

# 2018 Descriptive Report of Seafloor Mapping: Saco Bay to Monhegan Island, Gulf of Maine

Chief of Party – Benjamin Kraun, Project Hydrographer, Contractor to the Maine Coastal Program

Maine Coastal Mapping Initiative, April 2019

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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>.

# Acknowledgements

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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-Locality:	Saco Bay to Monhegan Island
	2018
Benjamin Krau	CHIEF OF PARTY In, Hydrographer, Contractor to the State of Maine
	LIBRARY & ARCHIVES
Date:	

	MAINE COASTAL MAPPING INITIATIVE	REGISTRY NUMBER:
	MAINE COASTAL PROGRAM	
ΠΙΔΑΟΥ	GRAPHIC TITLE SHEET	
INSTRUCTIONS: The hydrog	graphic sheet should be accompanied by this form, filled in as completely as possible, w	when the sheet is forwarded to the Office.
State(s):	Maine	
General Locality:	Gulf of Maine	
Sub-Locality:	Saco Bay to Monhegan Island	
Scale:		
Dates of Survey:	08/01/2018 to 11/19/2018	
Instructions Dated:		
Project Number:		
Field Unit:	Amy Gale	
Chief of Party:	Benjamin Kraun, Hydrographer, Contract	or 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:		

# **Table of Contents**

Acknowledgementsiii
ABSTRACT1
1.0 Area Surveyed
1.1 Survey Purpose
1.2 Survey Quality4
1.3 Survey Coverage
2.0 Data Acquisition
2.1 Survey Vessel
2.2 Acquisition Systems
2.3 Vessel Configuration Parameters6
2.4 Survey Operations
2.5 Survey Planning
2.6 Calibrations
3.0 Quality Control9
3.1 Crosslines9
3.2 Junctions
3.3 Equipment Effectiveness
3.4 Sound Speed Methods11
4.0 Data Post-processing
4.1 Horizontal Datum
4.2 Vertical Datum and Water Level Corrections11
4.3 Processing Workflow12
4.4 Final Surfaces14
4.5 Backscatter
5.0 Results
5.1 Charts Comparison16
6.0 Summary
References
Appendix A – Specific dates of data acquisition for mainscheme surveys
Appendix B – Configuration settings for Seapath 33023

Appendix C – Template database settings in QINSy (for acquisition)	35
Appendix D – Configuration settings for QINSy EM controller	61

#### Suggested citation:

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# ABSTRACT

During the survey season (July-November) of 2018 the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic surveying using a multibeam echosounder (MBES) in the waters off southern and mid-coast Maine. The surveying was conducted in part to support the Federal Bureau of Ocean and Energy Management's (BOEM) efforts to enhance coastal resiliency through identification and characterization of potential sand and gravel resources on the outer continental shelf that may be used for beach nourishment. The surveys also coincide with state efforts to update coastal data sets and increase high resolution bathymetric coverage for Maine's coastal waters. A total of approximately 18 mi<sup>2</sup> (47 km<sup>2</sup>) of high-resolution multibeam data were collected in the surveyed area. An additional 3.6 mi<sup>2</sup> were collected in nearshore waters for the purposes of assessing nearshore sand movement and mapping eelgrass beds. This work is summarized in separate reports.

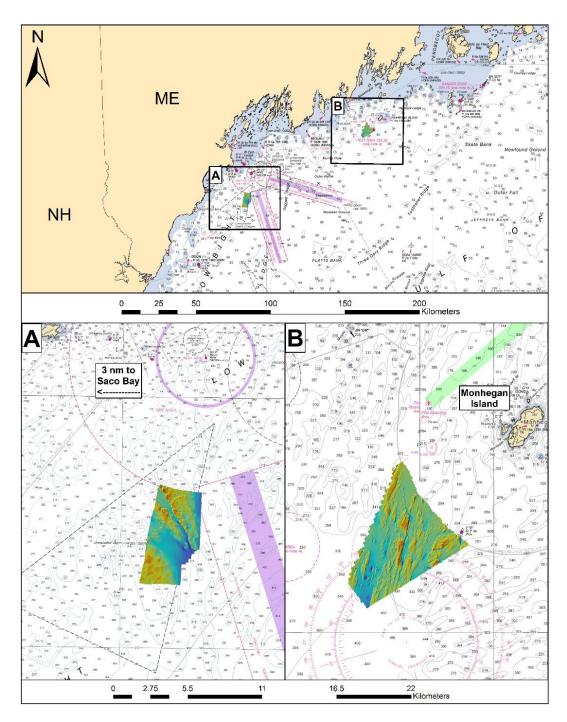
# **1.0 Area Surveyed**

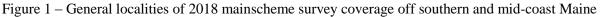
The 2018 mainscheme survey area was located off Maine's southern and mid-coast regions in the Gulf of Maine, with a sub-locality of Saco Bay to west of Monhegan Island as shown in Figure 1. The approximately 18 mi<sup>2</sup> (47 km<sup>2</sup>) mainscheme survey area adjoins the eastern extent of the areas mapped by MCMI in 2017 (data were submitted and are currently under review by NOAA, who lists the survey as W00450) (Figure 2). 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.

Mainscheme 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.

Saco Bay	
Southwest Limit	Northeast Limit
43° 22.576' N	43° 26.229' N
70° 8.963' W	70° 5.608' W
Monhegan Island	
Southwest Limit	Northeast Limit
43° 40.704' N	43° 44.907' N
69° 25.046' W	69° 23.617' W

Table 1 - 2018 mainscheme survey limits





# **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 Bureau of Ocean and Energy Management (BOEM). The purpose of this project was to enhance coastal resiliency through identification and characterization of potential sand and gravel resources in waters of federal jurisdiction that may be used for beach replenishment. This project also coincides with state efforts to update coastal data sets for Maine's coastal waters and provides new data in the areas covered by National Oceanic and

Atmospheric Administration (NOAA) nautical charts 13286, 13288, and 13301 in mid-coast and southern Maine. Additional objectives included habitat classification for planning purposes. These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible, and were shared with the UNH-NOAA Join Hydrographic Center / Center for Coastal and Ocean Mapping 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.

