Data Acquisition and Processing Report

Summer Hydro 2019

Gulf of Maine Survey

CCOM/JHC, UNH

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A.1 Survey Vessels

A.1.1 R/V Gulf Surveyor

Built in 2015, the R/V Gulf Surveyor is a 14.6m aluminum catamaran, designed to collect high resolution, multibeam bathymetry data. A laser geodetic survey was conducted by Doucet Survey Inc. in 2016, which established the origin of the vessel, as well as major mounting points. See Appendix 1 for wiring diagrams.

Figure 1: R/V Gulf Surveyor

Name	R/V Gulf Surveyor	
Hull Number	TD14-45AA	
Utilization	Survey operations	
Dimensions	*LOA*	14.6m (48 feet)
	Beam	5.18m (17 feet)
	Max Draft	1.68m (5ft 6 inches)
Most Recent Full Static Survey	April 26, 2016 By Doucet Survey Inc.	
Flag	U.S.	
Top speed	18 knots (8 knots survey speed)	
GPS antennas	2 x Trimble Zephyr Antennas	
RTK GPS receiver	Trimble Trimark 3	
Positioning and attitude	Applanix PosMV 320 with IMU 200	
Primary Echosounder	R2Sonic 2026	

Table 1: R/V Gulf Surveyor specifications

A.2 Multibeam Sonars

A.2.1 R2Sonic 2026

The Sonic 2026 was installed on the stern strut aboard the R/V Gulf Surveyor. The Sonic 2026 is a wideband, shallow water MBES with a 60 kHz signal bandwidth. The sonar consists of three major components: a compact projector, a receiver and a small, dry-side Sonar Interface Module (SIM).

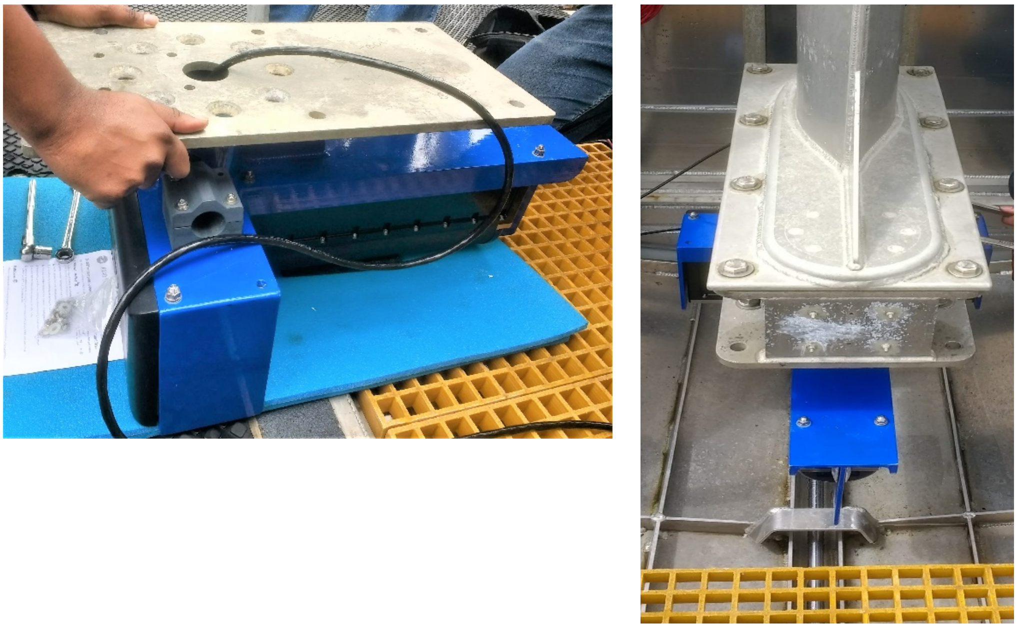


Figure 2: Sonic 2026 multibeam echo sounder

Instrument	Sonic 2026			
Manufacturer	R2Sonic			
Description	The Sonic 2026 has wide selectable operating frequencies between 170 kHz and 450 kHz in steps of 1 Hz resolution. The Sonic 2026 provides the user with flexibility in controlling resolution, range and interference from other active acoustic systems. This instrument also provides variable swath coverage selections from 10° to 160°.			
Serial Numbers	Transmitter	S/N 820013	Receiver	S/N 101587
Specifications	Frequency		170 - 450 kHz	
	Beamwidth (Tx)		0.45° at 450 kHz	
	Beamwidth (Rx)		0.45° at 450 kHz	
	Number of beams		1024	
	Ping Rate		Up to 60 Hz	
	Max Range		Up to 800 m	
	Pulse Length		15µs - 1ms	

Table 2: Sonic 2026 specifications

A.3 SideScan Sonar

An Edgetech 6205 Sidescan Sonar and Bathymetry System was installed on the RV Gulf Surveyor. The Edgetech 6205 Sidescan Sonar was not used because of interference with the R2Sonic 2026.

Figure 3: EdgeTech 6205 Sidescan Sonar

Instrument	EdgeTech 6205	
Manufacturer	EdgeTech	
Description	The EdgeTech 6205 is a fully integrated Swath Bathymetry and Dual Frequency Side Scan Sonar System that produces real time, high resolution, side scan imagery and three-dimensional maps of the seafloor.	
Serial Number	53462	
Specification	Bathymetric Sonar	
	Selectable Frequencies	230 & 550 kHz
	Beamwidths	1° x 0.5° at 550 kHz 1° x 0.7° at 230 kHz
	Max. Number of Soundings	800
	Ping rate	up to 60 Hz
	Optimal Operating Depth	<100 m for 230 kHz <50 m for 550 kHz
	Max. Swath Sector	200°

Table 3: EdgeTech 6205 specifications

A.5 Positioning and Attitude Equipment

A.5.1 Applanix POS/MV

The R/V Gulf Surveyor is configured with an Applanix Pos M/V 320, to provide position and attitude information about the vessel. The Inertial Motion Unit (IMU) is located on the deployment strut, beside the Sonic 2026 transducer.

Figure 4. Applanix PosMV 320 V5

Manufacture	Applanix		
Model	POS/MV 320		
Description	The Applanix POS/MV 320 V5 provides the R/V Gulf Surveyor with attitude, heading, position, and timing data. This data is fed into the Sonic 2026 via the following protocols: GGA, GGK, ZDA, VTG, HTG and TSS1.		
PCS	*Manufacturer*	Applanix	
	Model	320 version 5	
	Description	The POS/MV computer system consists of a processor, GPS receiver, and interface cards. These elements allow the computer to process data from both the IMU and antennas.	
	Firmware Version	9.12	
	Software Version	9.21	
	Serial Number	PCS s/n	6921
IMU	*Manufacturer*	Applanix	
	Model	IMU-200 in IP 65 housing	
	Description	The IMU provides roll, pitch, and yaw vessel motion data to the POS computer.	
	Serial Numbers	IMU s/n	2886
Antennas	*Manufacturer*	Trimble	
	Model	Zephyr	

	Description	There are two GPS antennas mounted to the top of the R/V Gulf Surveyor. The port antenna is the primary antenna; the starboard antenna was utilized to improve accuracy of heading measurements.
	Serial Numbers	Port Side: 7756
		Starboard Side: 7766

Table 4: Applanix POS/MV specifications.

