

H12991

NOAA Form 76-35A

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

DESCRIPTIVE REPORT

Type of Survey: Navigable Area

Registry Number: H12991

LOCALITY

State: Washington

General Locality: Puget Sound, WA

Sub-locality: Approaches to Everett, WA

2018

CHIEF OF PARTY
David J. Zezula, CAPT/NOAA

LIBRARY & ARCHIVES

Date:

HYDROGRAPHIC TITLE SHEET

H12991

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: **Washington**

General Locality: **Puget Sound, WA**

Sub-Locality: **Approaches to Everett, WA**

Scale: **20000**

Dates of Survey: **05/09/2018 to 05/24/2018**

Instructions Dated: **05/08/2018**

Project Number: **OPR-N305-RA-18**

Field Unit: **NOAA Ship *Rainier***

Chief of Party: **David J. Zezula, 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:

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

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Descriptive Report to Accompany Survey H12991

Project: OPR-N305-RA-18

Locality: Puget Sound, WA

Sublocality: Approaches to Everett, WA

Scale: 1:20000

May 2018 - May 2018

NOAA Ship *Rainier*

Chief of Party: David J. Zezula, CAPT/NOAA

A. Area Surveyed

The survey area is referred to as H12991, "Approaches to Everett, WA" (sheet 1) within the Project Instructions. The area encompasses approximately 38 square nautical miles west of Port of Everett surrounding Gedney Island where Possession Sound, Saratoga Pass, and Port Susan meet.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
48° 5' 4" N 122° 25' 47.57" W	47° 56' 38.65" N 122° 12' 51.85" W

Table 1: Survey Limits

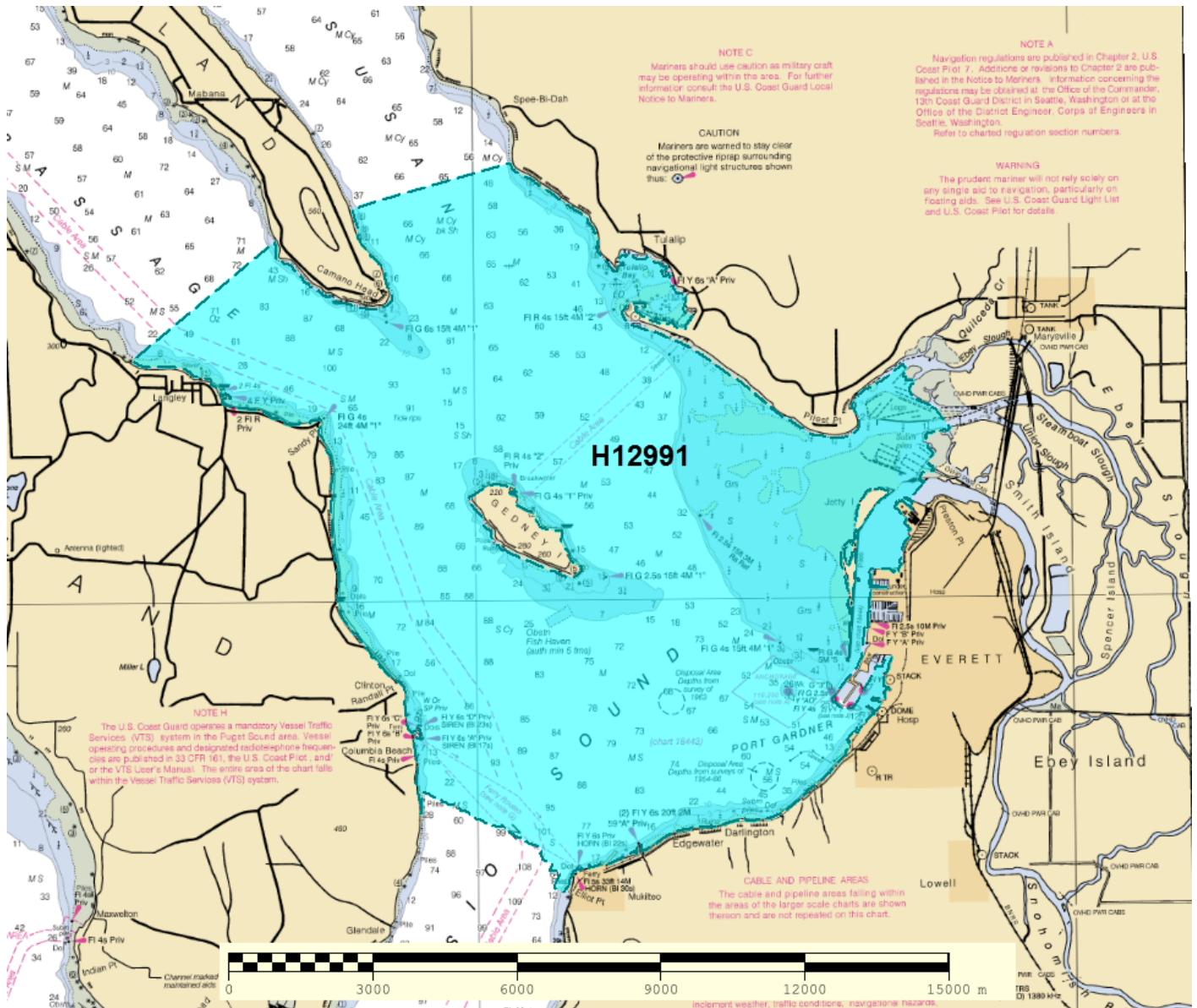


Figure 1: H12991 assigned survey area (Chart 18441).

Data were acquired within the assigned survey limits as required in the Project Instructions and HSSD.

A.2 Survey Purpose

The primary purpose of this survey is to provide contemporary data for updating National Ocean Service nautical charts and products in an area which is critical to the nation's economy.

The Port of Everett, Washington has experienced an increase in vessel traffic and vessel capacity. The project area includes The Port of Everett which supports the aviation supply chain to Boeing as well as Naval Station Everett, home port to Navy destroyers and US Coast Guard cutters.

The new bathymetric data will also support military traffic transiting to and from Bangor Naval Submarine Base, the Washington State Ferries' Mukilteo/Clinton ferry route, tug/barge, commercial/tribal fishing and recreational boating in the area.

Survey data from this project is intended to supersede all prior survey data.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

Pydro QC Tools 2 Grid QA was used to analyzed H12991 multibeam echosounder (MBES) data density. The submitted H12991 variable resolution (VR) complete coverage and object detection surfaces met HSSD density requirements (Figures 2 and 3).