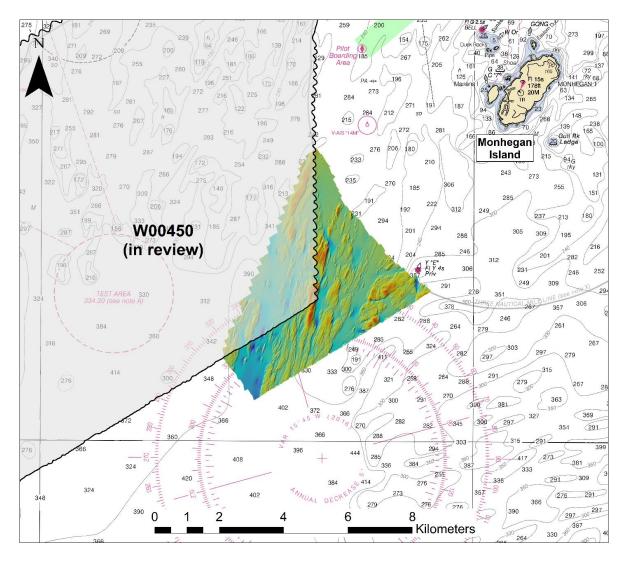


Figure 2 – 2018 survey relative to 2017 survey (NOAA survey ID: W00450, in review); plotted over RNC 13288

# 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 2018 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 3), 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 based out of Boothbay Harbor, Maine 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 3 – 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 2018 survey are outlined in Table 2. Data acquisition was performed using the Quality Positioning Services (QPS) QINSy (Quality Integrated Navigation System; v.8.18.2) 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.

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

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)
Acquisition Software and Workstation	QINSy software v.8.18.2 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

### **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) (Figure 4). 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 5), 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 2018 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).

	<b>x</b> ( <b>m</b> )	<b>y</b> ( <b>m</b> )	<b>z</b> ( <b>m</b> )
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

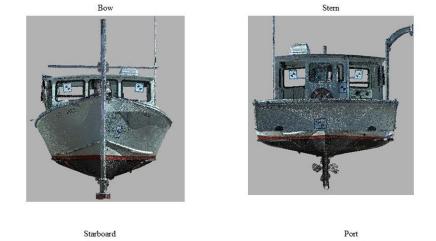




Figure 4 – Amy Gale RGB color images generated from 3D laser scan survey (GPS antennas and external cabling not included in survey) data (.pts file converted to .las for visualization)



Figure 5 – 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 4-meters for real-time visualization. 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 the specifications set forth in the BOEM grant, but also met requirements for NOAA hydrographic standards (NOAA Field Procedures Manual, 2014). 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  $\pm 60$  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 Quality Positioning Services 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 2018 survey season to correct for alignment offsets. 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.1.7.0) patch test tool. After calibration was complete, offsets (Table 4) were entered in to the template database in QINSy. Overall, roll and pitch offsets calculated for this patch test slightly differed from calibrations from previous seasons. A second patch test was run later in the season once verified tide data was available. These updated offsets (table 5) were used entered into Qimera's internal engine during post-processing. 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 – Initial 2018	patch test calibration	ation offsets for l
	7/30/2018	
Latency (seconds)	0.06	
Roll (degrees)	-0.39	
Pitch (degrees)	0.34	
Heading (degrees)	-0.15	

EM2040C

Table 5 – Updated 2018 patch test calibration offsets for EM2040C

	8/20/2018
Latency (seconds)	0.01
Roll (degrees)	-0.39
Pitch (degrees)	0.51
Heading (degrees)	-0.21

# **3.0 Quality Control**

# 3.1 Crosslines

Due to unforeseen scheduling conflicts, crosslines were not run in either mainscheme area during the 2018 field season. A late start to the field season resulting from the hire of a new hydrographer and poor weather conditions during the months of September through October were two major factors in the inability of the MCMI to conduct crosslines in 2018 survey areas. In order to meet the BOEM requirement, crosslines for the 2018 areas are planned to be run in the upcoming 2019 field season. Updated and expanded datasets and the resulting descriptive report will be generated following the 2019 season.

### **3.2 Junctions**

The junctions shown in Table 6 were made with this survey. Survey W00450 was conducted by the Maine Coastal Program's Maine Coastal Mapping Initiative aboard the Amy Gale in 2017. The areas of overlap between the 2018 survey and the junction survey (NOAA survey ID W00450, currently in review) 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 2018 surface. A summary of surface difference test results is shown in Table 7. The extent of overlap between the 2017 base surface and the corresponding 2018 junction surface is illustrated in Figure 8. The surfaces used for these tests are submitted with the data in these surveys.

Registry Number	Grid Resolution	Year	Field Unit	Relative Location(s)
W00450	4 meters	2017	Amy Gale	W and N

Table 6 – 2018 mainscheme survey junctions

Junction Surface ID	New Surface ID	Median (m)	Mean (m)	Std. Dev. (m)
MCMI_2017_mainscheme_ 4m_mllw	MCMI_2018_mainscheme_Monhegan_ 4m_MLLW	0.06	0.05	0.75

Table 7 – Summary of surface difference test results for overlapping (junction) surveys

Several factors are thought to contribute to the high standard deviation in the overlapping mainscheme surveys: 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.

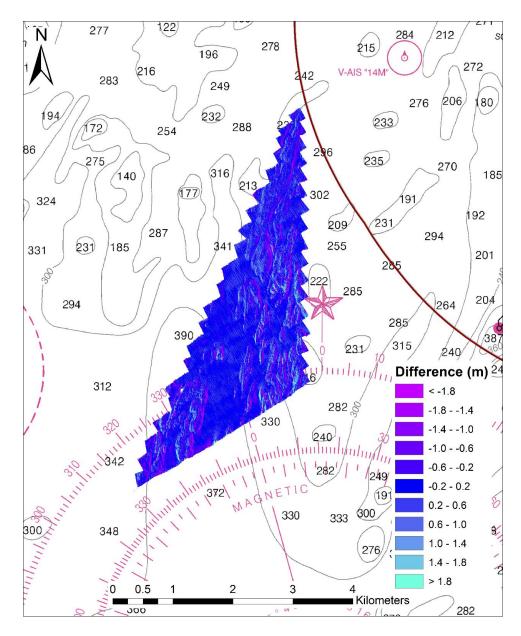


Figure 6 – Junctioning areas between W00450 and 2018 mainscheme survey (4-meter surfaces) shown as surface difference results; scale is 1:15,000.

# **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 (>  $\pm 60$  degrees from the nadir; as identified by QPS engineers). As a result (and as per QPS recommendation), soundings greater than  $\pm 60$  degrees from the nadir were not included in final bathymetric surfaces.

#### Hydrographic Workstation

Prior to October 2018, a BIOS setting related to CPU power throttling on the hydrographic workstation PC created brief (<1 second) and semi-regular losses of QINSy's time sync status (e.g. PPS time tagging of incoming data) while recording data. Troubleshooting of this problem was successful prior to all surveying conducted in and after October 2018.

