H13582

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13582

LOCALITY

State(s):	Northern Mariana Islands
General Locality:	Western Pacific Ocean
Sub-locality:	Agrihan Island

2022

CHIEF OF PARTY
Hector L. Casanova, CAPT/NOAA

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13582**

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):	**Northern Mariana Islands**
General Locality:	**Western Pacific Ocean**
Sub-Locality:	**Agrihan Island**
Scale:	**10000**
Dates of Survey:	**06/20/2022 to 08/06/2022**
Instructions Dated:	**01/07/2022**
Project Number:	**OPR-T381-RA-22**
Field Unit:	**NOAA Ship *Rainier***
Chief of Party:	**Hector L. Casanova, CAPT/NOAA**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Pacific 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 (MA11) UTM 55N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

Table of Contents

List of Tables

List of Figures

Descriptive Report to Accompany Survey H13582

Project: OPR-T381-RA-22

Locality: Western Pacific Ocean

Sublocality: Agrihan Island

Scale: 1:10000

June 2022 - August 2022

NOAA Ship *Rainier*

Chief of Party: Hector L. Casanova, CAPT/NOAA

A. Area Surveyed

This survey is referred to as H13582, "Agrihan Island" (sheet 12) within the Project Instructions. The assigned survey area encompassed an estimated 1,072 square nautical miles located approximately 300 nautical miles north of Guam in the Western Pacific Ocean.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
19° 0' 35.69" N 145° 32' 59.83" E	18° 40' 3.72" N 145° 45' 32.89" E

Table 1: Survey Limits

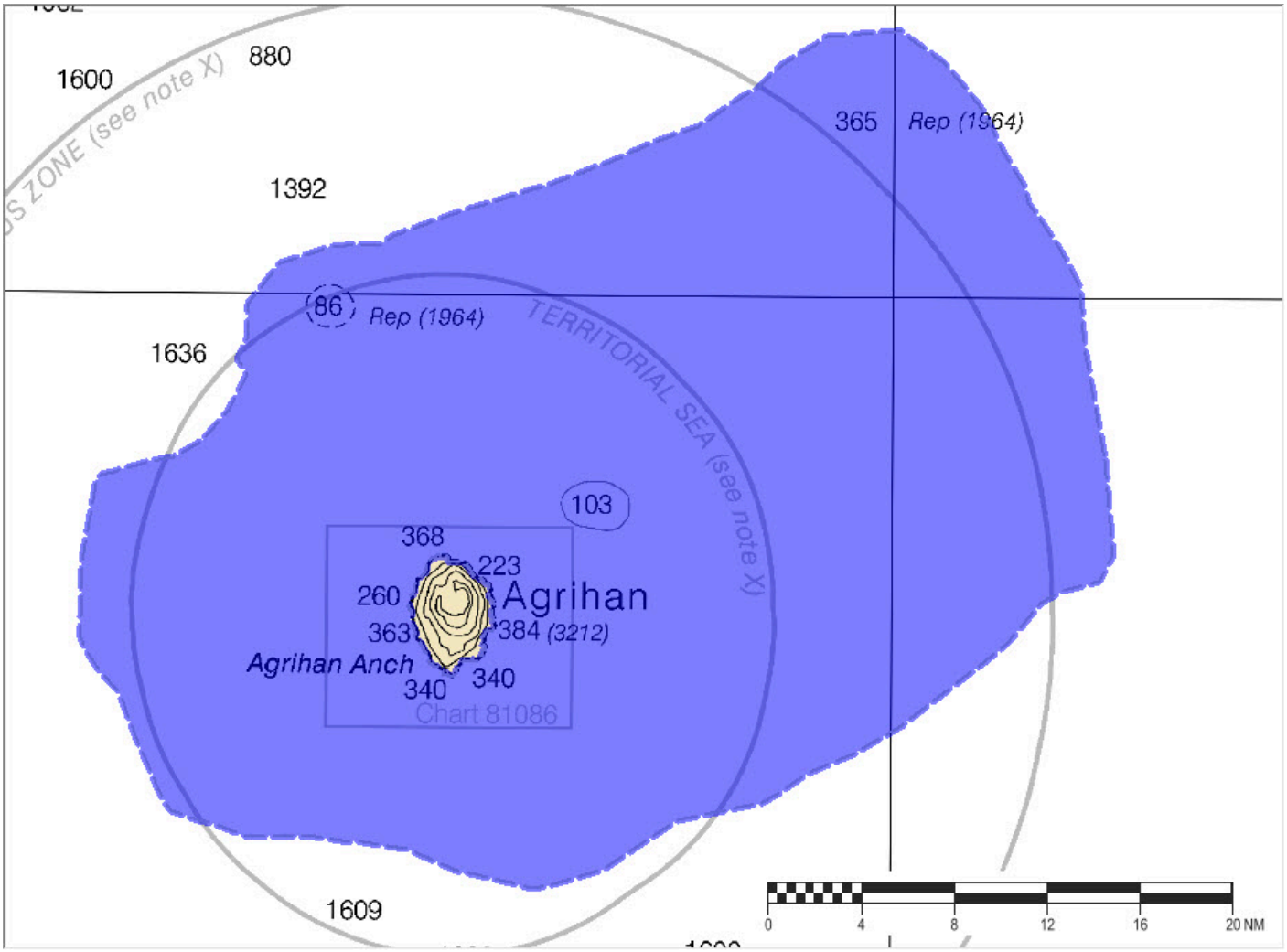


Figure 1: H13582 assigned survey area.

The originally assigned survey limits extended into areas with depths greater than RAINIER could efficiently acquire quality multibeam data. Therefore we requested, and the Operations Branch approved, that we survey to the 1,500 meter depth contour and not beyond. See Supplemental Records for more information.

This project's requirement to coordinate hydrographic operations with reef diving priorities imposed significant limitations on the amount of MBES data we could acquire for this survey. The amount of bathymetric data we did acquire for H13582 totaled 85 square nautical miles.

