H13814

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13814

LOCALITY

State(s):	Illinois
General Locality:	Southwestern Lake Michigan, Wisconsin and Illinois
Sub-locality:	5 NM Southeast of Waukegan Breakwater Light

2023

CHIEF OF PARTY
John R. Bean

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13814**

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):	**Illinois**
General Locality:	**Southwestern Lake Michigan, Wisconsin and Illinois**
Sub-Locality:	**5 NM Southeast of Waukegan Breakwater Light**
Scale:	**5000**
Dates of Survey:	**07/15/2023 to 09/30/2023**
Instructions Dated:	**07/07/2023**
Project Number:	**OPR-Y398-KR-23**
Field Unit:	**Ocean Surveys**
Chief of Party:	**John R. Bean**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Low Water Datum IGLD-1985**

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 16N, Low Water Datum IGLD-1985. 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 H13814

Project: OPR-Y398-KR-23

Locality: Southwestern Lake Michigan, Wisconsin and Illinois

Sublocality: 5 NM Southeast of Waukegan Breakwater Light

Scale: 1:5000

July 2023 - September 2023

Ocean Surveys

Chief of Party: John R. Bean

A. Area Surveyed

This survey provides hydrographic data for waters in southwestern Lake Michigan. The general locations of the survey limits are presented in Table 1.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
42° 22' 56" N 87° 49' 16" W	42° 11' 9.25" N 87° 41' 10.55" W

Table 1: Survey Limits

Survey limits were acquired in accordance with the requirements in the Project Instructions and the HSSD.

A.2 Survey Purpose

This project is located in Southwestern Lake Michigan and extends from northern Milwaukee to the suburbs of northern Chicago. The Port of Milwaukee is the only port on Lake Michigan that serves the Mississippi inland riverway system, which generates over $1M in revenue for the local economy (1). The region experiences high recreational, commercial, and tourism traffic, including cruise ships and ferries. The majority of existing chart data in this survey area predates the 1950s, while the Milwaukee region was last surveyed in the 1970s. Conducting a modern bathymetric survey in this region will provide critical data for updating National Ocean Service (NOS) charting products and services, thus increasing maritime safety for the southern Wisconsin and northern Illinois shorelines.

(1) https://www.freightwaves.com/news/freightwaves-classics-port-of-milwaukee-serves-thegreat-lakes-and-us-inland-waterway-system

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

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 (HSSD 5.2.2.3)
UCF-designated anchorage areas	Object Detection Coverage (HSSD 5.2.2.2)

Table 2: Survey Coverage

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

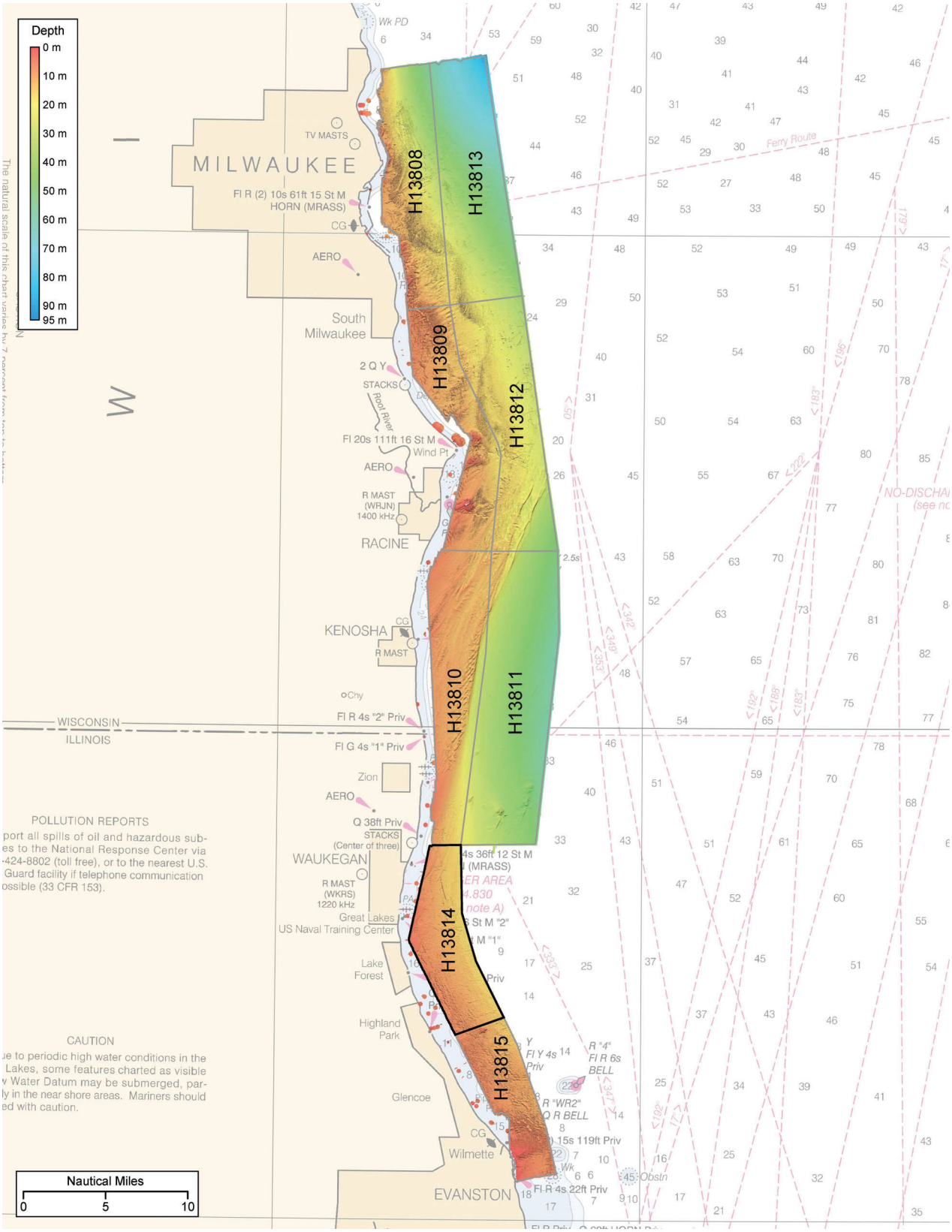


Figure 1: Project OPR-Y398-KR-23 coverage with H13814 highlighted.

A.6 Survey Statistics

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

	HULL ID	*RV North Cove*	*RV South Cove*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0	0.0
	MBES Mainscheme	1239.3	484.9	1724.2
	Lidar Mainscheme	0.0	0.0	0.0
	SSS Mainscheme	0.0	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0	0.0
	MBES/SSS Mainscheme	0.0	0.0	0.0
	SBES/MBES Crosslines	64.0	2.3	66.3
	Lidar Crosslines	0.0	0.0	0.0
Number of Bottom Samples				5
Number Maritime Boundary Points Investigated				0
Number of DPs				0
Number of Items Investigated by Dive Ops				0
Total SNM				36.2

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
07/15/2023	196
07/16/2023	197
07/17/2023	198
07/18/2023	199
07/21/2023	202
08/26/2023	238
08/27/2023	239
08/28/2023	240
08/29/2023	241
08/31/2023	243
09/01/2023	244
09/02/2023	245
09/03/2023	246
09/04/2023	247
09/05/2023	248
09/06/2023	249
09/09/2023	252
09/10/2023	253
09/11/2023	254
09/13/2023	256
09/14/2023	257
09/15/2023	258
09/16/2023	259
09/20/2023	263
09/21/2023	264
09/22/2023	265
09/23/2023	266
09/29/2023	272
09/30/2023	273

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	*RV North Cove*	*RV South Cove*
LOA	11.1 meters	9.4 meters
Draft	0.8 meters	0.8 meters

Table 5: Vessels Used

Figure 2: RV North Cove configured for survey operations.

Figure 3: RV South Cove configured for survey operations.

