H13520

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

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13520

LOCALITY

State(s):	Washington
General Locality:	Approaches to Puget Sound
Sub-locality:	Discovery Bay

2021

CHIEF OF PARTY
Olivia A. Hauser, CDR/NOAA

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13520**

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):	**Washington**
General Locality:	**Approaches to Puget Sound**
Sub-Locality:	**Discovery Bay**
Scale:	**20000**
Dates of Survey:	**05/21/2021 to 05/26/2021**
Instructions Dated:	**05/19/2021**
Project Number:	**OPR-N305-RA-21**
Field Unit:	**NOAA Ship *Rainier***
Chief of Party:	**Olivia A. Hauser, CDR/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 UTM 10N, 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 H13520

Project: OPR-N305-RA-21

Locality: Approaches to Puget Sound

Sublocality: Discovery Bay

Scale: 1:20000

May 2021 - May 2021

NOAA Ship *Rainier*

Chief of Party: Olivia A. Hauser, CDR/NOAA

A. Area Surveyed

The survey area is referred to as H13520, "Discovery Bay" in the project instructions. The survey area is an approximately 9 square nautical mile bay connected to the Strait of Juan de Fuca and the entrance to Sequim Bay, west of the survey area.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
48° 7' 6.4" N 123° 2' 50.7" W	47° 59' 42.8" N 130° 10' 42.4" W

Table 1: Survey Limits

Data was acquired within the assigned survey limits as required in the Project Instructions and HSSD unless otherwise denoted.

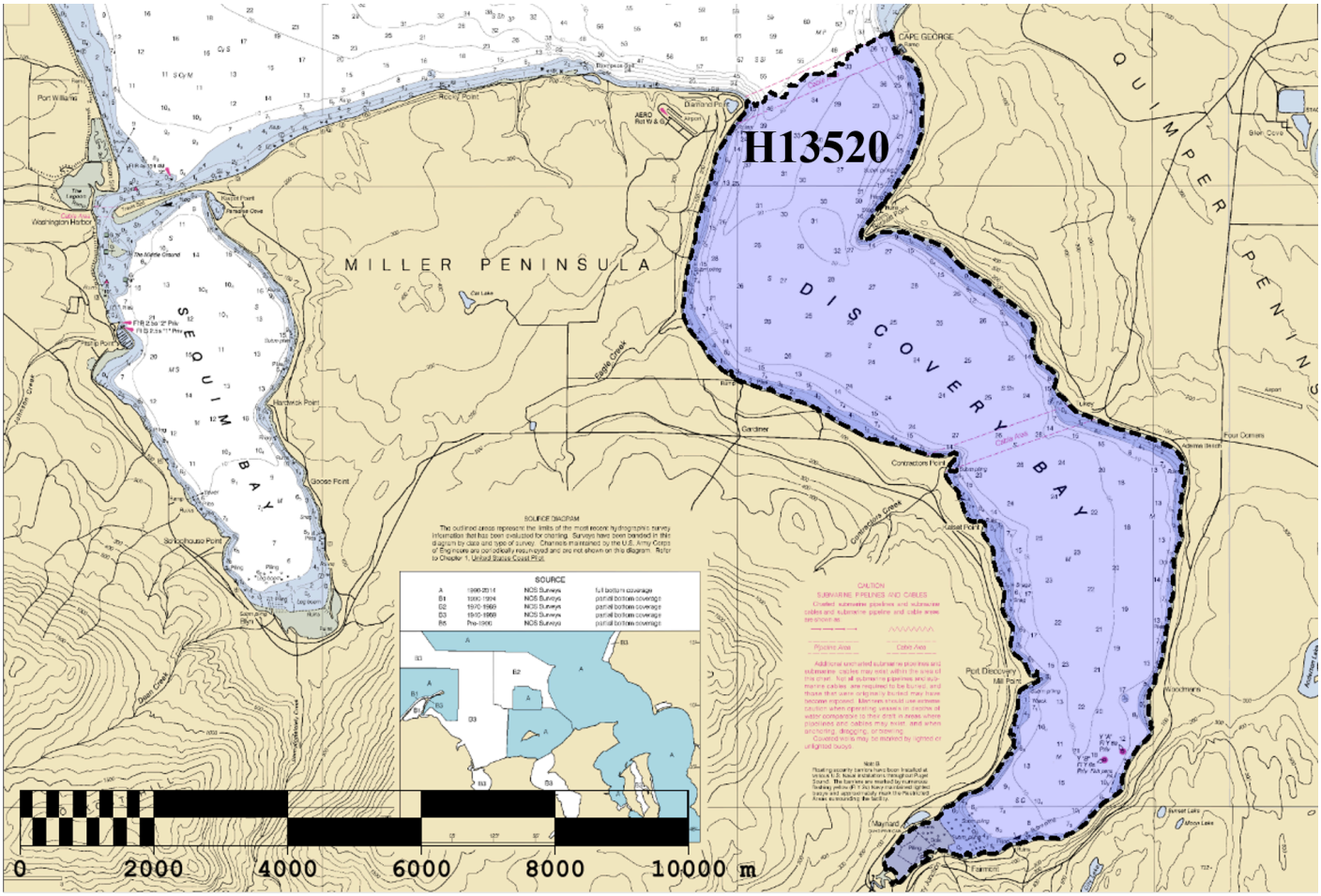


Figure 1: H13520 assigned survey area (Chart 18471)

A.2 Survey Purpose

This 43 square nautical mile project is located within the Strait of Juan de Fuca, WA, a major coastal waterway within the Salish Sea. The Salish Sea supports a robust industrial economy with 8,300 transits of deep-draft container ships, cargo and chemical carriers, oil tankers, fuel and coal barges arriving and departing from Puget Sound and Vancouver, Canada through the strait each year. Fishing, recreational, tug and barge vessels add an additional 50,000 transits and Washington ferries add 170,000 transits each year through the Strait of Juan de Fuca. Additionally, the region is home to 8 million people including fifty First Nation communities with centuries old cultural ties to traditional fishing.

The majority of the area was last surveyed in the 1940s and 1960s. This project provides modern bathymetry for updating National Ocean Service Nautical charting products improving maritime safety in this navigationally busy region as well as support the Seabed 2030 global mapping initiative.

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 (Refer to HSSD Section 5.2.2.3)

Table 2: Survey Coverage

NOAA Ship RAINIER acquired complete multibeam echosounder coverage to the inshore limit of hydrography, the Navigable Area Limit Line (NALL). The NALL is defined as the most seaward of the following: the surveyed 3.5 meter depths contour, the line defined by the distance seaward from the observed MHW line which is equivalent to 0.8 millimeters at chart scale (the assigned sheet limits closely reflects this) or the inshore limit of safe navigation. Areas where H13520 survey coverage reached neither the 3.5 meter depth contour or assigned sheet limits, were due to presence of pilings, an aquaculture site and a lack of shoreline window to further develop the NALL. Additional coverage was acquired near the entrance to Sequim Bay.

The processing team used Pydro Explorer QC Tool Holiday Finder to detect gaps in the data ("holidays") on the finalized Variable Resolution (VR) surfaces for submission. Holidays finder yielded one holiday present in the data.

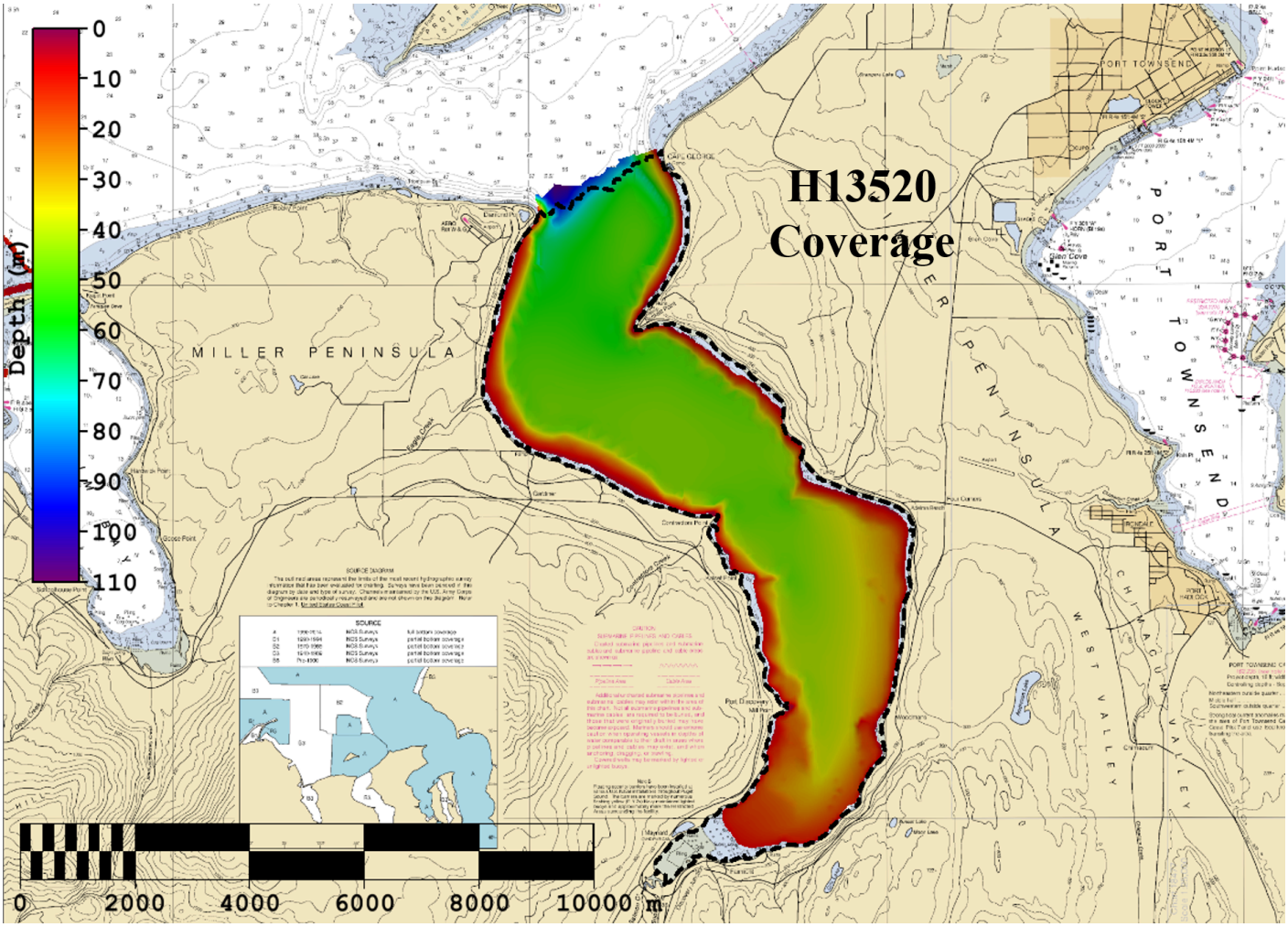


Figure 2: H13520 MBES coverages and assigned survey limits (dashed line) (Chart 18471). Colorbar indicates depth in meters.

