W00290

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Survey

DESCRIPTIVE REPORT

Type of Survey:	Outside Source Data
Registry Number:	W00290

LOCALITY

State(s):	North Carolina
General Locality:	Offshore of North Carolina
Sub-locality:	Between Cape Island and Cape Lookout

2014

CHIEF OF PARTY

David Berrane, Warren Mitchell, Matt Wilson

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Date:

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00290

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):	**North Carolina**
General Locality:	**Offshore of North Carolina**
Sub-Locality:	**Between Cape Island and Cape Lookout**
Scale:	**40000**
Dates of Survey:	**07/05/2014 to 08/02/2014**
Instructions Dated:	**N/A**
Project Number:	**OSD-AHB-14**
Field Unit:	**NOAA Ship *Pisces***
Chief of Party:	**David Berrane, Warren Mitchell, Matt Wilson**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks: The Simrad ME70 multibeam data was collected over hardbottom habitats as part of fishery sampling research.

The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Any revisions to the Descriptive Report (DR) generated during office processing are shown in bold red italic text. The processing branch maintains the DR as a field unit product, therefore, all information and recommendations within the body of the DR are considered preliminary unless otherwise noted. The final disposition of surveyed features is represented in the OCS nautical chart update products. All pertinent records for this survey, including the DR, are archived at the National Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.

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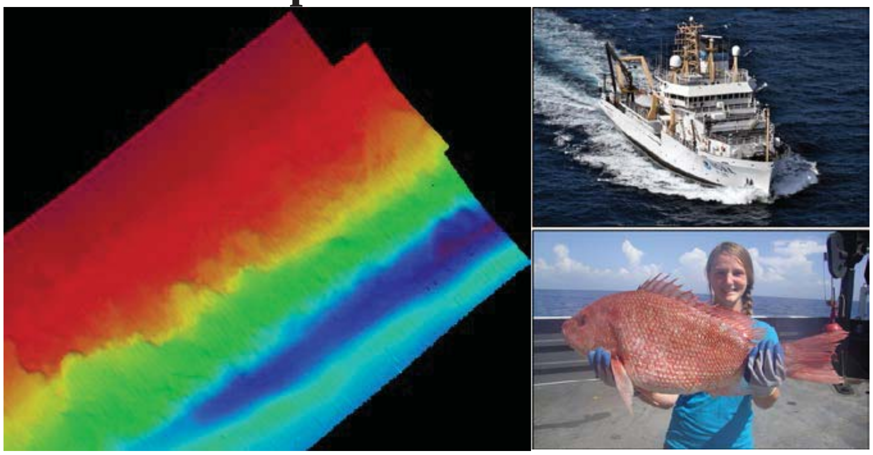
NOAA Ship *Pisces* Cruise PC-14-02



OBJECTIVES AND BACKGROUND

The objective of NOAA Ship *Pisces* during cruise PC-14-02 was to conduct applied fishery-independent research in continental shelf and shelf-break waters off the southeastern U.S., on behalf of the NMFS SEFSC Southeast Fishery-Independent Survey (SEFIS). A key focus of this research was the acoustic mapping of hardbottom, reef fish habitats using the Simrad ME70 multibeam sonar. Data were collected for non-standard hydrographic purposes, thus do not strictly conform to required OCS specifications. **However these data are hereby submitted to the National Ocean Service (NOS) Office of Coast Survey (OCS) as outside source data, should additional uses be deemed beneficial (e.g., potential nautical chart updates).** A secondary objective was to continue building the capacity for the NOAA Ship *Pisces* and the SEFIS program to conduct acoustic mapping operations, and for this document to serve as a perennial reference.

Mapping operations occurred overnight (usually between 1800-0600 local time) and hydrographic data were processed and assessed rapidly for immediate use. Each morning during the cruise, multibeam bathymetry and backscatter geotiffs were delivered to Chief Scientists; maps were used to select fish sampling sites (i.e., camera-trap deployments) that targeted hardbottom habitat. Hydrographic data have now been significantly reprocessed, resulting in this Descriptive Report and associated data submission.

NOAA ship *Pisces* Operations Officer LT Kyle Byers, ET Patrick Bergin, and ET Bob Carter are recognized for pursuing improvements to *Pisces* mapping capabilities before the 2014 cruise began. We appreciate Glen Rice (NOS OCS) and *Pisces* ST Adria McClain for their support of the mission. Thanks to SEFIS Chief Scientists Nathan Bacheler and Zeb Schobernd, and Commanding Officer CDR Peter Fischel and all officers and crew of NOAA Ship *Pisces*. Surveys were operated by Mary Eaton and Christina Hefron (College of Charleston), Erik Ebert (NOS NCCOS), Dawn Glasgow (SCDNR), Laura Kracker (NOS NCCOS), and the report authors. The report was prepared and submitted by Matthew Wilson (OCS), Warren Mitchell (SEFIS), and David Berrane (SEFIS).

ACRONYMS AND ABBREVIATIONS

BITE	Built-In Test Equipment
CTD	Conductivity Temperature Depth
DGPS	Differential Global Positioning System
FMGT	Fledermaus Geocoder Toolbox
GAMS	GPS Measurement Azimuth Subsystem
GPS	Global Positioning System
GSF	Generic Sensor Format
HDCS	Hydrographic Data Cleaning System
HIPS	Hydrographic Information Processing System
HSSD	Hydrographic Survey Specifications and Deliverables
HSTP	Hydrographic Systems and Technology Programs
HVF	HIPS Vessel File
IMU	Inertial Measurement Unit
IOCM	Integrated Ocean and Coastal Mapping
LNM	Local Notice to Mariners
MBES	Multibeam Echo Sounder
MLLW	Mean Lower Low Water
NCCOS	National Centers for Coastal and Ocean Science
NGS	National Geodetic Survey
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NTM	Notice to Mariners
NWLON	National Water Level Observation Network
OCS	Office of Coast Survey
POS MV	Position and Orientation System for Marine Vessels
SBE	Sea Bird Electronics
SBET	Smoothed Best Estimate of Trajectory
SCDNR	South Carolina Department of Natural Resources
SCS	Scientific Computer Systems
SEFSC	Southeast Fisheries Science Center
SEFIS	Southeast Fisheries-Independent Survey
XBT	Expendable Bathythermograph
XML	Extensible Markup Language
UNH-CCOM	University of New Hampshire, Center for Coastal and Ocean Mapping

Descriptive Report to Accompany NOAA Ship *Pisces* 2014
Project PC-14-02, OCS Registry # W00290
Morehead City, North Carolina to Morehead City, North Carolina
July 05-18, July 20-August 2, 2014

A. AREA SURVEYED

The survey areas were in the southeast U.S. continental shelf waters offshore of North and South Carolina, ranging from over 88 nm east of Wilmington, NC on the northern extent, to 110 nm off Georgetown, SC on the southern extent (Figure 1). The survey consisted of complete coverage multibeam using the Simrad ME70 (fisheries MBES) over a series of boxes predetermined by SEFIS fisheries biologists based on external information (e.g., legacy fishery-independent monitoring sites, observed commercial catches, partial bathymetry). The surveyed distance totaled approximately 2,180 linear km within 46 discrete survey areas.

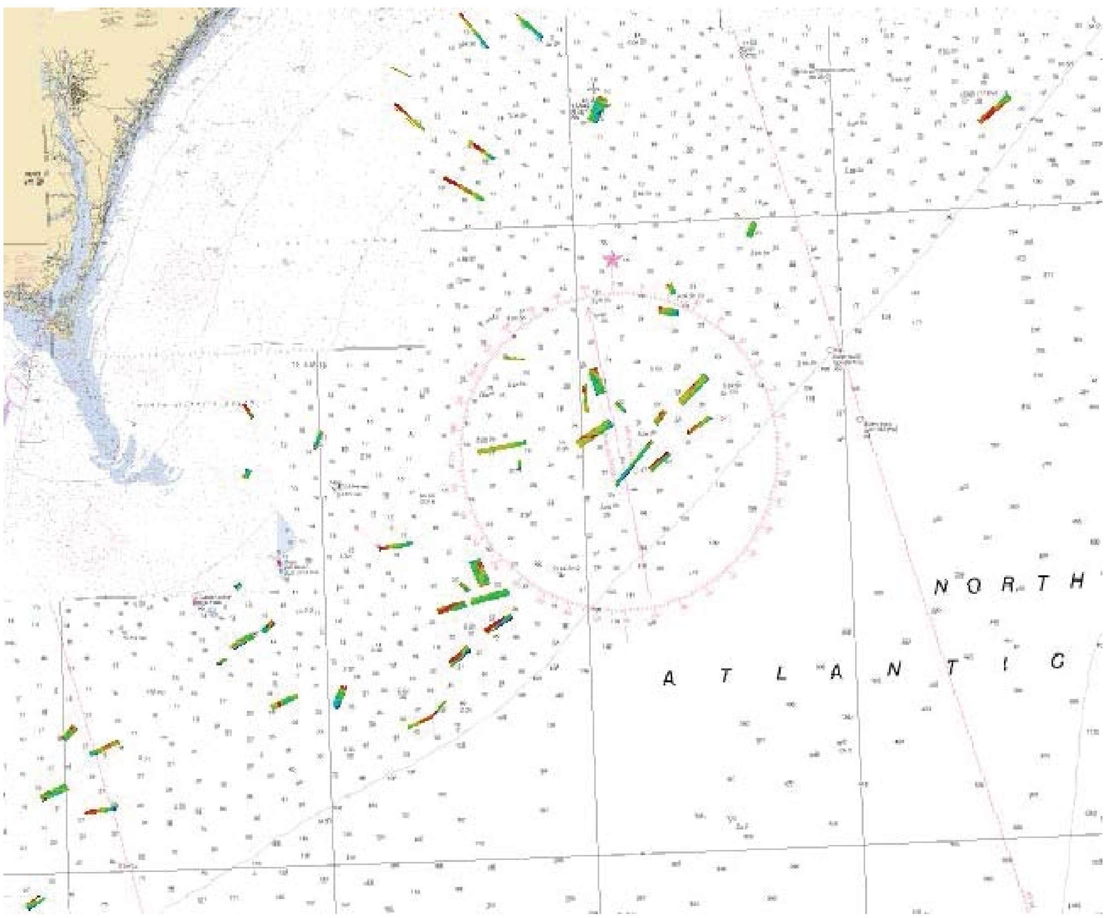


Figure 1. W00290 survey areas (NOAA Raster Charts 11536, 11539, and 11520 in background).

B. DATA ACQUISITION AND PROCESSING

B1. Equipment

B1a. Vessel

Specifications for the NOAA Ship *Pisces* are listed below in Table 1.

Table 1. Vessel and equipment

	 **NOAA Ship *Pisces***
Hull Number	R226
Builder	VT Halter Marine, Inc., Moss Point, MS
Length	63.8 m (209 ft)
Beam	15.0 m (49.2 ft)
Draft (centerboard retracted)	6.0 m (19.4 ft) Full load
Draft (centerboard extended)	9.05 m (29.7 ft)
Cruising Speed	14.5 knots (16.0 knots max)
Survey Speed	5 - 9 knots
Primary Echosounder	Simrad ME70
Sound Speed Equipment	Seabird CTD, Sippican XBT, SBE45, SBE21
Attitude and Positioning Equipment	Applanix POS MV V3, Leica MX420 DGPS

B1b. Multibeam echo sounder

The Simrad ME70 is a multibeam echo sounder designed for fishery research applications, and therefore can collect information from the full water-column while minimizing side-lobe levels

(Trenkel et al. 2008). The system operates in the 70 to 120 kHz frequency range over a 150° maximum total swath width. The beam parameters of the system are configurable and designated by XML file. Note that each of the beams can be set at a different frequency.

One beam configuration was used during W00290, written by Dr. Tom Weber from the University of New Hampshire Center for Coastal and Ocean Mapping. For display purposes, beam characteristics were read directly from example *.raw files, via Myriax Echoview fisheries acoustics software, and reformatted in spreadsheet form by Erik Ebert (NCCOS). The configuration is included in Appendix II: ME70 Beam Configuration.

At the cruise outset a known ME70 technical issue was present where both live display and data acquisition would occasionally "dropout" for a period of seconds to minutes (Figure 2). The issue was mitigated during cruise leg I, and greatly reduced during leg II (see additional discussion in Section B2).

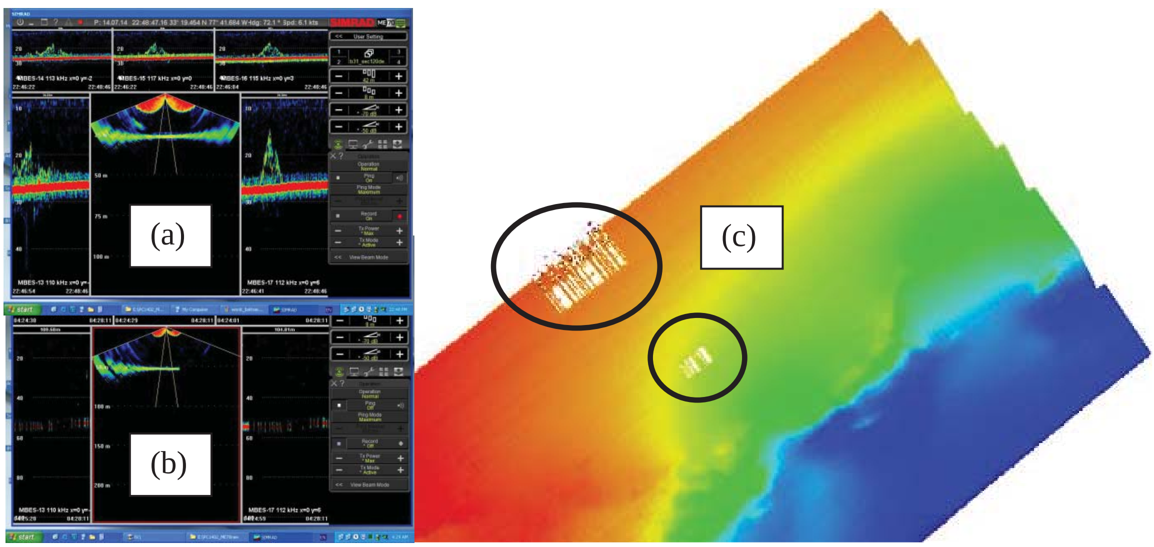


Figure 2. Example images of data dropouts experienced during W00290. Panels at left depict ME70 live displays during (a) normal operation with fish schools visible in the water column, and (b) during dropouts. Panel (c) depicts the resulting effect of data dropouts on bathymetric surfaces (circled).

During normal operation, the ME70's Built-In Test Equipment (BITE) utility revealed four significantly defective array elements (Figure 3). The ME70 Operator Manual states, "... up to four defect elements show no significant degradation of performance."

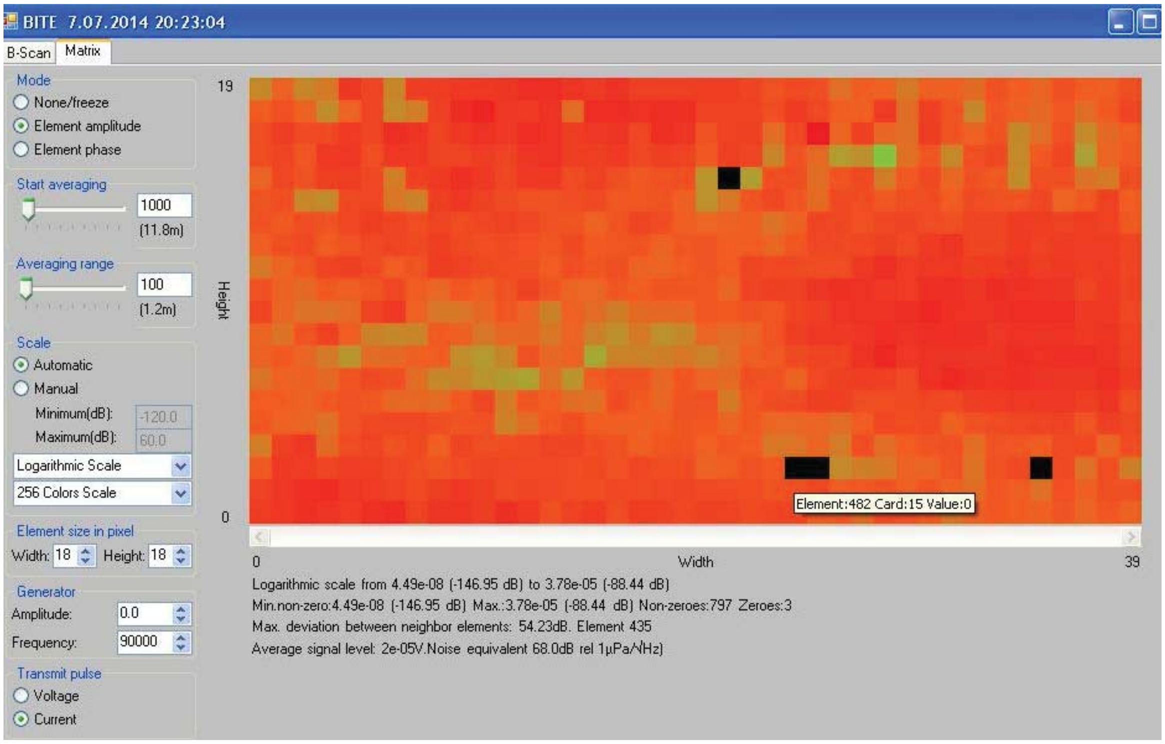


Figure 3. BITE transmitter test run on 7 July 2014. Elemental transmissions were equal per methods described on page 46 of the ME70 Operator Manual. Four elements showed aberrant transmission.

B1c. Position, heading, and motion reference systems

The POS MV system with DGPS and inertial reference system supplies attitude, heading, heave, and position. The system consists of an IMU (used as the reference point for the ship), computer system, and two GPS antennas.

Antenna re-positioning

During March 2014, NOAA ship *Pisces* POS MV antennas were relocated to the ship's mast (Figure 4) to achieve a better view of the horizon, as had been recommended (e.g., W00269, 2014). Following relocation, a survey measured new offsets from each antenna to the POS MV IMU (see Appendix II: Vessel Documents). Note that both the 2014 and original 2007 survey reports utilize the "granite block" master reference plate as X, Y, Z reference point. Thus, offsets listed in survey reports do not correlate with the W00290 POS MV configuration. During W00290, updated IMU-to-port primary POS MV antenna offsets were calculated and entered into POSView using the POS MV IMU as the reference point; offsets were then verified via post-processing of logged motion data in Applanix POSPac software. The calibrated installation parameters revealed the X, Y, Z lever arm to stray up to 25, 42, and 15 cm, respectively, over an 11 hour dataset.

Figure 4. 2013 and 2014 POS MV antenna positions relative to ship superstructures. The port antenna is labelled in each image.

Successful GAMS calibration

The POS MV GPS Azimuth Measurement Subsystem (GAMS) provides heading aiding to the system. A successful GAMS calibration was achieved while underway (Figure 5), and the updated baseline vector was updated. To our knowledge, this was the first successful GAMS calibration since system installation. The successful calibration is attributed primarily to the re-positioning of the POS MV antennas. The re-positioning provides the antennas with a more clear view from horizon to horizon (no longer blocked by the mast), and the intermittent heading “dropouts” observed in the past (W00269, 2014) were mitigated.

Figure 5. Results of a successful GAMS calibration (i.e., "GAMS Online") achieved on 7 July 2014. Note that the heave LED accuracy indicator and label "Heave" are colored gray; it was verified that heave data were being correctly applied in real time, though the LED indicator remained gray during PC-14-02 Leg I (See Appendix II for correspondence). An in-port adjustment by *Pisces* ET staff circa 19 July yielded a green LED indicator during Leg II.

