H13594

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

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	H13594

LOCALITY

State(s):	North Carolina
General Locality:	Cape Lookout Onslow Bay, NC
Sub-locality:	15 NM SE of Cape Lookout

2022

CHIEF OF PARTY
Michael Gonsalves, CDR/NOAA

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Date:

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

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

H13594

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:	**Cape Lookout Onslow Bay, NC**
Sub-Locality:	**15 NM SE of Cape Lookout**
Scale:	**40000**
Dates of Survey:	**03/11/2022 to 03/25/2022**
Instructions Dated:	**02/08/2022**
Project Number:	**OPR-F364-FH-22**
Field Unit:	**NOAA Ship *Ferdinand R. Hassler***
Chief of Party:	**Michael Gonsalves, CDR/NOAA**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 18N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

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Descriptive Report to Accompany Survey H13594

Project: OPR-F364-FH-22

Locality: Cape Lookout Onslow Bay, NC

Sublocality: 15 NM SE of Cape Lookout

Scale: 1:40000

March 2022 - March 2022

NOAA Ship *Ferdinand R. Hassler*

Chief of Party: Michael Gonsalves, CDR/NOAA

A. Area Surveyed

Survey H13594 (sheet 1) is located 15 nautical miles southeast of Cape Lookout in Onslow Bay, North Carolina and encompasses approximately 52 square nautical miles.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
36° 49' 46.56" N 75° 28' 38.64" W	36° 41' 4.56" N 75° 13' 13.08" W

Table 1: Survey Limits

Data were acquired within the assigned survey limits as required in the Project Instructions and HSSD unless otherwise noted in this report.

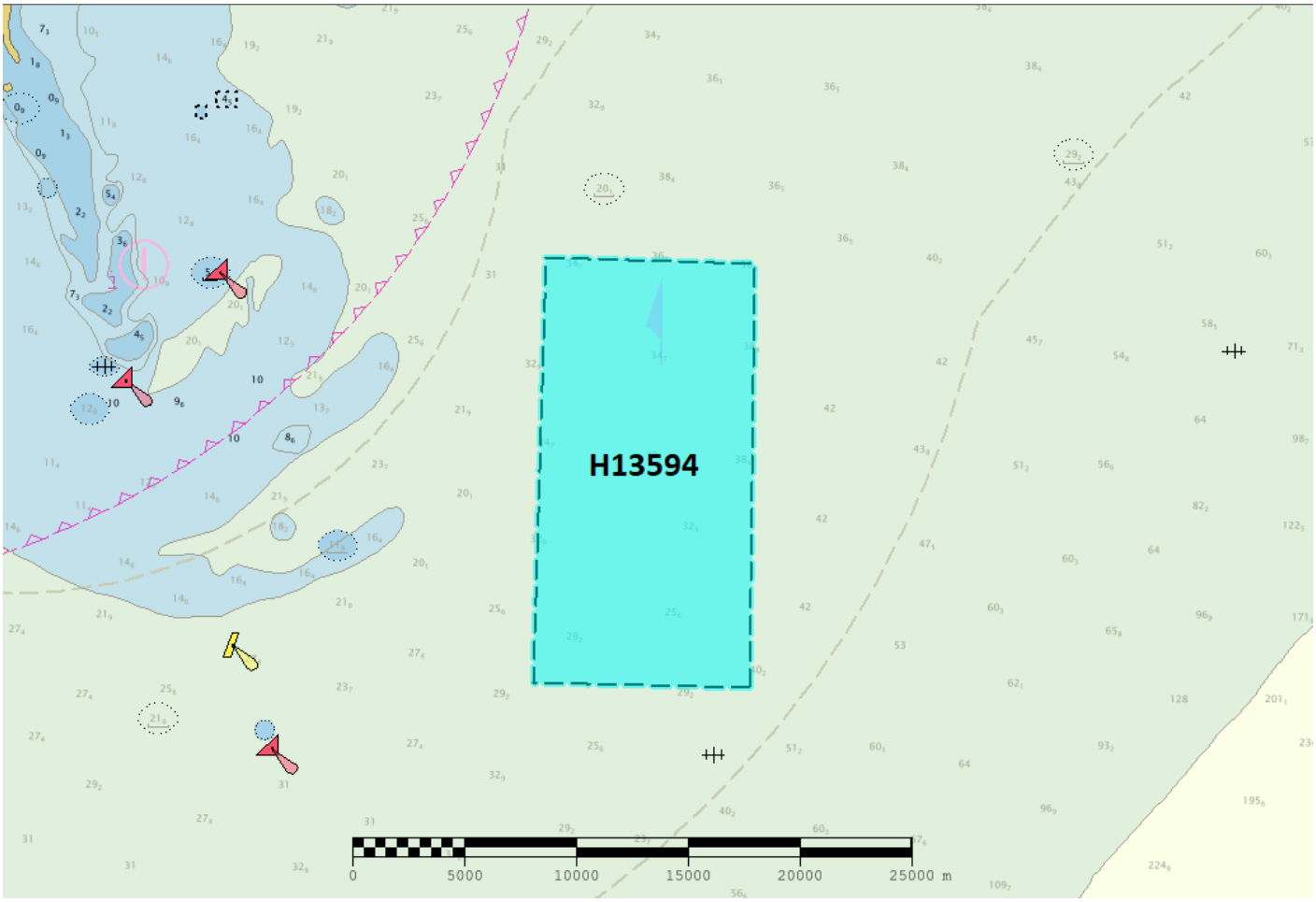


Figure 1: Sheet limits for survey H13594 (ENC US3SC10M).

A.2 Survey Purpose

The objective of survey H13594 was to acquire high quality multibeam bathymetric and backscatter data. The existing charted soundings within this area is from 1970 and earlier. The shoaling seabed is exposed to open ocean and has likely changed from numerous storms and hurricanes over the past several decades. This data will provide modern bathymetry for updating National Ocean Service nautical charting products as well as support the Seabed 2030 global mapping initiative.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

Data acquired in H13594 meet multibeam echo sounder (MBES) coverage requirements for complete coverage, as specified by the 2022 HSSD. This includes crosslines (Section B.2.1), NOAA allowable uncertainty (Section B.2.2) and density requirements (Section B.5.2).

A.4 Survey Coverage

The following table lists the coverage requirements for this survey as assigned in the project instructions:

Water Depth	Coverage Required
All waters in survey area	Complete Coverage (Refer to HSSD Section 5.2.2.3)
All waters in survey area	Acquire backscatter data during all multibeam data acquisition (Refer to HSSD Section 6.2)

Table 2: Survey Coverage

Survey coverage was in accordance with the requirements listed above and in the HSSD.