Figure 5. Applanix POS/MV antenna configuration.

A.6 Sound Speed Equipment

A.6.1 CTD Profiler

A.6.1.1: AML MVP 30

The AML Moving Vessel Profiler (MVP) was mounted on the aft deck of the vessel, for deployment over the A-Frame.

Figure 6: AML MVP30 sound speed profiler with the winch.

Manufacturer	AML	
Model	MVP 30	
Description	AML MVP 30 (Moving Vessel Profiler) was used to collect Conductivity, Temperature and Depth profiles of the water column during survey operations. From this, the sound velocity was calculated. The profiles were then imported and applied to the bathymetry data in Qinsy.	
Serial Numbers	AML SVTP sensor s/n	7670

Table 5: AML MVP30 sound speed profiler specifications.

A.6.1 Sound Speed Profiler

A.6.1.1: ODOM Digibar Pro

The ODOM Digibar Pro was used as a backup device to provide sound speed profiles, in the event of an issue arising with the AML MVP 30.

Figure 7: Odom Digibar Pro sound speed profiler.

Manufacturer	Teledyne Odom Hydrographic	
Model	Digibar Pro	
Description	The Digibar Pro was used to collect sound speed profiles of the water column during survey operations. The profiles were loaded into Qinsy.	
Serial Numbers	Controller Unit S/N	98136

Table 6: Odom Digibar Pro specifications.

A.6.2 Surface Sound Speed

A.6.1.1: ODOM Digibar Pro

A second ODOM Digibar pro sensor was secured to the mounting cage, which holds the Sonic 2026, to acquire accurate sound speed measurements at the transducer head to be used for beam forming.

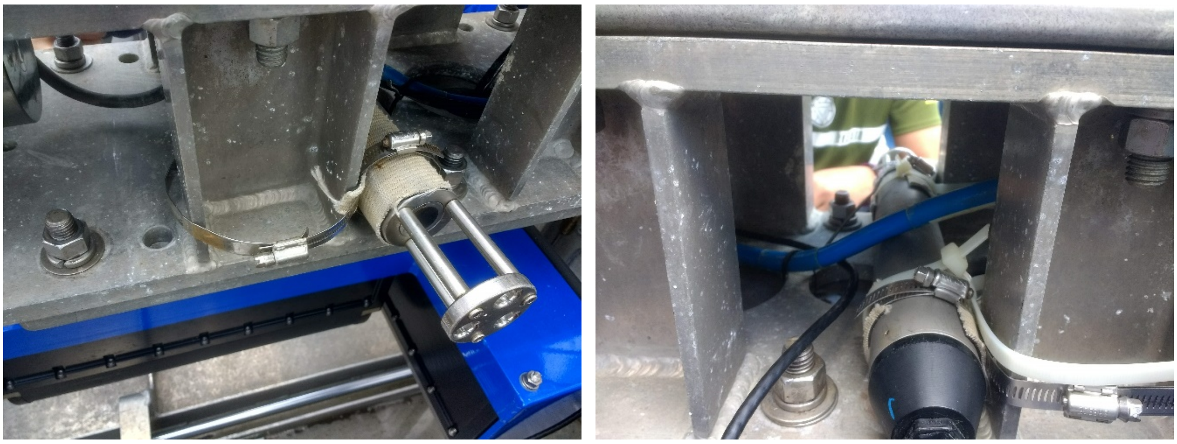


Figure 8: ODOM Digibar Pro secured to mounting cage

Manufacturer	Teledyne Odom Hydrographic	
Model	Digibar Pro	
Description	The Odom Digibar Pro was used to collect sound velocity information pertinent for this survey. Mounted to the R/V Gulf Surveyor's mounting cage directly above the Sonic 2026 transducer and connected to the RVGS 02 computer via a serial connector cable.	
Serial Numbers	Controller Unit S/N	98536
Specifications	Sing-Around Frequency	11 kHz
	Sound Velocity Accuracy	+/- 0.3 m/s
	Sound Velocity Resolution	0.03 m/s
	Depth Accuracy	31.0 cm
	Sampling Rate	10 Hz

Table 7: ODOM Digibar Pro specifications.

A.7 Horizontal and Vertical Control Equipment

A.7.1 RTK Base Station Equipment

An RTK base station broadcasts RTK corrections, which is to be received via the Trimble TRIMMARK 3 UHF modem on board the R/V Gulf Surveyor. The base station is permanently located on the roof of the Seacoast Science Center at Odiorne State Park, NH.

Figure 9: RTK base station at Odiorne Point.

GPS Antennas	*Manufacturer*	Trimble
	Model	Zephyr Geodetic
	Description	Base station antenna at Odiorne
	Serial Numbers	Unknown
GPS Receivers	*Manufacturer*	Trimble
	Model	5700
	Description	Odiorne Point base station is powered by A/C supply from the Science Center building. It continuously broadcasts RTK corrections via UHF radio at a frequency of 461.075 MHz, in CMR+ format.
	Firmware Version	Unknown
	Serial Number	220311827
UHF Antennas	*Manufacturer*	Trimble
	Model	24253-46
	Description	The CMR+ formatted correctors broadcast on UHF antennas. The antennas are able to transmit and receive at frequencies 450-470 MHz
	Serial Number	unknown
UHF Radios	*Manufacturer*	Trimble

	Model	Trimmark 3
	Description	The modem for broadcasting corrections from the RTK base stations.
	Firmware Version	unknown
	Serial Number	unknown
Solar Panels	No solar panels were installed.	
Solar Chargers	No solar chargers were installed.	
DQA Tests	No DQA tests were performed.	

Table 8: RTK Base Station specifications.

A.7.2 Trimble Trimmark 3

The GPS antennas are secured atop the RVGS approximately 3.74m apart, with the port side antenna being the primary antenna. These antennas receive RTK corrections from the base station at the Seacoast Science Centre at Odiorne Point State Park, NH. The Trimble Trimmark 3 Radio Modem relays these corrections to the POS M/V. The Trimmark was secured inside the RVGS main cabin above the main systems rack and ~2 m above the vessel RP.

Figure 10: (left) GPS antennas (red circles) on RVGS top platform. (Right) Trimble Receiver Modem inside main cabin above system rack.