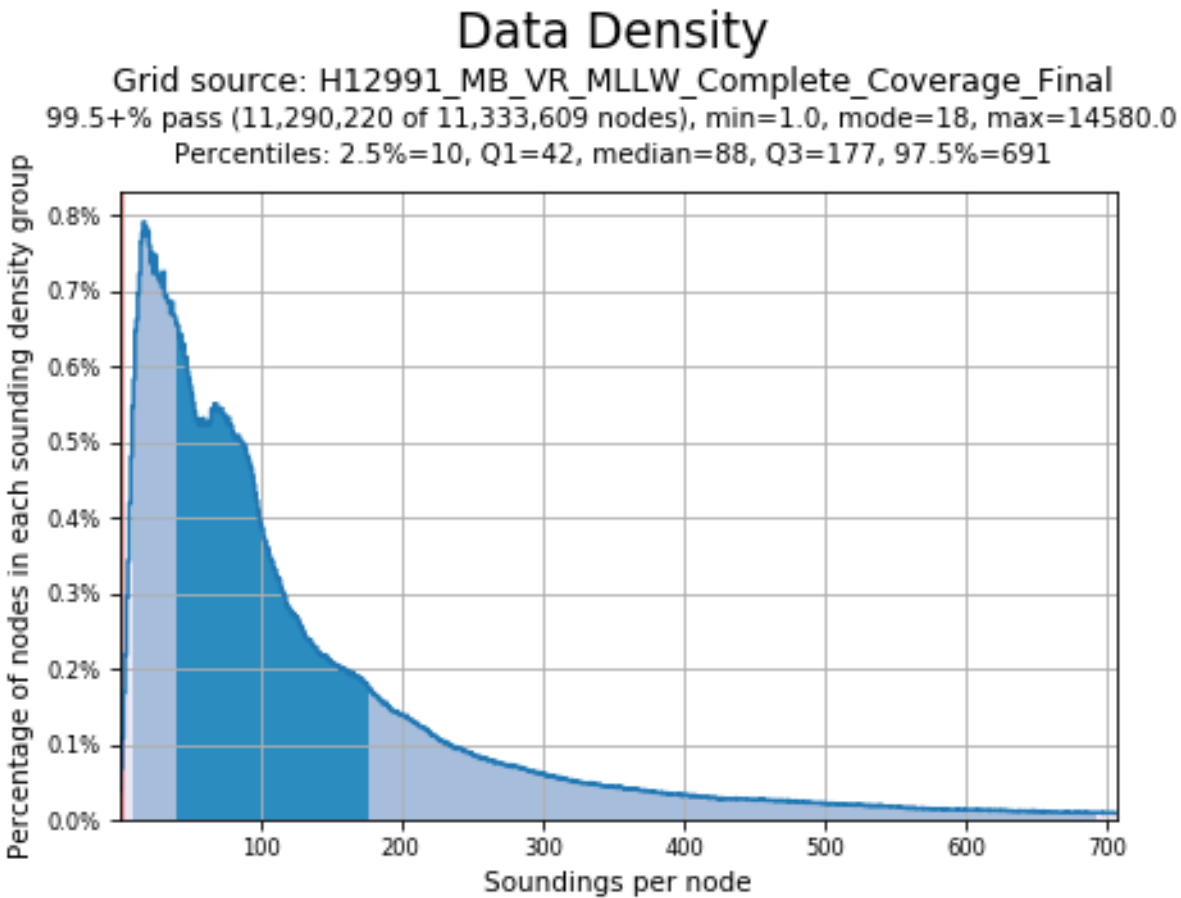


Figure 2: Pydro derived plot showing HSSD density compliance of H12991 complete coverage area's finalized variable resolution MBES data.

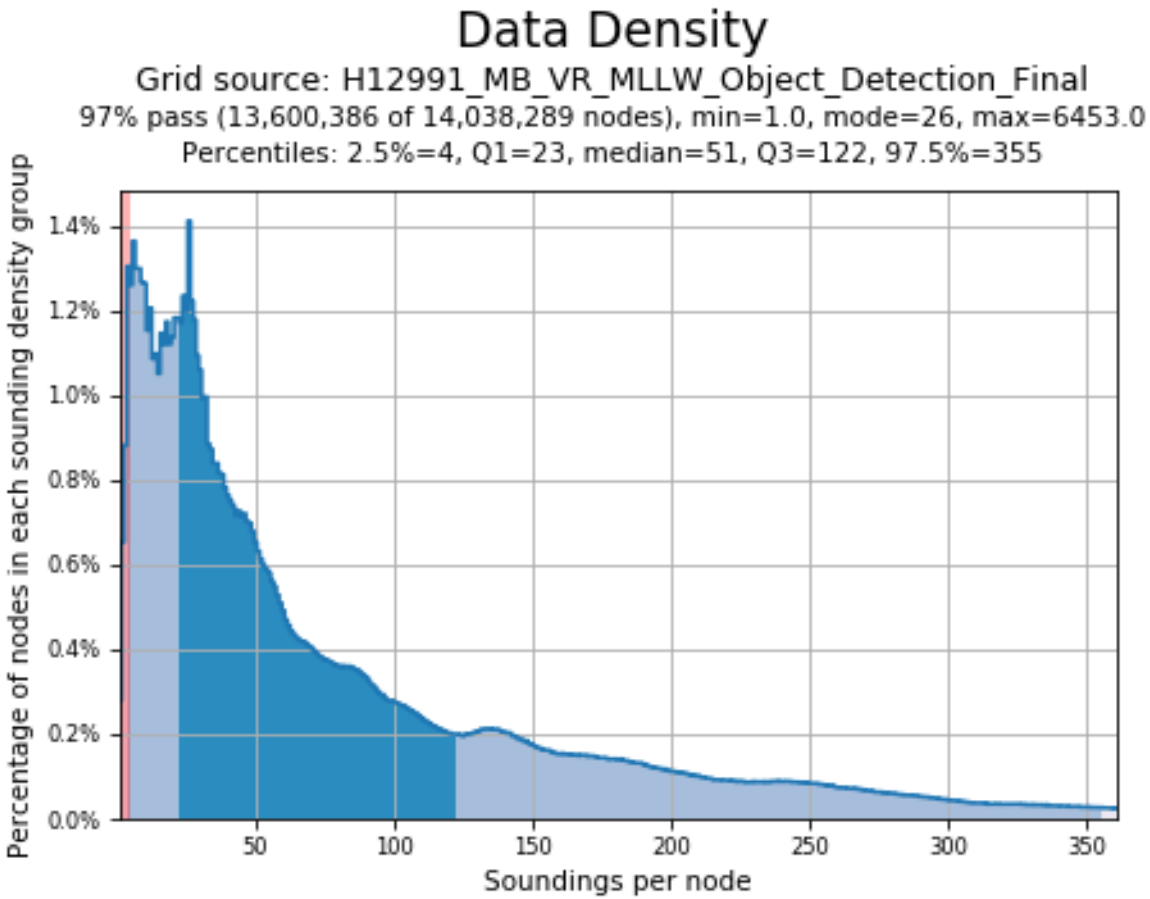


Figure 3: Pydro derived plot showing HSSD density compliance of H12991 object detection area's finalized variable resolution MBES data.

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 within ENC US5WA51M Boundary	Object Detection Coverage (refer to HSSD Section 5.2.2.2)
All other waters in survey area	Complete Coverage (refer to HSSD Section 5.2.2.3)

Table 2: Survey Coverage

Complete multibeam echosounder (MBES) coverage was acquired to the inshore limit of hydrography, the 3.5-meter Navigable Area Limit Line (NALL). Areas where survey coverage did not meet the NALL or the assigned sheet limits was due to the survey vessel reaching the inshore extent of safe navigation as shown

in Figure 5. These areas are characterized as being very near shore and subject to hazards such as shoals and rocks.