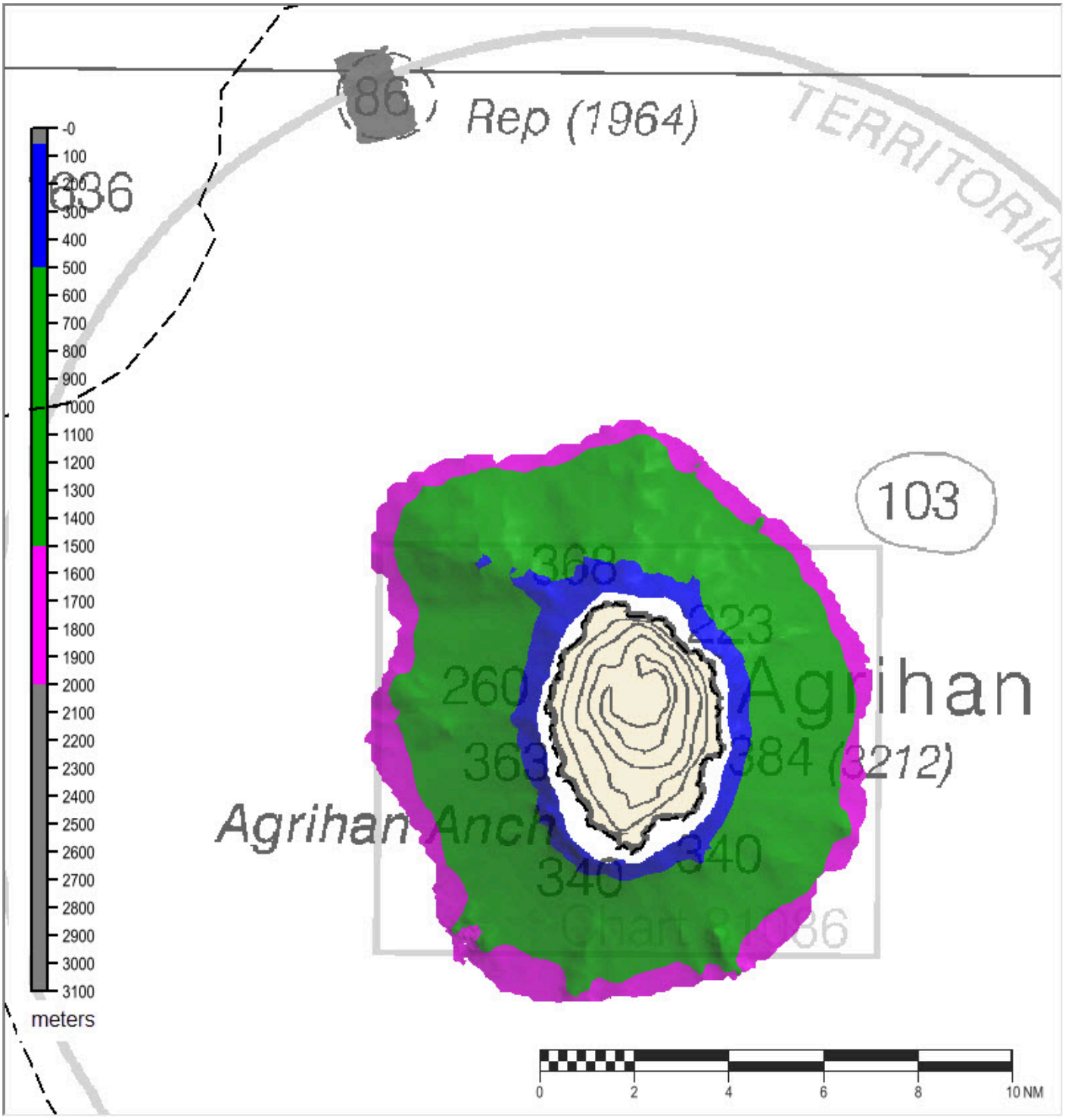


Figure 2: Acquired H13582 MBES coverage, note pink colored surface indicates 1,500-meter depths or greater.

A.2 Survey Purpose

The ecosystem surrounding the Commonwealth of the Northern Mariana Islands (CNMI) is experiencing stress imposed by climate change and other environmental factors. This survey is part of extensive hydrographic project intended to map the bathymetry and habitat around the CNMI in support of nautical charting and habitat mapping.

With the collaboration and partnership of the National Centers for Coastal and Ocean Science (NCCOS), the NOAA Coral Reef Conservation Program (CRCP), and the National Marine Fisheries Service (NMFS), this survey will also study the health of coral reef systems, ocean chemistry, and fisheries habitat. This team has developed a strategy to map the waters from nearshore to depths greater than 1000 meters. Within these waters, the ship's crew and visiting scientists will map bathymetry and backscatter and characterize habitat, while concurrently performing coral reef assessment dives and collecting other oceanographic observations.

Data collected during this mission are pivotal to long-term biological and oceanographic monitoring of coral reef ecosystems around the CNMI. Data from this survey will add to information collected during prior monitoring and mapping projects. Oceanographic and ecological time series data will allow scientists to evaluate potential changes in environmental conditions and coral reef health in the Mariana Archipelago. This will enable federal and state resource managers to more effectively conserve the coral reef ecosystems of the CNMI, and to manage ecosystems services. Data collected during this survey also support monitoring components of the CRCP Coral Reef Ecosystem Integrated Observing System.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

We used Pydro QC Tools (v.3.7.0) Grid QA to analyze H13582 multibeam echosounder (MBES) data density. The submitted H13582 variable-resolution surfaces met HSSD density requirements as shown in the histogram below. Grid QA results determined that a lower than expected percentage of H13582 nodes met full coverage resolution requirements as explained below.

For project OPR-T381-RA-22 Resolution Requirements graphs produced by Pydro’s Grid QA tool have been showing relatively low percentages of grid nodes meeting full coverage resolution requirements. The likely cause of this issue is RAINIER’s use of 64m grids in depths greater than 1000m to maintain a reasonable data density. Since the Grid QA tool was written to match the HSRR specifications with a maximum 32m grid in all waters greater than 640m, RAINIER grids created using the 64m increase in resolution will always fail the resolution requirements check in areas exceeding 1000m. This will of course decrease the percentage of grid nodes meeting coverage resolution requirements. For surveys with a large percentage of area greater than 1000m in depth, this reduction can be significant. The OCS QC tools team has been made aware of this issue and are working on a solution for this deviation from the specifications. See the Supplemental Records for more information.

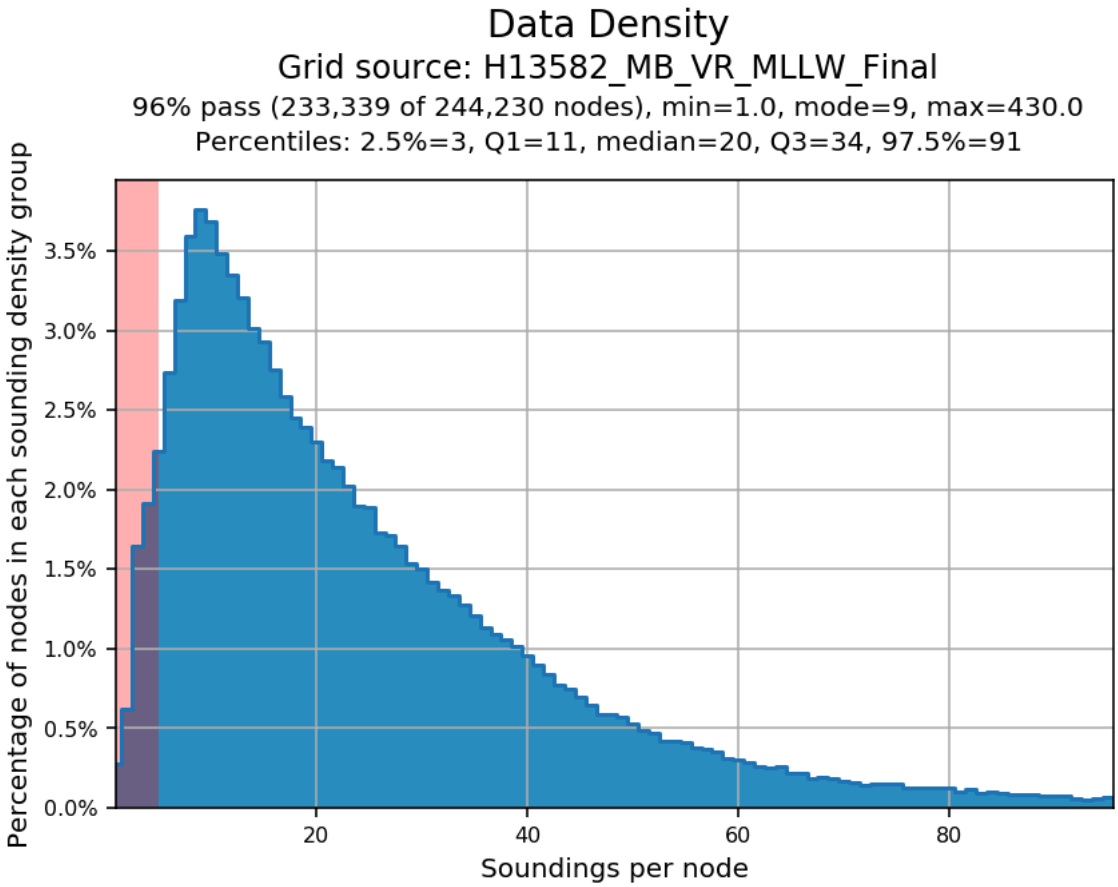


Figure 3: Pydro derived plot showing HSSD density compliance of H13582 finalized variable-resolution MBES data.