Ongoing Issues

In 2013 (W00269, 2014), Applanix staff examined recorded motion data from the NOAA Ship *Pisces* POS MV and noticed an excessive number of cycle slips in both frequencies, particularly the L2. Cycle slips were attributed to environmental interference on board NOAA ship *Pisces*. Another concern was that the Z gyro scale of the raw IMU readings (e.g., 750 ppm) far exceeded the maximum allowable tolerance (±200 ppm). Applanix staff recommended the IMU be sent in for calibration, which would allow for comparison of the IMU data to the results of the manufacturer specifications. The IMU was indeed removed during spring 2014 and tested at Applanix facilities (See Appendix II for correspondence). No major IMU malfunctions were found. The observed z gyro scale errors were found to be generally within specifications. Though there were fewer cycle slips in the L1 frequency, there continue to be excessive cycle slips in the L2 frequency. This may explain why attempts to post-process NOAA ship *Pisces* POS MV data to create Smoothed Best Estimate of Trajectory (SBET) positioning have mostly failed. A follow-up with Applanix is recommended in order to determine the reason for the high number of L2 cycle slips, as this is likely indicative of system performance less than its full capacity.

Application of delayed heave

As in 2013 (W00269, 2014), the application of the logged POS MV files (.000) for the Trueheave correction in post-processing using CARIS HIPS had no noticeable effect on the data, so this step was not regularly performed.

B1d. Sound speed equipment

NOAA ship *Pisces* has two thermosalinographs (SBE45 and SBE21) that supply seawater real-time transducer sound speed, and a CTD sensor (SBE 03 Plus) that provides water column sound speed for ray trace corrections in post-processing. All sensors were calibrated in 2014 (Table 2, courtesy of *Pisces* ET staff). Additionally, a XBT system that measured temperature as a function of elapsed time was stationed approximately amidships on the starboard side of the vessel.

Table 2. Sound speed sensor calibration dates

Sensor	**Date of last calibration**
SBE 03 Plus	3/29/2014
SBE45	1/11/2014
SBE21	1/11/2014

Real-time transducer sound speed

Accurate sound speed measurements at the transducer face are critical, because errors in these measurements are propagated through the ray trace and can introduce systematic error into raw data files. The SBE45 was designated to supply real-time sound speed data for beam steering, as discussed extensively in W00269 (2014). A formatted SCS sentence data feed was delivered to the ME70 system at a 1 Hz rate (Figure 6).

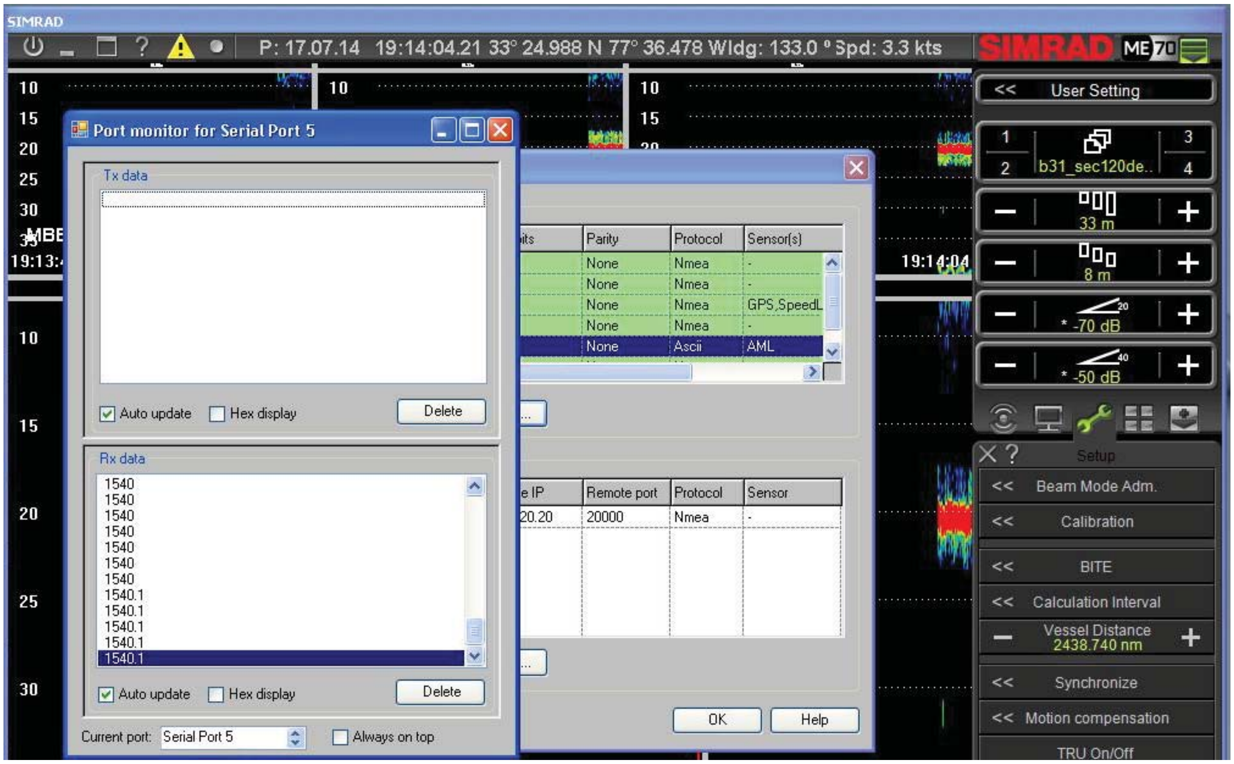


Figure 6. The real-time 1 Hz frequency feed from the SBE45, as reported to the ME70 system Serial Port 5 on 17 July 2014.

Water-column sound speed

Full water-column sound speed profiles can be obtained via SBE 03 Plus CTD or the XBT system. The SEFIS program used XBT's during nighttime mapping operations. Though sound speed was most commonly derived from XBT data for use in post-processing, CTD casts were occasionally used and assisted in assessing the performance of the XBT system. At the beginning of the cruise, on two separate occasions, a CTD cast was performed concurrently with a XBT cast, and the resulting sound speed profiles were compared via a ray-tracing uncertainty analysis. Results (see Appendix II) show that using XBT's for ray-tracing corrections (rather than CTDs) had a negligible effect on multibeam echo sounding and justified usage of the XBTs. File conversions from native format to Caris-compatible format (i.e., *.svp) were executed via the Pydro Velocipy python script.

B1e. Software inventory

The name, version, and purpose of software used during W00290 are given in Table 3.

Table 3. Software List

Hypack	v13.0.0.6	Line planning
GPS Utility	v5.17	Line plan format conversion
Rose Point ECS	v2.0.11159.1751	Navigation
Simrad ME70	v1.1.1	Acquisition
MATLAB executable script	22 April 2014	Extract soundings, convert *.raw to *.gsf
POSView	v3.3.0.0	Interface with POS MV
CARIS HIPS	v7.1.2 SP2	Process bathymetry
FMGT	v7.3.4	Process backscatter
POSPac MMS	V6.6	Process vessel drafts and SBETs
CARIS Base Editor	v4.0.4.0.11	GIS applications, create soundings
Pydro	v13.7	Fetch tides, Velocipy

B2. Quality Control

Nighttime surveyors maintained careful watch over the Simrad ME70, monitoring for issues affecting data quality during acquisition, such as interference from other sounders, errors, warnings, or screen freezes. The range gates on the ME70 were monitored carefully to ensure bottom detections were retained, and to ensure the reception of incoming position, motion, and sound speed data feeds. Alarms were set within Rose Point ECS to alert the start and end of survey lines.

On a few occasions, the ME70 had to be shut down and restarted in order to resolve frozen screens or errors from the transceiver boards, and the ship turned back around in order to maintain a complete coverage. The ME70 system shutdowns were minimized by ensuring pinging was halted prior to changing any sonar settings. Precautions were also taken to avoid connecting portable hard drives to the ME70 for data migration while data were being written to file. Data transfers occurred during turning maneuvers, while not recording data. We strongly recommend that the ship provide network data transmission capabilities, such that the transfer could occur without the need for portable hard drives.

During the first leg, the ME70 bottom loss (discussed above in Section B1b.) was a prevalent issue, somewhat mitigated by stopping the pinging during turns. The issue was largely eliminated during the second leg by replacing a malfunctioning Ethernet network switch.

Survey line spacing ranged 50-140 m to ensure overlap sufficient to maintain complete coverage. Survey line plans were generated in Hypack, and then converted, via GPS Utility, into a format usable by Rose Point ECS software in use on the NOAA ship *Pisces* bridge. Survey speeds were maintained at 6-8 knots in efforts to conform to HSSD requirements for data density that stipulates 95% of all grid nodes need contain 5 or more soundings. All data were gridded at a 4m resolution, regardless of the depth. As shown in Figure 7., most of the survey areas were in the 36-80m depth range that specifies a 4m resolution; however, there is a significant amount of survey area (>25%) that is less than 36m depth and would normally require a 2m resolution.

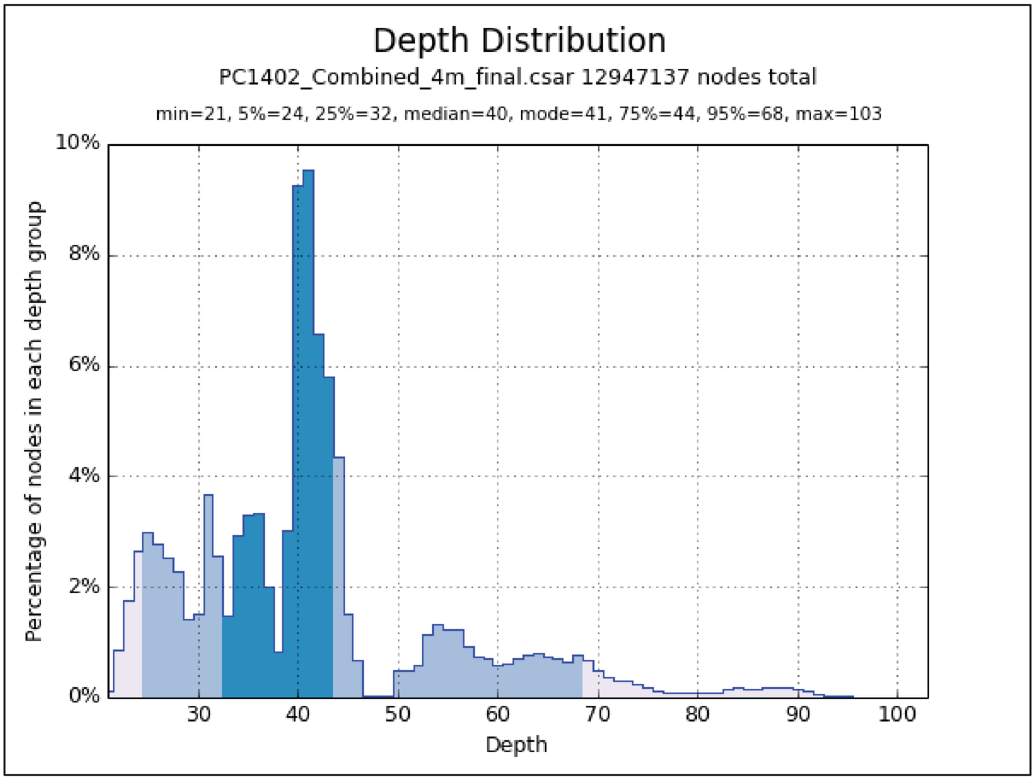


Figure 7. Depth distribution of W00290.

Gridding at a 2m resolution in depths less than 36m resulted in grid nodes with fewer than 5 soundings, or nodes with no soundings at all, in the nadir depths. Rather than reducing vessel speeds to achieve a 2m grid resolution, a 4m grid resolution was used in those areas less than 36m depth, which is not in compliance with NOS specifications. However, to meet SEFIS objectives a greater overall coverage was deemed preferable to achieving a finer grid resolution of the bathymetric data. In other words, the priority was to determine the general location of the bathymetric relief and hardbottom where reef fish might be, not to obtain the best representation of them.

Even at the 4m resolution, it was still sometimes difficult to achieve 5 or more soundings in the nadir beams when cruising at 6-7 knots. This is because phase detections (associated with the lower grazing angles of the outer beams against the seafloor) allow for multiple soundings per beam, whereas the amplitude detections of the nadir beams only permit one sounding per beam. Figure 8. shows the great disparity in data density between the nadir and outer beams.

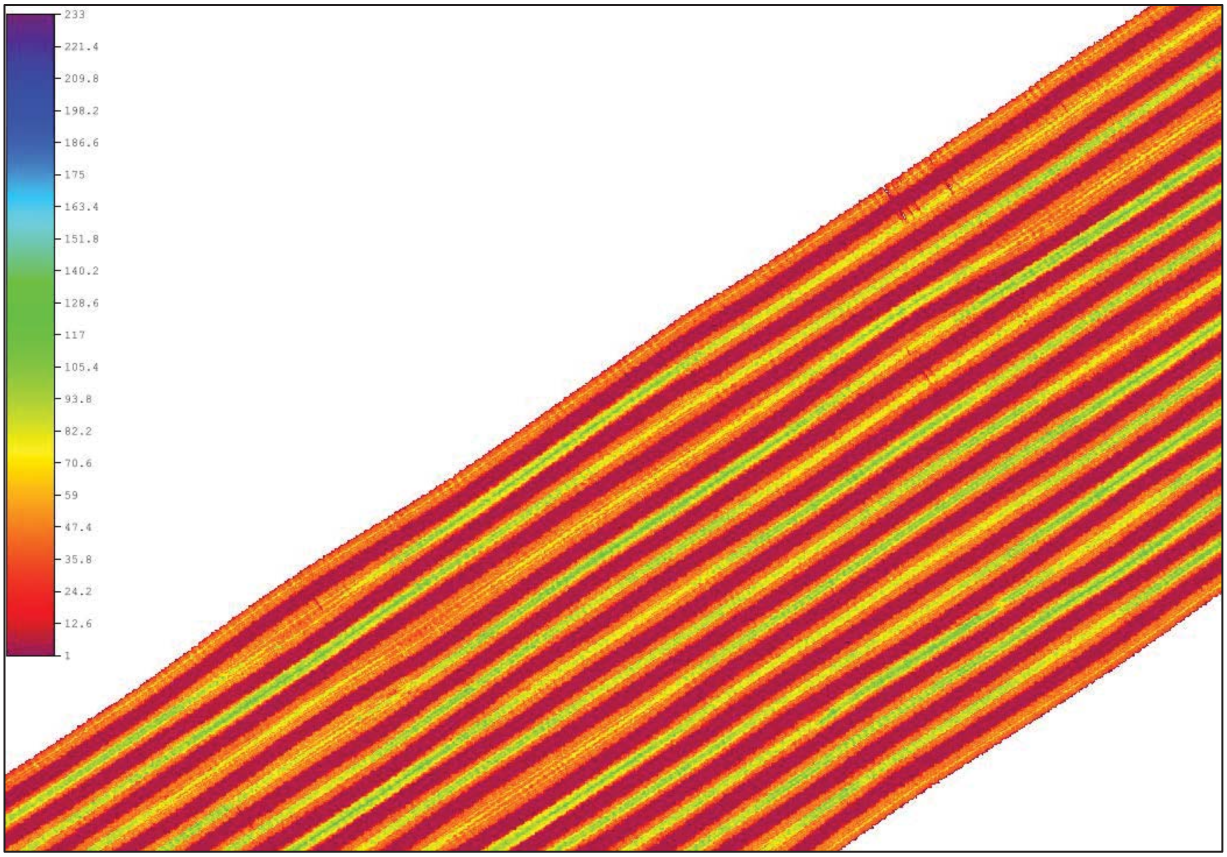


Figure 8. Box 26 (depth range 37-45m) at 4m resolution, where data density is shown in soundings per node (legend is given on the top left). There are 3 distinct "zones" of density: 1) the nadir beams, colored in purple (generally 5 soundings or less per node), 2) the outer beams, colored in orange (between 20-50 soundings per node), and 3) overlapping swaths of outer beams, colored in yellow/green (between 70 and 120 soundings per node).

There are occasional data holidays in the grids greater than 3 nodes across, the result of imperfect line steering. In addition, there are numerous areas of data dropouts (attributed to a malfunctioning Ethernet switch, discussed in Section B1b.) that were not backfilled. On most nights, SEFIS deemed the mapping of new areas preferable to backfilling holidays.

In total, 93.2% of grid nodes contain 5 or more soundings, slightly less than the 95% requirement per NOS specification. The breakdown of sounding per node against percentage of nodes in each sounding density group is given in Figure 9.

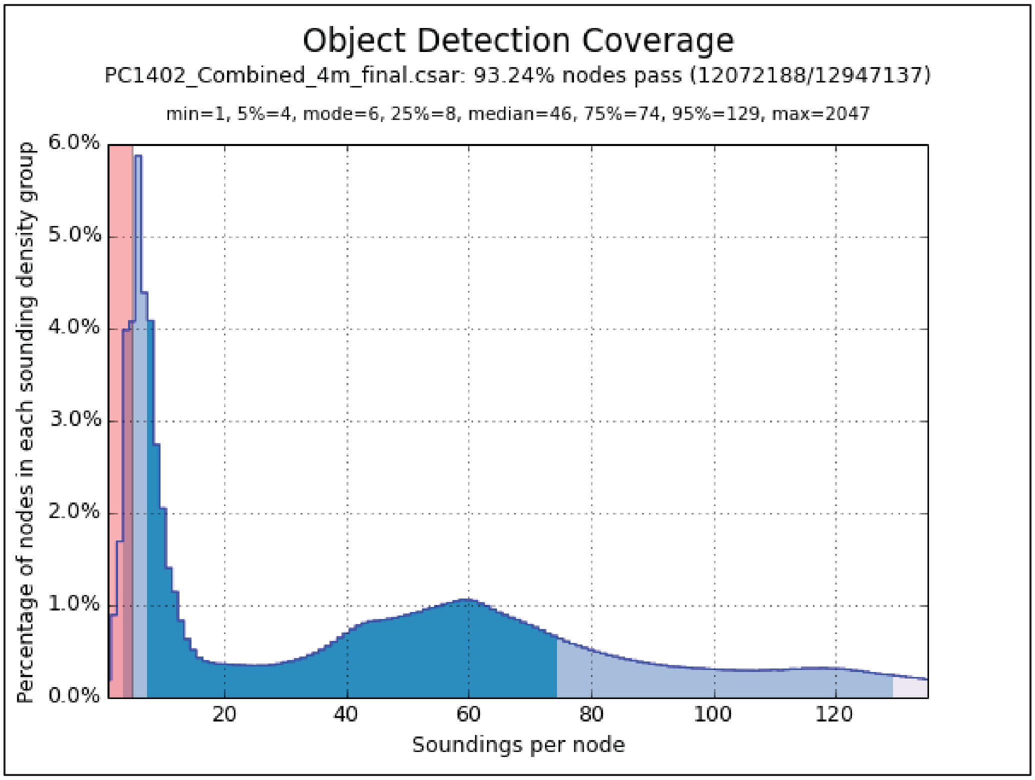


Figure 9. Soundings per node of all the 4m resolution grids against percentage of nodes in each sounding density group. In total, 93.2% of the nodes contain 5 or more soundings.

B2a. Crosslines

Crosslines were not a requirement for SEFIS, and a greater overall coverage was of higher priority than data redundancy checks. However, on DN198 (near the end of the first leg), there were opportunities to acquire data over wrecks recently surveyed by the NOAA Ship *Nancy Foster* in 2014 (cruise NF-14-04). Crosslines (Figures 10-11) were acquired during these investigations as an opportunistic data redundancy check, although these were acquired within a few hours of the mainscheme.

