2018-2019 Combined Descriptive Report of Seafloor Mapping: Vicinity of 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, March 2020

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

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:	Vicinity of Saco Bay to Monhegan Island

2018-2019

CHIEF OF PARTY
Benjamin Kraun, Hydrographer, Contractor to the State of Maine

LIBRARY & ARCHIVES

Date:

MAINE COASTAL MAPPING INITIATIVE MAINE COASTAL PROGRAM	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	

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

State(s):	**Maine**
General Locality:	**Gulf of Maine**
Sub-Locality:	**Vicinity of Saco Bay to Monhegan Island**
Scale:	
Dates of Survey:	**08/01/2018 to 11/19/2018; and**
	04/12/2019 to 08/29/2019
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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Suggested citation:
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ABSTRACT
During the 2018 survey season (July - November) and part of the 2019 field season (April - August), 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 71 mi^2 (184 km^2) of high-resolution multibeam data were collected in the surveyed areas. An additional 6.5 mi^2 were collected in nearshore waters for the purposes of assessing nearshore and riverine sand movement as well as mapping eelgrass beds. This work is summarized in separate reports.

1.0 Area Surveyed

The 2018 and 2019 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 Saco Bay and west of Monhegan Island as shown in Figure 1. The approximately 71 mi^2 (184 km^2) mainscheme survey areas adjoin the eastern extent of the areas mapped by MCMI in 2014 and 2017 (both accepted by NOAA, who lists the surveys as W00289 and W00450, respectively) as well as areas mapped by NOAA in 2015 (surveys H12725 and H12726) (Figure 3). 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. The data for both survey seasons were combined, reprocessed, and analyzed for quality control as a single 2018-2019 surface for each sub-locality (Figure 2).

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.

Table 1 – 2018-2019 mainscheme survey limits

Saco Bay

Southwest Limit	**Northeast Limit**
43° 22' 37.632" N 70° 13' 55.812" W	43° 31' 32.664" N 69° 57' 27.072" W

Monhegan Island

Southeast Limit	**Northwest Limit**
43° 39' 20.139" N 69° 20' 40.623" W	43° 44' 54.888" N 69° 23' 52.285" W

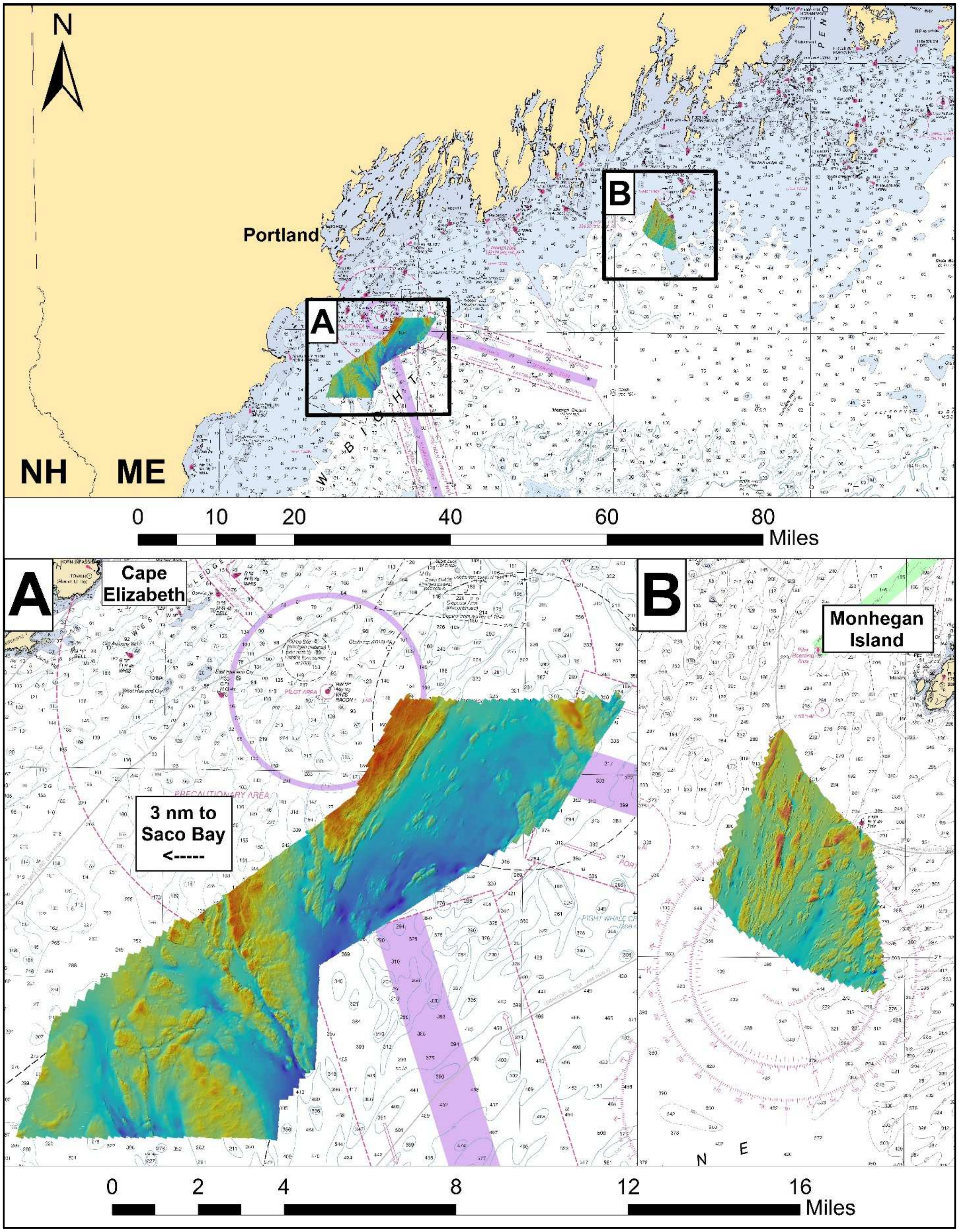


Figure 1 – General localities of 2018 - 2019 mainscheme survey coverage off southern and mid-coast Maine.

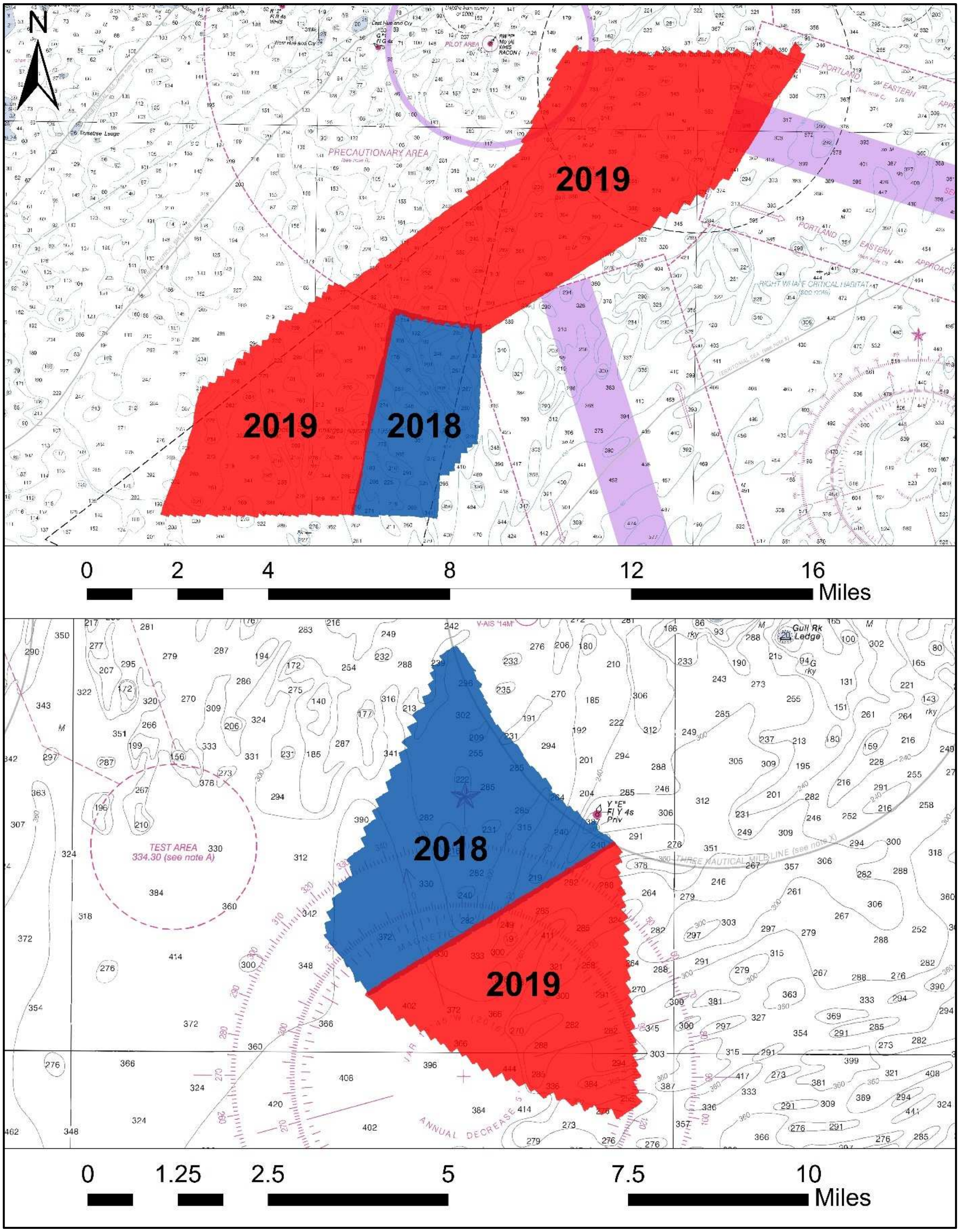


Figure 2 – 2018 - 2019 mainscheme survey coverage colored by year of data collection. The data for both survey seasons were combined, reprocessed, and analyzed for quality control as a single 2018-2019 surface for each sub-locality.

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, 13290, 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 NOAA Office of Coast Survey 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.

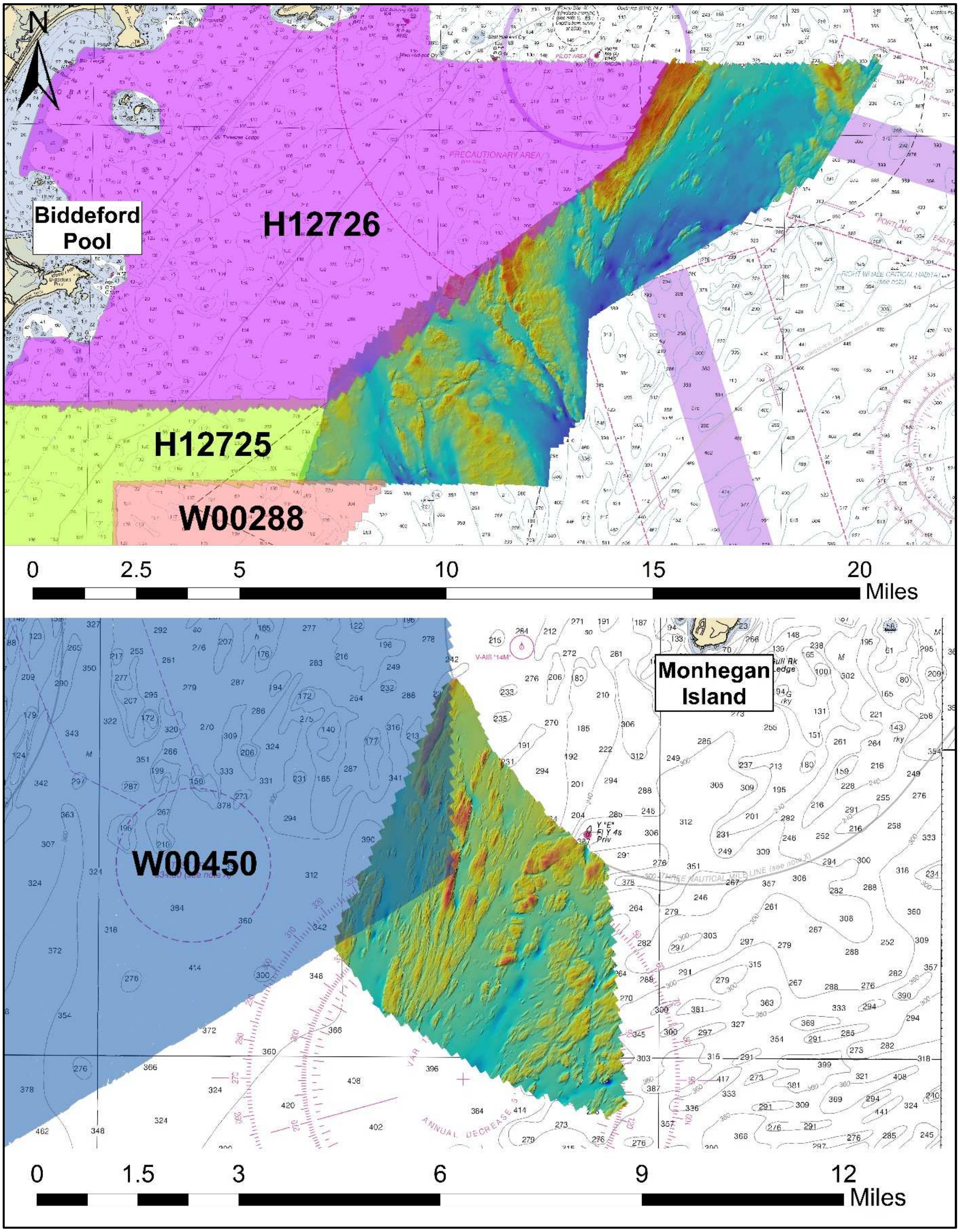


Figure 3 – 2018-2019 survey coverage relative to MCMI 2014 and 2017 surveys (NOAA survey IDs: W00288, W00450) and NOAA 2015 surveys (IDs: H12725 and H12726); plotted over RNCs 13288 and 13286, respectively

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 and 2019 survey seasons.

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 4), 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 Micro 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 4 – 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 and 2019 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) 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 ±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 ≤ 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 or 2019 survey seasons. 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).

Table 3 – 2017 equipment reference frame measurements for Seapath 330

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

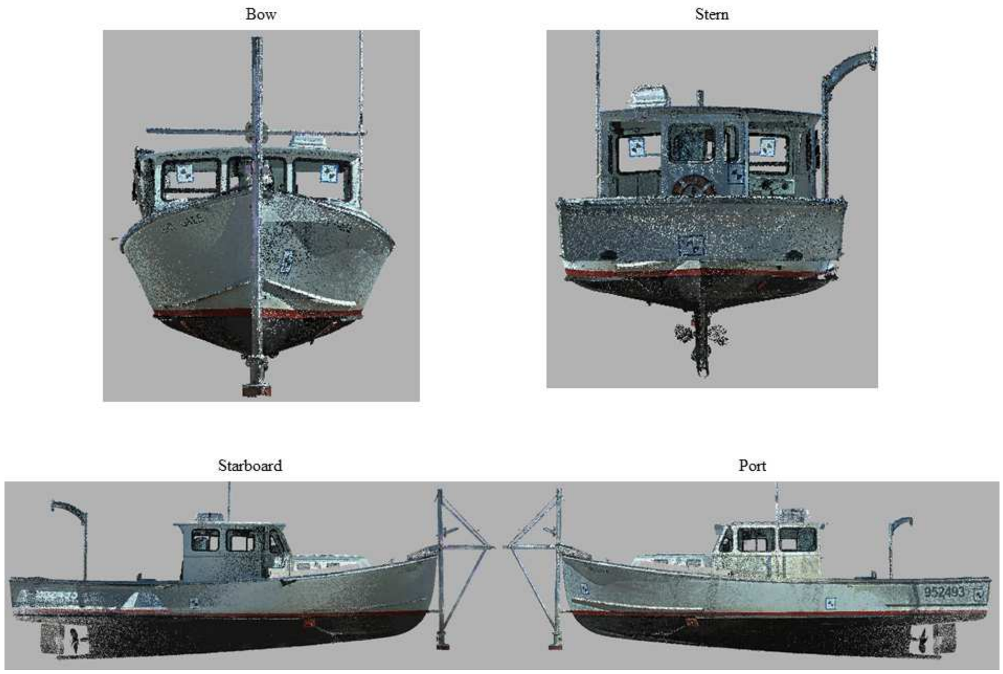


Figure 5 – Amy Gale RGB color images generated from 3D laser scan survey (GPS antennas and external cabling not included in survey) data (.pts file converted to .las for visualization)

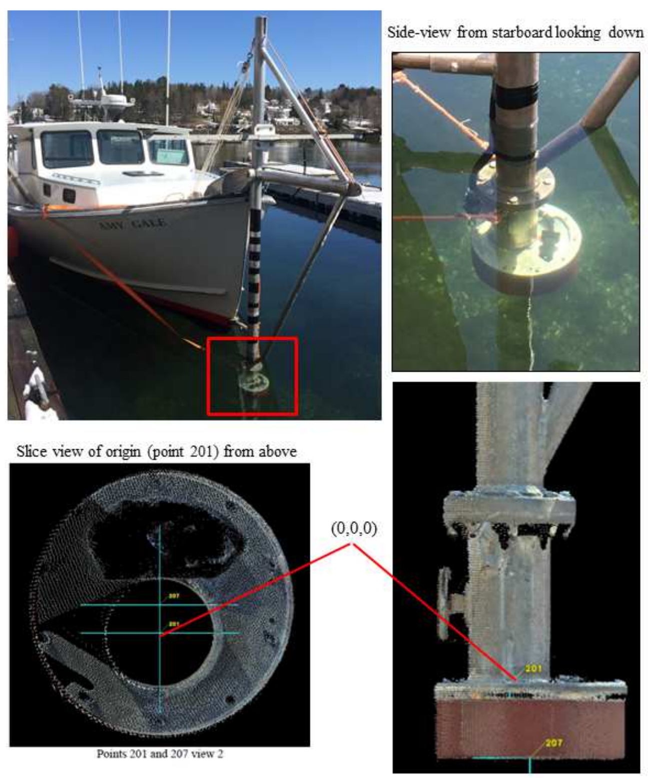


Figure 6 – Amy Gale origin (point 201 in RGB images) for vessel reference frame(s); origin is center point within the base of the pole (center point of base within internally-mounted motion reference unit (MRU) point 201 in images above)

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 2-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 ±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 and 2019 survey seasons to correct for alignment offsets. A second patch test was applied later in each season 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.1.7.2) patch test tool. After calibration was complete, offsets (Tables 4 and 5) were entered into the template database in QINSy. Roll and heading offsets calculated for this patch test slightly differed from calibrations from each other but varied more greatly compared to previous seasons. Pitch offsets for 2019 varied significantly from previous seasons' values. 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 and updated 2018 patch test calibration offsets for EM2040C

	7/30/2018	**8/20/2018**
Latency (seconds)	0.06	0.01
Roll (degrees)	-0.39	-0.39
Pitch (degrees)	0.34	0.51
Heading (degrees)	-0.15	-0.21

Table 5 – Initial and updated 2019 patch test calibration offsets for EM2040C

	5/16/2019	**5/28/2019**
Latency (seconds)	0.01	0.01
Roll (degrees)	-0.35	-0.43
Pitch (degrees)	0.72	2.27
Heading (degrees)	-0.43	-0.30

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. To meet the BOEM requirement, crosslines for the entire 2018 survey area were run during the 2019 season. Due to timing constraints, crosslines for the 2019 survey area were only run in areas of interest to BOEM (Figure 7).

Crosslines were run (staggered to save time on turns; in lieu of 900-meter BOEM requirement; U.S. Department of the Interior, 2014) to act as a data quality check over both years' coverage (Figure 7). Crosslines were filtered during post-processing to remove soundings greater than 45 degrees from the nadir. After filtering, the two-dimensional surface area of the crossline surfaces totaled approximately 20% of mainscheme acquisition. Crossline sounding agreement with mainscheme data was evaluated by using the crosscheck tool in Qimera v.2.1.1, which performs a beam-by-beam statistical analysis.

The mean difference between soundings was -0.006 meters with a standard deviation of 0.438 meters for the Saco Bay area and 0.071 meters with a standard deviation of 0.543 meters for the Monhegan Island area. Sounding agreement in both areas meet IHO Order 1 survey specifications according to the crosscheck tool.

95% of all differences for both survey areas were less than or equal to 1.15 meters from the mean (Figure 8). Summary statistics for this analysis are shown in Table 6 and Table 7. Additional statistical plots generated from this analysis are reported in Appendix E. Raw difference data, reference surfaces, and sonar files used for this analysis were submitted with the data in these surveys.

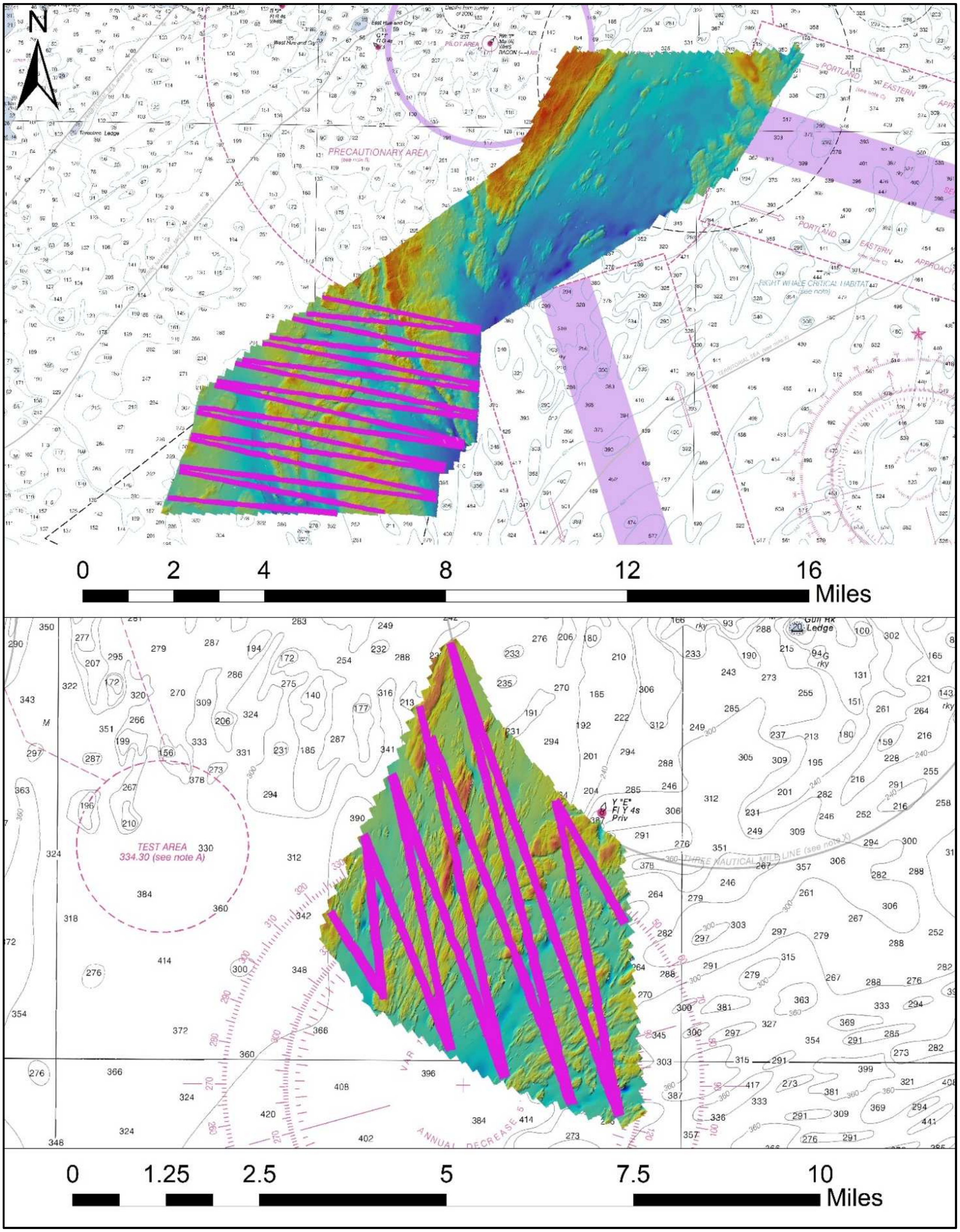
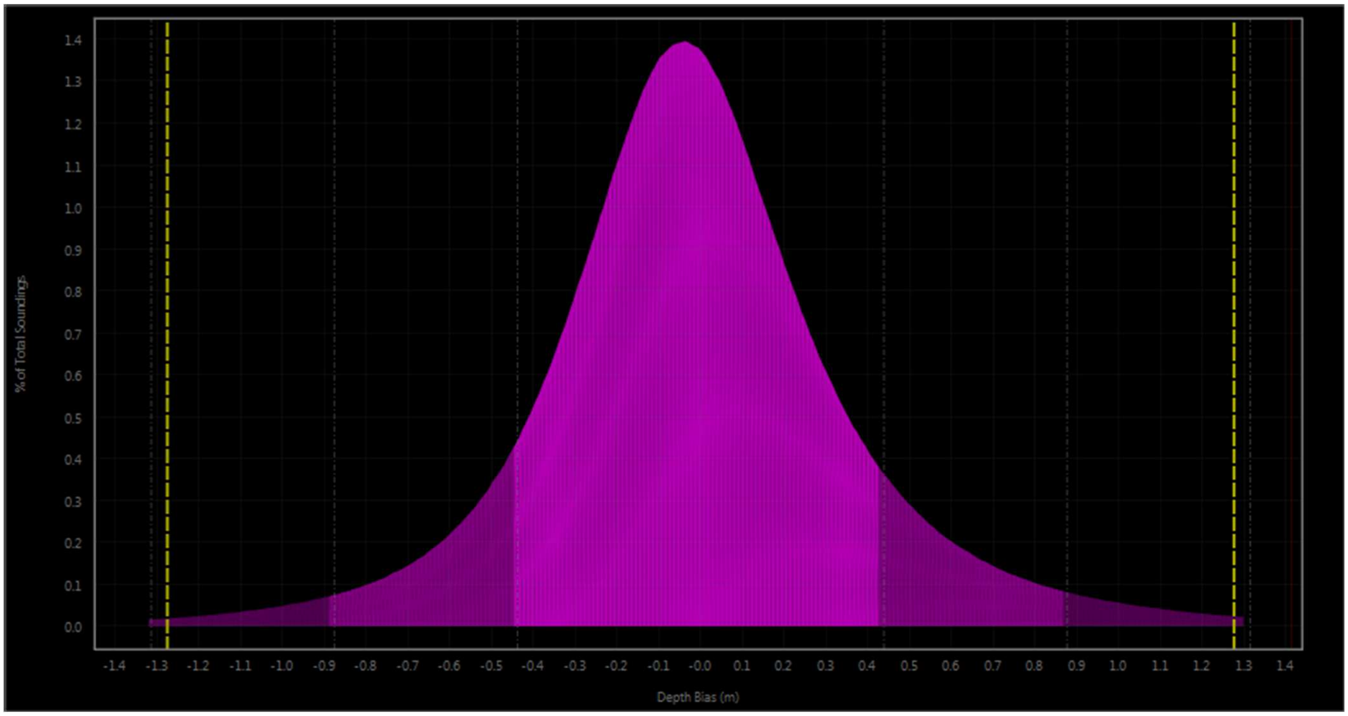


Figure 7 – Location of crosslines (shown in pink, beams filtered outside ±45º) and mainscheme data.

Saco Bay:



Monhegan Island:

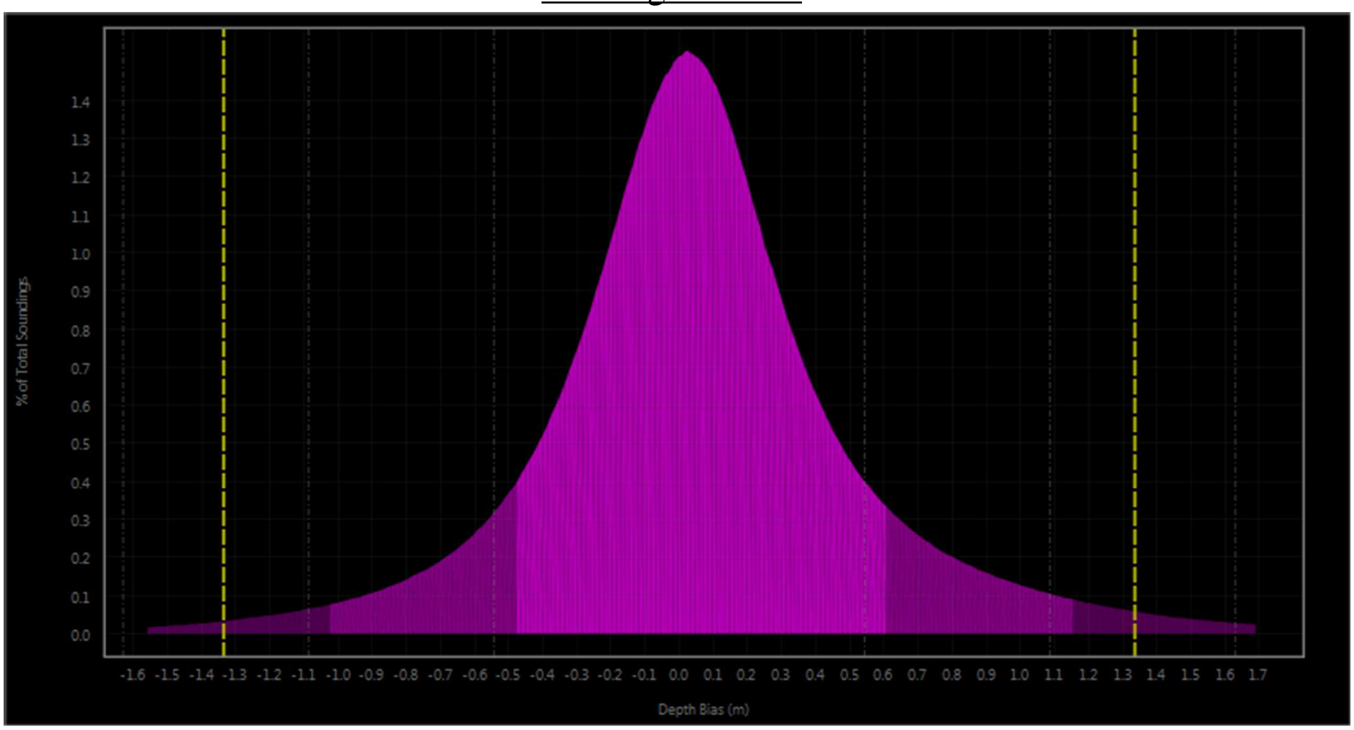


Figure 8 – 2018-2019 crosslines difference histogram; pink areas represent the 95% confidence interval based on normal distribution; yellow dashed lines represent limit of IHO Order 1 test vertical tolerance; gray dashed lines on histogram represent ±sigma 1, 2, and 3

Table 6 – Saco Bay survey area crossline difference (Qimera crosscheck) summary statistics

# of Points of Comparison	35,944,683
Data Mean	-90.286078 m
Reference Mean	-90.280010 m
Difference Mean	-0.006068 m
Difference Median	-0.026605 m
Std. Deviation	0.438126 m
Data Z - Range	-136.77 m to -47.96 m
Ref. Z - Range	-135.49 m to -48.39 m
Diff Z - Range	-16.94 m to 26.99 m
Mean + 2*stddev	0.882320 m
Median + 2*stddev	0.902857 m
Ord 1 Error Limit	1.275708 m
Ord 1 P-Statistic	0.017699 m
Ord 1 - # Rejected	636202
Order 1 Survey	ACCEPTED

*Order 1 parameters: a = 0.25 and b = 0.013

Table 7 – Monhegan Island survey area crossline difference (Qimera crosscheck) summary statistics

# of Points of Comparison	20,298,902
Data Mean	-95.157647 m
Reference Mean	-95.229265 m
Difference Mean	0.071618 m
Difference Median	0.046148 m
Std. Deviation	0.543356 m
Data Z - Range	-131.56 m to -59.81 m
Ref. Z - Range	-132.11 m to -60.48 m
Diff Z - Range	-13.77 m to 17.87 m
Mean + 2*stddev	1.158330 m
Median + 2*stddev	1.132860 m
Ord 1 Error Limit	1.335139 m
Ord 1 P-Statistic	0.032928
Ord 1 - # Rejected	668410
Order 1 Survey	ACCEPTED

*Order 1 parameters: a = 0.25 and b = 0.013

3.2 Junctions

The junctions shown in Table 8 were made with this survey. Survey W00450 was conducted by the Maine Coastal Program's Mapping Initiative aboard the Amy Gale in 2017. The areas of overlap between the 2018-2019 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 2018-2019 surface. A summary of surface difference test results is shown in Table 9. The extent of overlap between the 2017 base surface and the corresponding 2018-2019 junction surface is illustrated in Figure 9. The surfaces used for these tests are submitted with the data in these surveys.

Survey W00288 was conducted by the Maine Coastal Program's Mapping Initiative aboard the Amy Gale in 2014. The areas of overlap between the 2018-2019 survey and the junction survey (NOAA survey ID W00288) 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 (2014) was subtracted from the new 2018-2019 surface. A summary of surface difference test results is shown in Table 9. The extent of overlap between the 2014 base surface and the corresponding 2018-2019 junction surface is illustrated in Figure 10. The surfaces used for these tests are submitted with the data in these surveys.

Surveys H12725 and H12726 were conducted by NOAA aboard the Ferdinand R. Hassler in 2015. The areas of overlap between the 2018-2019 survey and the junction surveys (NOAA survey IDs H12725 and H12726) were evaluated for sounding agreement by performing surface (8-meter and 4-meter resolution, respectively) difference tests in Fledermaus (v.7.8.6, 64-bit), where the junctioning surfaces (2015) were subtracted from the new 2018-2019 surface. A summary of surface difference test results is shown in Table 9. The extent of overlap between the 2015 base surfaces and the corresponding 2018-2019 junction surface is illustrated in Figure 10. The surfaces used for these tests are submitted with the data in these surveys.

Table 8 – 2018-2019 mainscheme survey junctions

Registry Number	Grid Resolution	Mainscheme area	Year	Field Unit	Relative Location(s)
W00288	8 meters	Saco Bay	2014	AMY GALE	W and S
H12725	8 meters	Saco Bay	2015	FERDINAND R. HASSLER	W
H12726	4 meters	Saco Bay	2015	FERDINAND R. HASSLER	W and N
W00450	4 meters	Monhegan Island	2017	AMY GALE	W and N

Table 9 – Summary of surface difference test results for overlapping (junction) surveys

Junction Surface ID	New Surface ID	Median (m)	Mean (m)	Std. Dev. (m)
W00288_MB_8m_MLLW_Combined	MCMI_2018_2019_SacoBay_updated_8m_MLLW	-0.05	-0.04	0.25
H12725_MB_8m_MLLW_Combined	MCMI_2018_2019_SacoBay_updated_8m_MLLW	0.04	0.02	0.37
H12726_MB_4m_MLLW_Combined	MCMI_2018_2019_SacoBay_updated_4m_MLLW	0.03	0.04	0.42
MCMI_2017_mainscheme_4m_mllw	MCMI_2018_2019_Monhegan_4m_MLLW	0.00	0.01	0.55

Several factors are thought to contribute to the high standard deviation in the overlapping Monhegan Island area 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.