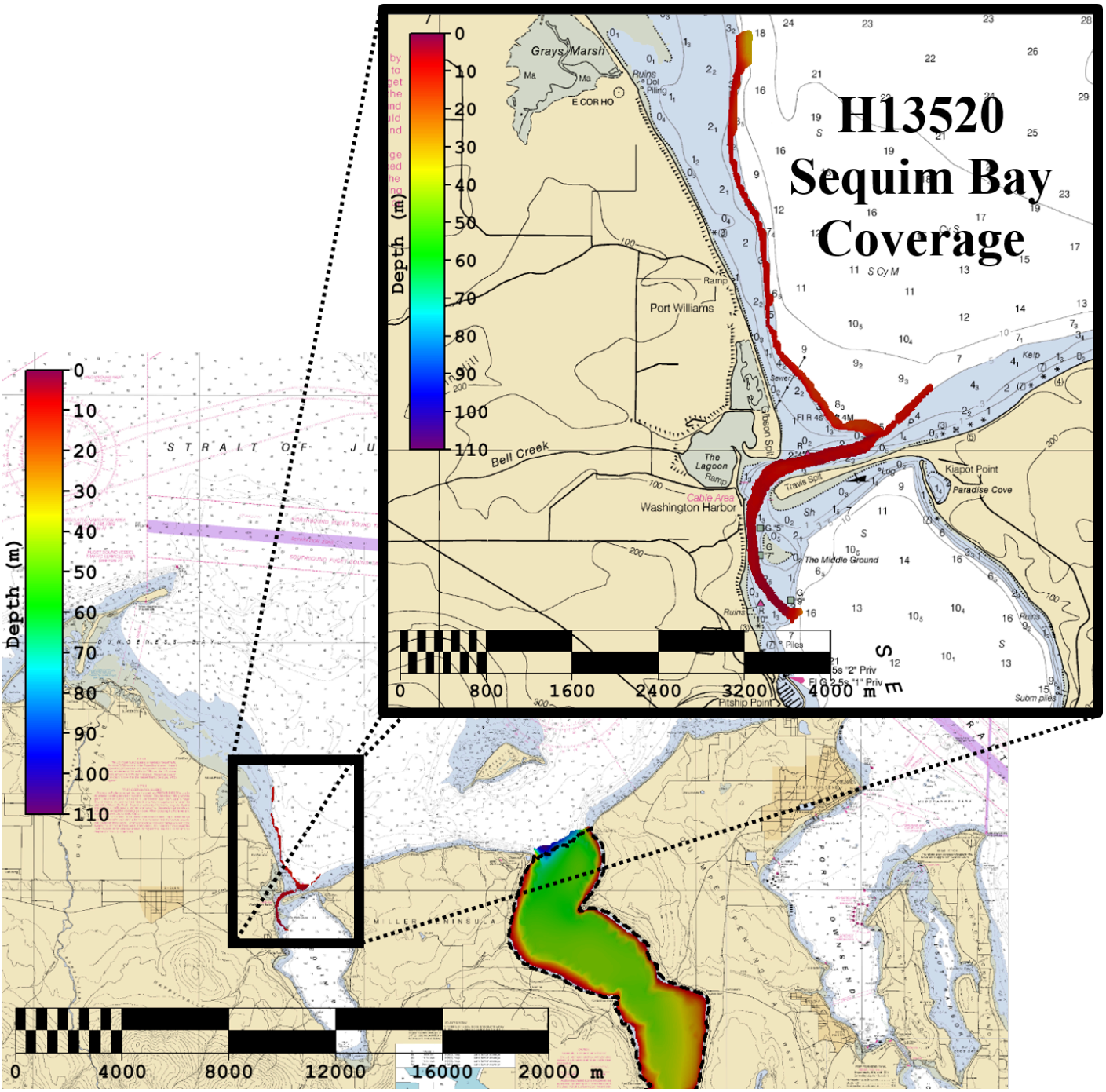


Figure 3: Sequim Bay entrance coverage (Chart 18471). Colorbar indicates depth in meters

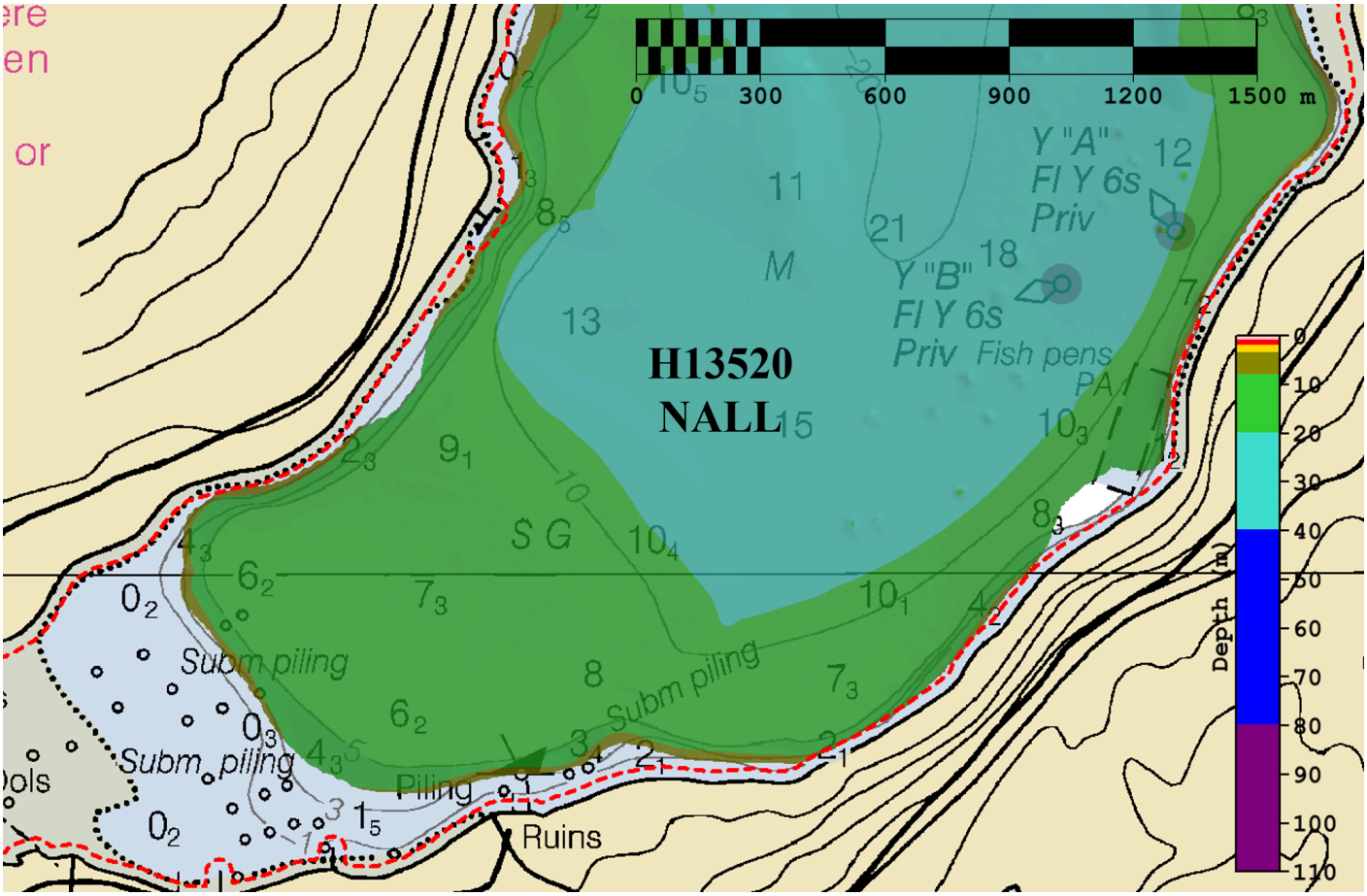


Figure 4: Example of nearshore area where the NALL was determined by the presence of pilings. Dashed red lines represent assigned survey limits and colorbar indicates depth in meters.