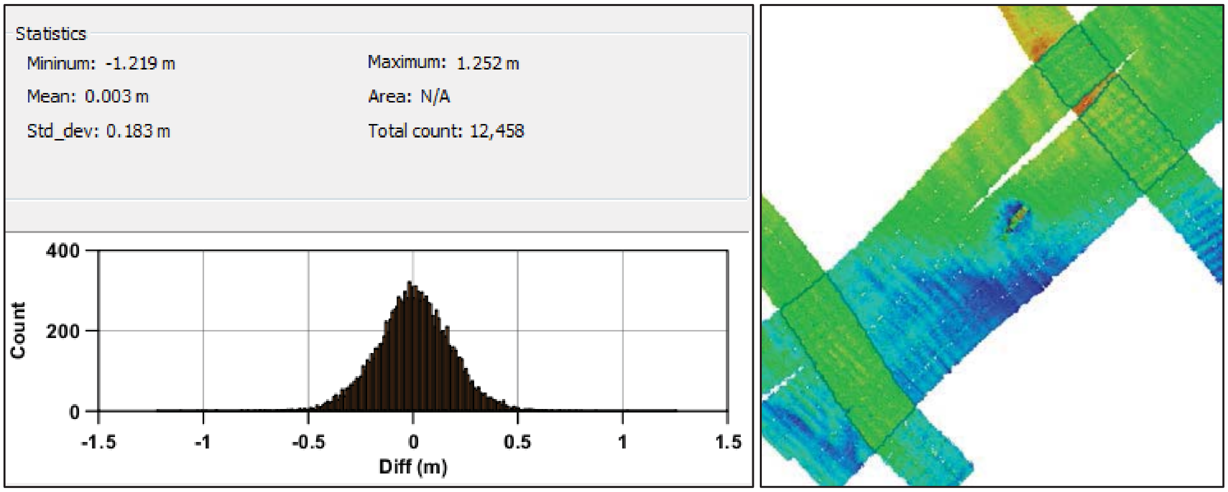


Figure 10. Statistics for a difference surface grid of the mainscheme versus crosslines, in the vicinity of a wreck located at approximately 33-23-38N, 77-52-41W.

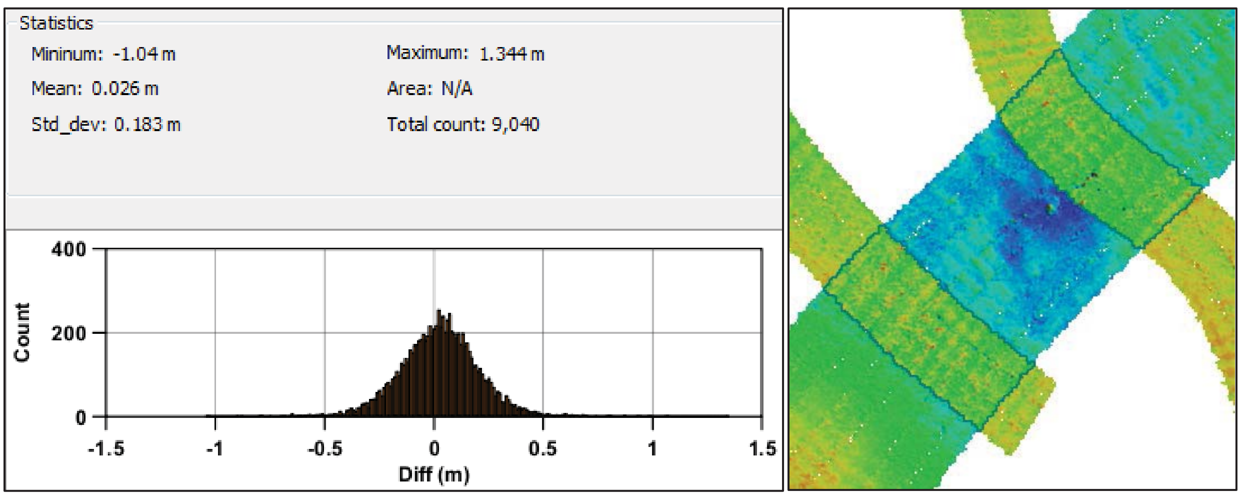


Figure 11. Statistics for a difference surface grid of the mainscheme versus crosslines, in a vicinity of a wreck located at approximately 33-24-19N, 77-42-44W.

B2b. Junctions

The 2014 NOAA Ship *Nancy Foster* data (cruise NF-14-04) were appropriate for assessing data junctions. Bathymetric surface comparisons (Figure 12) show that NOAA Ship *Pisces* data is half a meter deeper than NOAA Ship *Nancy Foster*, on average.

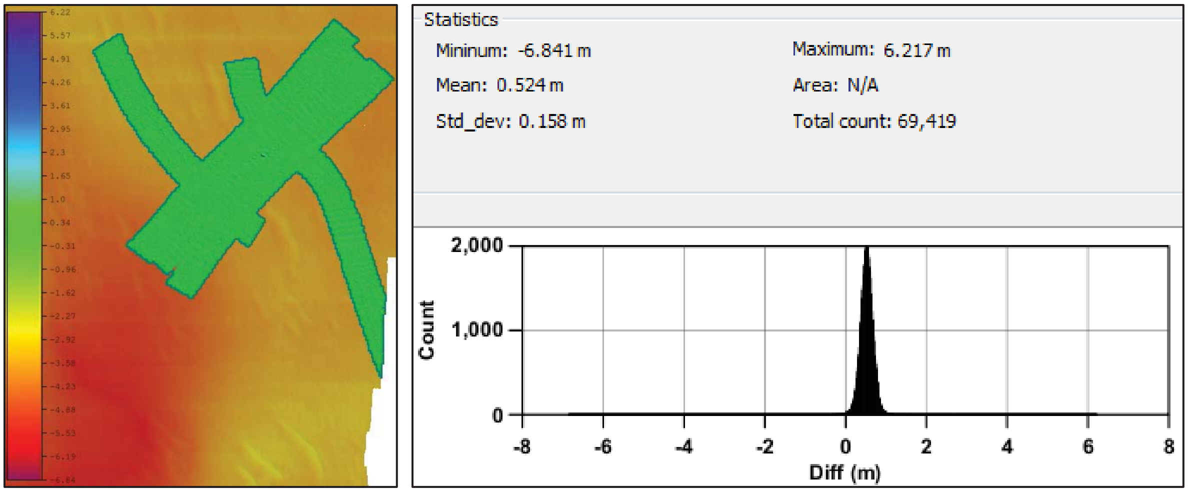


Figure 12. The difference surface of gridded bathymetry between NOAA Ship *Pisces* and NOAA Ship *Nancy Foster* has a mean and standard deviation of 0.524+/-0.158m. The wreck is very low-relief, except for one small section that extends 6 m off the seafloor. The least depth obtained by NOAA Ship *Pisces*, 20.687 m, is in an adjacent grid node to the least depth obtained by NOAA Ship *Nancy Foster*, 21.556m, and is the reason for the high minimum and maximum values of the difference surface.

NOAA Ship *Pisces* has a known deep bias (W00269, 2014) when compared to other survey platforms; however, the magnitude of the bias observed in 2014 is considerably less than observed previously, primarily because of an offseason update performed to the MATLAB code that derives the bottom detection from the raw ME70 sonar data (see Section B2d).

B2c. Uncertainty

Calculations of Total Propagated Uncertainty (TPU) were performed during post-processing of the data. In April of 2014, a CARIS HIPS device model for the beam configuration was created at CCOM-UNH and used in a HVF with estimates for each of the uncertainty components given in Table 4. The elements specific to tides and sound speed were entered into CARIS HIPS and are shown in Table 5.

Table 4. TPU standard deviation values

Motion Gyro (deg)	0.02
Heave %	5.00
Heave (m)	0.05
Roll (deg)	0.02
Pitch (deg)	0.02
Position Nav (m)	1.00
Timing Trans (s)	0.001
Nav Timing (s)	0.01
Gyro Timing (s)	0.01
Heave Timing (s)	0.01
Pitch Timing (s)	0.01
Roll Timing (s)	0.01
Offset X (m)	0.20
Offset Y (m)	0.20
Offset Z (m)	0.20
Vessel Speed (m/s)	0.03
Loading (m)	0.30
Draft (m)	0.025
Delta Draft (m)	0.02
MRU Align StdDev gyro	0.10
MRU Align StdDev Roll/Pitch	0.10

Table 5. TPU values of tides and sound speed

Tide	Measured: 0.01 m	Zoning: 0.2 m
Sound speed	Measured: 4 m/s	Surface: 0.2 m/s

Bathymetry was gridded using the Combined Uncertainty and Bathymetry Estimator (CUBE) algorithm. Additional layers were added to each surface that compute a ratio of the uncertainties to the allowable Total Vertical Uncertainty (TVU), per IHO Order 1 and Order 2 specifications:

$$(\text{Uncertainty}) / ((a^2 + (b * \text{depth})^2)^{0.5})$$

where a = 0.5m and b = 0.013m for Order 1, and a = 1.0m and b = 0.023m for Order 2. The resulting layers can be used for quality control purposes. Each grid node displays what percentage of the allowable TVU has been consumed (0 meaning there was essentially no uncertainty, and 1.0 meaning that 100% was consumed), and which nodes have exceeded the specification altogether. Any grid node with a value of 1.0 or of greater magnitude indicates that the allowable TVU has been exceeded, and therefore warrants further examination.

For this survey, somewhere between 5-10% of the grid nodes meet the IHO Order 1 specification (Figure 13). As shown in previous work onboard NOAA Ship *Pisces* (W00269, 2014), the ME70 generally does not meet the specification in depths less than 55m. For this survey, more than 75% of the nodes are in depths less than 55m (see Figure 7. Depth distribution of W00290).

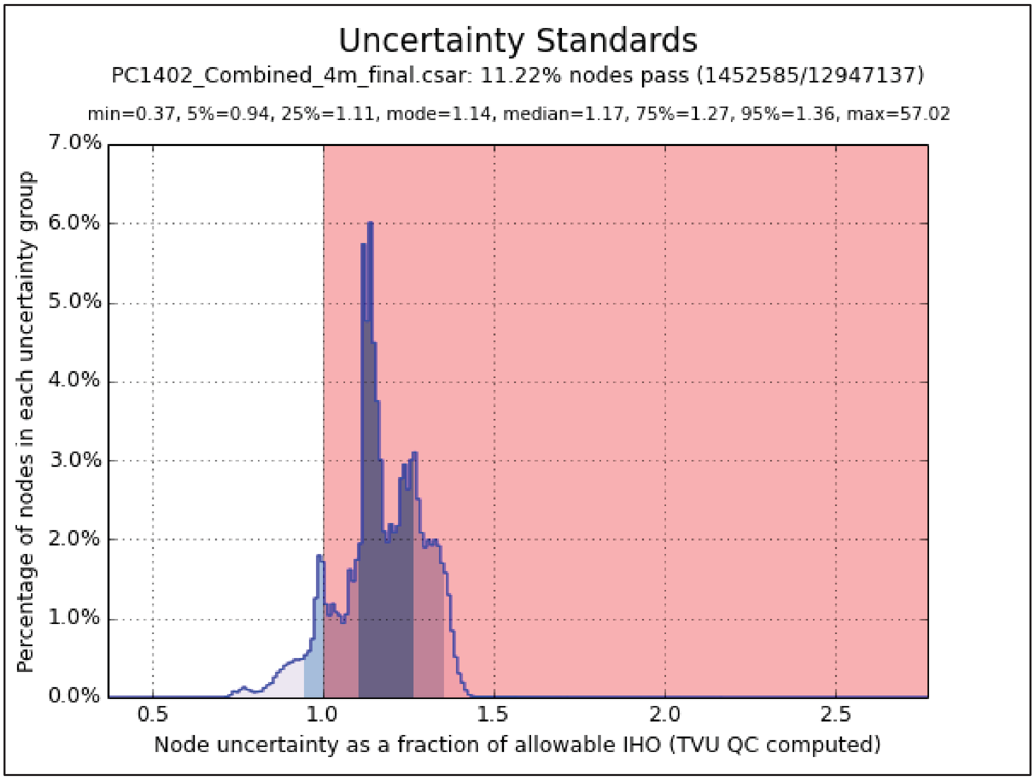


Figure 13. Node uncertainty per allowable IHO Order 1 (greater than 1.0 indicates the node has exceeded the specification)

Data at nadir begin to meet the IHO Order 1 criteria at depths deeper than 55m, as shown in Figure 14. The ME70 data generally meets IHO Order 2, in all depths.

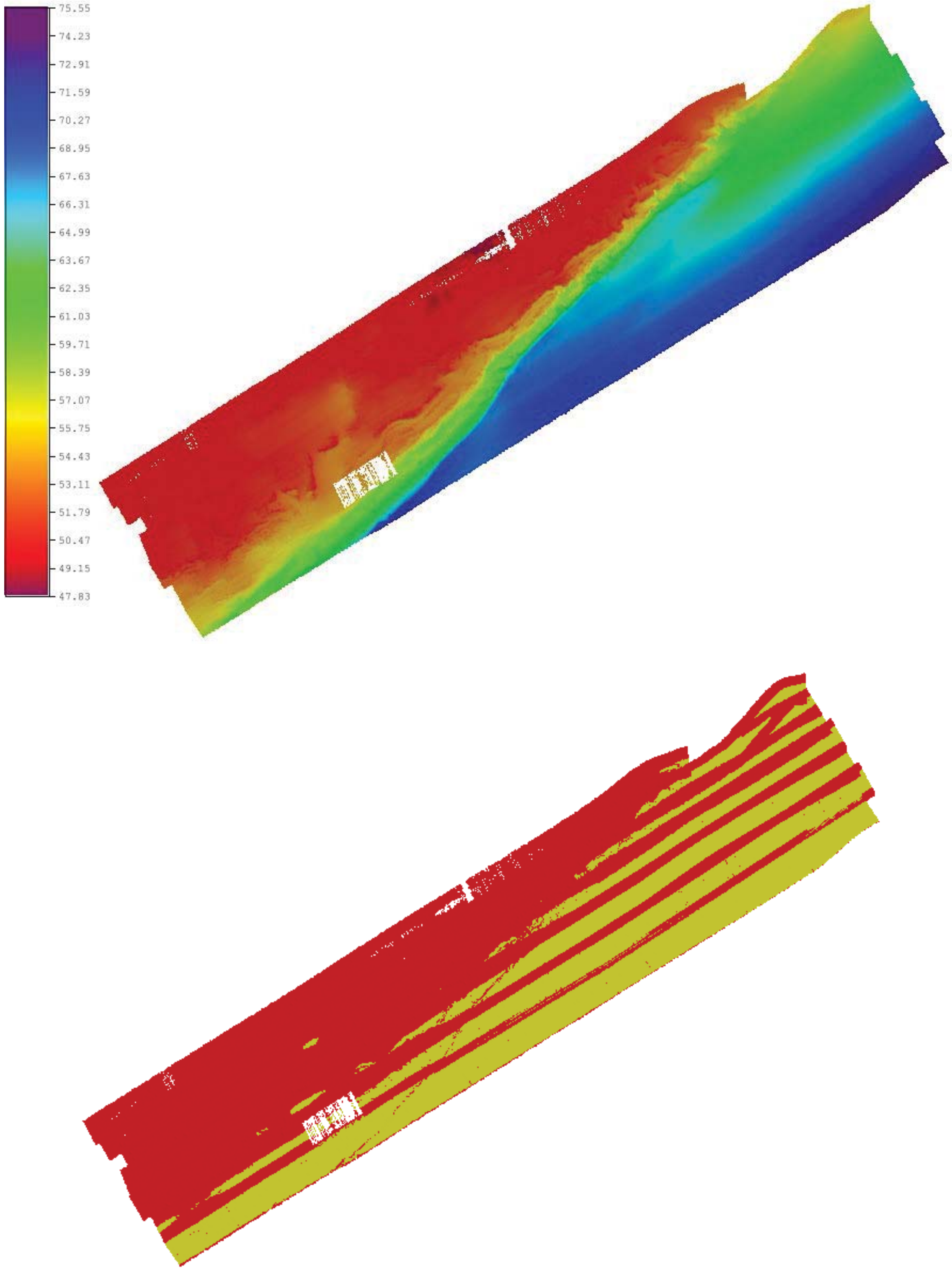


Figure 14. Depths between 47-75m of Box 36 (top), and the corresponding TVU QC layer (bottom), colored by “stoplight” criteria (i.e., red indicates nodes exceeded IHO Order 1 specifications, yellow nodes meet specifications). As depth increases beyond 55 m, a greater proportion of nodes at nadir meet specifications.

B2d. Issues affecting data quality

Software Update

Bathymetry data for this cruise showed a significant improvement from data collected in 2013. This was largely due to an update performed by Dr. Tom Weber to the MATLAB code that performs the bottom detection from the raw ME70 sonar data. The update was performed at CCOM-UNH during the offseason, delivered in April 2014, and used throughout the entirety of W00290.

The update corrects an offset in range of one pulse length that was not previously understood. This problem created an artifact in the data that resembled sound speed refraction, as well as a depth bias. Outer beams no longer needed to be filtered (as was done in 2013), and the deep bias likely has been improved as well. In 2013, ME70 data from NOAA Ship *Pisces* were 1.5-1.7m deeper than a NOAA contract vessel and NOAA Ship *Thomas Jefferson*. In 2014, the ME70 data were 0.52m deeper than NOAA Ship *Nancy Foster* (see Section B2b).

Heave

Real-time heave from the POS MV is logged in the raw ME70 data during acquisition and applied in post-processing. During 2014 operations the gridded bathymetry revealed a heave artifact up to 0.5m in magnitude. Application of True Heave in post-processing did not alleviate the artifact.

B3. Corrections to Echo Soundings

B3a. Vessel offsets

The POS MV antennas were repositioned in March of 2014 (see Section B1c), and resurveyed on March 27, 2014 by Schultz Geomatics (report included in Appendix II). Thus, the antenna offsets used in W00290 were taken from this 2014 survey. This survey did not, however, include measurements to the ME70 transducer. Thus, the offsets to the ME70 originate from a survey performed by Raymond C. Impastato in 2007 (also included in Appendix II). Note that both survey reports reference the ship's granite block, whereas offsets entered into the POS MV and into CARIS HIPS reference the IMU. An offset diagram is shown in Figure 15 (vertical) and Figure 16 (horizontal). The offset from the IMU to waterline is included in Figure 15 as well (waterline measurement is discussed in Section B3b).

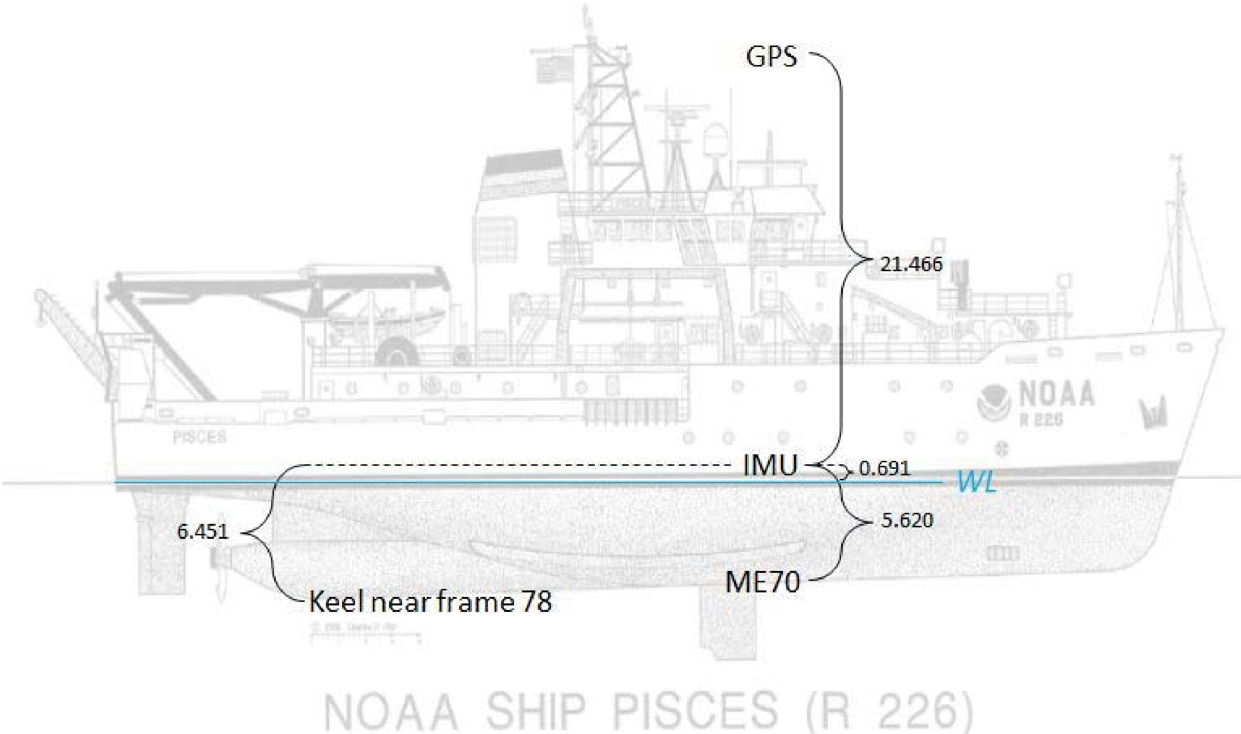


Figure 15. Vertical offsets referenced to the POS MV IMU (not to scale).