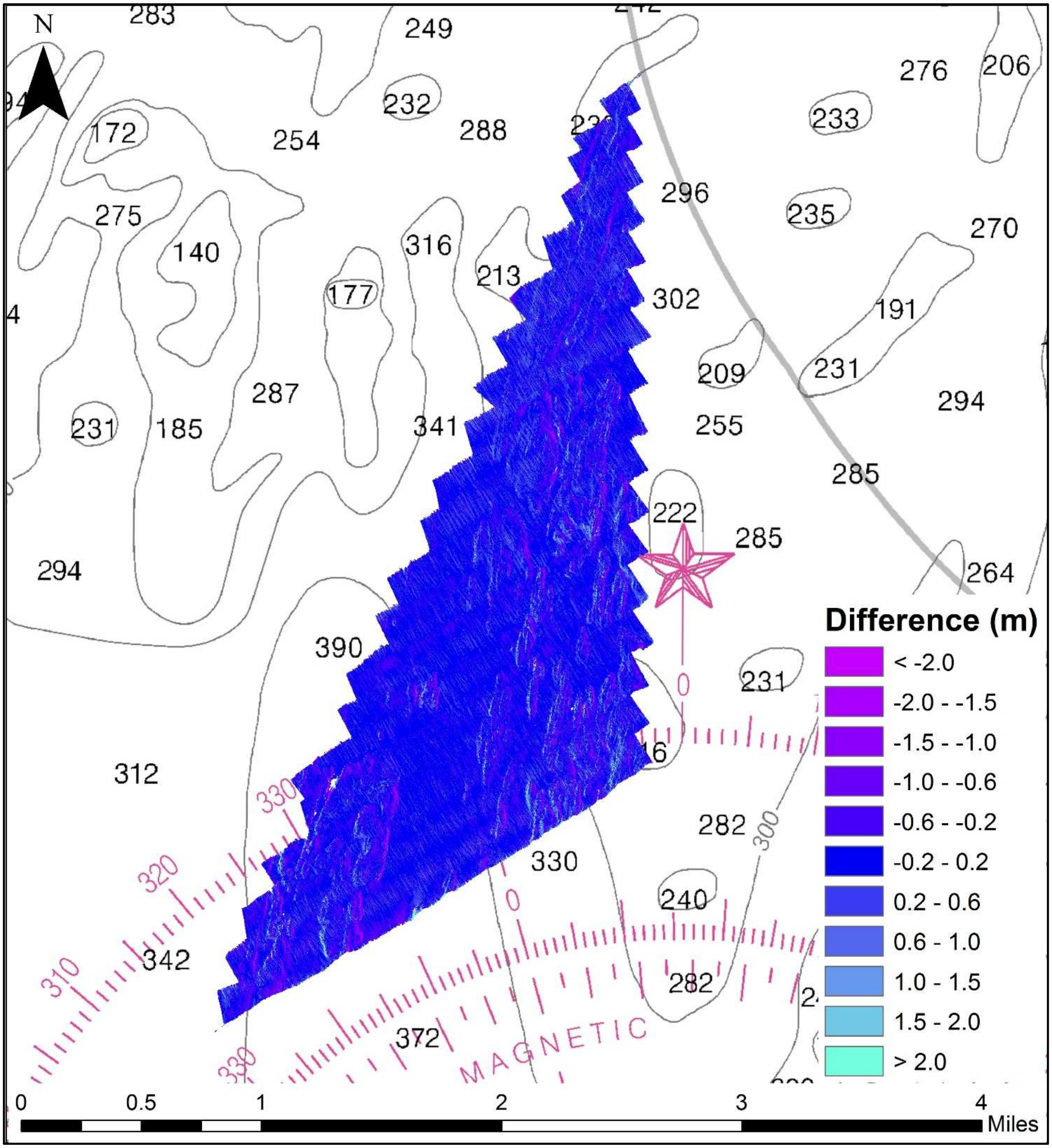


Figure 9 – Junctioning areas between W00450 and 2018-2019 Monhegan Island mainscheme survey (4-meter surfaces) shown as surface difference results; scale is 1:25,000.

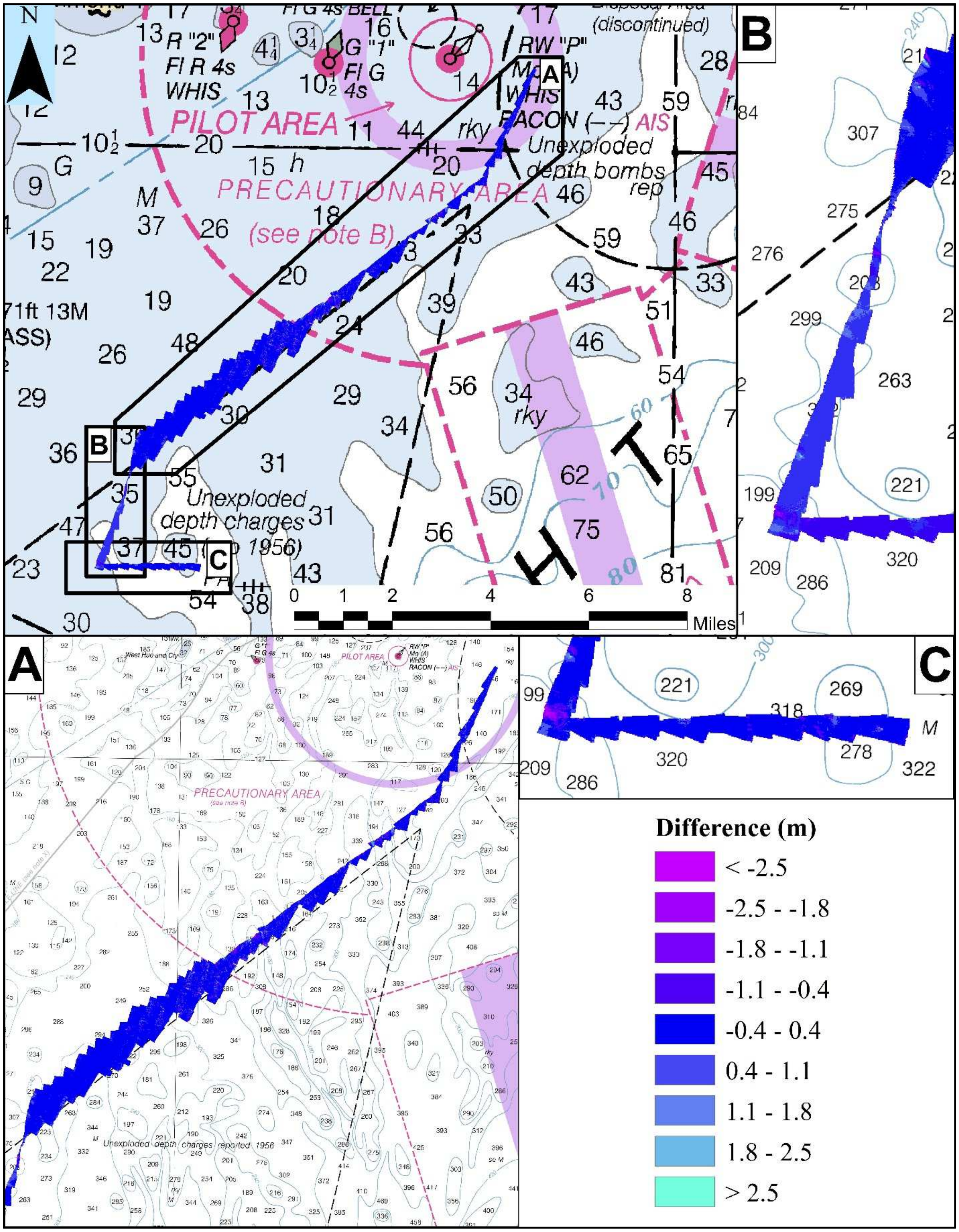


Figure 10 – Junctioning areas between H12726 (A), H12725 (B), W00288 (C), and 2018-2019 mainscheme survey; (4-meter and 8-meter surfaces) shown as surface difference results; scale in A is 1:30,000; scale in B and C is 1:10,000

3.3 Equipment Effectiveness

<u>Sonar</u>
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.

<u>Hydrographic Workstation</u>
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 October 2018 and thereafter.

3.4 Sound Speed Methods

Sound speed cast frequency: A total of 70 sound speed casts were taken within the boundaries of the 2018 and 2019 mainscheme 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 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.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 (.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 11). Time corrections, tide height offsets, and tide scale (range) for each zone are listed in Table 10.

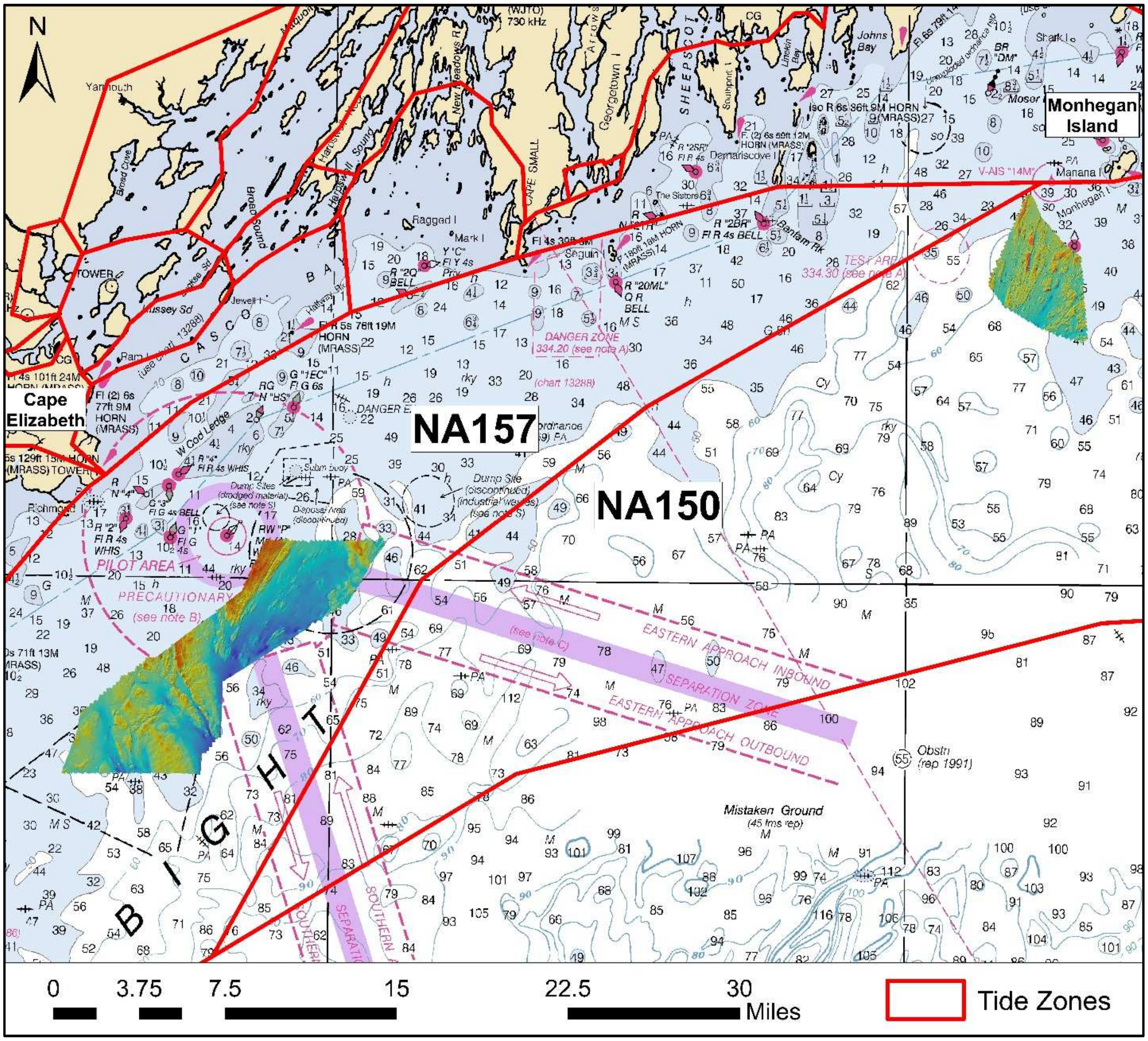


Figure 11 – Tide zones (outlined in red) relative to 2018-2019 mainscheme survey extent. Map scale 1:75,000.

Table 10 – Tide zones and corrections referenced to verified Wells (8419317)

Zone ID	Time Correction (mins.)	Tide Offset (m)	Tide Scale	Survey Area
NA150	-6	0	0.95	Mainscheme
NA157	-6	0	0.95	Mainscheme

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_4m CUBE settings enabled
5. Review and edit soundings/clean surface with 3D editor tool
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

CUBE

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 11) 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).

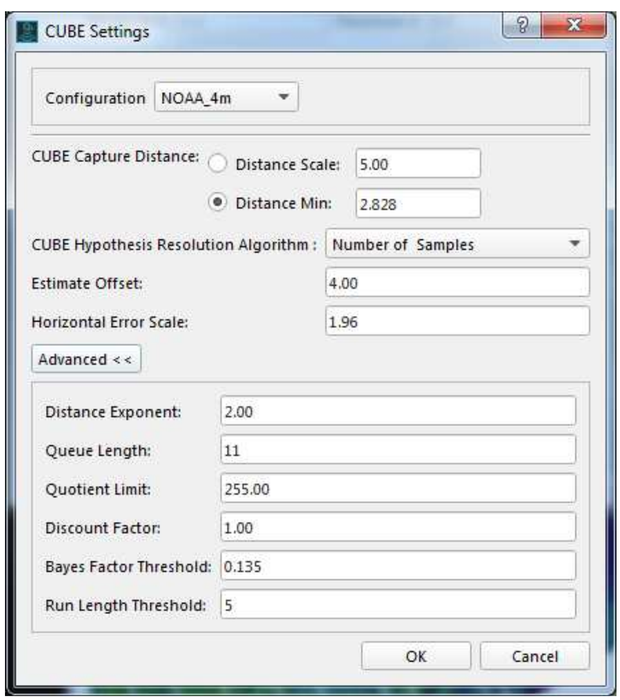


Figure 12 – CUBE settings parameters window shown with settings for NOAA 4-meter grid resolution

4.4 Final Surfaces

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

Table 11 – Surfaces submitted with 2018-2019 survey data

Surface Name	Resolution (m)	Depth Range (m)	Surface Parameter
MCMI_2018_2019_SacoBay_updated_2m_mllw	2	39 - 136	N/A
MCMI_2018_2019_SacoBay_updated_4m_mllw	4	38 - 136	N/A
MCMI_2018_2019_SacoBay_updated_8m_mllw	8	38 - 136	N/A
MCMI_2019_crosslines_SacoBay_4m_mllw	4	49 - 136	N/A
MCMI_2018_2019_Monhegan_2m_mllw	2	57 - 142	N/A
MCMI_2018_2019_Monhegan_4m_mllw	4	57 - 142	N/A
MCMI_2018_2019_Monhegan_8m_mllw	8	57 - 142	N/A
MCMI_2019_crosslines_Monhegan_4m_mllw	4	61 - 128	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 4-meter resolution and exported in greyscale and floating-point GeoTIFF format. The mosaics are shown in Table 12 and Figure 13. The GSF files containing the extracted were submitted with the data in this survey. Processed mosaics (Table 12) were also saved in geoTiff format and submitted.

Table 12 – Backscatter mosaics submitted with 2018-2019 survey data

Mosaic Name	Pixel Size (m)
MCMI_2018_2019_mainscheme_SacoBay_backscatter_db_4m.tif	4
MCMI_2018_2019_mainscheme_Monhegan_backscatter_db_4m.tif	4
MCMI_2018_2019_mainscheme_all_backscatter_db_4m.tif	4
MCMI_2018_2019_mainscheme_SacoBay_backscatter_gs_4m.tif	4
MCMI_2018_2019_mainscheme_Monhegan_backscatter_gs_4m.tif	4
MCMI_2018_2019_mainscheme_all_backscatter_gs_4m.tif	4

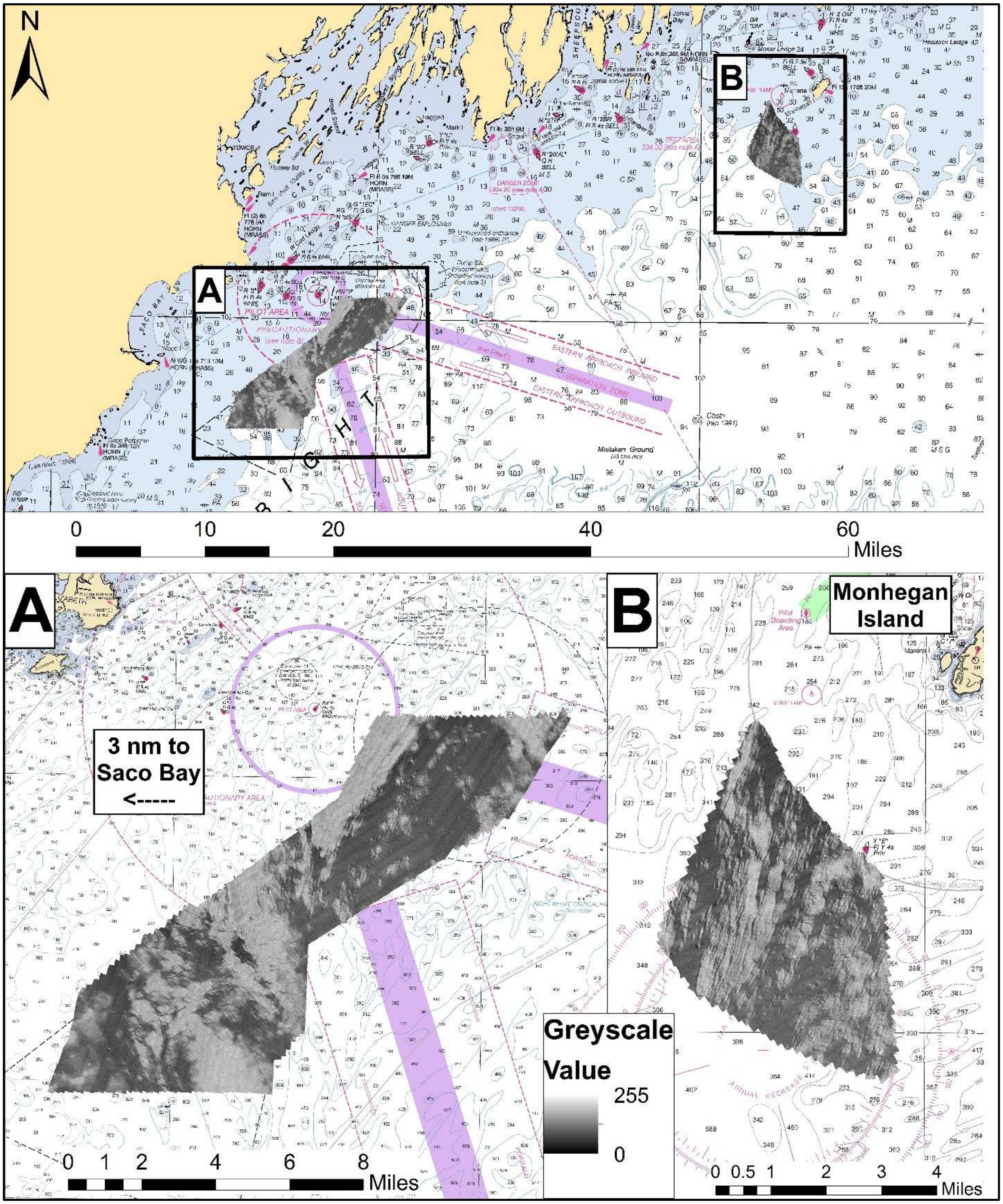


Figure 13 – Backscatter mosaic (4-meter pixel size) of 2018-2019 mainscheme surveys.

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 13. 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.

Table 13 – Largest scale raster charts in survey area

Chart	Scale	Source Edition	Source Date	NTM Date
13301	1:40,000	22	12/11/2018	12/11/2018
13288	1:80,000	44	3/1/2016	2/20/2020
13290	1:40,000	41	10/9/2019	2/20/2020
13286	1:80,000	34	3/19/2019	1/9/2020

Chart 13301

A small portion of the Monhegan Island survey area coincides with chart 13301. Surveyed depths have good overall agreement with charted contours and soundings (Figure 14), although individual soundings may disagree at any given location.

Chart 13288

The entire Monhegan Island survey area and approximately one-third of the Saco Bay survey area coincide with chart 13288. Charts with scales 1:80,000 (and smaller) inherently contain very generalized contours. As shown in Figure 15 and Figure 17, the agreement between chart contours and new survey data (reclassified at 60 feet intervals; same as chart) is generally good at depths less than 240 feet (73.1 meters). Agreement becomes increasingly poor at depths beyond 240 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 13290

A small portion of the Saco Bay survey area coincides with chart 13290. Surveyed depths have good overall agreement with charted contours and soundings (Figure 16), although individual soundings may disagree at any given location.

Chart 13286

The entire Saco 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 420 feet (128 meters). However, since a relatively small total surface area deeper than 420 feet exists in the survey area, this disagreement could be considered negligible.

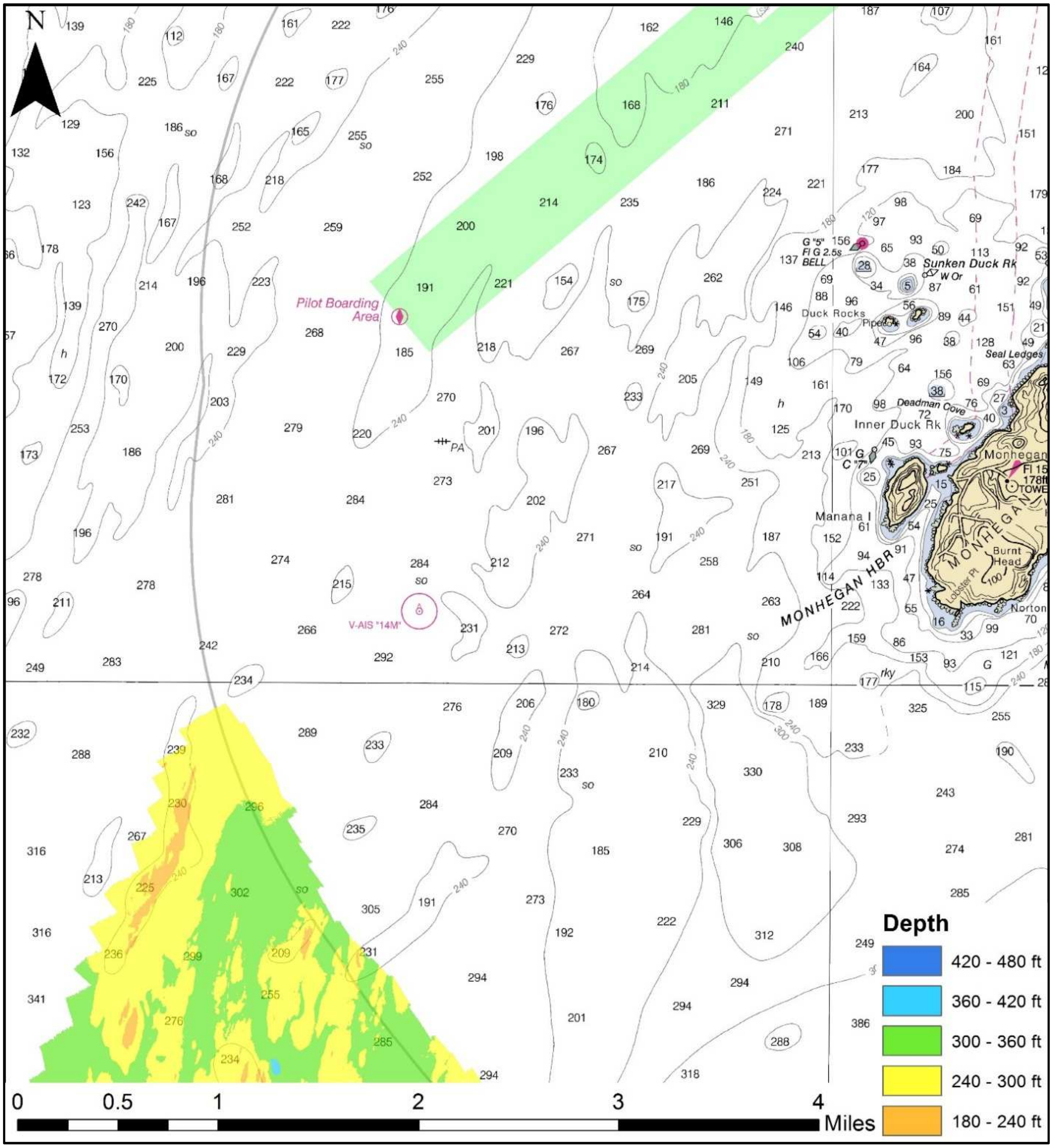


Figure 14 – Comparison between surveyed depth in Monhegan Island area (reclassified at 60-feet intervals) and chart 13301 (scale: 1:40,000, 60-feet contour intervals)

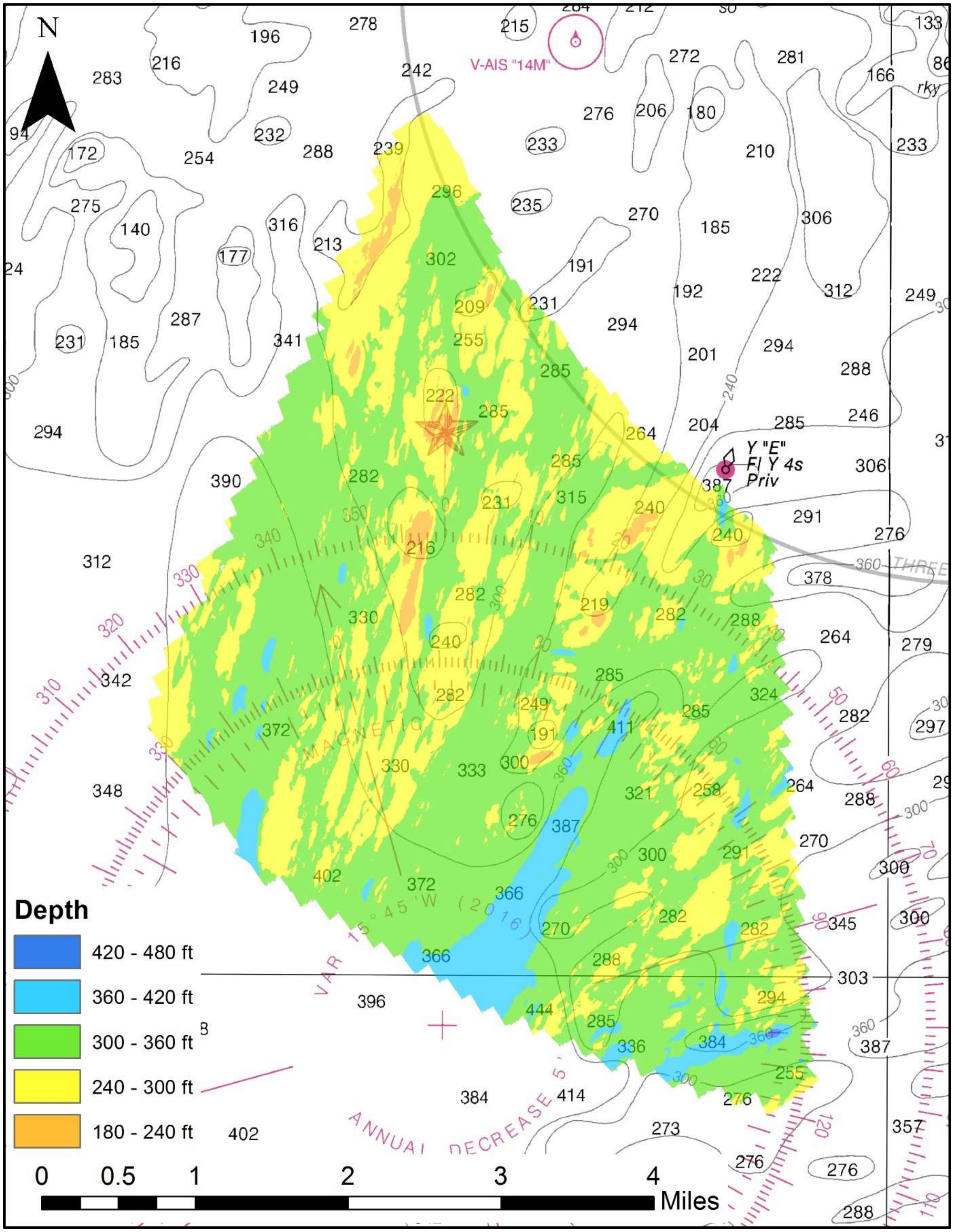


Figure 15 – Comparison between surveyed depth in Monhegan Island area (reclassified at 60-feet intervals) and chart 13288 (scale: 1:80,000, 60-feet contour intervals)

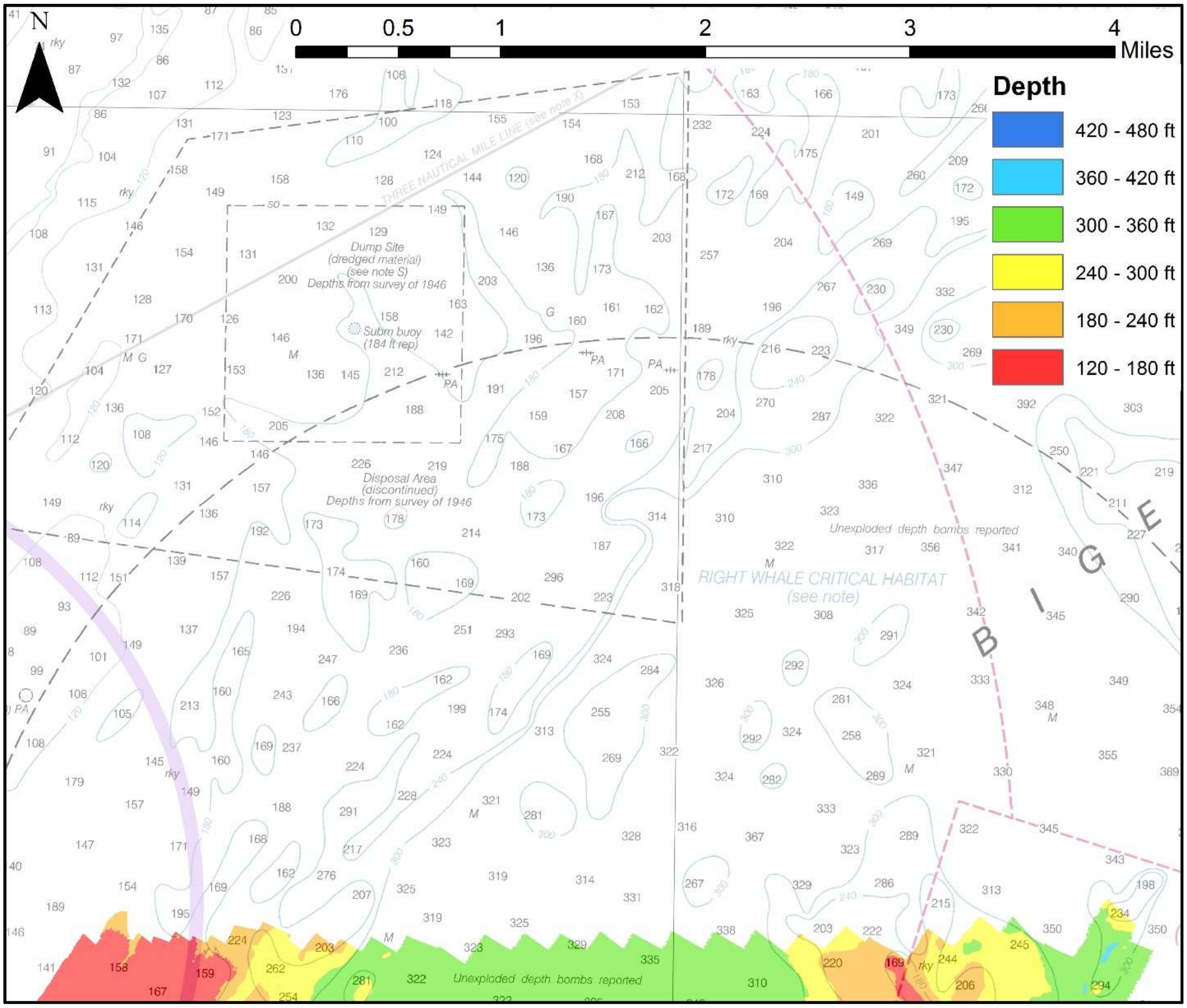


Figure 16 – Comparison between surveyed depth in Saco Bay area (reclassified at 60-feet intervals) and chart 13290 (scale: 1:40,000, 60-feet contour intervals)

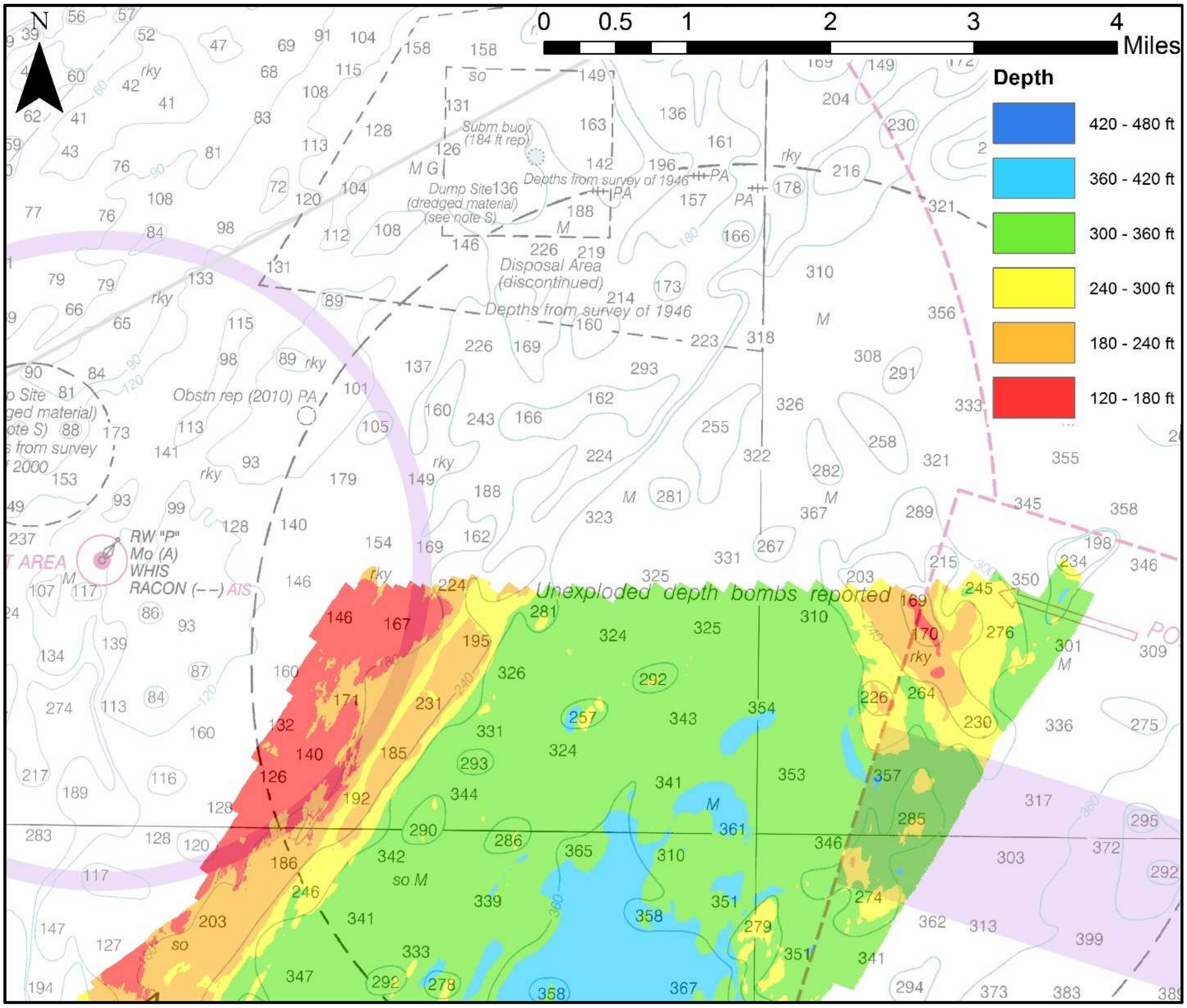


Figure 17 – Comparison between surveyed depth in Saco Bay area (reclassified at 60-feet intervals) and chart 13288 (scale: 1:80,000, 60-feet contour intervals)

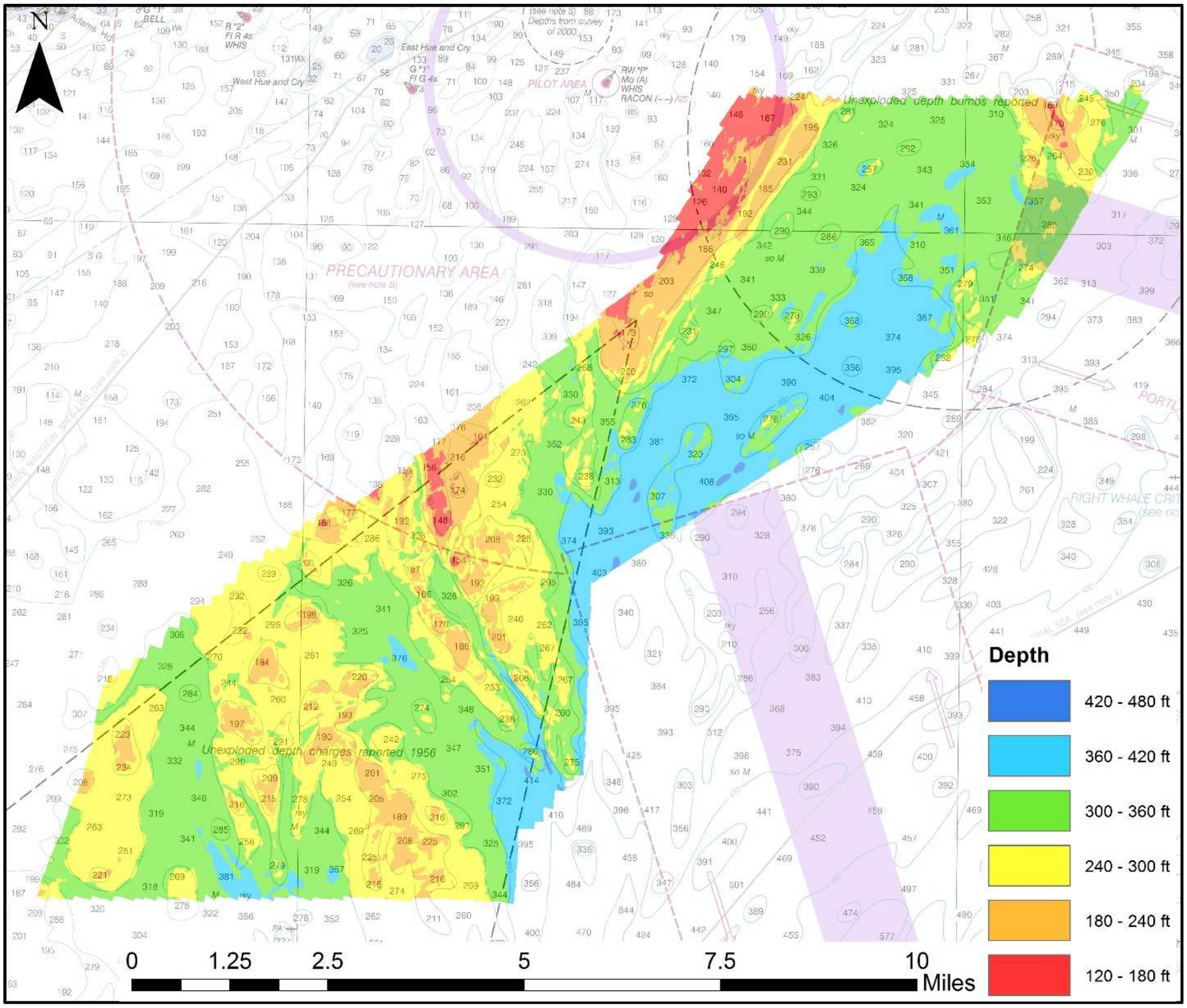


Figure 18 – Comparison between surveyed depth in Saco Bay area (reclassified at 60-feet intervals) and chart 13286 (scale: 1:80,000, 60-feet contour intervals)

6.0 Summary

A total of approximately 71 mi^2 (184 km^2) of high-resolution multibeam data were collected in the mainscheme survey areas by MCMI from August to November of 2018 and April to August of 2019. 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. 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 0.1 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 73 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 Joint Hydrographic Center / Center for Coastal and Ocean Mapping for review.