# **3.4 Sound Speed Methods**

Sound speed cast frequency: A total of 17 sound speed casts were taken within the boundaries of the 2018 mainscheme survey. 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 were in agreement.

# 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.1.7.2, 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 (.zdf; provided by NOAA CO-OPS) containing time and range corrections for verified data referenced from the Wells, ME (8419317) tide gauge was applied to all areas surveyed (Figure 9). Time corrections, tide height offsets, and tide scale (range) for each zone are listed in Table 8.

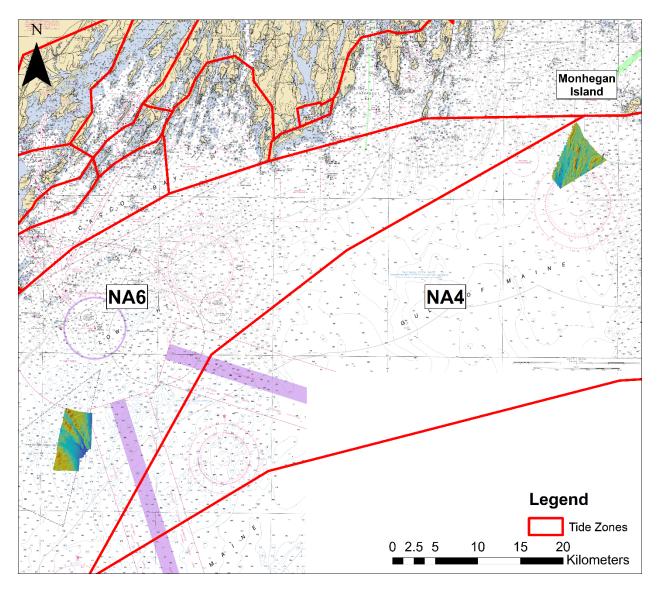


Figure 7 – Tide zones (outlined in red) relative to 2018 mainscheme survey extent. Map scale 1:80,000.

Table 8 – Tide zones and corrections referenced to verified Wells (8419317) tide data
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Zone ID	Time Correction (mins.)	Tide Offset (m)	Tide Scale	Survey Area
NA4	-18	0	0.99	Mainscheme
NA6	-12	0	0.99	Mainscheme

# 4.3 Processing Workflow

The general post-processing work flow 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\_4m CUBE settings enabled
- 5. Review and edit soundings/clean surface with 3D editor tool
- 6. Export final surface to .BAG file and CUBE surface
- 7. 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 'NOAA\_4m' configuration (Figure 10) was selected for each surface. The mainscheme survey was gridded at 4 meters based on the average depth of the area and in accordance with NOAA's survey recommendations (NOAA, 2014).

CUBE Settings			? x
Configuration NOAA_4	m 💌		
CUBE Capture Distance:	Distance Sca	le: 5.00	
	Distance Mir	1: 2.828	
CUBE Hypothesis Resolution	on 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 8 – 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.

Surface Name	Resolution (m)	Depth Range (m)	Surface Parameter
MCMI_2018_mainscheme_Saco_4m_MLLW	4	51 - 134	N/A
MCMI_2018_mainscheme_Monhegan_4m_MLLW	4	57 - 130	N/A

Table 9 - Surfaces submitted with 2018 survey data

#### 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.1.7.2. 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. The 4-meter backscatter mosaics of the data is shown in Figure 11. The GSF files containing the extracted were submitted with the data in this survey. Processed mosaics (Table 10) were saved in geoTiff format and also submitted.

Table 10 – Backscatter mosaics submitted with 2018 survey data

Mosaic Name	Pixel Size (m)
MCMI_2018_mainscheme_Saco_backscatter_4m	4
MCMI_2018_mainscheme_Monhegan_backscatter_4m	4

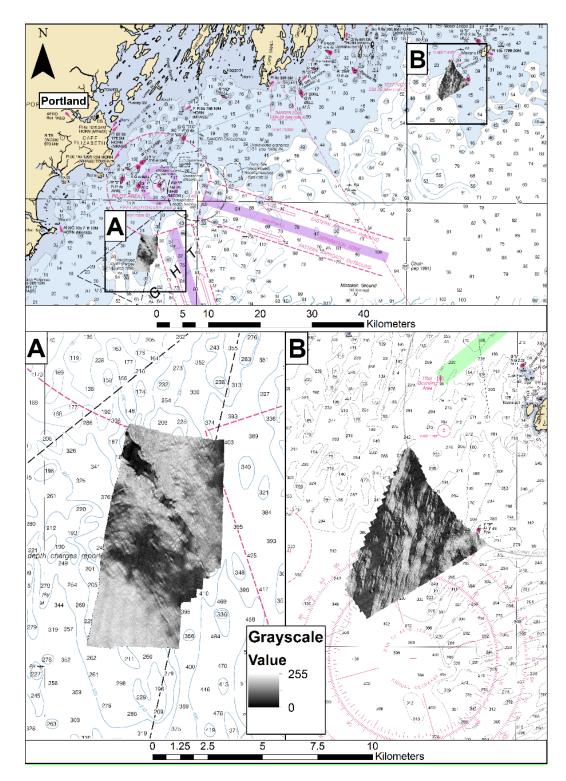


Figure 9 – Backscatter mosaic (4-meter pixel size) of 2018 mainscheme survey

# **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 raster navigational charts which cover the survey areas are listed in Table 11. Prior hydrographic surveys in the vicinity were conducted by NOAA between 1888 and 1954 and consisted only of partial bottom coverage. These data were not compared with data collected by the MCMI.

Chart	Scale	Source Edition	Source Date	NTM Date
13288	1:80,000	44	2/1/2016	6/28/2018
13286	1:80,000	34	3/19/2019	3/19/2019
13301	1:40,000	22	12/11/2018	12/11/2018

Table 11 – Largest scale raster charts in survey area

#### Chart 13288

Charts with scales 1:80,000 (and smaller) inherently contain very generalized contours. As shown in Figure 10, the agreement between chart contours and new survey data (contoured at 60 feet intervals; same as chart) is good at depths less than 240 feet (73.1 meters). However, agreement becomes poor at depths beyond 300 feet throughout the surveyed area. This disagreement is most 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 13286

Charts with scales 1:80,000 (and smaller) inherently contain very generalized contours. As shown in Figure 11, the agreement between chart contours and new survey data (contoured at 60 feet intervals; same as chart) is good at depths less than 420 feet (128 meters). However, since only a very small surface area deeper than 420 feet exists in the survey area, this disagreement could be considered negligible.