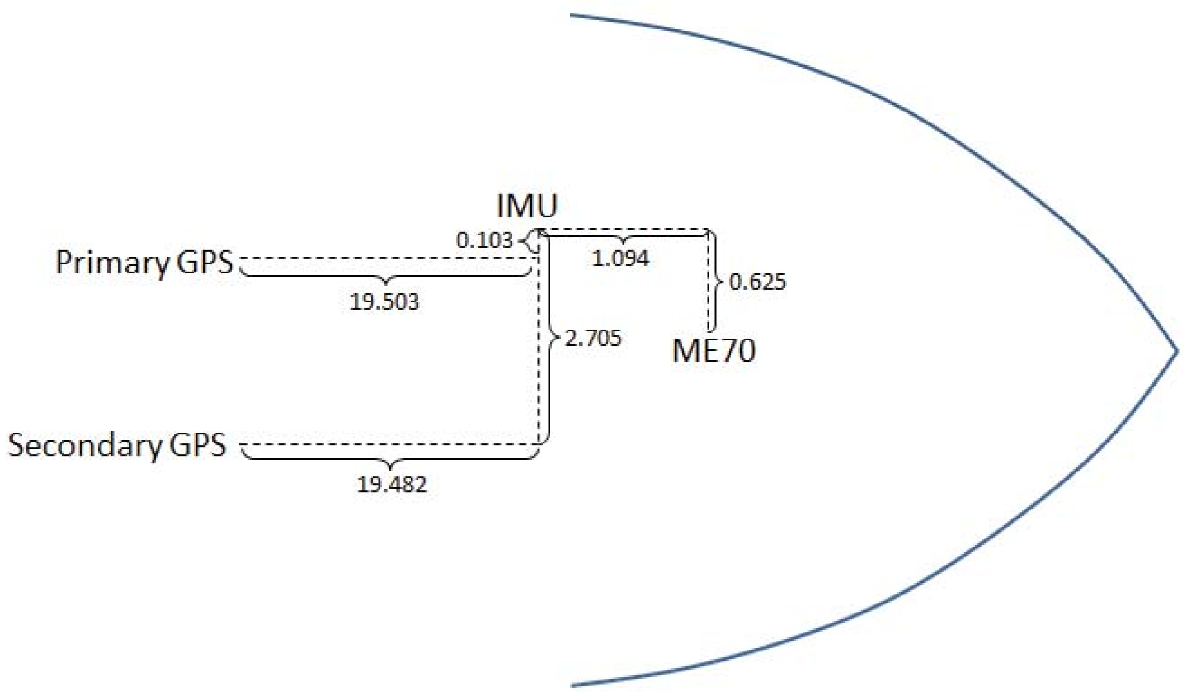


Figure 16. Horizontal offsets referenced to the POS MV IMU (not to scale).

B3b. Waterline

In 2013, the IMU to waterline offset was measured by three separate, independent methods; results obtained were all each within 3.4cm.

The first technique uses the vessel draft marks and ship offsets. Vessel draft marks reported from the bridge when leaving port on 6/12/2013 were 5.45 m (forward) and 6.13 m (aft). The average value (5.79 m) is an assumed measurement up from the keel near frame 78 mark (see Figure 15), which is the lowest surveyed offset on the ship according to the Impastato offsets (see Appendix II: Vessel Documents). The draft mark is then differenced from the offset from IMU to keel near frame 78 (6.451 m). The result is the offset from IMU to waterline, 0.661m.

The second technique, courtesy of Charles Thompson (see Appendix II: Correspondence), was measurement via lead line. The top of the IMU to the deck surface was 0.479 m, and from the deck surface to the waterline was 0.178 m. The result is the offset from IMU to waterline, 0.657 m.

The third technique uses ellipsoid reference methods in a procedure established by Glen Rice (2011), who also supplied the Python script. A time series of vessel ellipsoid heights (generated using Applanix POSPac from post-processed POS MV data to create an SBET) is differenced from a time series of a nearby water level gauge ellipsoid heights (Figure 17, left panel). Remaining offsets were a time series of IMU to waterline values (Figure 17, right panel), from which the mean provides the final estimate of 0.691m. The estimated uncertainty is high, 0.457m, a result of the high noise in the ellipsoid heights of the SBET, as noted in Section B1c., and observed in Figure 17.

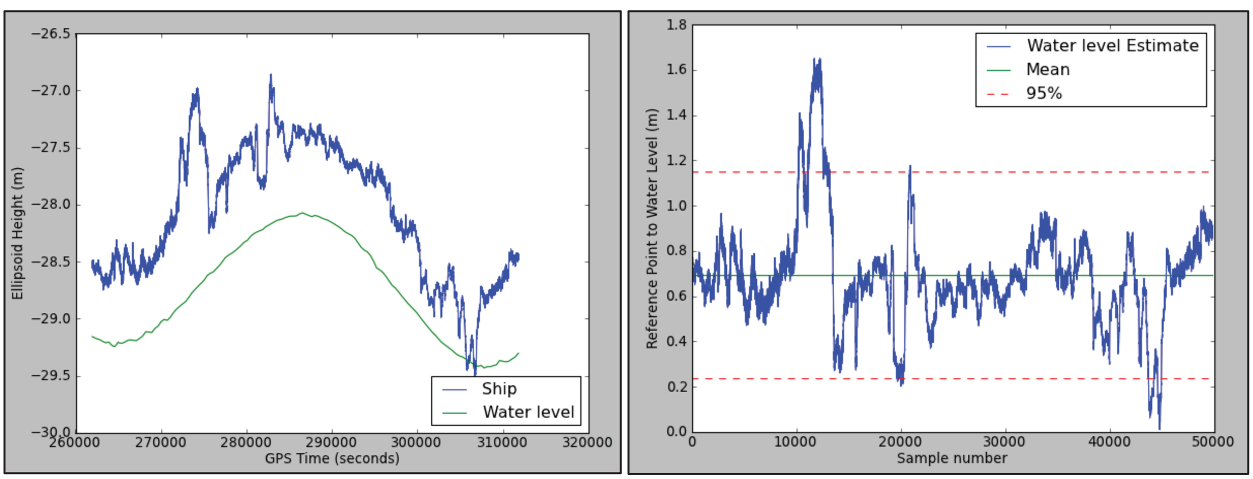


Figure 17. Vertical offset from ship reference point to waterline. The vessel and water level gauge ellipsoid heights (left) are differenced (right) to obtain an estimate.

The estimate of 0.691m was utilized as the waterline offset in the CARIS HVF and applied in post-processing.

B3c. Dynamic draft

The dynamic draft used in W00290 is taken from measurements performed onboard NOAA Ship *Henry Bigelow* in 2013 (Wilson and Wolfskehl, 2013), a fisheries survey vessel of the same class. The measurements were collected via ellipsoid referenced dynamic draft procedure (Rice, 2009), and involve post-processing of the ship POS MV data to obtain the ellipsoid heights at various speeds. The dynamic draft curve, and the values entered into CARIS HIPS (for application during post-processing) are shown in Figure 18.

$$+0.0118*X^3 - 0.111*X^2 + 0.401*X$$

Speed [m/s]	Delta Draft [m]
0.00	0.00
0.50	0.17
1.00	0.30
1.50	0.39
2.00	0.45
2.50	0.50
3.00	0.53
3.50	0.55
4.00	0.59
4.50	0.64
5.00	0.72
5.50	0.82
6.00	0.97

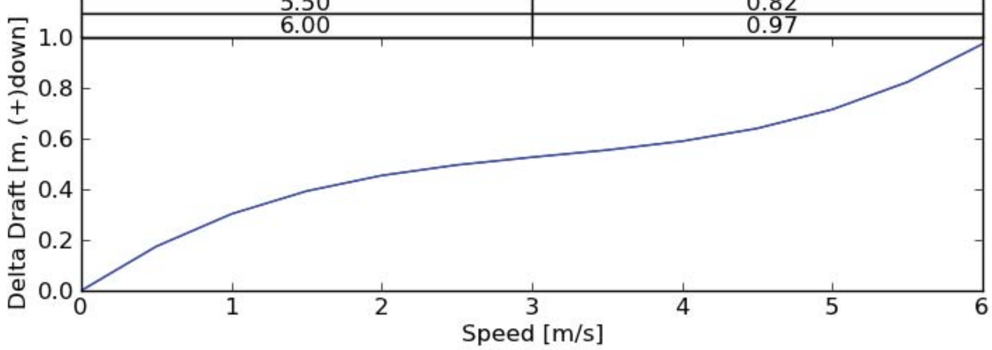


Figure 18. A 3rd order polynomial curve is fit to the ellipsoid heights at various vessel speeds. The values entered into the CARIS HIPS vessel file are shown in the embedded table.

B3d. Patch test

Latency, pitch, and heading calibrations were performed on DN188 over the wreck Yancey (LKA-93), an amphibious cargo ship sunk in 1990 as an artificial reef, located at approximately 34-10-15N, 076-13-44W. The wreck is approximately 140m in length, has up to 11m of height off the bottom, and sits in water depths of approximately 50m. The roll calibrations were performed over flat seafloor nearby.

All mapping personnel derived timing and misalignment values. The average values are shown in Table 6, and were entered into the POS MV settings for Sensor 1 Frame with respect to Reference Frame, rather than the CARIS HVF. Setting the values in the POS MV ensures the motion data is in the correct reference frame prior to the roll and pitch compensation performed by the ME70. However, the real-time heading logged in the raw data remains in the IMU reference frame, so it must be applied in CARIS. This is why the HVF contains only the heading correction. The configuration as explained here was originally provided by Glen Rice (see Appendix II: Correspondence).

Table 6. Patch Test values

Pitch	1.080°
Roll	1.32°
Heading	-1.245°
Timing	0 seconds

B3e. Sound speed corrections

Sound speed profiles were acquired via CTD sensor (SBE 03 Plus) and XBT. At the beginning of the survey, CTD and XBT casts were taken concurrently as an independent check (see Appendix II: Field Reports).

The profiles were acquired over a large area and therefore have considerable variability, a function of depth, latitude, sea state, and proximity to the Gulf Stream (Figure 19). The variability is mostly related to temperature. The upper portion of the water-column has a mixed layer ranging from several meters up to 20 m thick, above a thermocline of varying depth and gradient.

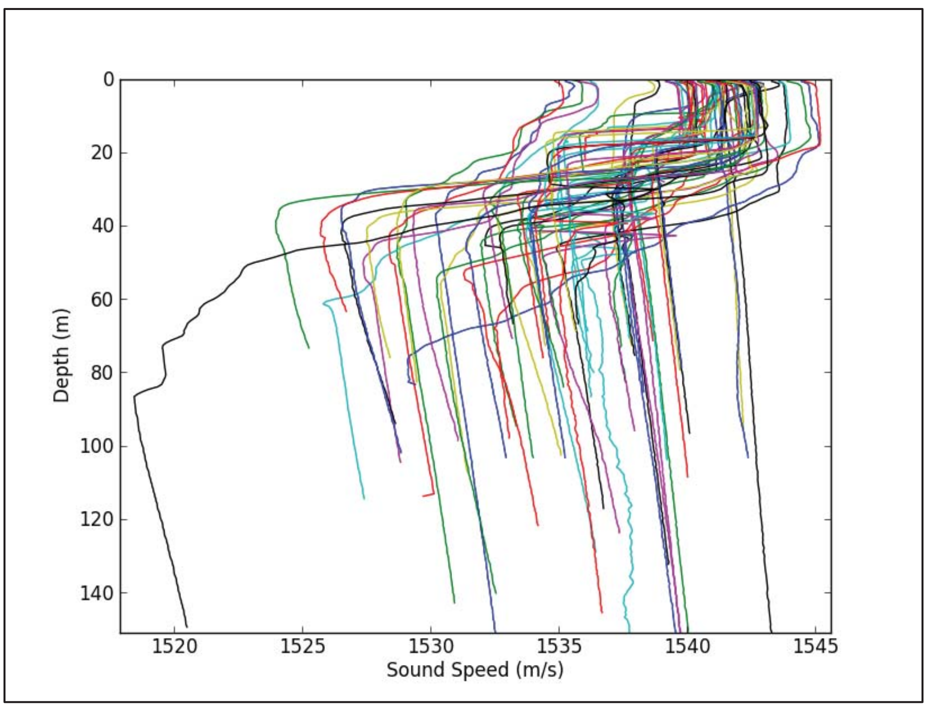


Figure 19. Sound speed profiles acquired during W00290.

The casts were converted to .svp file format in Velocipy and applied during post-processing. The XBT supply allotted for four casts per night shift, and these were dropped such as to maximize the spatial and depth extents of the survey areas.

B3f. Tides and water levels

Soundings were reduced to MLLW using first the predicted, and then verified, data from National Water Level Observation Network (NWLON) station 8658163 (Wrightsville Beach, NC).

B4. Backscatter

The backscatter collected along each beam of the ME70 was retained in the raw data and the GSF output from MATLAB. After corrections were applied in CARIS HIPS, data were exported from HIPS once more into GSF. The GSFs were imported into Fledermaus Geocoder Toolbox, and mosaics created.

While the bathymetry will reveal areas of structure and relief, one cannot necessarily infer hardbottom across an entire map, as hardbottom may not have any depth variation. This is why multibeam backscatter is essential, as hardbottom can be inferred from areas of strong returns of acoustic intensity. Thus when used together, the backscatter is an effective complement to the bathymetry. A useful example is shown in Figure 20.

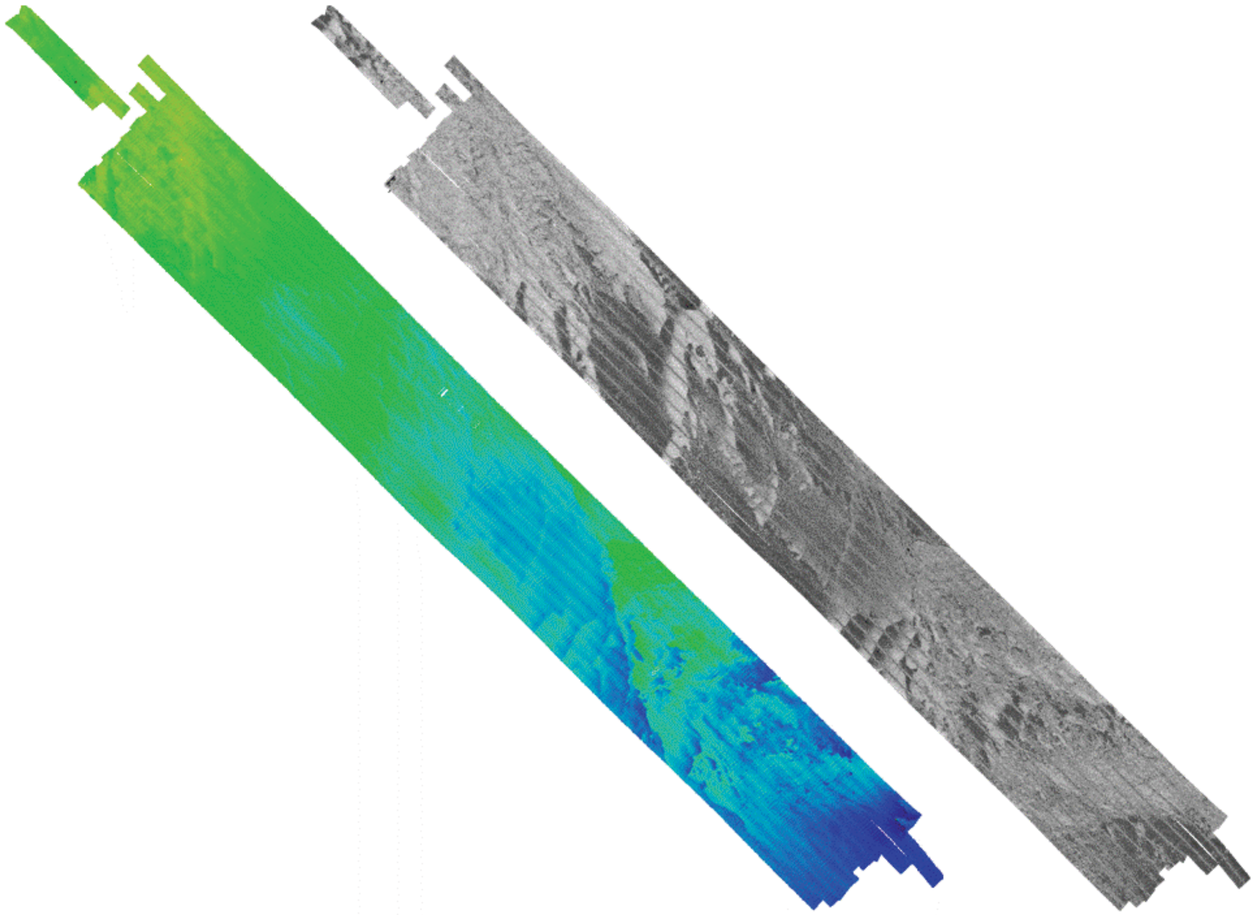


Figure 20. Multibeam bathymetry and backscatter showing ledges and habitat suitable for the deployment of fish sampling gears (e.g., traps, camera arrays). Note the visual inconsistencies between areas of hard bottom revealed by bathymetry (left) and backscatter (right); backscatter is important when considering optimal reef fish sampling locations.

B5. Data Processing

The work flow from data acquisition to the delivery of both daily products to SEFIS, and the final product to OCS, is given below in Figure 21.