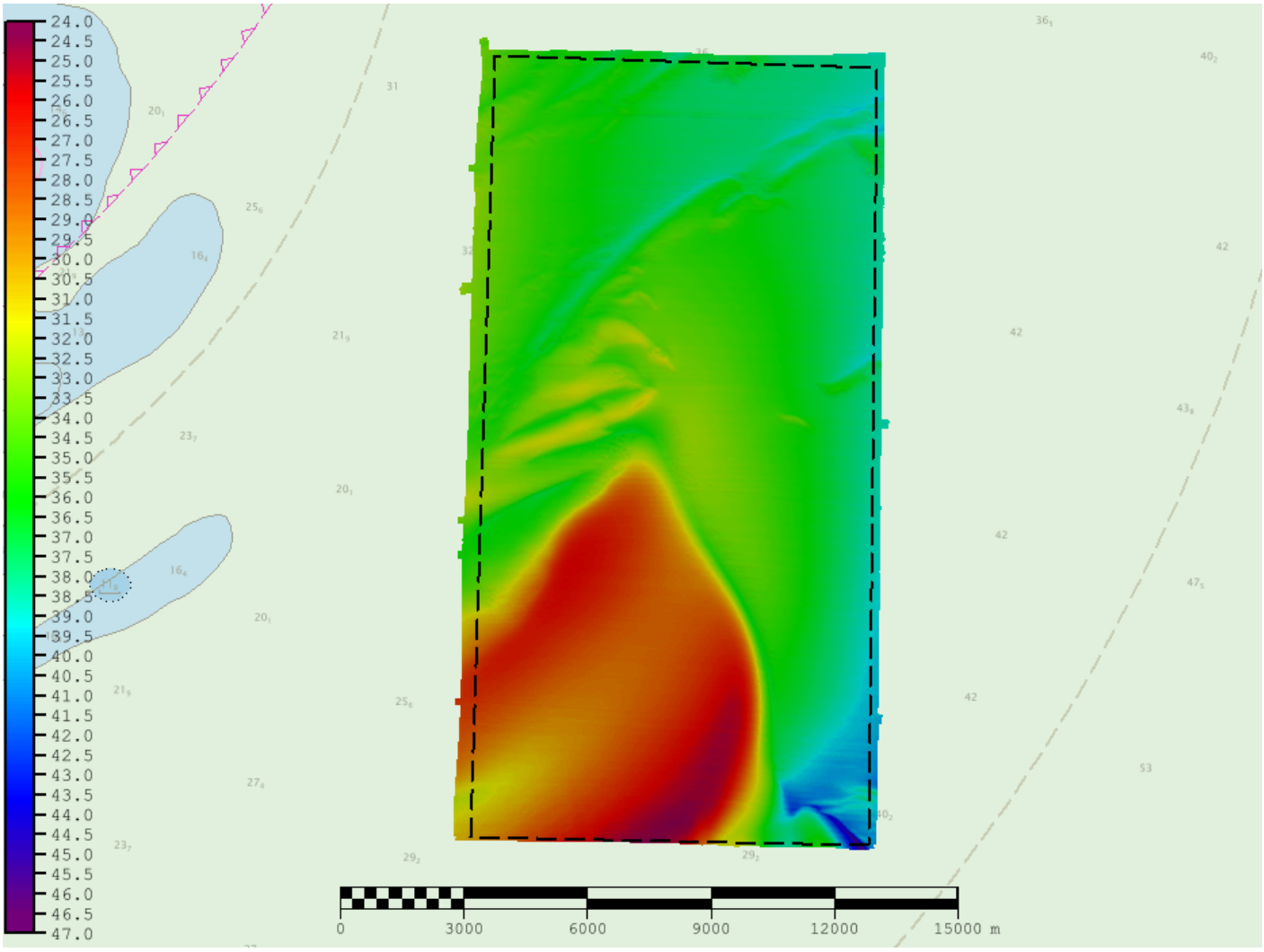


Figure 2: Survey coverage for H13594 (ENC US3SC10M). Dashed black line indicates assigned sheet limits.

A.6 Survey Statistics

The following table lists the mainscheme and crossline acquisition mileage for this survey:

	HULL ID	*S250*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0
	MBES Mainscheme	806.68	806.68
	Lidar Mainscheme	0.0	0.0
	SSS Mainscheme	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0
	MBES/SSS Mainscheme	0.0	0.0
	SBES/MBES Crosslines	39.55	39.55
	Lidar Crosslines	0.0	0.0
Number of Bottom Samples			4
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			55.72

Table 3: Hydrographic Survey Statistics

The following table lists the specific dates of data acquisition for this survey:

Survey Dates	Day of the Year
03/11/2022	70
03/12/2022	71
03/13/2022	72
03/14/2022	73
03/15/2022	74
03/16/2022	75
03/22/2022	81
03/23/2022	82
03/25/2022	84

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures and data processing methods. Additional information to supplement sounding and survey data, and any deviations from the DAPR are discussed in the following sections.

B.1.1 Vessels

The following vessels were used for data acquisition during this survey:

Hull ID	*S250*
LOA	37.7 meters
Draft	3.85 meters

Table 5: Vessels Used

Figure 3: NOAA Ship Ferdinand R. Hassler (S-250).

B.1.2 Equipment

The following major systems were used for data acquisition during this survey:

Manufacturer	Model	Type
Kongsberg Maritime	EM 2040	MBES
Kongsberg Maritime	EM 2040	MBES Backscatter
Applanix	POS MV 320 v5	Positioning and Attitude System
Teledyne RESON	SBE 19plus V2	Conductivity, Temperature, and Depth Sensor
Teledyne RESON	SVP 70	Sound Speed System

Table 6: Major Systems Used

B.2 Quality Control

B.2.1 Crosslines

Multibeam echo sounder crosslines acquired for this survey totaled 4.90% of mainscheme acquisition. Ferdinand R. Hassler (S-250) acquired 39.55 nautical miles of multibeam crosslines. H13594 crossline data is adequate for verifying and evaluating the internal consistency of the survey data. The Compare Grids function in Pydro Explorer analyzed finalized VR surfaces of H13594 crossline-only data and mainscheme-only data. In the difference surface, 99.5% of nodes met IHO allowable Total Vertical Uncertainty (TVU) standards. Refer to Figures 4-6 for additional crossline results.

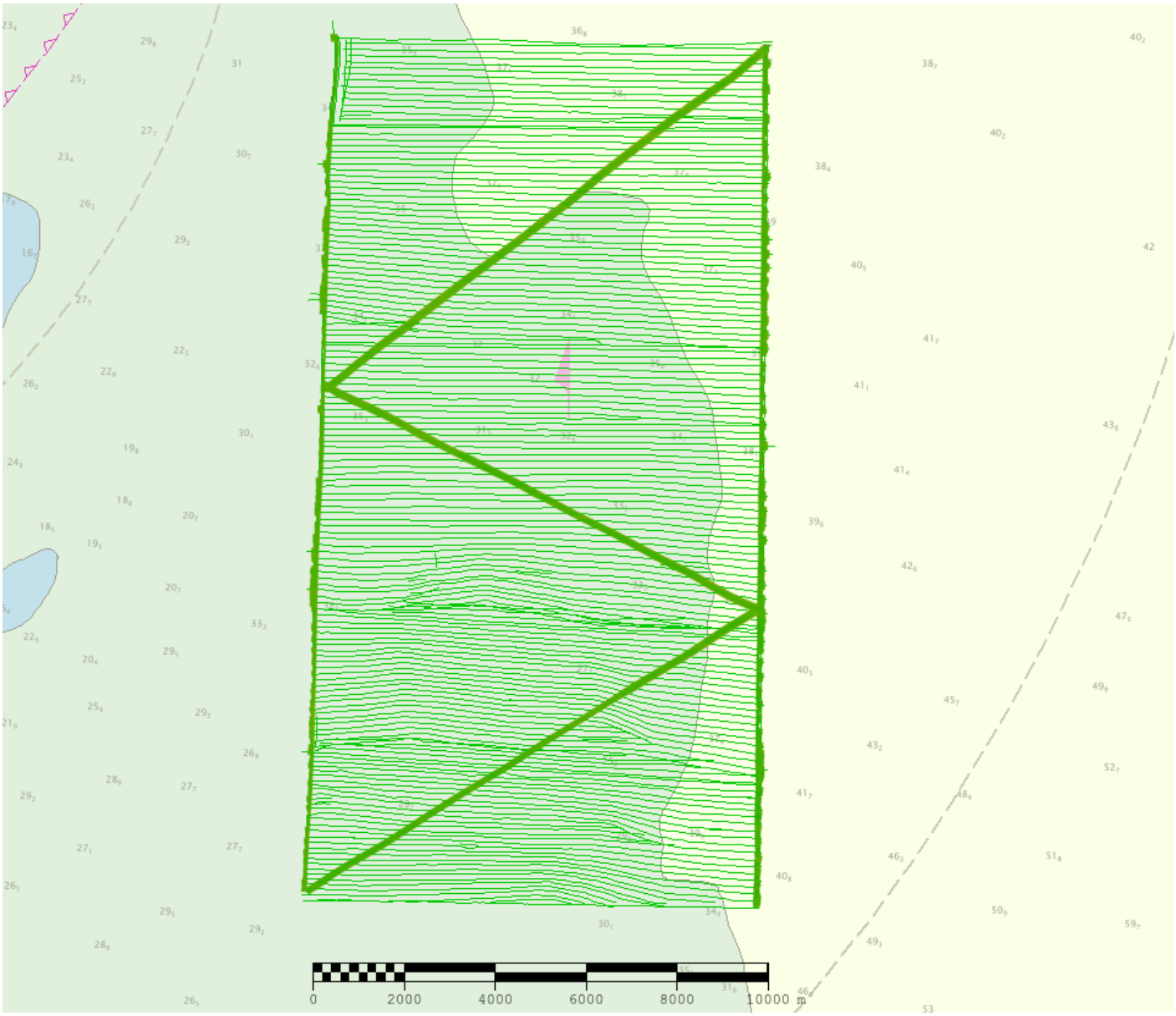


Figure 4: H13594 crossline surface overlaid on mainscheme tracklines. Color scale coded as green = meets IHO standard and red = fails IHO standard (ENC US4NC16M).