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

References

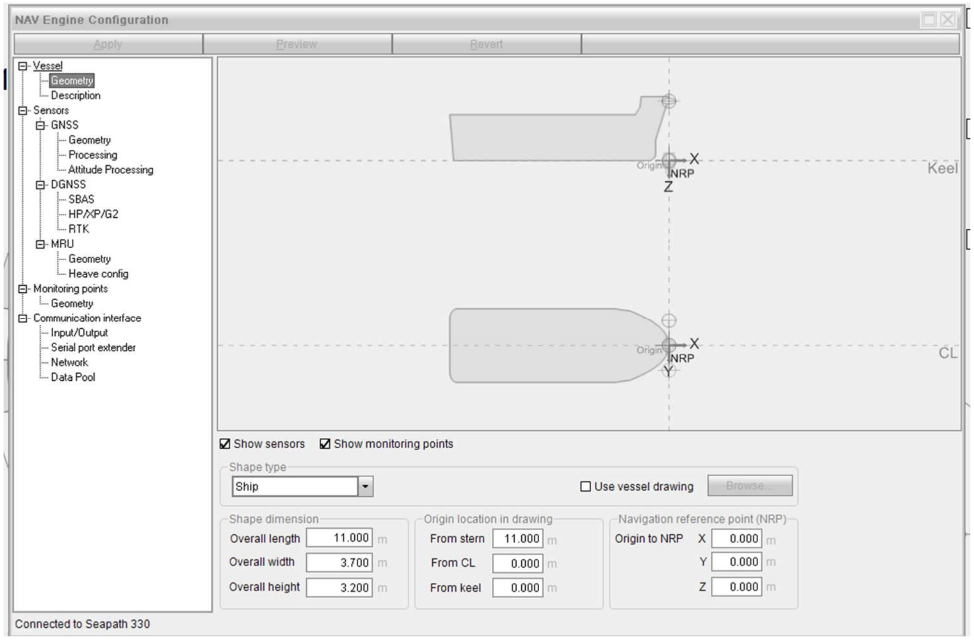
NOAA, 2014. NOS hydrographic surveys specifications and deliverables: U.S Department of Commerce National Oceanic and Atmospheric Administration. Page 89.

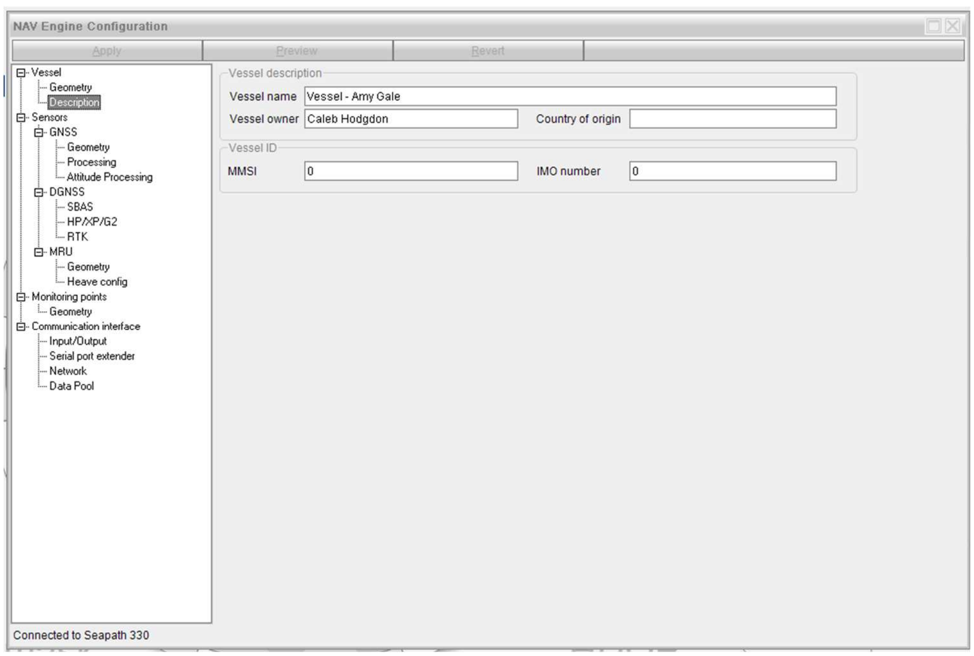
U.S. Department of the Interior, 2014. Proposed geophysical and geological activities in the Atlantic OCS to identify sand resources and borrow areas north Atlantic, mid-Atlantic, and south Atlantic-Straits of Florida planning areas, *final environmental assessment.* OCS EIS/EA BOEM 2013-219 U.S. Department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

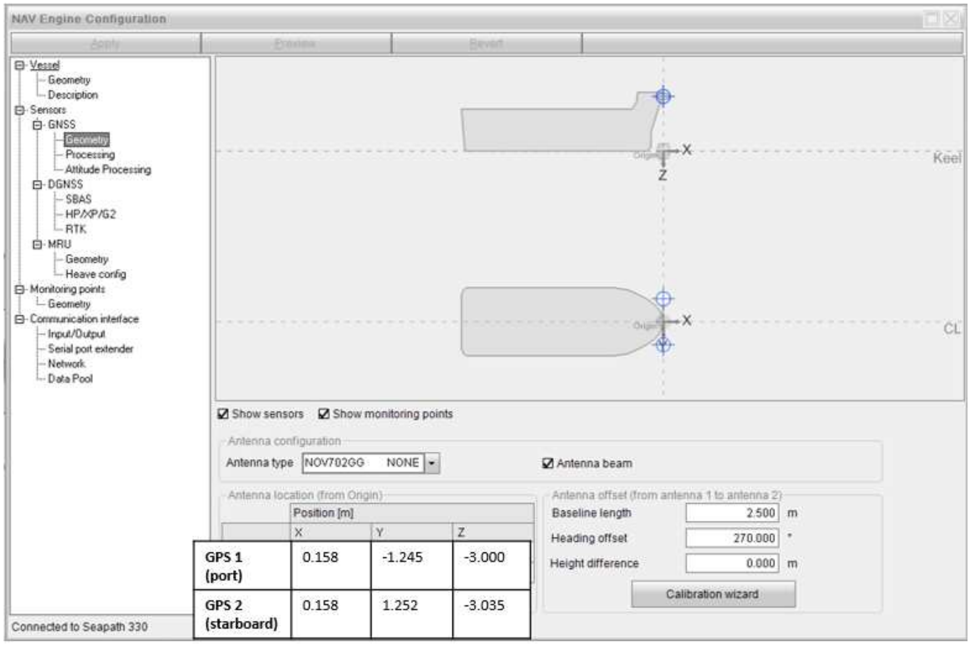
Appendix A – Specific dates of data acquisition for mainscheme surveys

Mainscheme
08/01/18
08/06/18
08/16/18
08/17/18
09/04/18
10/01/18
11/15/18
11/19/18
04/17/19
04/18/19
04/24/19
04/30/19
05/16/19
05/23/19
05/28/19
06/03/19
06/05/19
06/07/19
06/12/19
06/17/19
06/18/19
06/19/19
06/20/19
07/11/19
07/25/19
07/26/19
08/01/19
08/02/19
08/15/19
08/20/19
08/29/19

Appendix B – 2018-2019 Configuration settings for Sea path 330



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Revert
Vessel
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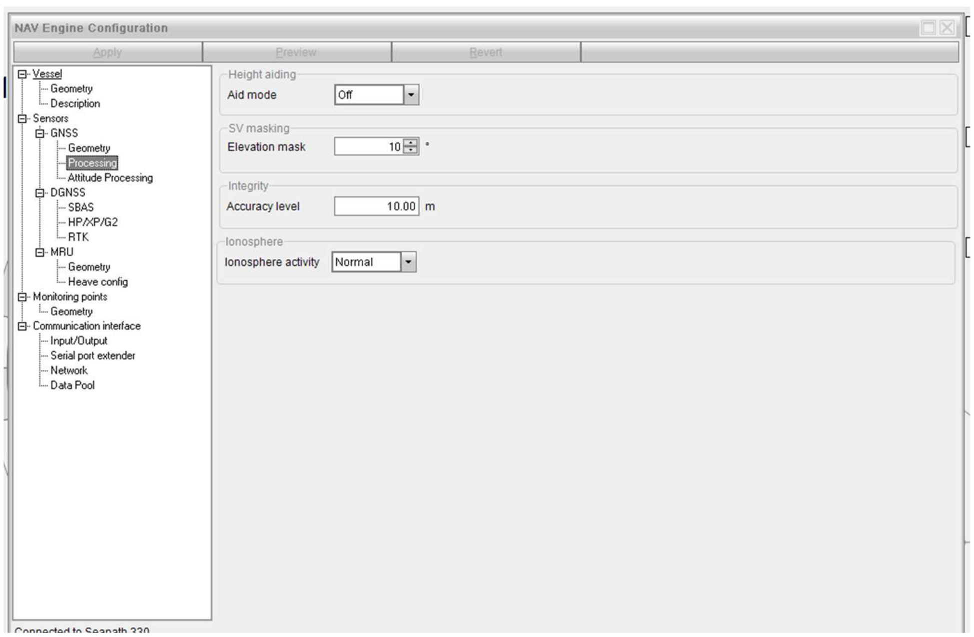
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Keel
CL
X
Z
Show sensors
Show monitoring points
Antenna configuration
Antenna type NOV702GG NONE
Antenna beam
Antenna location (from Origin)
Position [m]
X
Y
Z
GPS 1 (port) 0.158 -1.245 -3.000
GPS 2 (starboard) 0.158 1.252 -3.035
Antenna offset (from antenna 1 to antenna 2)
Baseline length 2.500 m
Heading offset 270.000 °
Height difference 0.000 m
Calibration wizard
Connected to Seapath 330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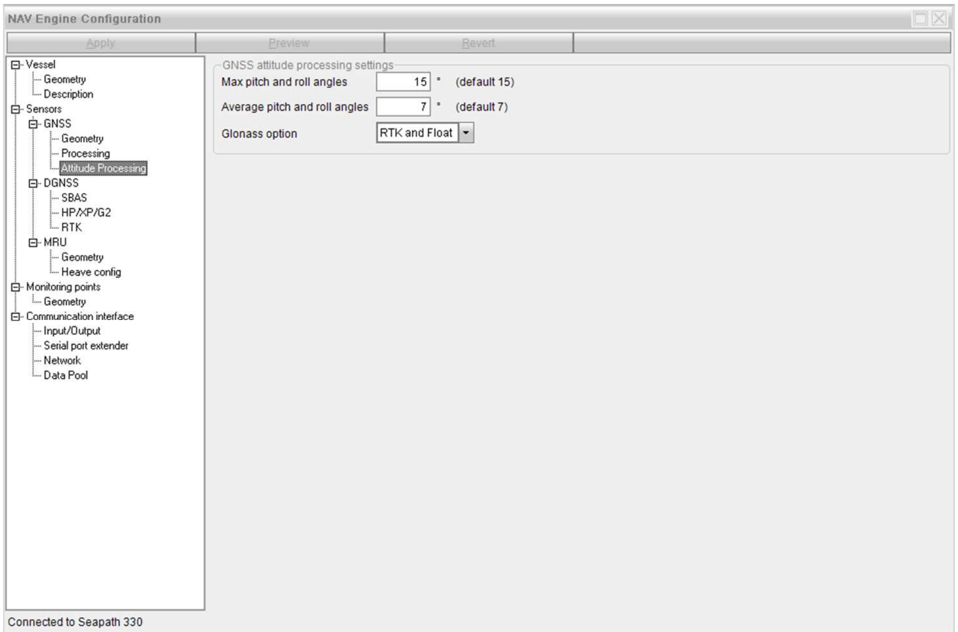
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Height aiding
Aid mode Off
SV masking
Elevation mask 10 °
Integrity
Accuracy level 10.00 m
Ionosphere
Ionosphere activity Normal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HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
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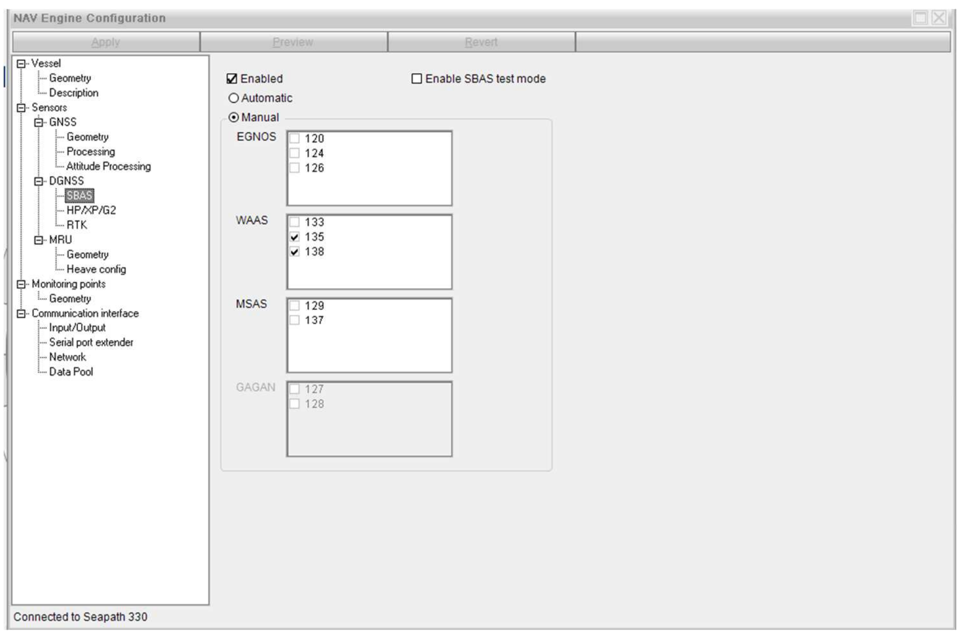
Average pitch and roll angles 7 ° (default 7)
Glonass option RTK and Float
Connected to Seapath 330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Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
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Automatic
Manual
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MSAS 129 137
GAGAN 127 128
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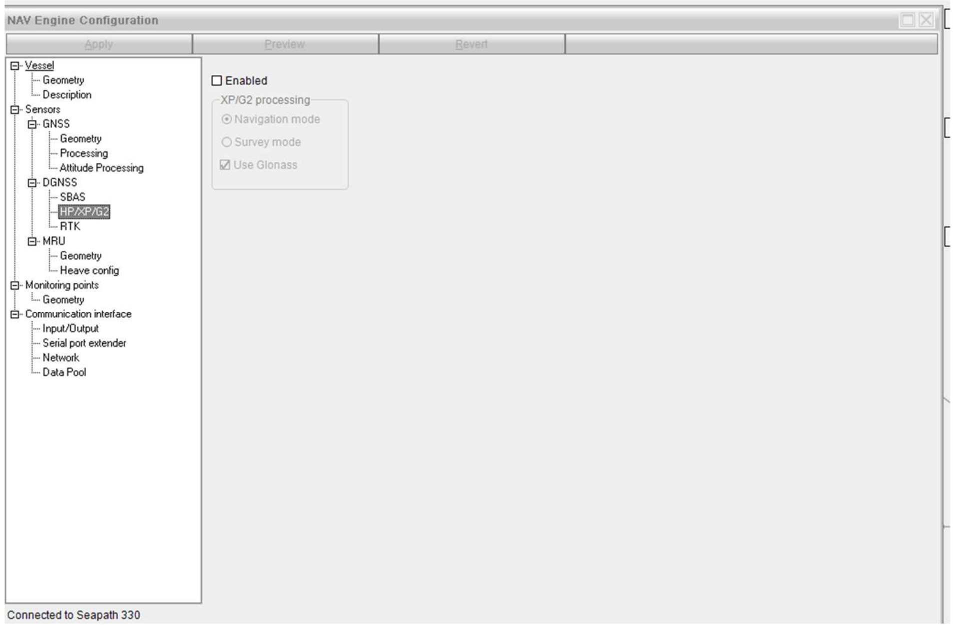
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Survey mode
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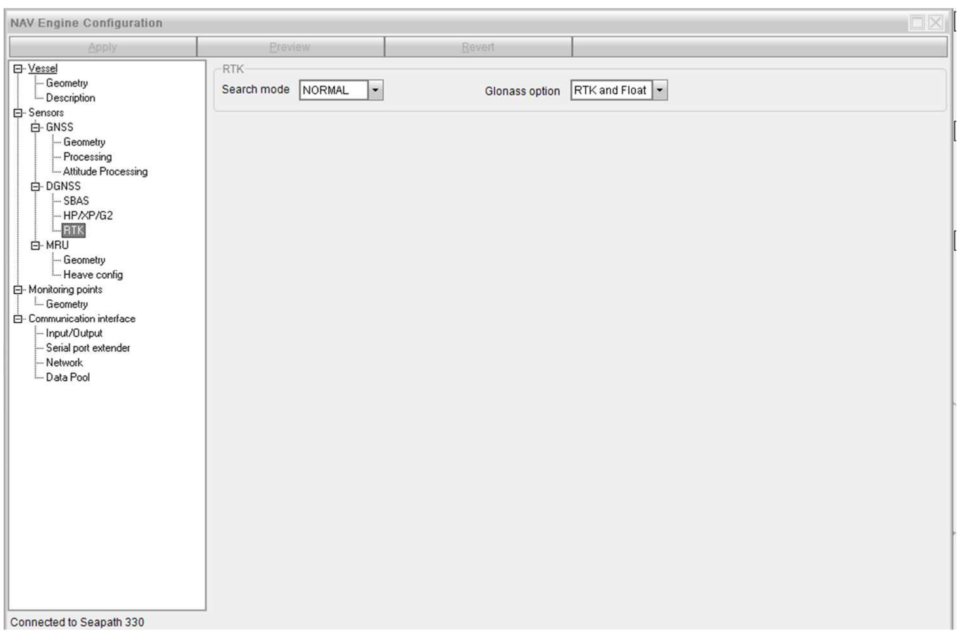
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Heave config
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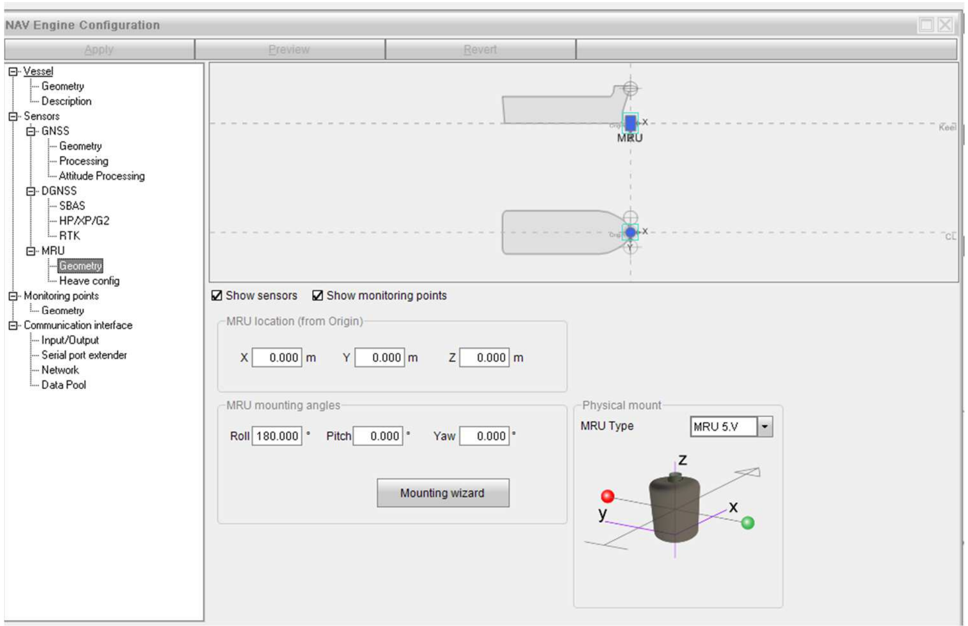
RTK and Float
Connected to Seapath 330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Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
MRU
Show sensors
Show monitoring points
MRU location (from Origin)
X 0.000 m
Y 0.000 m
Z 0.000 m
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Pitch 0.000 °
Yaw 0.000 °
Mounting wizard
Physical mount
MRU Type
MRU 5.V
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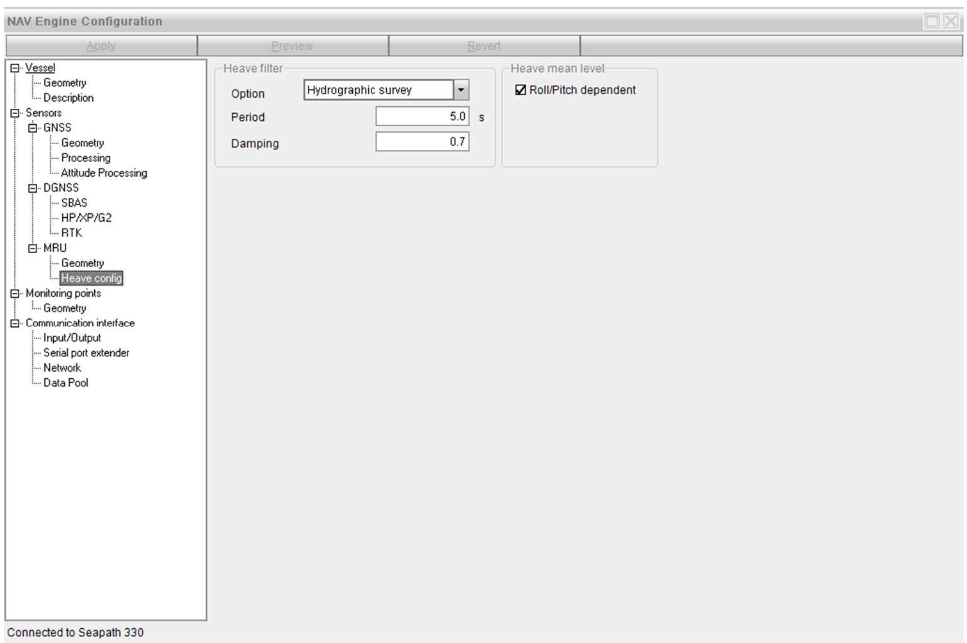
y
x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Communication interface
Input/Output
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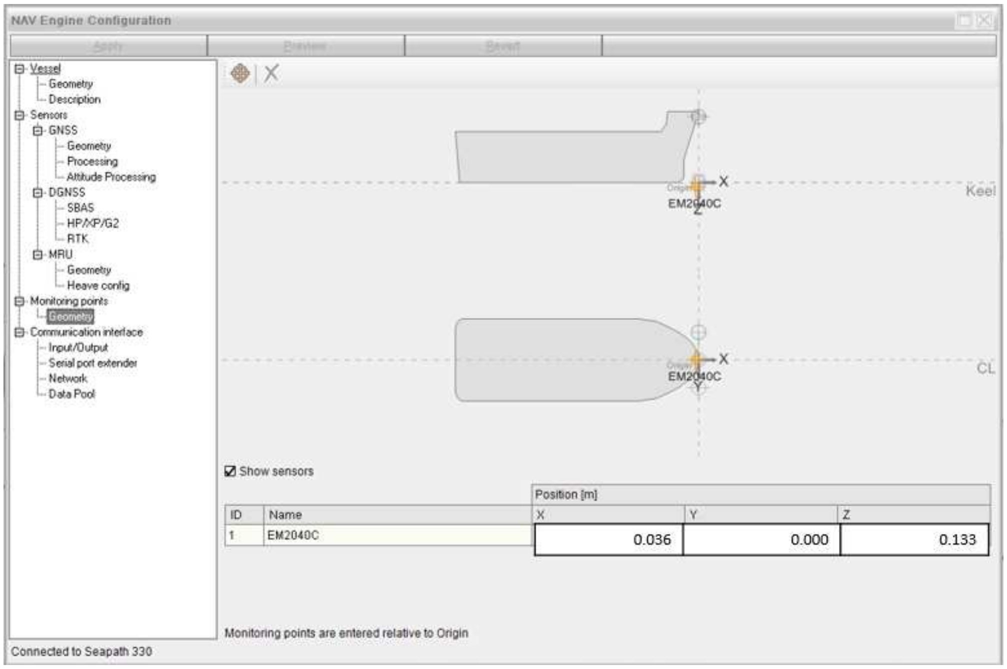
Damping 0.7
Heave mean level
Roll/Pitch dependent
Connected to Seapath 330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Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
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EM2040C
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Name
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Y
Z
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0.000
0.133
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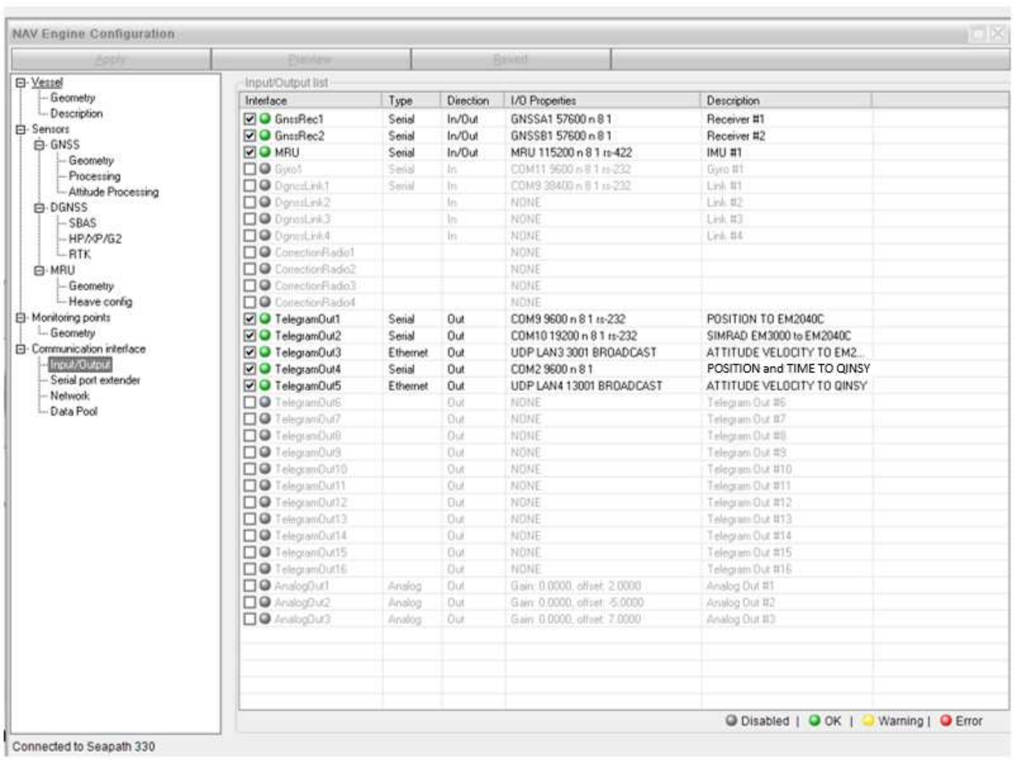
Connected to Seapath 330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HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
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GnssRec2 | Serial | In/Out | GNSSB1 57600 n 8 1 | Receiver #2
MRU | Serial | In/Out | MRU 115200 n 8 1 rs-422 | IMU #1
Gyro1 | Serial | In | COM11 9600 n 8 1 rs-232 | Gyro #1
DgnssLink1 | Serial | In | COM9 38400 n 8 1 rs-232 | Link #1
DgnssLink2 | In | NONE | Link #2
DgnssLink3 | In | NONE | Link #3
DgnssLink4 | In | NONE | Link #4
CorrectionRadio1 | NONE
CorrectionRadio2 | NONE
CorrectionRadio3 | NONE
CorrectionRadio4 | NONE
TelegramOut1 | Serial | Out | COM9 9600 n 8 1 rs-232 | POSITION TO EM2040C
TelegramOut2 | Serial | Out | COM10 19200 n 8 1 rs-232 | SIMRAD EM3000 to EM2040C
TelegramOut3 | Ethernet | Out | UDP LAN3 3001 BROADCAST | ATTITUDE VELOCITY TO EM2...
TelegramOut4 | Serial | Out | COM2 9600 n 8 1 | POSITION and TIME TO QINSY
TelegramOut5 | Ethernet | Out | UDP LAN4 13001 BROADCAST | ATTITUDE VELOCITY TO QINSY
TelegramOut6 | Out | NONE | Telegram Out #6
TelegramOut7 | Out | NONE | Telegram Out #7
TelegramOut8 | Out | NONE | Telegram Out #8
TelegramOut9 | Out | NONE | Telegram Out #9
TelegramOut10 | Out | NONE | Telegram Out #10
TelegramOut11 | Out | NONE | Telegram Out #11
TelegramOut12 | Out | NONE | Telegram Out #12
TelegramOut13 | Out | NONE | Telegram Out #13
TelegramOut14 | Out | NONE | Telegram Out #14
TelegramOut15 | Out | NONE | Telegram Out #15
TelegramOut16 | Out | NONE | Telegram Out #16
AnalogOut1 | Analog | Out | Gain: 0.0000, offset: 2.0000 | Analog Out #1
AnalogOut2 | Analog | Out | Gain: 0.0000, offset: -5.0000 | Analog Out #2
AnalogOut3 | Analog | Out | Gain: 0.0000, offset: 7.0000 | Analog Out #3
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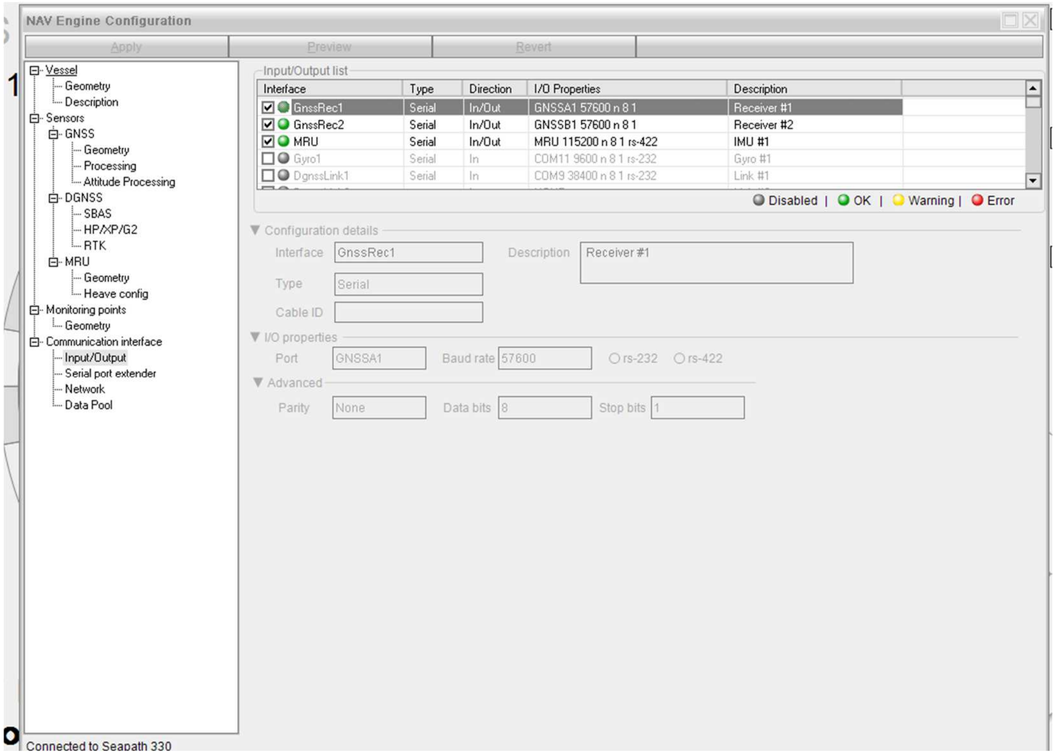
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RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
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GnssRec2 | Serial | In/Out | GNSSB1 57600 n 8 1 | Receiver #2
MRU | Serial | In/Out | MRU 115200 n 8 1 rs-422 | IMU #1
Gyro1 | Serial | In | COM11 9600 n 8 1 rs-232 | Gyro #1
DgnssLink1 | Serial | In | COM9 38400 n 8 1 rs-232 | Link #1
Disabled | OK | Warning | Error
Configuration details
Interface GnssRec1
Description Receiver #1
Type Serial
Cable ID
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Baud rate 57600
rs-232
rs-422
Advanced
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Stop bits 1
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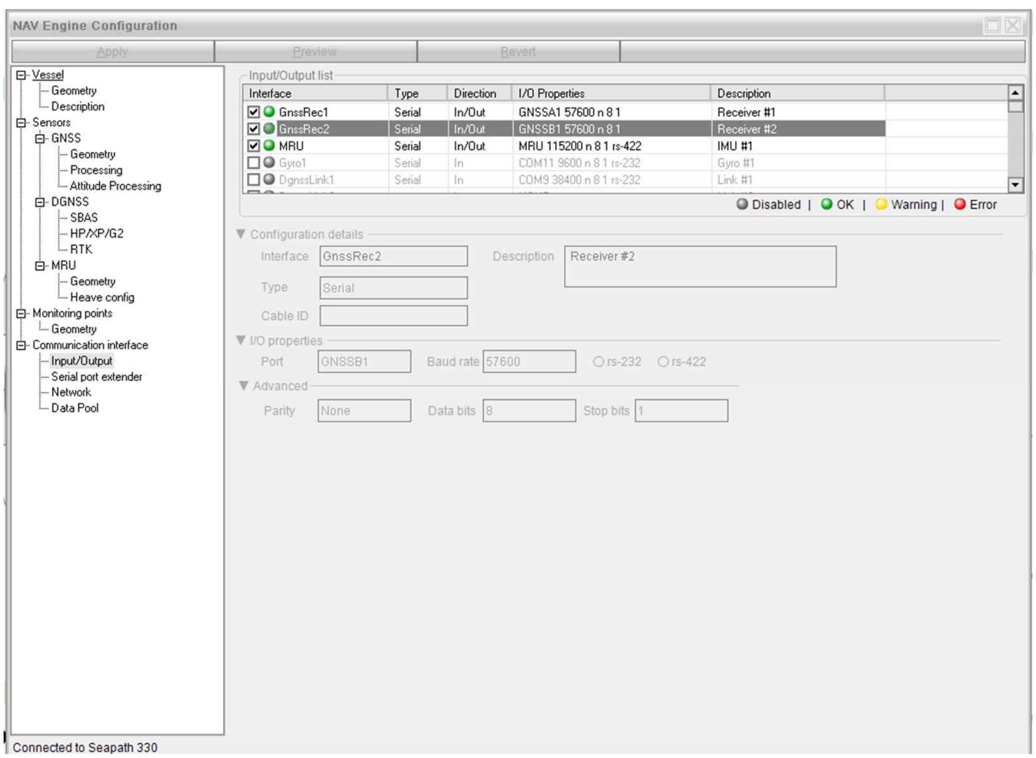
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Preview
Revert
Vessel
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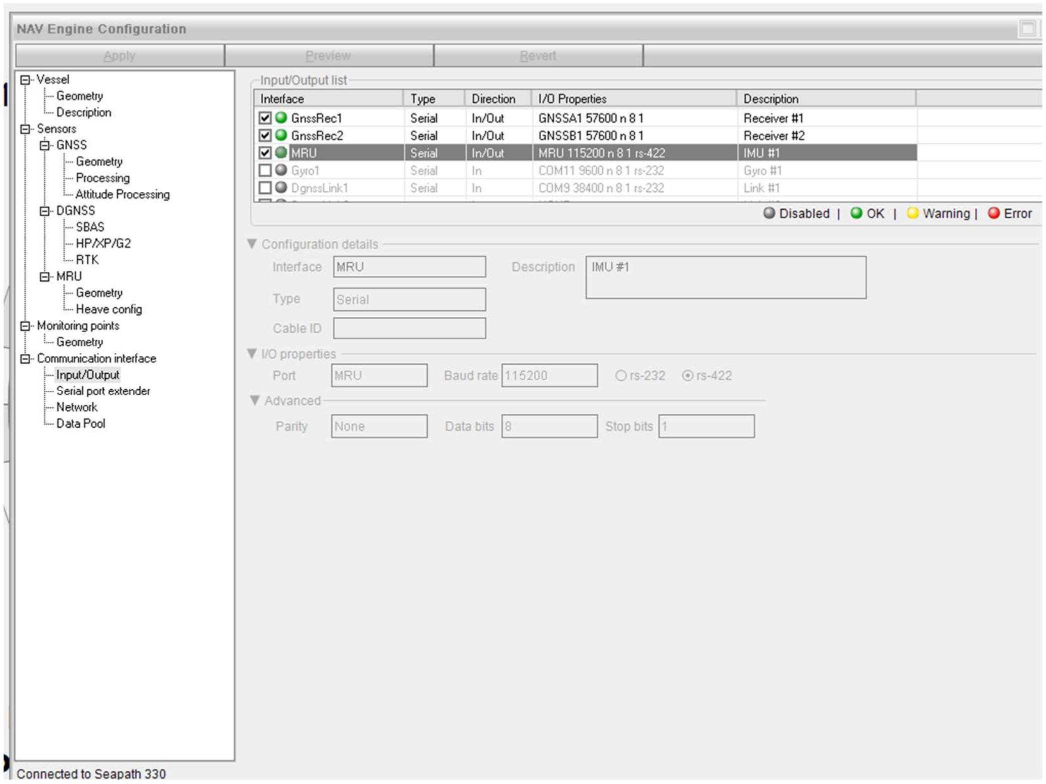
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
GnssRec1 | Serial | In/Out | GNSSA1 57600 n 8 1 | Receiver #1
GnssRec2 | Serial | In/Out | GNSSB1 57600 n 8 1 | Receiver #2
MRU | Serial | In/Out | MRU 115200 n 8 1 rs-422 | IMU #1
Gyro1 | Serial | In | COM11 9600 n 8 1 rs-232 | Gyro #1
DgnssLink1 | Serial | In | COM9 38400 n 8 1 rs-232 | Link #1
Disabled | OK | Warning | Error
Configuration details
Interface GnssRec2
Description Receiver #2
Type Serial
Cable ID
I/O properties
Port GNSSB1
Baud rate 57600
rs-232
rs-422
Advanced
Parity None
Data bits 8
Stop bits 1
Connected to Seapath 330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Apply
Preview
Revert
Vessel
Geometry
Description
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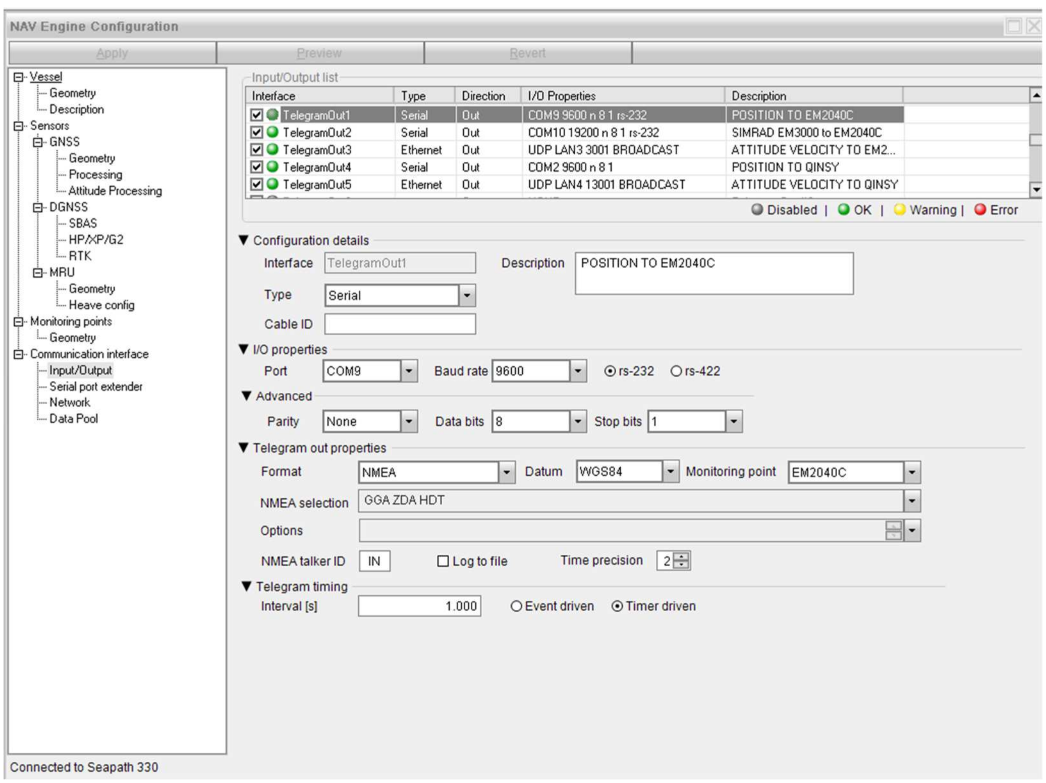
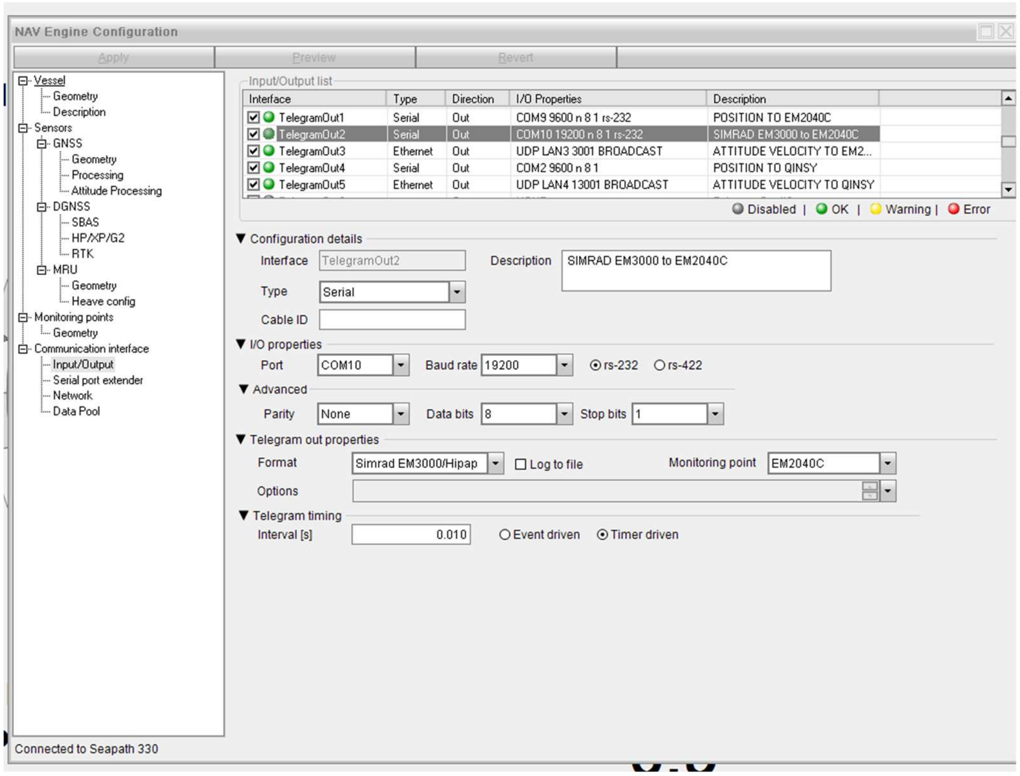
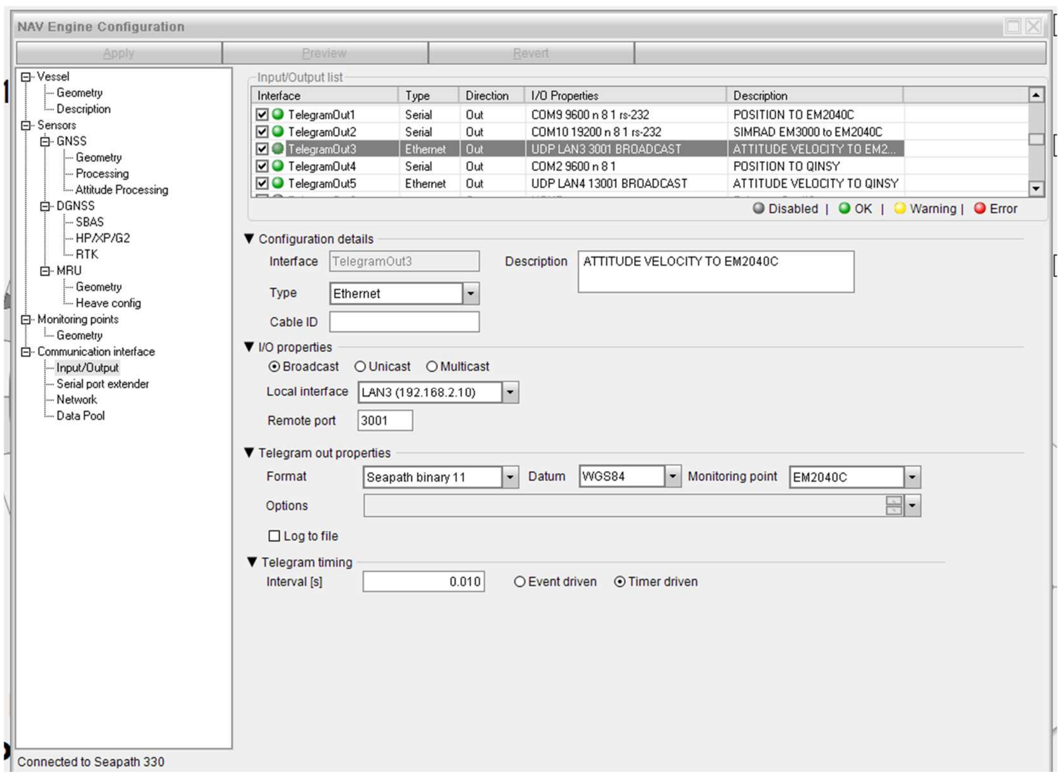
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
GnssRec1 | Serial | In/Out | GNSSA1 57600 n 8 1 | Receiver #1
GnssRec2 | Serial | In/Out | GNSSB1 57600 n 8 1 | Receiver #2
MRU | Serial | In/Out | MRU 115200 n 8 1 rs-422 | IMU #1
Gyro1 | Serial | In | COM11 9600 n 8 1 rs-232 | Gyro #1
DgnssLink1 | Serial | In | COM9 38400 n 8 1 rs-232 | Link #1
Disabled | OK | Warning | Error
Configuration details
Interface MRU
Description IMU #1
Type Serial
Cable ID
I/O properties
Port MRU
Baud rate 115200
rs-232
rs-422
Advanced
Parity None
Data bits 8
Stop bits 1
Connected to Seapath 330