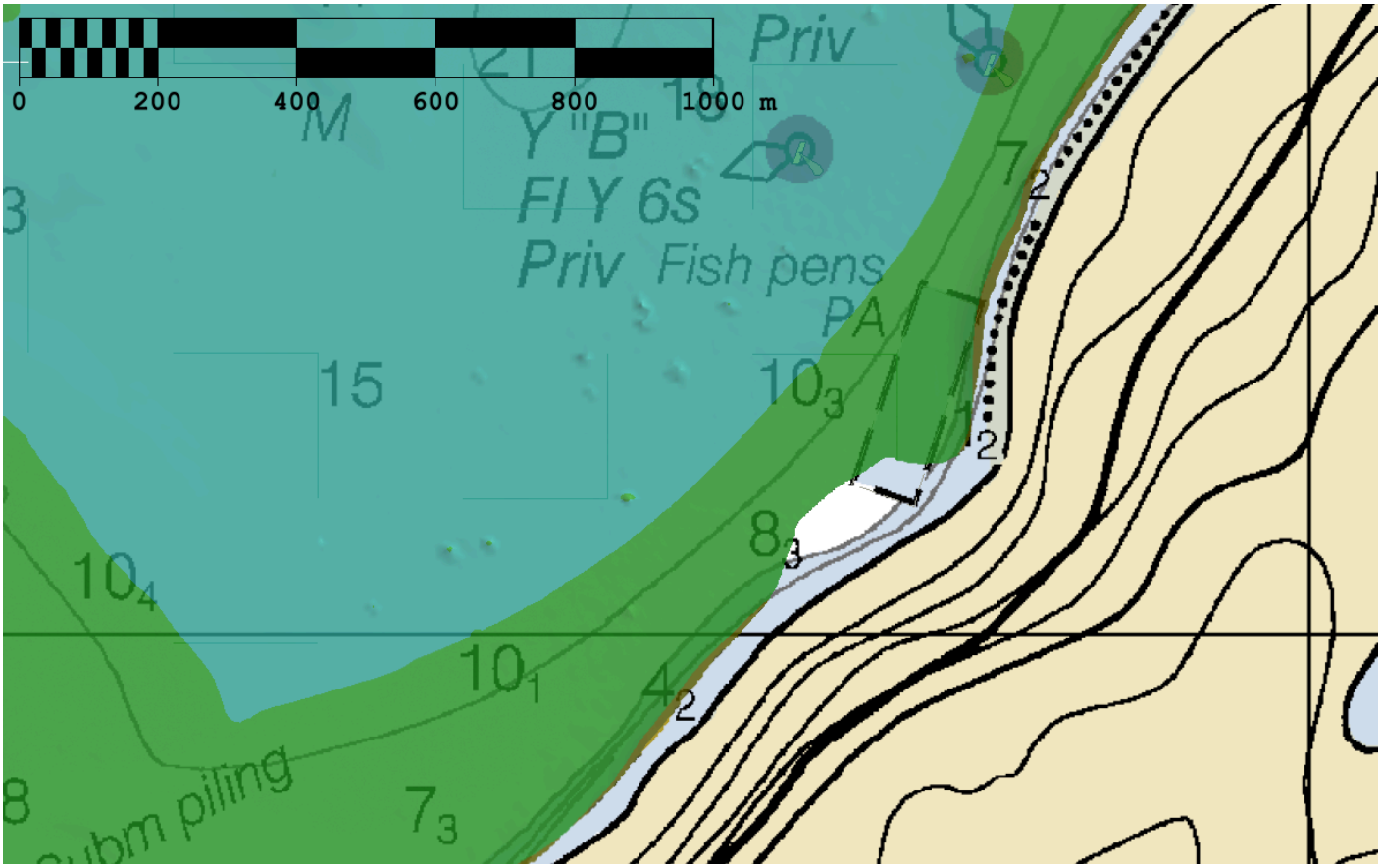


Figure 5: Section where coverage was not acquired to the 3.5 meters contour due to suspected presence of the Discovery Bay Seafarm. Field units were unable to acquire visual evidence of the seafarm.

A.6 Survey Statistics

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

	HULL ID	*2801*	*2802*	*2803*	*Total*
LNM	**SBES Mainscheme**	0.0	0.0	0.0	0.0
	MBES Mainscheme	81.89	98.7	84.79	265.37
	Lidar Mainscheme	0.0	0.0	0.0	0.0
	SSS Mainscheme	0.0	0.0	0.0	0.0
	SBES/SSS Mainscheme	0.0	0.0	0.0	0.0
	MBES/SSS Mainscheme	0.0	0.0	0.0	0.0
	SBES/MBES Crosslines	5.04	9.16	0.0	14.2
	Lidar Crosslines	0.0	0.0	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					9.96

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
05/26/2021	146
05/25/2021	145

Survey Dates	Day of the Year
05/24/2021	144
05/23/2021	143
05/22/2021	142
05/21/2021	141

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	*2801*	*2802*	*2803*
LOA	8.8 meters	8.8 meters	8.8 meters
Draft	1.1 meters	1.1 meters	1.1 meters

Table 5: Vessels Used

Figure 6: RAINIER launch 2802 underway to Discovery Bay.

All data for survey H13520 was acquired by NOAA Ship RAINIER launches 2801, 2802, 2803. The vessels acquired MBES bathymetry, backscatter, and sound velocity 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 2040	MBES
Sea-Bird Scientific	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

RAINIER launch 2801 acquired 5.04 linear nautical miles (lnm) and launch 2802 acquired 9.16 lnm of crosslines across most depth ranges on two boat days. Crosslines were not collected near the entrance to Sequim Bay due to insufficient coverage. A Compare Grids functions analysis was performed in Pydro Explorer on finalized VR surfaces of H13520 mainscheme only and crosslines only data. Pydro found that +99.5 % of nodes met allowable uncertainties. For additional results see plots below.

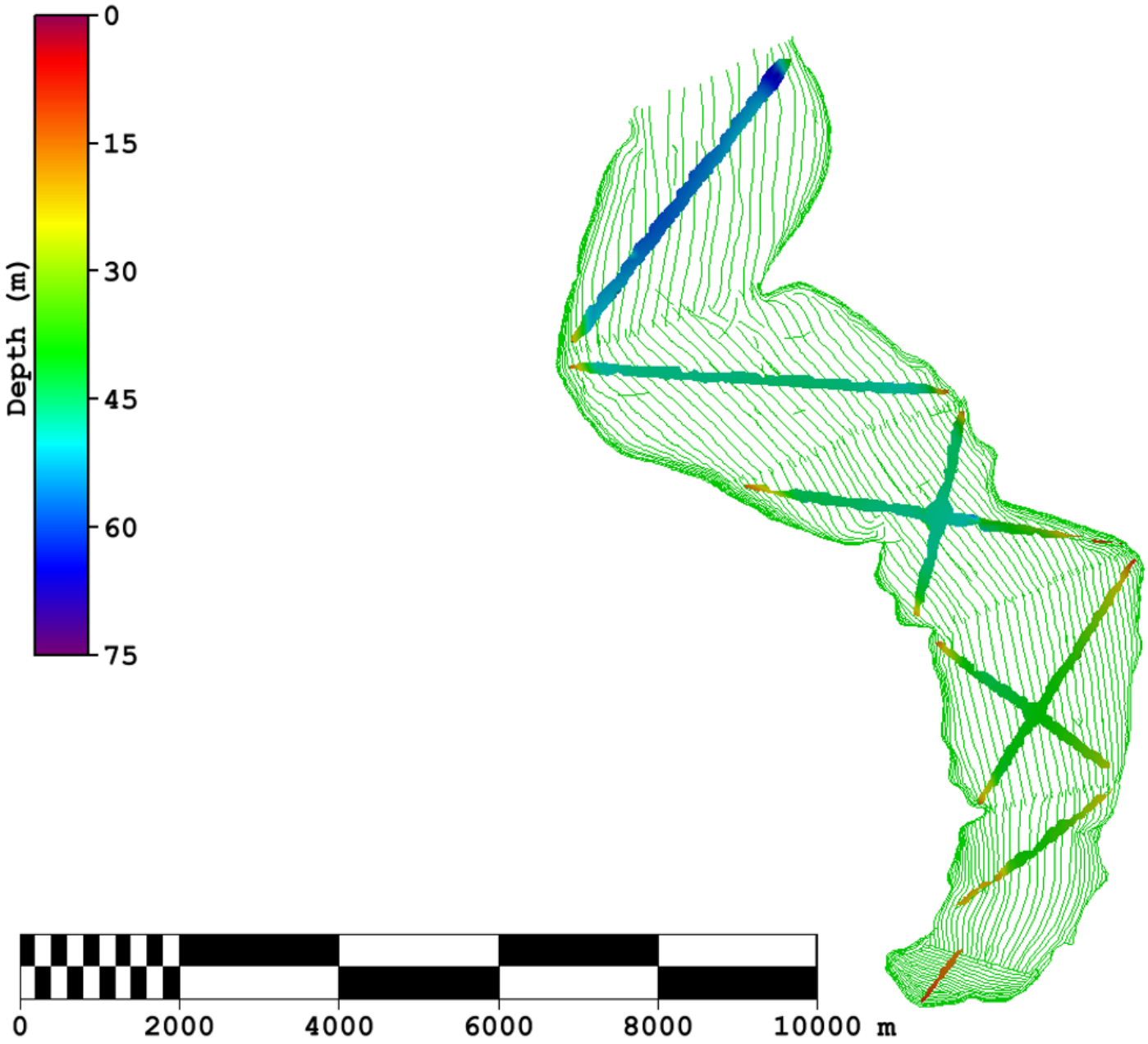
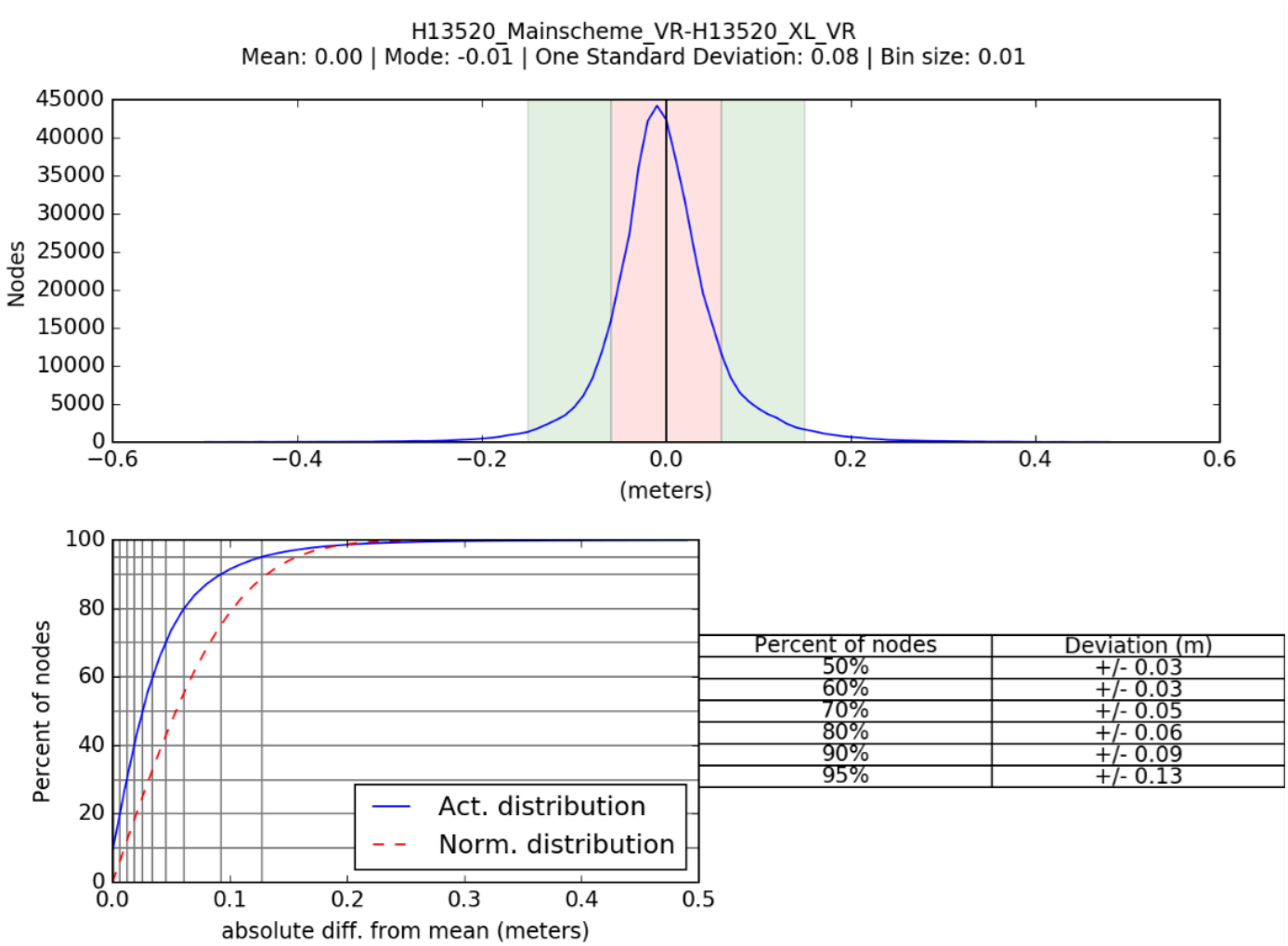


Figure 7: H13520 crosslines surface overlaid on mainscheme tracklines (green lines). Colorbar indicates depth in meters.