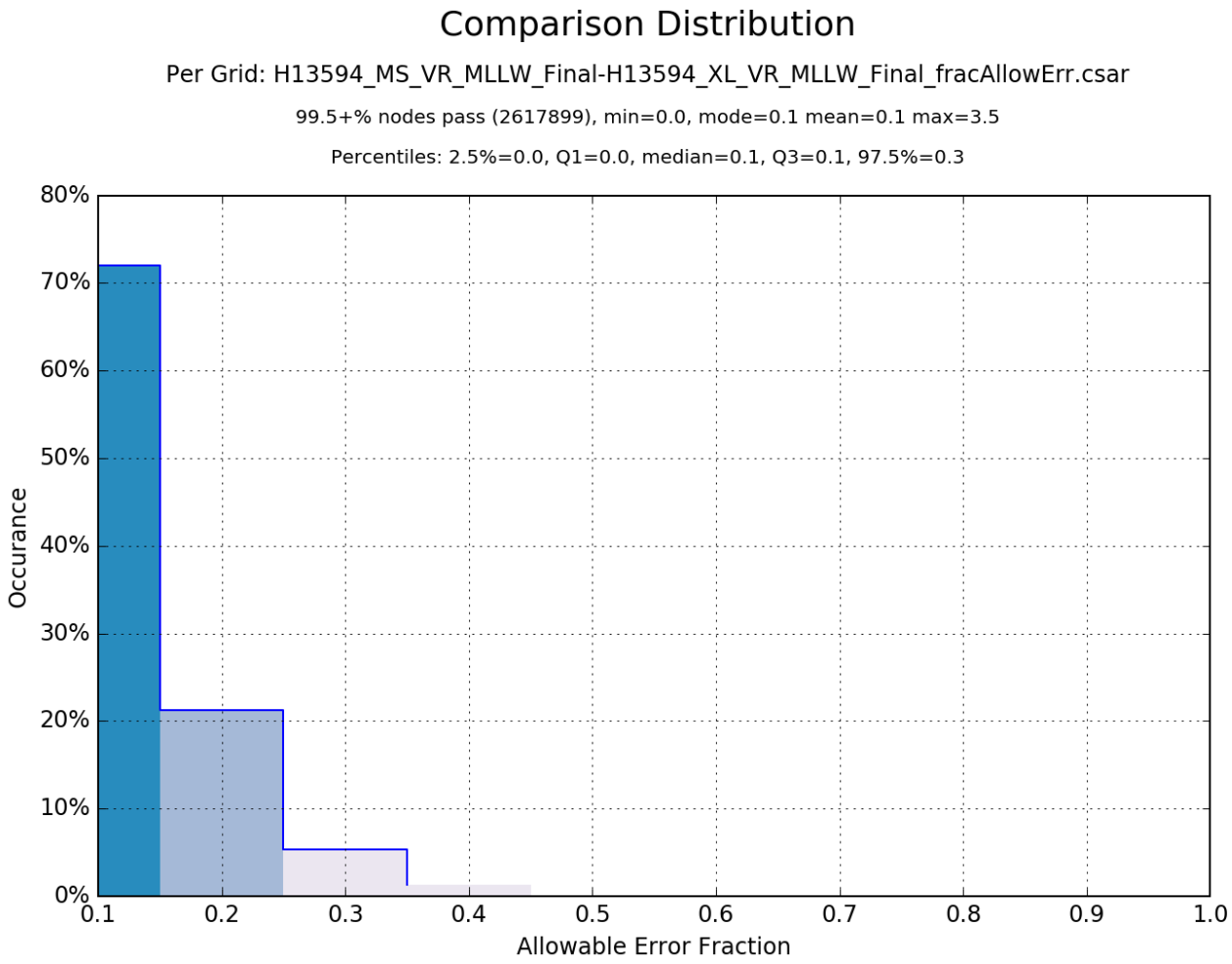
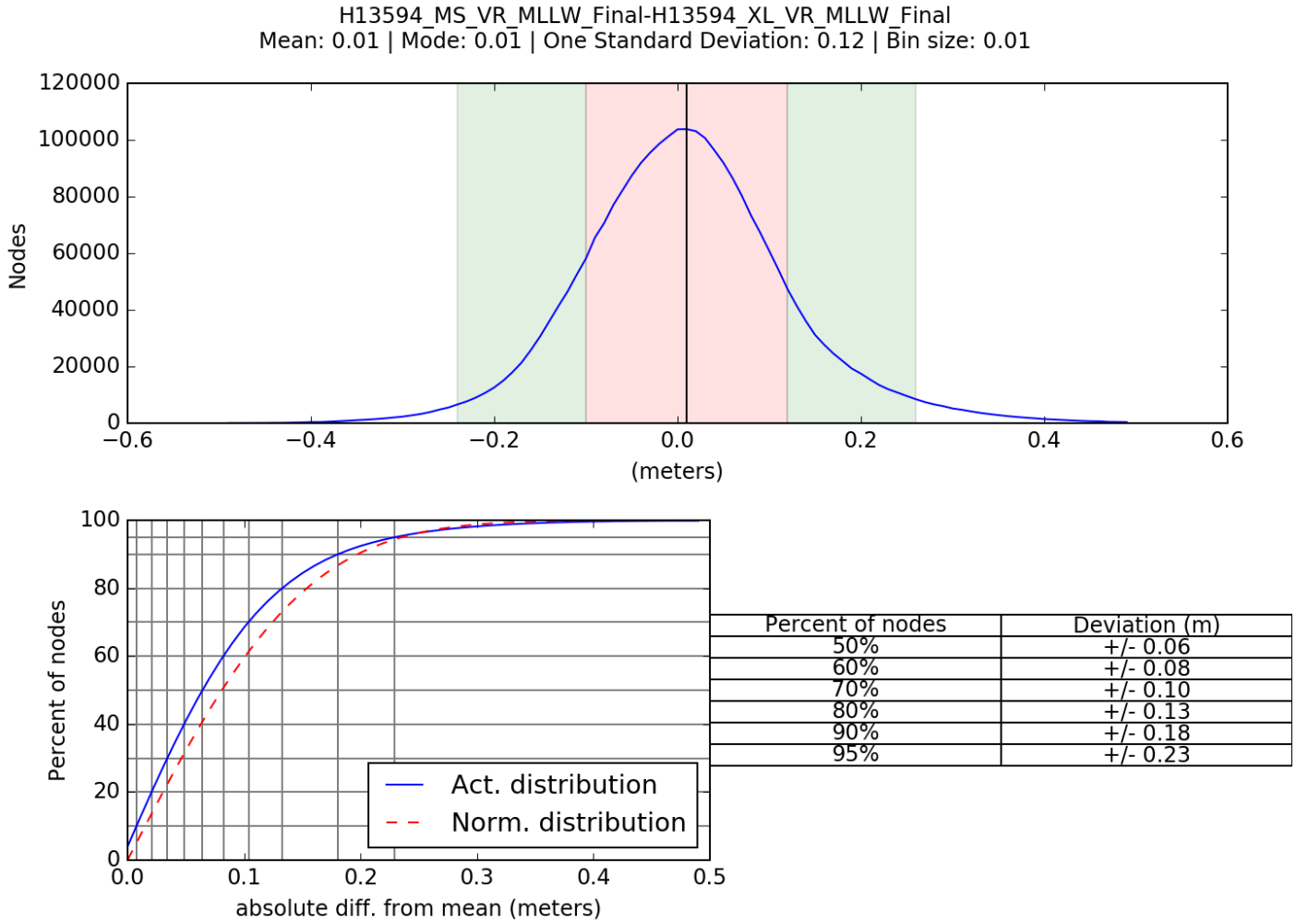


Figure 5: Pydro derived plot showing percentage-pass value of nodes in H13594 mainscheme and crossline data.



Percent of nodes	Deviation (m)
50%	+/- 0.06
60%	+/- 0.08
70%	+/- 0.10
80%	+/- 0.13
90%	+/- 0.18
95%	+/- 0.23

Figure 6: Pydro derived plot showing absolute difference statistics of H13594 mainscheme and crossline data.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.0 meters	0.097 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
S250	4.0 meters/second	N/A meters/second	N/A meters/second	0.5 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Total Propagated Uncertainty (TPU) values for survey H13594 were derived from a combination of fixed values for equipment and vessel characteristics, as well as from field assigned values for sound speed uncertainties. Additionally, real-time and post-processed uncertainty sources associated with position were applied using SBET and RMS files generated using POSPac MMS software. The bathymetric surface is compliant with 2022 HSSD uncertainty standards; over 99.5% of all nodes pass.