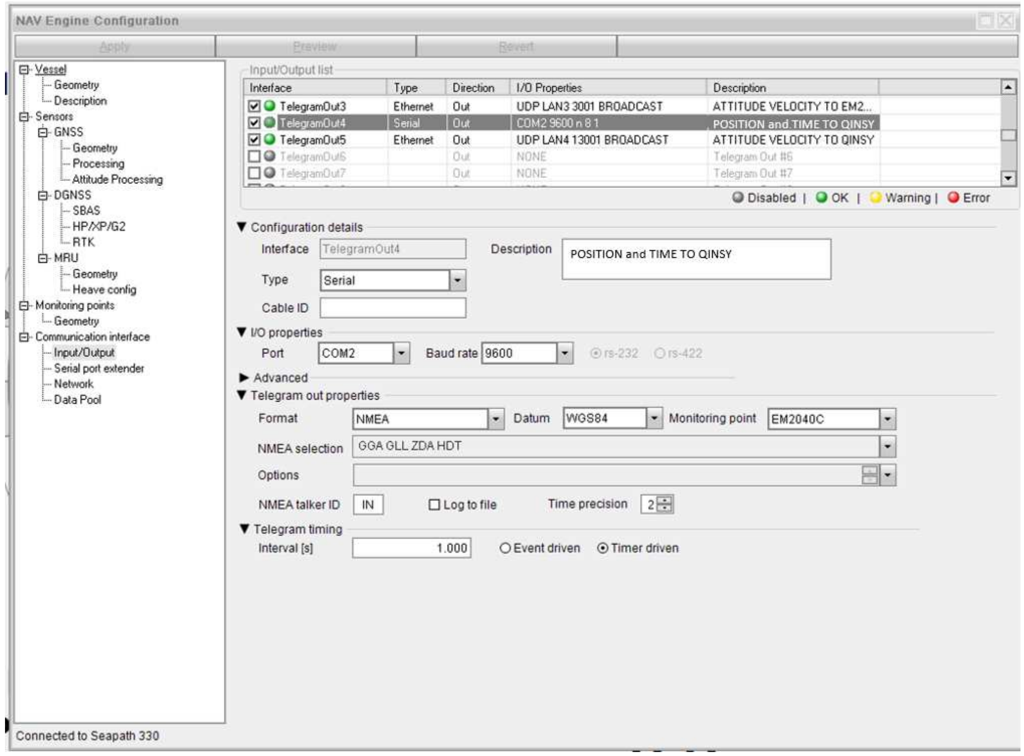

NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
TelegramOut1 | Serial | Out | COM9 9600 n 8 1 rs-232 | POSITION TO EM2040C
TelegramOut2 | Serial | Out | COM10 19200 n 8 1 rs-232 | SIMRAD EM3000 to EM2040C
TelegramOut3 | Ethernet | Out | UDP LAN3 3001 BROADCAST | ATTITUDE VELOCITY TO EM2...
TelegramOut4 | Serial | Out | COM2 9600 n 8 1 | POSITION TO QINSY
TelegramOut5 | Ethernet | Out | UDP LAN4 13001 BROADCAST | ATTITUDE VELOCITY TO QINSY
Disabled | OK | Warning | Error
Configuration details
Interface TelegramOut1
Description POSITION TO EM2040C
Type Serial
Cable ID
I/O properties
Port COM9
Baud rate 9600
rs-232
rs-422
Advanced
Parity None
Data bits 8
Stop bits 1
Telegram out properties
Format NMEA
Datum WGS84
Monitoring point EM2040C
NMEA selection GGA ZDA HDT
Options
NMEA talker ID IN
Log to file
Time precision 2
Telegram timing
Interval [s] 1.000
Event driven
Timer driven
Connected to Seapath 330

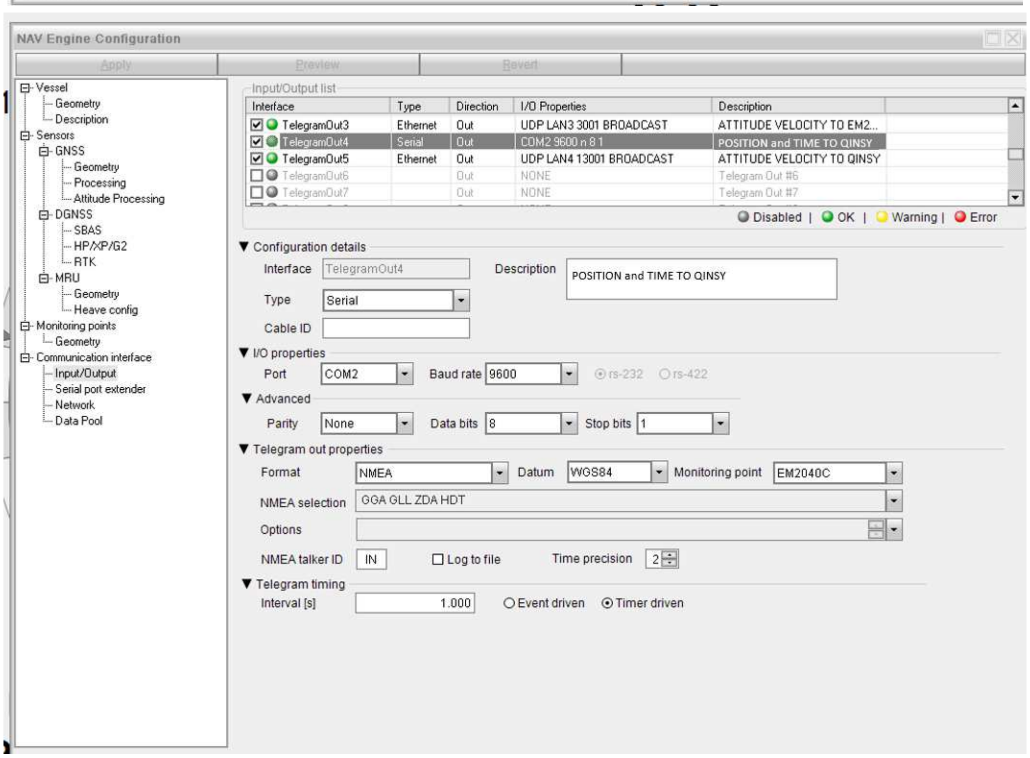


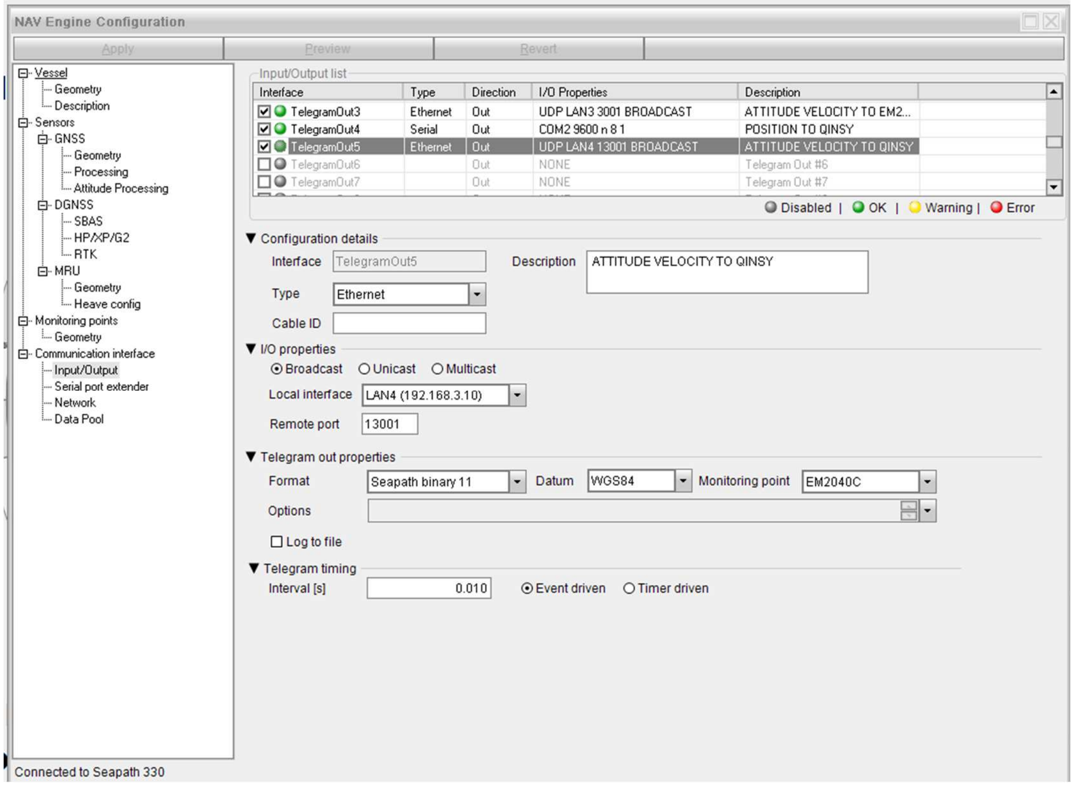
NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
TelegramOut1 | Serial | Out | COM9 9600 n 8 1 rs-232 | POSITION TO EM2040C
TelegramOut2 | Serial | Out | COM10 19200 n 8 1 rs-232 | SIMRAD EM3000 to EM2040C
TelegramOut3 | Ethernet | Out | UDP LAN3 3001 BROADCAST | ATTITUDE VELOCITY TO EM2...
TelegramOut4 | Serial | Out | COM2 9600 n 8 1 | POSITION TO QINSY
TelegramOut5 | Ethernet | Out | UDP LAN4 13001 BROADCAST | ATTITUDE VELOCITY TO QINSY
Disabled | OK | Warning | Error
Configuration details
Interface TelegramOut2
Description SIMRAD EM3000 to EM2040C
Type Serial
Cable ID
I/O properties
Port COM10
Baud rate 19200
rs-232
rs-422
Advanced
Parity None
Data bits 8
Stop bits 1
Telegram out properties
Format Simrad EM3000/Hipap
Log to file
Monitoring point EM2040C
Options
Telegram timing
Interval [s] 0.010
Event driven
Timer driven
Connected to Seapath 330

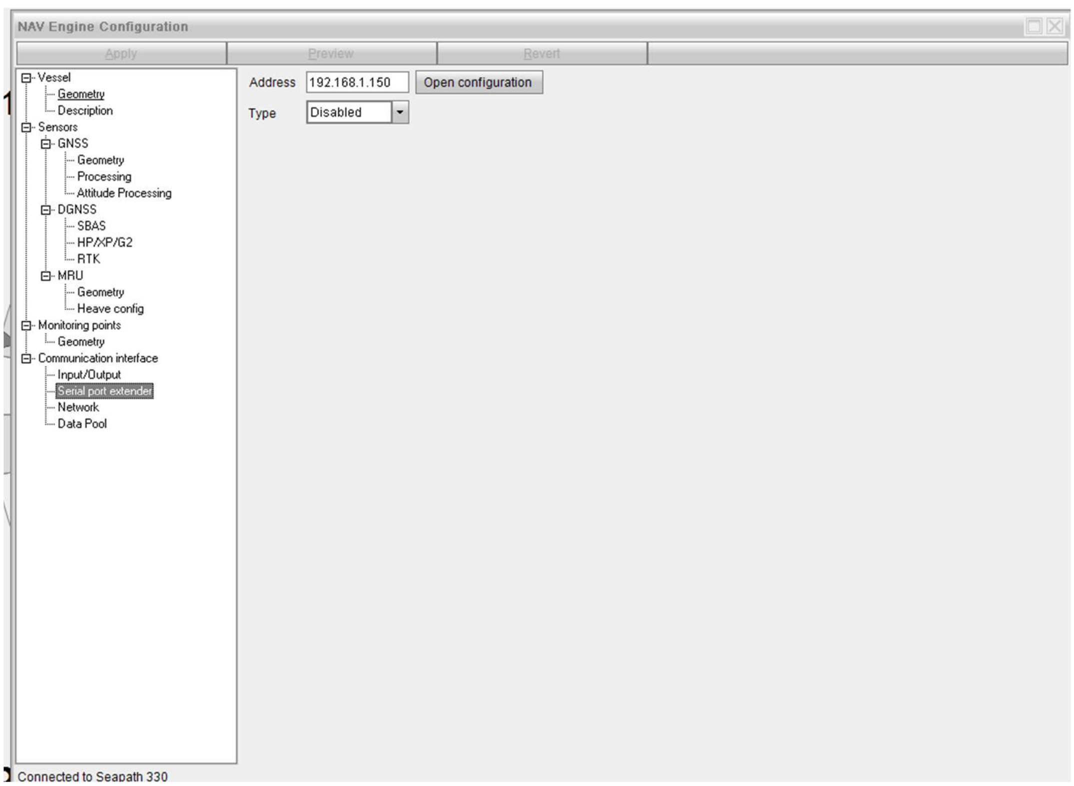


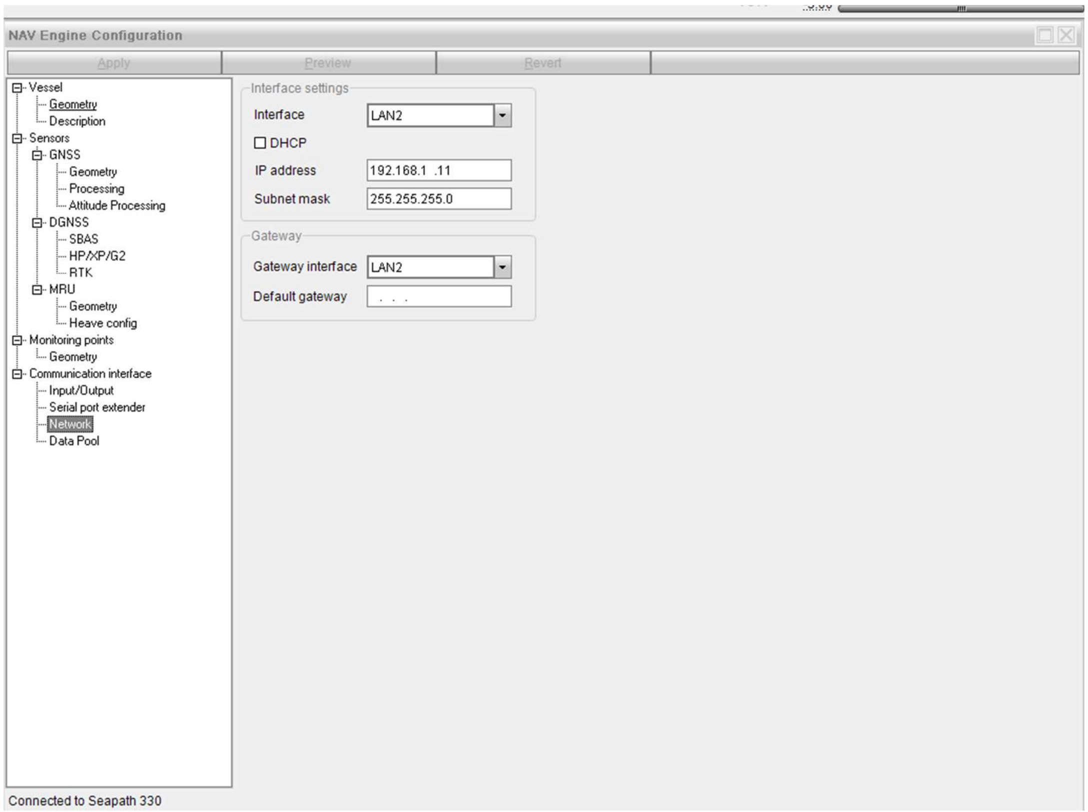
NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface | Type | Direction | I/O Properties | Description
TelegramOut1 | Serial | Out | COM9 9600 n 8 1 rs-232 | POSITION TO EM2040C
TelegramOut2 | Serial | Out | COM10 19200 n 8 1 rs-232 | SIMRAD EM3000 to EM2040C
TelegramOut3 | Ethernet | Out | UDP LAN3 3001 BROADCAST | ATTITUDE VELOCITY TO EM2...
TelegramOut4 | Serial | Out | COM2 9600 n 8 1 | POSITION TO QINSY
TelegramOut5 | Ethernet | Out | UDP LAN4 13001 BROADCAST | ATTITUDE VELOCITY TO QINSY
Disabled | OK | Warning | Error
Configuration details
Interface TelegramOut3
Description ATTITUDE VELOCITY TO EM2040C
Type Ethernet
Cable ID
I/O properties
Broadcast
Unicast
Multicast
Local interface LAN3 (192.168.2.10)
Remote port 3001
Telegram out properties
Format Seapath binary 11
Datum WGS84
Monitoring point EM2040C
Options
Log to file
Telegram timing
Interval [s] 0.010
Event driven
Timer driven
Connected to Seapath 330

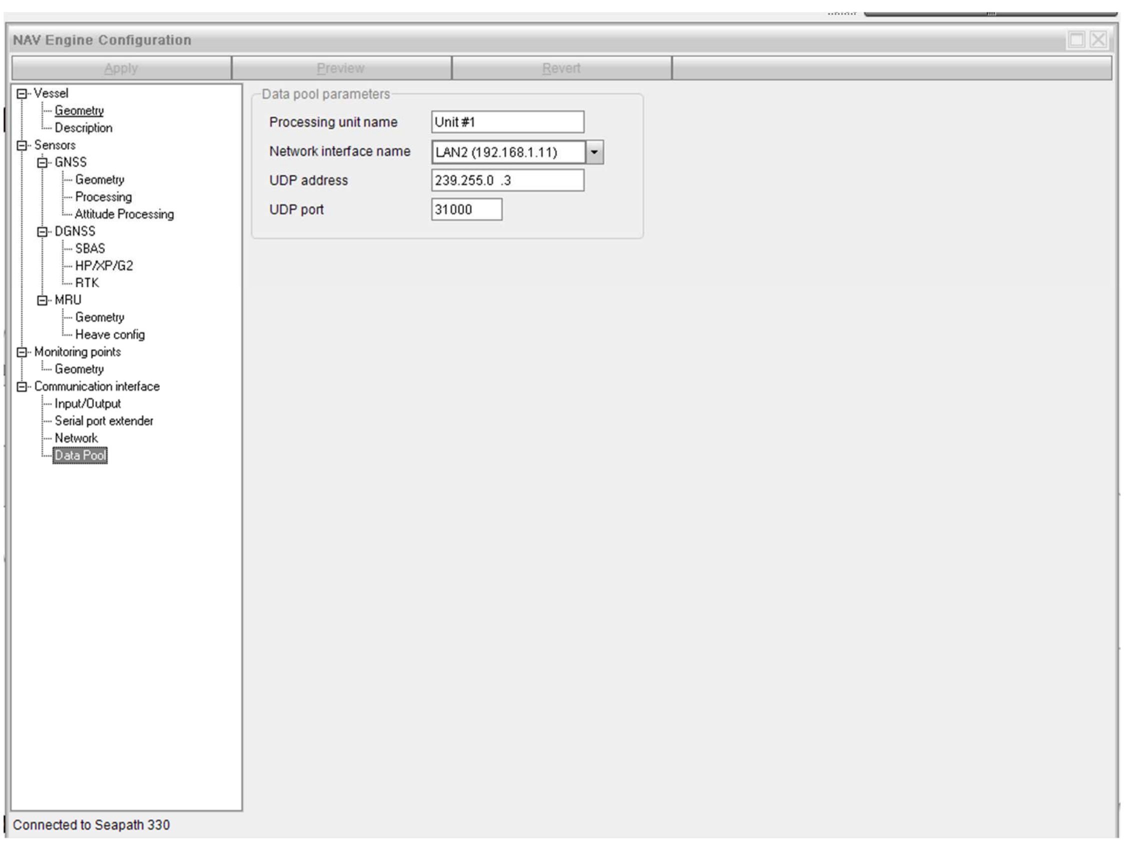





NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Input/Output list
Interface
Type
Direction
I/O Properties
Description
TelegramOut3 Ethernet Out UDP LAN3 3001 BROADCAST ATTITUDE VELOCITY TO EM2...
TelegramOut4 Serial Out COM2 9600 n 8 1 POSITION TO QINSY
TelegramOut5 Ethernet Out UDP LAN4 13001 BROADCAST ATTITUDE VELOCITY TO QINSY
TelegramOut6 Out NONE Telegram Out #6
TelegramOut7 Out NONE Telegram Out #7
Disabled | OK | Warning | Error
Configuration details
Interface
TelegramOut5
Description
ATTITUDE VELOCITY TO QINSY
Type
Ethernet
Cable ID
I/O properties
Broadcast
Unicast
Multicast
Local interface
LAN4 (192.168.3.10)
Remote port
13001
Telegram out properties
Format
Seapath binary 11
Datum
WGS84
Monitoring point
EM2040C
Options
Log to file
Telegram timing
Interval [s]
0.010
Event driven
Timer driven
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Address
192.168.1.150
Open configuration
Type
Disabled
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Interface settings
Interface
LAN2
DHCP
IP address
192.168.1 .11
Subnet mask
255.255.255.0
Gateway
Gateway interface
LAN2
Default gateway
Connected to Seapath 330


NAV Engine Configuration
Apply
Preview
Revert
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/XP/G2
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Network
Data Pool
Data pool parameters
Processing unit name
Unit #1
Network interface name
LAN2 (192.168.1.11)
UDP address
239.255.0 .3
UDP port
31000
Connected to Seapath 330

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

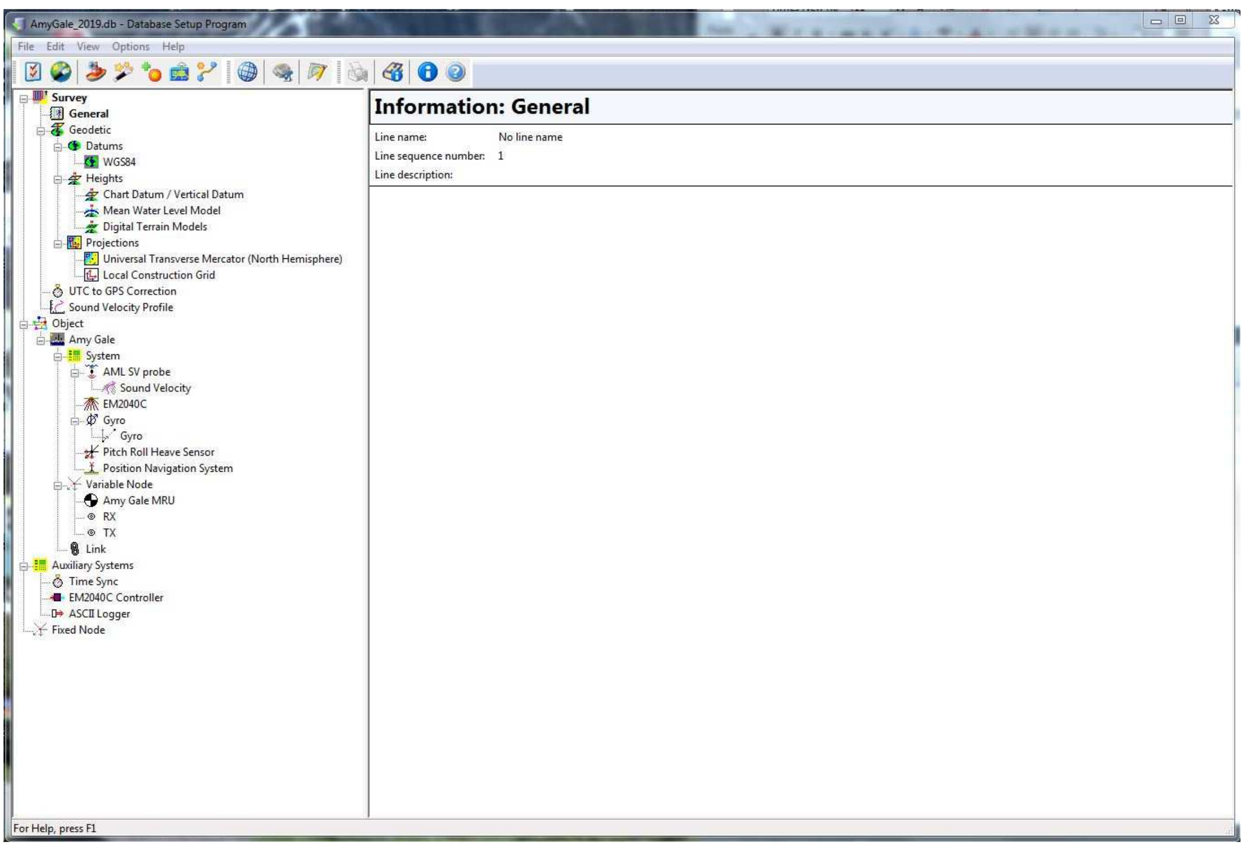
Note: Only the 2019 template database is shown in this appendix. The 2018 and 2019 template databases are identical with the exception of EM2040C calibration offsets (e.g. pitch, roll, and heading). These differences and their historical values across the two years' survey seasons are summarized in table 4 of report's main text.