Percent of nodes	Deviation (m)
50%	+/- 0.03
60%	+/- 0.03
70%	+/- 0.05
80%	+/- 0.06
90%	+/- 0.09
95%	+/- 0.13

Figure 8: Pydro derived plot showing percentage-pass value of H13520 mainscheme to crossline data.

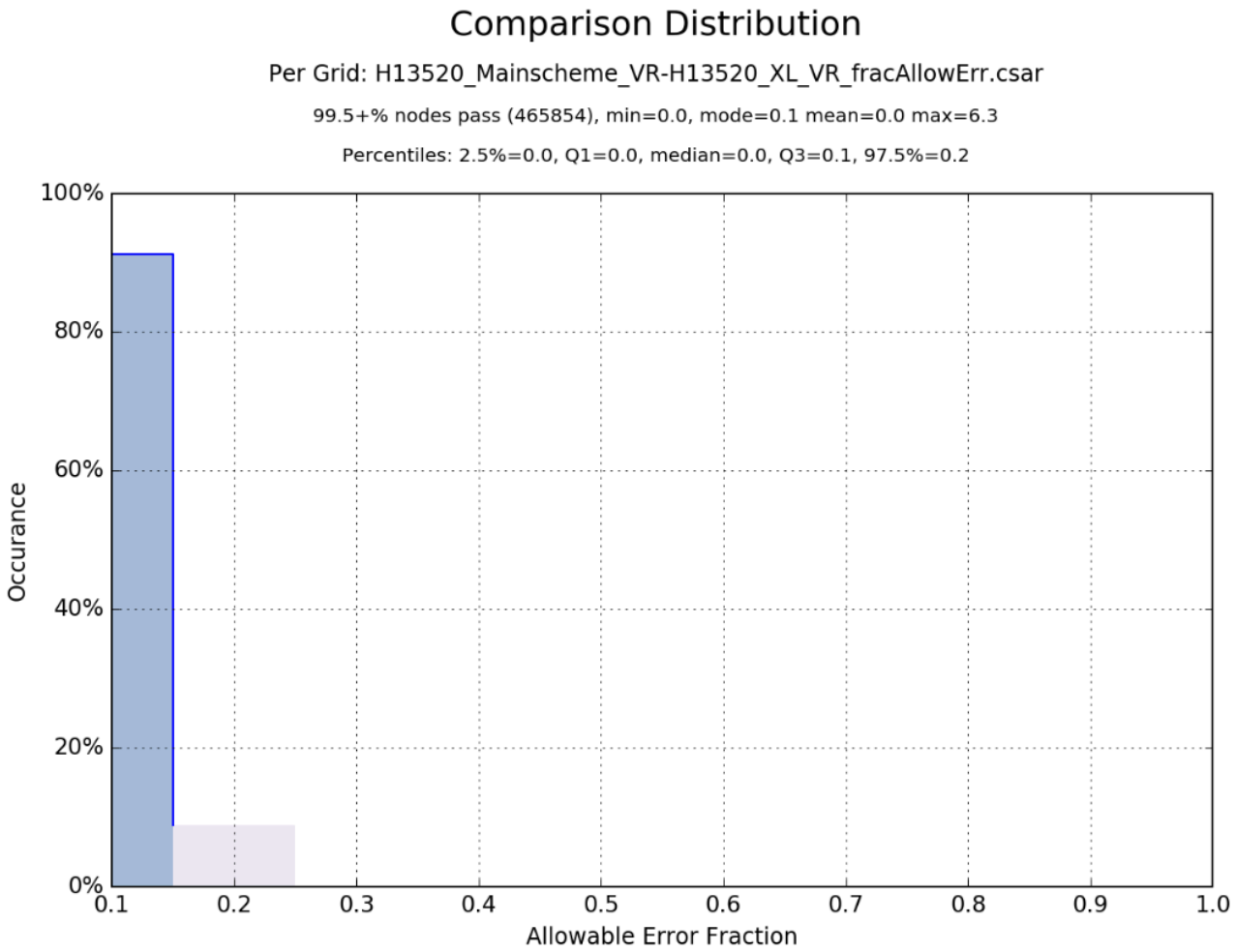


Figure 9: Pydro derived plot showing absolute difference statistics of H13520 mainscheme to crossline data.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0.0 meters	13.3 centimeters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Measured - XBT	Surface
All vessels	3.0 meters/second	NA meters/second	NA meters/second	0.05 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Total Propagated Uncertainty (TPU) values for survey H13520 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 the project instructions for NOAA vertical datum, transformation model used in the survey.

In addition to the usual 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, attitude, and vessel motion data from Applanix POS MV were applied during acquisition and initially in post-processing. We later applied POSPac SBET and RMS files 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 v5 within Hydro QC Tools was used to analyze H13520 TVU compliance. H13520 met HSSD requirements of over 99.5 % of grid nodes, which is shown in the histogram plots below.

Pydro QC Tools 2 Grid QA was used to analyze H13520 multibeam echosounder (MBES) data density. The submitted H13520 variable-resolution (VR) surface met HSSD density requirements shown in histograms below.

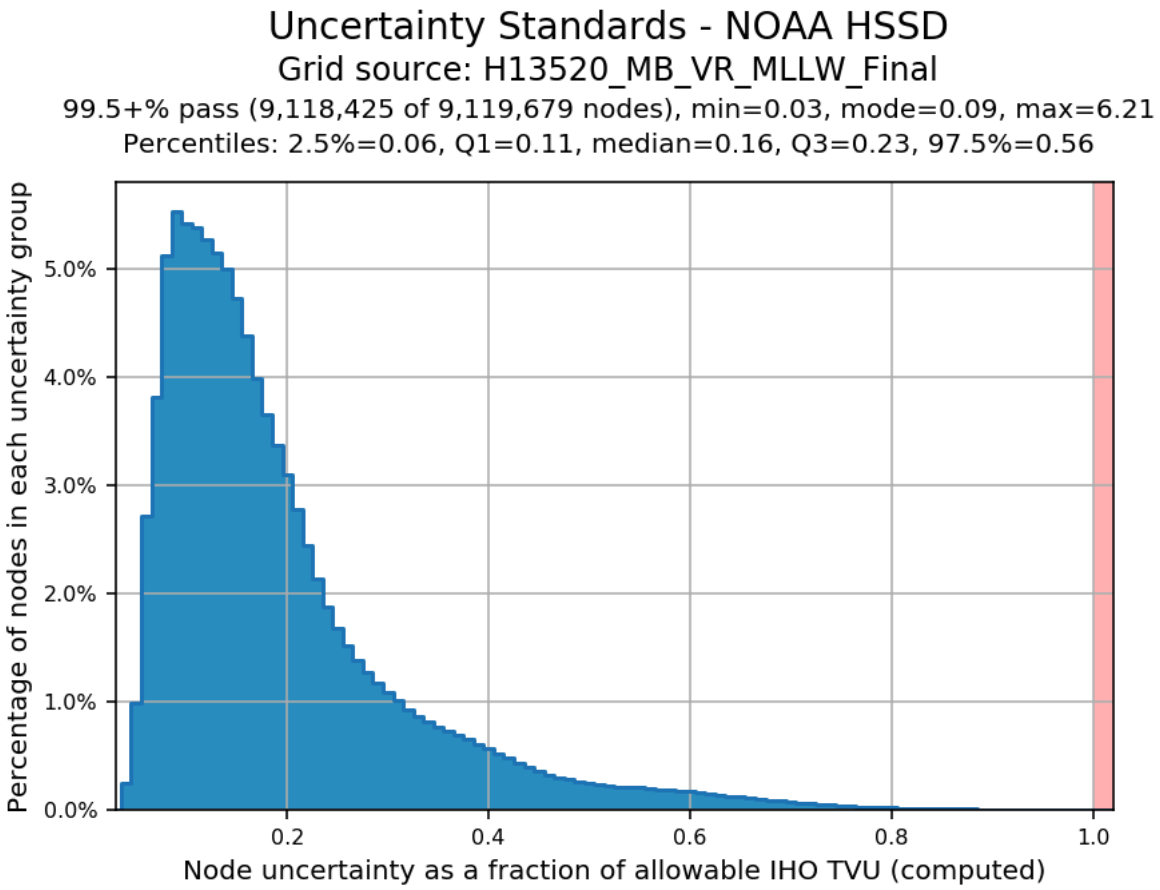


Figure 10: Pydro derived plot showing TVU compliance of H13520 finalized multi-resolution MBES data