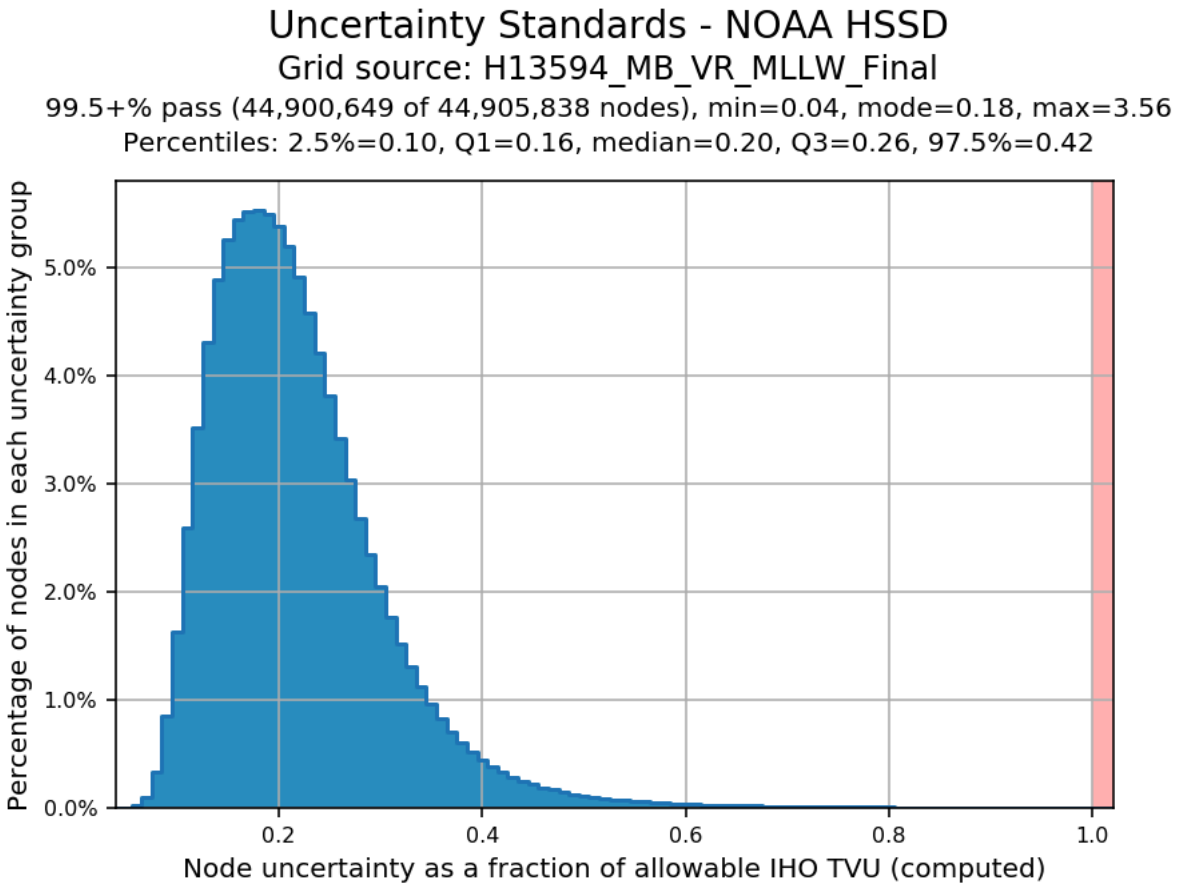


Figure 7: Pydro derived plot showing Total Vertical Uncertainty (TVU) compliance of H13594's finalized VR surface.

B.2.3 Junctions

H13594 junctions with surveys H13595 and H13597. Both surveys are within the same project area (OPR-F364-FH-22). The junction analyses for these surveys can be found in their respective Descriptive Reports.

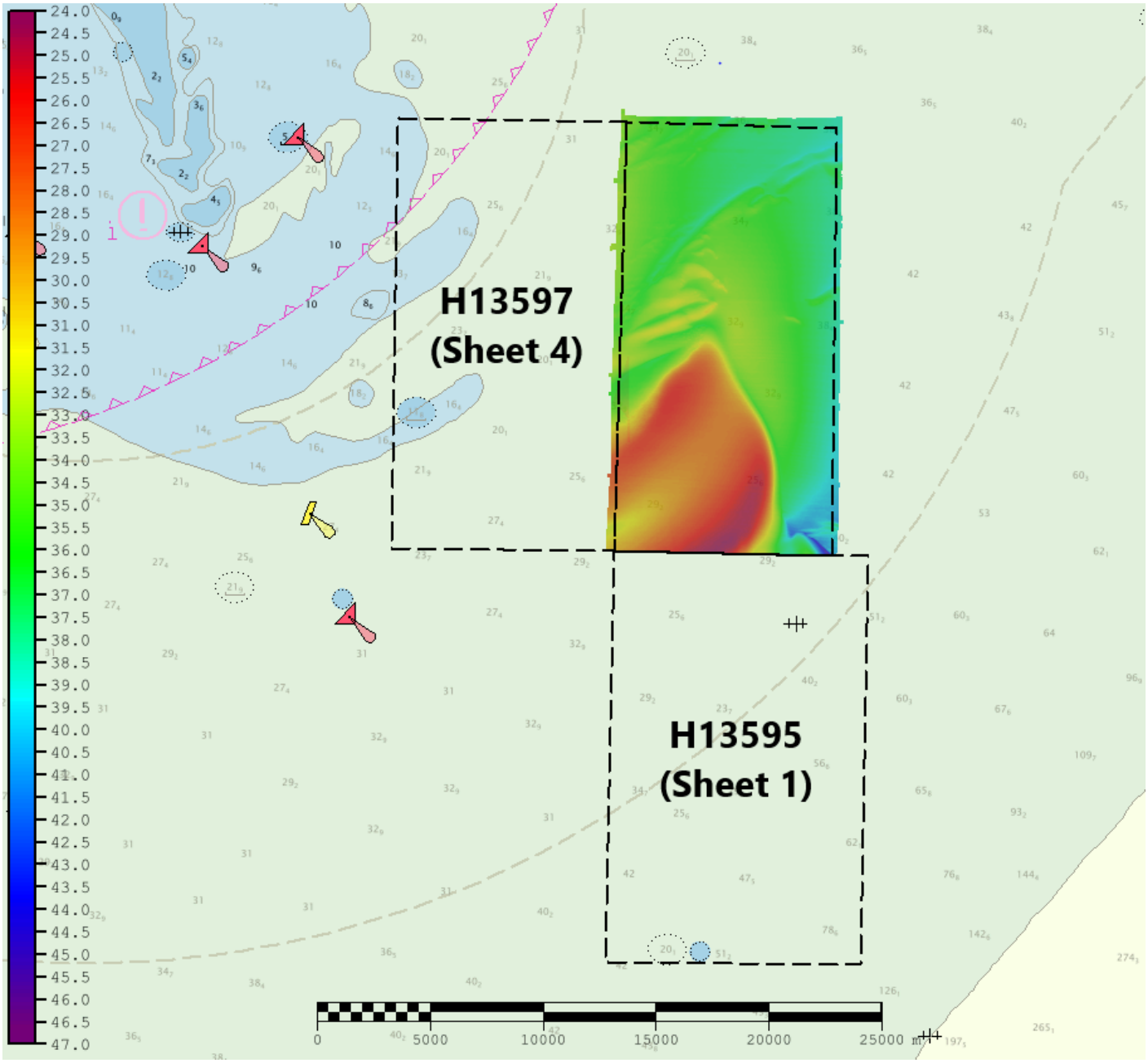


Figure 8: Overview of H13594 junctions with H13595 and H13597 (ENC US3SC10M).

There are no contemporary surveys that junction with this survey.

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the quality control section of the DAPR.

B.2.5 Equipment Effectiveness

There were no conditions or deficiencies that affected equipment operational effectiveness.

B.2.6 Factors Affecting Soundings

Variable Sound Speed

The large shoaling area in the southwest corner of H13594 showed a large variation in sound speed between it and surrounding areas. In some cases, the north and south sides of the survey display a surface sound speed difference up to 7 meters per second. The ship's Moving Vessel Profiler was not available during acquisition on H13594, so manual CTD casts were taken at a reduced frequency of every 4 hours. This reduced frequency of sampling caused sound speed artifacts across the surface but most significantly over the shoal area. Any data exceeding the allowable vertical uncertainty for those depths were rejected. See Figure 9 for example of this data rejection.