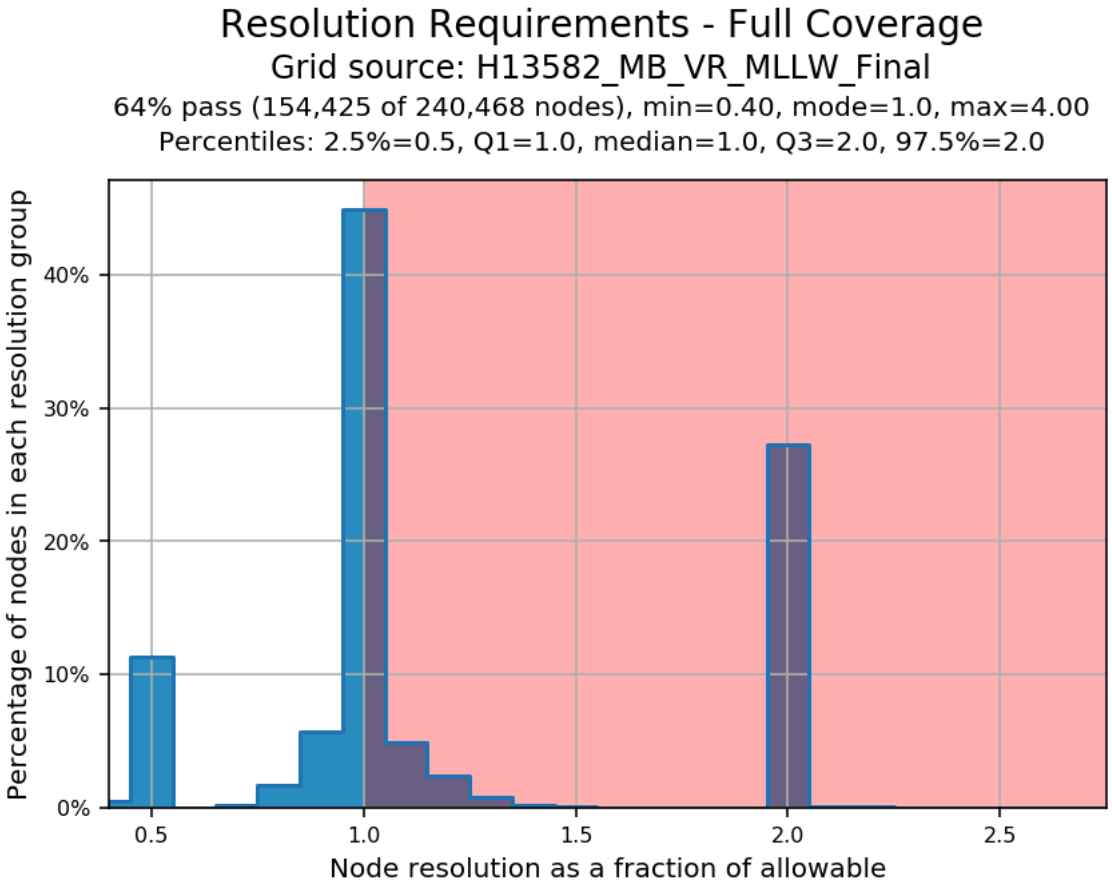


Figure 4: Pydro derived plot showing Grid QA results of H13582 full coverage resolution requirements.

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	Complete Coverage (Refer to HSSD Section 5.2.2.3)

Table 2: Survey Coverage

As stated above, survey operations were significantly impacted by reef diving priorities. We did acquire 118 nautical miles of ship (deep-water) MBES data for this survey, unfortunately time constraints prevented us from investigating H13582 nearshore areas.

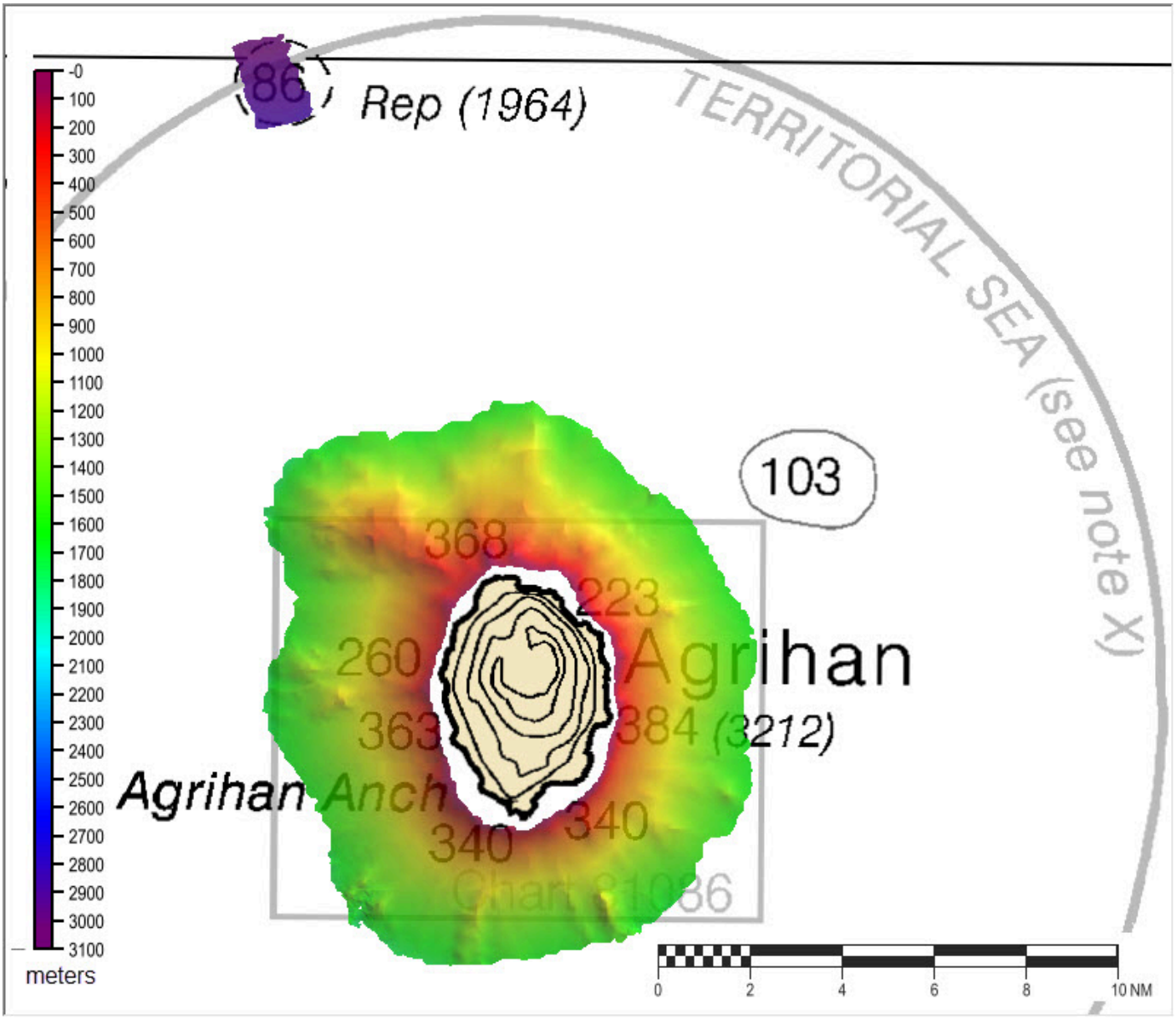


Figure 5: Acquired H13582 MBES coverage.