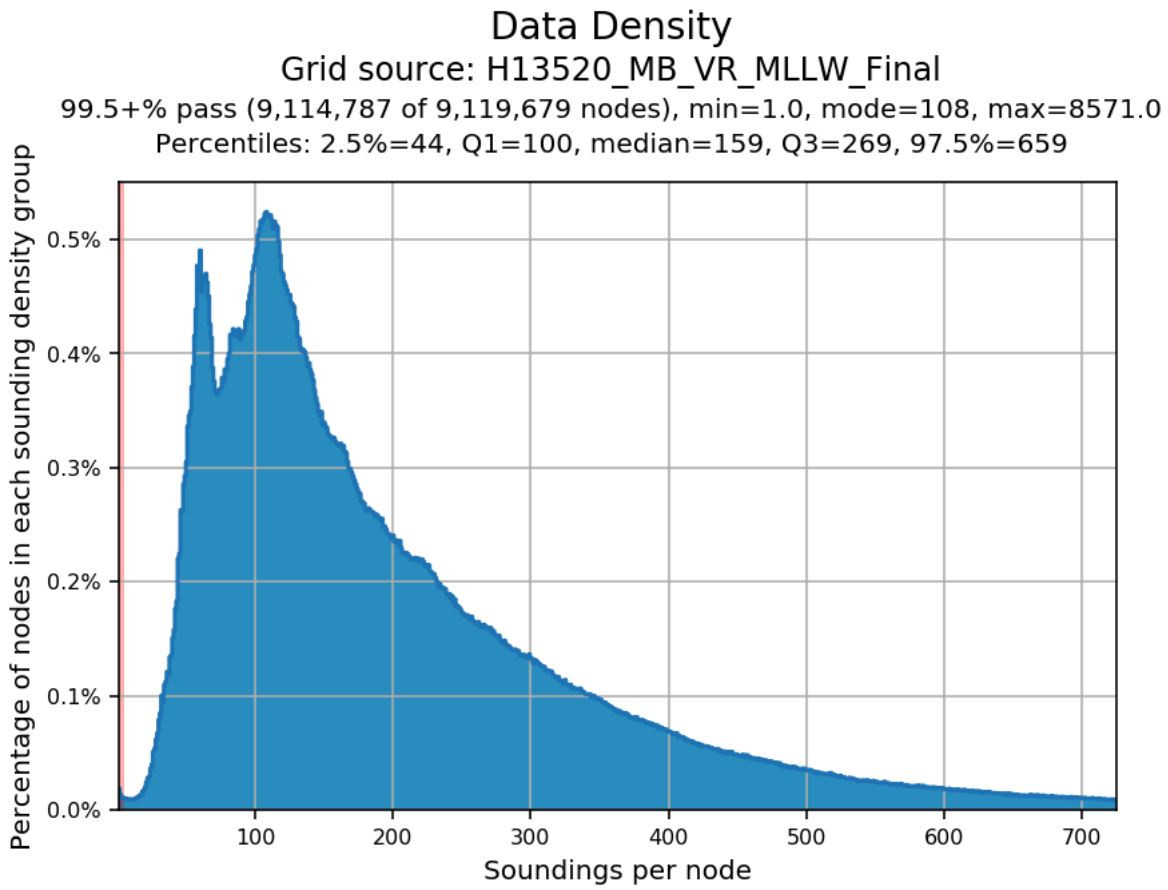


Figure 11: Pydro derived histogram plot showing HSSD density compliance of H13520 finalized variable-resolution MBES data.

B.2.3 Junctions

One junction comparison was completed between H13520 and H12623. Survey H12623 was completed by NOAA Ship RAINIER in 2014.

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
H12623	1:20000	2014	NOAA Ship Rainier	N

Table 9: Junctioning Surveys

H12623

The junction with 2014 survey H12623 encompassed approximately 0.16 square nautical miles along the northern boundary of H13520. An 8 m single-resolution surface from H13520 was compared to the 8 m resolution BAG surface from H12623. Pydro's Compare Grids results showed that 92 % of nodes in the overlapping area met NOAA allowable error standards. Junction analysis indicated a -0.35 meter average difference between the survey; although, insufficient overlap makes it difficult to determine the cause of the discrepancy.

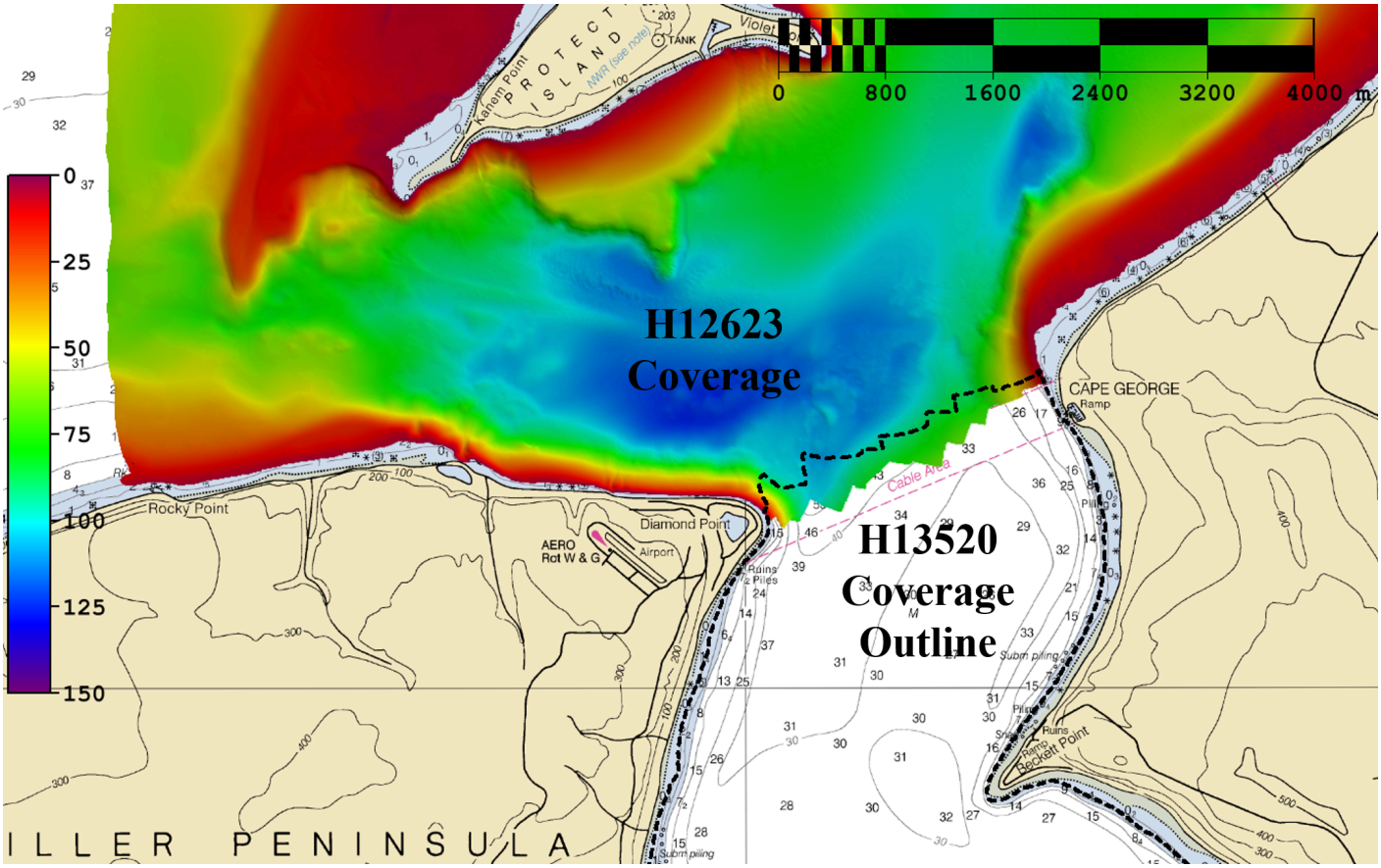
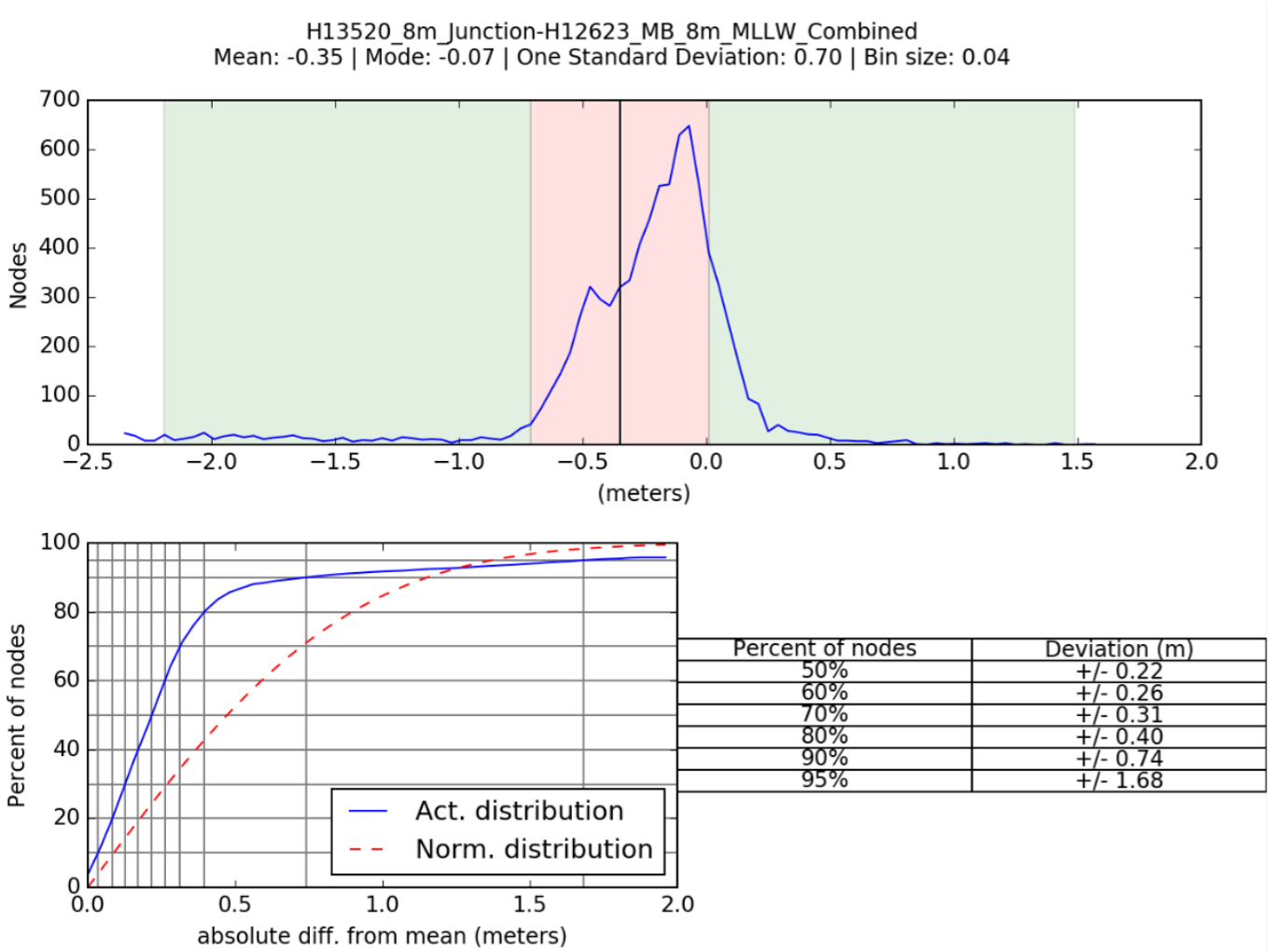


Figure 12: Junction comparison between H12623 (coverage) and H13520 (dashed line). Dashed lines represent H13520 coverage outline and colorbar indicates depths in meters.