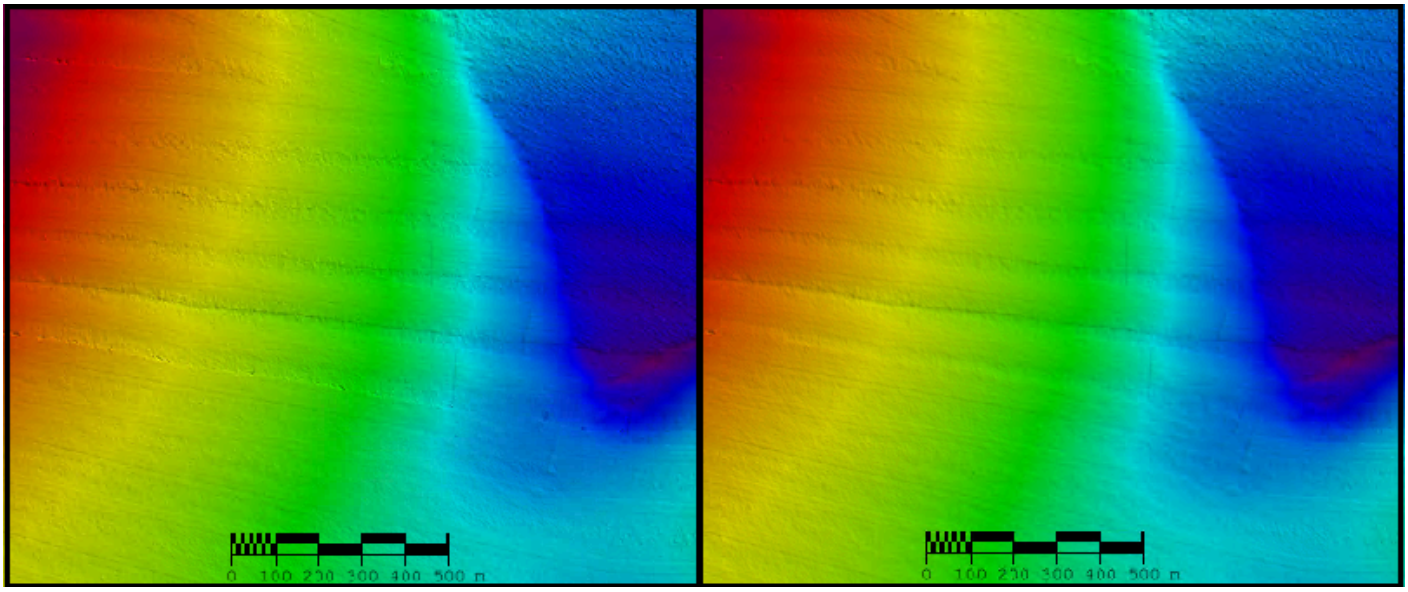


Figure 9: Comparison between the uncleaned (left) and cleaned (right) 2-meter surfaces at 10x exaggeration.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: Sound speed casts were acquired approximately every four hours.

A total of 27 sound speed casts were acquired on H13594. Additional casts were taken when significant changes to surface sound speed were observed. Sound speed profiles were acquired using a Sea-Bird Scientific SBE 19plus profiler. All casts were concatenated into a master file and applied to the MBES data using the "Nearest in distance within time" (4 hours) profile selection method.

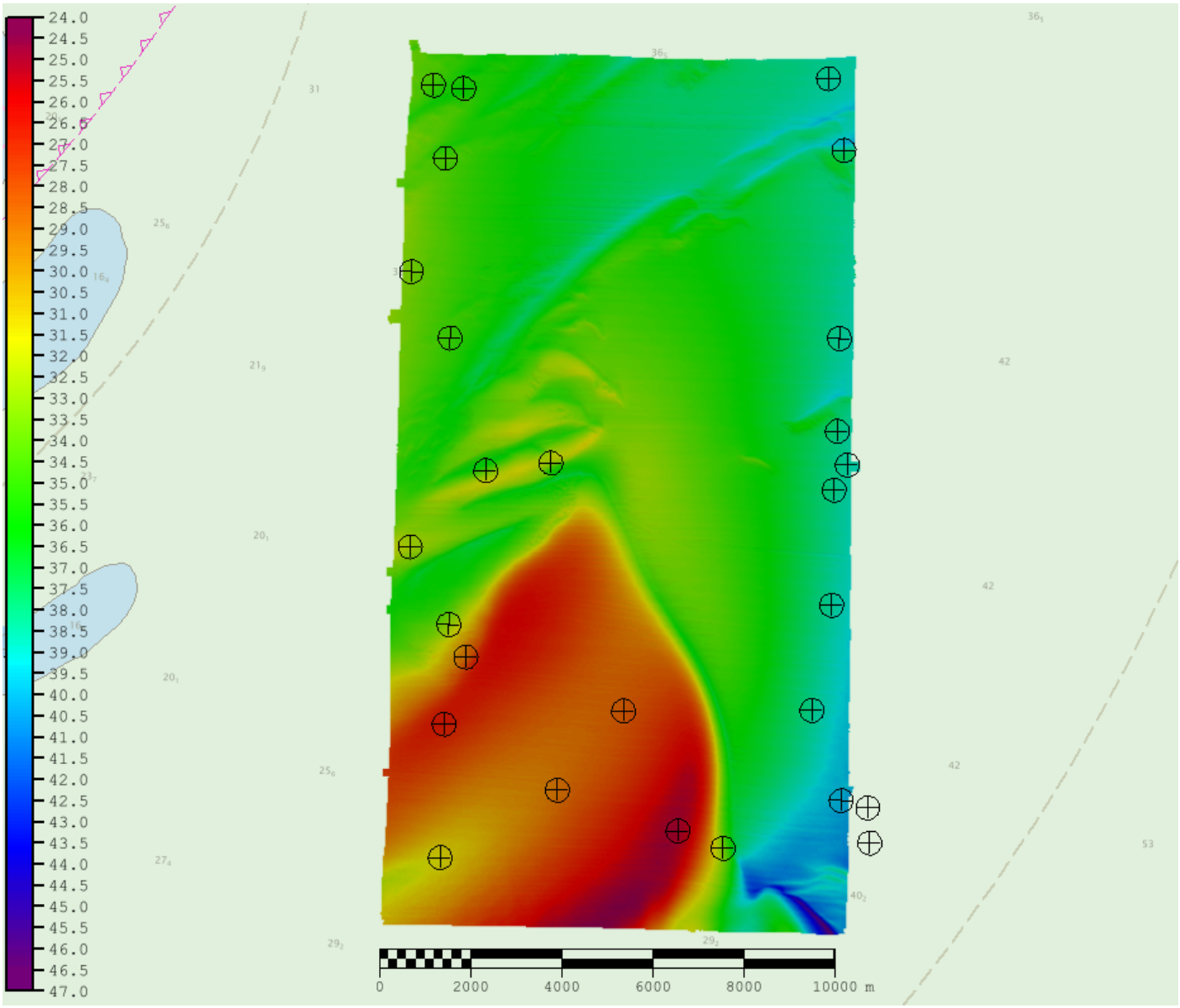


Figure 10: H13594 sound speed profile locations.

B.2.8 Coverage Equipment and Methods

All equipment and survey methods were used as detailed in the DAPR.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

All data reduction procedures conform to those detailed in the DAPR.

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

Raw backscatter data was acquired as .all files logged during MBES acquisition and processed by the field unit per 2022 HSSD. The .GSF files and backscatter mosaic has been delivered with this report.