A.6 Survey Statistics

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

	HULL ID	*S221*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0
	MBES Mainscheme	118.6	118.6
	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	2.2	2.2
	Lidar Crosslines	0.0	0.0
Number of Bottom Samples			0
Number Maritime Boundary Points Investigated			0
Number of DPs			0
Number of Items Investigated by Dive Ops			0
Total SNM			84.9

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
06/20/2022	171
08/06/2022	218

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	***S221***
LOA	70.4 meters
Draft	4.7 meters

Table 5: Vessels Used

Figure 6: NOAA Ship RAINIER (S221).

We acquired all data for H13582 with NOAA Ship RAINIER. The vessel acquired depth soundings, backscatter imagery and sound speed profiles.

B.1.2 Equipment

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

Manufacturer	Model	Type
Applanix	POS MV 320 v5	Positioning and Attitude System
Kongsberg Maritime	EM 710	MBES
ODIM Brooke Ocean	MVP200	Sound Speed System
Teledyne RESON	SVP 70	Sound Speed System

Table 6: Major Systems Used

B.2 Quality Control

B.2.1 Crosslines

NOAA Ship RAINIER (S221) acquired a single 2.2 nautical mile (1.9% of mainscheme) MBES crossline across limited depth ranges, water masses and boat days due to time constraints, however we believe it has value for evaluating the internal consistency of H13582 sonar data. We performed crossline analysis using the Compare Grids function within Pydro Explorer on Caris variable-resolution surfaces of H13582 mainscheme only and crossline only data. Results showed 99.5% of grid nodes met allowable uncertainties as shown in the Pydro generated plots below.

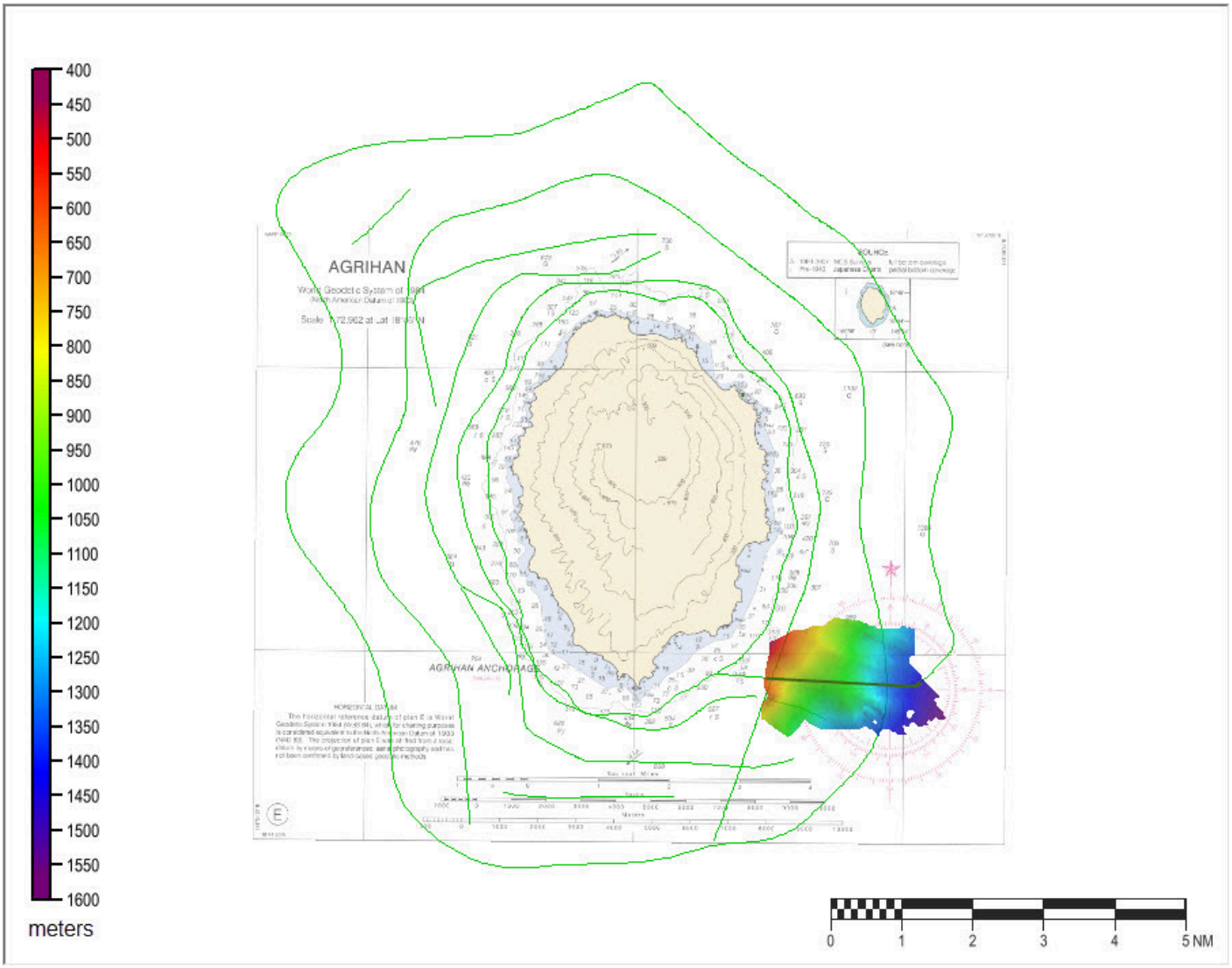


Figure 7: H13582 crossline surface overlaid on mainscheme tracklines.