UHF Radio Modem	*Manufacturer*	Trimble	
	Model	TRIMMARK 3	
	Description	UHF radio transmits RTK corrections to the POS/MV system.	
	Serial Number	UHF Radio s/n	JUP-9414-450
	Line of Sight	15km	
	Channels	20	
	Channel Spacing	12.5khz or 25kHz	
	Transmit Power	2W, 10W, 25W	

	Frequency	410-420MHz, 430-450MHz, 450-470MHz	
	Data Output	9600 baud rate	
	Range	10-12 km (for 25W), 5-8 km (for 2W)	
UHF Antennas	*Manufacturer*	Trimble	
	Model	24253-46	
	Description	UHF antennas receive the CMR+ correctors from the RTK base station. The antennas transmit and receive at frequencies of 450-470 MHz	
	Serial Numbers	UHF Radio s/n	Unknown

Table 9: Trimble Trimmark 3 Specifications

A.8 Ground Truthing Equipment

A.8.1 Wildco Shipek grab sampler

The grab sampler is lowered to the bottom from a deck winch. When the sampler reaches the bottom, the impact force of the grab sampler triggers a trip weight that releases springs that causes the scoops of the grab sampler to clamp shut. When the sampler is recovered to the boat deck, the bottom substrate samples were analyzed for grain size, sediment color, and any notable biological specimen and then stored in plastic bags. Specifications for the WILDCO SHIPEK grab sampler are provided in Table 13. Details for the Grab Samples are described in the Ground Truth Report.

Figure 11: Wildco Shipek grab sampler.

Manufacturer	WILDCO®
Model	SHIPEK® grab sampler (P/N 860-A10, S/N 3710)
Description	The Shipek sampler is designed for sampling unconsolidated sediments from soft ooze to hard packed sand. The sole driving force is the Shipek's® weight, which totals over 130 pounds with the trip weight. The body itself weighs about 40 kg (85 pounds) which is augmented by the trip weight 22 kg (48 lbs), which is securely fastened by two side pins.
Model	Shipek grab sampler (P/N 860-A10)
Serial Number	3710
Material	316 Stainless Steel
Size	472 x 638 x 422 mm
Weight	60 kg
Case	546 x 762 x 1092 mm
Volume	3000 mL
Sample Area	1/24 square meter
Bite depth	102 mm
Scoop top area	198 x 198 mm
Weight	Body: 49 kg; Trip weight: 22 kg
Winch	
Manufacturer	DT Marine Products Incorporated
Serial Number	1570-5005HLWRR

Table 10: SHIPEK Grab Sampler Specifications

A.8.2 Drop Camera System

Visual samples of the seafloor were collected using a Delta Vision Industrial HD Underwater Video Camera, commonly referred to as a 'drop cam' (Figure 11), in the areas A and C (Figure 12). Details of the Ground Truth Survey are described in the Ground Truth Report. Specifications for the Delta Vision drop camera are provided in Table 10.

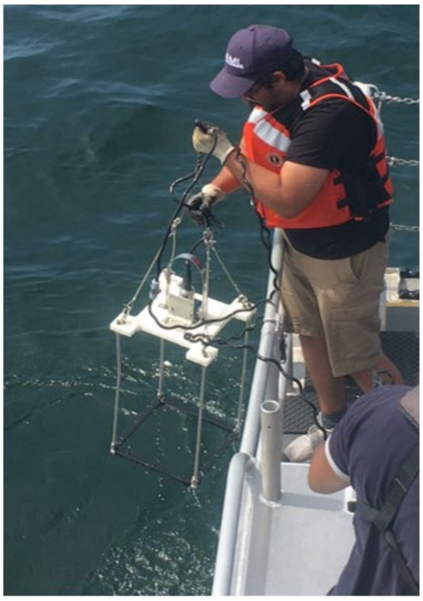


Figure 12: Drop Camera Deployment

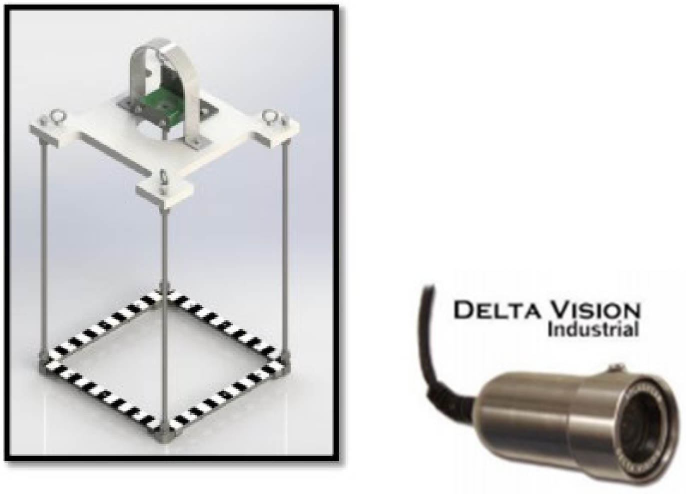


Figure 13: Drop camera cage (left) and camera (right)

Manufacturer	Paul Lavoie (designed and constructed cage), Ocean Systems (camera)
Model	Delta Vision Industrial HD Underwater Video Camera
Description	The drop camera system provides *in situ* information of the benthic environment being mapped. This facilitates the linking of bathymetric surface characteristics (rugosity, slope, etc.), backscatter measurements, and physical characteristics (vegetation, sediment type, etc.) of the sample site.

Table 11: Drop camera specifications

A.9 Acquisition and Processing System

A.9.1 Acquisition Software

- The R2Sonic proprietary software, Sonic Controller 2000, was used to interface with the sonar head, along with monitoring the operational parameters and multibeam data in real time. Bathymetry and backscatter data were both collected.
- QPS' Qinsy was used to acquire and manage the multibeam data.
- Applanix's PosMV was used to monitor and acquire position and motion data.
- The MVP was controlled and data acquired through the MVP Controller software.
- Hypack, Hypack Survey and Hysweep, a hydrographic surveying software, will be used for line planning, visualisation and for sharing navigational information with the bridge.

Manufacturer	*Software*	*Version*
R2Sonic	Sonic Controller 2000	2009
QPS	Qinsy	8.18.3
Xylem	Hypack 2018	1.18
Applanix	MV POSView	9.21
EdgeTech	Discover - Bathymetric	36.0.1.120
DJI	DJI Go4 App	

Table 12: Acquisition Software Details

A.9.2 Processing Software

- POSPac was used to post-process the positioning data, to produce more accurate GNSS solutions.
- CARIS was utilised for the processing and quality control of multibeam data, along with the visualisation of data.
- FMGeocoder Toolbox was used to process the backscatter data and produce mosaics.
- CARIS Hips and Sips was utilised for junctioning evaluation and chart sounding comparisons.