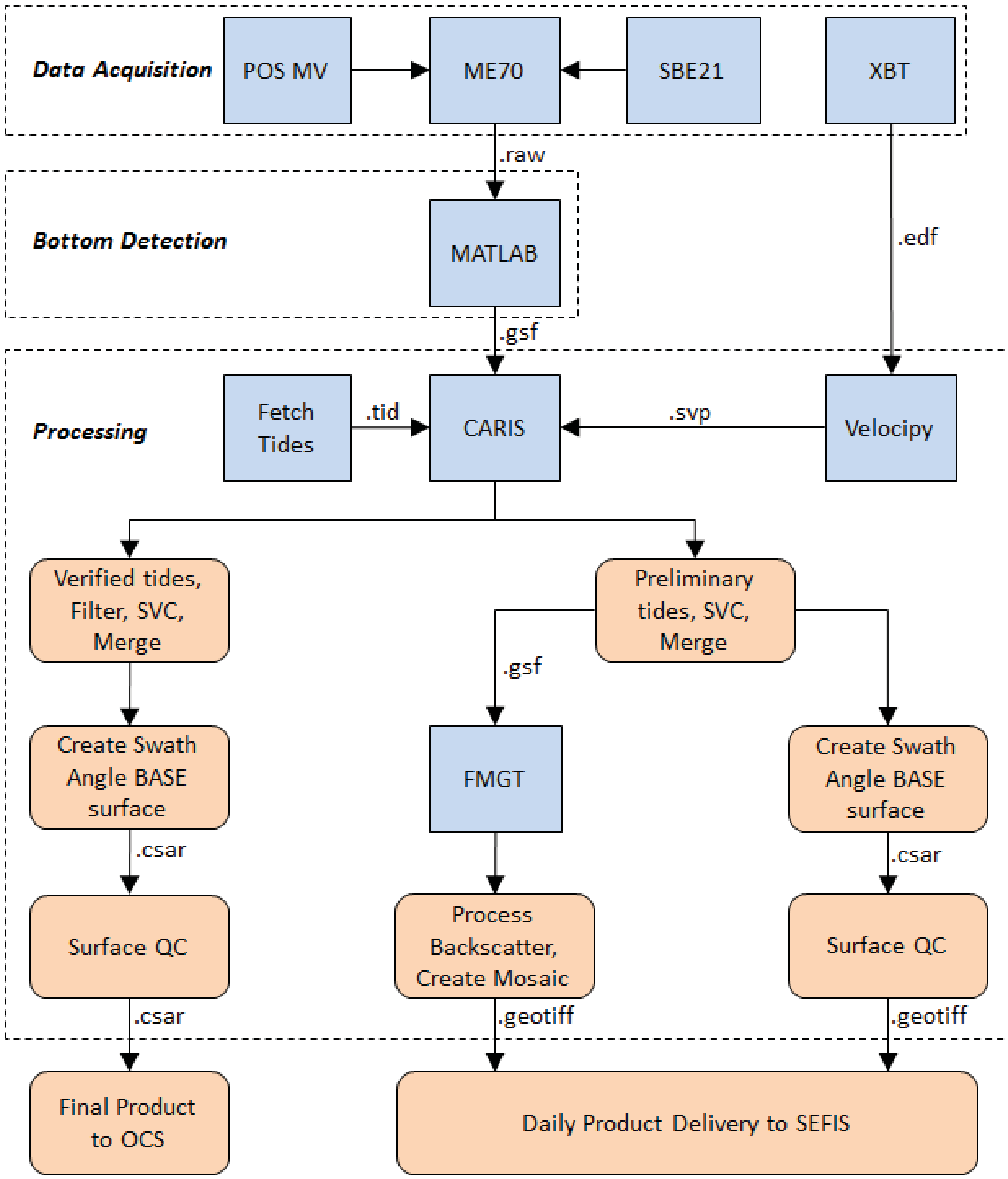


Figure 21. The W00290 work flow, from data acquisition to product delivery.

B5a. Bottom detections

As a fisheries multibeam echo sounder, the ME70 is not designed to derive bottom detections. However, the acoustic intensity returns are collected and stored for each beam in the raw data, thus depth soundings can be extracted in post-processing. A MATLAB software package written by Dr. Tom Weber derives bottom detections from raw ME70 data. The software output is GSF that can then be readily converted into CARIS HIPS and other data processing softwares.

Minimum and maximum depth gates must be set in MATLAB, which the program will use to focus the bottom detection algorithm. Narrower depth gates noticeably improved the performance of the algorithm; however, it required a close watch by the users to ensure actual depths never surpassed the gate bounds.

B5b. CARIS HIPS workflow

Vessel file

- The CARIS HIPS Vessel File was entitled "PISCES_FISH_2014.hvf".
- Linear offsets between the IMU and the ME70 are entered into the Swath1 X,Y,Z field.
- The motion data are shifted to the correct reference frame in POSView; this is why the roll and pitch misalignment values of Swath1 are set to zero. The exception is yaw (i.e., heading), as explained in Section B3d.
- Linear offsets between the IMU and the primary GPS antenna were entered into POSView, thus the Navigation X,Y,Z fields are set to zero in the HVF.
- The X,Y,Z offset values are entered into the heave to shift the heave data to the ME70 because it is not actually applied in real-time.
- The dynamic and static drafts are applied in post-processing via the Draft and Waterline Height fields in the HVF.
- The SVP corrections are shifted to the ME70 via the X,Y,Z offsets in the SVP1 field.

Data conversion and correctors

- The GSF output from MATLAB was converted into CARIS HDCS format using the CARIS Conversion Wizard. Geographic coordinates were selected, and no filters were applied during the conversion.
- After the conversion, the lines were opened within HIPS, and tide corrected (see Section B3f) to reduce all sounding data to MLLW.
- Sound speed corrections were applied predominantly with nearest in time, though in some instances nearest in distance within 2 hours was used. In all cases, only XBT casts collected within a specific survey box were used (see Section B3e).
- The merge operation in CARIS was then performed, without applying smoothing to sensors.

Data cleaning

- Lines were spot-checked in HIPS navigation and attitude editors.
- Field sheets were created to encompass the survey areas and used for creating surfaces, gridded to 4m resolution.
- The depth and statistical layers of the grid were used to find anomalous data points, which were removed using CARIS Subset Editor.

B5c. Fledermaus Geocoder Toolbox workflow

Data were exported from CARIS HIPS to a GSF and imported into a FMGT Project. The sonar default values were set to "Custom Override All"; Sonar Type was "Simrad ME70"; source files were added, and a mosaic created. The greyscale bar of the resulting mosaic was adjusted to maximize the contrast of the backscatter strength.

C. VERTICAL AND HORIZONTAL CONTROL

C1. Vertical Control

The vertical datum for this project is MLLW. Soundings were reduced to MLLW using verified tides from the National Water Level Observation Network (NWLON) station 8658163 (Wrightsville Beach, NC)

C2. Horizontal Control

The horizontal datum for this survey is NAD83, and all projections to UTM Zone 17N.

DGPS corrections were supplied to the POS MV positioning via Leica MX-420 DGPS receiver and coupled with attitude from the IMU to establish horizontal control.

D. RESULTS AND RECOMMENDATIONS

D1. Chart Comparison

The chart comparison was performed with the largest scale rasters charts that contain the survey areas. Charts used in comparison are listed in Table 7.

Table 7. Raster charts used for comparison

Chart	Scale	Edition	Edition Date	Latest LNM	Latest NTM
11520	1:432,720	45	9/1/2013	12/30/2014	1/3/2015
11536	1:80,000	20	1/1/2015	12/16/2014	12/27/2014
11539	1:80,000	20	9/1/2014	1/6/2015	1/10/2015

According to the source diagrams for charts 11536, 11539, and 11520, the ship was operating in areas last updated with partial bottom coverage in the timeframe between 1940-1969, or, in a few instances, 1900-1939. Comparing the W00290 data against the chart, there are instances of localized seafloor relief easily detected by a multibeam swath, but not detected from the original source, and therefore not properly accounted for in the chart.

A shoal-biased sounding selection was created to facilitate chart comparison. The soundings, and the gridded bathymetry, were overlaid atop the chart.

Survey soundings generally compare within 1-2 feet of the charted soundings from charts 11539 and 11536, and within 1 fathom of the charted soundings from chart 11520, with some exceptions highlighted in the images below (Figures 22-25).

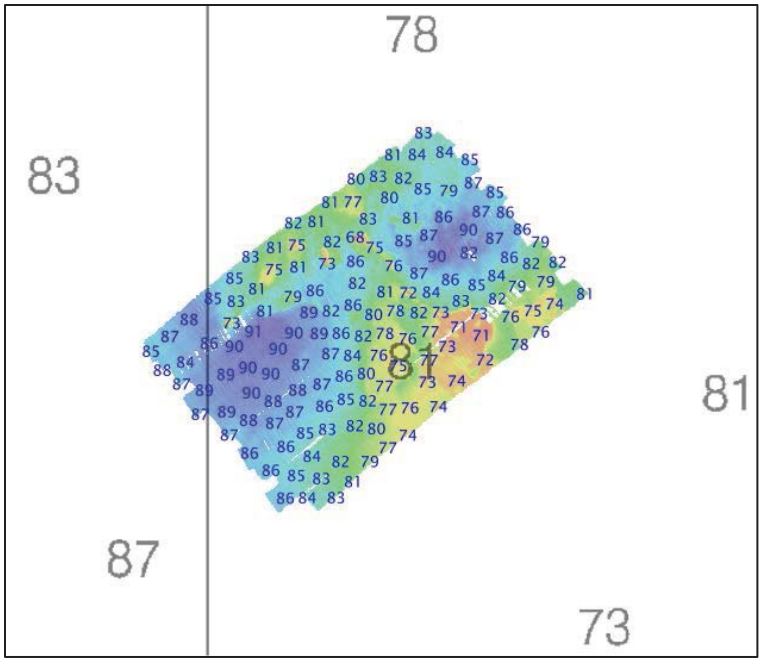


Figure 22. Shoal soundings atop the bathymetric relief in Box 65 are between 68 – 73 feet, compared to chart 11536 soundings in this vicinity, between 78-83 feet (image center is approximately 33-26-46N, 077-39-34W).

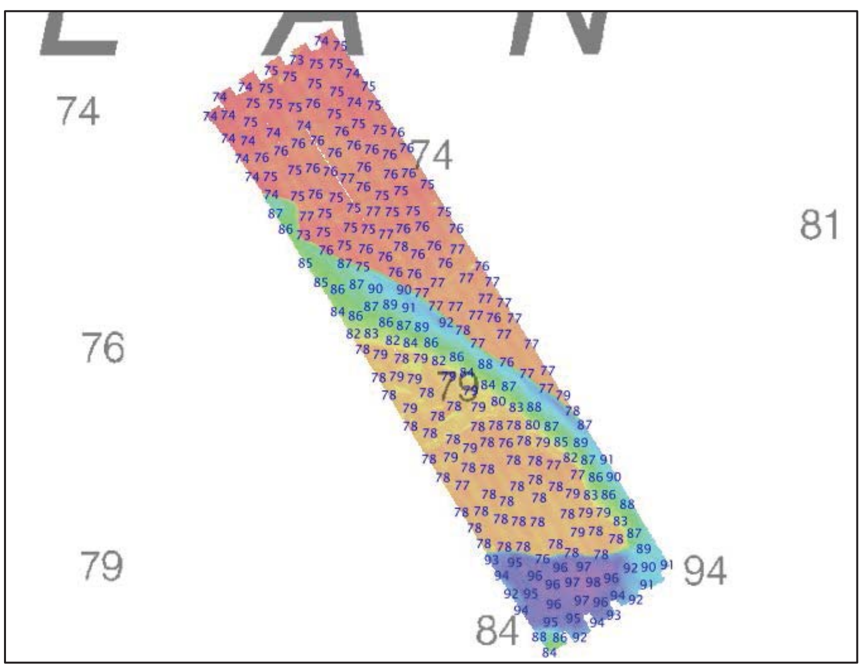


Figure 23. Shoal soundings atop the bathymetric relief in Box 61 are between 73 – 76 feet, compared to chart 11536 soundings in this vicinity, between 79-94 feet (image center is approximately 33-43-19N, 077-37-50W).

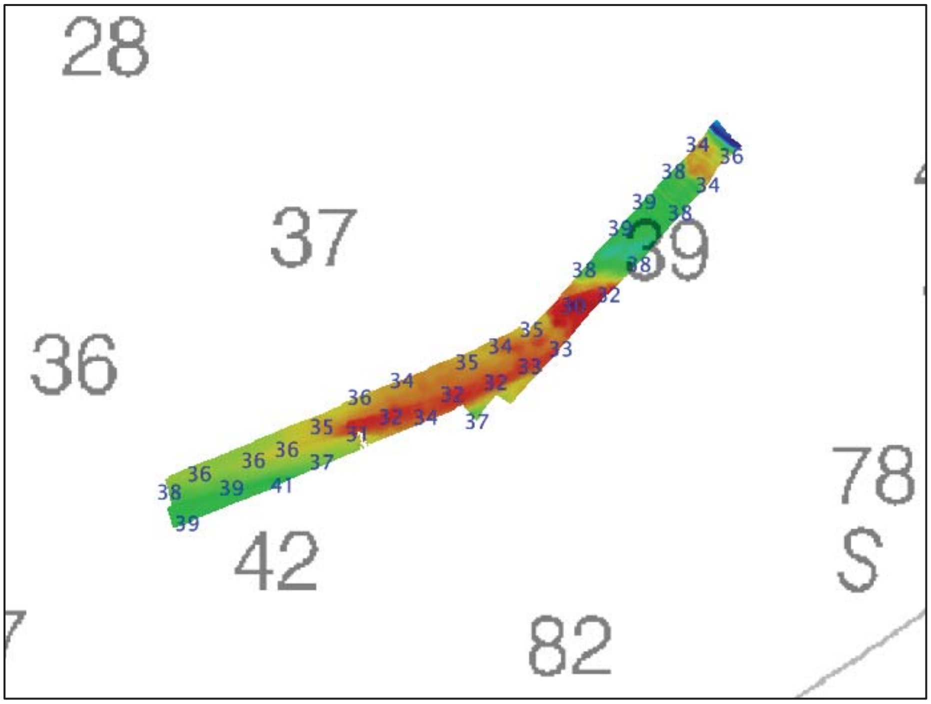


Figure 24. Shoal soundings atop the bathymetric relief in Box 50 and Box 46 are between 30-36 fathoms, compared to chart 11520 soundings in this vicinity, between 37-42 fathoms (image center is approximately 33-13-52N, 077-18-17W).

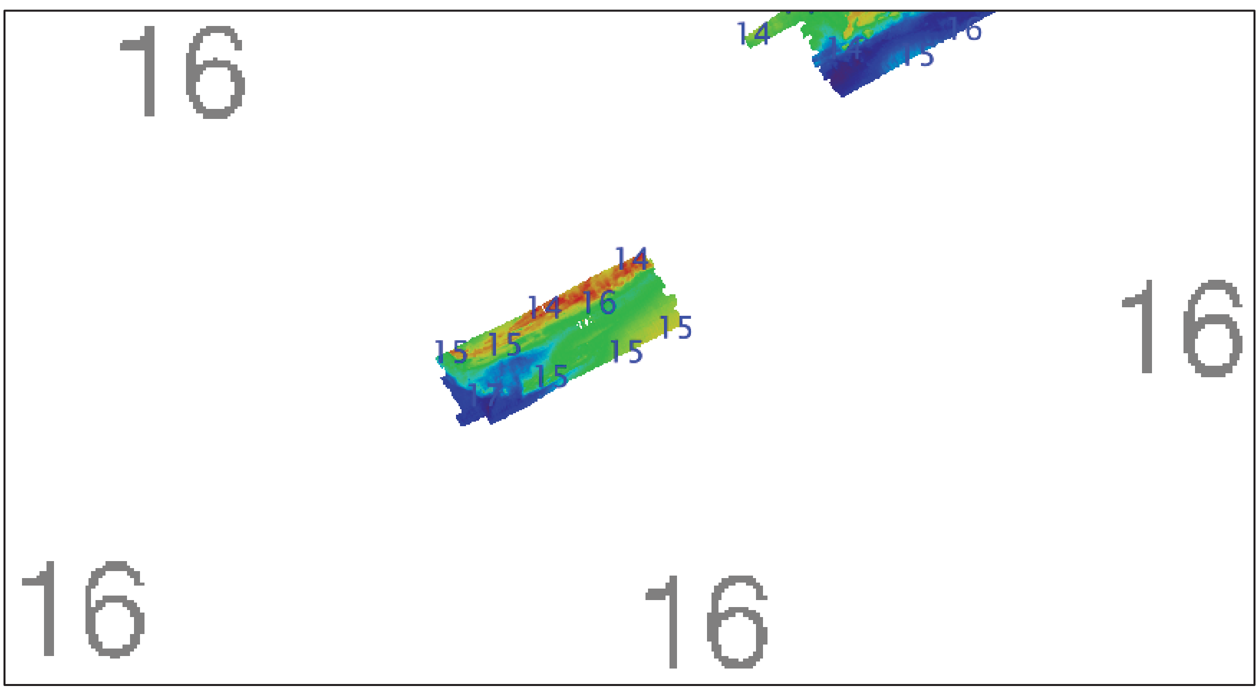


Figure 25. Shoal soundings atop the bathymetric relief in Box 67 are between 14-15 fathoms, compared to chart 11520 soundings in this vicinity of 16 fathoms (image center is approximately 33-19-38N, 077-41-12W).

D2. Additional Results

There was no shoreline, bridges, overhead cables, pipelines, platforms, unusual submarine features, present or planned construction within this survey.

D3. Summary and Recommendations

Federally funded ship time is limited and valuable. More specifically, where NOAA hydrographic surveys are concerned, it is a NOAA IOCM objective to further "intra- and inter-agency coordination with a focus on streamlining operations, reducing redundancies, improving efficiencies, developing common standards, and stimulating innovation and technological development" (i.e., Map once, use many times; link). During this 32-day NMFS survey, 46 areas were mapped in continental shelf and shelf-break waters off the southeastern U.S., totaling approximately 227 km^2 between 32.9°N and 34.3 °N. Maps were comprehensively useful for fisheries science purposes; a total of 391 paired fish trap catches and underwater video recordings were collected from previously-unmapped and -unsampled reef fish habitats. Additionally, the NOAA ship *Pisces* ME70 data reported here can inform OCS nautical charts.

The calculations of total propagated uncertainty show that the ME70 data generally did not meet IHO Order 1 specifications in shallower depths, which indicates that the ME70 may not be suitable for object detection, feature disproval, or for areas of critical underkeel clearance. However, it is important to consider the areas that the ship may be working in, and the source of the charted soundings. Deeper areas further offshore where the ship may be operating often have not received a chart update in several decades. For example, some areas surveyed as part of survey W00290 were last updated between 1900-1939 (e.g., NOAA Chart 11520 Source "B4"), in which case the application of suggested shoal soundings from this cruise is easily justified.

Building upon previous results (W00269, 2014), the following is a list of accomplishments related to and during PC-14-02:

1. Crew onboard NOAA Ship Pisces shipped the IMU to Applanix for evaluation and "tumble test," and repositioned POS MV antennas higher and away from other structures on the ship such that a much clearer view from horizon to horizon was achieved.
2. A successful POS MV GAMS calibration was achieved (last achieved in 2008).
3. A software update provided by UNH-CCOM corrected issues known to exist in the file conversion from *.raw to *.gsf, which in turn improved both a refraction-like artifact and vertical depth bias formerly present in bathymetry.
4. A model to compute total propagated uncertainty for the ME70 was developed and utilized, allowing for the usage of uncertainty as a quality control tool.
5. With total propagated uncertainty calculated for the individual soundings, bathymetry was gridded using the Combined Uncertainty and Bathymetry Estimator (CUBE) algorithm, which allows for additional measures of quality control, improves confidence in the final grids, and is in-line with current NOS specifications for gridded bathymetry.
6. No "skunk stripe" data filtrations were necessary (as necessary during W00269), and complete multibeam coverage was achieved.

7. Several patch tests were successfully conducted after POS MV system antennas were located and offsets were updated. Motion data were properly rotated into the multibeam reference frame in real-time.
8. Processing workflows were updated to better correct derived bottom detections for vessel offsets, tides, and sound speed.
9. Trainings were conducted with SEFIS personnel and undergraduate students, building knowledge and hydrographic capacity for future mapping work, as well as shared tools and best practices.

The following is a list of recommendations for NOAA Ship *Pisces* crew in order to further build capacity for acoustic mapping, listed in the order of priority, such that the first item on the list is deemed most urgent.

1. Hardware and software updates to POS MV POSView and ME70 systems.
    a. A next-generation hardware upgrade is available for the ME70. The report authors understand that an upgrade is scheduled to happen on board *Pisces* as soon as possible.
    b. POSView and ME70 software updates are available.
    c. Defective ME70 transducer elements should be evaluated.
2. Network data transmission capabilities to circumvent the usage of portable hard drives for data transfer. Manual hard drive transfers risk data loss, and have been a consistent impediment to survey operations.
3. An updated vessel offset survey by NGS is recommended using the top of the POS MV IMU as the ship's reference point, and to include the following information:
    a. The exact point on the ME70 to which measurements are made should be clearly defined.
    b. Offset measurements between the POS MV IMU and the face of the ME70 transducer should be reported.
    c. The offsets to the auxiliary GPS antenna should be made, as these have only been estimated in the past and not surveyed.
    d. An estimate for the vessel's center of rotation should also be attained, as this is a requested input into the POS MV.
4. A follow-up with Applanix is recommended in order to determine the reason for the high number of documented L2 cycle slips, as this is likely indicative of system performance less than its full capability.
5. The regular removal of bio-fouling on all sonar transducer faces is recommended, with a report on activities made available to science crews.
6. Further testing of ME70 data acquisition with Hypack is recommended, to include line steering and real-time swath display, as well as real-time bottom detections during acquisition with file conversions to Hypack *.hsx files. The report authors understand that discussions and collaboration are ongoing between UNH-CCOM, HSTP, Hypack, and SEFSC Mississippi Labs staff regarding this potential capability.
7. It is recommended that *Pisces* obtain resident software licenses that will facilitate multiple methods of ME70 data processing (e.g., CARIS HIPS, FMGT). The report authors understand that HYPACK licensing is underway.