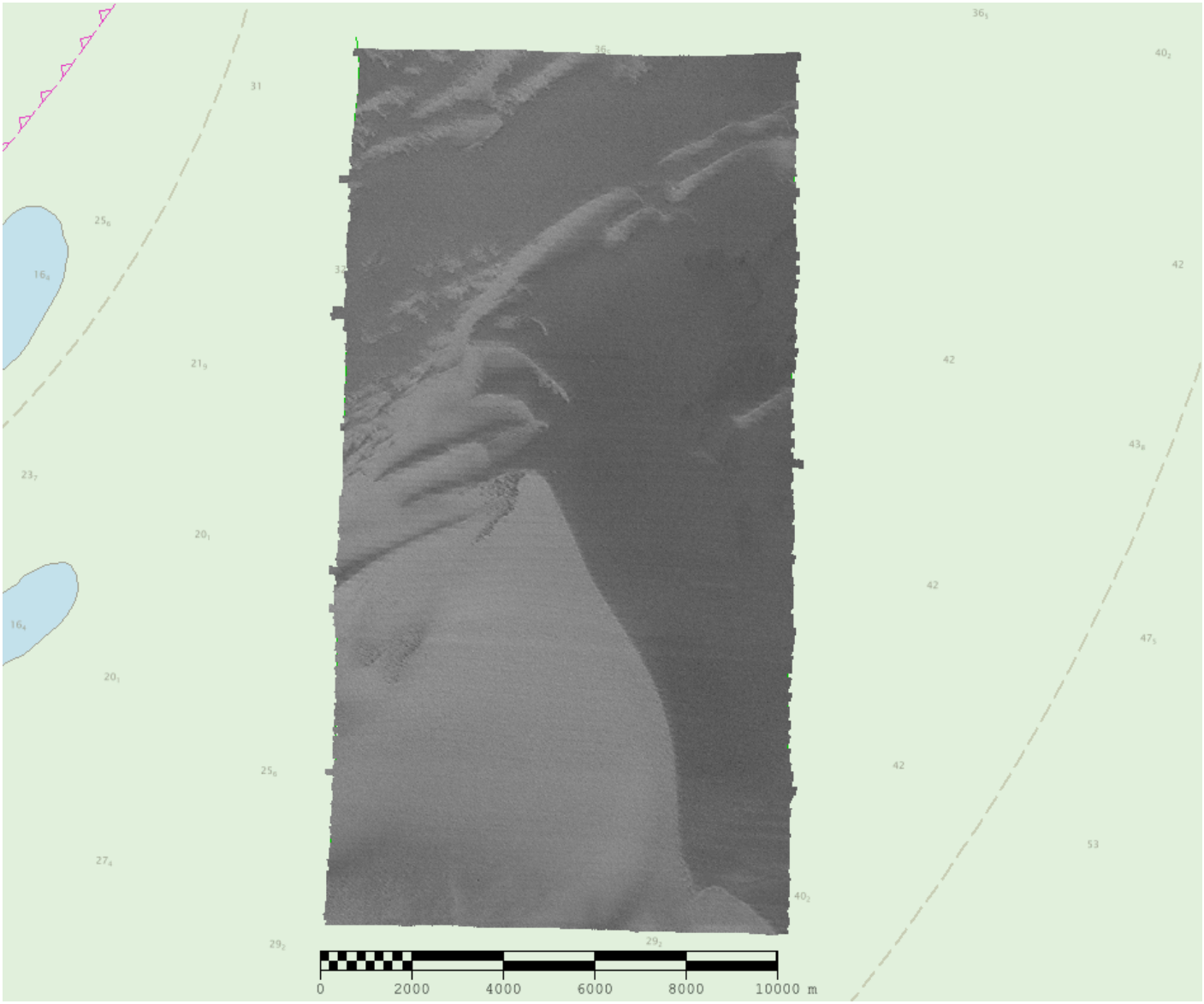


Figure 11: Overview of H13594 backscatter mosaics (US3SC10M).

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following software program was the primary program used for bathymetric data processing:

Manufacturer	Name	Version
CARIS	HIPS/SIPS	11.3.14
CARIS	BASE Editor	5.5.8

Table 9: Primary bathymetric data processing software

The following software program was the primary program used for imagery data processing:

Manufacturer	Name	Version
Fledermaus	FMGT	7.9.5

Table 10: Primary imagery data processing software

The following Feature Object Catalog was used: NOAA Profile Version 2021.

B.5.2 Surfaces

The following surfaces and/or BAGs were submitted to the Processing Branch:

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H13594_MB_VR_MLLW	CARIS VR Surface (CUBE)	Variable Resolution	24.2 meters - 46.7 meters	NOAA_VR	Complete MBES
H13594_MB_VR_MLLW_Final	CARIS VR Surface (CUBE)	Variable Resolution	24.2 meters - 46.7 meters	NOAA_VR	Complete MBES
H13594_MBAB_2m_S250_300kHz_1of1	MB Backscatter Mosaic	2 meters	-	N/A	Complete MBES

Table 11: Submitted Surfaces

Submitted surfaces were generated using the NOAA recommended parameters for depth-based (Ranges) CARIS variable-resolution bathymetric grids as specified in the 2022 HSSD.

QC Tools' Flier Finder, available in NOAA's Pydro XL-19 suite, detected edge fliers that were rejected during surface cleaning. After multiple rounds of cleaning, Flier Finder detected zero fliers.

Pydro QC Tools Grid QA was used to analyze H13594 multibeam echosounder (MBES) data density. The submitted H13594 variable-resolution (VR) surface met HSSD density requirements as shown in the histogram below.

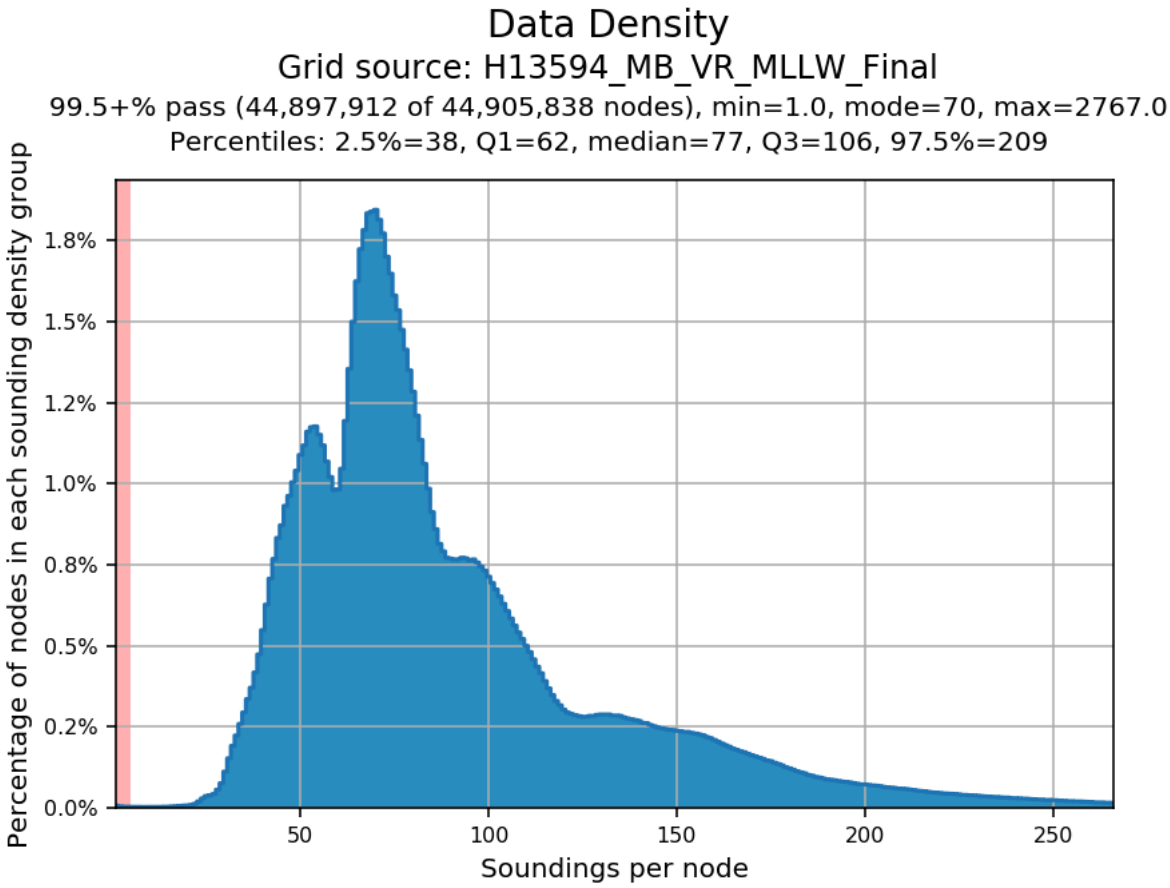


Figure 12: Pydro derived plot showing HSSD density compliance of H13594 finalized variable-resolution surface.

C. Vertical and Horizontal Control

Additional information discussing the vertical or horizontal control for this survey can be found in the accompanying 2022 DAPR.

C.1 Vertical Control

The vertical datum for this project is Mean Lower Low Water.

ERS Datum Transformation

The following ellipsoid-to-chart vertical datum transformation was used:

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	OPR_F364_FH_22_VDatum_xyNAD83-MLLW_geoid12b.csar

Table 12: ERS method and SEP file

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD 83).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 18.

The following PPK methods were used for horizontal control:

- RTX

Post Processed Real-Time Extended (PP-RTX) processing methods were used in Applanix POSPac MMS 8.7 software to produce SBETs for horizontal and vertical corrections.

WAAS

The Wide Area Augmentation System (WAAS) was used for real-time horizontal control during data acquisition.

D. Results and Recommendations

D.1 Chart Comparison

Survey soundings from H13594 were generated from a finalized variable resolution CUBE surface in CARIS HIPS and SIPS and compared with the soundings from the largest scale Electronic Navigational Chart (US4NC16M) using CA Tools SS vs Chart comparison tool (Figure 13).