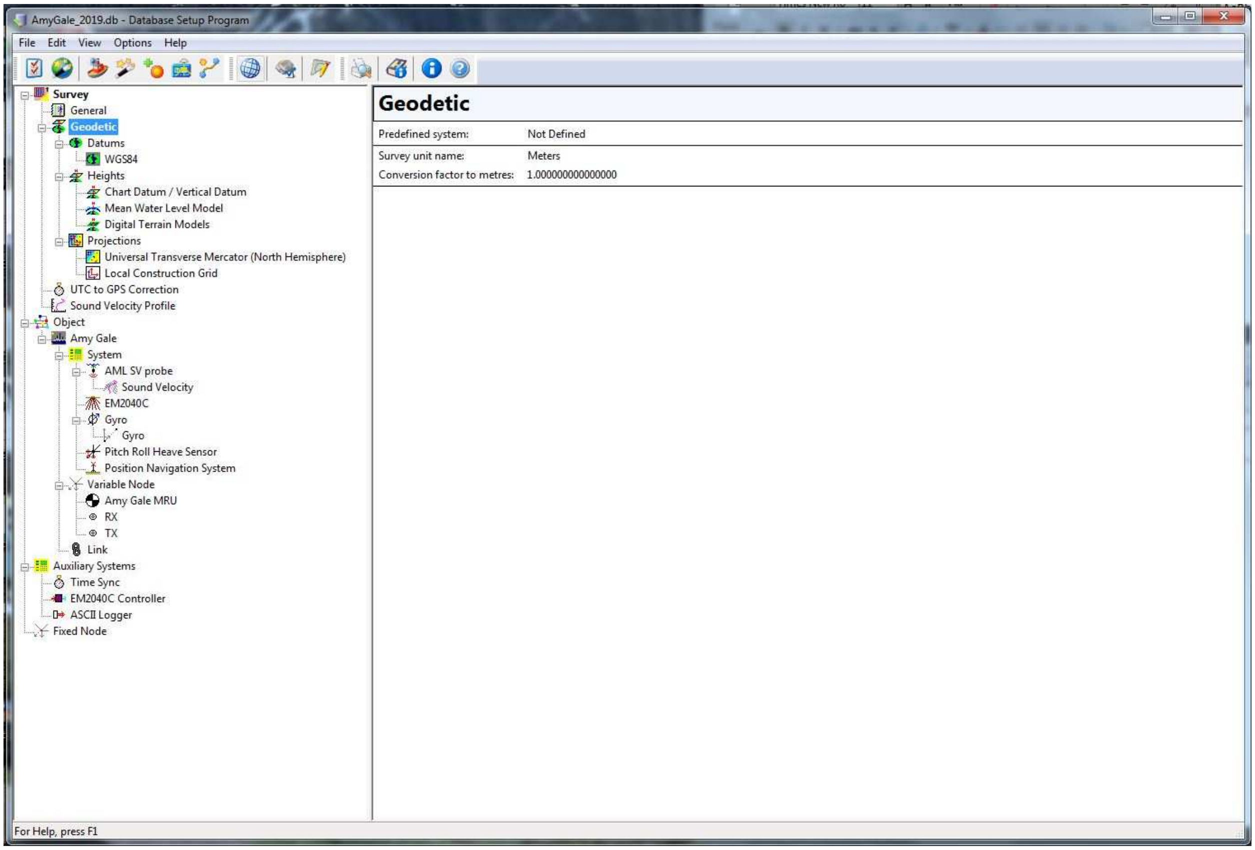
Template database name: AmyGale_2019.db

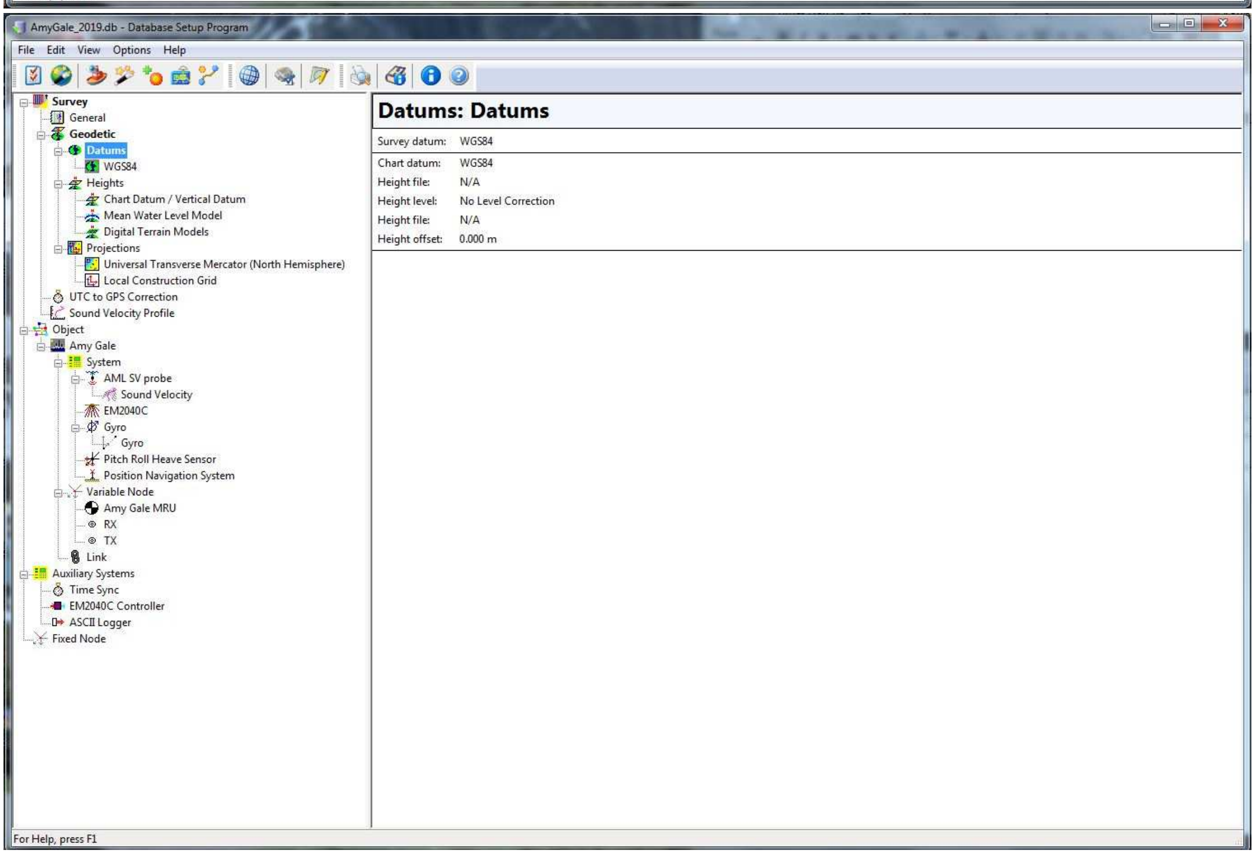
QINSy uses the following reference frame conventions (these differ from those used by Seapath 330):

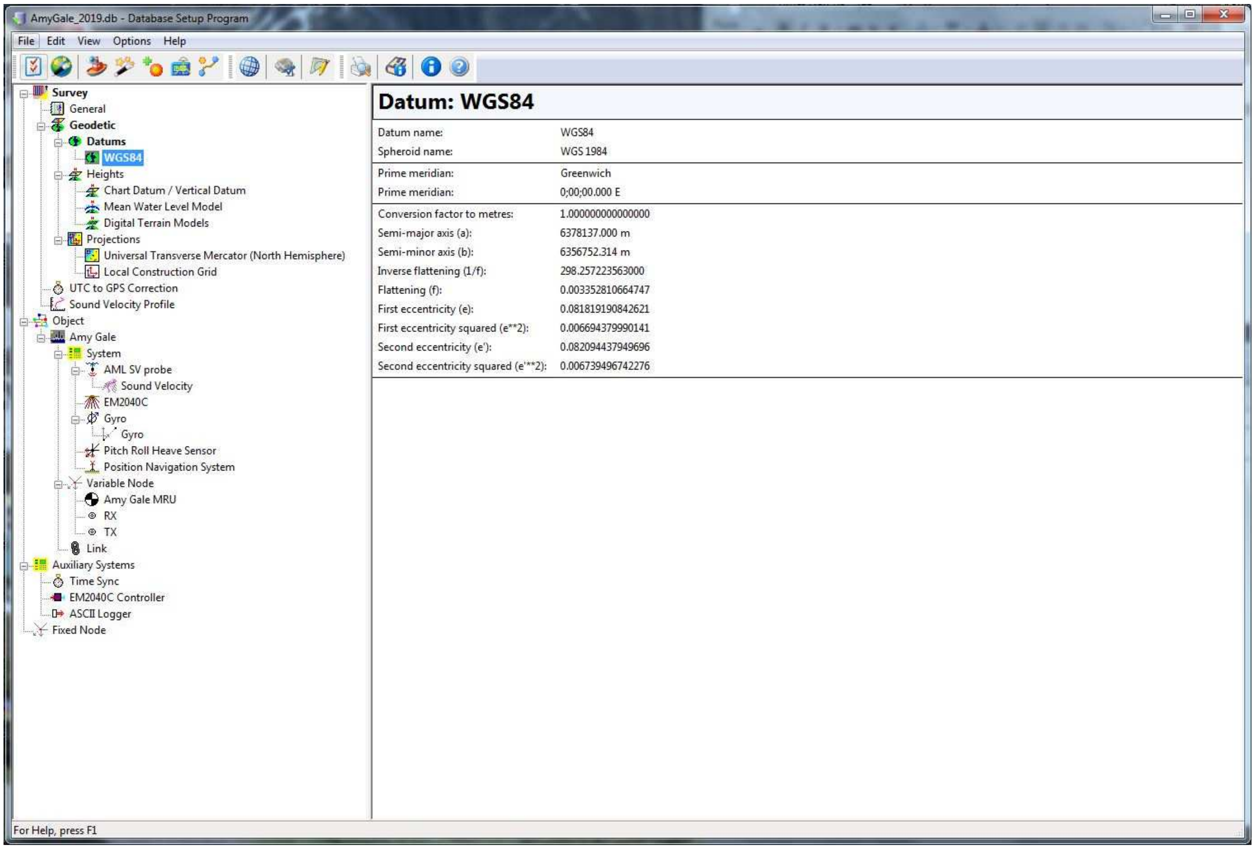
Pitch rotation: + bow up
Roll rotation: + heeling to starboard
Heave: + upwards

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




AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Geodetic
Predefined system: Not Defined
Survey unit name: Meters
Conversion factor to metres: 1.000000000000000
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Datums: Datums
Survey datum: WGS84
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
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Local Construction Grid
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Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
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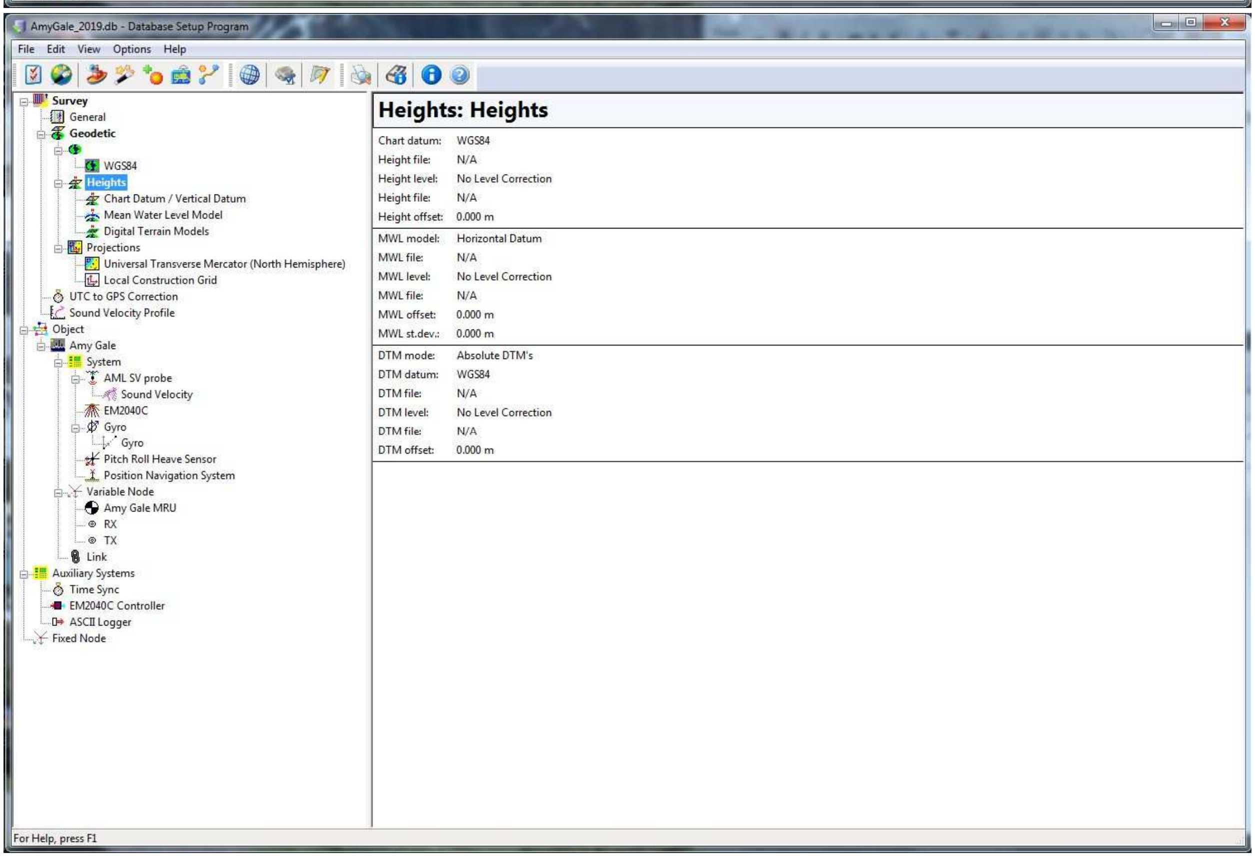
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Datum: WGS84
Datum name: WGS84
Spheroid name: WGS 1984
Prime meridian: Greenwich
Prime meridian: 0;00;00.000 E
Conversion factor to metres: 1.000000000000000
Semi-major axis (a): 6378137.000 m
Semi-minor axis (b): 6356752.314 m
Inverse flattening (1/f): 298.257223563000
Flattening (f): 0.003352810664747
First eccentricity (e): 0.081819190842621
First eccentricity squared (e**2): 0.006694379990141
Second eccentricity (e'): 0.082094437949696
Second eccentricity squared (e'**2): 0.006739496742276
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
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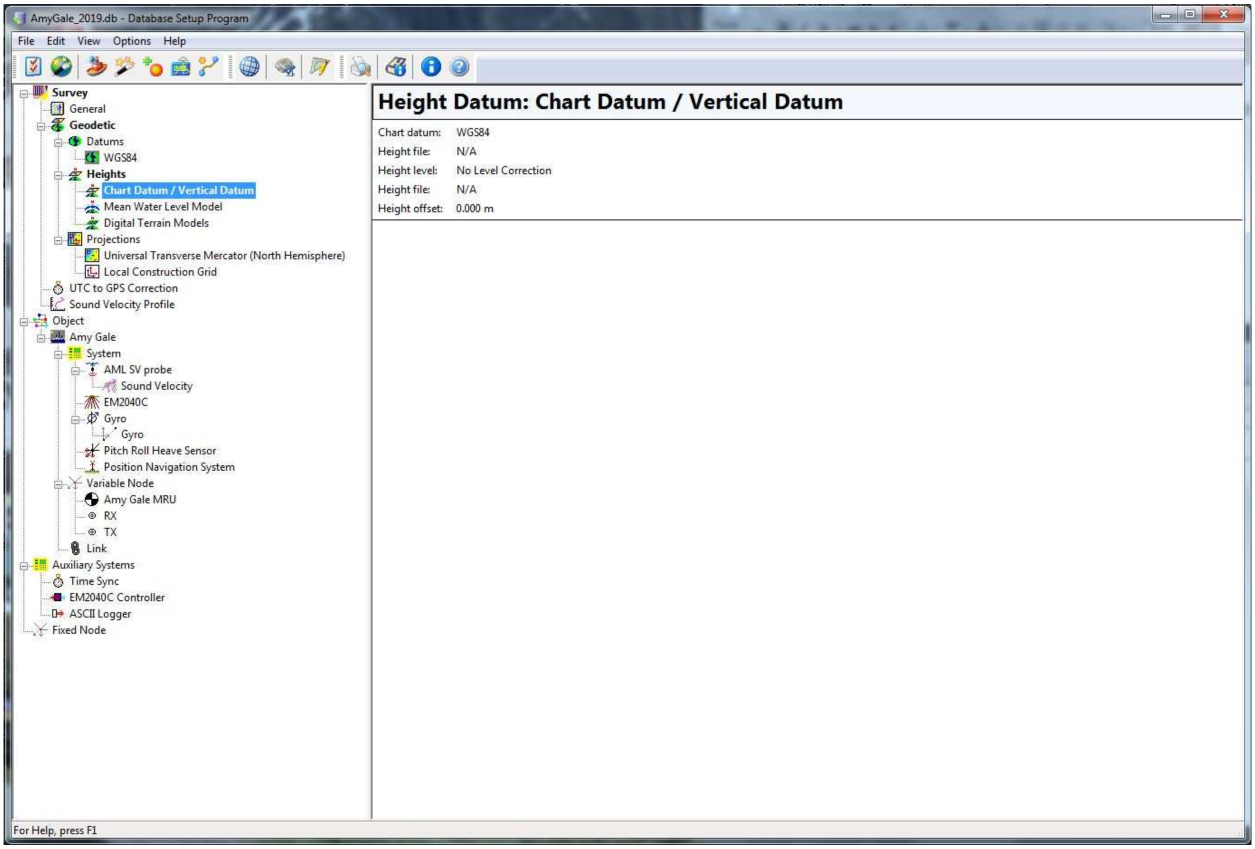
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Heights: Heights
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
MWL model: Horizontal Datum
MWL file: N/A
MWL level: No Level Correction
MWL file: N/A
MWL offset: 0.000 m
MWL st.dev.: 0.000 m
DTM mode: Absolute DTM's
DTM datum: WGS84
DTM file: N/A
DTM level: No Level Correction
DTM file: N/A
DTM offset: 0.000 m
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
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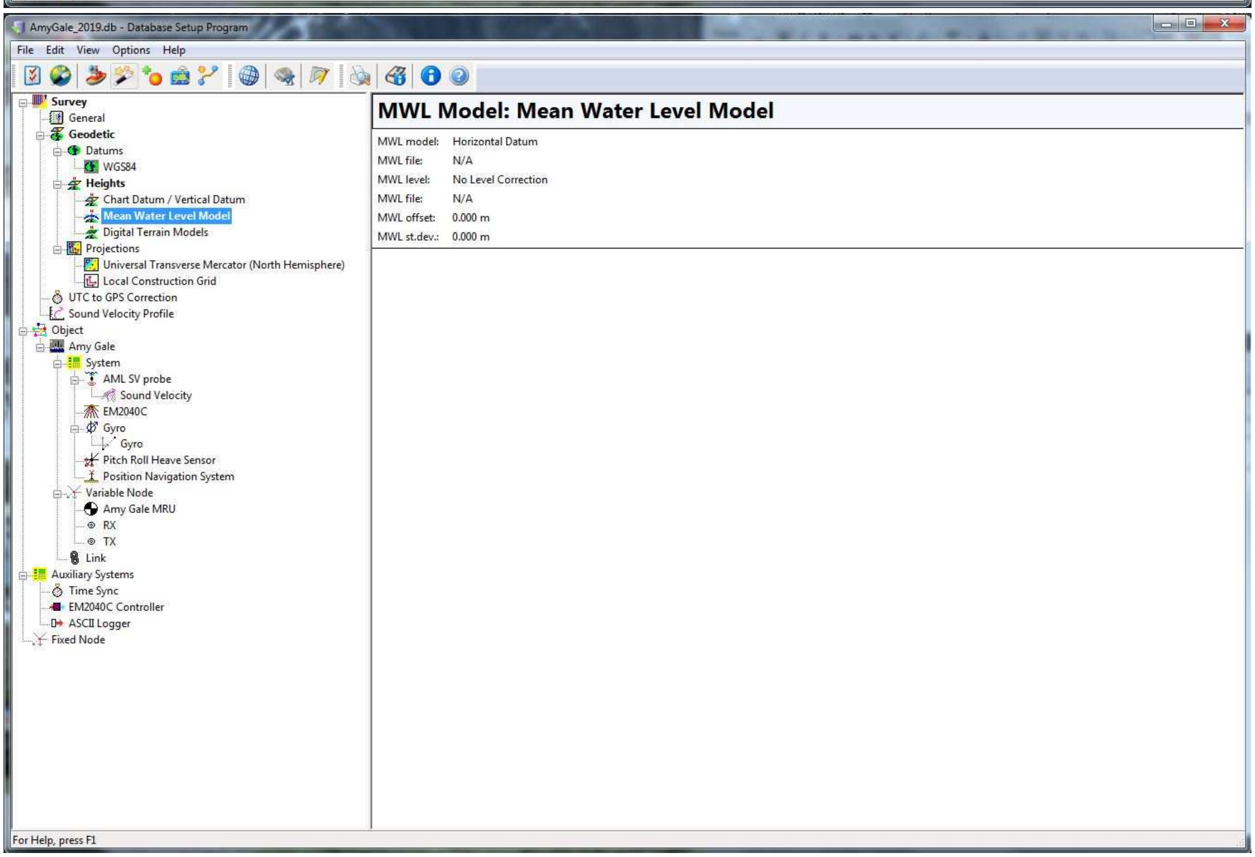
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Height Datum: Chart Datum / Vertical Datum
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
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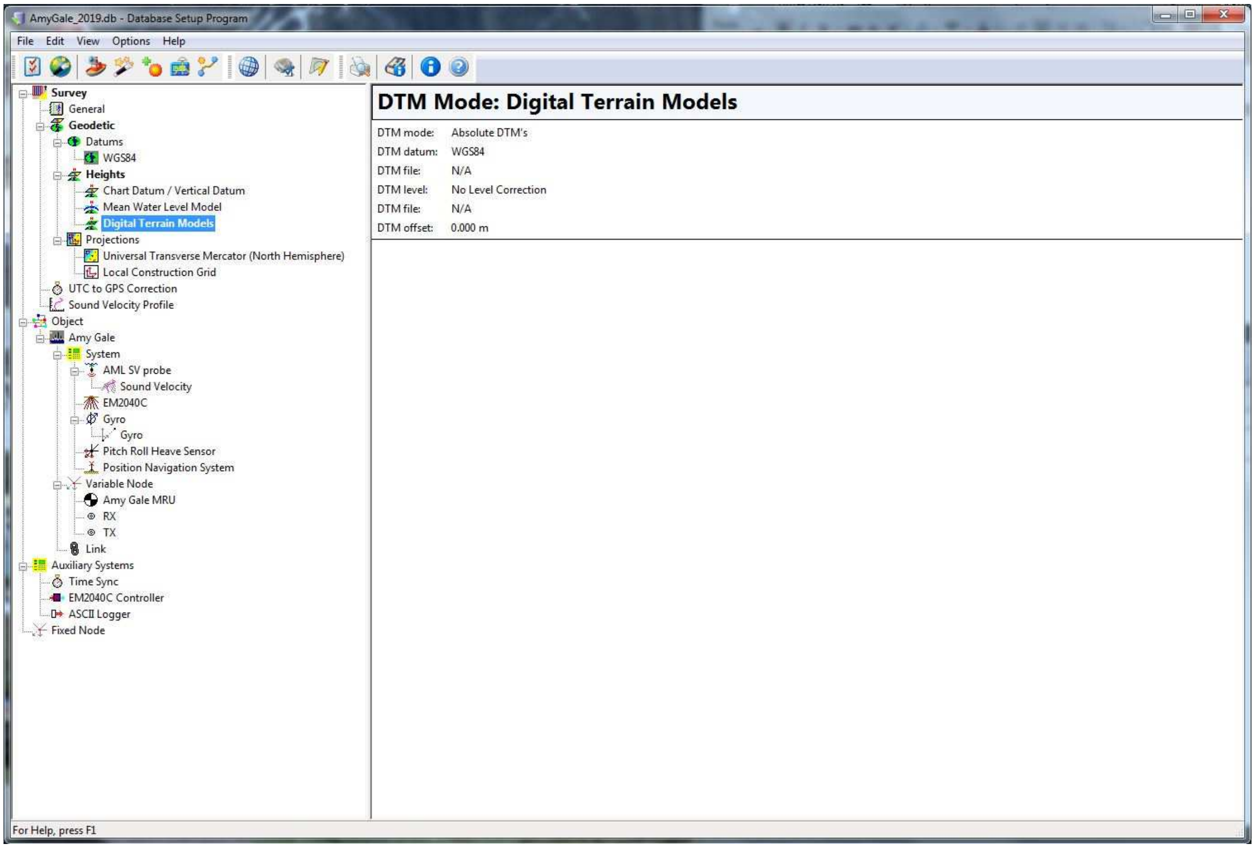
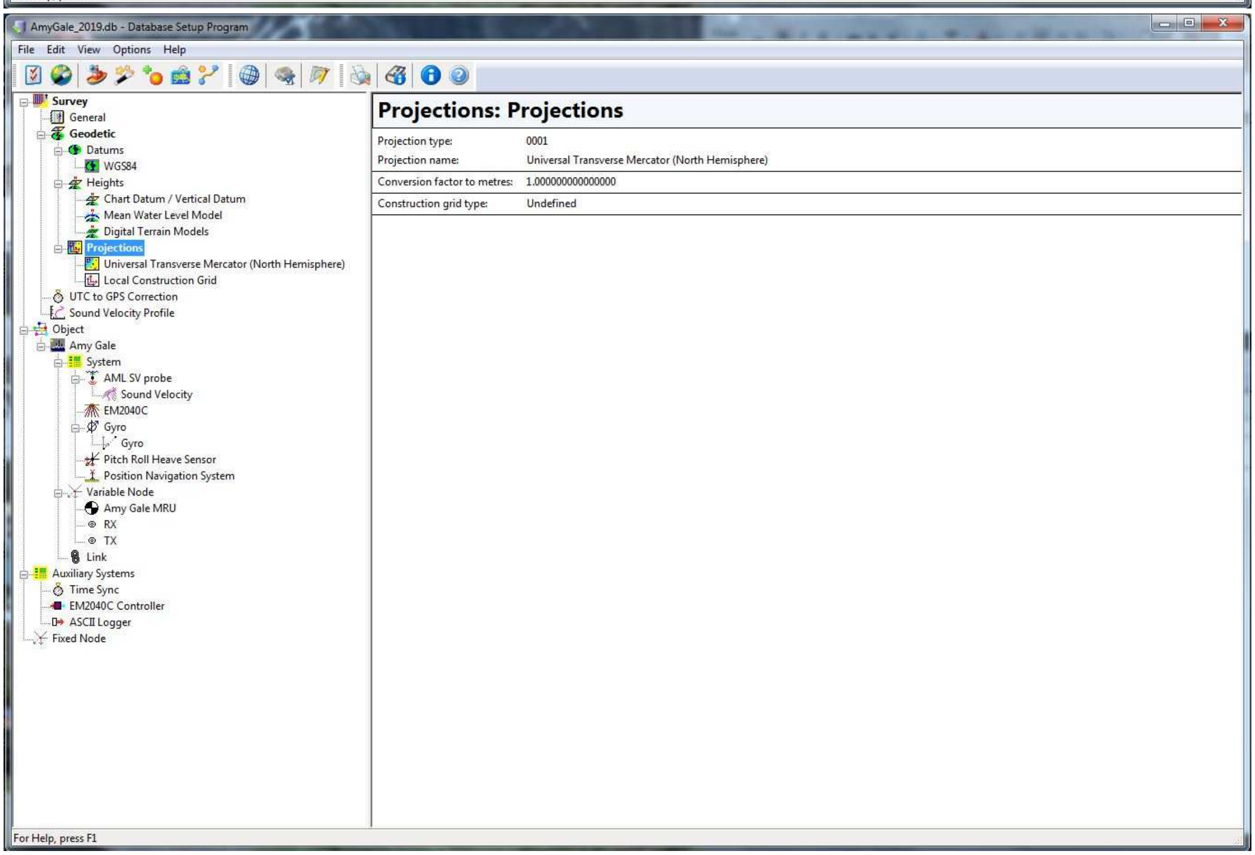
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
MWL Model: Mean Water Level Model
MWL model: Horizontal Datum
MWL file: N/A
MWL level: No Level Correction
MWL file: N/A
MWL offset: 0.000 m
MWL st.dev.: 0.000 m
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
DTM Mode: Digital Terrain Models
DTM mode: Absolute DTM's
DTM datum: WGS84
DTM file: N/A
DTM level: No Level Correction
DTM file: N/A
DTM offset: 0.000 m
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
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Universal Transverse Mercator (North Hemisphere)
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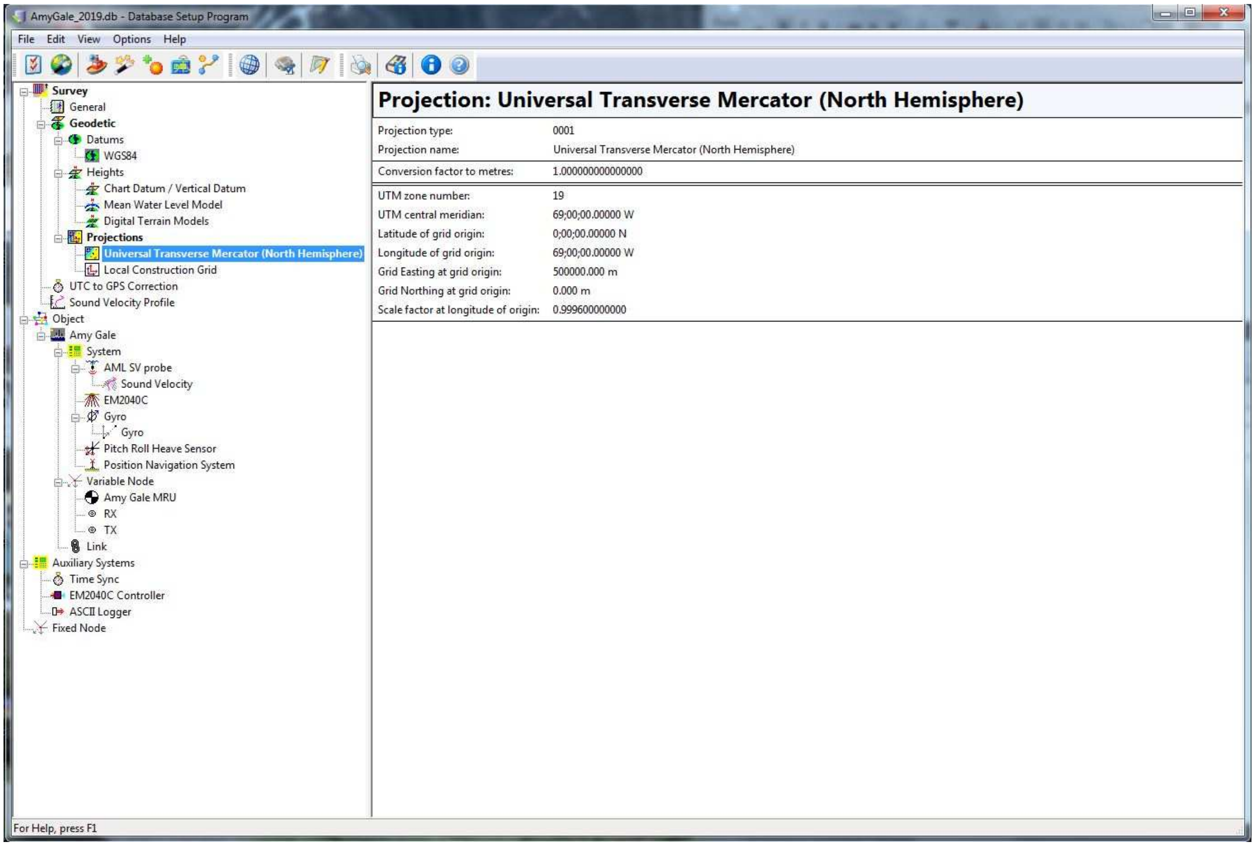
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Projections: Projections
Projection type: 0001
Projection name: Universal Transverse Mercator (North Hemisphere)
Conversion factor to metres: 1.000000000000000
Construction grid type: Undefined
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
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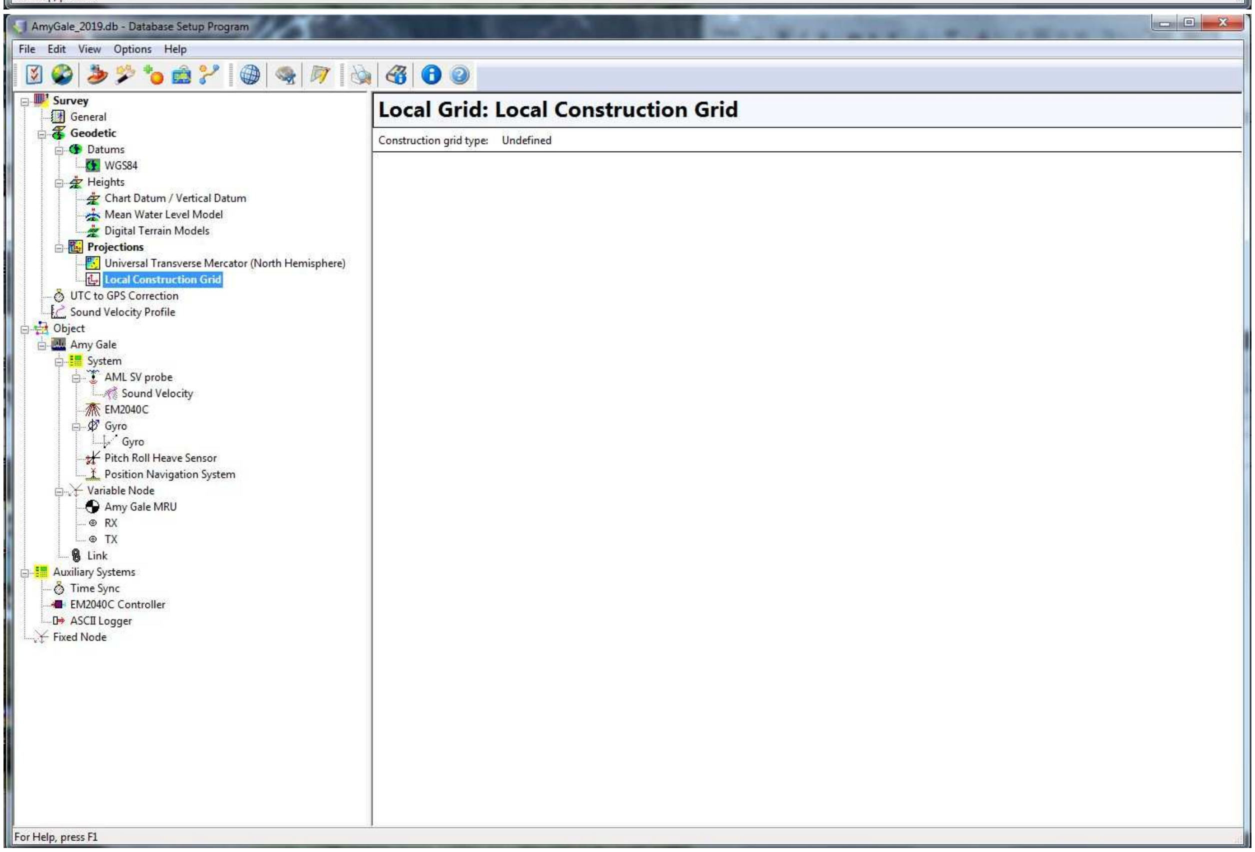
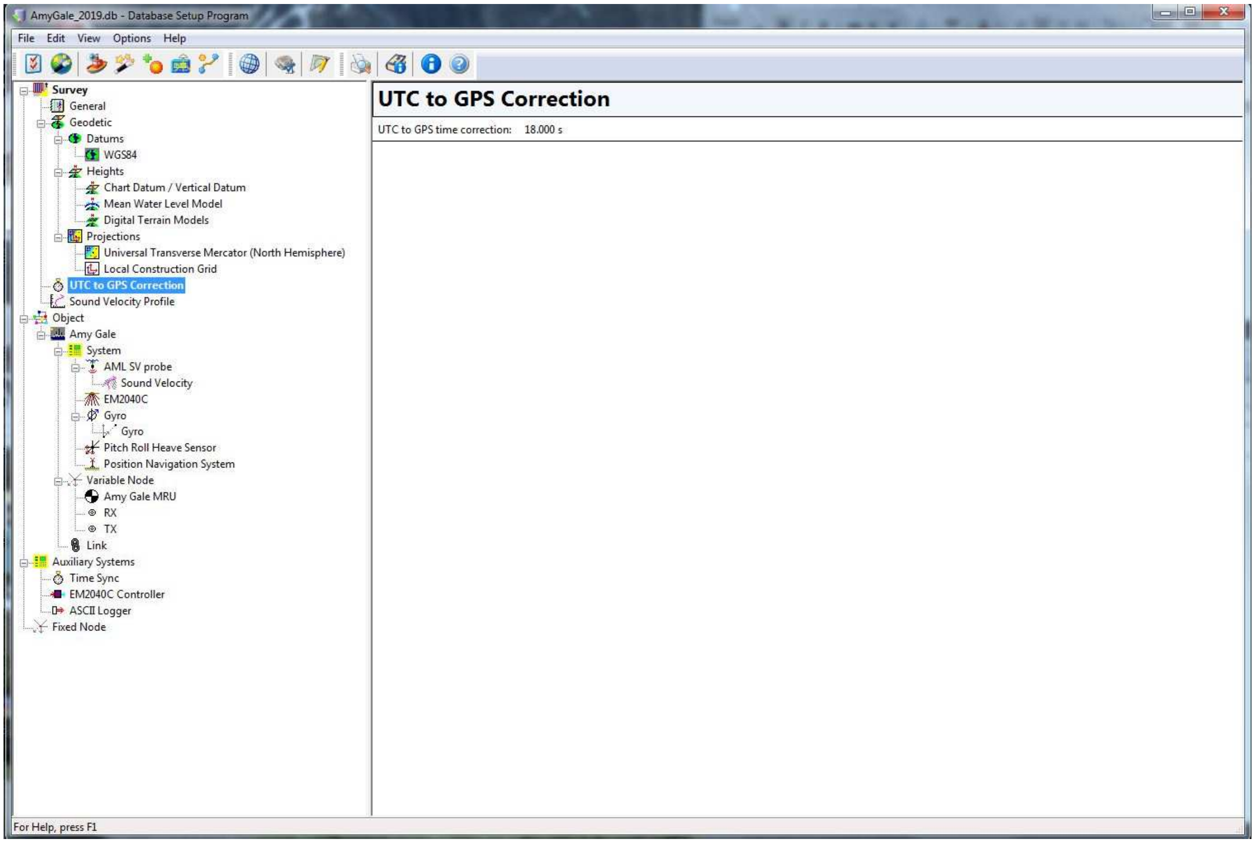
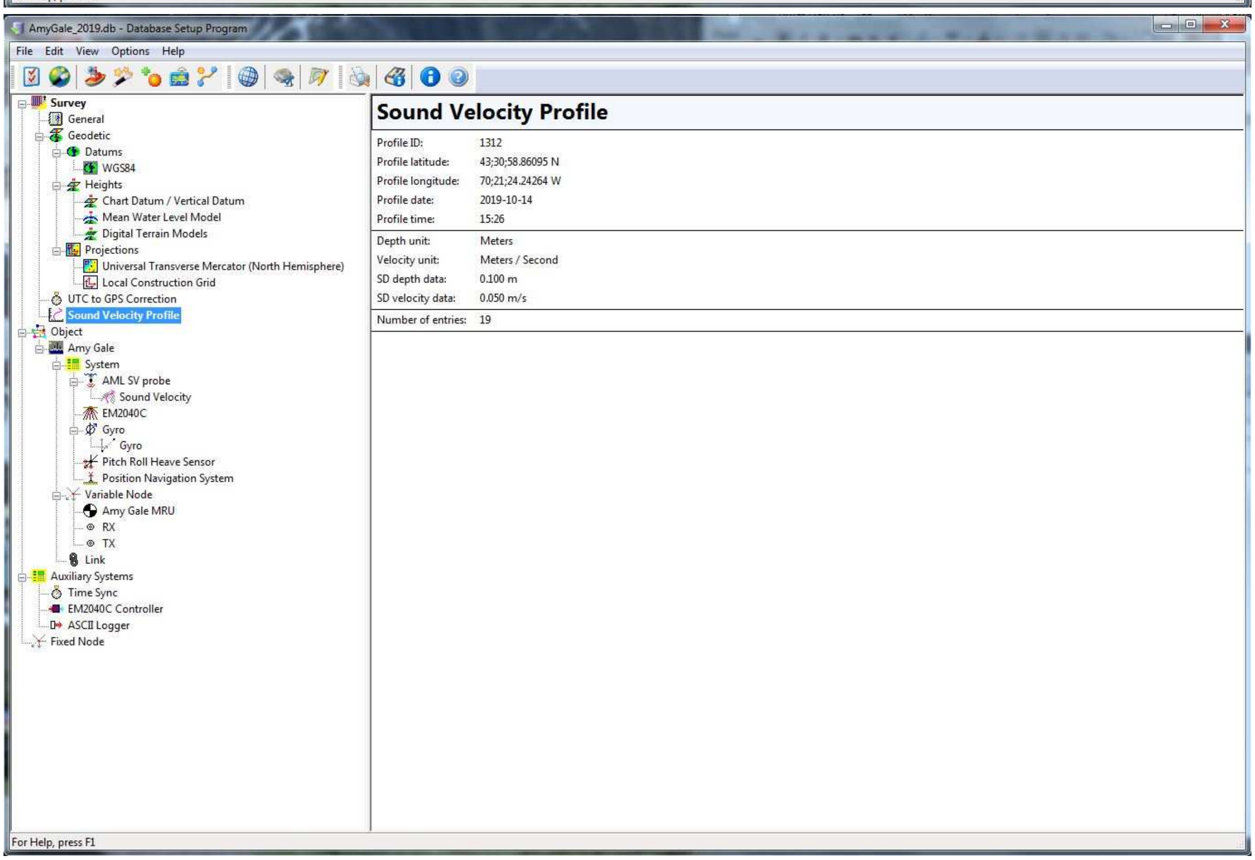
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Projection: Universal Transverse Mercator (North Hemisphere)
Projection type: 0001
Projection name: Universal Transverse Mercator (North Hemisphere)
Conversion factor to metres: 1.000000000000000
UTM zone number: 19
UTM central meridian: 69;00;00.00000 W
Latitude of grid origin: 0;00;00.00000 N
Longitude of grid origin: 69;00;00.00000 W
Grid Easting at grid origin: 500000.000 m
Grid Northing at grid origin: 0.000 m
Scale factor at longitude of origin: 0.999600000000
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Local Grid: Local Construction Grid
Construction grid type: Undefined
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
UTC to GPS Correction
UTC to GPS time correction: 18.000 s
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
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Object
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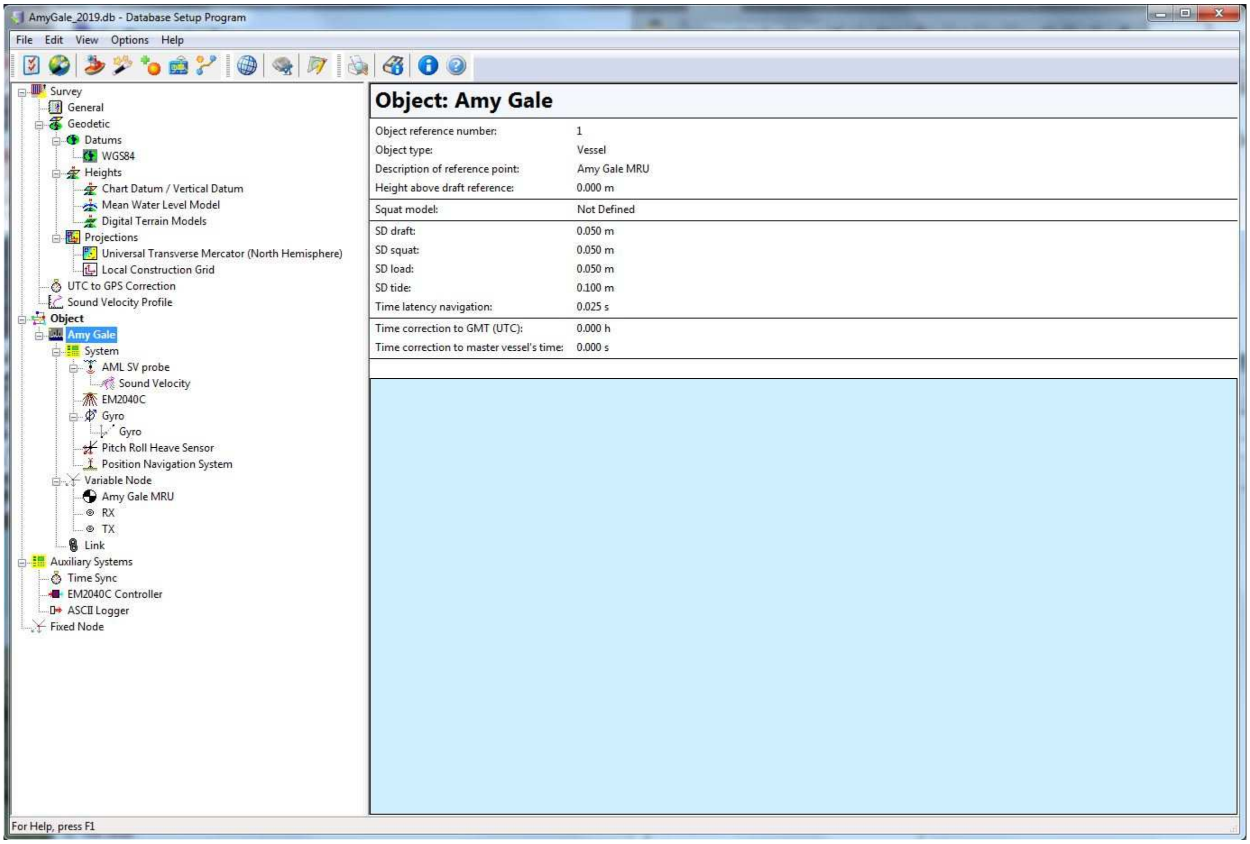
System
AML SV probe
Sound Velocity
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Sound Velocity Profile
Profile ID: 1312
Profile latitude: 43;30;58.86095 N
Profile longitude: 70;21;24.24264 W
Profile date: 2019-10-14
Profile time: 15:26
Depth unit: Meters
Velocity unit: Meters / Second
SD depth data: 0.100 m
SD velocity data: 0.050 m/s
Number of entries: 19
For Help, press F1