#### Chart 13301

A small portion of the survey area coincides with chart 13301. Surveyed depths have good overall agreement with charted contours and soundings (Figure 12), although individual soundings may disagree at any given location.

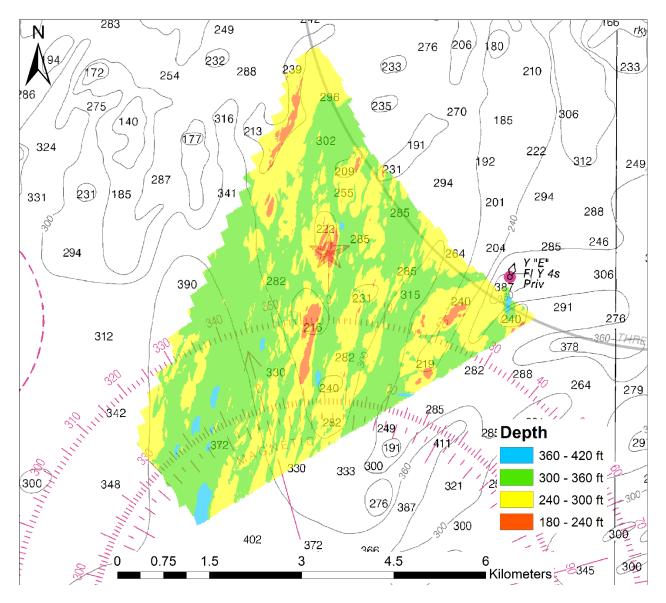


Figure 10 – Comparison between surveyed depth (reclassified at 60-feet intervals) and chart 13288 contours (60-feet interval)

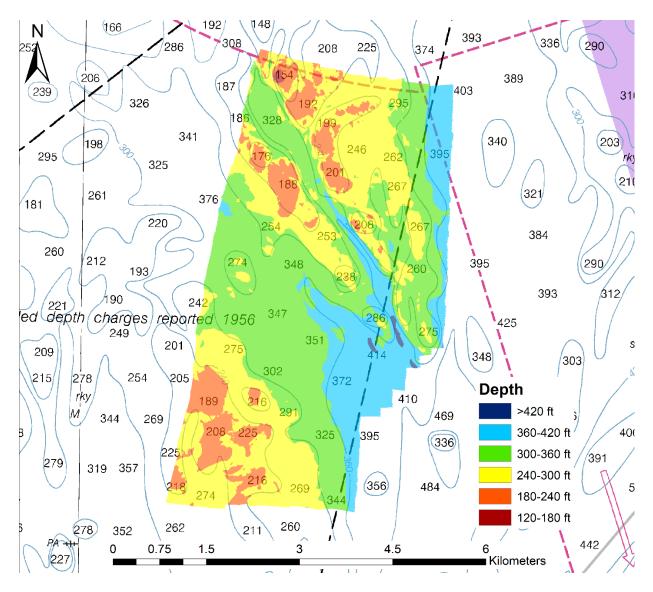


Figure 11 – Comparison between surveyed depth (reclassified at 60-feet intervals) and chart 13286 contours (60-feet interval)

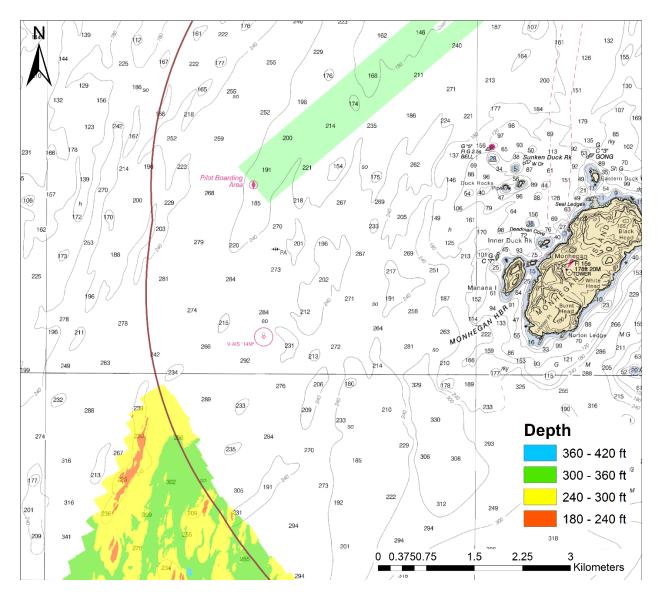


Figure 12 – Comparison between surveyed depth (reclassified at 60-feet intervals) and chart 13301 contours (60-feet interval)

# 6.0 Summary

A total of approximately 18 mi<sup>2</sup> (47 km<sup>2</sup>) of high-resolution multibeam data were collected in the mainscheme survey area by MCMI between August and November 2018. With the exception of numerous small holidays, multibeam coverage was 100% in all areas surveyed. Survey data were processed with 4-meter grid resolution. The consistency of hydrographic data collected aboard the R/V Amy Gale was reflected in the results of the surface difference tests between junction survey data, where mean vertical differences for all tests were less than 0.05 meters. Standard deviations of all tests were relatively low and comparable to those achieved by small NOAA vessels (e.g. *Ferdinand R. Hassler*) for similar surveys in Maine's coastal waters. 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 91 meters (locality off Monhegan Island) and 120 meters (locality off Saco Bay). 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 and determine the spatial extent of sand deposits within federal water. 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 more effectively manage and understand coastal and marine resources.

These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible, and were shared with the UNH-NOAA Join Hydrographic Center / Center for Coastal and Ocean Mapping for review.

Please contact the Maine Coastal Mapping Initiative for additional information or data requests.

# References

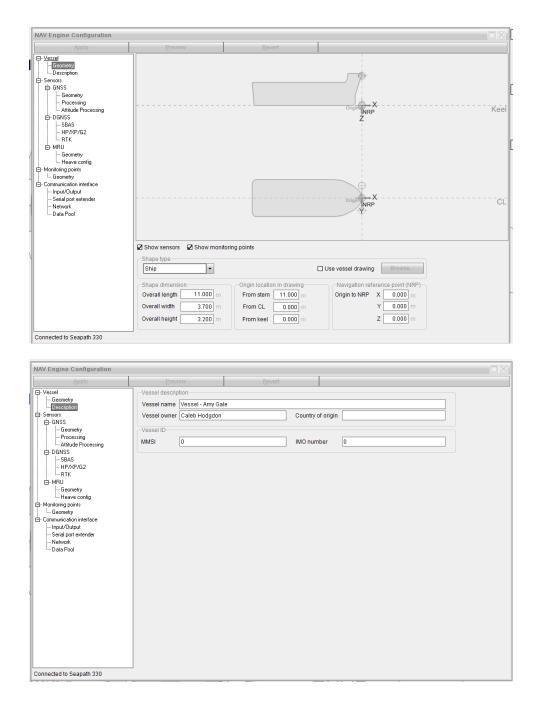
NOAA, 2014. NOS hydrographic surveys specifications and deliverables: U.S Department of Commerce National Oceanic and Atmospheric Administration. Page 89.