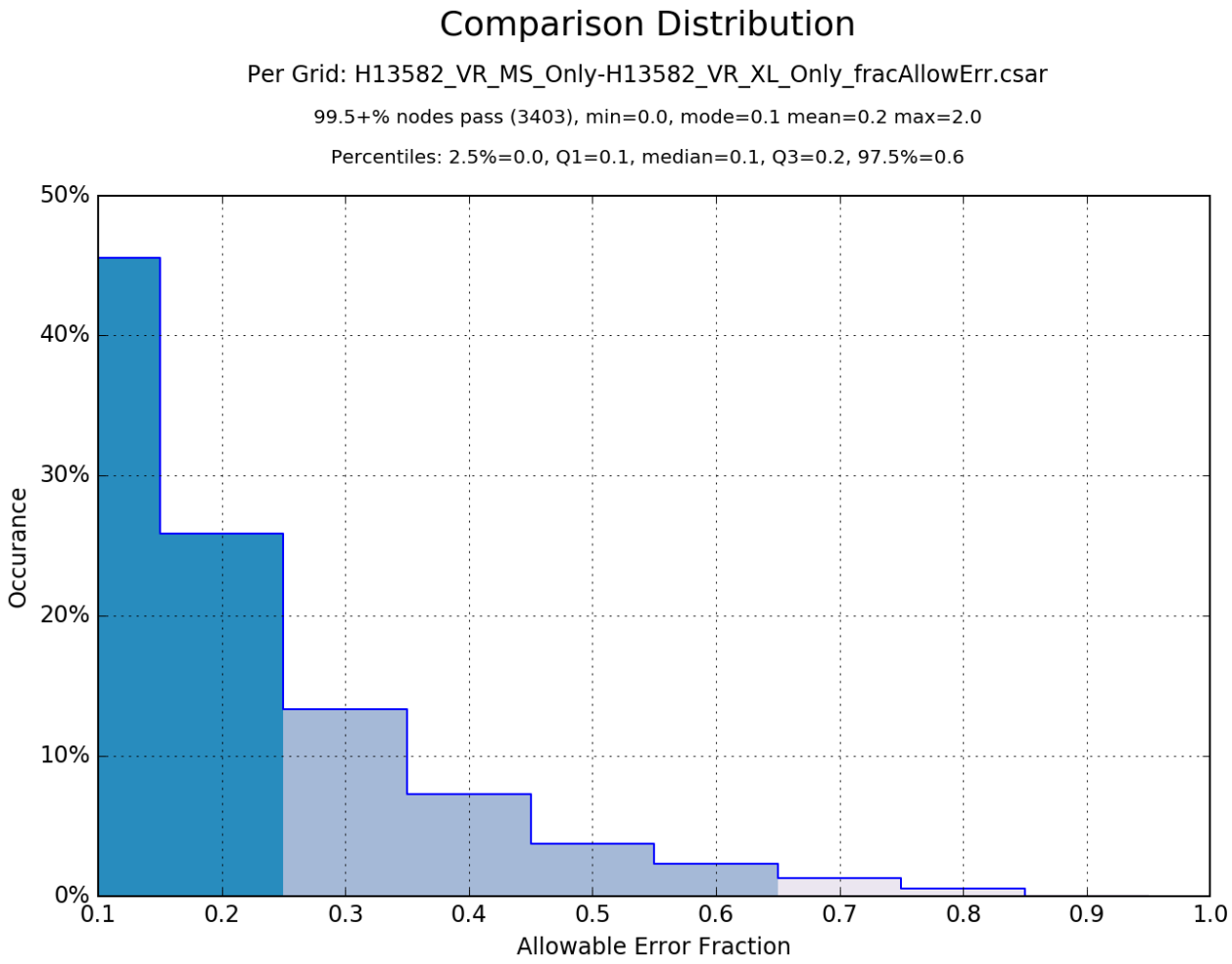
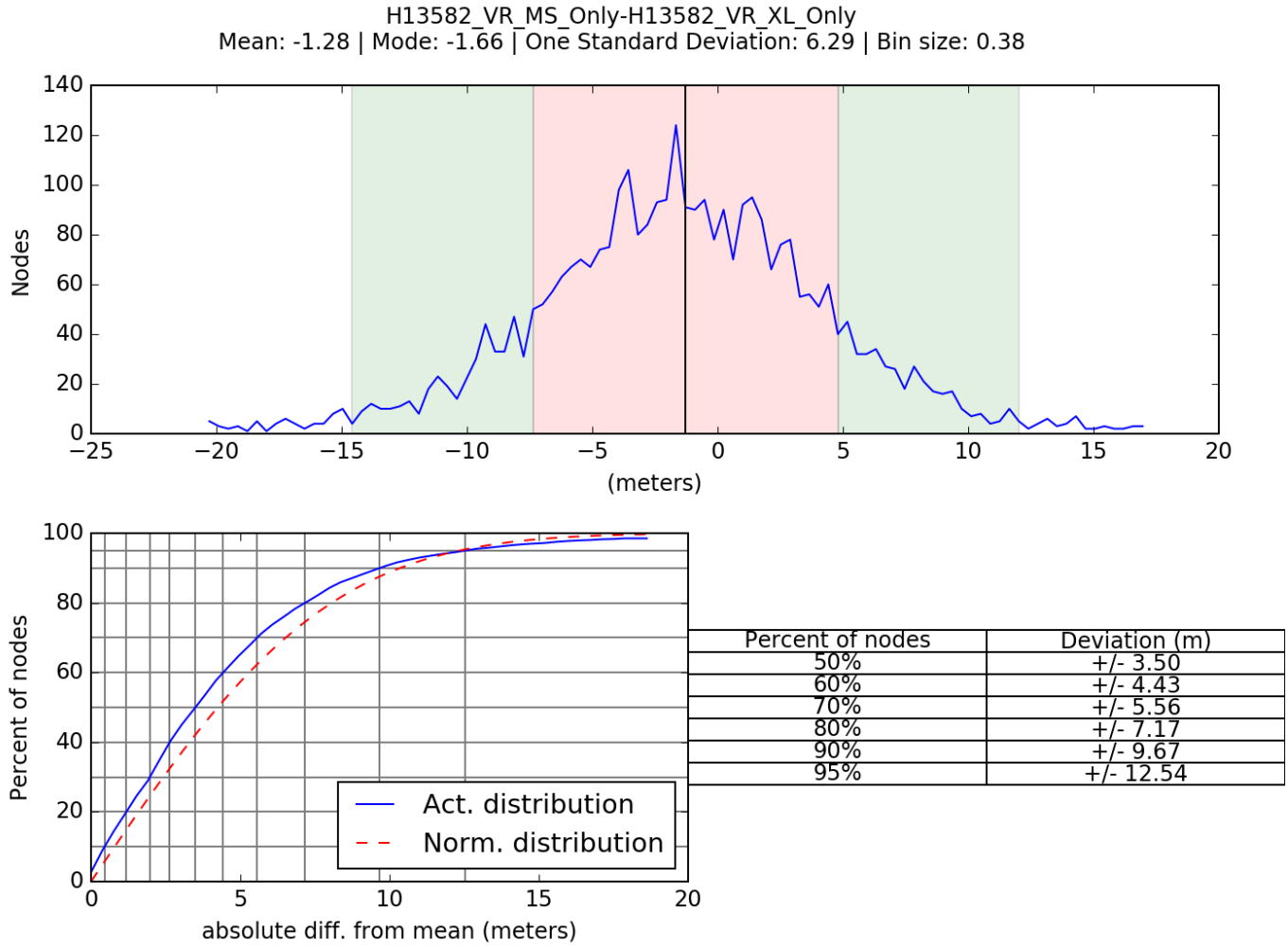


Figure 8: Pydro derived plot showing node percentage pass value of H13582 mainscheme to crossline data.



Percent of nodes	Deviation (m)
50%	+/- 3.50
60%	+/- 4.43
70%	+/- 5.56
80%	+/- 7.17
90%	+/- 9.67
95%	+/- 12.54

Figure 9: Pydro derived plot showing absolute difference statistics of H13582 mainscheme to 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	0.11 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
S221	N/A	1 meters/second	N/A	0.05 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Total Propagated Uncertainty (TPU) values for survey H13582 were derived from a combination of fixed values for equipment and vessel characteristics, as well as from field assigned values for sound speed uncertainties. Tidal uncertainty was provided in metadata for the NOAA vertical datum transformation model used for this survey.

In addition to the usual a priori estimates of uncertainty, real-time and post-processed uncertainty sources were also incorporated into the depth estimates of this survey. Real-time uncertainties for position, navigation and vessel motion data from Applanix POS MV were applied during acquisition and initially in post-processing. POSPac SBET and RMS files were subsequently applied in Caris HIPS to supersede POS MV uncertainties associated with GPS height and position.

Uncertainty values of the submitted finalized grids were calculated in Caris using "Greater of the Two" of uncertainty and standard deviation (scaled to 95%). Grid QA v6 within Pydro QC Tools was used to analyze H13582 TVU compliance. H13582 met HSSD requirements in 99% percent of grid nodes as shown in the histogram plot below.