D4. References

Rice, G., 2009, Fairweather Ellipsoidally Referenced Dynamic Draft Measurement.

Rice, G., 2011. Estimating Vessel Static Waterline Using Vessel Ellipsoid Height.

Trenkel, V. M., Mazauric, V., and Berger, L. 2008. The new fisheries multibeam echosounder ME70: description and expected contribution to fisheries research. ICES Journal of Marine Science 65: 645–655.

W00269, 2014. Descriptive Report to accompany 2013 NOAA ship *Pisces* research cruise PC-13-04, Survey Number W00269. Link.

Wilson, M., Wolfskehl, S. 2013. NOAA Ship *Henry Bigelow* Patch Test and Assessment.

E. LETTER OF APPROVAL

Efforts were made in the field to adhere to NOS Hydrographic Specifications and Deliverables (2014). Because data were collected for non-hydrographic purposes this was not always possible, as detailed in the report. The data are submitted as outside source data, for use by the NOAA Office of Coast Survey, should it be deemed beneficial.

This report and the accompanying data are respectfully submitted.

Matthew J. Wilson
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Lead Hydrographer

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JHT Contract Fisheries Biologist, Southeast Fisheries Science Center
Southeast Fishery-Independent Survey

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Appendix I: Tides and Water Levels

Verified 6 minute Water Level Data (W1)

Station	--	Unique seven character identifier for the station
Date Time	--	Date and time the data were collected by the DCP
WL	--	Water level height
Sigma	--	Standard deviation of 1 second samples used to compute the water level height
I	--	A flag that indicates that the water level value has been inferred.
F	--	A flag that when set to 1 indicates that the flat tolerance limit was exceeded
R	--	A flag that when set to 1 indicates that the rate of change tolerance limit was exceeded
T	--	A flag that when set to 1 indicates that the temperature difference tolerance limit was exceeded

Data are in Meters above MLLW.
Times are on UTC (GMT)

8658163 Wrightsville Beach, NC from 20140701 to 20140812
Click HERE <http://tidesandcurrents.noaa.gov/station_info.shtml?stn=8658163+Wrightsville+Beach,+NC> for further station information.

First record in series:

Station	Date	Time	WL	Sigma	I	F	R	T
8658163	2014/07/01	00:00	1.103	0.113	0	0	0	0

Last record in series:

Station	Date	Time	WL	Sigma	I	F	R	T
8658163	2014/08/12	23:54	1.408	0.080	0	0	0	0

Appendix II: Supplemental Survey Records and Correspondence

ME70 Beam Configurations

A. B31_sec120deg_XmitByDecreaseSteering (Tom Weber, UNH-CCOM)

Beam Configuration, Dr. Tom Weber (UNH-CCOM), "b31_sec120deg_XmitByDecreaseSteering"

Beam #	Minor-axis beam steering angle(degrees)	Major-axis beam steering angle(degrees)	Absorption Coefficient	EK60 SaCorrection	EK60 Transducer Gain	Frequency	Major Axis 3db Beam Angle	Major Axis Angle Offset
0	0	-65.886	0.205355	-1.509	16.5114	73.23	11.29	0
1	0	-56.749	0.0219545	-1.5024	21.4327	76.09	8.09	0
2	0	-49.698	0.0234011	-1.5332	23.9341	78.95	6.61	0
3	0	-43.76	0.024873	-1.5435	26.2886	81.81	5.72	0
4	0	-38.541	0.0263682	-1.5525	28.126	84.66	5.1	0
5	0	-33.833	0.0278844	-1.549	29.8321	87.52	4.64	0
6	0	-29.513	0.0294197	-1.5548	31.0714	90.38	4.29	0
7	0	-25.496	0.0309721	-1.5589	31.6415	93.24	4.01	0
8	0	-21.726	0.0325395	-1.5582	32.1157	96.1	3.78	0
9	0	-18.158	0.0341201	-1.5562	32.5372	98.95	3.59	0
10	0	-14.761	0.035712	-1.5499	33.182	101.81	3.43	0
11	0	-11.509	0.0373136	-1.5753	33.6903	104.67	3.29	0
12	0	-8.38	0.038923	-1.5739	34.1049	107.53	3.17	0
13	0	-5.357	0.0405387	-1.5698	34.8434	110.39	3.07	0
14	0	-2.425	0.0421591	-1.5531	34.9524	113.24	2.98	0
15	0	0.419	0.044161	-1.573	34.6922	116.77	2.89	0
16	0	3.246	0.0429706	-1.5421	34.8525	114.67	2.95	0
17	0	6.143	0.0413485	-1.5606	34.8145	111.82	3.04	0
18	0	9.132	0.0397302	-1.5602	34.3404	108.96	3.14	0
19	0	12.227	0.0381174	-1.5649	34.0878	106.1	3.26	0
20	0	15.444	0.0365117	-1.5489	33.3743	103.24	3.39	0
21	0	18.805	0.0349147	-1.548	32.8707	100.38	3.55	0
22	0	22.335	0.0333282	-1.5563	32.5383	97.53	3.74	0
23	0	26.067	0.031754	-1.5547	32.0085	94.67	3.97	0
24	0	30.042	0.0301939	-1.5554	31.3318	91.81	4.25	0
25	0	34.317	0.0286498	-1.53	30.3649	88.95	4.6	0
26	0	38.975	0.0271238	-1.5081	28.8346	86.09	5.05	0
27	0	44.139	0.0256178	-1.5158	26.8605	83.24	5.65	0
28	0	50.011	0.024134	-1.5072	24.88	80.38	6.54	0
29	0	56.978	0.0226745	-1.5107	21.9911	77.52	7.99	0
30	0	65.99	0.0212414	-1.4759	17.6196	74.66	11.12	0

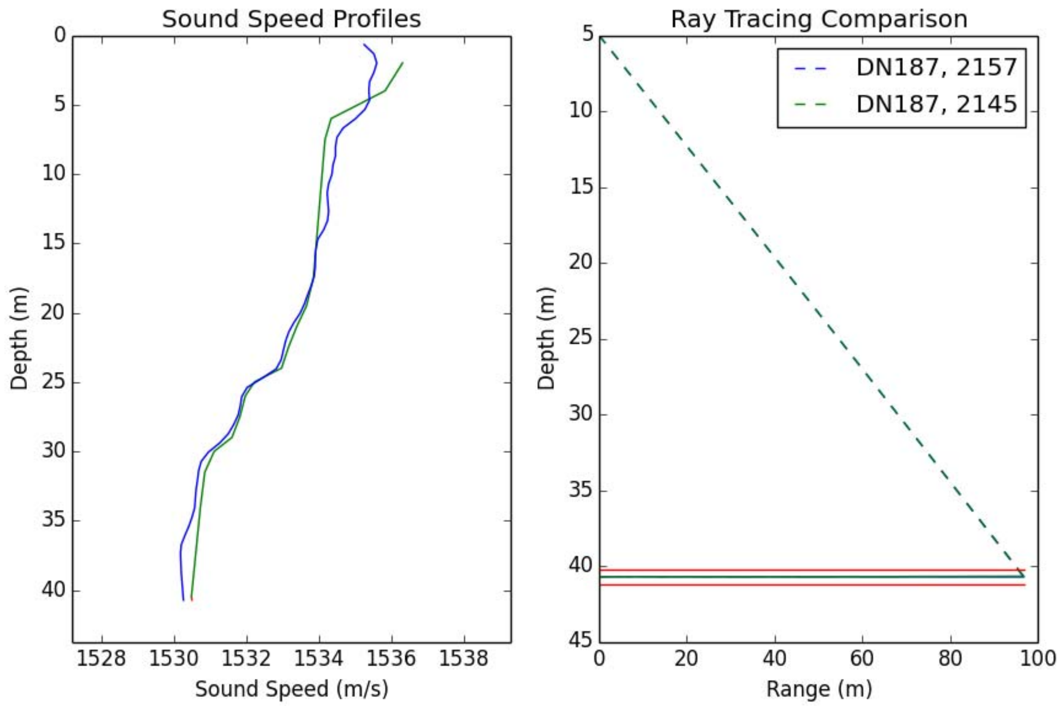
For display purposes, beam characteristics were read directly from example ME70 *.raw files, via Myriax Echoview fisheries acoustics software.

Beam #	Major Axis Angle Sensitivity	Minor Axis 3db Beam Angle	Minor Axis Angle Offset	Minor Axis Angle Sensitivity	Sound Speed	Transmitted Power	Transmitted Pulse Length	Tvg Range Correction	Two Way Beam Angle
0	21.27	4.63	0	51.86	1542.5	81.47754	1.536	SimradEx60	-20.450947
1	29.65	4.45	0	53.89	1542.5	85.23	1.536	SimradEx60	-22.6061117
2	36.29	4.29	0	55.91	1542.5	85.98632	1.536	SimradEx60	23.09897
3	41.99	4.14	0	57.94	1542.5	83.3707	1.536	SimradEx60	-23.886911
4	47.07	4	0	59.96	1542.5	80.09018	1.536	SimradEx60	-24.531351
5	51.67	3.87	0	61.99	1542.5	76.15279	1.536	SimradEx60	-25.080978
6	55.9	3.75	0	64.01	1542.5	74.11713	1.536	SimradEx60	-25.562269
7	59.82	3.63	0	66.03	1542.5	73.25302	1.536	SimradEx60	-25.991278
8	63.45	3.53	0	68.06	1542.5	73.75516	1.536	SimradEx60	-26.378506
9	66.83	3.42	0	70.08	1542.5	74.99984	1.536	SimradEx60	-26.731215
10	69.98	3.33	0	72.11	1542.5	77.11973	1.536	SimradEx60	-27.054628
11	72.9	3.24	0	74.13	1542.5	74.28594	1.536	SimradEx60	-27.352652
12	75.61	3.15	0	76.15	1542.5	68.12886	1.536	SimradEx60	-27.628239
13	78.12	3.07	0	78.18	1542.5	58.948	1.536	SimradEx60	-27.883692
14	80.42	2.99	0	80.2	1542.5	51.04043	1.536	SimradEx60	-28.120838
15	82.99	2.9	0	82.7	1542.5	44.5407	1.536	SimradEx60	-28.390734
16	81.37	2.96	0	81.21	1542.5	48.95229	1.536	SimradEx60	-28.226677
17	79.02	3.03	0	79.19	1542.5	55.53407	1.536	SimradEx60	-27.989418
18	76.46	3.11	0	77.17	1542.5	64.60277	1.536	SimradEx60	-27.734127
19	73.7	3.19	0	75.14	1542.5	70.35807	1.536	SimradEx60	-27.458996
20	70.73	3.28	0	73.12	1542.5	76.19363	1.536	SimradEx60	-27.161732
21	67.54	3.38	0	71.09	1542.5	76.00295	1.536	SimradEx60	-26.839361
22	64.12	3.47	0	69.07	1542.5	73.84613	1.536	SimradEx60	-26.488024
23	60.44	3.58	0	67.05	1542.5	73.06338	1.536	SimradEx60	-26.102505
24	56.49	3.69	0	65.02	1542.5	73.10033	1.536	SimradEx60	-25.675587
25	52.22	3.81	0	63	1542.5	75.12555	1.536	SimradEx60	-25.196833
26	47.57	3.94	0	60.97	1542.5	77.64481	1.536	SimradEx60	-24.650288
27	42.46	4.07	0	58.95	1542.5	80.8847	1.536	SimradEx60	-24.009666
28	36.71	4.22	0	56.93	1542.5	84.16721	1.536	SimradEx60	-23.226706
29	30.03	4.37	0	54.9	1542.5	85.56769	1.536	SimradEx60	-22.196171
30	21.59	4.54	0	52.88	1542.5	82.8196	1.536	SimradEx60	-20.601021

Field Reports

A. XBT-CTD Comparisons

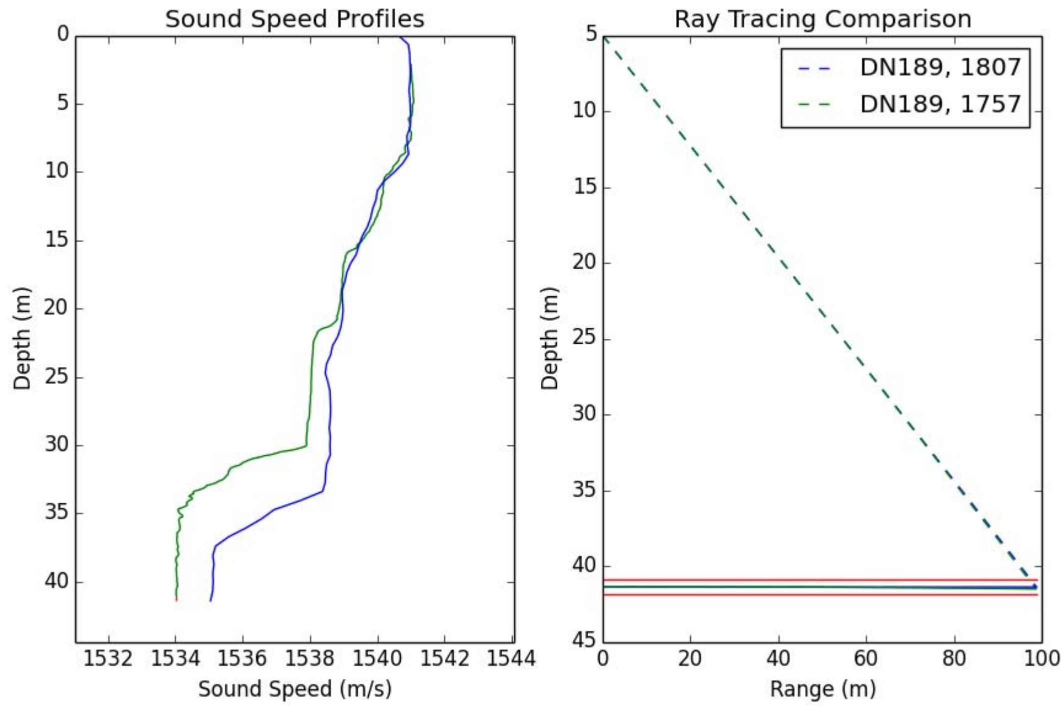
CTD (green) versus XBT (blue) comparison performed on July 6th.



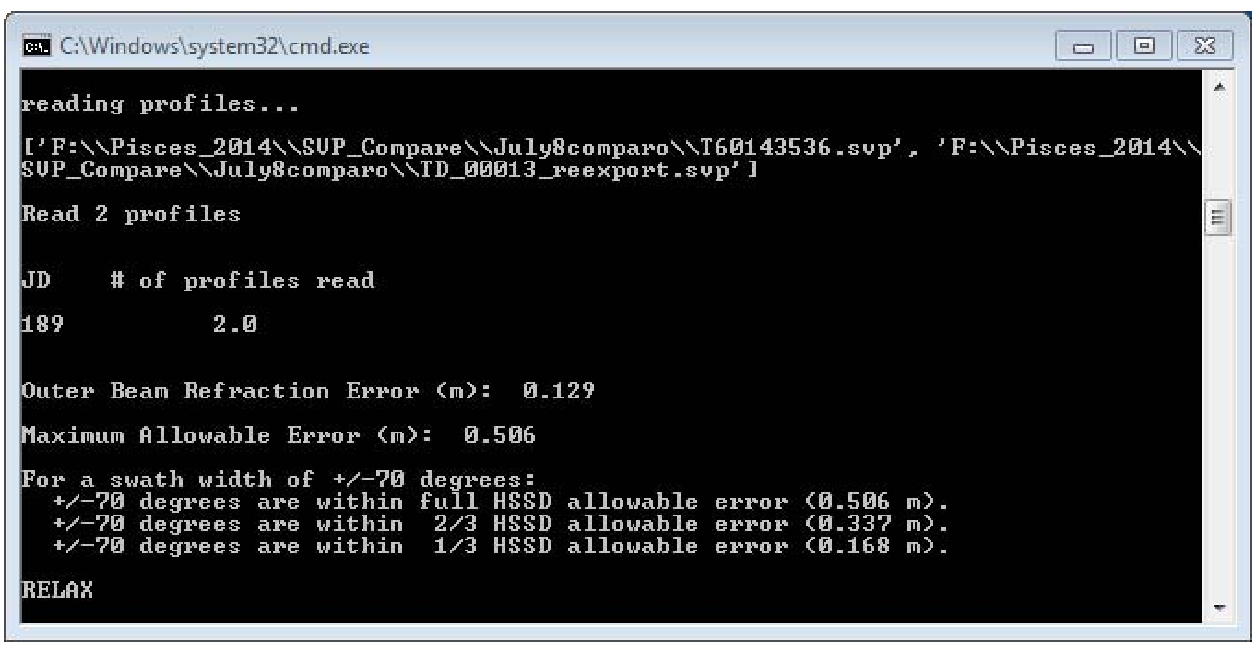
A ray tracing uncertainty analysis between the CTD and the XBT profile results in a maximum outer beam refraction of less than 5 cm, well within tolerance levels (0.503) for this depth (~41 m).

```
C:\Windows\system32\cmd.exe

reading profiles...

['F:\\Pisces_2014\\SVP_Compare\\July6comparo\\1872150AFLDB2S.svp', 'F:\\Pisces_2
014\\SVP_Compare\\July6comparo\\1872150_reexport.svp']

Read 2 profiles


JD    # of profiles read

187          2.0


Outer Beam Refraction Error (m):  0.046

Maximum Allowable Error (m):  0.503

For a swath width of +/-70 degrees:
   +/-70 degrees are within full HSSD allowable error (0.503 m).
   +/-70 degrees are within  2/3 HSSD allowable error (0.335 m).
   +/-70 degrees are within  1/3 HSSD allowable error (0.167 m).

RELAX
```

CTD (green) versus XBT (blue) comparison performed on July 8th



A ray tracing uncertainty analysis between the CTD and the XBT profile results in a maximum outer beam refraction of less than 13 cm, well within tolerance levels (0.506 m) at this depth (~42 m).




```
reading profiles...
['F:\\Pisces_2014\\SVP_Compare\\July8comparo\\T60143536.svp', 'F:\\Pisces_2014\\SVP_Compare\\July8comparo\\TD_00013_reexport.svp']
Read 2 profiles

JD    # of profiles read
189          2.0

Outer Beam Refraction Error (m):  0.129
Maximum Allowable Error (m):  0.506
For a swath width of +/-70 degrees:
   +/-70 degrees are within full HSSD allowable error (0.506 m).
   +/-70 degrees are within  2/3 HSSD allowable error (0.337 m).
   +/-70 degrees are within  1/3 HSSD allowable error (0.168 m).
RELAX
```

Vessel Documents

A. Schultz 2014 POS MV GPS Antenna Location Survey

B. Impastato 2007 Vessel Offsets Report

SURVEY REPORT

POS MV GPS ANTENNA LOCATION SURVEY

REPORT DATE: 27 MARCH 2014

This report issued on the 27th,day of March, 2014

Terry C. Schultz, RPLS
Schultz Geomatics
Magnolia, TX 77355

Revision Description Sheet
This sheet will be completed to detail all changes at each revision, once the document has been approved.