Percent of nodes	Deviation (m)
50%	+/- 0.22
60%	+/- 0.26
70%	+/- 0.31
80%	+/- 0.40
90%	+/- 0.74
95%	+/- 1.68

Figure 13: Pydro derived plots showing percentage-pass value of the H13520 and H12623 junction comparison.

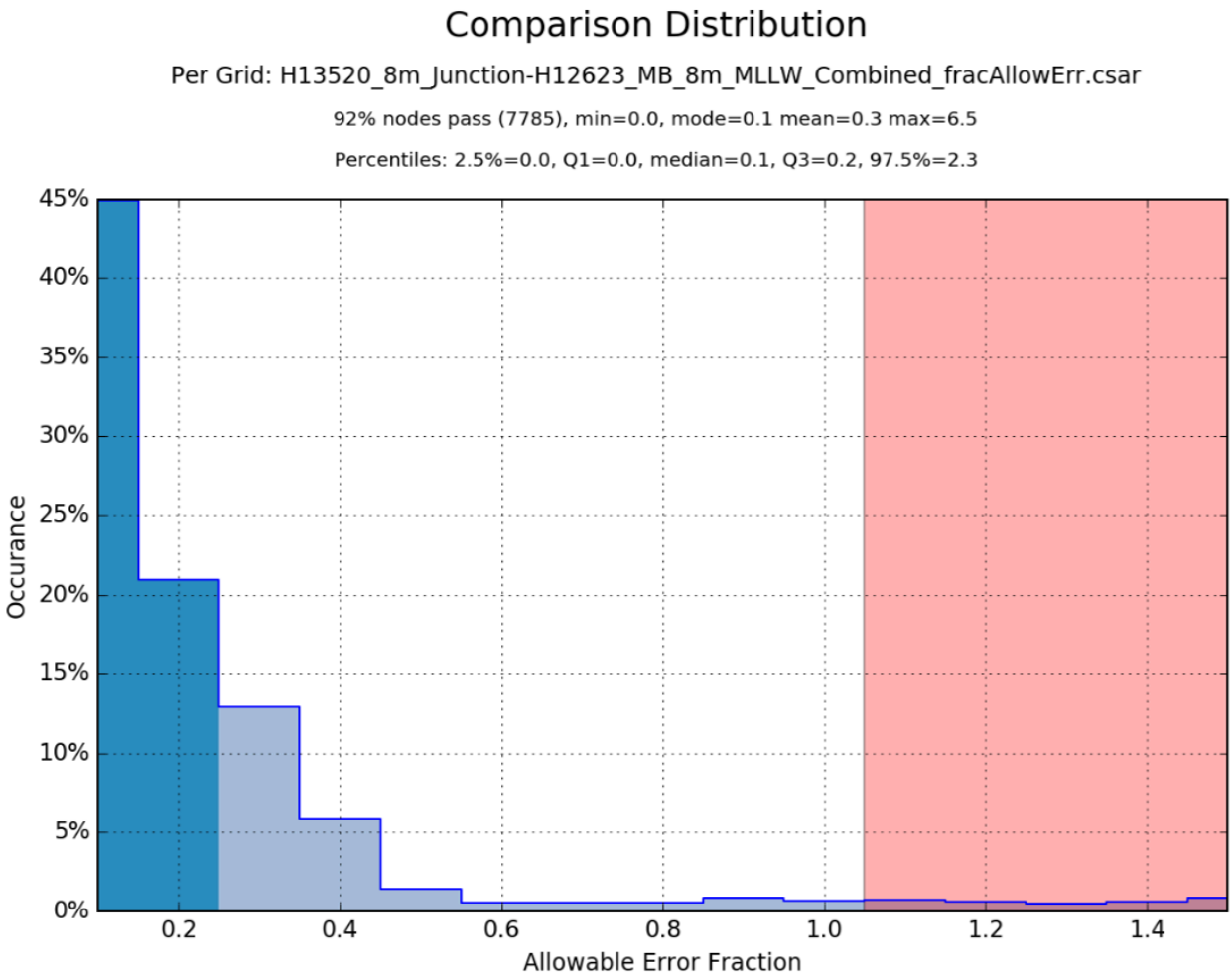


Figure 14: Pydro derived plot showing absolute difference statistics of the H13520 and H12623 junction comparison.

Given that the area of overlap is at the entrance to Discovery Bay, it is likely that the soft substrate has shifted due to tidal and current influences. The data from H13520 is adequate to supersede charted and prior survey data.

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

Seafloor Composition and Turbidity

Difficulty was encountered during acquisition by all the field units in finding the seafloor, particularly in the deep sections of H13520. Additionally, the field units would randomly "lose the seafloor" which appeared as swath gaps or "blowouts" in the collected data. The probable cause was determined to be the muddy composition of the seafloor and particulate matter floating through the water column. Field units resorted to decrease survey vessel speed and change sonar frequency.

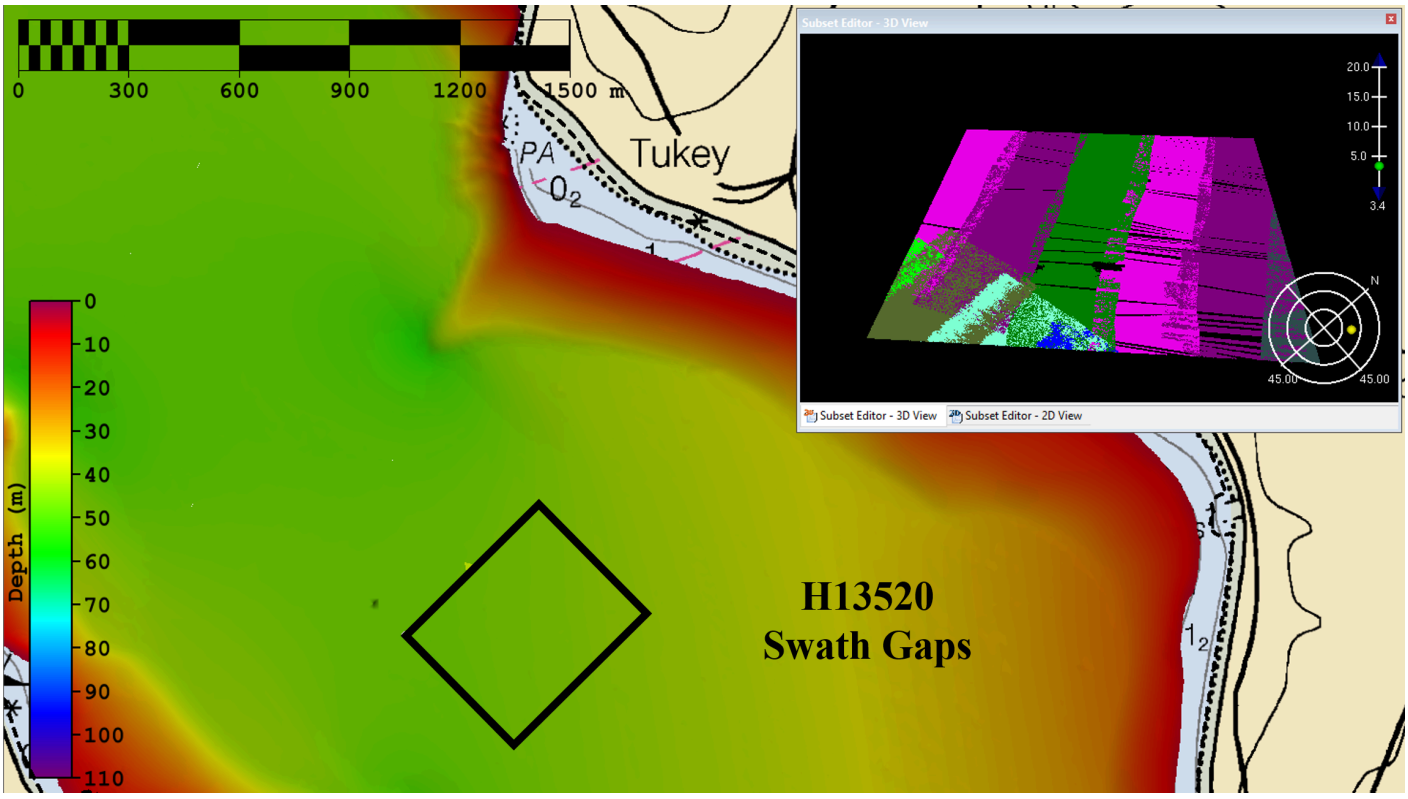


Figure 15: Example of swath gaps in the H13520 data. Colorbar indicates depth in meters and black box delineates coverages shown in subset editor.

Vegetation

Patches of noisy soundings were observed in nearshore areas during data cleaning and determined to be the effect of marine vegetation.