Pydro QC Tools 2 v2.7.1 Holiday Finder v4 was run on a finalized object detection surface and found 94 holidays. These were investigated and several are primarily caused by cleaned out piles and piers (Figure 6). The majority are the result of the VR surface's gridding methods; they occur in a 0.5 meter resolution square that is deeper than 20 meters because of the slope of the seafloor and are there not valid holidays (Figure 7).

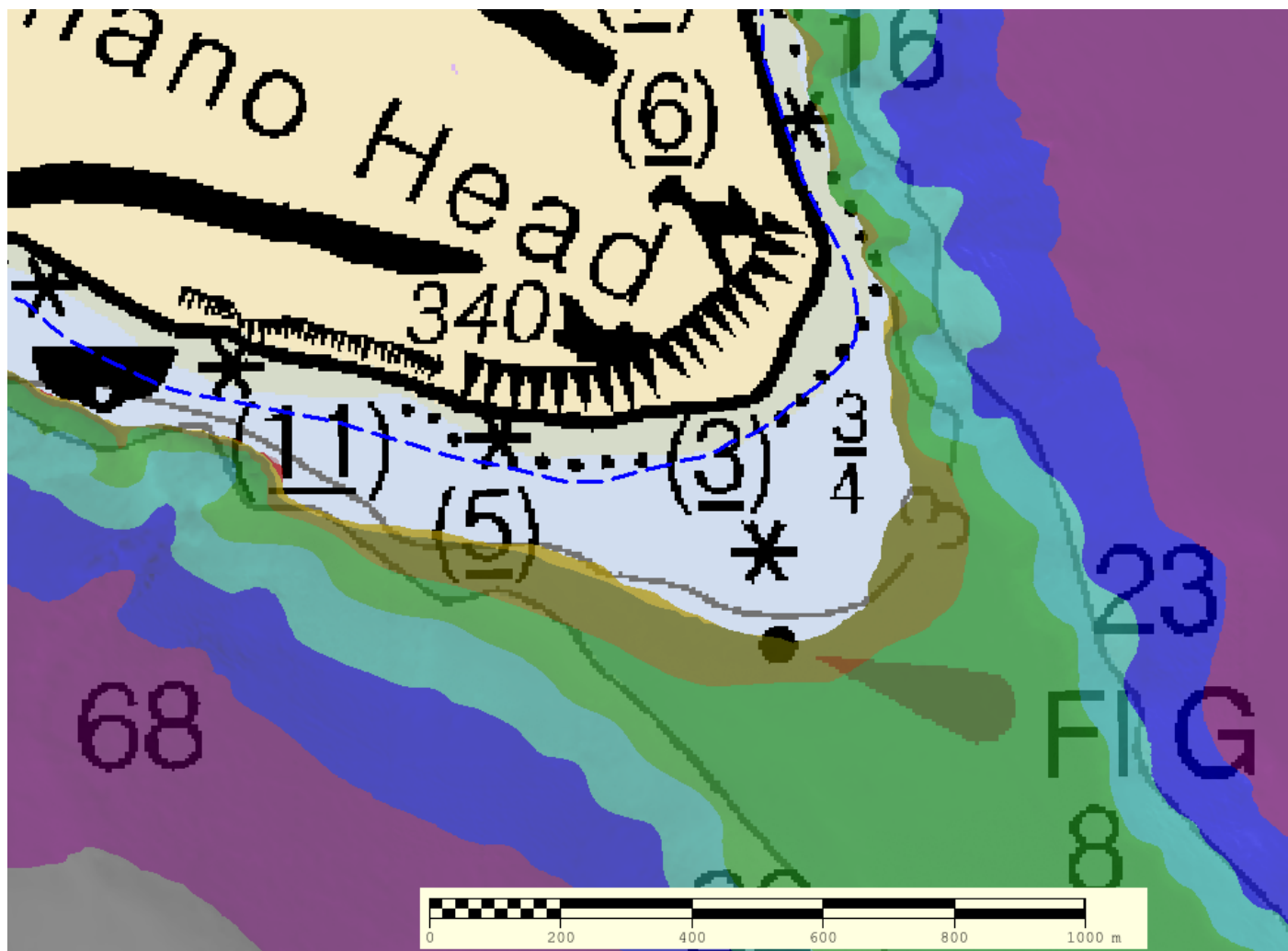


Figure 4: Example of Navigable Area Limit Line (NALL) determination southeast of Camano Head; the blue dashed line indicates assigned sheet limits and yellow coverage indicates where the 3.5 meter contour was reached.