Manufacturer	*Software*	*Version*
QPS	Qimera	1.7.6
QPS	FMGeocoder Toolbox	7.8.10
Applanix	POSPac MMS 8	8.3
TeledyneCaris	HIPS and SIPS 11.1	11.1
Pix4D	Pix4Dcapture	

Table 13: Processing Software Details

B. Quality Control

B.1 Data Acquisition

B.1.1 Multibeam Echosounder

The Sonic 2026 was the primary echo sounding equipment, which collected data throughout the survey operations at a frequency of 330 kHz. A middle CW pulse was used with a pulse length of 40 µm and a coverage of 150^0. The speed of the vessel during survey operations was 7 knots, and planned line files that were developed in Hypack were used. To ensure that the highest quality data was obtained during the survey, the software, Sonic Controller 2000 was used to toggle the settings of the Sonic 2026. Adaptive line running was performed during holiday data acquisition.

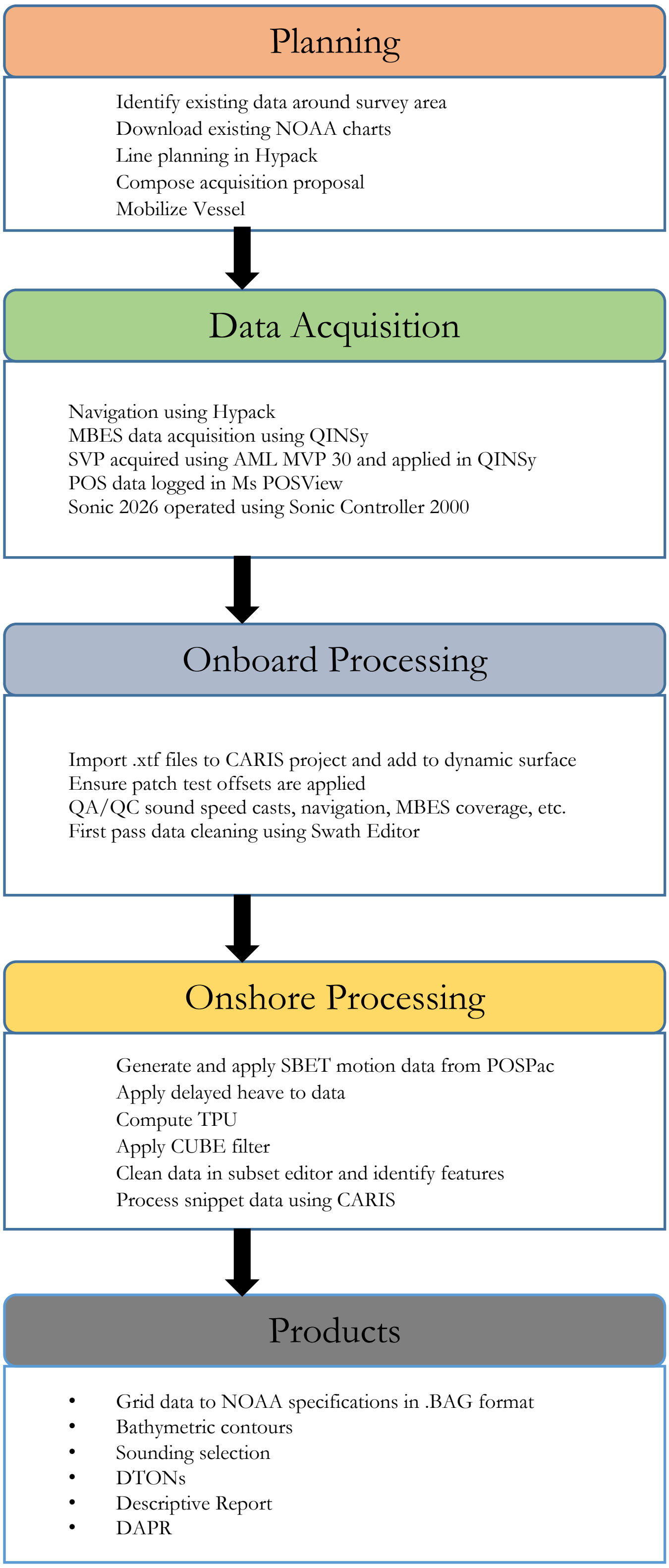


Figure 14: MBES Processing Workflow

B.1.2 Sound Speed

B.1.2.1 Sound Speed Profiles

The AML MVP 30 was the primary sound speed profile acquisition method, with a Digibar pro used as the secondary method. The MVP 30 consists of CTD sensors, attached to a tow fish, which was attached to a winch and deployed via the A-frame using a pulley system. The winch is attached to a deck controller unit, which is connected to the topside MVP interface and can be accessed via a dedicated laptop. MVP Controller software was used to deploy the tow fish, receive the sound velocity data, and monitor the status of the fish in real time. The sound speed profile was downloaded, imported and applied in Qinsy. Prior to importing the SSP into Qinsy, the operator has to vet the profile. The fish was programmed to remain 2 m below the surface during survey line acquisition, and to dive to 2 m above the seabed when it was deployed. Depth information was provided by the Sonic 2026.

The secondary method of acquiring sound speed was through the use of the ODOM Digibar Pro. This is a hand held unit, manually deployed over the side of the vessel. The device was then connected to the acquisition computer, and the casts were imported into Qinsy.

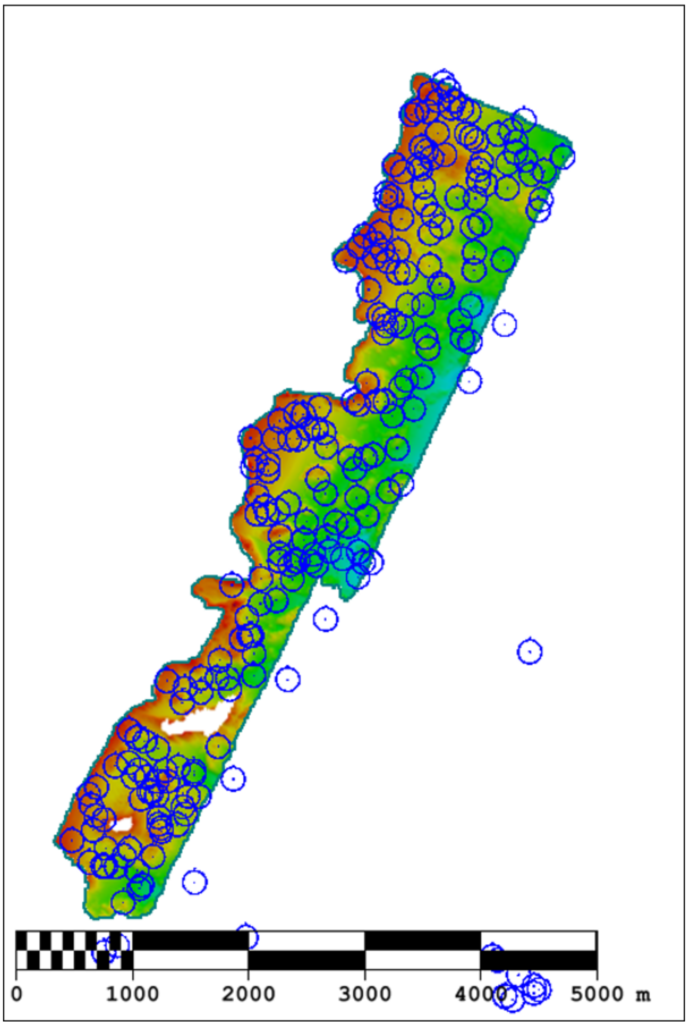


Figure 15: Example locations of sound speed profiles acquired for a survey (Area A and D).