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
08/01/18
08/06/18
08/16/18
08/17/18
09/04/18
10/01/18
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11/19/18

# Appendix A – Specific dates of data acquisition for mainscheme surveys

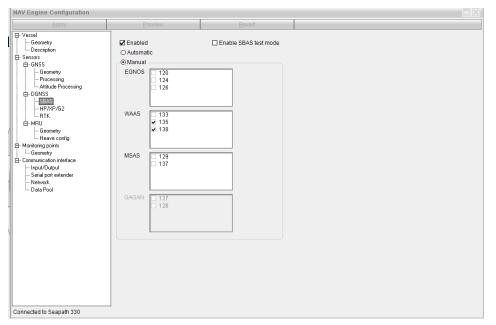
# **Appendix B – Configuration settings for Seapath 330**



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Connected to Seapath 330	GPS 2 (starboard)	0.158	1.252	-3.035	Calibration wizard

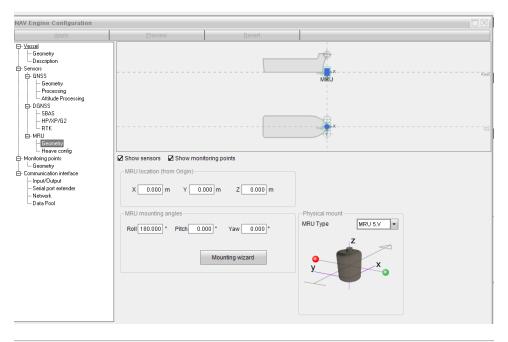
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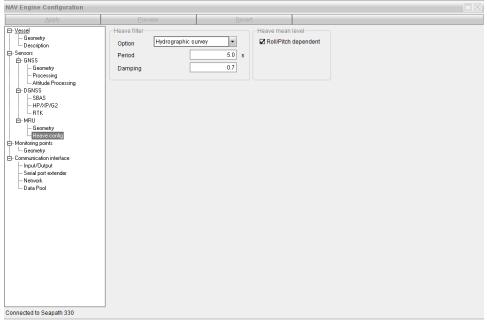
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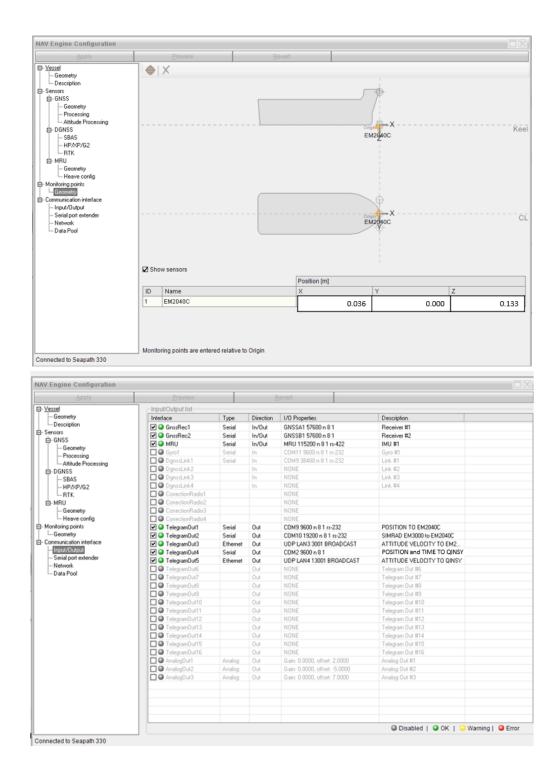


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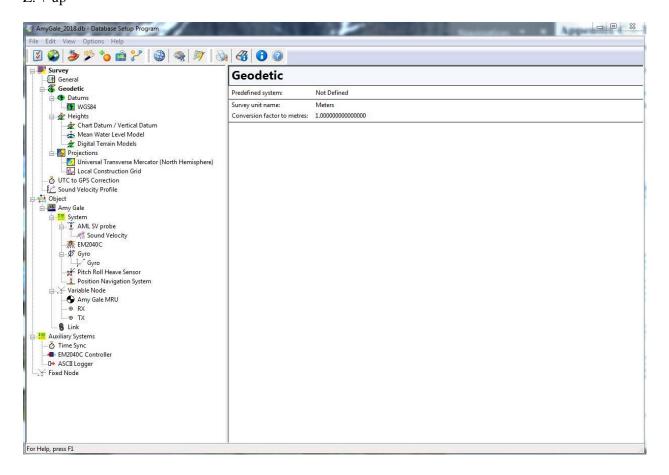
## Appendix C – Template database settings in QINSy (for acquisition)

Template database name: AmyGale\_2018.db

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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Survey	Datums: Datums
Geodetic	Survey datum: WGS84
WGS84	Chart datum: WGS84
🕀 🚖 Heights	Height file: N/A
🚽 🖉 Chart Datum / Vertical Datum	Height level: No Level Correction
Mean Water Level Model	Height file: N/A
Digital Terrain Models	Height offset: 0.000 m
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Local Construction Grid	
- Ö UTC to GPS Correction	
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- 🖝 Geodetic	Datum name:	WG584	
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🛓 Chart Datum / Vertical Datum	Prime meridian:	0;00;00.000 E	
	Conversion factor to metres:	1.000000000000000	
→ Ż Digital Terrain Models	Semi-major axis (a):	6378137.000 m	
Universal Transverse Mercator (North Hemisphere)	Semi-minor axis (b):	6356752.314 m	
Local Construction Grid	Inverse flattening (1/f):	298.257223563000	
💩 UTC to GPS Correction	Flattening (f):	0.003352810664747	
Sound Velocity Profile	First eccentricity (e):	0.081819190842621	
Object - Mary Gale	First eccentricity squared (e**2):	0.006694379990141	
	Second eccentricity (e'):	0.082094437949696	
AML SV probe	Second eccentricity squared (e'**2):	0.006739496742276	
Sound Velocity M2040C Sound Velocity Sound			