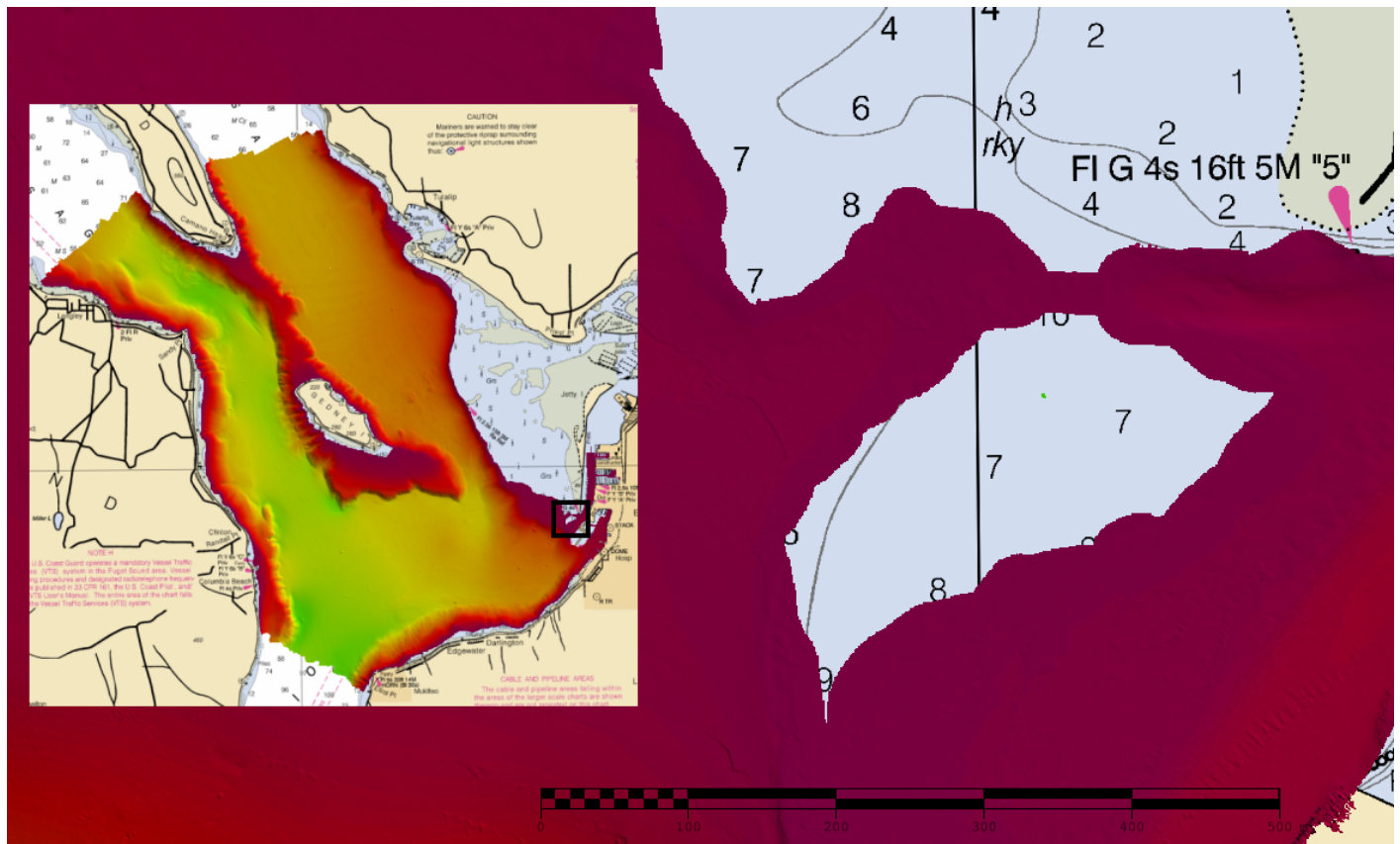


Figure 5: Holiday was created attempting to reach the 3.5 meter NALL surrounding a mud flat. Field unit did not have the necessary equipment to obtain shoalest sounding within the mud flat. The shoalest sounding recorded around the holiday is 2.5 meters.

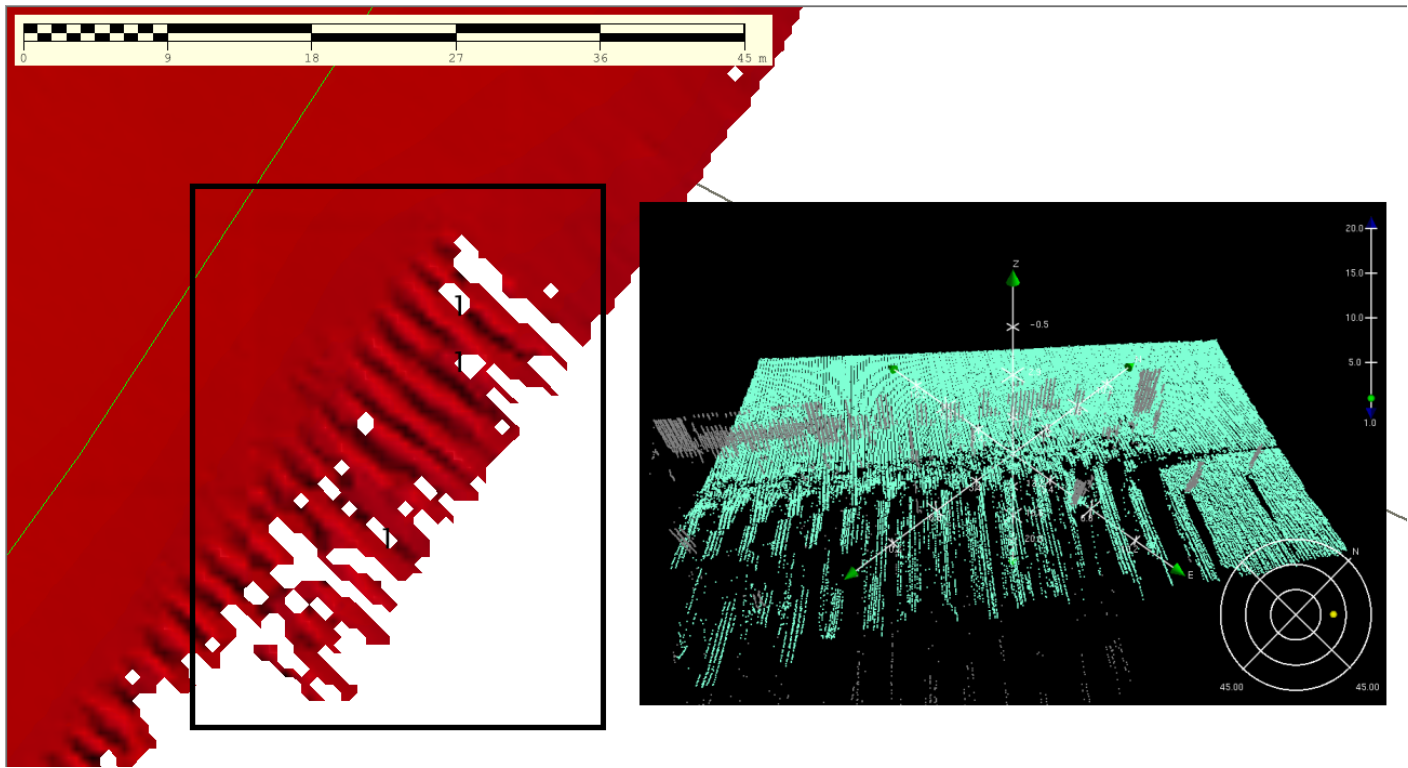


Figure 6: Example of holidays resulting from cleaned out pilings and pier supports in the object detection area.