Revision	Date	Section	Details
0	27MAR2014	All	Submitted

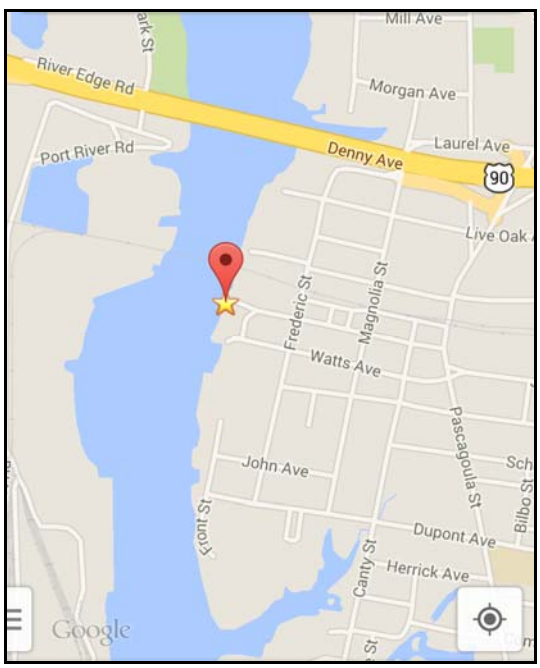
Table of Contents

1.0 Introduction

The NOAA Office of Marine and Aviation Operations required a dimensional control survey to position two POS MV GPS antennas on the R/V Pisces which was located at their facility in Pascagoula, MS. The two new antennas were installed on the upper horizontal flag mounts just aft of the super structure (see photos). These two new antennas are to replace the existing GPS antennas located just forward and atop of the pilot house.

Schultz Geomatics of Magnolia, Texas were contacted to come out and perform a survey to establish coordinates for the two new antenna positions relative to existing control benchmarks on the ship, which were initially surveyed by Raymond C. Impastato, PLS, on September 25th, 2007.

On March 24th, 2014, T. Schultz of Schultz Geomatics arrived on the site and consulted with the NOAA representative to discuss the scope of work and to determine the new location for the antennas, also, to indicate where the existing Bench Marks were on the vessel.



Location of NOAA Operations Facility, Pascagoula, MS

2.0 Survey Operations

Survey operations commenced on 24 March 2014. After the initial meeting on the vessel and the location of the bench marks, a survey project was set up in the total station unit with the bench mark coordinate data from the installation report. On 25 March 2014, the field survey commenced. A point was established on the starboard side at the top of the stairs leading to the roof of the pilot house. From this point four existing bench could be seen and tied into. In addition, the two new GPS antennas were tied into from this point and the two other POS MV GPS antennas which are to be removed, were also tied in for a check.

After completing the operations on the top of the pilot house, bench mark No. 18 on the aft main deck was occupied and measurements were made to the new port GPS antenna. The starboard antenna was not tied in from this point due to blockage from the “A” frame pad-eye. Bench mark No. 17, forward, main deck, was then occupied and measurements were taken to the new starboard antenna and again, additional measurements to the port GPS antenna.

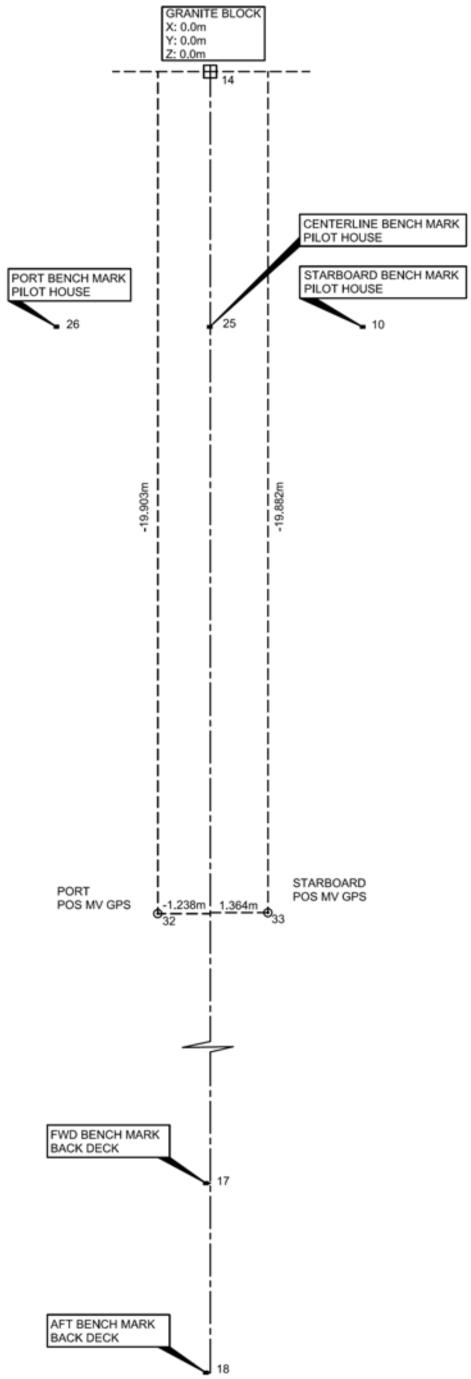
These data were the computed and a set of final coordinates were determined for the new antenna locations.

Applanix POS MV utilizes a “right hand” method for X,Y,Z values, positive X forward, positive Y starboard, and positive Z downward. The final coordinates noted in the table are relative to the granite Master Reference Plate positioned forward and below toward the bow.

2.1 Coordinate Schedule

Units are in Metric

Point	X-Axis	Y-Axis	Z-Axis	Notes
18	-36.261	-0.102	-6.640	Back Deck Aft Bench Mark
17	-31.777	-0.102	-6.618	Back Deck Fwd Bench Mark
10	-5.953	3.564	-17.243	Pilot House Starboard Bench Mark
25	-5.953	-0.053	-17.244	Pilot House Center Bench Mark
26	-5.953	-3.670	-17.242	Pilot House Port Bench Mark
32	-19.903	-1.238	-25.900	***POSMV-Port GPS Antenna***
33	-19.882	1.364	-25.900	***POSMV-Starboard GPS Antenna***
14	0	0	0	Granite Master Reference Plate


GRANITE BLOCK
X: 0.0m
Y: 0.0m
Z: 0.0m
14
CENTERLINE BENCH MARK
PILOT HOUSE
PORT BENCH MARK
PILOT HOUSE
STARBOARD BENCH MARK
PILOT HOUSE
26
25
10
-19.903m
-19.882m
PORT
POS MV GPS
STARBOARD
POS MV GPS
-1.238m
1.364m
32
33
FWD BENCH MARK
BACK DECK
17
AFT BENCH MARK
BACK DECK
18

3.0 Personnel and Equipment

3.1 Personnel

The following personnel were on the project for the survey:

Terry Schultz, RPLS	Schultz Geomatics	Surveyor
Danielle Bates	NOAA	Client Representative

3.2 Equipment

Leica TS12 robotic 2 sec total station / 400m laser (calibration due Dec 2014)

- 2 – Tripods
- Leica CS15 / CTR16 Data collector
- 1 – Leica Round Prism
- 1 – Leica 360° Prism
- 1 – Leica mini Prism
- 1 – Leica Disto hand held laser measurement unit

Miscellaneous survey support equipment

4.0 Photos

Location of new POS MV GPS Antennas

Installing new GPS antennas 25 March 2014

Bracket used to mount GPS antennas

5.0 Chronology of Events

March 24, 2014

05:00: Depart Magnolia, Texas

13:30: T. Schultz arrives at ship, has meeting with NOAA representative. Tour ship and located existing bench marks with help of NOAA. Discuss installation and mounting materials. Prepare survey project for next day field survey.

March 25, 2014

08:00: Arrive at ship and set up survey control.
09:30: Antennas are installed by ship personnel and begin to survey in locations
13:30: Completed field survey, begin computations for offsets results
16:00: Meet with NOAA personnel, discuss end of field survey

March 26, 2014

Return to Magnolia, Texas

6.0 Conclusions

The survey operations were conducted in a safe manner without any incidences. The NOAA personnel were very helpful in their support of the operation. Other than some high winds during the day, the weather was very suitable.

SURVEY REPORT

SHIP: FRV40/3
Pisces

LOCATION: PASCAGOULA, MS

DATE: 9/17-9/21, 2007

PURPOSE:

Determine the ship's centerline, roll, and pitch. Install benchmarks above decks, in the transducer room, and IMU room. Install the master reference plane in the same planes as the measured roll, pitch, and azimuth of the ship. Assist the shipyard to install the IMU parallel to the centerline, and in the same plane as the ship's roll and pitch.

PERSONNEL:

Eric Kostelak
Raymond Impastado

EQUIPMENT LIST:

WILD T2 THEODALITE SN: 73083E CAL EXPIRATION DATE 7/14/08
WILD T2 THEODALITE SN: 129697 CAL EXPIRATION DATE 7/14/08
WARREN KNIGHT 23-2252 CLINOMETER SN: 24297 CAL EXPIRATION DATE 8/18/08
Lietz SDM3E10 TOTAL STATION: SN 77485 CAL EXPIRATION DATE 9/06/08
WILD NA1 AUTO LEVEL: SN 472810 CAL EXPIRATION DATE 9/06/08

PROCEDURES:

Step 1: Generate a closed traverse including points on the vessel
Step 2: Determine the ships pitch by taking elevations on the keel and Comparing them to the engineering information on elevations of the keel above the Base line.
Step 3: Determine the roll and centerline from points shot in the closed traverse
Step 4: Transfer centerline into the transducer room, place bench marks, and set The Master reference plane in place in agreement to the ship's roll, pitch, and Centerline
Step 5: Transfer the centerline into the ship via a hole cut into the side, and then Transfer it to the IMU space and trunk area
Step 6: Place benchmarks in the trunk space

Step 7: Place benchmarks by, and assist the shipyard in placing the IMU foundation
Step 8: Measure the transducer trunk deviation as it is placed in the fully deployed And fully retracted positions
Step 9: install benchmarks on decks
Step 10: Shoot azimuths from known points to each bearing repeater, then set each Each one to be parallel to the centerline
Step 11: Place marks on the hull defining centerline for future use
Step 12: Confirm all transducer mounts are level with the keel

RESULTS

Roll was determined to be 9 min, 3 sec, starboard high
Pitch was determined to be 2 min, 56 sec, bow low

The IMU was found to be 32min, 54sec lower in the bow than the MRP, and 39 min,42 sec higher on the starboard side than the MRP

The center board had 28mm of side to side motion, and 7.5mm of fore/aft motion between the fully extended and fully retracted positions.

The ADCP LEVEL from the MRP is; roll 34 min, 12 sec port high,
Pitch 5 min, 27 sec bow low

The Multibeam LEVEL from the MRP is; Roll 14 min, 10 sec port high
Pitch is zero

For future reference, the bearings from the two top bearing repeaters to the center bench mark on the same deck are:
Port repeater to bench mark=74.8 deg
Starboard repeater to bench mark= 283.75 deg

For the lower bearing repeaters to the forward mast bench mark;
Port repeater to bench mark=14.5 deg
Starboard repeater to bench mark=345.25 deg

The bearing repeater stands are parallel to the centerline with no readable errors, limited by the accuracy of the azimuth circles

The master reference plane is .045M starboard of the centerline and over frame 26

Attached is the X,Y,Z address of each survey point, and the field notes
All measurements are in meters

RAYMOND C. IMPASTATO
PROFESSIONAL LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LA 70460
(985) 774-1955

PISCES

X Y Z SURVEY

September 25, 2007

Revised October 30, 2007
Revised December 1, 2007

POINT	X-AXIS	Y-AXIS	Z-AXIS	DESCRIPTION
4	-33.411	-0.053	+2.017	KEEL NEAR FRAME 78
7	8.698	-0.052	+0.934	KEEL FRAME 11
10	-5.953	3.564	-17.243	STARBOARD BENCH MARK ON PILOT HOUSE
14	0.000	0.000	0.000	MASTER REFERENCE PLATE
17	-31.777	-0.102	-6.618	FORWARD BENCH MARK ON BACK DECK
18	-36.261	-0.102	-6.640	AFT BENCH MARK ON BACK DECK
19	0.277	-1.687	+1.074	AFT WELD BEAD NEAR TRANSDUCER
20	1.411	-1.680	+1.033	FORWARD WELD BEAD NEAR TRANSDUCER
23	-0.400	-1.341	-4.434	IMU
24	-0.400	-0.890	-3.945	STARBOARD BENCH MARK NEAR IMU
25	-5.953	-0.053	-17.244	CENTERLINE BENCH MARK ON PILOT HOUSE
26	-5.953	-3.670	-17.242	PORT BENCH MARK ON PILOT HOUSE
27	-0.400	-0.388	-3.945	PORT BENCH MARK NEAR IMU
28	0.726	-1.805	+0.995	ADCP
29	0.694	-0.716	+1.186	MULTI BEAM
30	-4.830	1.356	-18.870	STARBOARD GPS (CENTERLINE TOP OF PLATE)
31	-4.842	-1.566	-18.870	PORT GPS (CENTERLINE TOP OF PLATE

Correspondence

A. Applanix, re: POS MV gray heave indicator

B. NOAA ship *Pisces* Ops Officer, re: confirmed IMU tumble test

C. Charles Thompson, re: waterline offset

D. Glen Rice, re: various issues

Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>

POSMV grey indicator?

Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> Fri, Jul 25, 2014 at 3:24 PM
To: Adrian Gibbons <agibbons@applanix.com>

Hi Adrian. Thanks again for your quick work.

As I about to pass on your latest idea to the Electronics Technician on Pisces, I received this positive, surprising answer.

"Warren : On Wednesday [23rd], the posmv computer, **not the** orange deck unit, came up with a hard drive fail. Thankfully, it was not fatal, but I had to do a cold start on the computer and sensors recovered with heave status green on the POS MV VIEW window! Its been running recently with no issues. ... Pat"

All indicators are apparently green now. So it seems no further action is needed here. Given that we succeeded with a GAMS calibration this summer (for the first time in 3 years trying), morale is high and folks are happy.

I have passed on your advice regarding the POSView and PCS versions, and I suspect they'll update the next time the vessel is free of an ongoing science mission.

Thanks again and kindly, - Warren

--
Warren Mitchell
JHT Contract Fisheries Biologist
Habitat Mapping Lead, Fisheries Ecosystems Branch - SEFIS Group
NOAA Fisheries, Beaufort Laboratory
warren.mitchell@noaa.gov
252.728.8755
http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
www.nmfs.noaa.gov

On Thu, Jul 24, 2014 at 6:05 PM, Adrian Gibbons <agibbons@applanix.com> wrote:

> Hi Warren,
>
> Damir is correct, you should be using POSView 3.4 with PCS fw 3.42. However, I have a suspicion this is not the reason for the Heave LED being greyed out.
>
> Please open POSView window **View | Heave Data** and wait approx. 5 minutes. Once you have done this select in POSView **Settings | Save Settings** and send me a screenshot of the Heave window & the POSView main window. Opening the Heave window will resend the command to enable TruHeave. Saving the setting will ensure it is set for next time.
>
> Finally, if the LED is still greyed out, would you send me a copy of your PCS setting file. This can be

extracted from the PCS via POSView command **File | Save POSConfig**.

Regards,

Adrian

From: Warren Mitchell - NOAA Affiliate [mailto:warren.mitchell@noaa.gov]
Sent: Thursday 24 July 2014 21:41
To: Adrian Gibbons
Subject: Re: POSMV grey indicator?

Hi Adrian:

Thanks for your assistance. The cruise leg wound down on the 18th, and I'm off the ship - I apologize for not getting back to you sooner. I did follow your guidance, and found group 111 was indeed checked. So that did not solve the problem. We also heard back from a separate request to techsupport@applanix.com, excerpt below.

As was sent to Damir, here I've attached a screen cap of 'view statistics' and 'help about'. I'm but a scientist who sails on board Pisces, and am not cleared by the vessel's technicians to make modifications such as update controllers. While that could well do the job, it is curious that the heave indicator was green just a month ago, no? The ship's technicians seemed quite sure that neither software nor firmware had been altered recently.

Anyway, I primarily wanted to recognize your efforts in support. Please do send any last thoughts, and if you need more information from the ship I'll have colleagues on board through 2 August.

Respectfully, - Warren

*****

Hello Warren,

Thank you for the screenshots,

It looks like there is a mismatch between the firmware you are using and the controller, you should be using controller v3.4.0.0 with FW 3.42, I have uploaded the MV POSView setup to our server, you can download it via FTP.

Let me know if this resolves the issue,

Best regards,

Damir Gumerov, Product Support Analyst | ***Applanix – A Trimble Company***

85 Leek Crescent, Richmond Hill ON Canada L4B 3B3 |T: 1-289-695-6031 |C: 1-416-417-5230

--
Warren Mitchell
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NOAA Fisheries, Beaufort Laboratory
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252.728.8755

http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
www.nmfs.noaa.gov

On Wed, Jul 16, 2014 at 11:43 AM, Adrian Gibbons <agibbons@applanix.com> wrote:

Hi Warren,

I apologise for the delay responding, Mike no longer works for Applanix and your email took a while to catch up internally.

The POSView heave LED will be greyed out if group 111 (TrueHeave) is not selected as an output under POSView pull down menu **Logging | Ethernet logging**. Selecting this will hopefully resolve your problem.

Further, depending on the POS MV model you have the TrueHeave option may have to be set in the PCS. If selecting group 111 does not resolve the problem, please send me a screenshot of POSView **View | Statistic** screen for me to check the options you have defined.

If you have any further questions please let me know.

Regards,

Adrian

From: Warren Mitchell - NOAA Affiliate [mailto:warren.mitchell@noaa.gov]
Sent: Monday 14 July 2014 5:19 AM

To: Mike Stasko
Cc: Matthew Wilson - NOAA Federal

Subject: POSMV grey indicator?

Greetings Mike Stasko,

If we may, colleague Matt Wilson and I have a POSMV question and have referenced correspondence from last summer to reach you. We also see from paperwork that you performed a tumble test on NOAA ship Pisces' IMU in January. I hope our question is simple.

We notice a grey indicator for heave in the attached screen capture, and the text 'heave' is also greyed out. This is a new one to us, and the manual and google searches have yielded little on the subject. We can see real time heave data transmitting from POSMV to the ME70 sonar, and the bathymetry maps we've created are decent-to-good. And so we're confused about what this means. Might you share some thoughts, please?

As a random, 'great news' update, this Pisces cruise seems to have achieved a successful GAMS calibration; POSMV performance appears very good and morale is high.

Kindly, - Warren and Matt

Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>

POS MV IMU Tumble Testing

Kyle Byers - NOAA Federal <kyle.byers@noaa.gov> Thu, Jul 10, 2014 at 6:39 PM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>
Cc: Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>

No problem. Patrick and Bob re-installed it. I am assuming since they used the pre-existing mounts, everything should be the same. I hope that is the correct answer!