B.1.2 Equipment

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

Manufacturer	Model	Type
Teledyne RESON	SeaBat T50-R	MBES
Applanix	POS MV 320 v5	Positioning and Attitude System
Trimble	NetR9	Positioning System
AML Oceanographic	AML-3 LGR	Conductivity, Temperature, and Depth Sensor
AML Oceanographic	MVP30	Conductivity, Temperature, and Depth Sensor
AML Oceanographic	Micro SV-Xchange	Sound Speed System

Table 6: Major Systems Used

B.2 Quality Control

B.2.1 Crosslines

Crossline mileage in H13814 totaled 3.8% of the mainscheme survey miles. Agreement between crosslines and mainscheme bathymetry was very good, with a mean difference of 0.03m in the 1m resolution surface.

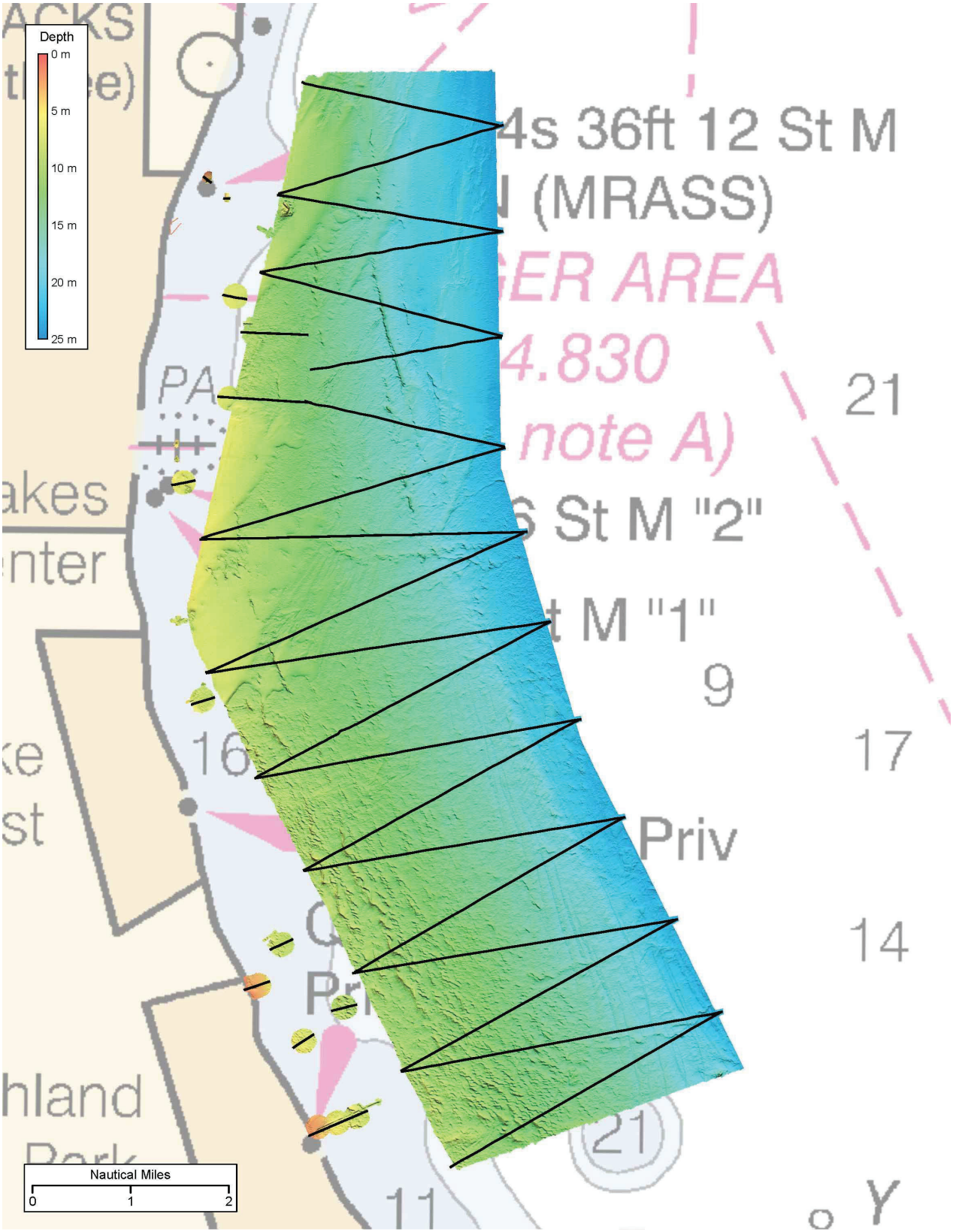
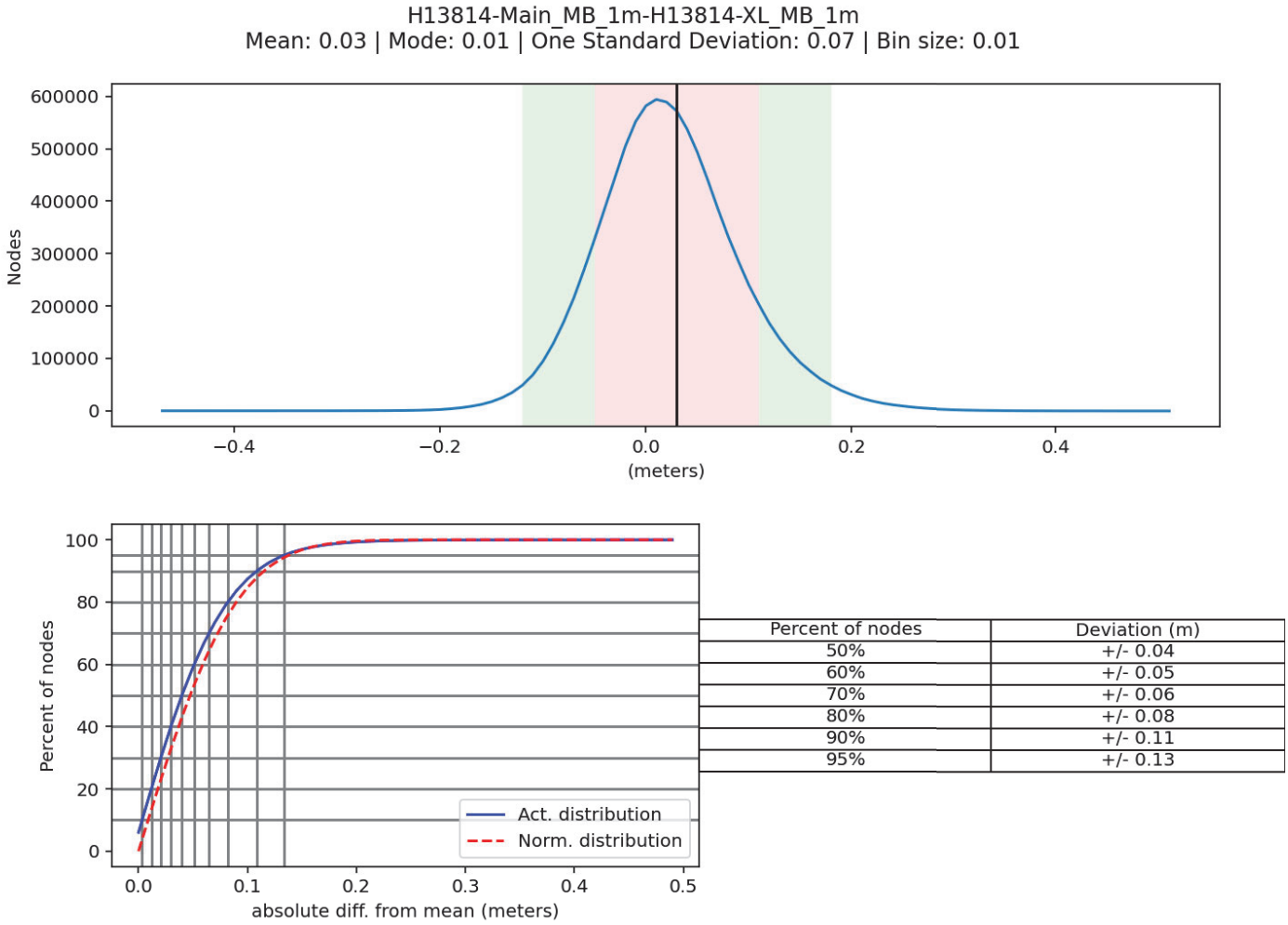


Figure 4: Crossline tracks overlaid on a coverage surface.