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Geodetic	Chart datum: WGS84		
WGS84	Height file: N/A		
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Mean Water Level Model	Height offset: 0.000 m		
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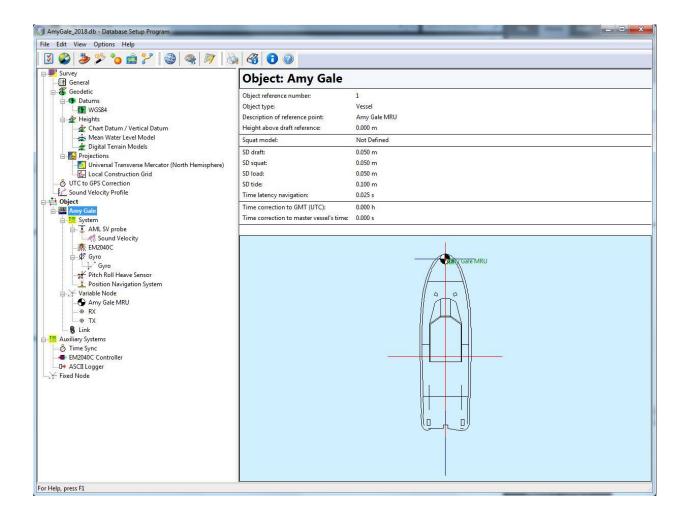
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Geodetic	Profile ID: 1040	
🖻 🐠 Datums	Profile latitude: 43;31;54.26900 N	
└─∰ WGS84 ⋳∽∰ Heights	Profile longitude: 70;19;29.69000 W	
🚽 🛣 Freights	Profile date: 2018-08-30	
A Mean Water Level Model	Profile time: 16:22	
Digital Terrain Models		
Projections	1977 BAY BAY BAY BAY	
	Velocity unit: Meters / Second	
Local Construction Grid	SD depth data: 0.100 m	
OUTC to GPS Correction	SD velocity data: 0.050 m/s	
Sound Velocity Profile Object	Number of entries: 12	
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	System: AML	SV probe
Image: Second control of the secon	System: AML Description: Type: Driver: Executable and Cmdline: Port: Baudrate: Data bits: Stop bits: Parity: Byte frame length (time): Maximum data transfer rate: Update rate: Latency: Acquired by; Observation time from: Number of slots:	AML SV probe Underwater Sensor Sound Velocity - Smart SV (AML, ASCII) (Active) DrvSoundVelocity.exe ACT 3 9600 8 1 1 None 10 bits (1.042 ms)

Survey	Observation	: Sound Velocity
General Ge	Observation description: Observation type: 'At' node: Measurement unit code: System description: (C-O) option: Scale factor: Fixed system (C-O): Variable (C-O):	Sound Velocity Sound Velocity Amy Gale MRU

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WGS84	Driver:	Kongsberg EM2040/EM710/EM302/EM122
Heights	Executable and Cmdline:	
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Mean Water Level Model	Driver specific settings:	MANUFACTURER=2;MODEL=2045;RAW_BATHY=1;RAW_SNIP=1;RAW_WCD=1;
🚽 🚈 Digital Terrain Models	Port:	2001
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Universal Transverse Mercator (North Hemisphere)     Local Construction Grid	Acquired by:	[Directly into QINSy] (No additional time tags)
- @ UTC to GPS Correction	Observation time from:	N/A
C Sound Velocity Profile	Number of slots:	1
Object	Manufacturer:	Kongsberg
Amy Gale	Model:	EM2040C
🖶 🛄 System	NAME SOLOGI	5. 00 - PA (5. 00
AML SV probe	Object location:	Amy Gale
M Sound Velocity	Node name:	RX
B B Gyro	X (Stbd = Positive)::	0.000 m
Gyro	Y (Bow = Positive)::	-0.045 m
Pitch Roll Heave Sensor	Z (Up = Positive)::	0.006 m
L Position Navigation System	A-priori SD:	0.010 m
Variable Node	Roll offset:	-0.390
	Pitch offset:	0.340
@ RX	Heading offset:	-0.150
L	Unit is roll stabilized:	No
Auxiliary Systems	Unit is pitch stabilized:	No
- Ö Time Sync	Unit is heave compensated:	No
EM2040C Controller	Beam steering (flat transducer):	No
- D→ ASCII Logger	Beam angle width along:	1.500 m
Fixed Node	Beam angle width across:	1.500 m
	Maximum number of beams per ping:	
	Use sound velocity from unit:	Yes
	Slot:	1
	Sound velocity for beam angle:	Sound Velocity
	SD type:	Pulse, Sampling
	SD pulse length:	0.150 ms
	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 heave compensation:	0.000 m
	SD sound velocity:	0.050 m/s

Pite far view Option: Her   Pite far vi	Image: Survey       Image: Survey       Image: Survey       Image: Survey         Image: Survey       Image: Survey       Image: Survey       Image: Survey         Image: Survey       Image: Survey       Image: Survey       Image: Survey         Image: Survey       Image: Survey       Image: Survey       Image: Survey       Image: Survey         Image: Survey	AmyGale_2018.db - Database Setup Program	
Survey       General         General       General         General       Gyro         Type       Gyro Compass         Type       Gyro Compass         Diversit       Diversit         Object       Diversit         System       Gyro         Pretic	Survey       General         Codedici       General         Codedici       Gyre         Model       Gyre         Type       Gyre Compase:         Diver:       Mexive: Sepath Binary Format 11 (Hdg) (With UTC)         Executable and Cindline       Drope:         Diversi       Mexive: Sepath Binary Format 11 (Hdg) (With UTC)         Executable and Cindline       Drope:         Diversi       Mexive: Sepath Binary Format 11 (Hdg) (With UTC)         Executable and Cindline       Drope:         Diversi       Man Models         Diversi       12001         Update rate:       0.000 s         Acquired by       (Directly into QINSy] (No additional time tage)         Observation time from:       N/A         Number of slote:       0         System       Girles         System       Girles         System       Girles         Proticin Ningviston System       Girles         Virable Node       Girles         Study       Girles         Man Syrper       Girles         Study       Girles         Model       Girles         System       Girles         Study       Girle	File Edit View Options Help	
System:       System:       System:       System:         System:       System:       Observation         System:       System:       System:         System:       System:       System	Sensal       System: Gyro         Image: Sensal       System: Gyro         Image: Sensal       Description:       Gyro         Image: Sensal       Diver:       Network: Sensal: Binary Format 11 (Hdg) (With UTC)         Image: Sensal: Transverse Merctor (North Hemisphere)       Executable and Cmdline:       Dr/QPSCountedUDP.exe SEAPATH_FMT11 PPS         Image: Sensal: Transverse Merctor (North Hemisphere)       Acquired by:       (Directly into QINSy] (No additional time tags)         Image: Sensal: S		
Image: Construction     Observation     Option     Option       Image: Construction     Type:     Gyro Compass:       Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binay Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Notice     Diver:       Image: Construction     Observation time from:     N/A       Image: Construction     Observation time from:     N/A	Image: Construction     Operations     Operations       Image: Construction     Type:     Gyro Compass:       Diver:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Diver:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     Network - Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     None Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     None Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     None Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     None Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     None Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers:     None Sepath Binary Format 11 (Hdg) (With UTC)       Image: Construction     Divers: <th>General</th> <th>System: Gyro</th>	General	System: Gyro
		Survey     General     Gedicic     G	System: Gyro           Description:         Gyro           Type:         Gyro Compass           Drive:         Network - Sepath Binary Format 11 (Hdg) (With UTC)           Executable and Cmdline:         Drive: SEAPATH_FMT11 PPS           Port:         13001           Update rate:         0.000 s           Latency:         0.060 s           Acquired by:         [Directly into QINSy] (No additional time tags)           Observation time from:         N/A