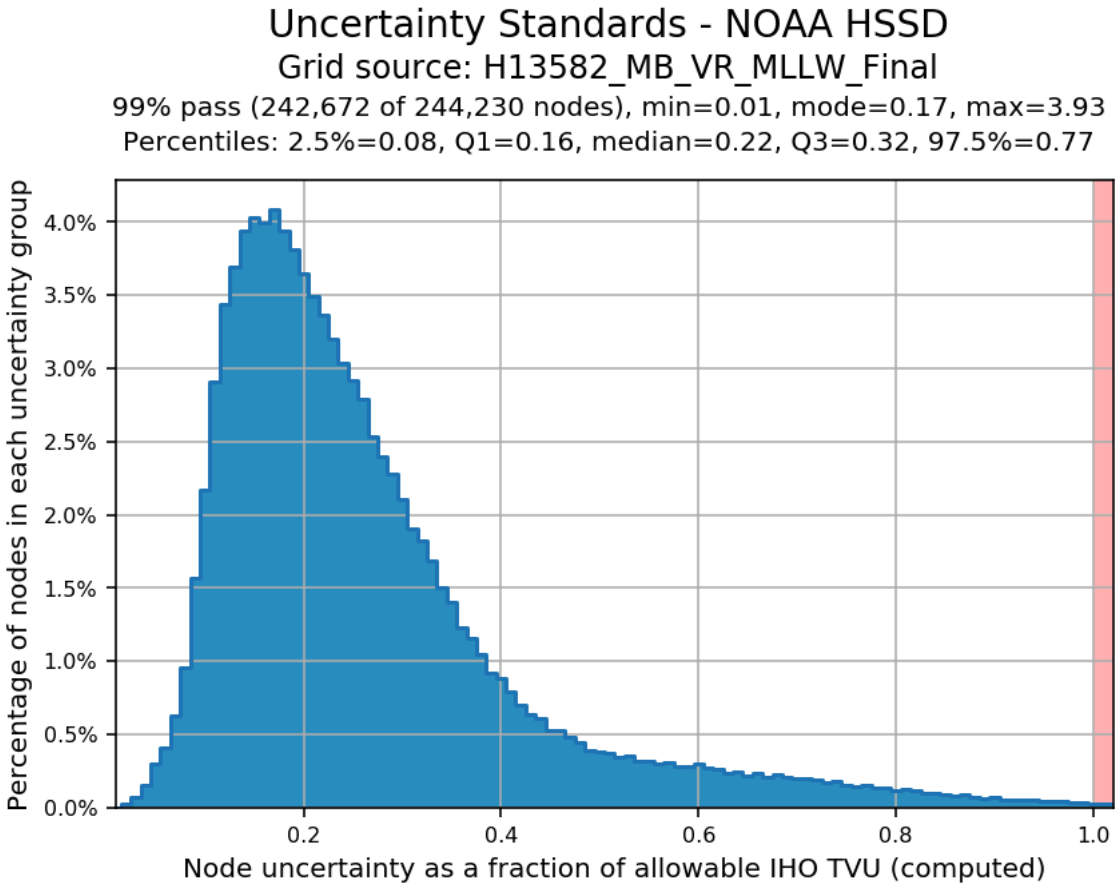


Figure 10: Pydro derived plot showing TVU compliance of H13582 finalized multi-resolution MBES data.

B.2.3 Junctions

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

There were no other factors that affected corrections to soundings.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: We acquired six sound speed profiles ("casts") for this survey at discrete locations within the assigned area at least once every four hours, when significant changes to surface sound speed were observed, or when shifting operations to a new area. All sound speed profiles were concatenated into a master file and applied to H13582 MBES data using the "Nearest distance within Time" (4 hours) profile selection method.

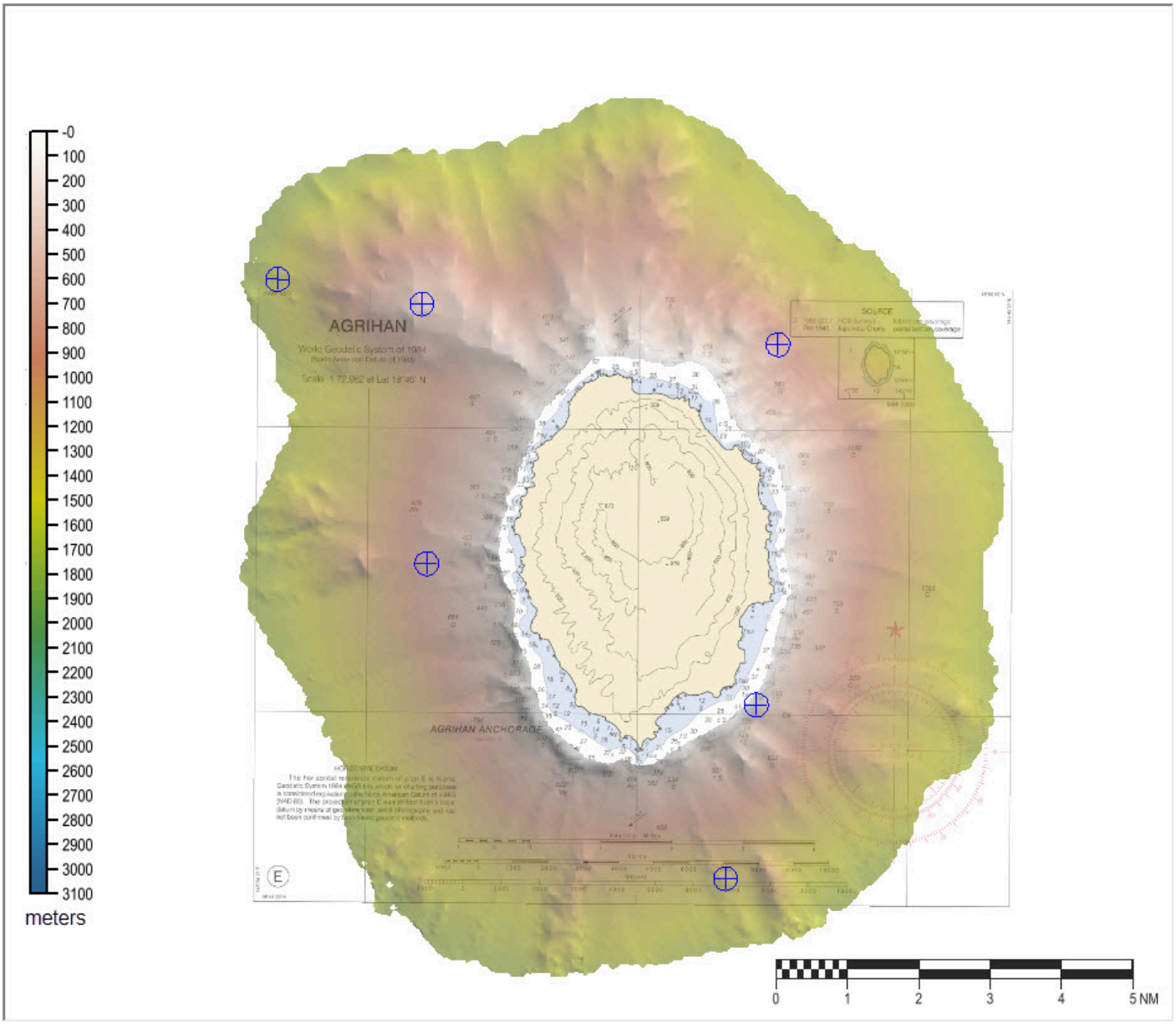


Figure 11: H13582 sound speed cast locations.

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 were acquired as .all files logged during MBES operations and subsequently processed by RAINIER personnel. The .GSF files created during processing, and backscatter mosaic data has been delivered with this report. Backscatter processing procedures are described in the DAPR.

Figure 12: Overview of H13582 multibeam acoustic backscatter.

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
N/A	N/A	N/A

Table 9: Primary bathymetric data processing software

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

Manufacturer	Name	Version
N/A	N/A	N/A

Table 10: Primary imagery data processing software

The following Feature Object Catalog was used: NOAA Profile 2022v2.