B.1.2.1 Surface Sound Speed

Surface sound speed at the transducer head was collected by an ODOM Digibar Pro during survey operations. The sensor was placed in the mounting cage, directly above the Sonic 2026. The probe was connected to the ODOM Digibar Pro controller unit which was connected to the SIM Unit. The device measured sound speed at a rate of 1 Hz.

B.1.3 Ground Truthing

Ground truth operations utilise an underwater camera and a SHIPEK Wildco sampler. Sample locations are pre-selected based on the bathymetry and backscatter data acquired during survey operations.

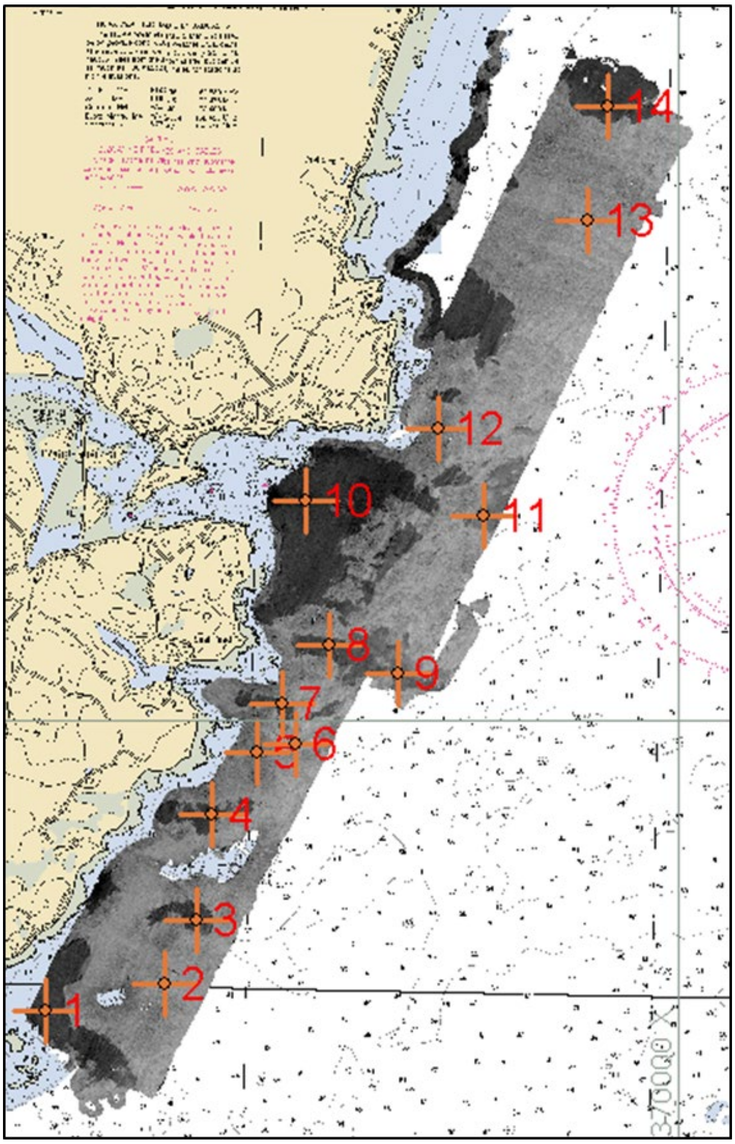


Figure 16: Example Ground Truthing Locations on Backsactter Map

Video imaging was performed using the Delta Vision Industrial HD Underwater Video Camera mounted in the cage. This was then manually deployed using a cable connected to a laptop in the cabin, through which video footage could be monitored in real time. The collected samples were photographed, logged, and stored.

Figure 17: Deploying the grab sampler from the R/V Gulf Surveyor

B.1.4 Backscatter

An R2Sonic 2026 multibeam Echosounder system was utilized at 300 kHz with a pulse length of 40 µs and with a swath width of 150°. During acquisition, the power level and gain were set to full dynamic range in an attempt to prevent clipping. Aside from bathymetry, the R2Sonic also collect 'snippets' data. This consists of short intensity time series data for each beam; these snippets data can be patched together to form a Sidescan like record. Qinsy was used to collect simultaneous bathymetry and backscatter data in real-time, which was stored in the .db format.

B.2 Data Processing

B.2.1 Multibeam Echosounder

See Figure 14 above for MBES processing flow.

During acquisition, .db files, .xtf files and .qpd files were logged utilizing Qinsy acquisition software. The .db files contain both the bathymetry and snippets data, as well as attitude and position data form the Pos M/V. The .db files also contain the sound speed profiles that have been applied to the line during acquisition. Binary navigation data was also logged in MS-PosView. At the end of each survey day, the Qinsy project, the CARIS project and the binary navigation files were all copied to an external hard drive. The data was then uploaded onto the CCOM network from the hard drive, for further processing.

As the data was acquired, the .xtf files were brought into CARIS to investigate any holidays or systematic errors. The sound speed files associated with each line file were uploaded to CARIS. Sound speed parameters were set to nearest in distance within time and a time limit of 1 hour was selected. In the office, the binary navigation was post processed using POSView and SBET files were produced for each survey day. The .SBET files were then applied to the data.

CARIS, HIPS and SIPS version 11.1 was utilized to process all multibeam data. Post processing the MBES data includes computing the TPU, data cleaning and generating surfaces. The patch test angular offsets were also entered in CARIS.

The data was gridded at 0.5 and 1.0 meter resolution, with NOAA_0.5 and NOAA_1 CUBE settings correspondingly to increase the likelihood separate hypothesis creation for outer beams. Once the data was gridded a CUBE filter was applied to reject all soundings beyond two standard deviations from the CUBE surface.

A static offset of -29.18 was applied to the data to transform the vertical datum from WGS84 to MLLW. NOAA's VDatum tool was used to obtain the offset value.