AmyGale_2019.db - Database Setup Program
File Edit View Options Help
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Variable Node
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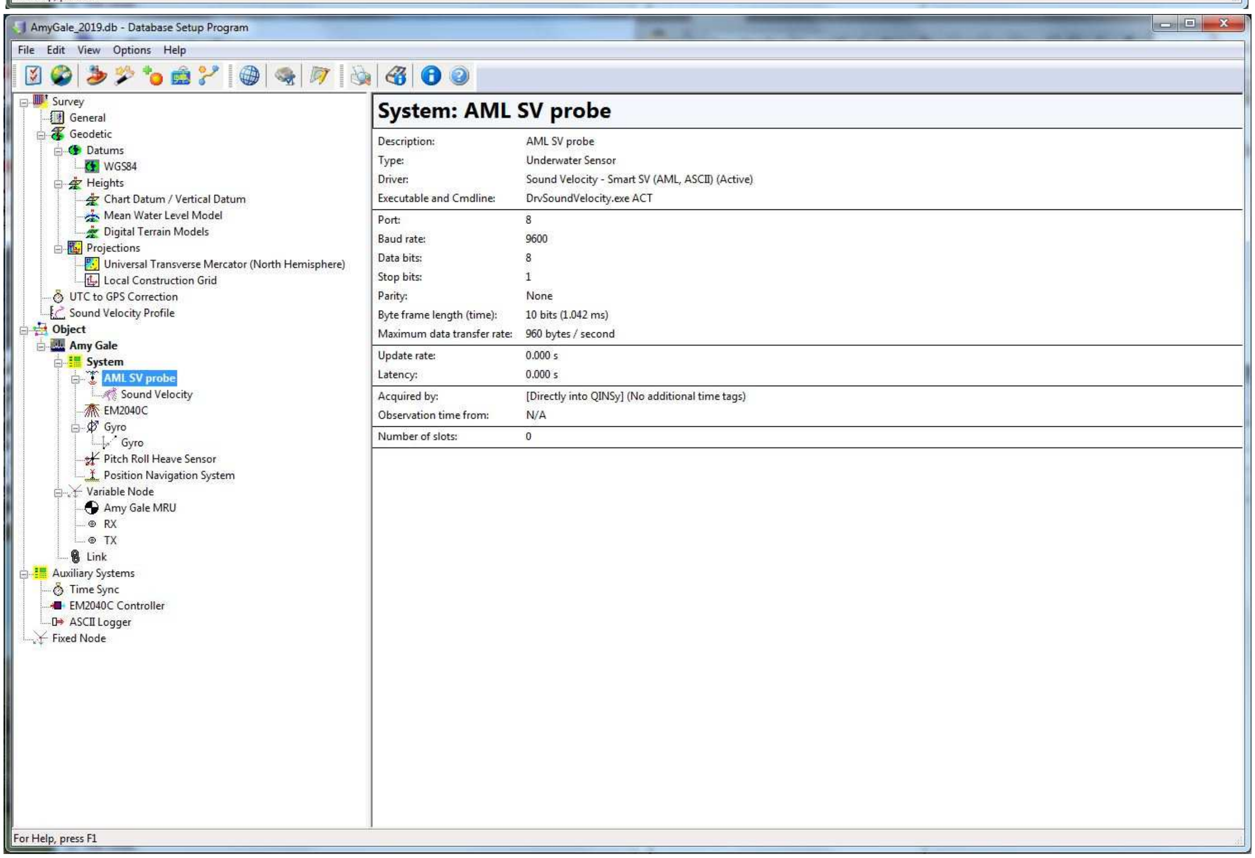
EM2040C Controller
ASCII Logger
Fixed Node
Object: Amy Gale
Object reference number: 1
Object type: Vessel
Description of reference point: Amy Gale MRU
Height above draft reference: 0.000 m
Squat model: Not Defined
SD draft: 0.050 m
SD squat: 0.050 m
SD load: 0.050 m
SD tide: 0.100 m
Time latency navigation: 0.025 s
Time correction to GMT (UTC): 0.000 h
Time correction to master vessel's time: 0.000 s
For Help, press F1


AmyGale_2019.db - Database Setup Program
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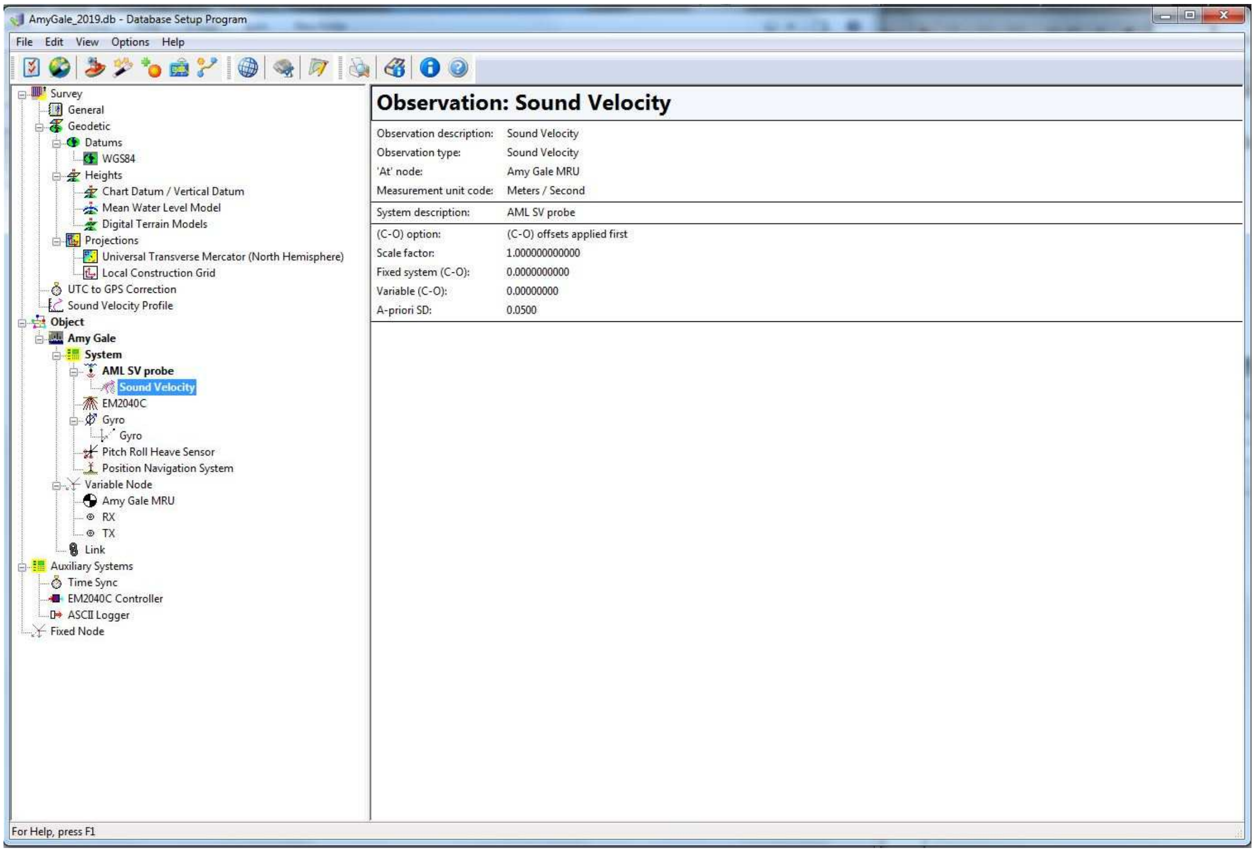
EM2040C Controller
ASCII Logger
Fixed Node
System: AML SV probe
Description: AML SV probe
Type: Underwater Sensor
Driver: Sound Velocity - Smart SV (AML, ASCII) (Active)
Executable and Cmdline: DrvSoundVelocity.exe ACT
Port: 8
Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: None
Byte frame length (time): 10 bits (1.042 ms)
Maximum data transfer rate: 960 bytes / second
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
For Help, press F1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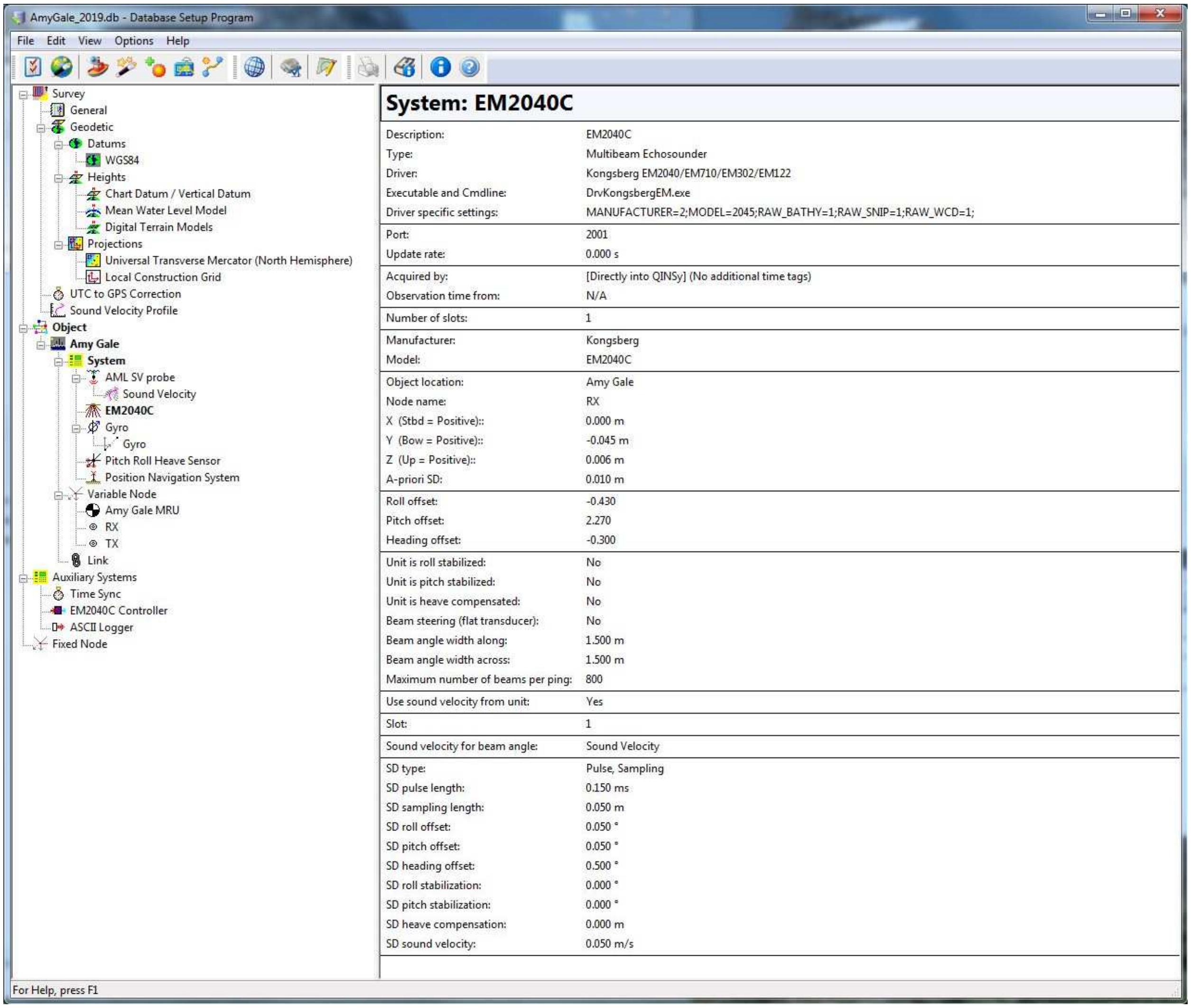
Fixed Node
Observation: Sound Velocity
Observation description: Sound Velocity
Observation type: Sound Velocity
'At' node: Amy Gale MRU
Measurement unit code: Meters / Second
System description: AML SV probe
(C-O) option: (C-O) offsets applied first
Scale factor: 1.000000000000
Fixed system (C-O): 0.0000000000
Variable (C-O): 0.00000000
A-priori SD: 0.0500
For Help, press F1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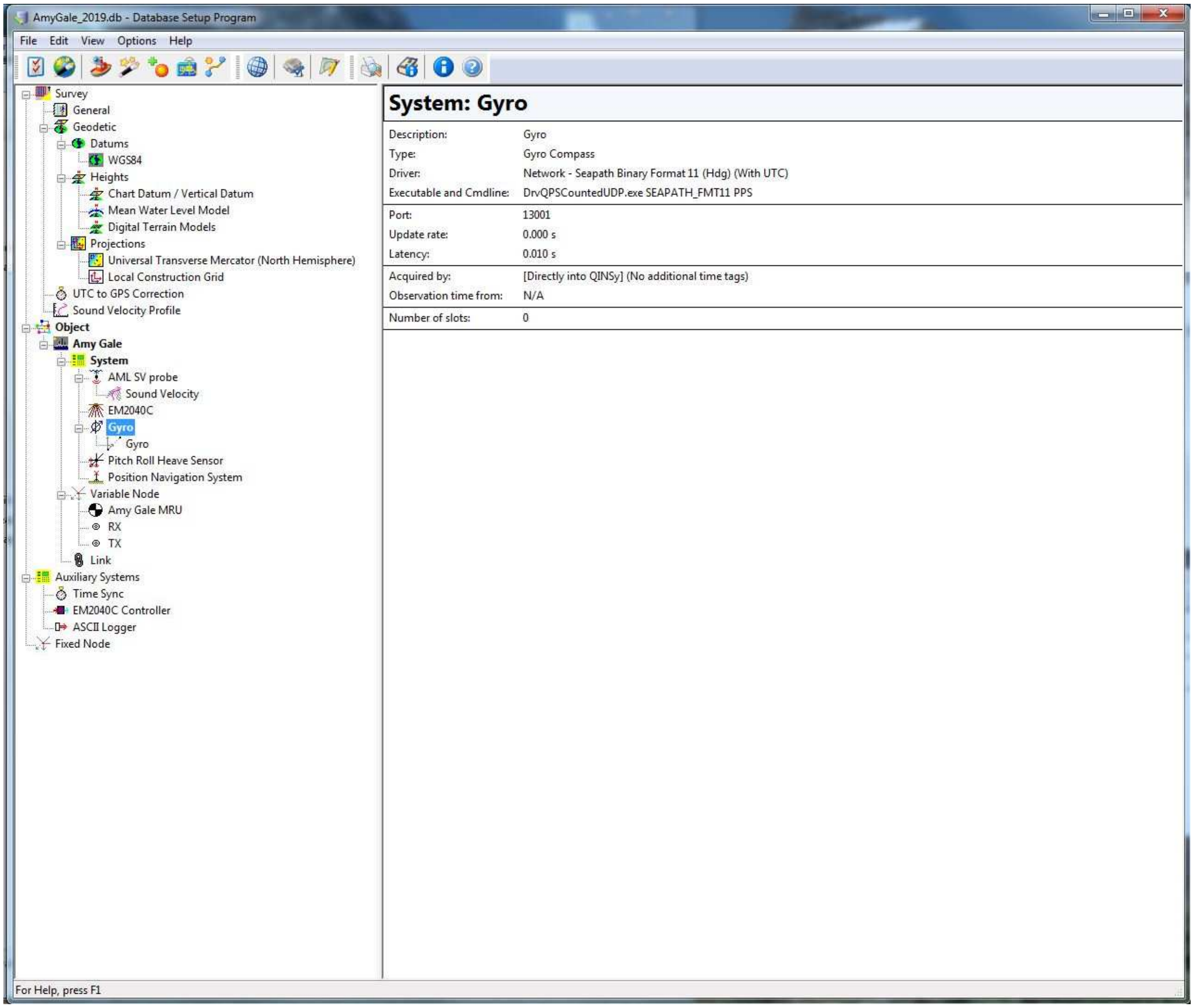
EM2040C Controller
ASCII Logger
Fixed Node
System: EM2040C
Description: EM2040C
Type: Multibeam Echosounder
Driver: Kongsberg EM2040/EM710/EM302/EM122
Executable and Cmdline: DrvKongsbergEM.exe
Driver specific settings: MANUFACTURER=2;MODEL=2045;RAW_BATHY=1;RAW_SNIP=1;RAW_WCD=1;
Port: 2001
Update rate: 0.000 s
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 1
Manufacturer: Kongsberg
Model: EM2040C
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: -0.045 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Roll offset: -0.430
Pitch offset: 2.270
Heading offset: -0.300
Unit is roll stabilized: No
Unit is pitch stabilized: No
Unit is heave compensated: No
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
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
For Help, press F1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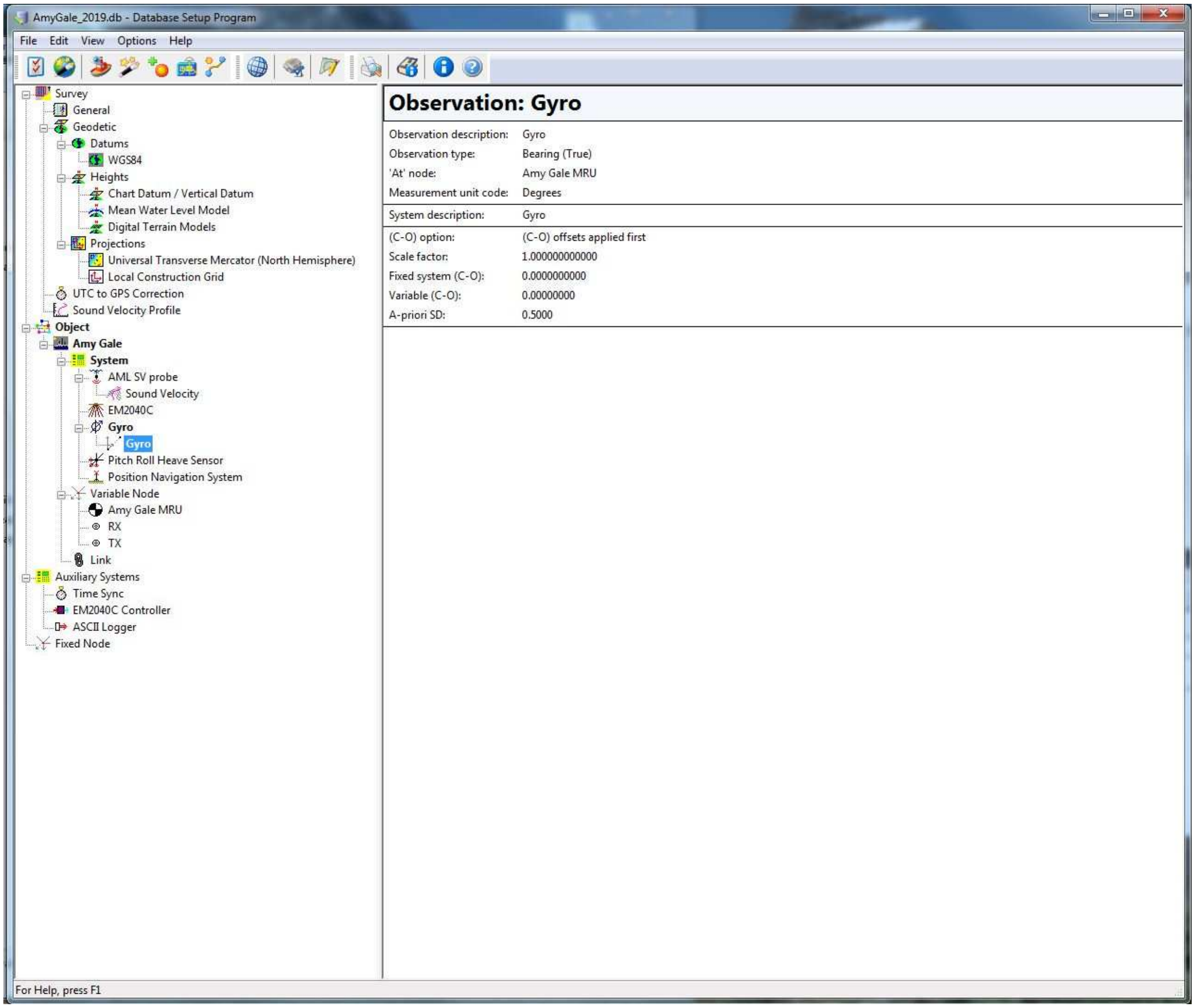
ASCII Logger
Fixed Node
System: Gyro
Description: Gyro
Type: Gyro Compass
Driver: Network - Seapath Binary Format 11 (Hdg) (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.010 s
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
For Help, press F1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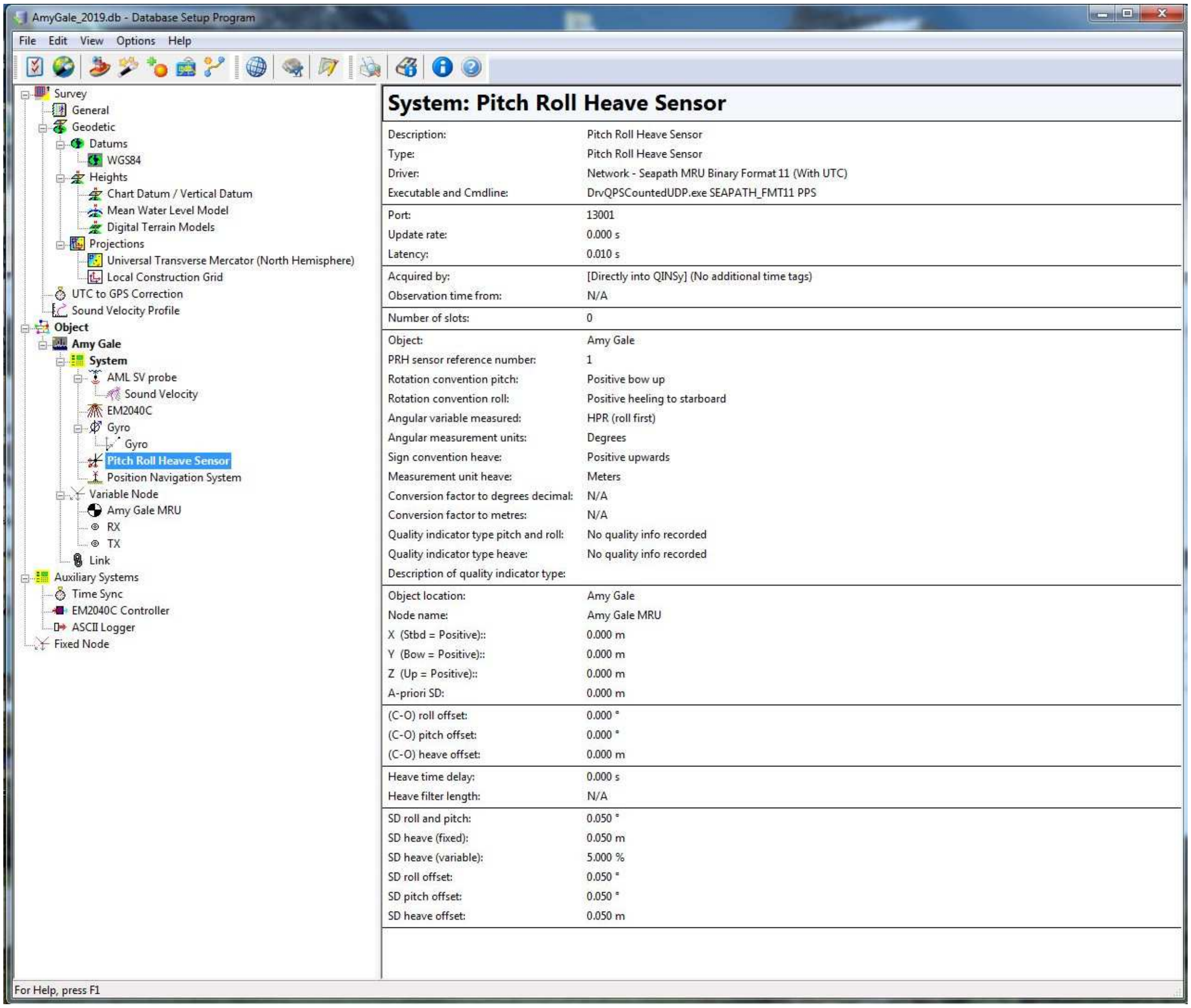
Fixed Node
Observation: Gyro
Observation description: Gyro
Observation type: Bearing (True)
'At' node: Amy Gale MRU
Measurement unit code: Degrees
System description: Gyro
(C-O) option: (C-O) offsets applied first
Scale factor: 1.000000000000
Fixed system (C-O): 0.0000000000
Variable (C-O): 0.00000000
A-priori SD: 0.5000
For Help, press F1