Geodetic Observation descr Observation descr Datums Observation type: Heights 'At' node:	tion: Gyro
Geodetic Observation desc. ⊕ Datums Observation type: ↓ ∰ W6584 'At' node:	ption: Gyro Bearing (True)
Mean Water Level Model     System descriptio     Digital Terain Models     (C-0) option:     Scale factor:     Coordinate System     Object     Digital Terain Models     (C-0) option:     Scale factor:     Coordinate System     Object     Digital Terain Models     (C-0):     Approximate System     Any Gale     Amy Gale     Amy Gale MRU     Amy Gale MRU     T X     Notice System     Any Gale MRU     T X     Notice System     Any Gale MRU     T X     Notice System     Any Gale MRU     Any Gale MRU     T X     Sund Velocity     Fixed Node     T reside System     Sound Velocity     Fixed Node     Sound Velocity     Fixed Node     Sound Velocity     Fixed Node	(C-O) offsets applied first 1.0000000000

dit View Options Help		
Survey General	System: Pitch Roll	Heave Sensor
🕉 Geodetic	Description:	Pitch Roll Heave Sensor
WGS84	Туре:	Pitch Roll Heave Sensor
⊖ ∰ Heights	Driver	Network - Seapath MRU Binary Format 11 (With UTC)
Chart Datum / Vertical Datum	Executable and Cmdline:	DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
- 🚣 Mean Water Level Model	Port:	13001
📥 🚈 Digital Terrain Models	Update rate:	0.000 s
e E Projections	Latency:	0.060 s
	Acquired by:	[Directly into QINSy] (No additional time tags)
UTC to GPS Correction	Observation time from:	N/A
Sound Velocity Profile		
Object	Number of slots:	0
🛄 Amy Gale	Object:	Amy Gale
📴 📴 System	PRH sensor reference number:	1
AML SV probe	Rotation convention pitch:	Positive bow up
	Rotation convention roll:	Positive heeling to starboard
B-\$ Gyro	Angular variable measured:	HPR (roll first)
Gyro	Angular measurement units:	Degrees
	Sign convention heave:	Positive upwards
Desition Navigation System	Measurement unit heave:	Meters
⊨ 🔆 Variable Node	Conversion factor to degrees decimal:	N/A
	Conversion factor to metres:	N/A
@ RX	Quality indicator type pitch and roll:	No quality info recorded
	Quality indicator type heave:	No quality info recorded
Auxiliary Systems	Description of quality indicator type:	
Time Sync	Object location:	Amy Gale
EM2040C Controller	Node name:	Amy Gale MRU
D ASCII Logger	X (Stbd = Positive)::	0.000 m
Fixed Node	Y (Bow = Positive)::	0.000 m
	Z (Up = Positive)::	0.000 m
	A-priori SD:	0.000 m
	(C-0) roll offset:	0.000 *
	Contract of Contraction	
	(C-O) pitch offset:	0.000 *
	(C-O) heave offset:	0.000 m
	Heave time delay:	0.000 s
	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

AmyGale_2018.db - Database Setup Program	
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Survey	Node: Amy Gale MRU
General	
B Datums	Object location: Amy Gale
	Node name: Amy Gale MRU
🖨 💆 Heights	X (Stbd = Positive):: 0.000 m
🚽 Chart Datum / Vertical Datum	Y (Bow = Positive):: 0.000 m
Mean Water Level Model	Z (Up = Positive):: 0.000 m
	A-priori SD: 0.000 m
Universal Transverse Mercator (North Hemisphere)	
Universal Transverse Mercator (North Hemisphere)	
- 👌 UTC to GPS Correction	
Sound Velocity Profile	
🖶 🔂 Object	
System	
Gystem AML SV probe	
Sound Velocity	
B→ \$P Gyro	
Gyro →☆ Pitch Roll Heave Sensor	
Position Navigation System	
B Y Variable Node	
Amy Gale MRU	
⊛ TX	
Auxiliary systems     Monormal Systems	
ME EM2040C Controller	
D+ ASCII Logger	
or Help, press F1	

AmyGale_2018.db - Database Setup Program		
File Edit View Options Help		
Survey	Node: RX	
E Geodetic	Object location:	Amy Gale
🖨 🌗 Datums	Node name:	RX
- 🚱 WGS84	X (Stbd = Positive)::	
⊨ 2 Heights	Y (Bow = Positive)::	
Amean Water Level Model	Z (Up = Positive)::	0.006 m
Digital Terrain Models	A-priori SD:	0.010 m
Projections	A-priori ab.	
Universal Transverse Mercator (North Hemisphere)		
Local Construction Grid		
- 💍 UTC to GPS Correction		
Sound velocity Prome     Diject		
Amy Gale		
🚊 📕 System		
AML SV probe		
Sound Velocity		
—∰ EM2040C ⊜⊸∯ Gyro		
што буго Град буго		
Pitch Roll Heave Sensor		
Position Navigation System		
Variable Node		
Link		
Auxiliary Systems		
- Ö Time Sync		
EM2040C Controller		
D+ ASCII Logger		
Fixed Node		
For Help, press F1	1	
i vi Heip, press i z		