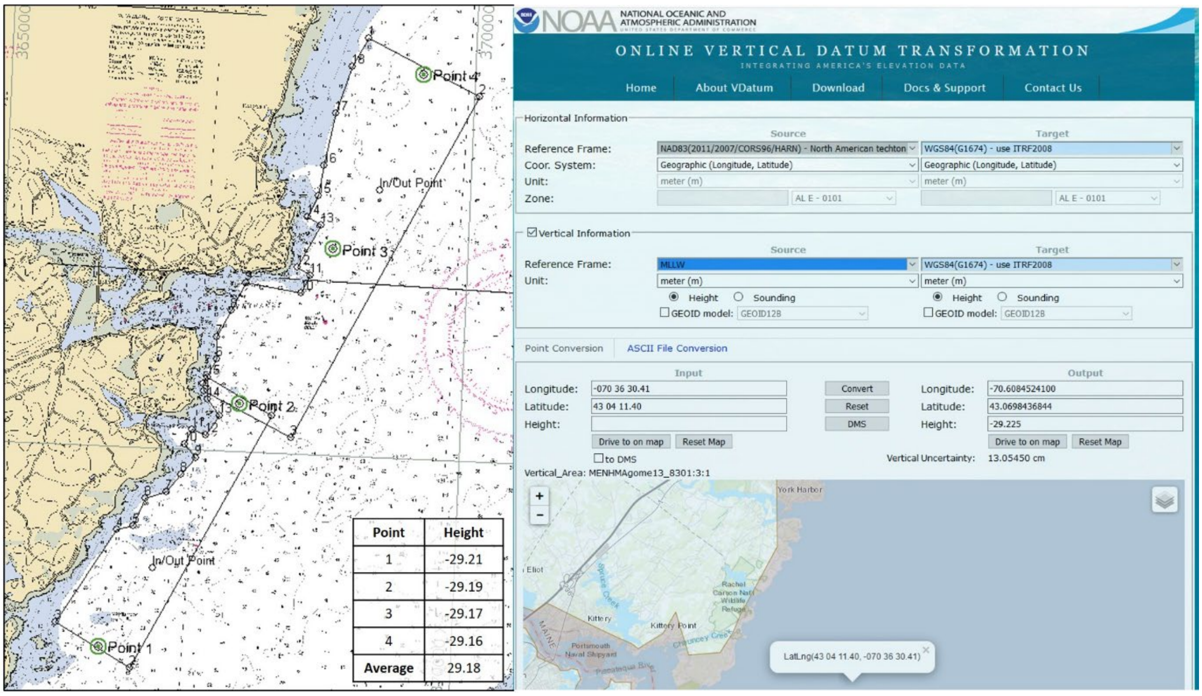


Figure 18: VDatum Transformation

B.2.2 Specific Data Processing Methods

B.2.2.1 Methods Used to Maintain Data Integrity

Acquisition and processing logs were maintained on a daily basis, and reviewed each day to ensure correct lever arms, angular offsets, and other correctors were applied during collection or in post processing. In instances of data holidays, adaptive line planning was carried out.

B.2.2.2 Methods Used to Generate Bathymetric Grids

Methods follow the specifications laid out in the NOAA NOS Hydrographic Surveys Specifications and Deliverables (April 2017).

B.2.2.3 Methods Used to Derive Final Depths

Final depths were derived via CUBE gridding parameters in CARIS, including cleaning filters and surface comparison algorithms.

B.2.3 Sound Speed

The data was collected through the MVP Controller software. The Qinsy operator used the SVP editor to visualize and QC the sound velocity profiles. It was then imported into Qinsy and applied to the data. The SVPs were also applied in CARIS during the Georeference Bathymetry step; Nearest in Distance within Time of 1 hour was the option which was employed for this processing.

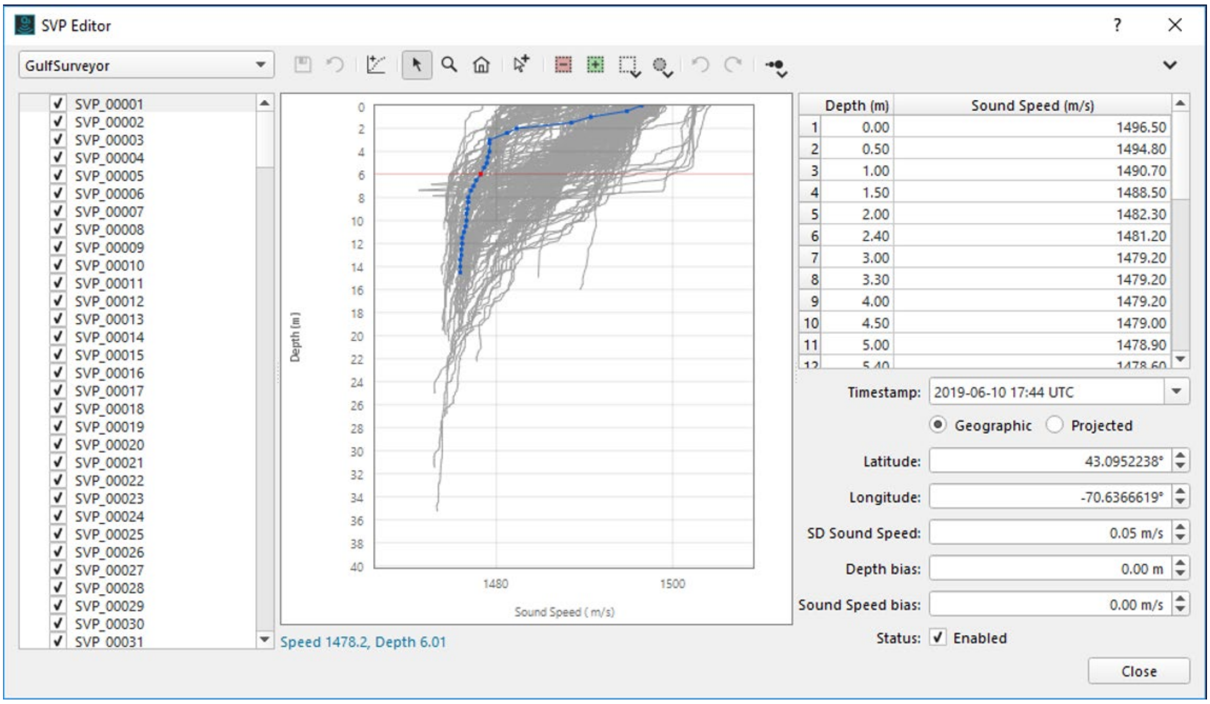


Figure 19: Qimera SVP Editor displaying the range of profiles acquired

B.2.4 Backscatter

Data was processed in QPS FMGeocoder Toolbox V7.8.10. Patch test offsets were applied to survey line data at the time of data collection. FMGT was used to mosaic the snippet data, provided by the Sonic 2026 MBES. The snippet data contains ALL metadata required to produce an image that is compensated for all radiometric effects that may be compensated for. See FMGT Backscatter Processing Procedure for further details on processing.