On Thursday, July 10, 2014, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

> Kyle,
> Thanks. I'm guessing the answer is then that they were able to return the IMU to its original location with very exact precision!
> Matt
>
> On Thu, Jul 10, 2014 at 9:20 AM, Kyle Byers - NOAA Federal <kyle.byers@noaa.gov> wrote:
>
>> Hi Matt,
>>
>> The IMU was sent off for a tumble test over the winter and was returned to the exact same position, on its mount by the ME70 cage.
>>
>> V/r,
>> Kyle
>>
>> On Thursday, July 10, 2014, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:
>>
>>> Kyle,
>>>
>>> We've been attempting calibrations of the ME70 over the past few days, and (so far) finding results quite similar to the previous values (those determined last summer). This was surprisingly to Warren and I, as we were under the impression that during the winter the IMU was "tumble-tested" by Applanix. I'm not familiar with exactly what a tumble test entails, but I had thought this meant the IMU was during the process removed from its position, tested, and then returned. If the IMU position is changed, this leads me to think that last year's patch test values would be rendered irrelevant, but as I mentioned already, it appears this is not the case. This leads me to guess at several possible reasons why this could be, and perhaps you could help us understand if one of these is true? As you can infer, I'm unfamiliar with the both the tumble test and also the process of moving/adjusting the IMU, as I've never participated in either.
>>>
>>> 1. Maybe the tumble test does not require the IMU to be moved, in which case the patch test values from last year are still applicable?
>>>
>>> 2. Maybe the IMU was moved for the tumble test but was returned to the absolute exact same position?
>>>
>>> 3. A tumble test was not performed at any time between summer 2013 and summer 2014 and therefore the IMU was not moved?
>>>
>>> Thanks Kyle, and if you like I could ask Applanix (Mike Stasko directly, or a different POC?), but thought I'd' run this by you first. Thanks!
>>>
>>> Matt
>>>
>>> --
>>> Respectfully,

> > Matthew J. Wilson
> > Physical Scientist, NOAA Office of Coast Survey
> > Atlantic Hydrographic Branch
> > matthew.wilson@noaa.gov
> > office (757) 441-6746 x205
> > cell (703) 638-3608
>
> --
> Respectfully,
>
> Matthew J. Wilson
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Caris Vessel Configuration File for Pisces

Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> Fri, Jan 16, 2015 at 4:47 PM
To: Warren Mitchell <Warren.Mitchell@noaa.gov>

---------- Forwarded message ----------
From: **Warren Mitchell - NOAA Affiliate** <warren.mitchell@noaa.gov>
Date: Thu, Jun 6, 2013 at 2:53 PM
Subject: Fwd: Caris Vessel Configuration File for Pisces
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>

For thought, some plumb line measurements on Pisces waterline have been made in the past (fall 2011). The message below may be helpful for hvf troubleshooting.

--
Warren Mitchell
JHT Contract Fisheries Biologist
Habitat Mapping Lead
Fisheries Ecosystems Branch - SEFIS Group
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warren.mitchell@noaa.gov
252.728.8755 Note: Voicemail is currently inoperable at the Beaufort Lab
http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
www.nmfs.noaa.gov

---------- Forwarded message ----------
From: **Charles H. Thompson** <charles.h.thompson@noaa.gov>
Date: Mon, Mar 25, 2013 at 5:45 PM
Subject: Re: Caris Vessel Configuration File for Pisces
To: Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>
Cc: Charles Thompson - NOAA Federal <charles.h.thompson@noaa.gov>, David.Dodd@usm.edu

Warren,
Thanks greatly for the .hvf.

I went back to the notes I made at the end of the workshop when you, me, Karen, Chris, and Vince were on the Pisces. Chris and I made some measurements with a lead line to get the following.

Top of IMU down to deck surface: 18.875" = 0.479m
Deck surface to water (in the centerboard trunk): 7" = 0.178m
Deck surface to inner hull surface at ME70 xdcr: 16'7.25" = 5.061m

So the IMU is 0.657m above the waterline. And the transducer is 4.883m below the waterline. If I understand correctly (not at all certain) the value -3.21 m should be replaced by +0.66 m. Does this make more sense?

Charles

On 3/19/2013 4:33 PM, Warren Mitchell - NOAA Affiliate wrote:

> Greetings Charles and David.
>
> Things are well, thanks; hoping for the same down your way.
>
> Totally willing and encouraged by supervisors to share, .hvf is attached. I also attached the casual "configuration" documentation for the Pisces ME70, started by Laura Kracker (NOAA NOS, Charleston) and Glen Rice (then-NOAA Corps; IOCM @ UNH) during PC1203. The config document was updated during PC1204 with help from folks listed just below. If needed, the document should contribute context on where sensor offsets were applied. I believe a hard copy exists in the acoustics lab - perhaps folks like Mike Jech have made contributions since August.
>
> That's great news on help from Fairweather, and here's to good luck on the cruise. All the best with getting Matlab and Caris; we (Nate Bacheler) are working on getting Caris this spring and the going is slow, - Warren
>
> Some additional comments from cruise notes; may be helpful:
>
> The offsets and corrections in the configuration file were set up during the beginning of PC1204 cruise time (approx 24 26 July 2012), with Glen Rice , Matt Wilson (UNH; NOAA Atlantic Hydro Branch), and Jon Beaudoin (UNH).
>
> Those men drove the calculation and Caris work; I was learning. I recall they weren't completely happy with offset figures, in part due to lack of confidence in the vessel survey.
>
> The x, y, and z offsets seen in a few places within the .hvf (e.g., swath 1, SVP 1; x=0.625, y=1.094, z=5.620) will match what is on page 8 of the attached pdf config. There's text on page 8 about why the numbers changed a smidge from what Glen had originally provided to Laura for PC1203 (Matt caught a small math mistake by Glen during PC1204). Note that the PosMV and Caris fundamentally swap x and y as alongship and athwartship. I can confirm the x and y were transposed on purpose.
>
> In my humble opinion, I think a value to confirm in its application is the /waterline height/ -3.21 m. I have a suspicion from watching different sounders
>
> and depth charts while on board that there may be a systematic mistake present.
>
> On Tue, Mar 19, 2013 at 5:00 PM, Charles H. Thompson <charles.h.thompson@noaa.gov <mailto:charles.h.thompson@noaa.gov>> wrote:
>
> > Warren,
> >
> > Hope you're doing well.
> >
> > In a recent phone conversation, I think you said that you had created a Caris Vessel Configuration File for the Pisces. Would you be willing to share it? If so please send it to me and to David.Dodd@usm.edu <mailto:David.Dodd@usm.edu>.
> >
> > I think you are probably aware that the FAIRWEATHER is going to put a survey tech on the PISCES for the first half of the upcoming reef fish survey in

the Gulf. I'm hoping to get a computer with Matlab and Caris onboard that he can use to do some processing.

Best Regards,
Charles

--
Warren Mitchell
*JHT Contract Fisheries Biologist Fisheries Ecosystems Branch - SEFIS Group
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warren.mitchell@noaa.gov <mailto:email@noaa.gov>
252.728.8755 <tel:252.728.8755> Note: Voicemail is currently inoperable at the Beaufort Lab*http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
*www.nmfs.noaa.gov <http://www.nmfs.noaa.gov/>

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Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>

On Pisces

Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> Fri, Jan 16, 2015 at 5:02 PM
To: Warren Mitchell <Warren.Mitchell@noaa.gov>

---------- Forwarded message ----------
From: **Glen Rice - NOAA Federal** <glen.rice@noaa.gov>
Date: Fri, Jun 14, 2013 at 3:32 PM
Subject: Re: On Pisces
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>
Cc: Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>

Hey Matt,

I recall heave being a problem, but we were also in pretty heavy conditions... How is your HVF setup? If I remember correctly, heave in the raw and GSF files are reported at the multibeam (see the PASHR data description), while True Heave is reported at the reference point (IMU). This makes it difficult for Caris to unapply and then reapply heave because of how your HVF should be setup depends on which stage of the process you are in...

All that said, I don't think that heave is applied real time... since all we have is range/angle, the vertical offset cannot be applied before Caris. The application of heave in real time is just for the reported display, not the logged data. If that is the case you should configure the HVF to put heave at the sonar if you are going to just apply real time heave. If you are going to apply True Heave you might want to do some testing, but I think you can put heave as reported at the IMU. In this case the real time heave will be applied in the wrong position, but then unapplied at the same place making it okay, and then True Heave will be applied. You might also try setting the heave to apply=no, and then applying True Heave. I think you can still apply True Heave even if the HVF says no, but you would need to check.

Those are my best guesses. Good luck,
Glen

On Fri, Jun 14, 2013 at 3:55 AM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

> Glen,
>
> We collected our patch test data with roll and pitch compensation off. Heave compensation was not turned off, however no heave data came through in the data,and we see a bad heave artifact. We noticed that our patch test data from last year also has no roll, pitch, and heave, and also has the bad heave artifact. Confused about this -- if heave should be coming through, and if so, we don't know why it didn't.
>
> Should we have set the misalignment values to zero in the POS? Or it doesn't matter if roll and pitch compensation is switched off in the ME70, right?
>
> We have time tomorrow to do GAMS, dynamic draft, and re-patch if we're not happy with the values. Right now we are all taking attempts at calibration, but the results are underwhelming because of the heave artifact.
>
> Thanks for any clarification you can provide.
> Matt
>
> On Fri, Jun 14, 2013 at 4:12 AM, Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> wrote:
>
>> Yes, thank you Glen. Patch test data collected this afternoon, and processing is underway for comparisons with last year. I like to think we're collecting good data... one incremental improvement at a time, - WAM

--
Warren Mitchell
JHT Contract Fisheries Biologist
Habitat Mapping Lead Fisheries Ecosystems Branch - SEFIS Group
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252.728.8755 Note: Voicemail is currently inoperable at the Beaufort Lab http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
www.nmfs.noaa.gov

On Thu, Jun 13, 2013 at 4:28 PM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

> Glen -
> Internet was down all day, just now able to send (hopefully)
> 1. Copy, we will go with the 0.661m waterline value.
> 2. Thanks for explaining this, your roll and pitch explanation makes perfect sense, will consult POS M/V manual further for the yaw. No reason to think any issues based on what we've seen in the data, just wanting to verify everything.
> 3. Will update x,y,z offset TPU values for Pisces IMU to ME70 offsets in the user_variables.txt. Will also tinker with sigmaDRMS and stdTide values as you suggested to see if the sounding uncertainties make more sense.
>
> Thanks,
> Matt
>
> On Thu, Jun 13, 2013 at 2:04 PM, Glen Rice - NOAA Federal <glen.rice@noaa.gov> wrote:
>
>> Hey Matt,
>>
>> Glad you guy are out working through stuff.
>>
>> 1. Your waterline value should be about right. The -3.2 value was a hold over from Dyson which references to their granite block rather than the IMU. I got that value using the method in the attached document. It had been my intention of doing this same thing for Pisces, but since the POSMV was not POSPac capable it got canned and forgotten about.
>>
>> 2. The ME70 is roll and pitch compensated, so applying roll and pitch are off in the HVF. Roll, pitch and heading are in the POS MV sensor 1 field so that the real time motion provided to the ME70 is in the correct reference frame, preventing cross talk between pitch and roll. Since roll and pitch are provided in the correct reference frame there should be no further need to account for these offsets. Heading is applied in Caris, and the logged heading value in the raw file (and therefore the GSF, and therefore used in Caris) is from the INHDT NMEA string. This string is in the IMU reference frame, so does not contain the Yaw offset. Therefore, the heading patch test value needs to be applied in Caris. You should look in the POS MV manual convince yourself of this.
>>
>> 3. The X/Y/Z values are the offsets between the POS MV (where nav and attitude are calculated) and the ME70 if I remember correctly, so those numbers should be larger (I think they were set for Dyson, but from the granite block to the ME70 for some reason). Uncertainty in the ME70 is large because the beam widths are so huge (5 degree along track). You might be able to improve the horizontal uncertainty some by dropping the sigmaDRMS value. I think the numbers that are in there are for a system without DGPS (Dyson). For the vertical (which does seem high) try adjusting the stdTide value. It might have been set large for AK. Feel free to play with those values to see how they effect the result.
>>
>> Fair winds and collect good data.

Glen

On Thu, Jun 13, 2013 at 1:40 AM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

Glen,

Hey how are you? Fighting through our first shift here on Pisces. A few things to run by you:

1. Waterline value we used previously was -3.21. I cannot explain nor can I reproduce this. Do you remember how we got that value?

Here are Charles Thompson's measurements / calculations:
"Top of IMU down to deck surface: 18.875" = 0.479m
Deck surface to water (in the centerboard trunk): 7" = 0.178m
Deck surface to inner hull surface at ME70 xdcr: 16'7.25" = 5.061m
So the IMU is 0.657m above the waterline. And the transducer is 4.883m below the waterline. If I understand correctly (not at all certain) the value -3.21 m should be replaced by +0.66 m. Does this make more sense?"

Here are my calculations:

6/12/2013 fwd and aft draft marks: 5.45m / 6.13m, average = 5.79m
Granite Block to Keel Near Frame 78 z value= 2.017m (Impastato)
Granite Block to IMU z value = -4.434m (Impastato)
4.434 + 2.017 - 5.79 = 0.661m (almost exactly the same as Charles Thompson)

I'm thinking we will go with the 0.66m value, unless you see blatant errors in what we've done.

2. The HVF we used last year lists Pitch and Roll values in Swath 1 for the patch test data; thereafter, data collection uses "0" for Pitch and Roll. However the Yaw value is always populated. The POS MV Sensor Mounting tab, Sensor 1 Frame w.r.t. Ref. Frame lists Roll, Pitch, and Yaw values. Why were Roll and Pitch switched off in the HVF? Is it b/c of the ME70 Roll and Pitch compensation? Why is Yaw seemingly applied twice then, in HVF and POS?

3. Transceiver boards were not ordered due to breakdown in communication. Nevertheless we are sailing and pinging and recorded a quick line which I've gone ahead and processed without issue, using the matlab .exe. Regarding the user_variable.txt -- are those all TPU values (after the reject_outerbeams value)? why are the x,y,z offset values so high? (currently set to 0.961, -1.736, and 1.338, respectively). Resulting soundings have Hz and Dp Tpu of 10m, and 3m (approx).

4. So far ME70 is behaving, though there are cryptic warnings about those transceiver boards, from personnel onboard, that they could fail at any time. We are having them ordered, hopefully to be replaced this weekend, is the word I'm getting from the CO.

Thanks Glen,

Matt

--
Respectfully,

Matthew J. Wilson
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Simrad ME70 on Pisces - latest notes

Glen Rice - NOAA Federal <glen.rice@noaa.gov> Thu, Aug 15, 2013 at 11:08 AM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>

Hey Matt,

The beams are not repointed in Matlab and there is no user setting for surface sound speed. The Matlab code is doing a bottom detection by beam, and then putting the angle information from the RAW file into the GSF without messing with it. Caris is handing any refraction stuff.

From what I understand the surface sound speed value in the RAW file is always what was provided by the user on the ME70, so it should not be used for repointing if the system was set to use the real time TSG information. What I was saying was that if the value in the RAW file contains the user value and not the real time value, maybe there is a bug such that the real time value is never being used by the ME70. While the value is displayed real time (thanks to your efforts), perhaps it is never actually used for beam pointing. I wanted to check that by drastically changing the value coming in from the TSG (by putting fresh water in it) and seeing if there was an observable change in the ME70 bathymetry. If the ME70 does not change, it would seem that it only ever uses the user supplied value, even when set to use real time information.

Regards,
Glen

On Thu, Aug 15, 2013 at 10:37 AM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

> Glen,
>
> Is the user set value you are referring to the value in the MATLAB code? Might we have potentially been pointing our beams in ME70 and then re-pointing them in MATLAB?
>
> There is a user set value in the ME70 acquisition software that we adjusted, which caused a very significant effect to the data. We finally got that value to auto-adjust based on the TSG feed.
>
> It will go on the list for next year to adjust the MATLAB sound speed value -- I didn't guess it would supersede the real-time value from the TSG.
>
> thanks,
> Matt
>
> On Thu, Aug 1, 2013 at 8:53 AM, Glen Rice - NOAA Federal <glen.rice@noaa.gov> wrote:
>
>> Sorry for the last minute suggestion. Only after the last email did it occur to me that a bug in the software might cause the real time feed to never be used and would cause a lot of the problems we see. The times that it is good would only be because the user set value happened to be close enough to being good values. Another way to check this would be to set the user value to something stupid and then switch to the real time feed. If there is not an improvement the system would have been stuck on the user value.
>>
>> You guys have earned your rest. Sleep well.
>> Glen
>>
>> On Wed, Jul 31, 2013 at 11:48 PM, Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> wrote:
>>
>>> Winner, Glen Rice. Your fresh ideas have finally outpaced our drive and determination. Matt and I are heading to the rack here soon. Thanks as ever for your support during the cruise. Talk to you soon, - WAM
>>>
>>> --
>>> **Warren Mitchell**
>>> *JHT Contract Fisheries Biologist*
>>> *Habitat Mapping Lead*
>>> Fisheries Ecosystems Branch - SEFIS Group
>>> NOAA Fisheries, Beaufort Laboratory
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>>> http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
>>> www.nmfs.noaa.gov

On Wed, Jul 31, 2013 at 3:54 PM, Glen Rice - NOAA Federal <glen.rice@noaa.gov> wrote:

Matt,

Can you dump some fresh water in the TSG to see if it effects the ME70 when using the real time feed? Seems like that would confirm that the system is actually using the real time feed at all. That might be a worth while check while you are on board.

Glen

On Tue, Jul 30, 2013 at 7:18 PM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

Glen - I've been writing my report in the DR template but it basically contains all elements of the DAPR and could be transitioned easily. Please do send a copy of the DR you've been producing for a reference, I'd appreciate that and draw mine up in a similar manner.
As for the temperature feed to the ME70, at the moment it comes from the SBE 21 that is not near the hull. Normally there is a SBE38 that supplies the hull-corrected temperature to the TSG45 as I understand however this is not currently functional. All that being said, the sound speed we see coming into the ME70 matches the transducer-level sound speed we see in the XBT and CTD casts.

Jonathan - prior to fixing the real-time feed, there was a manual value field we could enter in at the transducer face, and experimenting/adjusting that value drastically altered the smiles/frowns observed in post-processing. We see that field updating now that the real-time feed is fixed.

Thanks all,
Matt

On Tue, Jul 30, 2013 at 1:41 PM, Jonathan Beaudoin <jbeaudoin@ccom.unh.edu> wrote:

Perhaps the surface sound speed is only being used to scale the travel-times into ranges on the graphical display and is not used at all in the beam forming/steering?

jb

On 7/30/13 9:10 AM, Glen Rice - NOAA Federal wrote:

Hey Matt,
See inline.

Hope you all are well. ME70 performance on Pisces is always meeting SEFIS objectives for trap deploments well enough, and I'm also writing an OCS-style Descriptive Report for the cruise, hopefully useful in future cruises.

Awesome possum. From the most recent HTD it seems like HSD is looking for DAPRs more than full DRs, but this is something we have not done yet. Are you constructing this kind of document too? Would you be interested in a copy of the DRs we have been producing for reference? There has been some discussion about trying to fit FSVs into the XML DR process...

- uncertainty. We've normally been running the MATLAB scripts without uncertainty because the TPU calculations were slow enough such that we could not keep up with real-time processing and therefore would prevent timely delivery of products to SEFIS. However, for reporting purposes, as a side project I've ran the MATLAB executable that calculates uncertainty and the results must be incorrect (see first screen capture), up to 4.5m vertical uncertainty, and up to 65m horizontal uncertainty. Also, I believe I know each of the TPU components in the User_Variables.txt, except the last three (sigmaDeltaT, sigmaSOG, and sigmaDRMS). What are these and what might be a reasonable value? Anything else look fishy, or any advice otherwise?

If memory serves, sigmaDeltaT is the uncertainty in timing, sigmaSOG is the uncertainty in the speed over ground, and sigmaDRMS is the positioning uncertainty.

- refraction. See the second screen capture. This is what we've normally been seeing. The TSG is functional now and supplies the ME70 with the real-time feed, however has not been calibrated in 5 years. That said, it is matching both the XBT and CTD values at transducer level (within 0.4 m/s). The XBT's have been matching the CTD well enough not to be a concern (~2cm outerbeam depth sounding uncertainty in the comparison). The CTD has been calibrated recently. So I don't know the cause of the persistent refraction. We have generally 4 XBT's a night, and have had some challenging areas near the Gulf Stream, so it could be just that, but still it seems like we see "smiles" of this magnitude no matter what, like its a given.

We see problems with Dyson periodically too, but since we were not on board for the collection we cannot verify that things were working properly (it would be really nice if the system recorded the USED sound speed uncertainty for beam steering). Can you confirm the temperature being used is from the hull and not the TSG?

Best Regards,
Matt

This is good stuff. Thanks for your thoughts and good work.
Glen

--
Respectfully,

Matthew J. Wilson
Physical Scientist, NOAA Office of Coast Survey

APPROVAL PAGE

W00290

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NGDC for archive

- W00290_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- W00290_GeoImage.pdf

The survey evaluation and verification has been conducted according current OCS Specifications, and the survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Approved:____

Lieutenant Commander Matthew Jaskoski, NOAA
Chief, Atlantic Hydrographic Branch