Percent of nodes	Deviation (m)
50%	+/- 0.04
60%	+/- 0.05
70%	+/- 0.06
80%	+/- 0.08
90%	+/- 0.11
95%	+/- 0.13

Figure 5: Depth differences between 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	0.045 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
RV North Cove	4 meters/second	4 meters/second	N/A	1 meters/second
RV South Cove	4 meters/second	N/A	N/A	1 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

The HydrOffice "QC Tools" application was used to calculate TVU QC, determined by a ratio of uncertainty to the allowable error per NOAA and IHO specifications. A set of single resolution surfaces were finalized in CARIS HIPS using the "uncertainty" option to select the combination of a priori and realtime uncertainty estimates as the surface TVU source.

The surfaces passed the uncertainty check, with 99.5+% or 100% of nodes meeting the uncertainty standards.

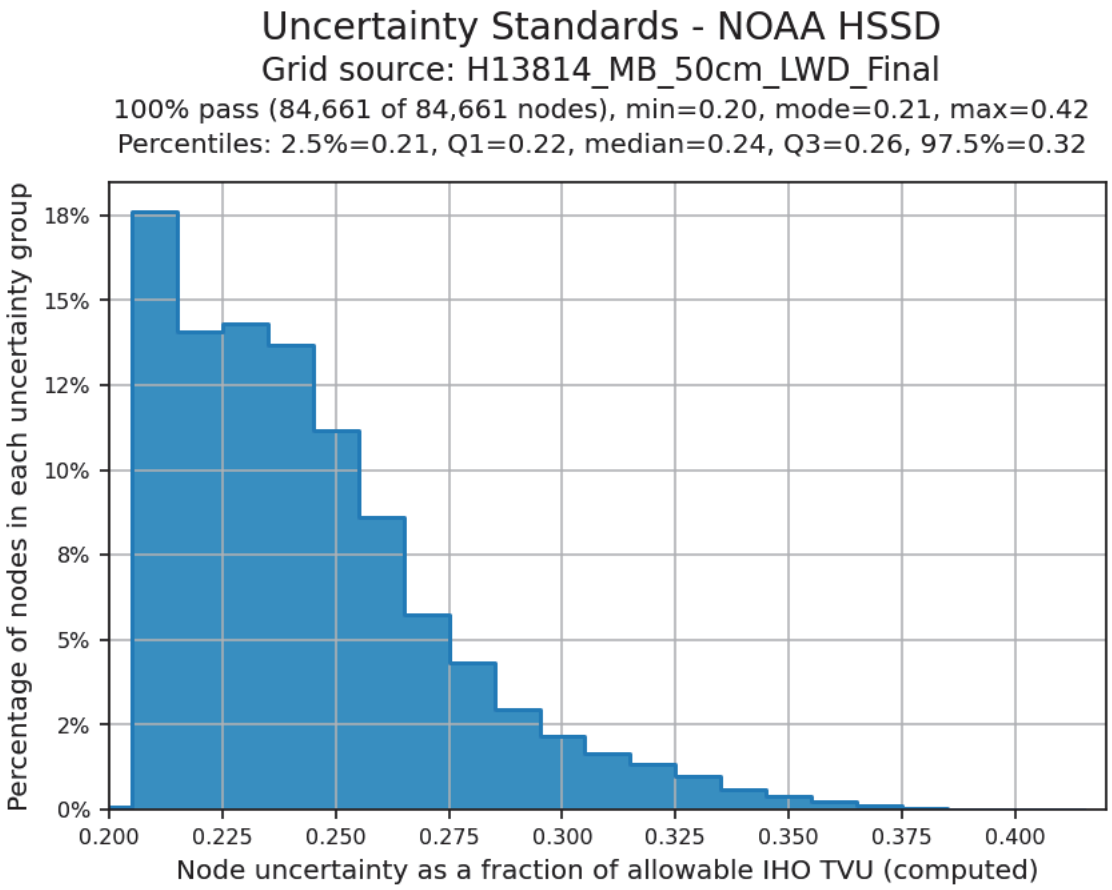


Figure 6: Uncertainty standards, 50cm resolution object detection coverage.

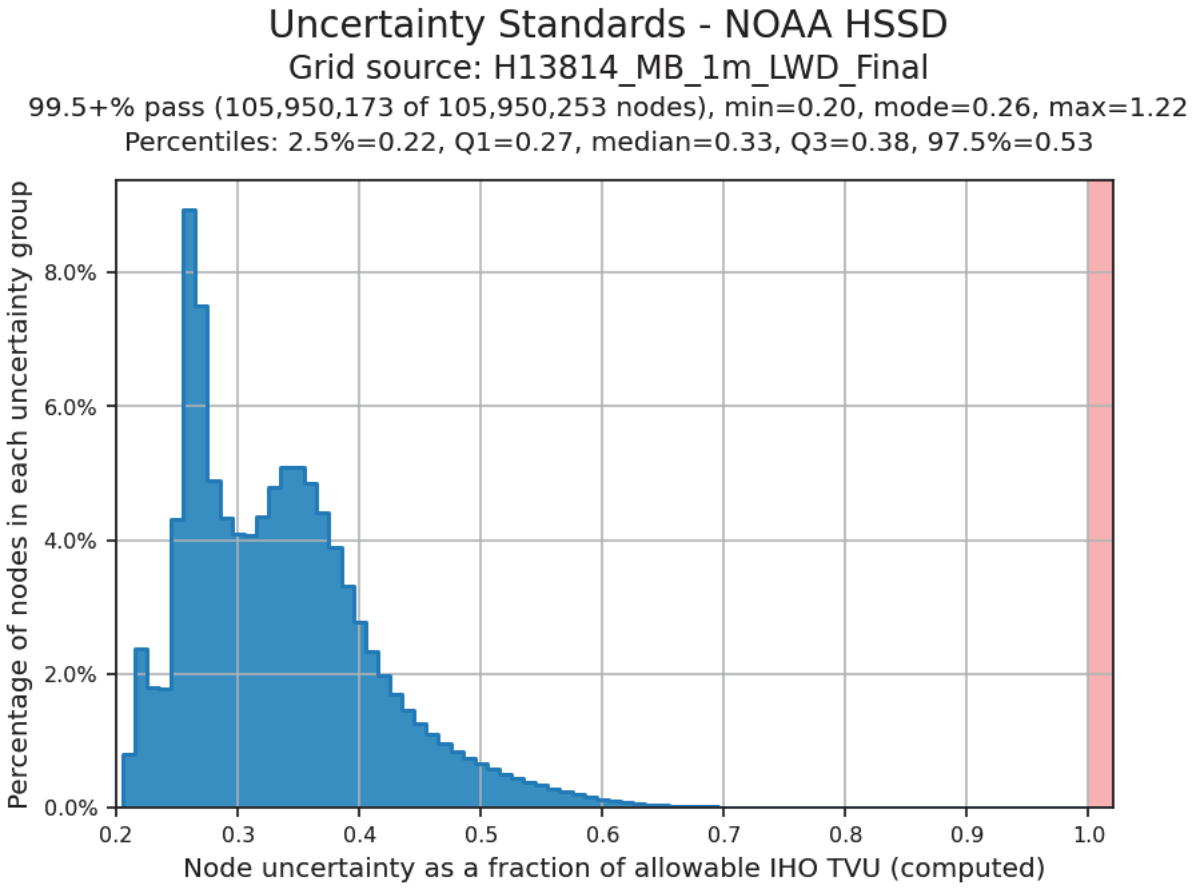


Figure 7: Uncertainty standards, 1m resolution complete coverage.