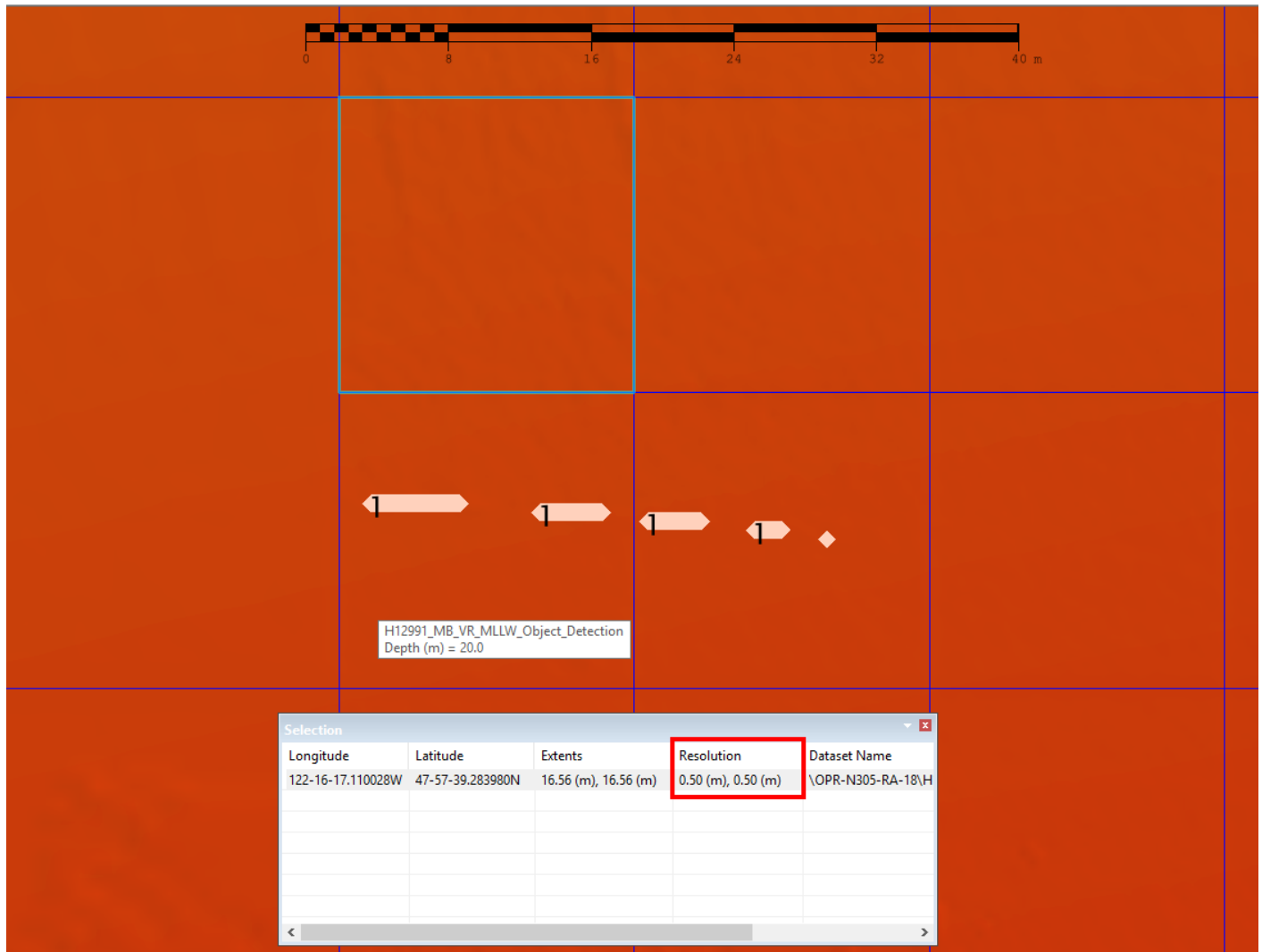


Figure 7: Example of holiday flagged in the 0.5 meter resolution grid of the finalized Variable resolution object detection surface.

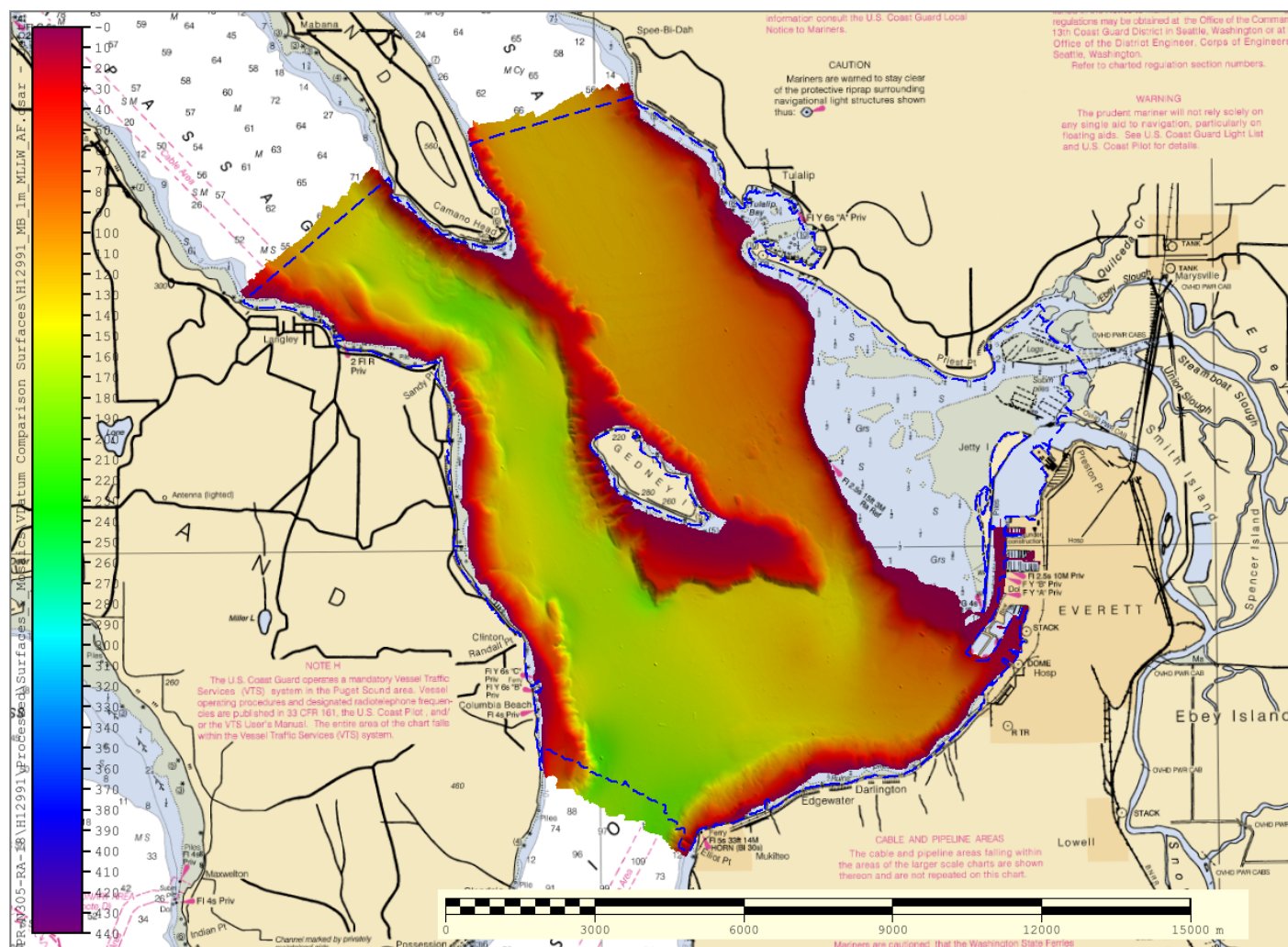


Figure 8: H12991 MBES coverage and assigned survey limits (Chart 18441).

A.5 Survey Statistics

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

	HULL ID	<i>2801</i>	<i>2802</i>	<i>2803</i>	<i>Total</i>
LNM	SBES Mainscheme	0	0	0	0
	MBES Mainscheme	220.82	176.37	90.87	488.06
	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	30.30	0	0	30.3
	Lidar Crosslines	0	0	0	0
Number of Bottom Samples					10
Number Maritime Boundary Points Investigated					0
Number of DPs					41
Number of Items Investigated by Dive Ops					0
Total SNM					31.30

Table 3: Hydrographic Survey Statistics

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

Survey Dates	Day of the Year
05/09/2018	129
05/10/2018	130

Survey Dates	Day of the Year
05/11/2018	131
05/12/2018	132
05/13/2018	133
05/14/2018	134
05/15/2018	135
05/16/2018	136
05/17/2018	137
05/18/2018	138
05/20/2018	140
05/21/2018	141
05/22/2018	142
05/23/2018	143
05/24/2018	144

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	2701
LOA	8.8 meters	8.8 meters	8.8 meters	8.2 meters
Draft	1.1 meters	1.1 meters	1.1 meters	0.5 meters

Table 5: Vessels Used



Figure 9: NOAA Ship Rainier survey launch 2801 (RA-4).



Figure 10: NOAA Ship Rainier survey launch 2701 (RA-2).

All data for H12991 were acquired by NOAA Ship RAINIER survey launches 2801, 2802, and 2803. The vessels acquired depth soundings, backscatter, and sound speed profiles. Shoreline verification was conducted from RAINIER launch 2701 (RA-2).