Contours from H13594 were also generated and visually compared with the charted contours from the largest scale Electronic Navigational Charts. The 36.5 meter (120 foot) contour generally agrees between the survey and the chart, with some outstanding deeper areas inshore of the charted 36.5 contour (Figure 14).

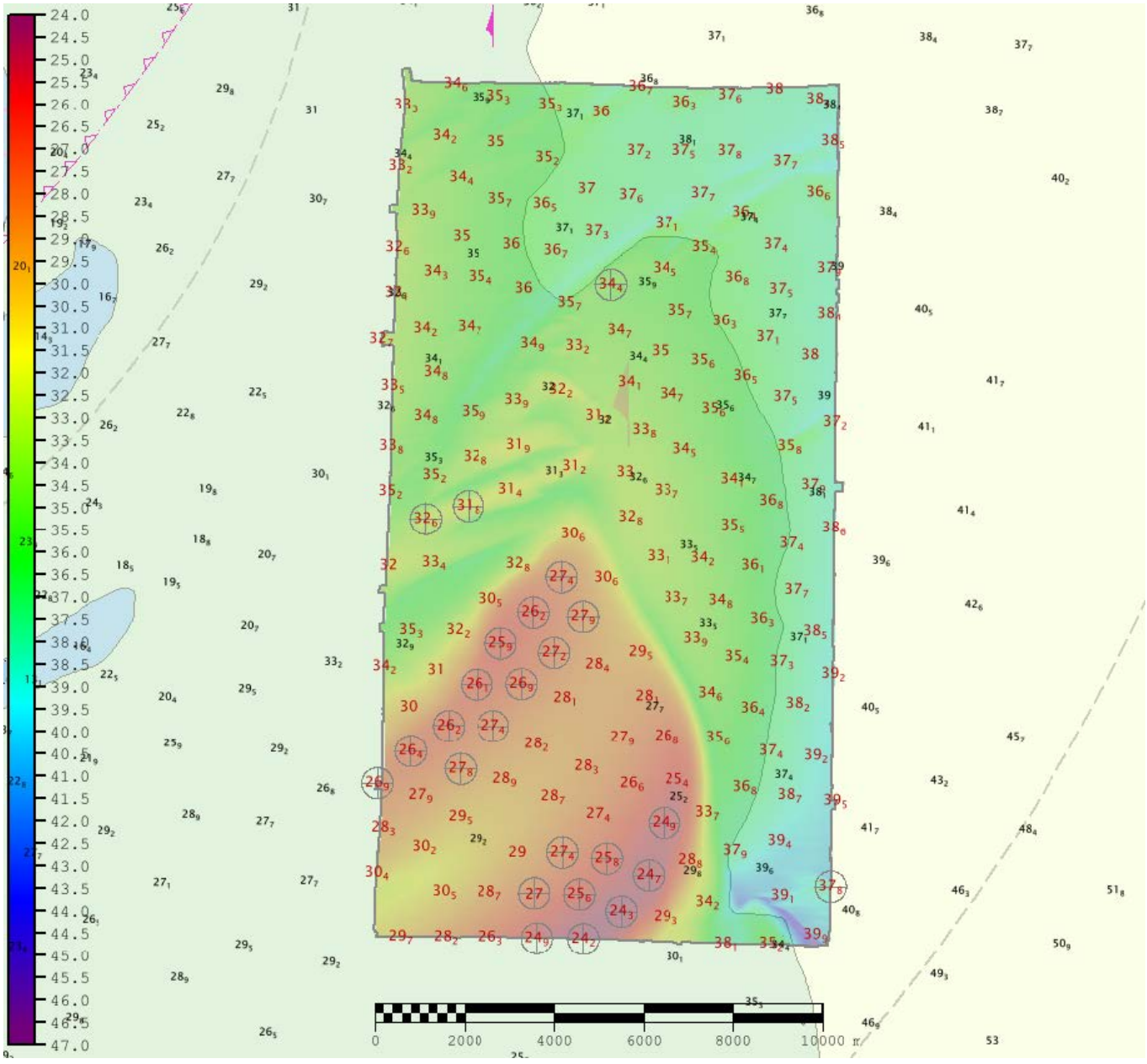


Figure 13: Overview of CA Tools' Soundings vs. Chart comparison of survey H13594 and ENC US4NC16M: grey line = coverage border, red soundings = H13594 soundings; black soundings = ENC soundings; grey targets = "DtoN" soundings flagged by CA Tools.

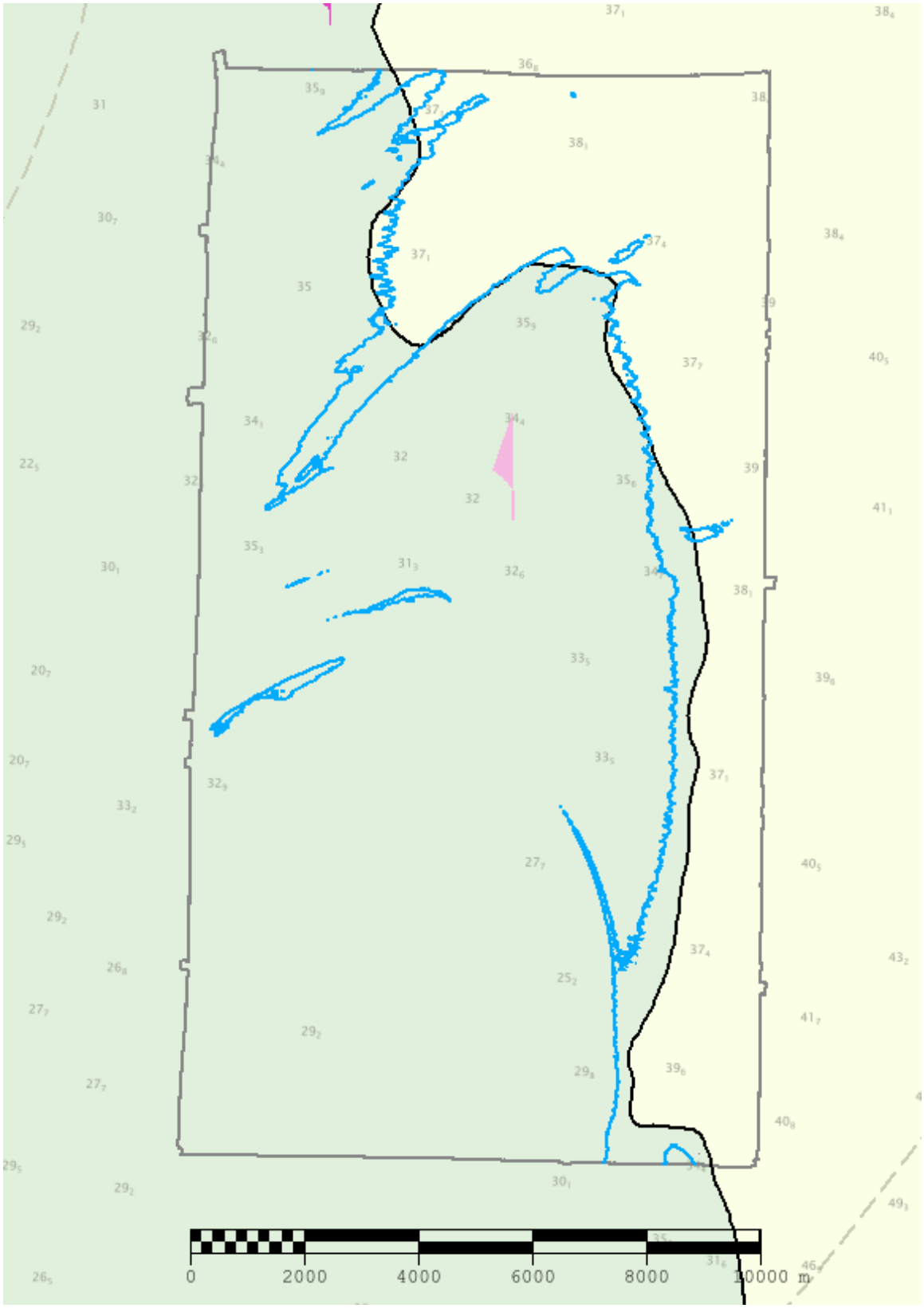


Figure 14: Comparison of 36.5 meter contour: grey line = coverage border; blue line = H13594's 36.5 meter contour; black line = ENC 36.5 meter contour (US4NC16M).

D.1.1 Electronic Navigational Charts

The following are the largest scale ENCs, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date
US4NC16M	1:80000	23	09/07/2021	11/23/2021
US3SC10M	1:432720	35	12/10/2021	04/18/2022

Table 13: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

CA Tools flagged 25 soundings as potential Dangers to Navigation, and, although none of these soundings fall within the HSSD requirements for sounding designation/DtoN designation, the hydrographer recommends the addition of these shoaler soundings to the ENC (Figure 15). These shoal soundings still fall within their charted depth contour.