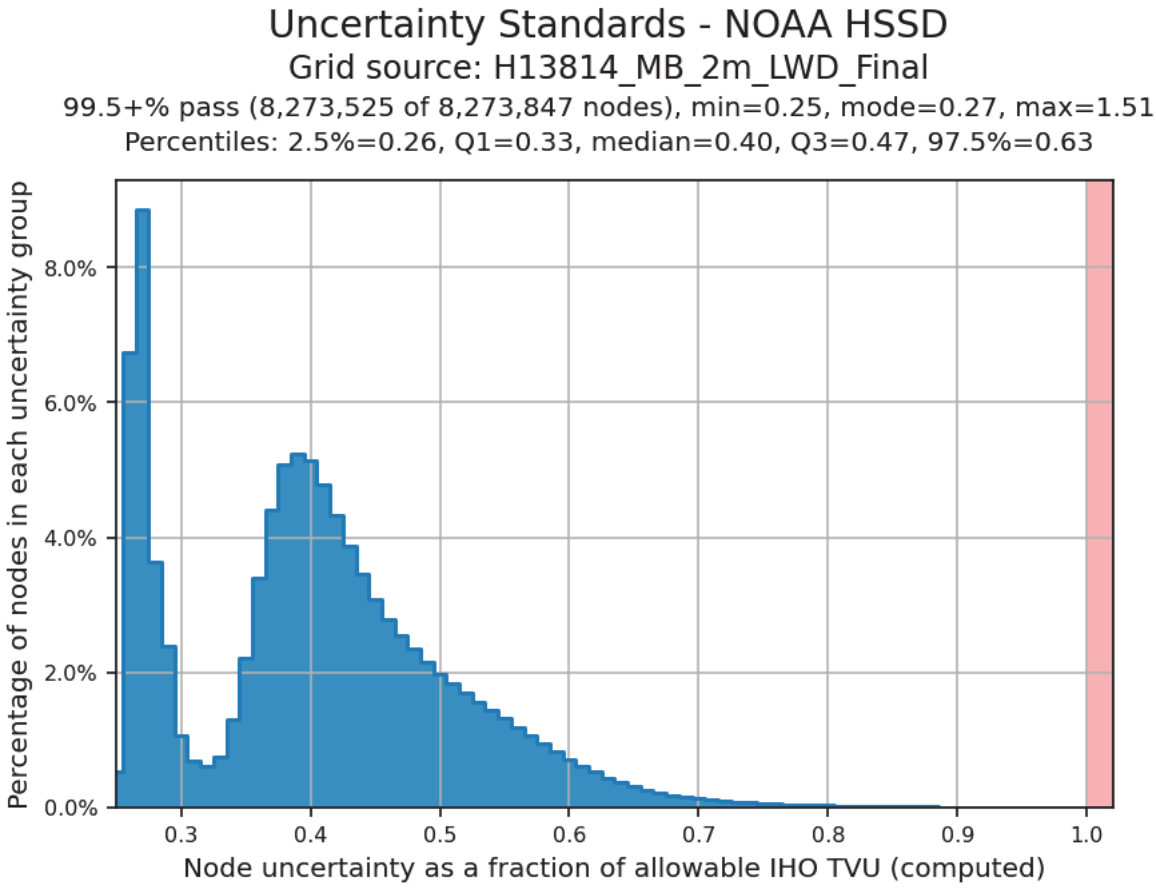


Figure 8: Uncertainty standards, 2m resolution complete coverage.

B.2.3 Junctions

Survey H13814 junctions with contemporary surveys along its north and south edges. The inshore investigations and western border junction with a prior topobathy lidar dataset. A small overlap at the northeast corner with contemporary survey H13811 is not addressed.

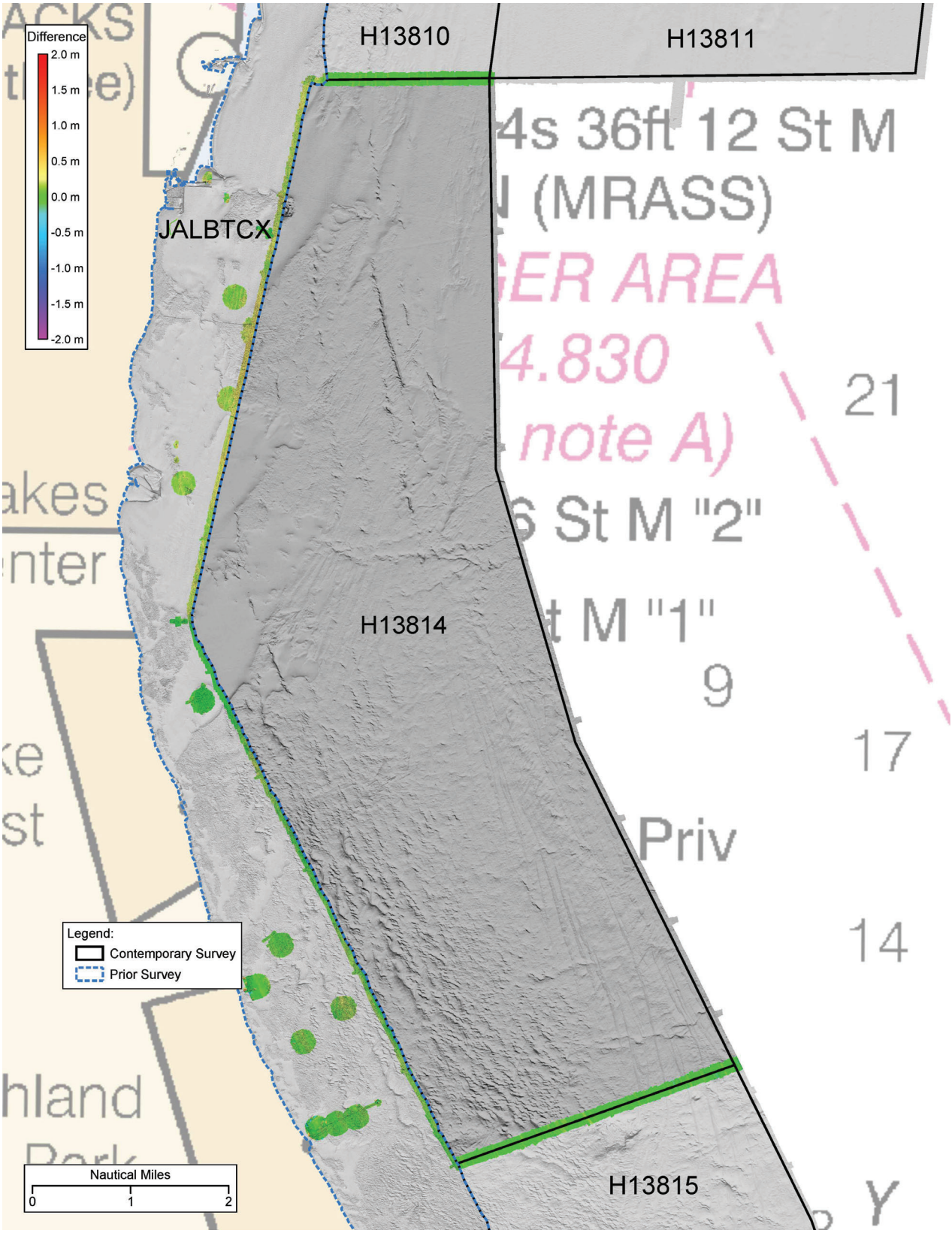


Figure 9: H13814 junction map with junction area depth differences.

The following junctions were made with this survey:

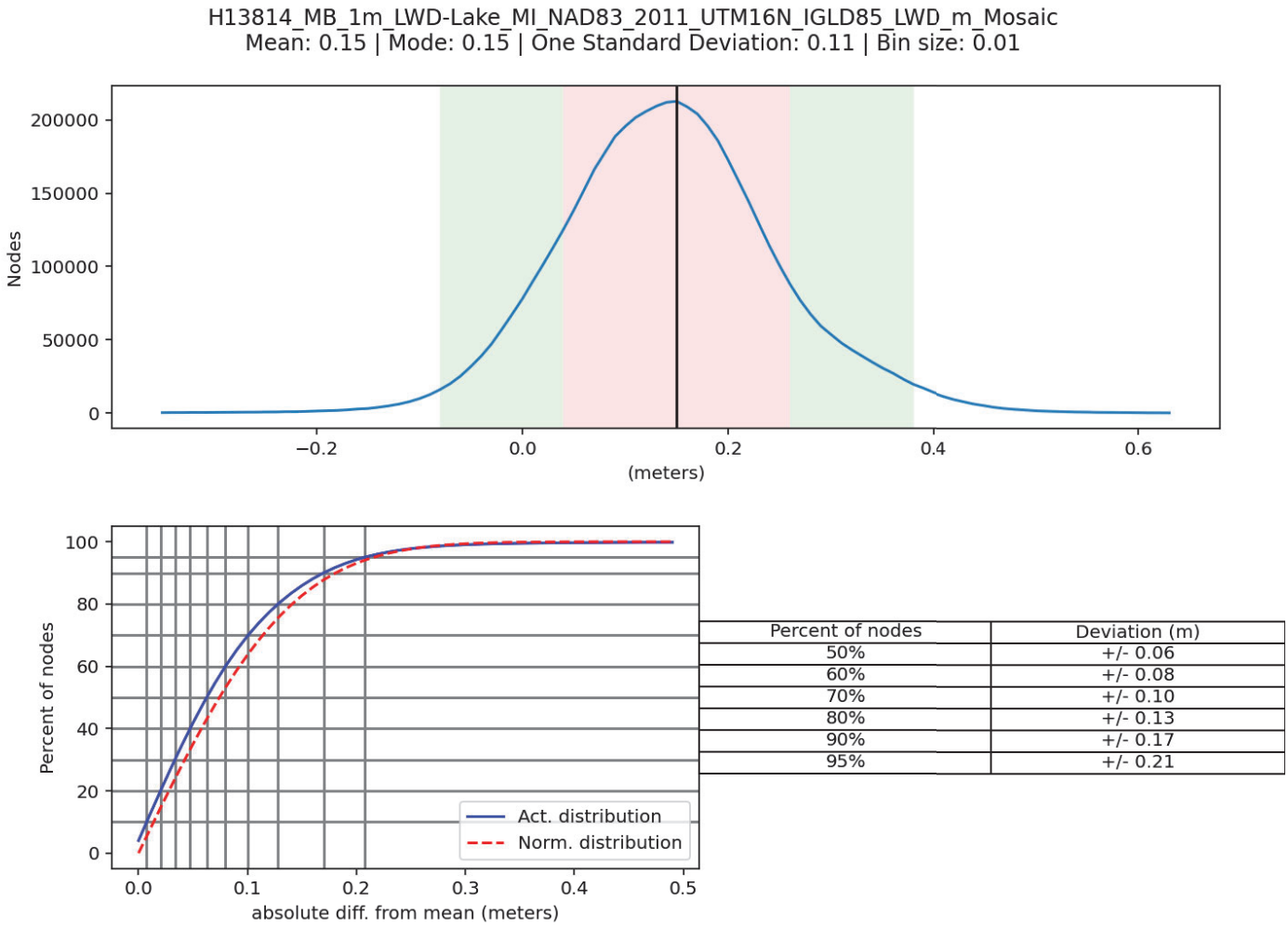
Registry Number	Scale	Year	Field Unit	Relative Location
USACE NCMP Topobathy Lidar	1:1	2020	JALBTCX	W
H13810	1:5000	2023	OSI	N
H13815	1:5000	2023	OSI	S

Table 9: Junctioning Surveys

USACE NCMP Topobathy Lidar

OSI received a preliminary digital elevation model of a recent topobathy lidar dataset that was undergoing review at the time of the PI, and which has since been published. According to the dataset quality notes, acquisition was focused on a swath of shoreline approximately 1500m wide, extending 500m onshore and 1000m offshore (or to laser extinction). All of the inshore investigations and the full length of the western edge of Survey H13814 are within the lidar coverage.

The mean difference between the two surveys was 0.15m, with the current survey bathymetry shoaler than the lidar data. The top of a shoal near the center of the junction length had the least difference, while the northern half of the junction area had the largest consistent depth difference. Features, rocks, and bottom texture also showed greater depth discrepancies. Despite this, overall agreement was good with 99.5+% of comparison nodes within the allowable error fraction.



Percent of nodes	Deviation (m)
50%	+/- 0.06
60%	+/- 0.08
70%	+/- 0.10
80%	+/- 0.13
90%	+/- 0.17
95%	+/- 0.21

Figure 10: Depth differences between H13814 and bathymetric lidar data.

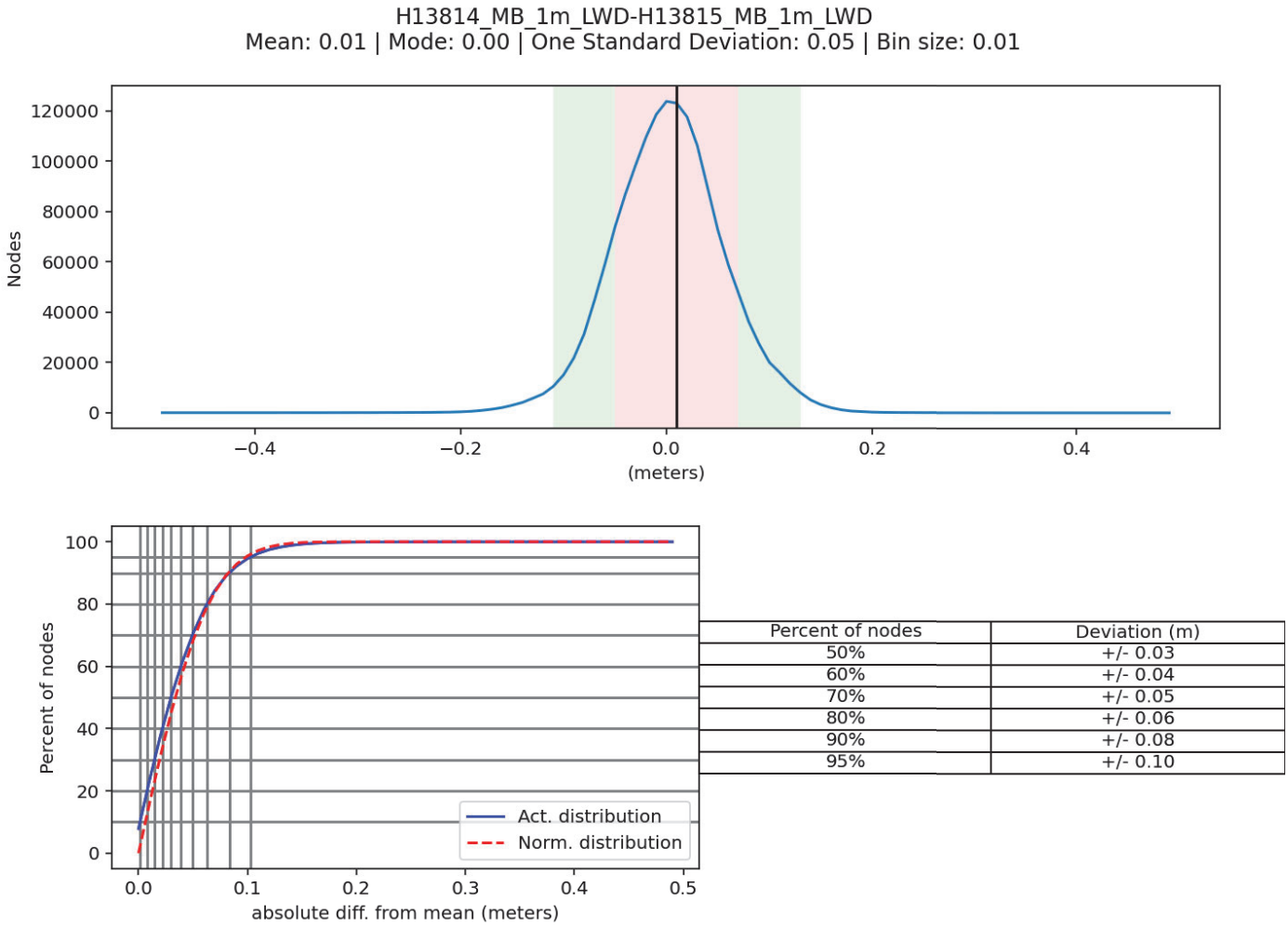
H13810

The junction with contemporary survey H13810 is discussed in the H13810 DR.

H13815

The junction with contemporary survey H13815 is approximately 6 km long and 200-300m wide. It runs the length of the southern border of Survey H13814.

Agreement between the two surveys was good, with a mean difference of 0.01m.



Percent of nodes	Deviation (m)
50%	+/- 0.03
60%	+/- 0.04
70%	+/- 0.05
80%	+/- 0.06
90%	+/- 0.08
95%	+/- 0.10

Figure 11: Depth differences between surveys H13814 and H13815.