B.4 Uncertainty and Error Management

B.4.1 Total Propagated Uncertainty (TPU)

Total Propagated Uncertainty values for this survey were derived from a combination of fixed values for equipment and vessel characteristics, as well as values for sound speed uncertainties. These values were included in the vessel configuration setup in CARIS.

EQUIPMENT	FEATURE	TPU

R2Sonic	*Echosounder*	*Pulse Length*	0.015ms
		Sampling Length	0.020 m
	Offsets	*Roll*	0.05 º
		Pitch	0.05 º
		Heading	0.05 º
	Sound Velocity (AML MVP-30)	*Surface Sound Speed*	0.05 m/s
	Stabilization	*Roll stabilization*	0.00 m
		Pitch stabilization	0.00 m
		Heave compensation	0.00 m
Beam width		*Along*	1 º
		Across	0.50 º
APPLANIX POS/MV 320 V5	*Motion*	*Roll*	0.05º
		Pitch	0.05º
		Heading	0.05º
		Heave Fixed	0.05 m
		Heave Variable	5%
		Roll Offset	0.05º
		Pitch Offset	0.05º
		Heading Offset	0.05º
	Position (IARTK mode, base station up to 15 km away)	*Horizontal*	0.5 m
		Vertical	1 m
AML MVP30	*Temperature / Conductivity*	*Temperature*	0.005ºC
		Conductivity	0.01 ms/cm
AML Smart SV&P	*Sound Velocity*	*Sound Velocity*	0.05 m/s

Table 14: TPU used in processing MBES data

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

$$TVU = \pm\sqrt{.25^2 + (0.0075 * d)^2}$$

For a depth of 6m, this would give a TVU= ± 0.253.

For a depth of 38m, this would give a TVU= ± 0.379.

C. Corrections to Echosoundings

C.1 Vessel Offsets

C.1.1 Description of Correctors

The R/V Gulf Surveyor was surveyed in a dry dock by Doucet Survey Inc. on April 26, 2016. Final coordinates were delivered to CCOM on June 3, 2016. A reference point in the main cabin was established. 13 monuments were established on the R/V Gulf Surveyor on April 26, 2016, at key locations such as the mounting bracket. Precision survey equipment such as theodolites, laser range finders, total stations and optical levels were utilized to determine the location of the vessel monuments.

C.1.2 Vessel Offset Correctors

The RVGS vessel reference frame is: +x bow forward, +y to starboard, and +z down

Vessel	R/V Gulf Surveyor		
Echosounder	R2Sonic Sonic 2026		
Date	April 26, 2016 (initial survey)		
	June 3, 2016 (final coordinates		
	June 6, 2016 (MBES ram offsets)		
Offset	Reference Point to IMU	X	-1.549
		Y	+0.018
		Z	+1.939
	Reference Point to Sonic 2026 Acoustic Center (Fully deployed)	X	-1.459
		Y	+0.019
		Z	+2.371
	Reference Point to Primary Antenna	X	3.320
		Y	-1.845
		Z	-4.319
	Primary Antenna to Secondary Antenna	Y	+3.665

Table 15: Vessel offsets entered into Qinsy and POSView

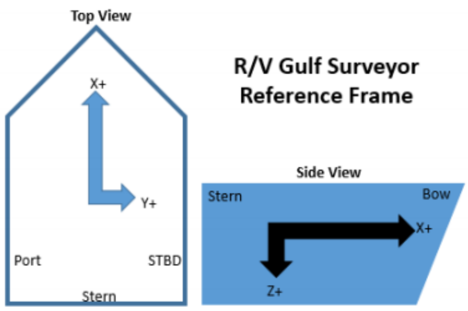


Figure 20: Ship Reference Frame.

C.2 Static and Dynamic Draft

C.2.1 Static Draft

Static draft was measured at the beginning of each survey day at the dock. The height of the waterline relative to the MBES ram grating was measured. This value changed day to day and was input daily into the Qinsy online section.

C.2.2 Dynamic Draft

No dynamic draft corrections were applied to the data. Dynamic draft was not needed as the measurements were made relative to the ellipsoid.

C.3 System Alignment

C.3.1 Patch Test

To determine the misalignment between the transducer and the IMU, a patch test was carried out, using the feature method. The location for the patch test was adjacent to the Newcastle pier, with a flat seabed, a gentle slope and a distinct feature, known as Cod Rock. The depths in this area (10-30m) area also similar to the depths expected in the survey area. Before and after multibeam acquisition, sound speed profiles were acquired.

The patch test was then processed in CARIS, and the result entered into the Qinsy Vessel Configuration file.