CA Tools flagged 25 soundings as potential Dangers to Navigation. While none of these soundings fall within NOAA's definition of a DTON (HSSD Section 1.6.1) and are are deep enough to not represent a hazard to surface navigation, the hydrographer recommends the addition of these shoaler soundings to the ENC (figure 15).

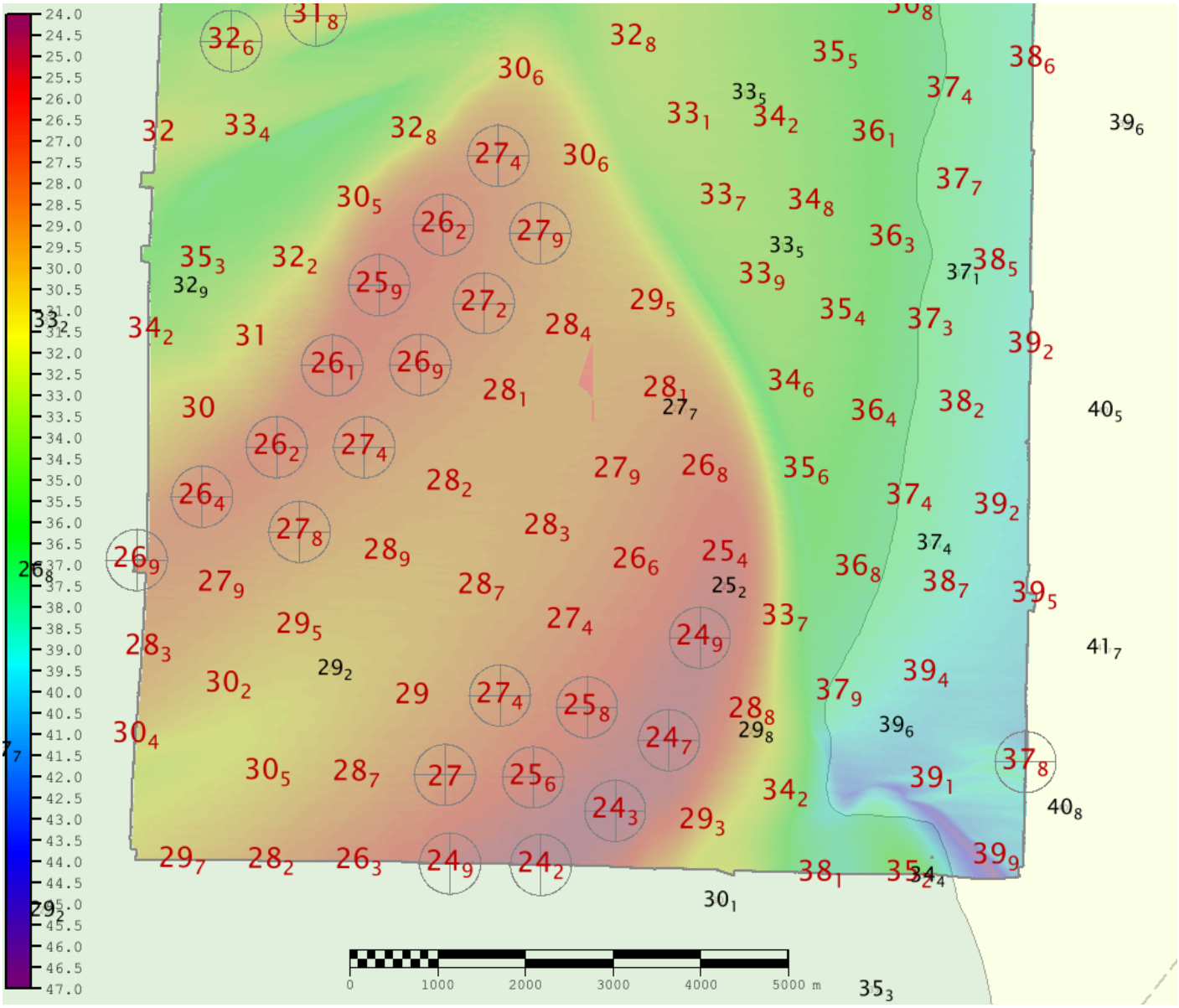


Figure 15: H13594 soundings vs. charted soundings over southern shoal area: grey line = coverage border, red soundings = H13594 soundings; black soundings = ENC soundings; grey targets = soundings flagged by CA Tools.

D.1.3 Charted Features

No charted features exist for this survey.

D.1.4 Uncharted Features

No uncharted features exist for this survey.

D.1.5 Channels

No channels exist for this survey. There are no designated anchorages, precautionary areas, safety fairways, traffic separation schemes, pilot boarding areas, or channel and range lines within the survey limits.

D.2 Additional Results

D.2.1 Aids to Navigation

No Aids to navigation (ATONs) exist for this survey.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

Four bottom samples were assigned and investigated. Refer to the Final Feature File for location and sample attribution.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

No submarine features exist for this survey.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.8 Abnormal Seafloor or Environmental Conditions

No abnormal seafloor and/or environmental conditions exist for this survey.

D.2.9 Construction and Dredging

No present or planned construction or dredging exist within the survey limits.

D.2.10 New Survey Recommendations

No new surveys or further investigations are recommended for this area.

D.2.11 ENC Scale Recommendations

No new insets are recommended for this area.

E. Approval Sheet

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

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

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

Report Name	Report Date Sent
Data Acquisition and Processing Report	2022-05-20

Approver Name	Approver Title	Approval Date	Signature
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F. Table of Acronyms

Acronym	Definition
AHB	Atlantic Hydrographic Branch
AST	Assistant Survey Technician
ATON	Aid to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BAG	Bathymetric Attributed Grid
BASE	Bathymetry Associated with Statistical Error
CO	Commanding Officer
CO-OPS	Center for Operational Products and Services
CORS	Continuously Operating Reference Station
CTD	Conductivity Temperature Depth
CEF	Chart Evaluation File
CSF	Composite Source File
CST	Chief Survey Technician
CUBE	Combined Uncertainty and Bathymetry Estimator
DAPR	Data Acquisition and Processing Report
DGPS	Differential Global Positioning System
DP	Detached Position
DR	Descriptive Report
DTON	Danger to Navigation
ENC	Electronic Navigational Chart
ERS	Ellipsoidal Referenced Survey
ERTDM	Ellipsoidally Referenced Tidal Datum Model
ERZT	Ellipsoidally Referenced Zoned Tides
FFF	Final Feature File
FOO	Field Operations Officer
FPM	Field Procedures Manual
GAMS	GPS Azimuth Measurement Subsystem
GC	Geographic Cell
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSD	Hydrographic Surveys Division

Acronym	Definition
HSSD	Hydrographic Survey Specifications and Deliverables
HSTB	Hydrographic Systems Technology Branch
HSX	Hypack Hysweep File Format
HTD	Hydrographic Surveys Technical Directive
HVCR	Horizontal and Vertical Control Report
HVF	HIPS Vessel File
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
ITRF	International Terrestrial Reference Frame
LNM	Linear Nautical Miles
MBAB	Multibeam Echosounder Acoustic Backscatter
MCD	Marine Chart Division
MHW	Mean High Water
MLLW	Mean Lower Low Water
NAD 83	North American Datum of 1983
NALL	Navigable Area Limit Line
NTM	Notice to Mariners
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRT	Navigation Response Team
NSD	Navigation Services Division
OCS	Office of Coast Survey
OMAO	Office of Marine and Aviation Operations (NOAA)
OPS	Operations Branch
MBES	Multibeam Echosounder
NWLON	National Water Level Observation Network
PDBS	Phase Differencing Bathymetric Sonar
PHB	Pacific Hydrographic Branch
POS/MV	Position and Orientation System for Marine Vessels
PPK	Post Processed Kinematic
PPP	Precise Point Positioning
PPS	Pulse per second

Acronym	Definition
PRF	Project Reference File
PS	Physical Scientist
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
RTX	Real Time Extended
SBES	Singlebeam Echosounder
SBET	Smooth Best Estimate and Trajectory
SNM	Square Nautical Miles
SSS	Side Scan Sonar
SSSAB	Side Scan Sonar Acoustic Backscatter
ST	Survey Technician
SVP	Sound Velocity Profiler
TCARI	Tidal Constituent And Residual Interpolation
TPU	Total Propagated Uncertainty
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDF	Zone Definition File