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

Sound Speed Variation

Sound speed variations were observed throughout the survey area, correlating to factors including the weather, water depth, and bathymetric features, such as slopes or sand waves. In data processing, sound speed profiles that did not adequately reflect the surrounding water mass were identified and removed, edited, or replaced. Sound speed casts were primarily applied using the CARIS HIPS "Nearest in Distance within Time" method, therefore, removing a profile collected on a steep slope would allow deeper and shoaler casts on either side to be applied instead. Casts that were empirically found to represent a large water zone were duplicated at additional locations within that zone to ensure proper corrections given the cast selection options available in the CARIS sound speed tools. Bathymetry, uncertainty, and standard deviation surfaces were used to direct editing and determine the accuracy of sound speed cast selection.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: MVP casts were taken approximately every 15-20 minutes by RV North Cove and AML-3 casts were taken at intervals of approximately 30 to 90 minutes by RV North Cove and RV South Cove.

RV North Cove made use of both AML-3 and MVP systems on different survey days, while RV South Cove used AML-3 casts exclusively.

Hydrographers acquired more frequent sound speed profiles if high variability was noted in the surface sound speed from the AML Micro-X installed on the head of the transducer, or when the surface sound speed comparison threshold was exceeded (>2m/s change) between the profile reading at the draft of the transducer and the Micro-X.

OSI submitted a data package titled "SOUND VELOCITY collected from MV Northstar Challenger, RV North Cove, and RV South Cove in southwestern Lake Michigan from 2023-07-15 to 2023-10-05" in NetCDF format to the National Centers for Environmental Information (NCEI) on March 7, 2024.

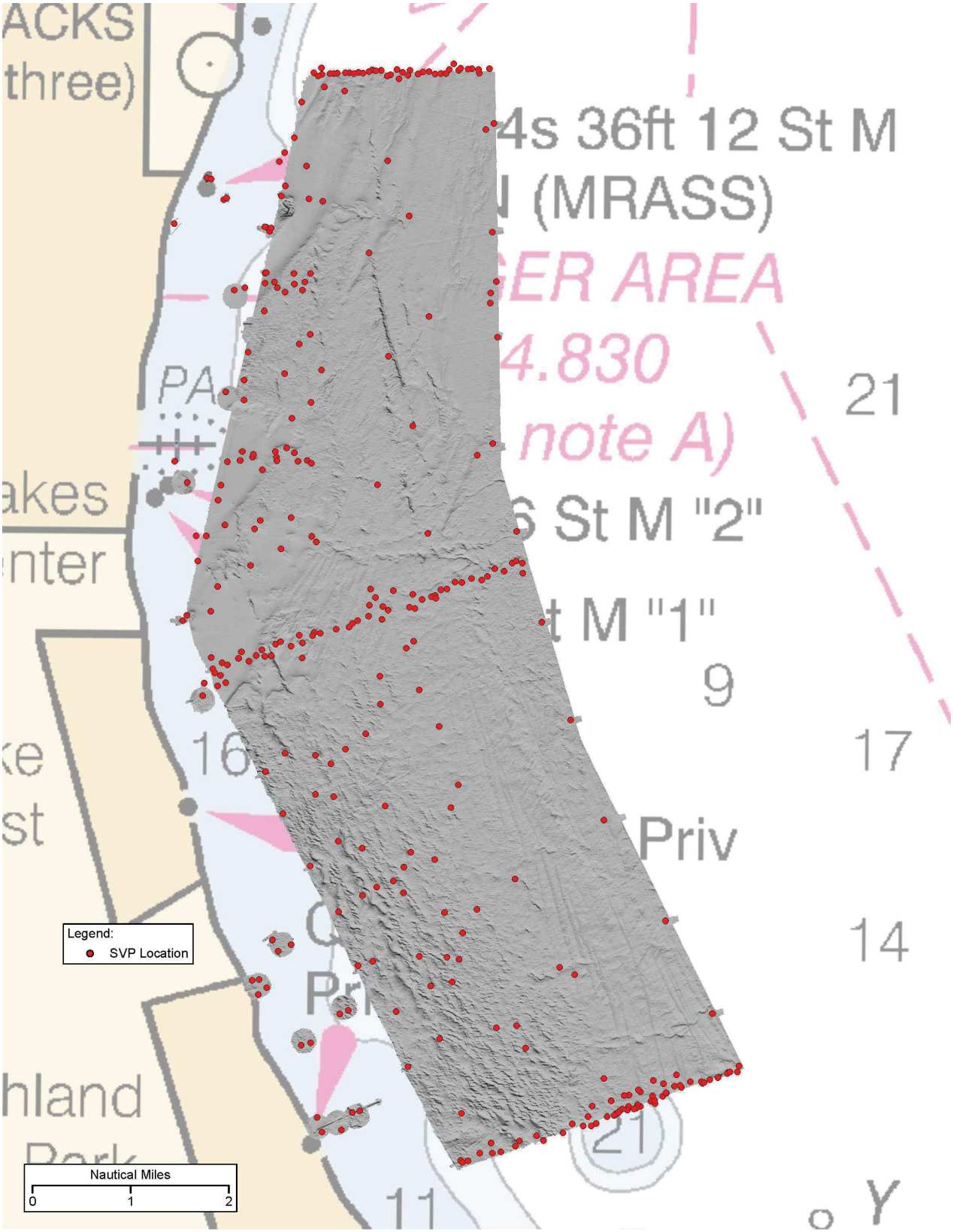


Figure 12: H13814 sound speed cast locations.

B.2.8 Coverage Equipment and Methods

The majority of this survey was conducted to achieve Complete Coverage with multibeam, as specified in HSSD 5.2.2.3, Option A. This calls for 100% bathymetric bottom coverage with multibeam sonars, and complete coverage multibeam developments of features. One area within the survey, centered on a charted wreck, was assigned Object Detection Coverage. The wreck was located and coverage on the feature achieved using Object Detection Multibeam Coverage (HSSD 5.2.2.2, Option A). An uncharted obstruction within the wreck search area was also investigated. The survey methods used to meet coverage requirements did not deviate from those described in the DAPR.

The HydrOffice "QC Tools" application was used to verify that the grid nodes met the density coverage requirements, with 99.5+% of the nodes meeting the requirement.

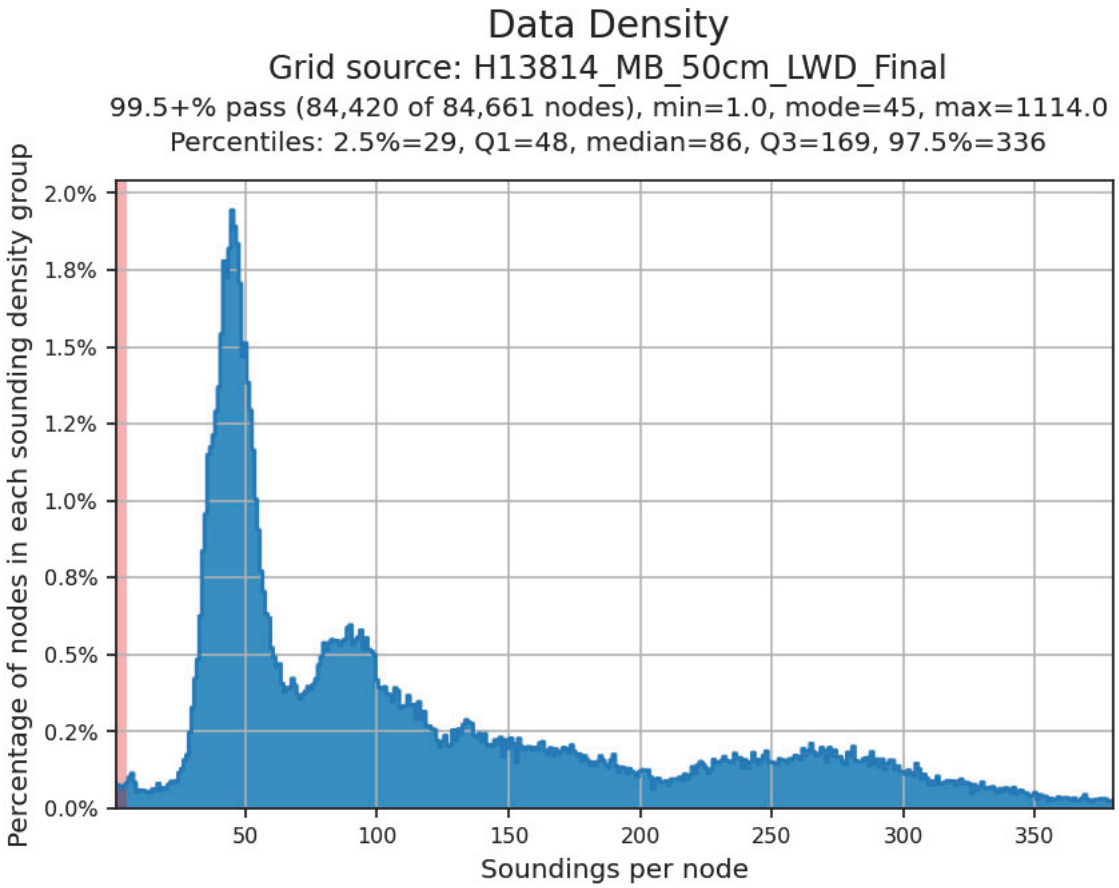


Figure 13: Data density, 50cm resolution object detection coverage.