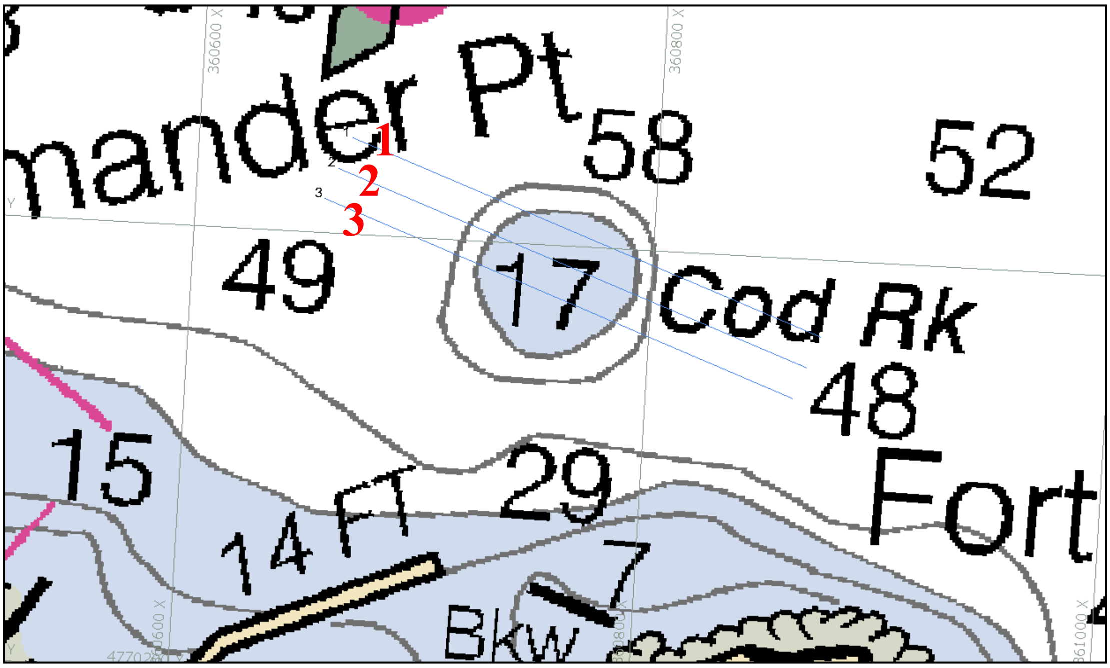


Figure 21: Overview of patch test line plan

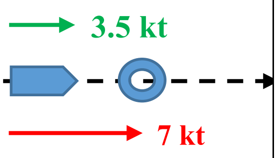
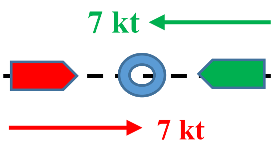
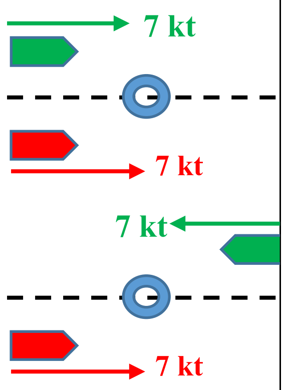
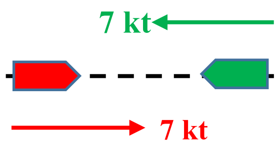
Time Bias	Pitch Bias	Yaw Bias	Roll Bias
 • Boat passes above a feature, e.g. a rock. • Same direction. • Same line • 2 different vessel speeds: 3.5 and 7 knots.	 • Boat passes above a feature, e.g. a rock. • Opposite directions. • Same line • Same vessel speed: 7 knots.	 • Boat passes next to a feature, e.g. a rock. • Same or opposite directions. • 2 different lines • Same vessel speed: 7 knots.	 • Boat passes above a flat featureless area. • Opposite directions. • Same line • Same vessel speed: 7 knots.

Figure 22: Patch test set up for single head MBES system

C.3.2 Patch Test Results

Vessel	R/V Gulf Surveyor	
Echosounder	Sonic 2026	
Date	13th June, 2019	
Patch Test Values	*Latency*	0.00 seconds (assumed)
	Pitch	0.0°
	Roll	-1.13°
	Yaw	0.0°

Table 16: Sonic2026 alignment correctors from patch test, inputted into CARIS

C.4 Positioning and Attitude

RTK correction data was collected from the GNSS base station established at Odiorne State Park. RTK corrections were broadcast from the roof of the Seacoast Science Center from a Trimble Trimmark 3 radio Modem via a frequency of 461.0750MHz at 4800 bps using TT450S Trimtalk protocol. They are provided in CMR+ format as 8 bit, 1 stop bit, and None Parity corrections with a 35W signal. The corrections are automatically brought into and applied in POSView.

C.5 Sound Speed

C.5.1 Sound Speed Profiles

Sound speed profiles were applied to the data during survey operations in Qinsy. As the sound speed profiles were acquired at a high sampling rate, there was no need to import further profiles in CARIS during post processing. In CARIS, post-processing sound speed profiles were applied to the multibeam data based on "Nearest in Distance within Time" of 1 hour methodology.

C.5.2 Surface Sound Speed

Surface sound speed was logged by the ODOM Digibar Pro located near to the transducer head. This was applied in real time, for ray tracing calculations.

D. Acceptance Sheet

Supervision Statement:

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

Approval Statement:

All field sheets, this Descriptive Report and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch

Adequacy Statement: The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys and Specifications Deliverables Manual, Field Procedures Manual. Standing and Letters Instructions and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

Any Additional Statements:

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

Appendix A

Survey Operations Wiring Diagram

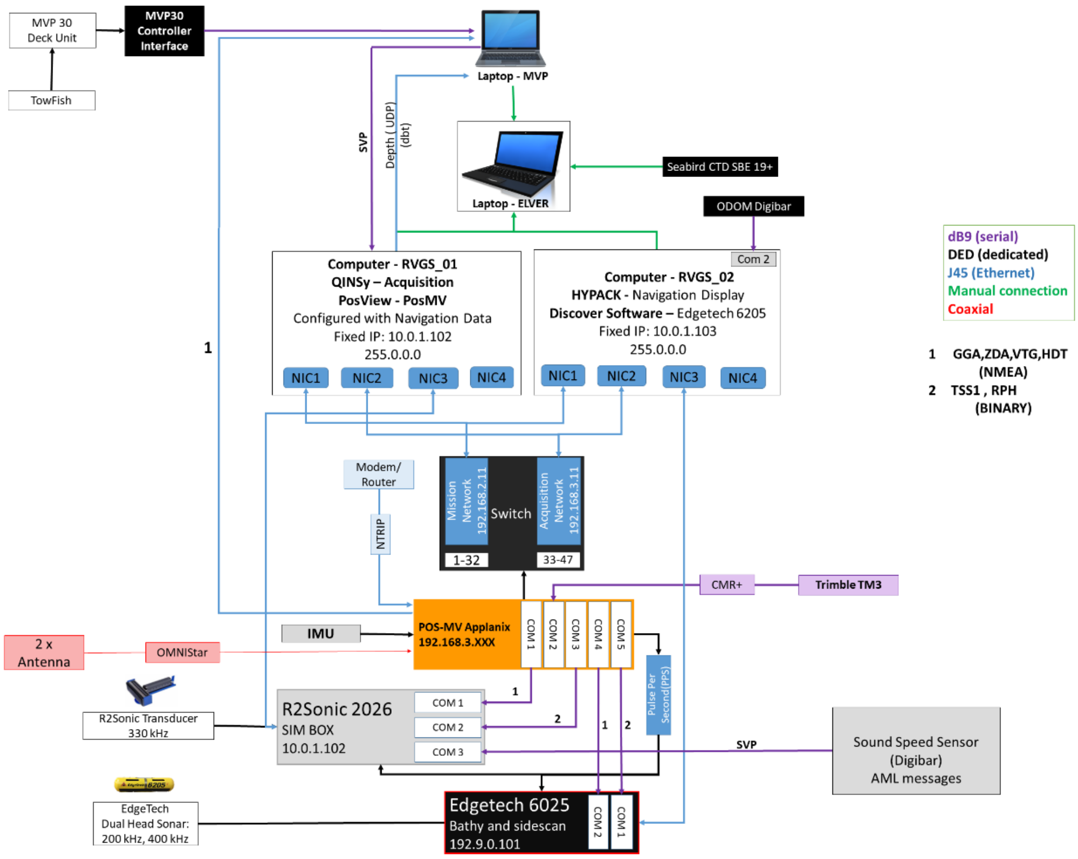


Figure 23: RVGS Survey Operations Wiring Diagram