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
H13582_MB_VR_MLLW	CARIS VR Surface (CUBE)	Variable Resolution	55.7 meters - 3038.8 meters	NOAA_VR	Complete MBES
H13582_MB_VR_MLLW_Final	CARIS VR Surface (CUBE)	Variable Resolution	55.7 meters - 3038.8 meters	NOAA_VR	Complete MBES

Table 11: Submitted Surfaces

We generated the submitted H13582 surfaces using NOAA recommended parameters for depth-based (Ranges) Caris variable-resolution bathymetric grids. Following correspondence with the Project Manager, we generated the submitted surfaces with an updated Range/Resolution file,

NOAA_DepthRanges_CompleteCoverage_2022_RA, that includes 64-meter grids for depths exceeding 1,000 meters. See Supplemental Records for more information.

We used Pydro flier finder tool with default settings as a quality control check of H13582 MBES grid data. We examined each of the potential fliers identified by the program, rejected errant soundings, then re-ran the process until we were satisfied that all remaining fliers identified were false-positives and represent actual seafloor topography.

C. Vertical and Horizontal Control

Additional information discussing the vertical or horizontal control for this survey can be found in the accompanying 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_T381-RA-22_GuamCNMI_EC_ERTDM2021_NAD83(MA11)-MLLW OPR_T381-RA-22_GuamCNMI_EC_ERTDM2021_NAD83(MA11)-MHW

Table 12: ERS method and SEP file

All submitted H13582 MBES data were vertically referenced to the ellipsoid. VDATUM models included with the Project Instructions were used for referencing H13582 data to MLLW and MHW.

C.2 Horizontal Control

The horizontal datum for this project is North American Datum 1983 (MA11).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 55.

RTK

Precise Positioning-Real time Extended (PP-RTX) processing methods were used in Applanix POSPac MMS (v8.5) software for post-processing horizontal correction of submitted H13582 MBES data.

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

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
US5SP08M	1:45602	9	09/30/2020	09/30/2020
US2SP01M	1:931650	19	09/07/2021	09/07/2021

Table 13: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

We investigated a charted 86-fathom depth reported in 1964, located approximately 11.5 nautical miles north of Agrihan Island. A single line of MBES coverage showed the actual depths to be approximately 1,600 fathoms (see image below).

Unfortunately, time constraints imposed by prioritizing reef diving operations, resulted in no additional MBES coverage on shoal areas located elsewhere within the assigned H13582 area.

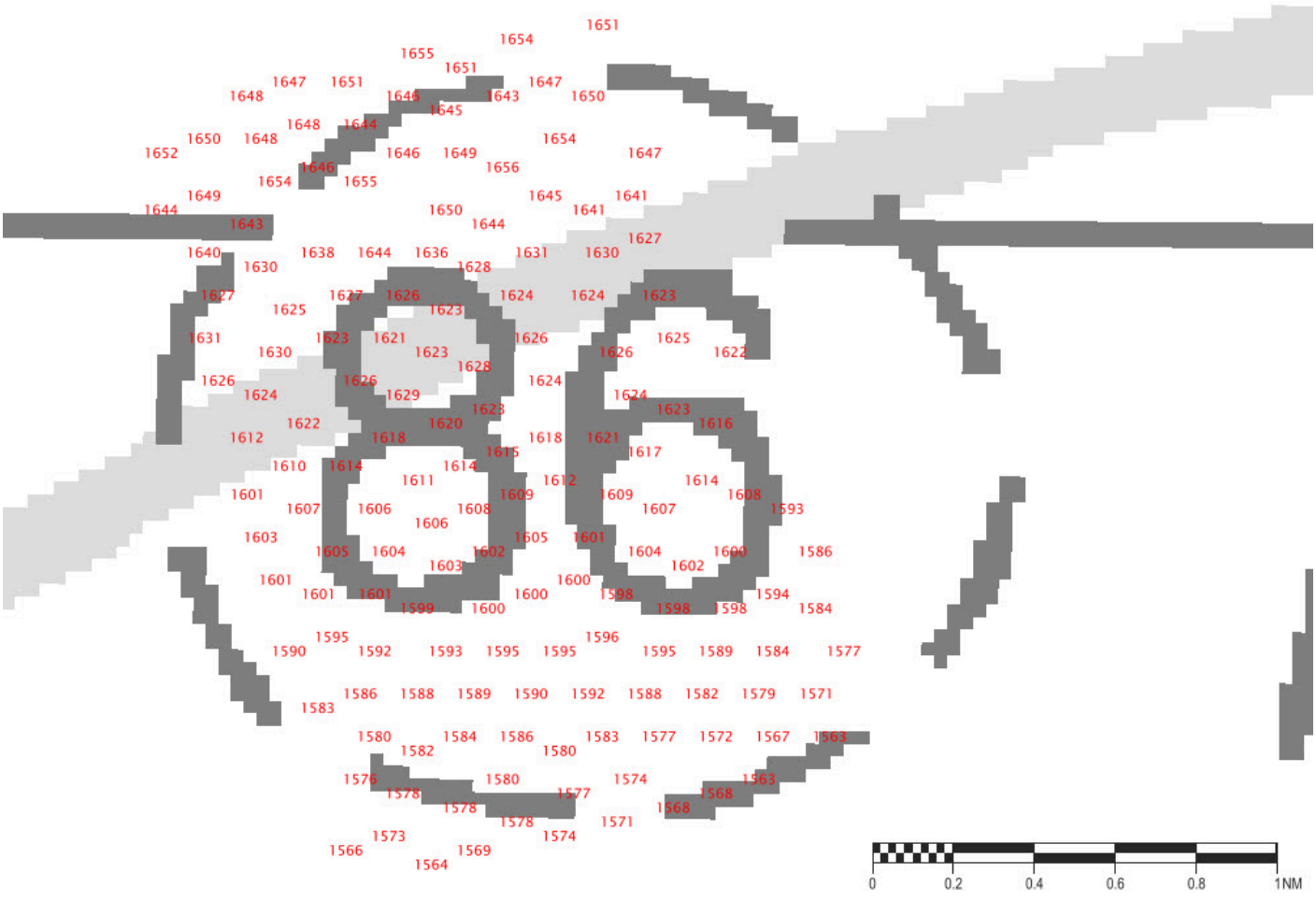


Figure 13: H13582 soundings (in red) overlaid on Chart 81004. Chart and survey units in fathoms.

D.1.3 Charted Features

Due to time constraints, we were unable to investigate a charted 365-fathom depth reported in 1964, located in the northeast part of the assigned survey area.

D.1.4 Uncharted Features

No uncharted features with navigational significance were identified for this survey.

D.1.5 Channels

The charted anchorage area on the southwest side of Agrihan Island was inshore of our survey operations and not addressed.

D.2 Additional Results

D.2.1 Aids to Navigation

No Aids to navigation (ATONs) are located within the assigned H13582 survey area.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

No bottom samples were required for this survey.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

No submarine features are located within the H13582 survey area.

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

We identified a prominent seafloor feature in the H13582 MBES data that was strikingly hull-shaped, however its height 55-100 meters effectively rules it out as a vessel.