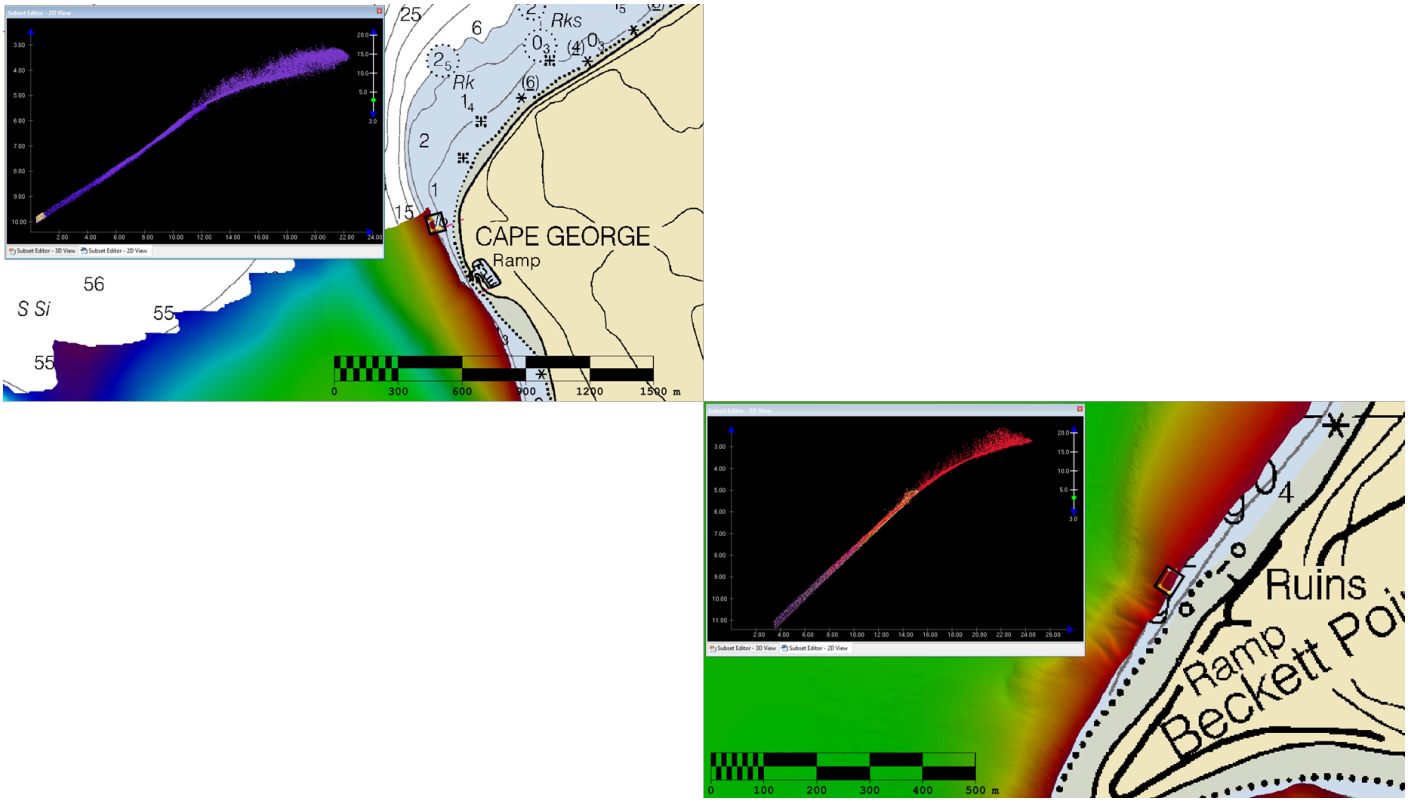


Figure 16: Example of noisy data due to presence of marine vegetation.
Black boxes delinieates the coverages shown in subset editor window.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: At least once every 4 hours or as needed.

During acquisition, 43 sound speed profiles were collected at discrete locations within the survey area at least once every four hours, when significant changes in surface sounds speed were observed, or when operating in a new region. Sound speed profiles were obtained using Sea-Bird 19plus SEACAT Profilers. All casts were concatenated into a master file and applied to MBES data using the "Nearest distance within time" (4 hours) profile selection method.

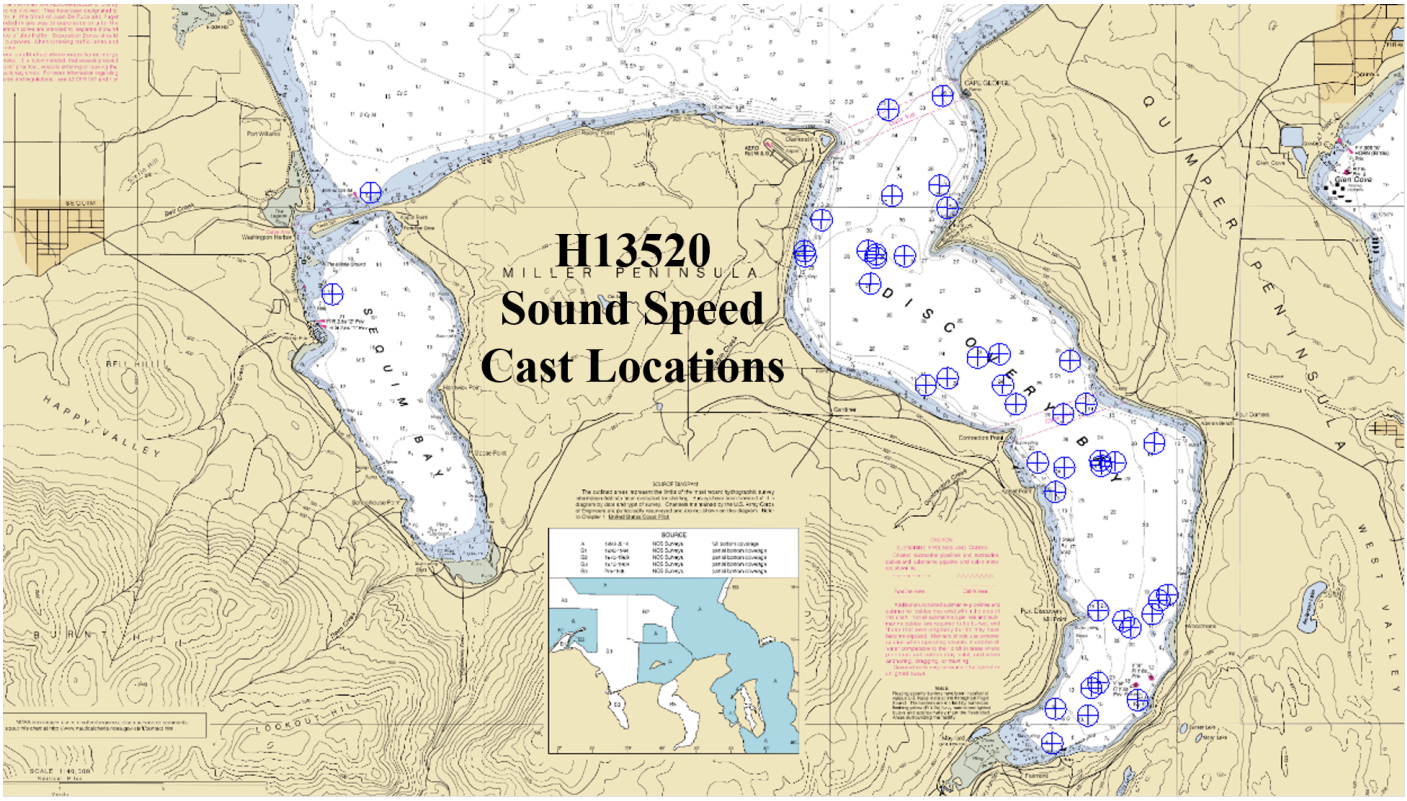


Figure 17: H13520 sounds speed cast locations.

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

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

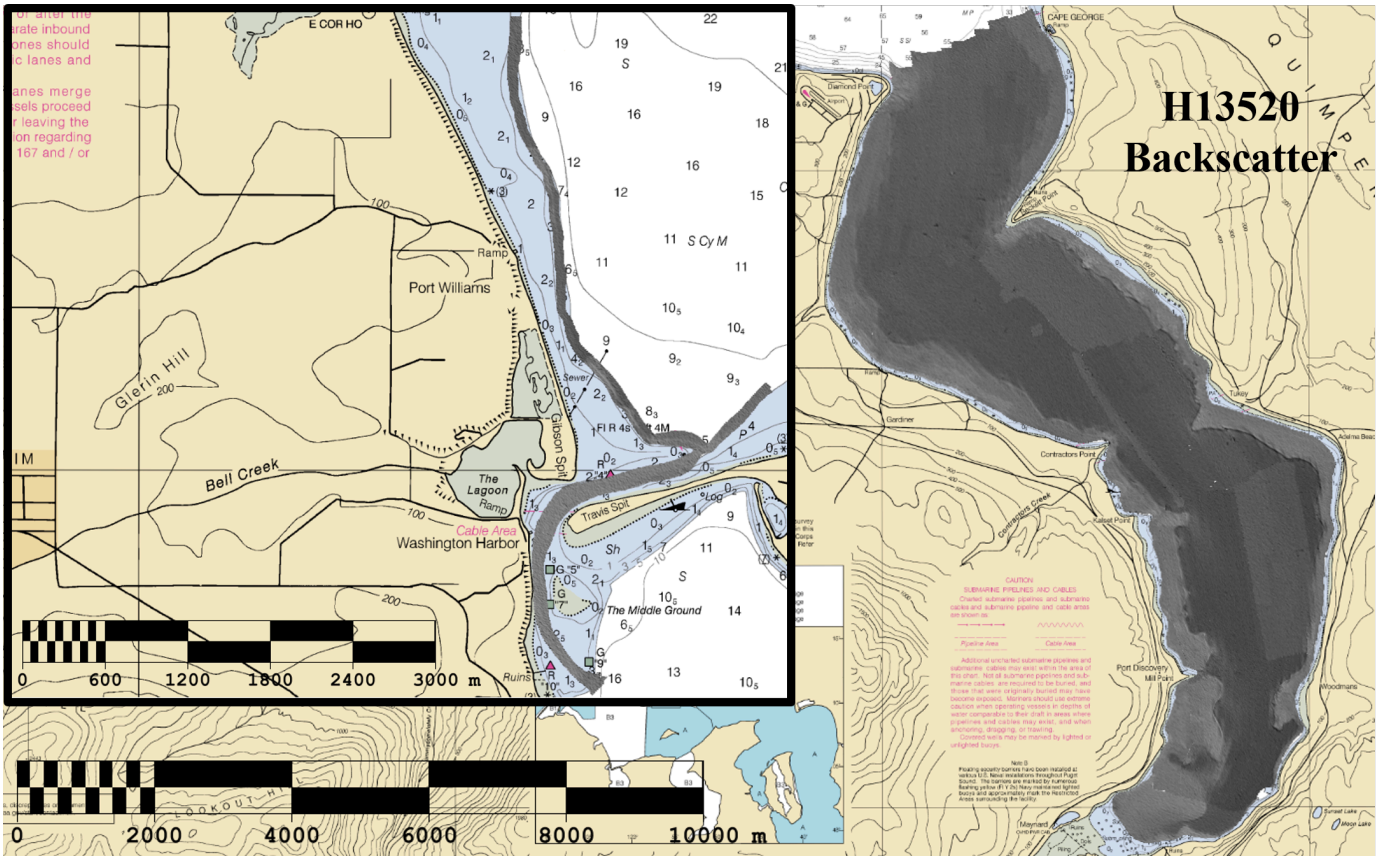


Figure 18: Overview of H13520 backscatter mosaics.

B.5 Data Processing

B.5.1 Primary 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
H13520_MB_VR_MLLW	CARIS VR Surface (CUBE)	Variable Resolution	0.78 meters - 109.92 meters	NOAA_VR	Complete MBES
H13520_MB_VR_MLLW_Final	CARIS VR Surface (CUBE)	Variable Resolution	0.78 meters - 109.92 meters	NOAA_VR	Complete MBES

Table 10: Submitted Surfaces

Submitted surfaces were generated using the recommended parameters for depth-based (Ranges) Caris variable resolution bathymetric grids specified in the 2021 HSSD.