AmyGale_2019.db - Database Setup Program
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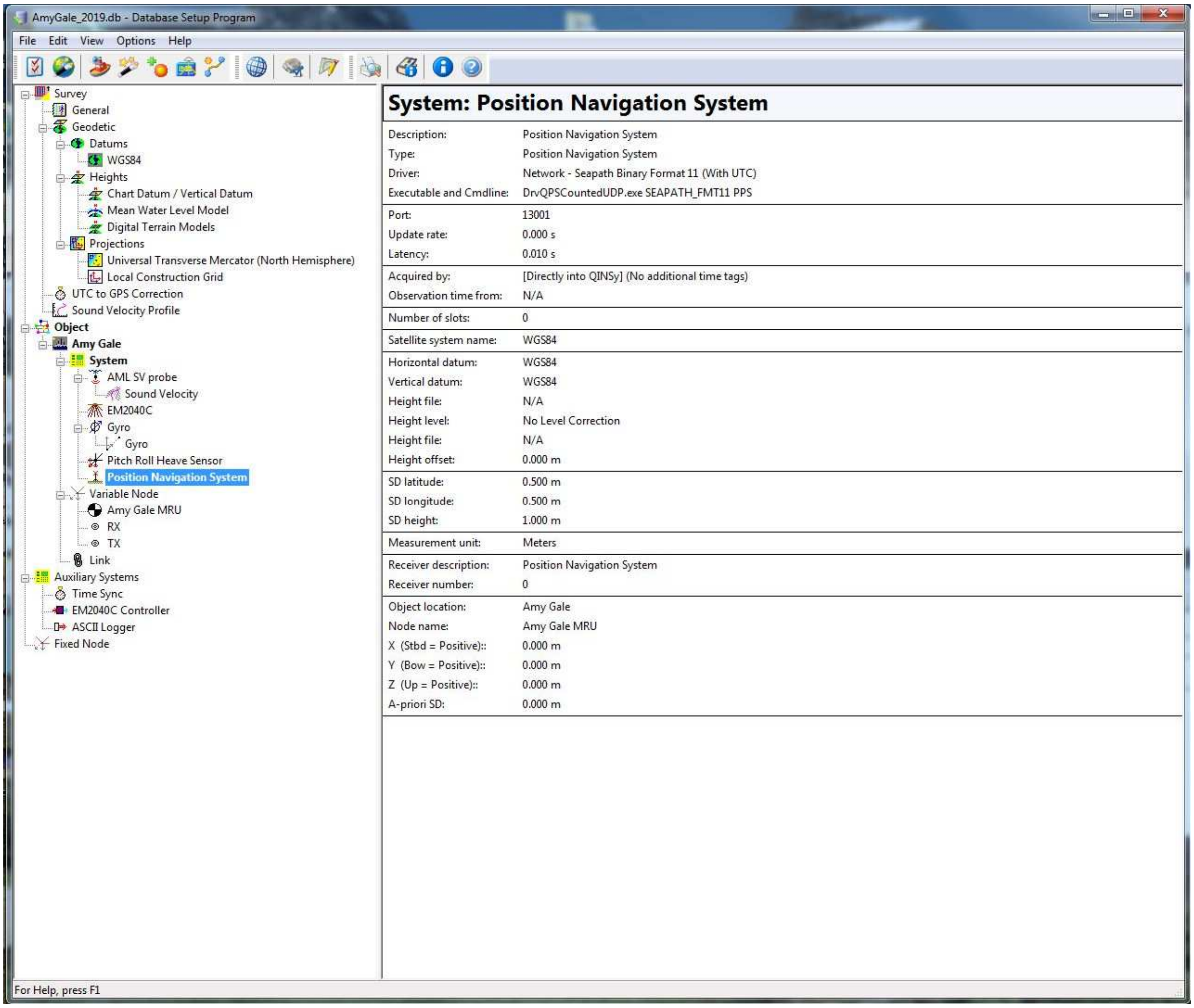
Fixed Node
System: Pitch Roll Heave Sensor
Description: Pitch Roll Heave Sensor
Type: Pitch Roll Heave Sensor
Driver: Network - Seapath MRU Binary Format 11 (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.010 s
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Object: Amy Gale
PRH sensor reference number: 1
Rotation convention pitch: Positive bow up
Rotation convention roll: Positive heeling to starboard
Angular variable measured: HPR (roll first)
Angular measurement units: Degrees
Sign convention heave: Positive upwards
Measurement unit heave: Meters
Conversion factor to degrees decimal: N/A
Conversion factor to metres: N/A
Quality indicator type pitch and roll: No quality info recorded
Quality indicator type heave: No quality info recorded
Description of quality indicator type:
Object location: Amy Gale
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
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
For Help, press F1



AmyGale_2019.db - Database Setup Program
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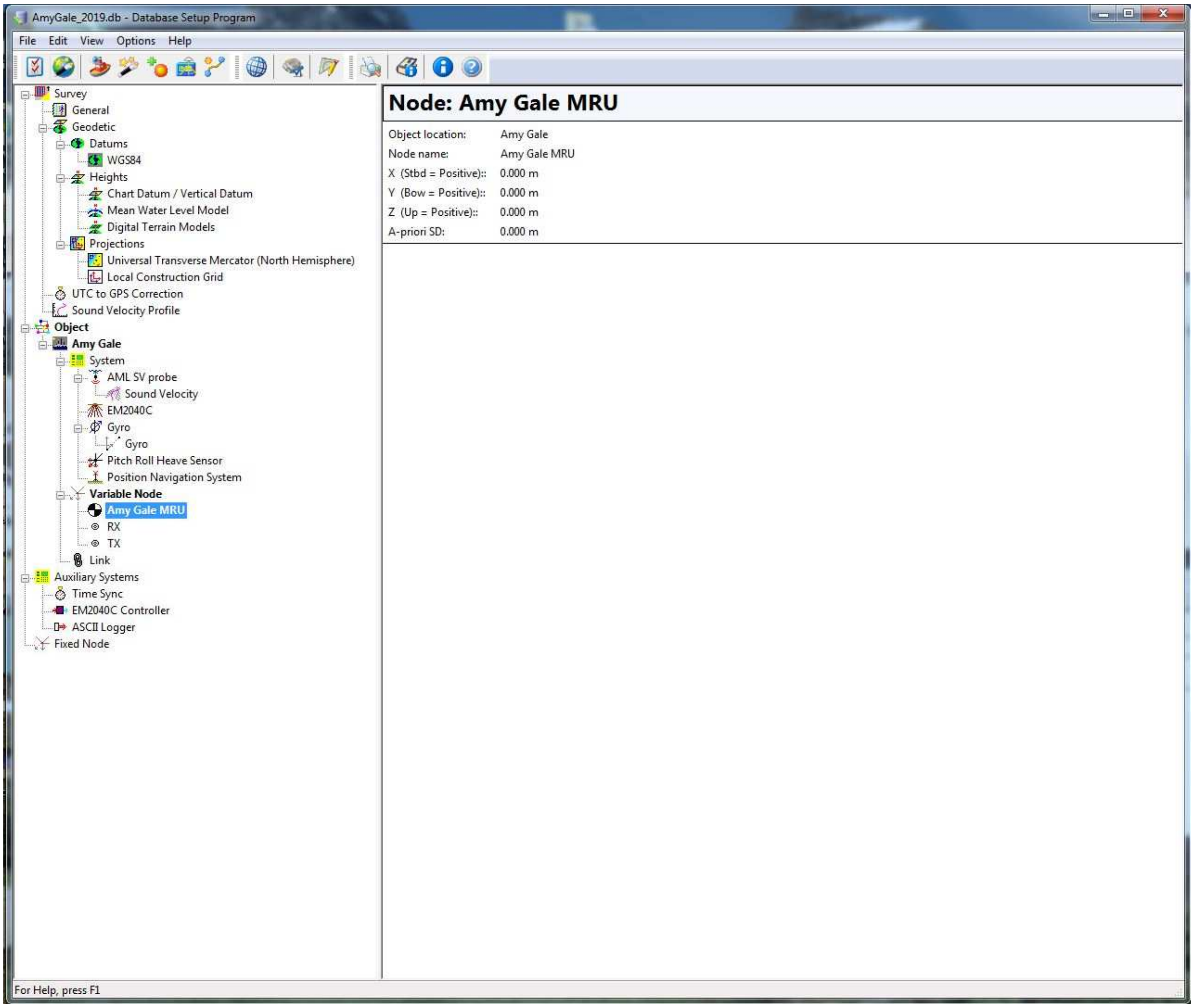
ASCII Logger
Fixed Node
System: Position Navigation System
Description: Position Navigation System
Type: Position Navigation System
Driver: Network - Seapath Binary Format 11 (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.010 s
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Satellite system name: WGS84
Horizontal datum: WGS84
Vertical datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
SD latitude: 0.500 m
SD longitude: 0.500 m
SD height: 1.000 m
Measurement unit: Meters
Receiver description: Position Navigation System
Receiver number: 0
Object location: Amy Gale
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
For Help, press F1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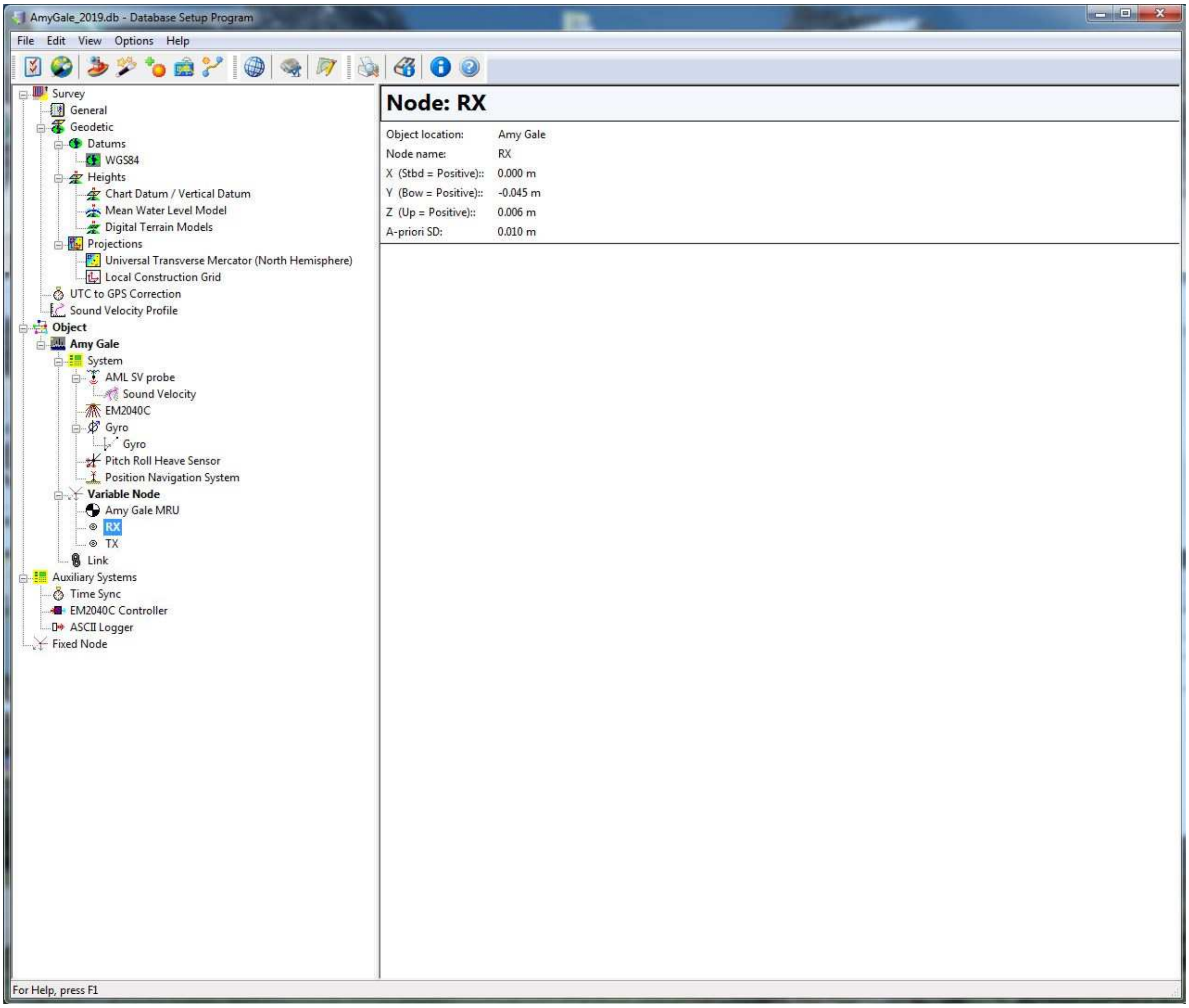
ASCII Logger
Fixed Node
Node: Amy Gale MRU
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
For Help, press F1



AmyGale_2019.db - Database Setup Program
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Amy Gale MRU
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TX
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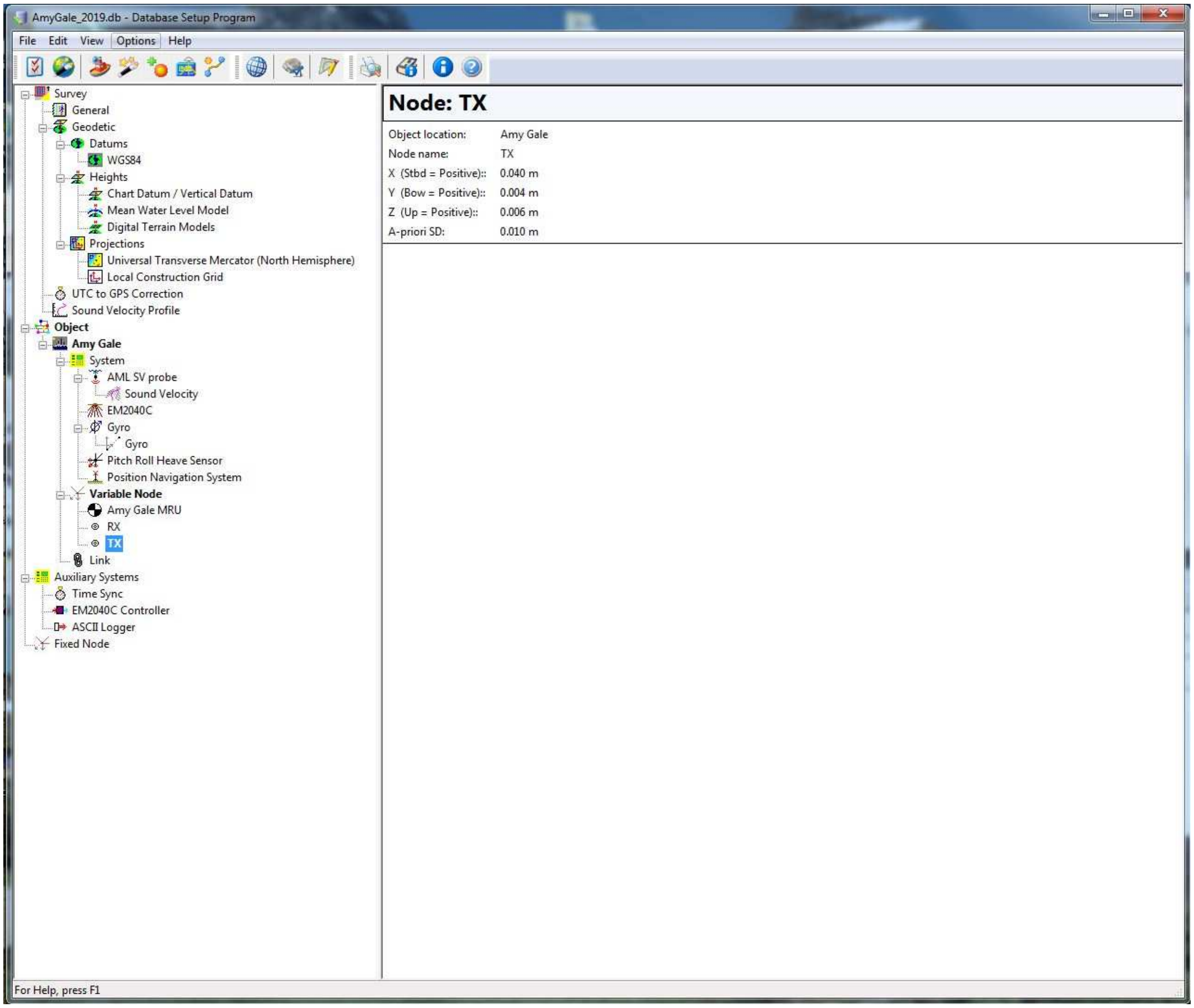
ASCII Logger
Fixed Node
Node: RX
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: -0.045 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
For Help, press F1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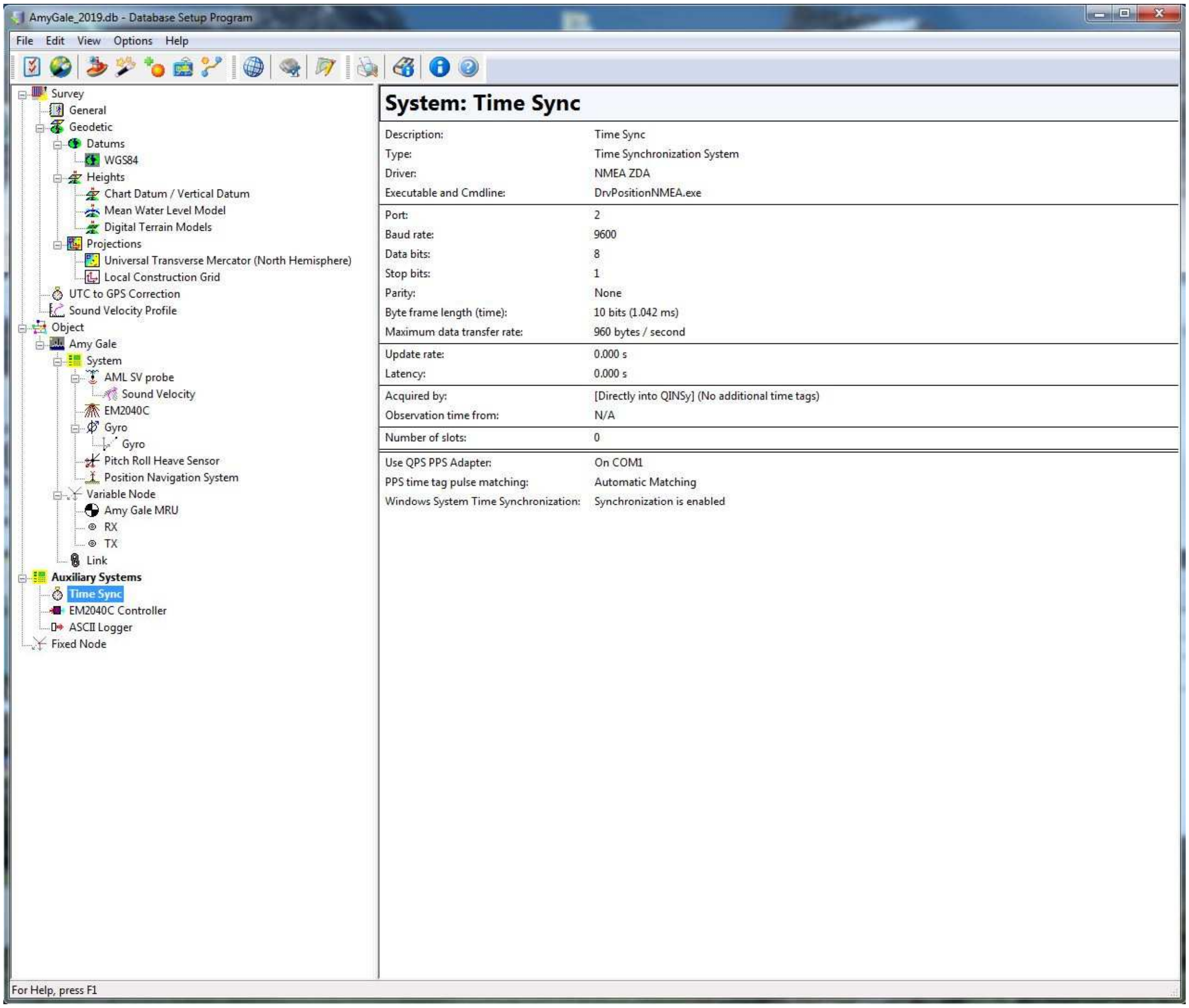
ASCII Logger
Fixed Node
Node: TX
Object location: Amy Gale
Node name: TX
X (Stbd = Positive):: 0.040 m
Y (Bow = Positive):: 0.004 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
For Help, press F1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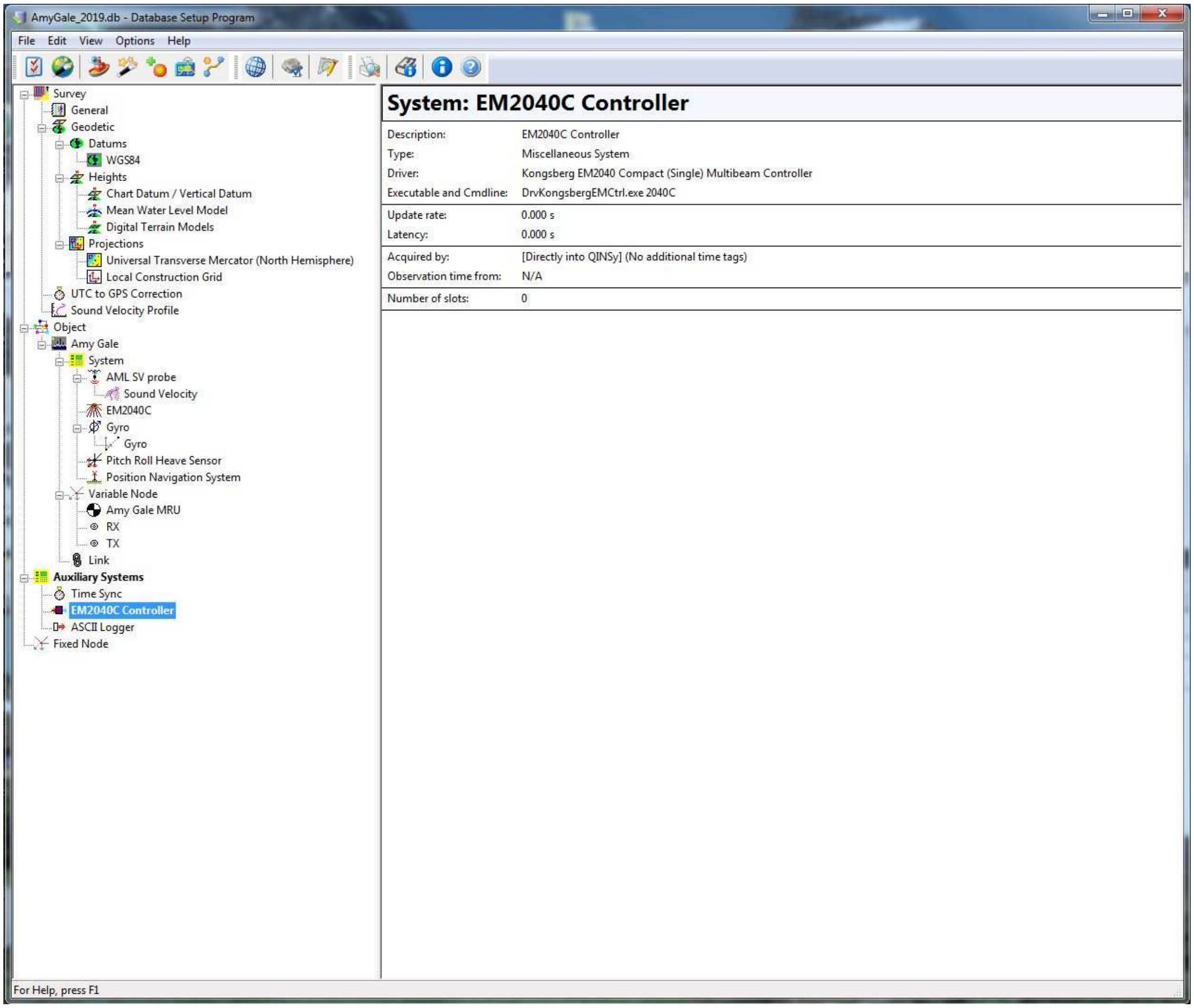
Fixed Node
System: Time Sync
Description: Time Sync
Type: Time Synchronization System
Driver: NMEA ZDA
Executable and Cmdline: DrvPositionNMEA.exe
Port: 2
Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: None
Byte frame length (time): 10 bits (1.042 ms)
Maximum data transfer rate: 960 bytes / second
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Use QPS PPS Adapter: On COM1
PPS time tag pulse matching: Automatic Matching
Windows System Time Synchronization: Synchronization is enabled
For Help, press F1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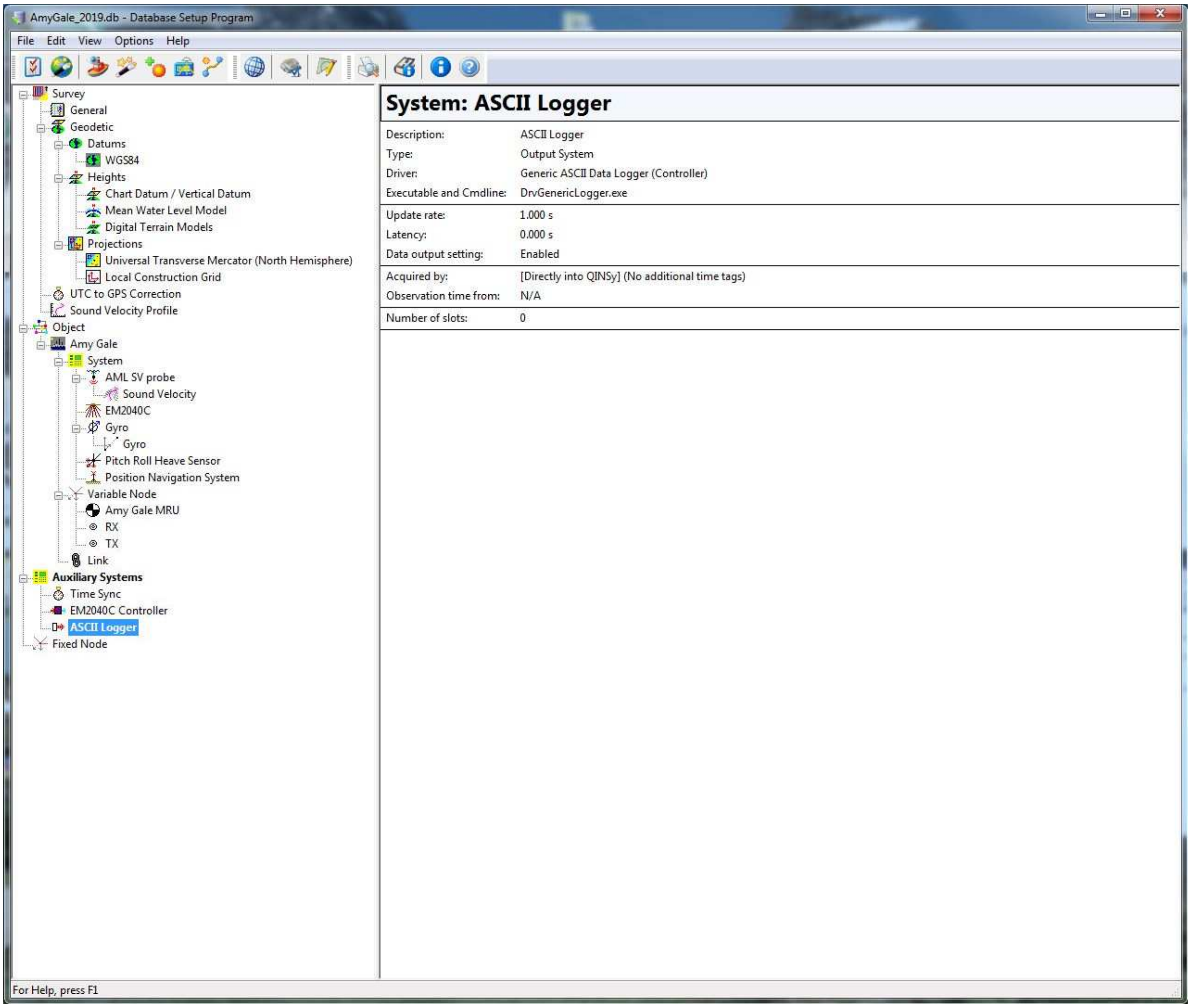
Fixed Node
System: EM2040C Controller
Description: EM2040C Controller
Type: Miscellaneous System
Driver: Kongsberg EM2040 Compact (Single) Multibeam Controller
Executable and Cmdline: DrvKongsbergEMCtrl.exe 2040C
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
For Help, press F1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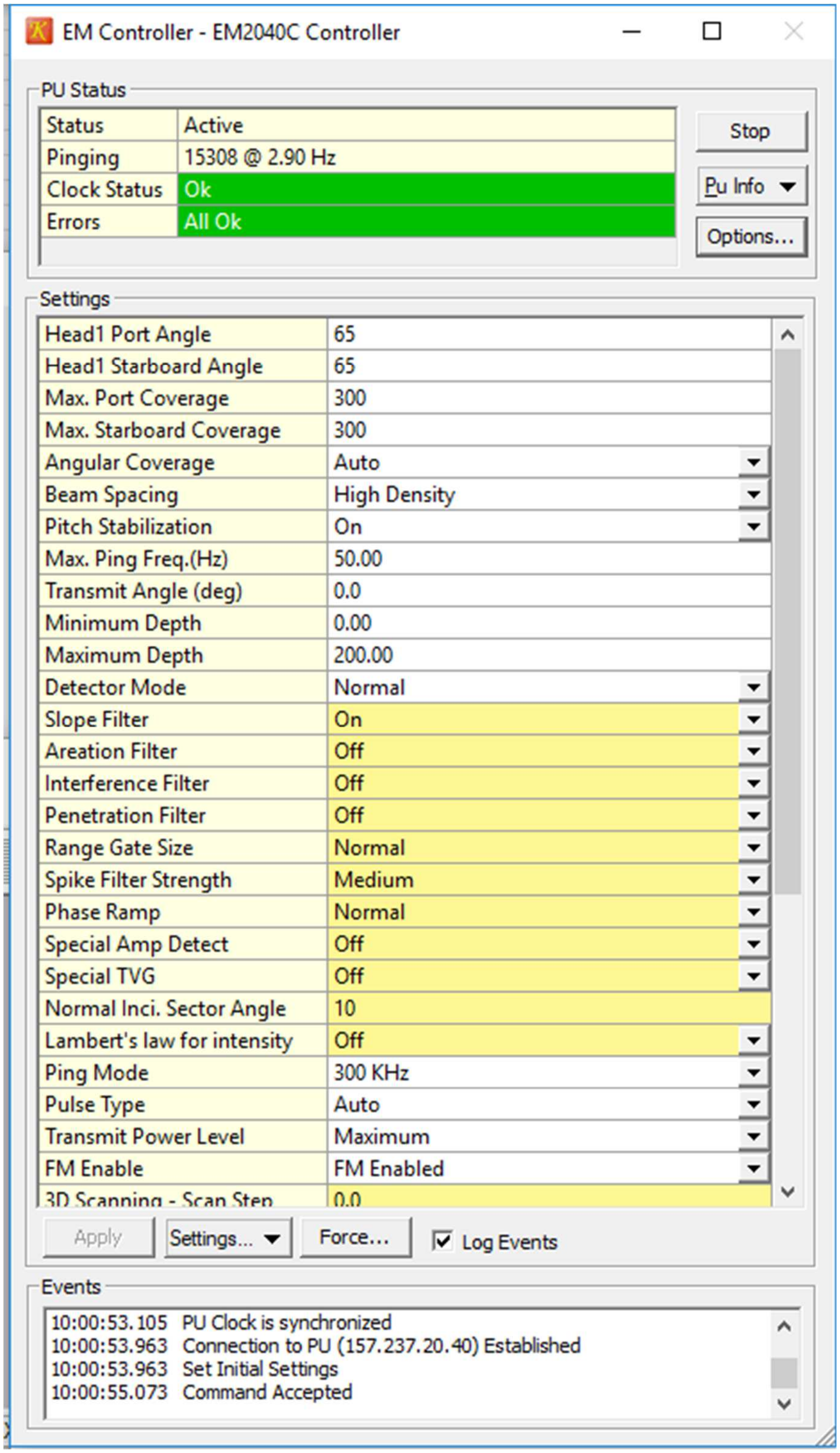
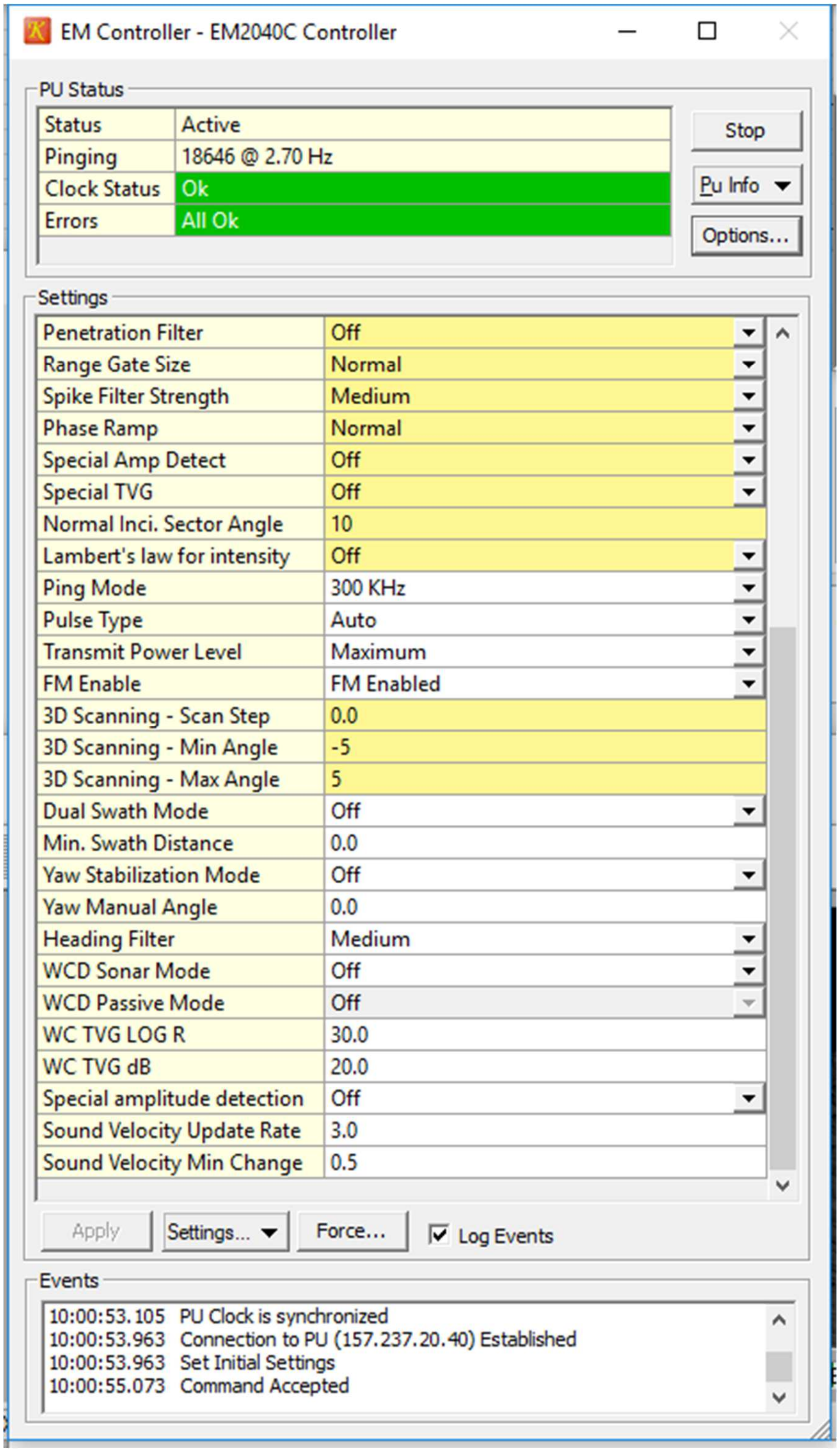
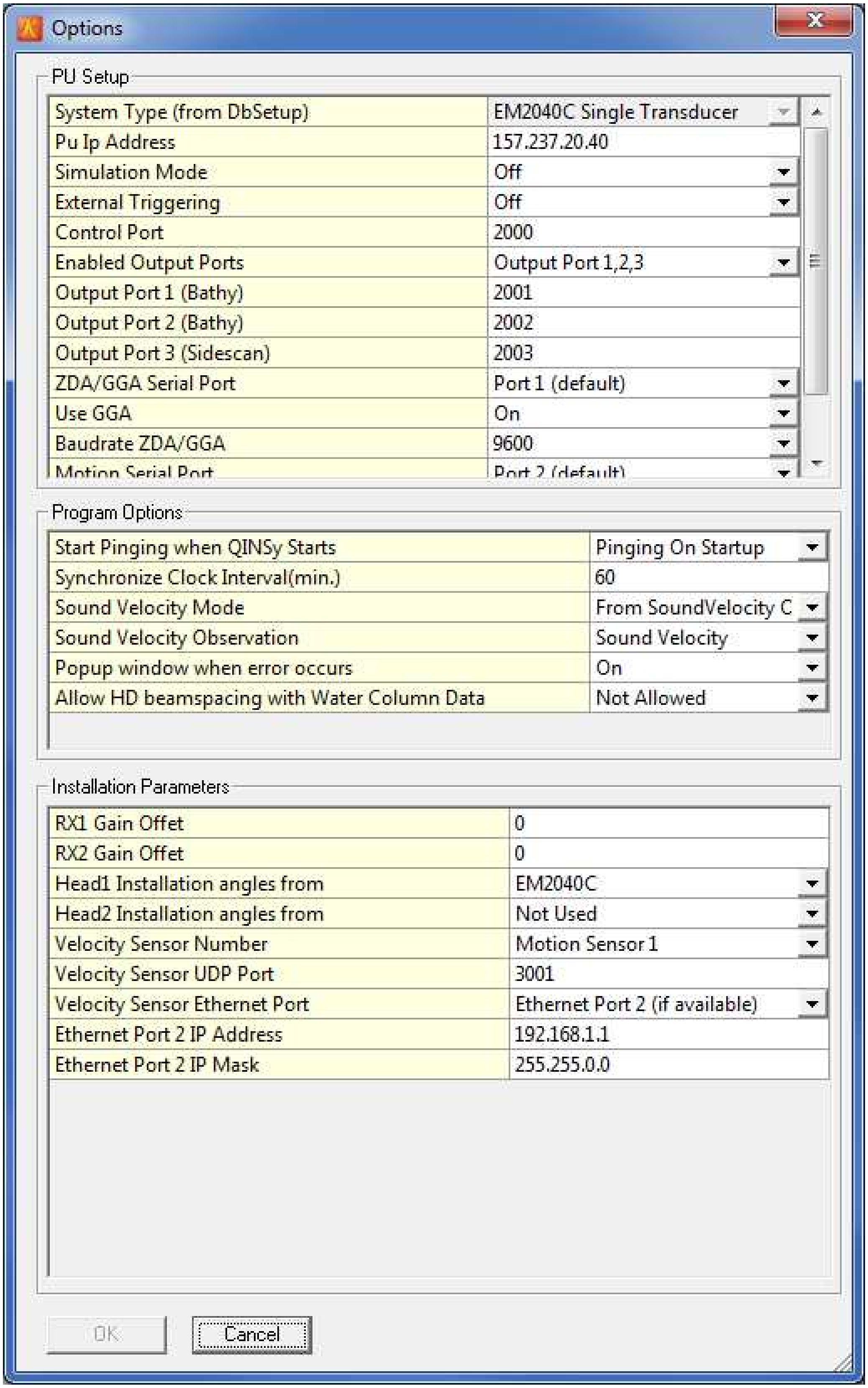
ASCII Logger
Fixed Node
System: ASCII Logger
Description: ASCII Logger
Type: Output System
Driver: Generic ASCII Data Logger (Controller)
Executable and Cmdline: DrvGenericLogger.exe
Update rate: 1.000 s
Latency: 0.000 s
Data output setting: Enabled
Acquired by: [Directly into QINSy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
For Help, press F1