B.1.2 Equipment

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

Manufacturer	Model	Type
Applanix	POS M/V v5	Positioning and Attitude System
Kongsberg Maritime	EM2040	MBES
Reson	SVP 70	Sound Speed System
Sea-Bird Electronics	SBE 19plus	Conductivity, Temperature, and Depth Sensor

Table 6: Major Systems Used

B.2 Quality Control

B.2.1 Crosslines

Multibeam/single beam echo sounder/side scan sonar crosslines acquired for this survey totaled 6.21% of mainscheme acquisition.

RAINIER launch 2801 (RA-4) acquired 30.3 nautical miles of multibeam crosslines. H12991 crossline data is adequate for verifying and evaluating the internal consistency of survey data. The Compare Grids function in Pydro Explorer analyzed separate finalized variable resolution surfaces of H12991 crossline only data and mainscheme only data for the complete coverage and object detection areas. In the complete coverage difference surface, 99.5% of nodes met IHO allowable Total Vertical Uncertainty (TVU) standards. In the object detection difference surface, 100% of nodes met IHO allowable Total Vertical Uncertainty (TVU) standards. Figures 11-17 provide additional results.

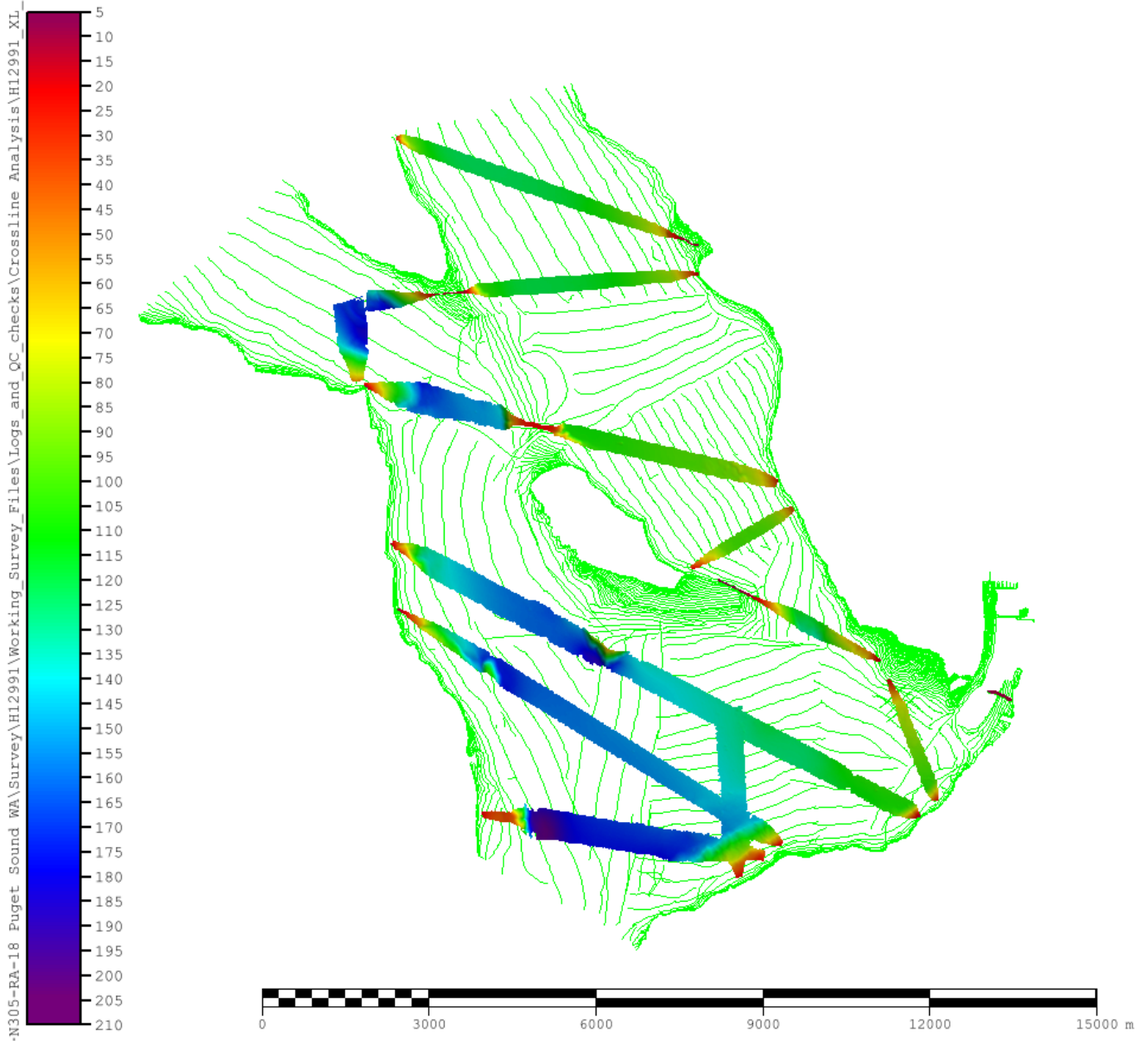


Figure 11: H12991 crossline surface overlaid on mainscheme tracklines.