AmyGale_2018.db - Database Setup Program	
File Edit View Options Help	
Survey	Node: TX
🖶 🐺 Geodetic	Object location: Amy Gale
🖨 🐠 Datums	Node name: TX
G WGS84	X (Stbd = Positive):: 0.040 m
⊢⊉ Heights ↓↓↓ Chart Datum / Vertical Datum	Y (Bow = Positive):: 0.004 m
Mean Water Level Model	Z (Up = Positive):: 0.006 m
Digital Terrain Models	A-priori SD: 0.010 m
E- 🔛 Projections	
Universal Transverse Mercator (North Hemisphere)	
Sound Velocity Profile	
Diject	
🖶 🏧 Amy Gale	
🖨 🏭 System	
🛱 - 🧵 AML SV probe	
₩	
d Gura	
⊟–∯ <sup>°</sup> Gyro ⊢↓∽ Gyro	
Pitch Roll Heave Sensor	
La Position Navigation System	
ip-x∓ Variable Node	
© RX	
Link	
Auxiliary Systems	
- 💍 Time Sync	
- D+ ASCII Logger	
In Y Fixed Node	
	1
For Help, press F1	

) 🍪   🏂 🎾 🍗 🧰 꾿    🎯   🧠   🕅    🗟 !! Survey	System: Time Sync	
General		
- 🚯 Datums	Description:	Time Sync
WGS84	Туре:	Time Synchronization System
😑 🚖 Heights	Driver:	NMEA ZDA
🛣 Chart Datum / Vertical Datum	Executable and Cmdline:	DrvPositionNMEA.exe
Mean Water Level Model	Port:	2
Digital Terrain Models	Baud rate:	9600
Universal Transverse Mercator (North Hemisphere)	Data bits:	8
Local Construction Grid	Stop bits:	1
- 👸 UTC to GPS Correction	Parity:	None
Sound Velocity Profile	Byte frame length (time):	10 bits (1.042 ms)
G Object	Maximum data transfer rate:	960 bytes / second
Amy Gale	Update rate:	0.000 s
🖶 🛄 System	Latency:	0.000 s
AML SV probe	1 200 0 200 4 20	
EM2040C	Acquired by:	[Directly into QINSy] (No additional time tags)
E Ø Gyro	Observation time from:	N/A
Gyro	Number of slots:	0
Pitch Roll Heave Sensor	Use QPS PPS Adapter:	On COM1
Desition Navigation System	PPS time tag pulse matching:	Automatic Matching
🖕 🏹 Variable Node	Windows System Time Synchronization:	
@ RX		
I® TX I		
Auxiliary Systems		
Ö Time Sync		
EM2040C Controller		
D* ASCII Logger		
Fixed Node		
	1	
	1	
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AmyGale_2018.db - Database Setup Program	-	
Edit View Options Help		
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Survey     General	System: ASC	II Logger
🖶 🐺 Geodetic	Description:	ASCII Logger
🖨 🚯 Datums	Туре:	Output System
₩GS84 ⊖ 🛣 Heights	Driver:	Generic ASCII Data Logger (Controller)
Chart Datum / Vertical Datum	Executable and Cmdline:	
👍 Mean Water Level Model	Update rate:	1.000 s
Digital Terrain Models	Latency:	0.000 s
Projections     Universal Transverse Mercator (North Hemisphere)	Data output setting:	Enabled
Local Construction Grid	Acquired by:	[Directly into QINSy] (No additional time tags)
- O UTC to GPS Correction	Observation time from:	N/A
Constant Sound Velocity Profile	Number of slots:	0
a Object a My Gale		
🗄 🔚 System		
🖕 🍸 AML SV probe		
Sound Velocity		
∰ EM2040C ⊨∲ Gyro		
Gyro		
Position Navigation System		
a ↓ Variable Node		
Auxiliary Systems		
🖉 Time Sync		
EM2040C Controller     ASCII Logger		
Fixed Node		
ielp, press F1		

## **Appendix D – Configuration settings for QINSy EM controller**

PU Status				
Status	Active		Stop	
Pinging	28848 @ 33.0	28848 @ 33.60 Hz		
Clock Status	Ok			
Errors	All Ok	[iii]	ptions	
			puoris	
Settings				
Transmit Ang	le (deg)	0.0		
Minimum Dep		1.00		
Maximum Dej		500.00		
Detector Mod		Normal	-	
Slope Filter		On	-	
Areation Filter		Off	-	
Interference Fi	ilter	Off	•	
Range Gate Si	ze	Normal	-	
Spike Filter Str	ength	Medium	-	
Phase Ramp		Normal	-	
Special Amp [	Detect	Off	-	
Special TVG		Off	-	
Normal Inci. S	ector Angle	10		
Ping Mode		300 KHz	<b>-</b>	
Pulse Type		Auto	- =	
Transmit Pow	er Level	Maximum	-	
FM Enable		FM Enabled	-	
3D Scanning -		0.0		
3D Scanning -	-	-5		
3D Scanning -		5		
Dual Swath M		Off	-	
Min. Swath Di		0.0		
Yaw Stabilizati		Off	-	
Yaw Manual A	-	0.0		
Heading Filter		Medium	• •	
Apply	Settings 🔻	Force 🔽 Log Events		
Events				
11:02:11.135 11:02:11.405	Set Initial Set Command Acc			

PU Setup				
System Type (from DbSetup)	EM2040C	Single Transducer	<b>–</b>	
Pu Ip Address	157.237.2	0.40	[	
Simulation Mode	Off	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)	ΨĽ	
Program Options				
Start Pinging when QINSy Starts		Pinging On Startup	•	
Synchronize Clock Interval(min.)		60		
Sound Velocity Mode		From SoundVelocit	y C 🖪	
Sound Velocity Observation		Sound Velocity		
Popup window when error occurs		On	-	
Allow HD beamspacing with Water Colum	nn Data	Not Allowed		
nstallation Parameters RX1 Gain Offet	0			
RX2 Gain Offet	0			
	EM204			
Head1 Installation angles from				
Head1 Installation angles from Head2 Installation angles from		Motion Sensor 1		
Head2 Installation angles from	Not Us	Sensor 1		
Head2 Installation angles from Velocity Sensor Number	Not Us Motion	Sensor 1		
Head2 Installation angles from Velocity Sensor Number Velocity Sensor UDP Port	Not Us Motion 3001			
Head2 Installation angles from Velocity Sensor Number Velocity Sensor UDP Port Velocity Sensor Ethernet Port	Not Us Motion 3001 Etherne	et Port 2 (if available)	•	
Head2 Installation angles from Velocity Sensor Number Velocity Sensor UDP Port	Not Us Motion 3001	et Port 2 (if available)		
Head2 Installation angles from Velocity Sensor Number Velocity Sensor UDP Port Velocity Sensor Ethernet Port Ethernet Port 2 IP Address	Not Us Motion 3001 Etherne 192.168	et Port 2 (if available)		