	On COM1		
- Amy Gale MRU	PPS time tag pulse matching:	Automatic Matching		
	Windows System Time Synchronization:	Synchronization is enabled		
Eink				
Auxiliary Systems				
Ime Sync EM2040C Controller				
- De ASCILLogger				
-X Fixed Node				
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AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program	m		-1		×		
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E % 🔜 🙏 💿 🖉 🛛 🔢 📟 🖉 🗟 💷 🔒 🛈	3						
E W Survey	System: EM2040C Controller						
Survey General Geodetic Datums Chart Datum / Vertical Datum Chart Datum / Vertical Datum Support Datum Support Datum / Ve	System: EM2 Description: Type: Driver: Executable and Cmdline: Update rate: Latency: Acquired by: Observation time from: Number of slots:	EM2040C Controller Miscellaneous System Kongsberg EM2040 Compact (Single) Multibeam Controller DrvKongsbergEMCtrl.exe 2040C 0.000 s (Directly into Qinsy] (No additional time tags) N/A 0					
Qinsy 9 For Help, press F1	1						

AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program	ı		– 🗆 X
File Edit View Options Help			
	1		
⊡ ^{IIII} Survey IIII General	System: ASC	II Logger	
General Geodetic Geodeti	Description: Type: Driver: Executable and Cmdline: Update rate: Latency: Data output setting: Acquired by: Observation time from: Number of slots:	ASCII Logger Output System Generic ASCII Data Logger (Controller) DrvGenericLogger.exe 1.000 s 0.000 s Enabled [Directly into Qinsy] (No additional time tags) N/A 0	
Qinsy 9 For Help, press F1			

Appendix D – Configuration settings for Qinsy EM controller

K Controller - EM2040C Co			
-PU Status			
Status Active			Stop
Pinging 15308 @ 2.90 H	z		
Clock Status Ok			<u>P</u> u Info ▼
Errors All Ok			
			Options
Settings			
Head1 Port Angle	65		~
Head1 Starboard Angle	65		
Max. Port Coverage	300		
Max. Starboard Coverage	300		
Angular Coverage	Auto		-
Beam Spacing	High Density		•
Pitch Stabilization	On		-
Max. Ping Freq.(Hz)	50.00		
Transmit Angle (deg)	0.0		
Minimum Depth	0.00		
Maximum Depth	200.00		
Detector Mode	Normal		-
Slope Filter	On		-
Areation Filter	Off		-
Interference Filter	Off		-
Penetration Filter	Off		<u>•</u>
Range Gate Size	Normal		<u>•</u>
Spike Filter Strength	Medium		-
Phase Ramp	Normal		-
Special Amp Detect	Off		-
Special TVG	Off		-
Normal Inci. Sector Angle	10		
Lambert's law for intensity	Off		-
Ping Mode	300 KHz		-
Pulse Type	Auto		
Transmit Power Level	Maximum		▼
FM Enable	FM Enabled		<u> </u>
13D Scanning - Scan Step	0.0		Ţ
Apply Settings	Force 🔽 Log Events		
Events			
10:00:53.105 PU Clock is synch	nronized		~
10:00:53.963 Connection to PL 10:00:53.963 Set Initial Setting	J (157.237.20.40) Established		
10:00:55.073 Command Accep	ted		
1			*

📶 EM Controlle	r - EM2040C Co	ontroller —	
-PU Status			
Status	Active		Stop
Pinging	18646 @ 2.70 H	z	
Clock Status	Ok		Pu Info ▼
Errors	All Ok		
			Options
Settings			
Penetration Filt	er	Off	- ^
Range Gate Size	e	Normal	•
Spike Filter Stre	nath	Medium	-
Phase Ramp	5	Normal	-
Special Amp De	etect	Off	-
Special TVG		Off	-
Normal Inci. Se	ctor Angle	10	
Lambert's law f	or intensity	Off	-
Ping Mode		300 KHz	-
Pulse Type		Auto	▼
Transmit Powe	r Level	Maximum	-
FM Enable		FM Enabled	-
3D Scanning - S	Scan Step	0.0	
3D Scanning - I	Min Angle	-5	
3D Scanning - I	Max Angle	5	
Dual Swath Mo	de	Off	-
Min. Swath Dist	tance	0.0	
Yaw Stabilizatio	on Mode	Off	-
Yaw Manual Ar	ngle	0.0	
Heading Filter		Medium	-
WCD Sonar Mo	de	Off	-
WCD Passive N	lode	Off	T
WC TVG LOG R		30.0	
WC TVG dB		20.0	
Special amplitu	ide detection	Off	-
Sound Velocity	Update Rate	3.0	
Sound Velocity	Min Change	0.5	
Apply Se	ettings 🔻	Force 🔽 Log Events	
Events			
10:00:53.105 10:00:53.963 10:00:53.963	PU Clock is synch Connection to PL Set Initial Setting	rronized J (157.237.20.40) Established	^
10:00:55.073	Command Accep	ted	~

Options			x
PU Setup			
System Type (from DbSetup)	EM2040C	Single Transducer	
Pu Ip Address 157.237.20		.40	
Simulation Mode Off			-
External Triggering	Off		-
Control Port	2000		
Enabled Output Ports	Output P	ort 1,2,3	- =
Output Port 1 (Bathy)	2001		
Output Port 2 (Bathy)	2002		
Output Port 3 (Sidescan)	2003		
ZDA/GGA Serial Port	Port 1 (de	fault)	-
Use GGA	On		-
Baudrate ZDA/GGA	9600		-
Motion Serial Port	Port 2 (de	fault)	- ⁻
Program Options			
Start Pinging when QINSy Starts		Pinging On Startup	-
Synchronize Clock Interval(min.)		60	
Sound Velocity Mode		From SoundVelocity	C -
Sound Velocity Observation		Sound Velocity	-
Popup window when error occurs		On	-
Allow HD beamspacing with Water Column Data		Not Allowed	-
Installation Parameters	0		
RXI Gain Offet	0		
RAZ Gain Offet	0		
Head1 Installation angles from	EIVI2040		
Head2 Installation angles from	Not Us	ed Several	
Velocity Sensor Number	2001	Sensor 1	_ <u> </u>
Velocity Sensor Ethernet Dort	Ethern	t Dort 2 (if available)	
Ethernet Dort 2 ID Address	102.169		_ <u> </u>
Ethernet Port 2 IP Address	255 255	0.0	
OK Cancel			