Comparison Distribution

Per Grid: H12991_MS_diff_XL_VR_Complete_Coverage_fracAllowErr.csar

99.5+% nodes pass (422692), min=0.0, mode=0.1 mean=0.1 max=4.1

Percentiles: 2.5%=0.0, Q1=0.0, median=0.1, Q3=0.1, 97.5%=0.4

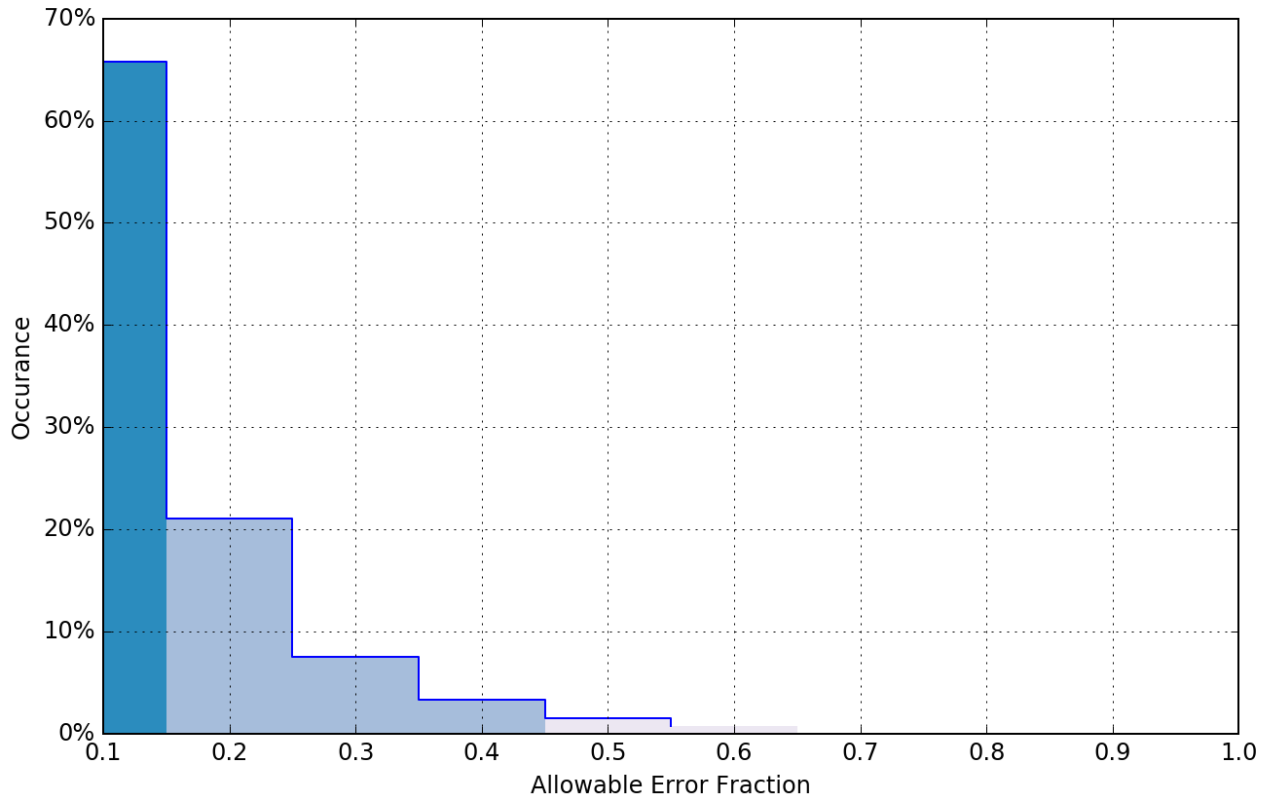


Figure 12: Pydro derived plot showing percentage-pass value of H12991 complete coverage mainscheme to crossline data.

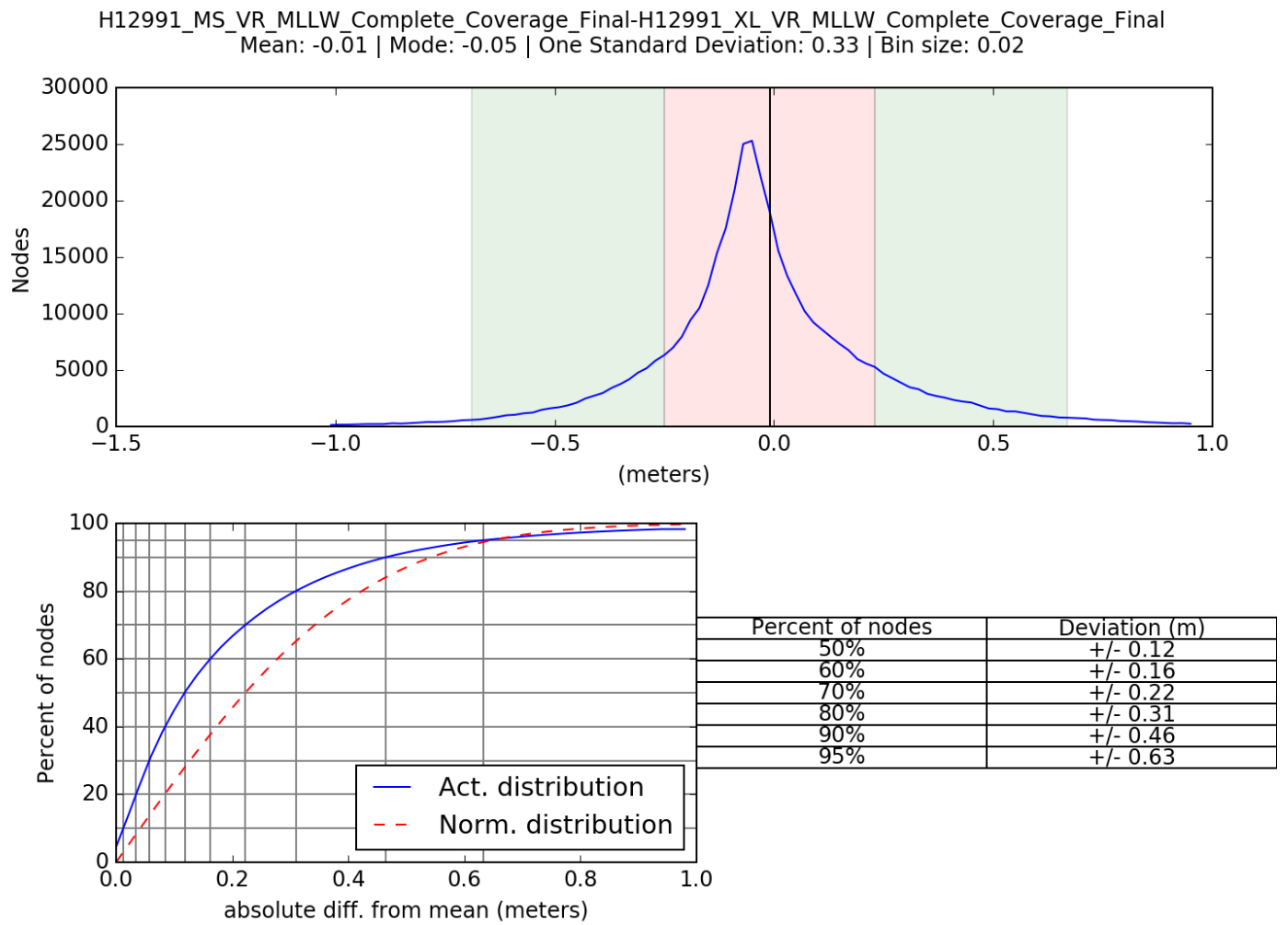


Figure 13: Pydro derived plot showing absolute difference statics of H12991 complete coverage mainscheme to crossline data.

Node Depth vs. Allowable Error Fraction

H12991_MS_diff_XL_VR_Complete_Coverage_fracAllowErr.csar, total comparisons 423272

Failed Stats [-inf,-1): min=-3.6, 2.5%=-2.6, Q1=-1.4, mean=-1.3, median=-1.2, Q3=-1.1, 97.5%=-1.0, max=-1.0

Failed Stats (+1,+inf): min=1.0, 2.5%=1.0, Q1=1.1, median=1.2, mean=1.4, Q3=1.5, 97.5%=2.6, max=4.1