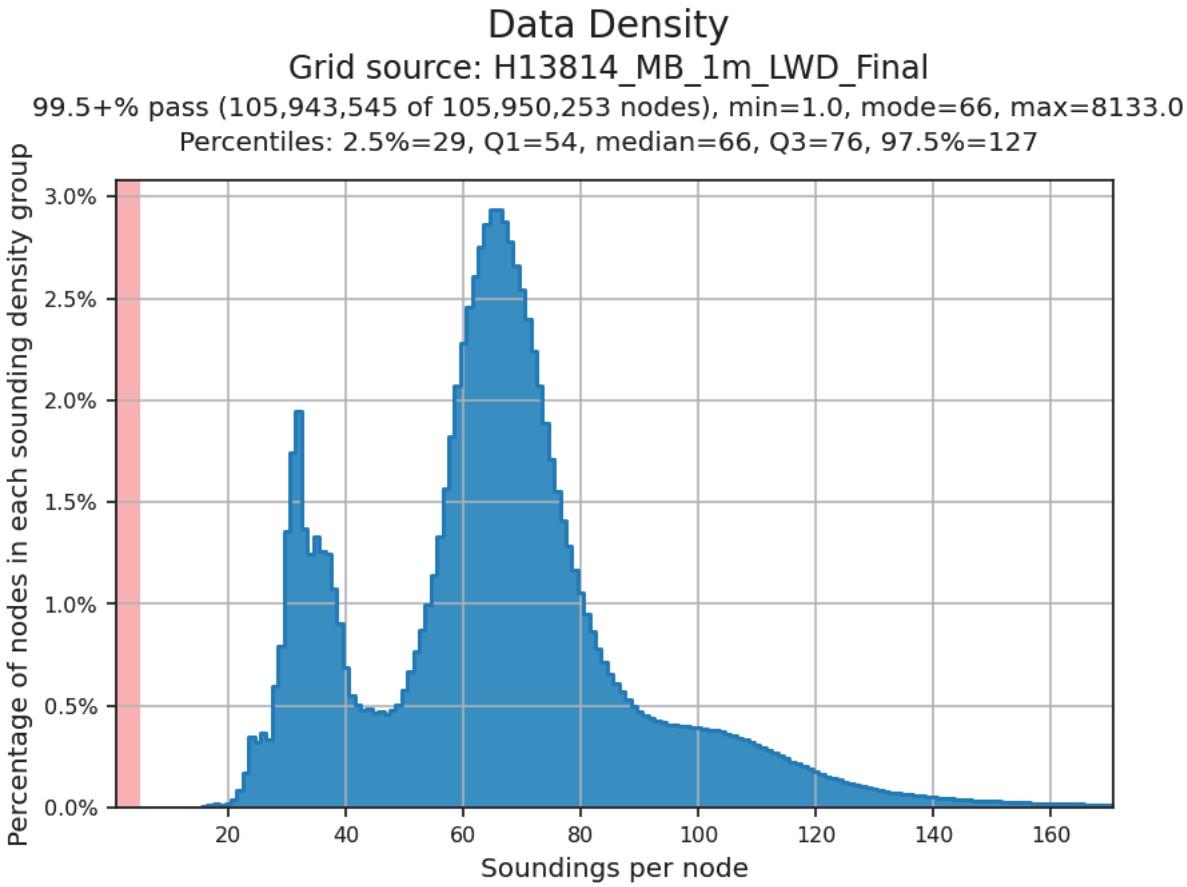


Figure 14: Data density, 1m resolution complete coverage.

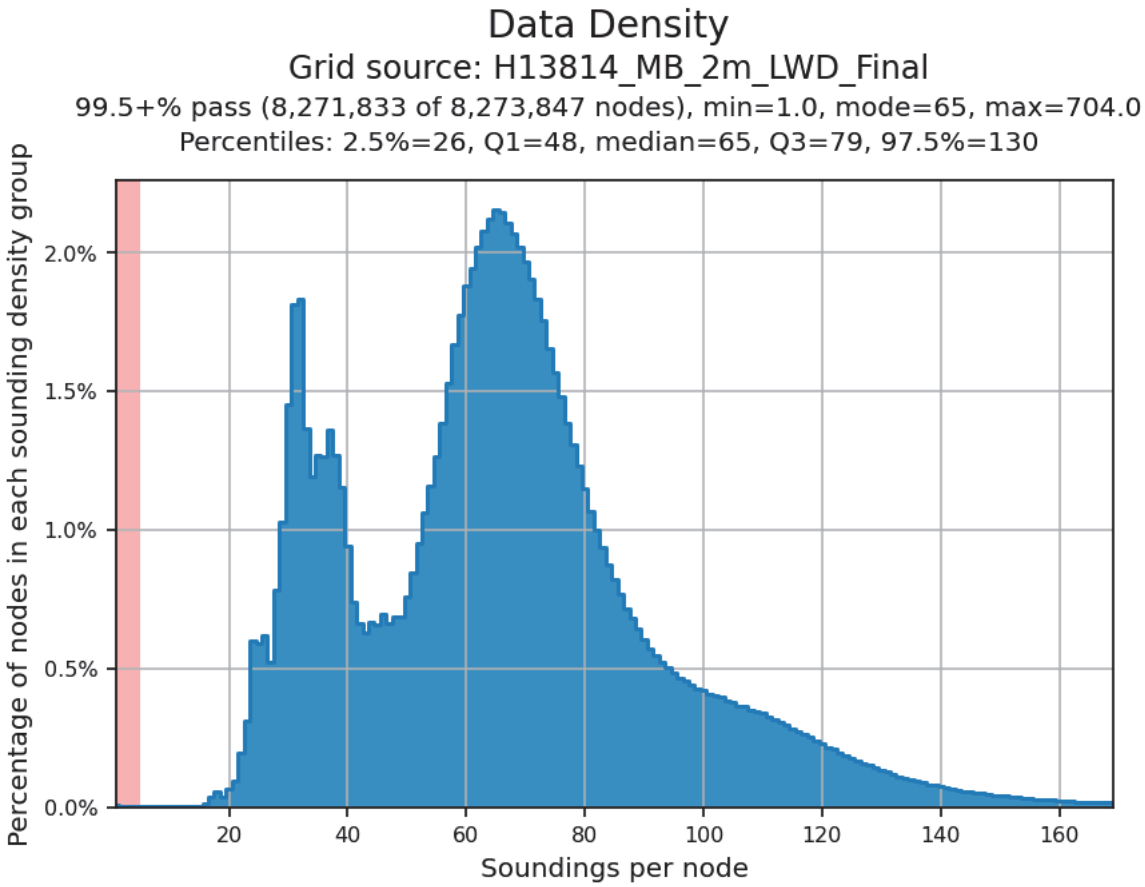


Figure 15: Data density, 2m resolution complete coverage.