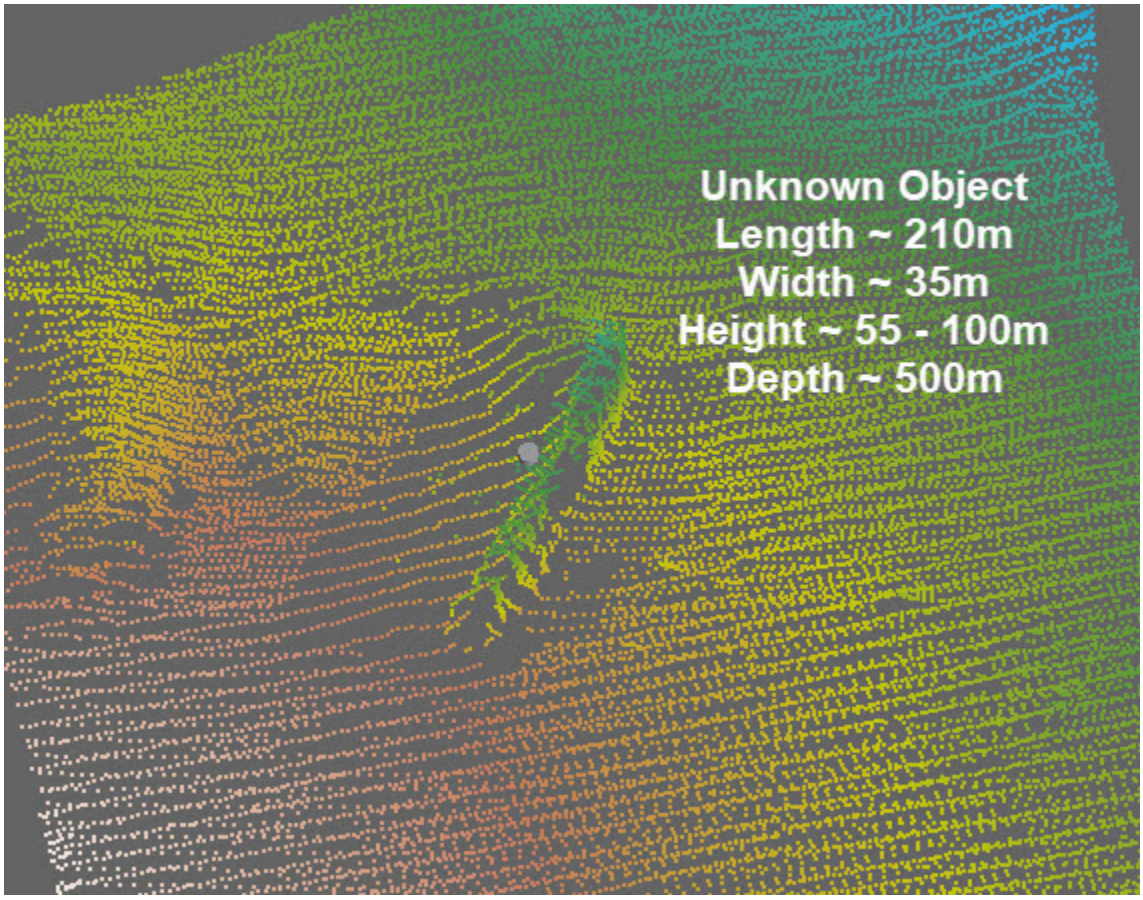


Figure 14: Subset view of hull-shaped H13582 seafloor feature.

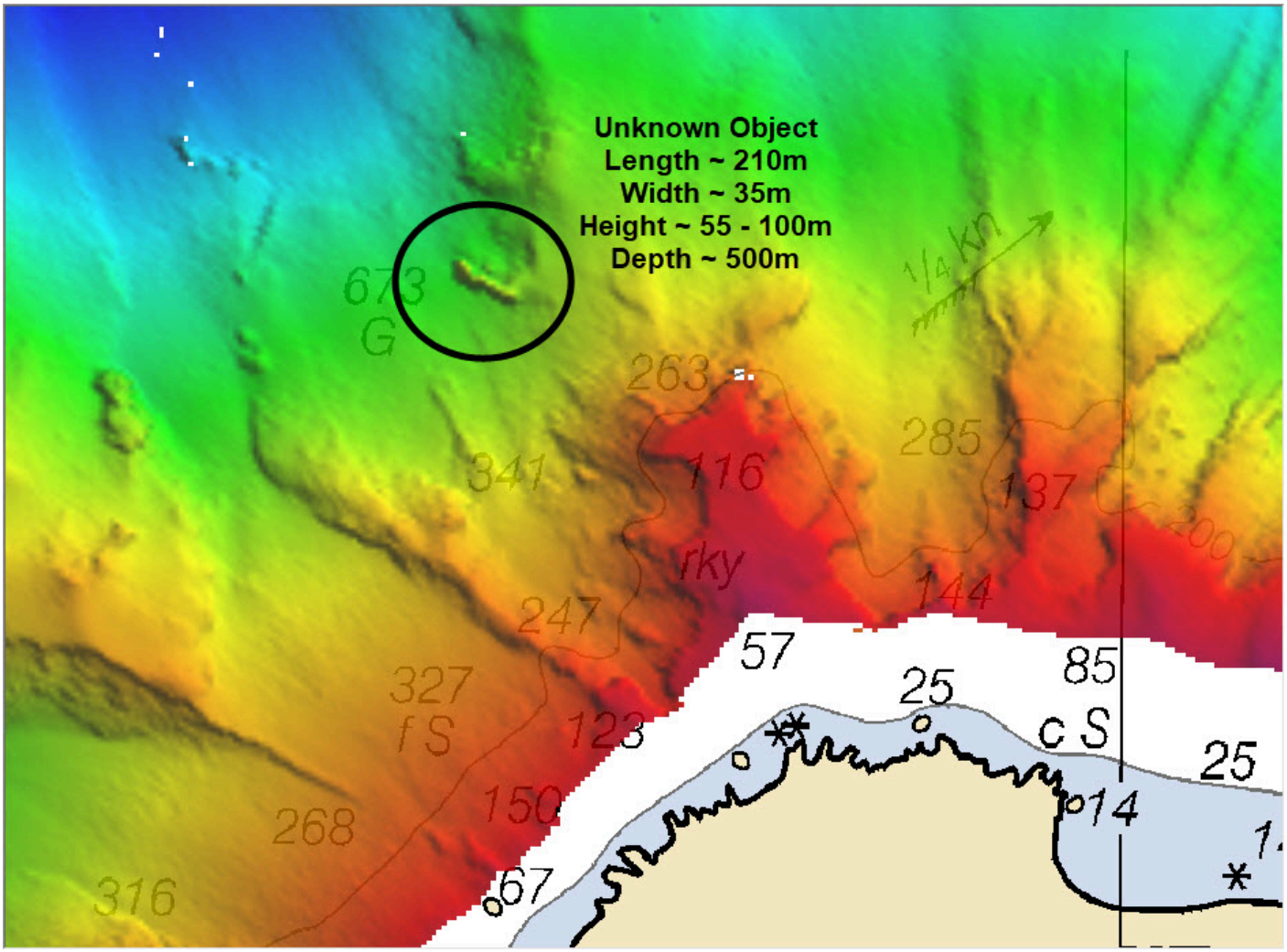


Figure 15: Surface plan-view showing location of H13582 hull-shaped seafloor feature.

D.2.9 Construction and Dredging

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

D.2.10 New Survey Recommendations

We recommend that the entire assigned H13582 survey area be completed when practical.

D.2.11 ENC Scale Recommendations

No new ENC scales 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 Specifications and 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.

Approver Name	Approver Title	Approval Date	Signature
Hector L. Casanova, CAPT/NOAA	Chief of Party	09/27/2022	Digitally signed by CASANOVA.HECTOR.LUIS.1253816461 Date: 2022.10.27 09:31:04 -07'00'
Collin H. Walker, LT/NOAA	Field Operations Officer	09/27/2022	WALKER.COLLIN.HARRISON.1523758540 2022.10.27 08:55:07 -07'00'
James B. Jacobson	Chief Survey Technician	09/27/2022	JACOBSON.JAMES.BRYAN.1269664017 I have reviewed this document 2022.10.21 12:51:09 -07'00'
Caroline M. Jahn, ENS/NOAA	Sheet Manager	09/27/2022	JAHN.CAROLINE.MARIE.1596183871 Digitally signed by JAHN.CAROLINE.MARIE.1596183871 Date: 2022.10.14 14:13:23 -07'00'

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