Pydro QC Tools Detect Fliers was used with default settings to find fliers in the finalized VR surface. Obvious noise was rejected by the hydrographer in Caris Subset Editor. After the data was cleaned, a second iteration of Detect Fliers was applied and found 1 potential fliers in the Complete Coverage surface. The flier was investigated and found to be false. The results of the Detect Fliers tool are included as .000 files in the Separates section of this report.

During office review, the submitted VR grid was split into two separate grids to facilitate downstream processes and are denoted with an Xof2 naming convention.

There were was one holiday flagged in the 1of2 grid. The holiday is on a slope between the ends of two survey lines and is at approximately 5 meters depth. It was examined and there is no indication of shoaling within the data gap.

B.5.3 SBET Processing Method

Post Processed-Real Time Extended (PP-RTX) processing methods were used in Applanix POSPac MMS 8.5 software to produce SBETs for post-processing horizontal correction.

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-N305-RA-21_VDatum_100m_NAD83-MLLW_geoid12b.csar

Table 11: ERS method and SEP file

Ellipsoid referenced GNSS derived heights and an applied separation models were used to reduce soundings to chart datum.

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 10.

The following PPK methods were used for horizontal control:

- RTX

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
US5WA16M	1:40000	20	05/30/2018	03/24/2021

Table 12: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey.

D.1.3 Charted Features

Charted features exist for the survey but were discussed in the Final Feature File

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

Two charted private Discovery Bay Seafarm Lighted Buoys were investigated during acquisition. Visually confirmation of lighted buoy B (southwest bouy in figure below) was obtained (picture included in the Final Feature File) while buoy A (northeast bouy in figure below) was not seen by the field units.

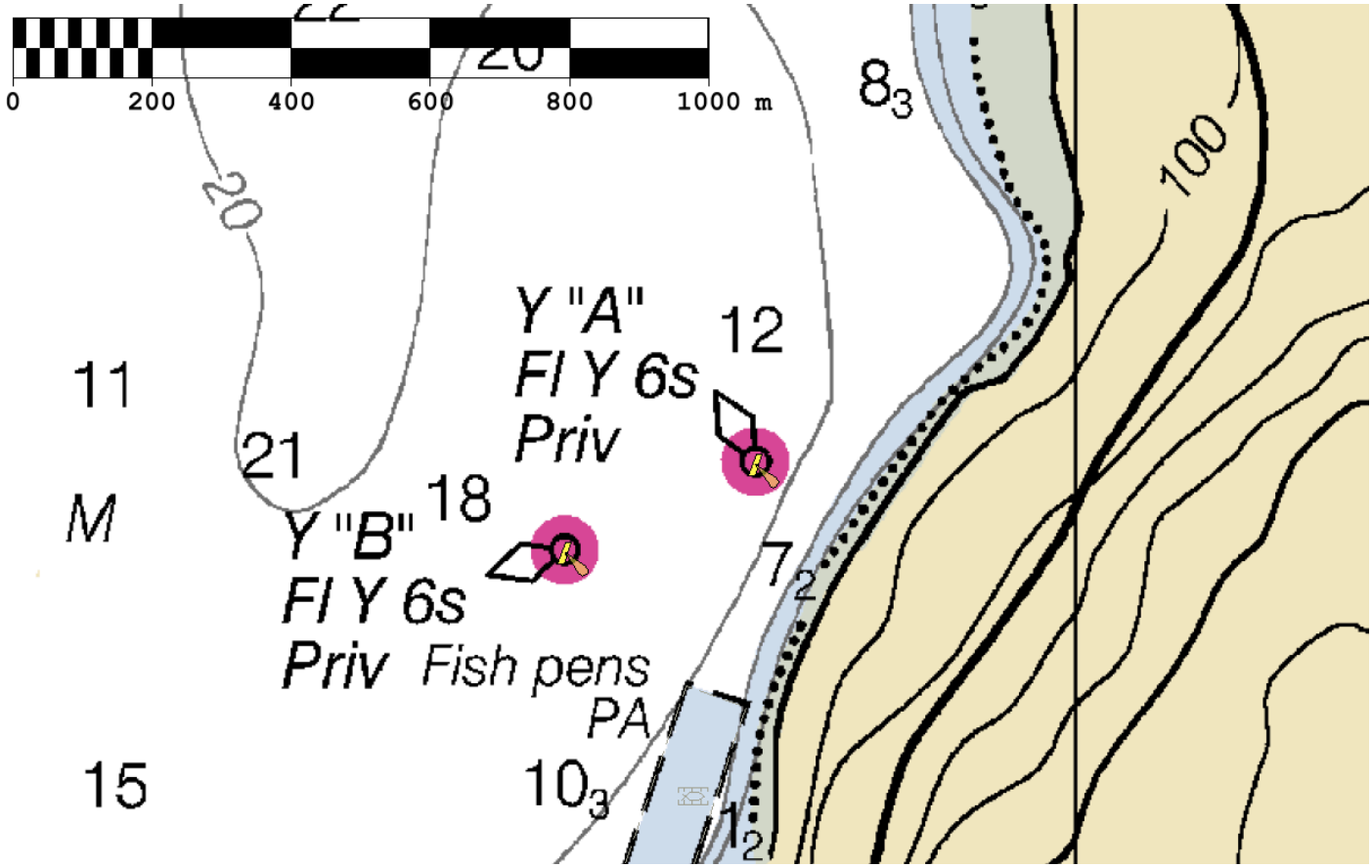


Figure 19: Charted Discovery Bay Seafarm Lighted Buoys investigated during H13520 field work.

Both Discovery Bay Seafarm Lighted Buoys are no longer listed in the USCG Light List Volume VI and they are no longer charted on the latest edition of ENC US5WA16M.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

Three bottom samples were assigned to H13520 but were unable to be collected due to muddy seabottom and faulty equipment.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

Charted submarine cable areas were not observed on the MBES data.

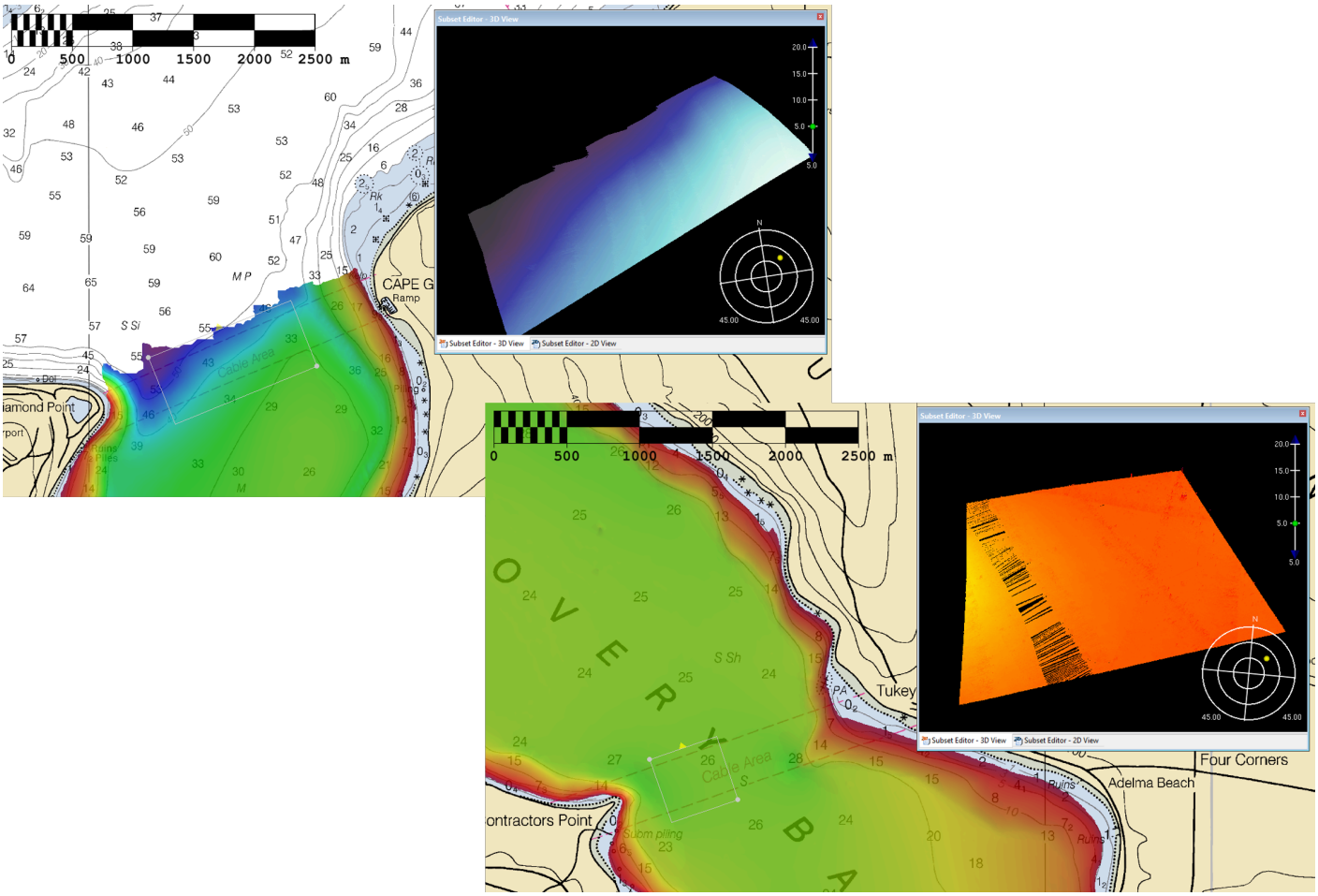


Figure 20: MBES data subset over charted cables areas.

There is also a charted cable area partial covered by the data acquired at the entrance to Sequim Bay. The data was examined and the cables were not observed in the area of coverage.

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
Olivia A. Hauser, CDR/NOAA	Chief of Party	07/01/2021	HAUSER.OLIVIA.ANN.1275636009 2021.07.01 09:55:09 -08'00'
Matthew B. Sharr, LT/NOAA	Field Operations Officer	07/01/2021	SHARR.MATTHEW.BRANDON.1503637126 2021.07.01 09:49:32 -08'00'
James B. Jacobson	Chief Survey Technician	07/01/2021	JACOBSON.JAMES.BRYAN.1269664017 I have reviewed this document 2021.07.01 13:03:59 -08'00'
Joan M. Bonilla-Pagan	Assistant Survey Technician	07/01/2021	BONILLA PAGAN.JOAN.MANUEL.1594693520 Digitally signed by BONILLA PAGAN.JOAN.MANUEL.1594693520 Date: 2021.07.01 16:38:22 -08'00'

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