Appendix D – Configuration settings for QINSy EM controller




EM Controller - EM2040C Controller
PU Status
Status
Active
Pinging
18646 @ 2.70 Hz
Clock Status
Ok
Errors
All Ok
Stop
Pu Info
Options...
Settings
Penetration Filter
Off
Range Gate Size
Normal
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
3D Scanning - Scan Step
0.0
3D Scanning - Min Angle
-5
3D Scanning - Max Angle
5
Dual Swath Mode
Off
Min. Swath Distance
0.0
Yaw Stabilization Mode
Off
Yaw Manual Angle
0.0
Heading Filter
Medium
WCD Sonar Mode
Off
WCD Passive Mode
Off
WC TVG LOG R
30.0
WC TVG dB
20.0
Special amplitude detection
Off
Sound Velocity Update Rate
3.0
Sound Velocity Min Change
0.5
Apply
Settings...
Force...
Log Events
Events
10:00:53.105 PU Clock is synchronized
10:00:53.963 Connection to PU (157.237.20.40) Established
10:00:53.963 Set Initial Settings
10:00:55.073 Command Accepted


Options
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 Port 1,2,3
Output Port 1 (Bathy)
2001
Output Port 2 (Bathy)
2002
Output Port 3 (Sidescan)
2003
ZDA/GGA Serial Port
Port 1 (default)
Use GGA
On
Baudrate ZDA/GGA
9600
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
RX1 Gain Offet
0
RX2 Gain Offet
0
Head1 Installation angles from
EM2040C
Head2 Installation angles from
Not Used
Velocity Sensor Number
Motion Sensor 1
Velocity Sensor UDP Port
3001
Velocity Sensor Ethernet Port
Ethernet Port 2 (if available)
Ethernet Port 2 IP Address
192.168.1.1
Ethernet Port 2 IP Mask
255.255.0.0
OK
Cancel

Appendix E – Mainscheme crossline surface difference test statistical plots

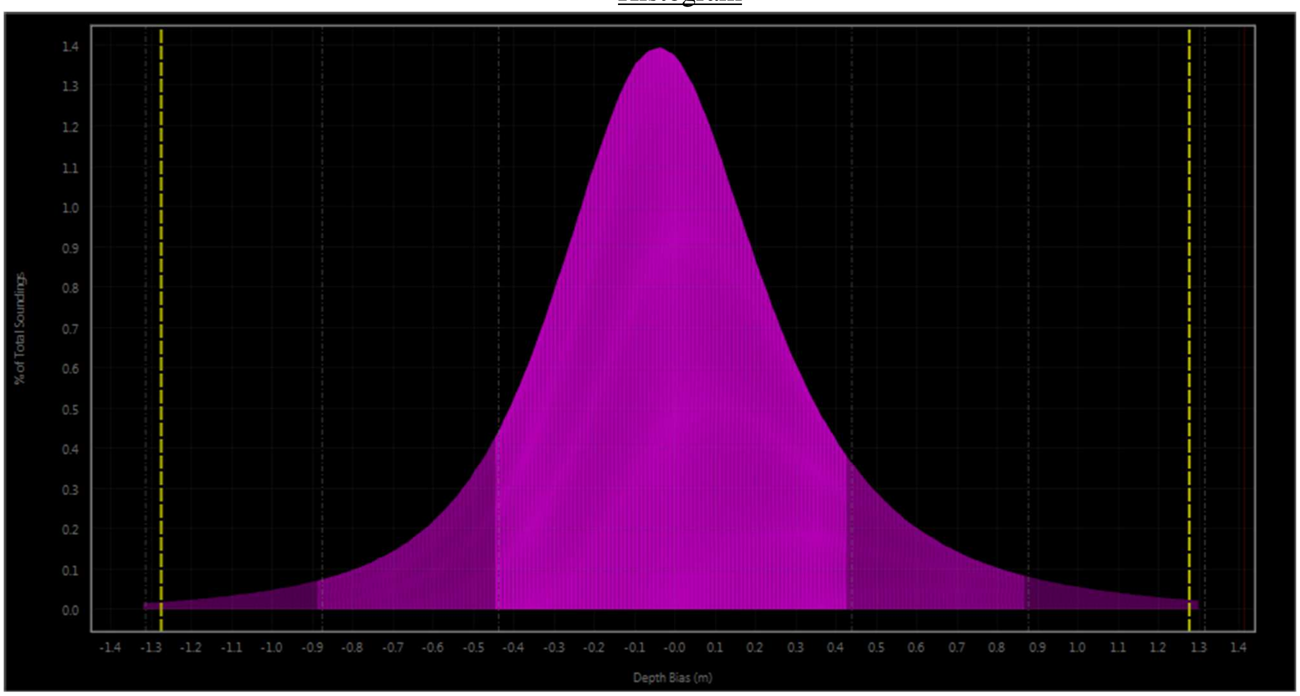
Plots (histogram, scatter, and uncertainty)

Key for plots:

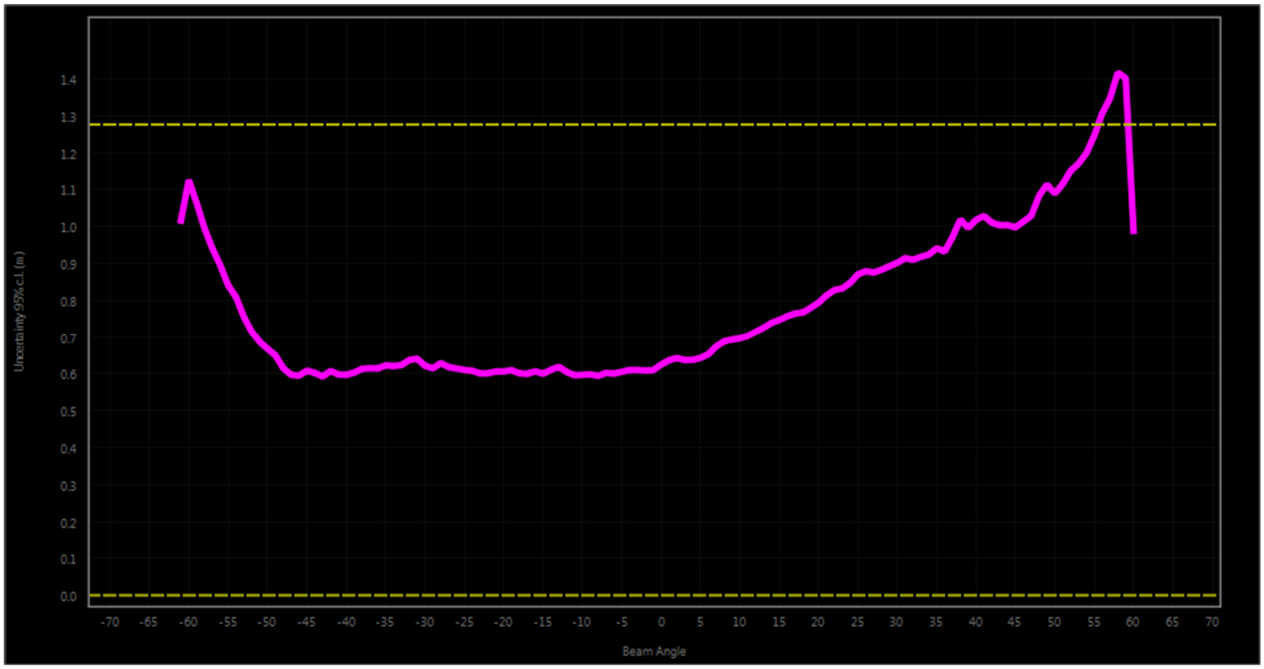
- Gray dots represent difference in depth between the crossline and the reference surface for individual beam angles or beam numbers
- Purple areas represent the 95% confidence interval (2 standard deviations) based on normal distribution (see histogram)
- Yellow dashed lines represent limit of IHO Order 1 test vertical tolerance
- Gray dashed lines on histogram represent ±sigma 1, 2, and 3
- Blue lines represent the mean value

Saco Bay Crossline Plots:

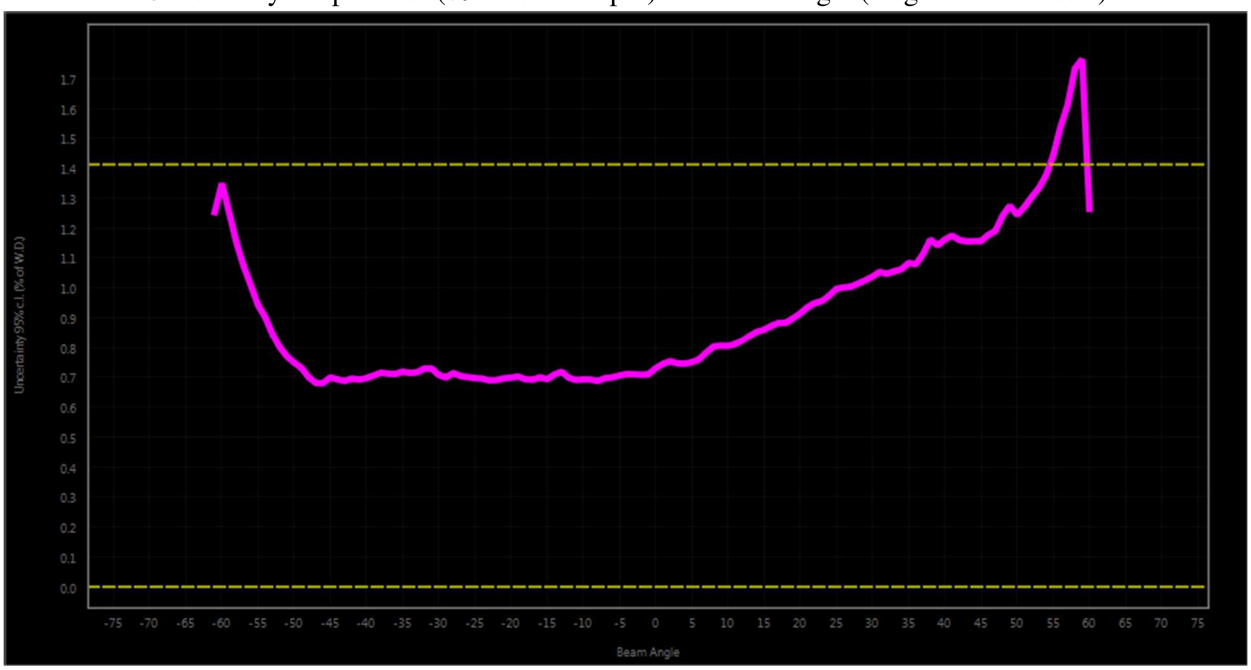
Histogram



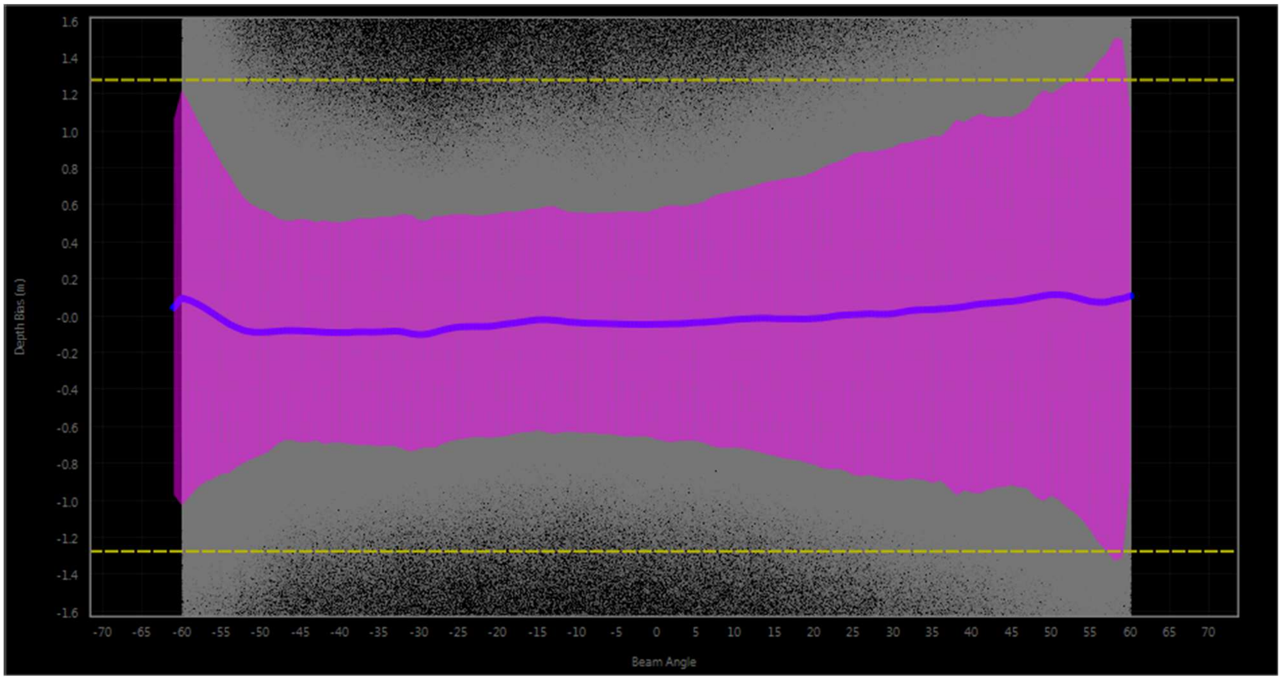
Uncertainty: Depth Bias (m) vs. Beam Angle (Degrees from nadir)



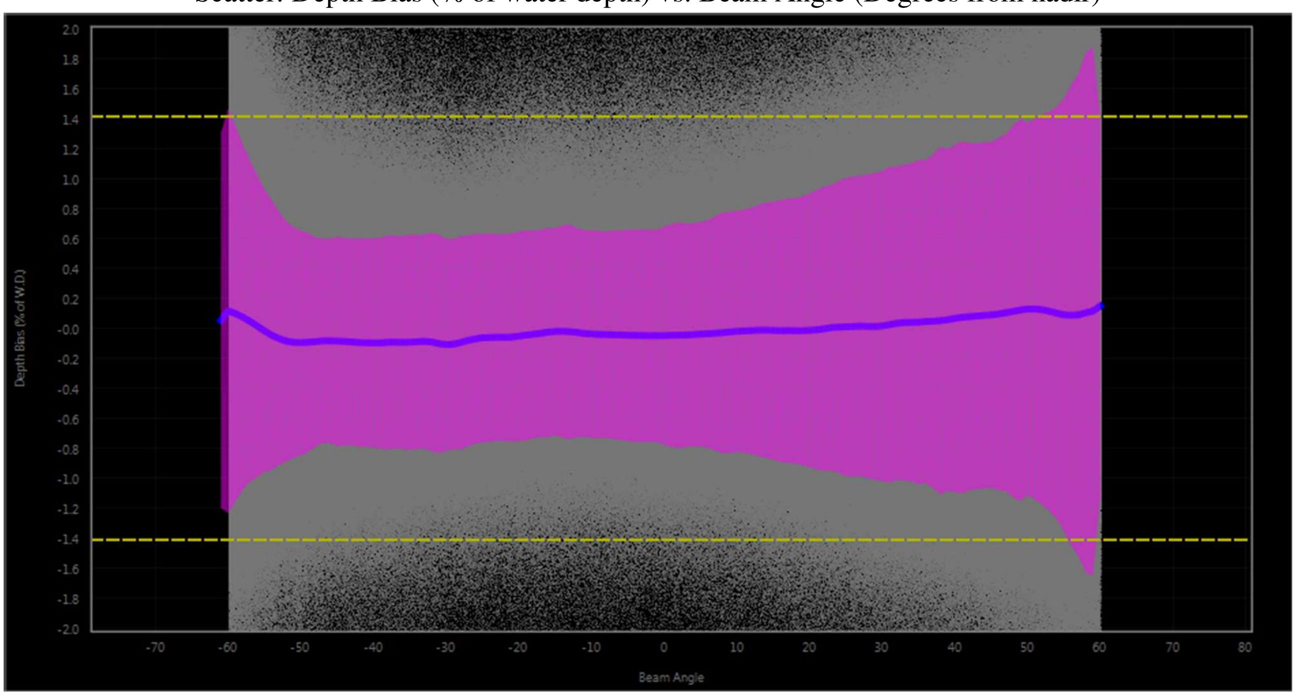
Uncertainty: Depth Bias (% of water depth) vs. Beam Angle (Degrees from nadir)



Scatter: Depth Bias (m) vs. Beam Angle (Degrees from nadir)

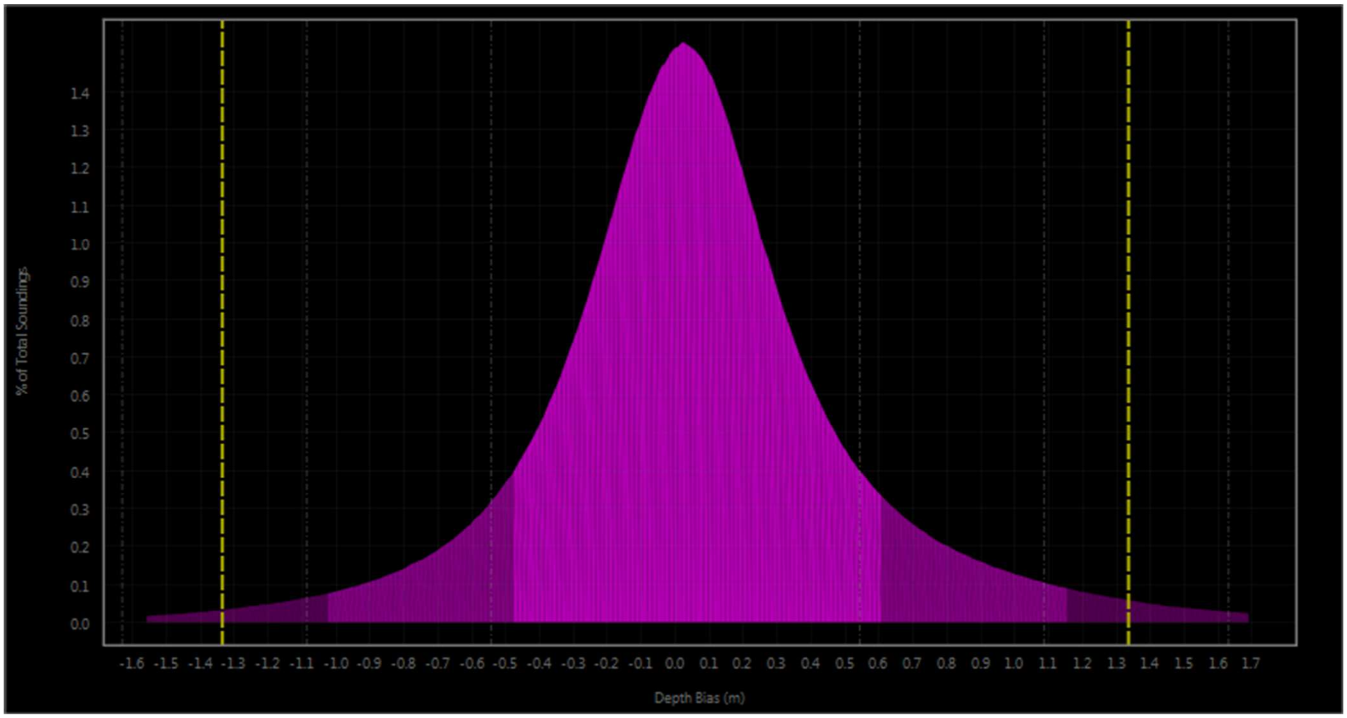


Scatter: Depth Bias (% of water depth) vs. Beam Angle (Degrees from nadir)

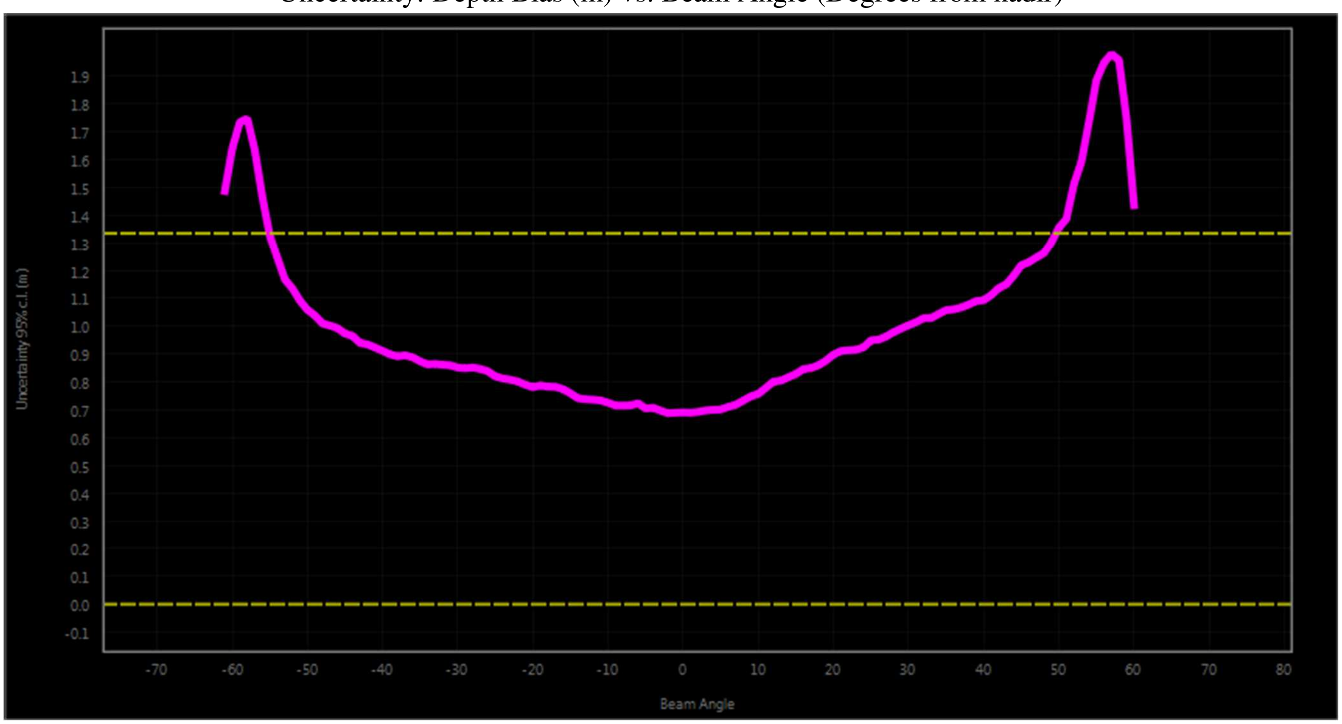


Monhegan Island Crossline Plots:

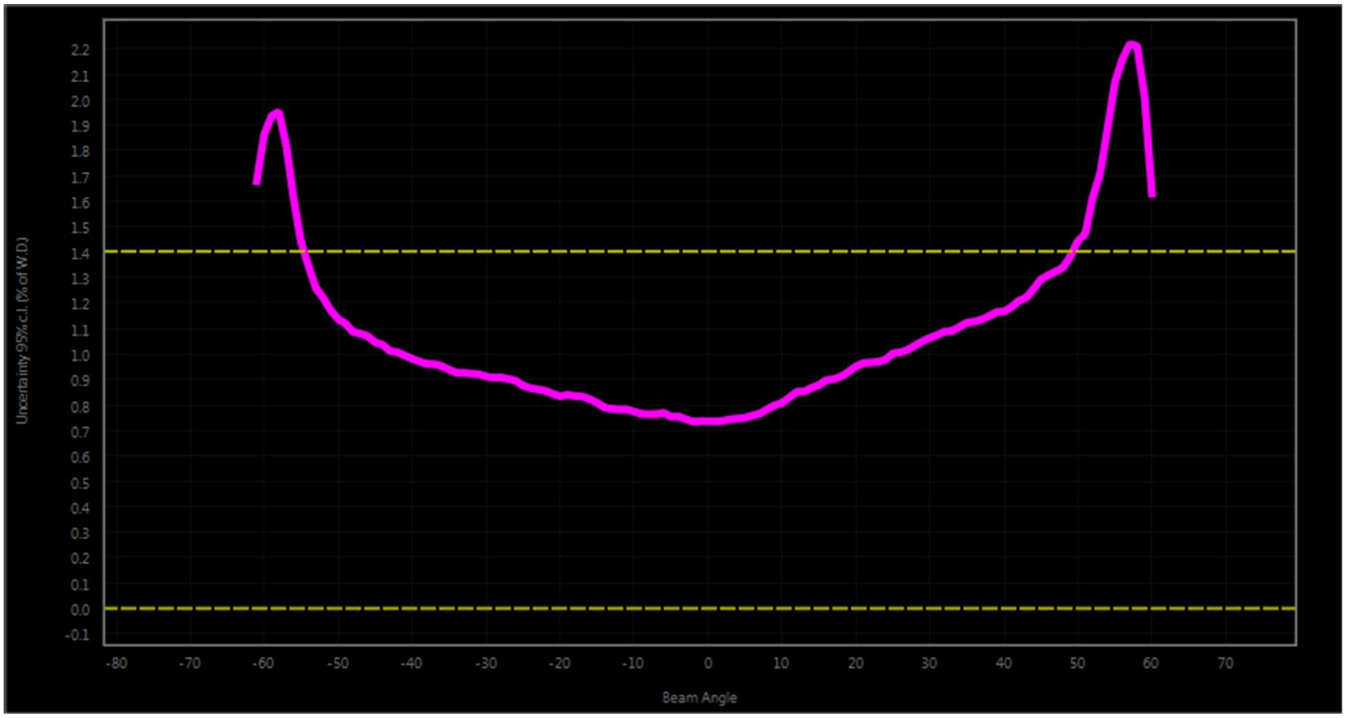
Histogram



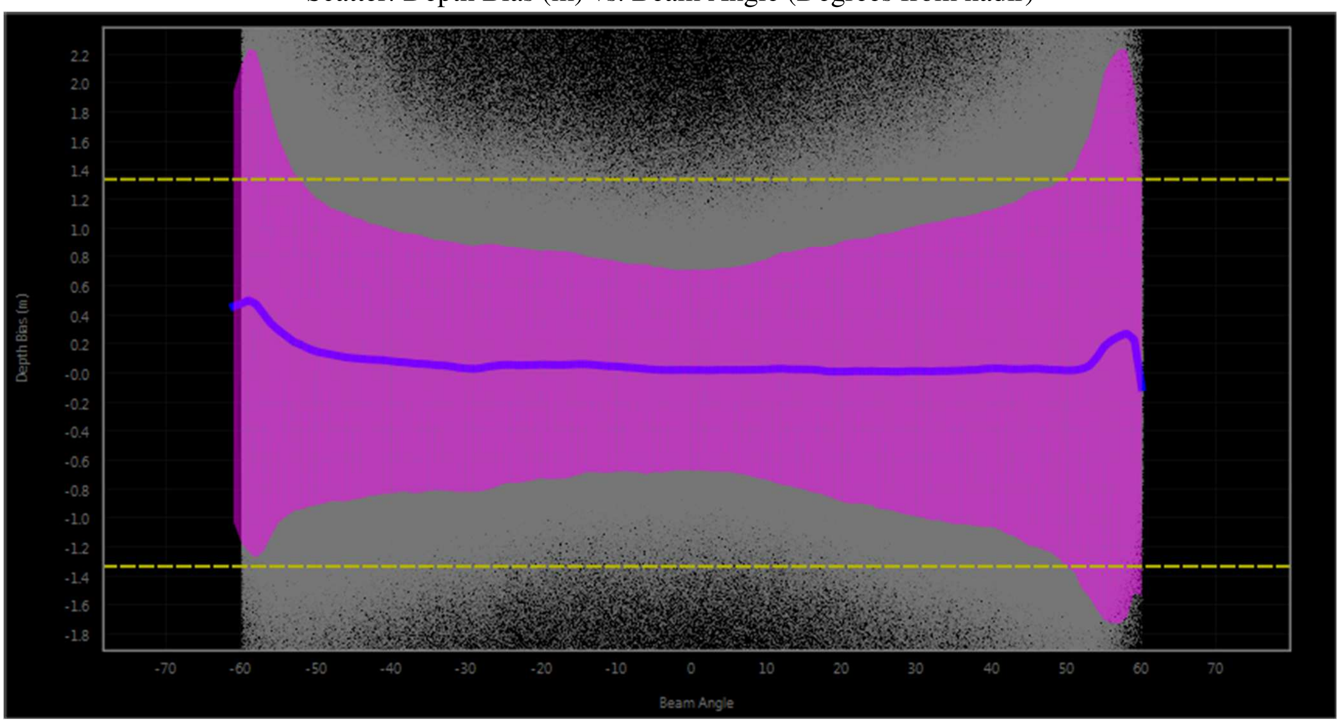
Uncertainty: Depth Bias (m) vs. Beam Angle (Degrees from nadir)



Uncertainty: Depth Bias (% of water depth) vs. Beam Angle (Degrees from nadir)



Scatter: Depth Bias (m) vs. Beam Angle (Degrees from nadir)



Scatter: Depth Bias (% of water depth) vs. Beam Angle (Degrees from nadir)