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

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

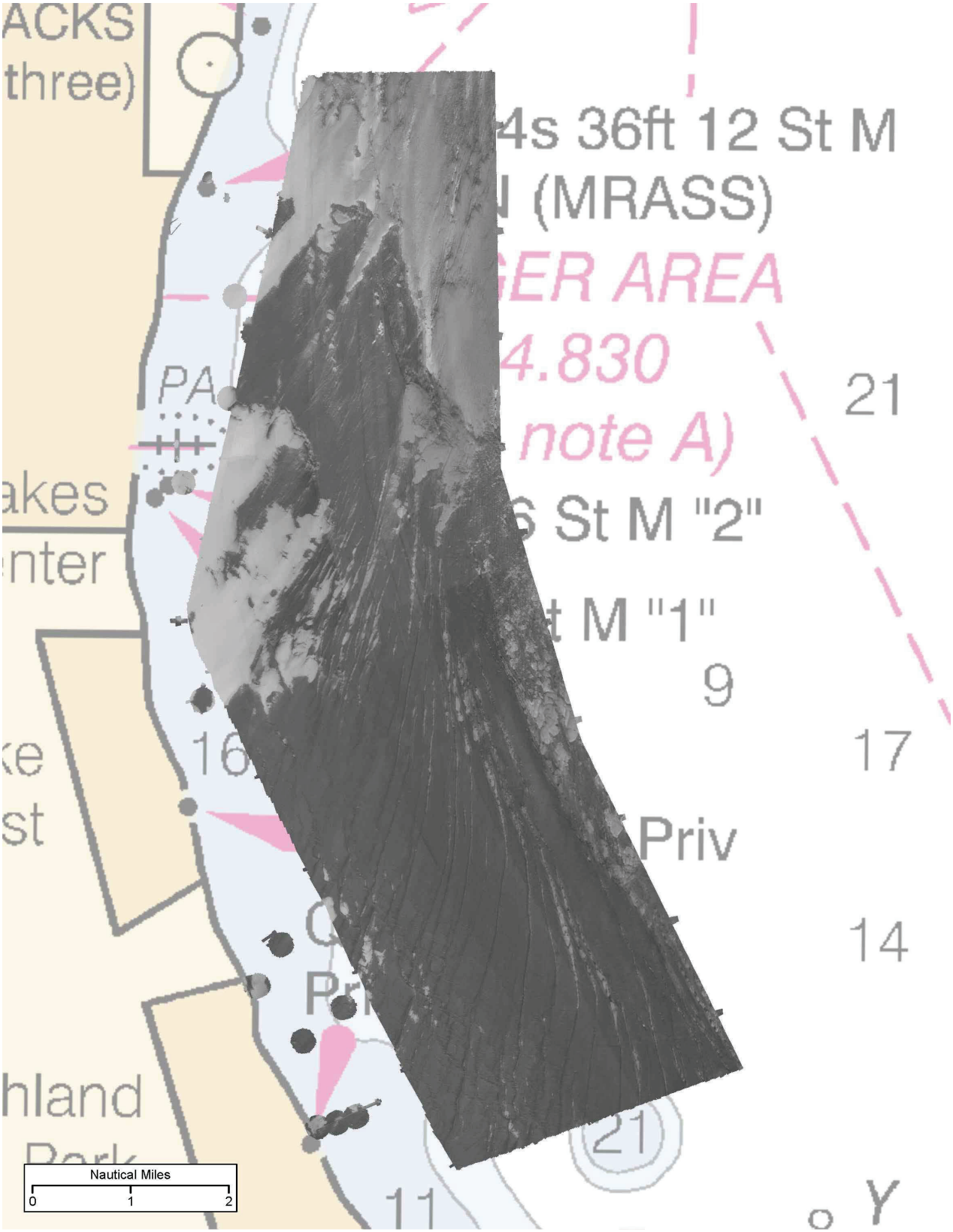


Figure 16: H13814 backscatter mosaic.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following Feature Object Catalog was used: NOAA Profile Version 2023.

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
H13814_MB_50cm_LWD_Final	CARIS Raster Surface (CUBE)	0.5 meters	3.66 meters - 7.77 meters	NOAA_0.5m	Object Detection
H13814_MB_1m_LWD_Final	CARIS Raster Surface (CUBE)	1 meters	0.88 meters - 20.0 meters	NOAA_1m	Complete MBES
H13814_MB_2m_LWD_Final	CARIS Raster Surface (CUBE)	2 meters	18.0 meters - 23.37 meters	NOAA_2m	Complete MBES
H13814_MB_50cm_LWD	CARIS Raster Surface (CUBE)	0.5 meters	3.82 meters - 7.77 meters	NOAA_0.5m	Object Detection
H13814_MB_1m_LWD	CARIS Raster Surface (CUBE)	1 meters	0.88 meters - 23.38 meters	NOAA_1m	Complete MBES
H13814_MB_2m_LWD	CARIS Raster Surface (CUBE)	2 meters	0.88 meters - 23.37 meters	NOAA_2m	Complete MBES
H13814_MBAB_2m_400kHZ_1of1	MB Backscatter Mosaic	2 meters	-	N/A	Processed Backscatter

Table 10: Submitted Surfaces

C. Vertical and Horizontal Control

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

C.1 Vertical Control

The vertical datum for this project is Low Water Datum IGLD-1985.

ERS Datum Transformation

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

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	Vdatum_Coverage_100m_NAD83_2011-LWD_IGLD85_geoid18.csar

Table 11: ERS method and SEP file

C.2 Horizontal Control

The horizontal datum for this project is North American Datum 1983 (2011).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 16.

The following PPK methods were used for horizontal control:

- Smart Base

CORS stations for this project were drawn from both the NOAA CORS Network, managed by NOAA/ National Geodetic Survey, and the WISCORS Network, managed by the Wisconsin Department of Transportation. See the HVCR for discussion and a map of stations labeled by network.

The following CORS Stations were used for horizontal control:

HVCR Site ID	Base Station ID
BURLINGTON	BURL
ROLLING MEADOWS	CCRM
HANOVER PARK COOP	DP5A
WOOD DALE 2	DP6B
KARA CO 2 COOP	KAR2
KENOSHA	KEHA
LAKE COUNTY DT	LCDT
BENTON HARBOR	MIBH
SOUTH HAVEN	MISH
SEILER FRWI 2	SIW2
DOWNERGROVE COOP	VODG

Table 12: CORS Base Stations

The following user installed stations were used for horizontal control:

HVCR Site ID	Base Station ID
Ocean Surveys Kenosha	OSKE

Table 13: User Installed Base Stations

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
US4IL1ZX	1:90000	1	12/21/2023	01/08/2024
US4IN01M	1:120000	16	12/21/2023	01/08/2023

Table 14: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

There was 1 DTON report submitted for a crib structure that was not charted. See the FFF for details.

D.1.3 Charted Features

There were 22 assigned features addressed in H13814, 13 of which were crib obstructions at the end of charted pipelines. There were also 3 snag/stump obstructions, 2 wrecks, and 4 rocks. Most features were found with new positions and geometry, only 4 were disproved. See the FFF for details.

D.1.4 Uncharted Features

There were 18 uncharted features surveyed in H13814; 17 obstructions and 1 wreck. Of the obstructions, most were near shore and associated with visible pipelines and crib structures. See the FFF for details.

D.1.5 Channels

No channels exist within the survey limits.

D.2 Additional Results

D.2.1 Aids to Navigation

There were 18 ATONS charted within or near survey H13814. All but 1 of these was observed to be on station; the breakwater light that was not seen is seasonal with the status attribute "periodic/intermittent" and so was not reported to the U.S. Coast Guard.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

There were 5 bottom samples assigned in H13814, all of which were at locations without previously-charted bottom types. The northernmost sample consisted of silt with shells, while the remaining samples were primarily coarse sand, some with shells, gravel, or pebbles in addition to the sand. See the FFF for details.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

There were 12 charted pipelines that extended from shore into H13814 survey data, 10 of which terminated at a charted crib obstruction and 2 terminated very near a charted crib obstruction. The outdated RNC showed all 12 pipelines terminating at an obstruction. No pipelines appeared to be correctly charted, but 10 were near visible evidence of pipelines and/or crib structures, including 6 pipelines with exposed segments. The exposed segments were reported in the Non-DTON Pipeline Report, and the crib obstructions are detailed in the FFF.

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 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 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
John R. Bean	Chief of Party	04/04/2024	Digitally signed by John R. Bean
David T. Somers	Data Processing Manager	04/04/2024	Digitally signed by David T. Somers

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