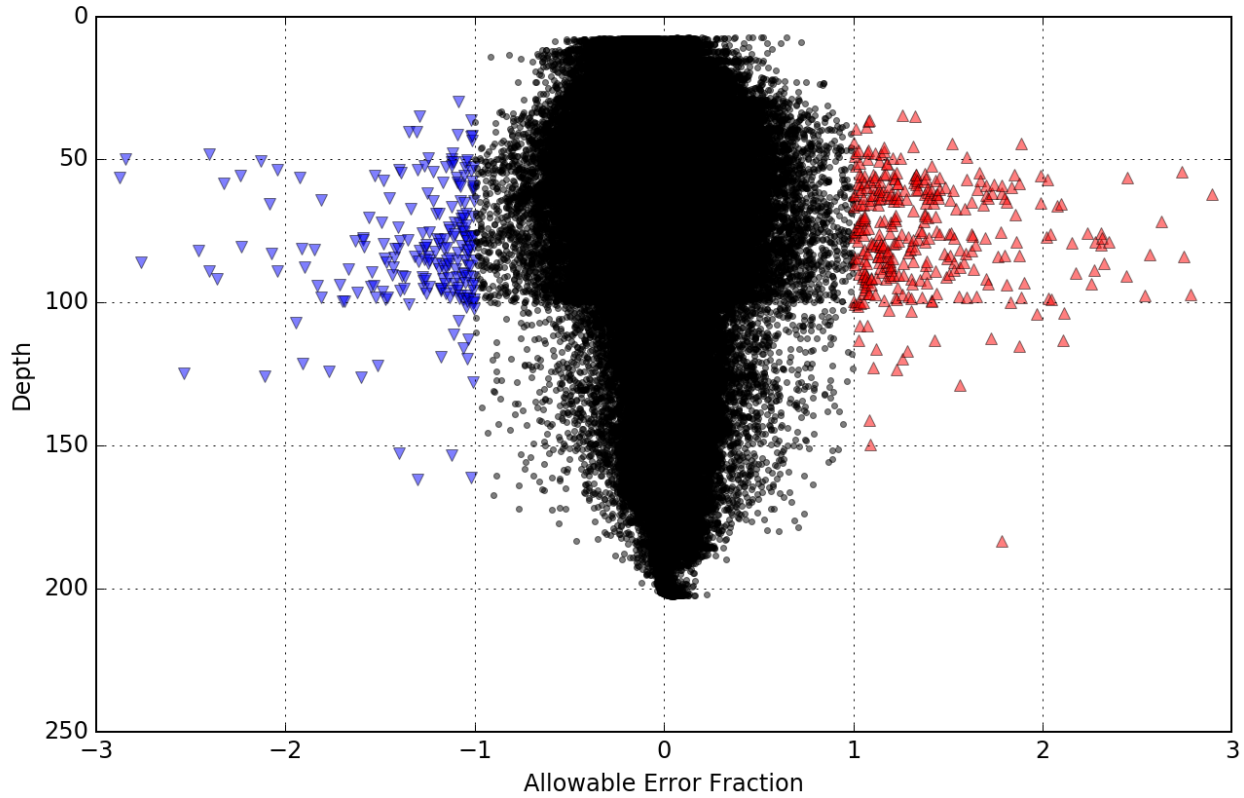


Figure 14: Pydro derived plot showing node depth vs. allowable error fraction of H12991 complete coverage mainscheme to crossline data.

Comparison Distribution

Per Grid: H12991_MS_diff_XL_VR_Object_Detection_fracAllowErr.csar

100% nodes pass (3836), min=0.0, mode=0.1 mean=0.1 max=0.5

Percentiles: 2.5%=0.0, Q1=0.0, median=0.0, Q3=0.1, 97.5%=0.2

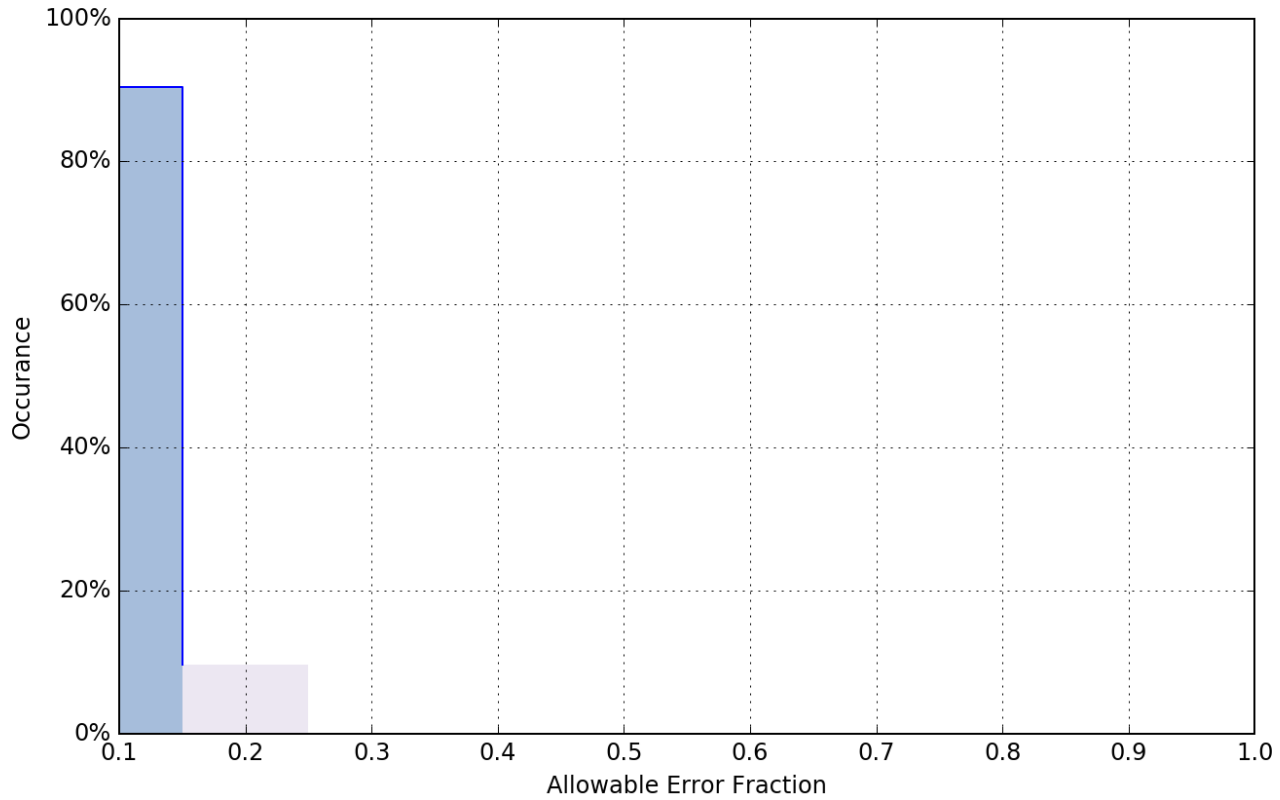
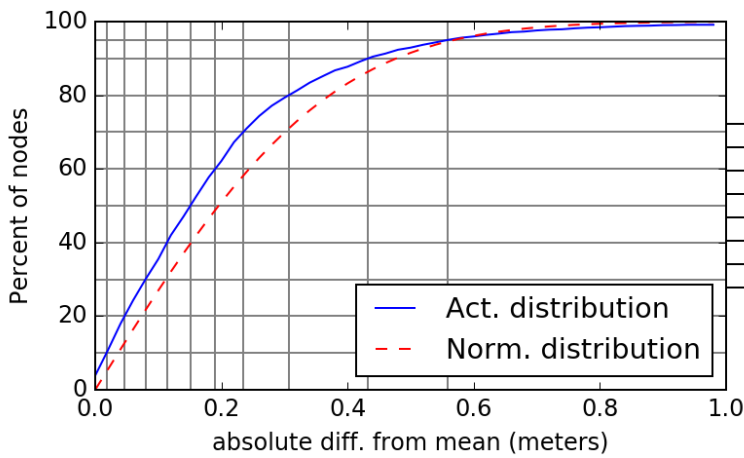
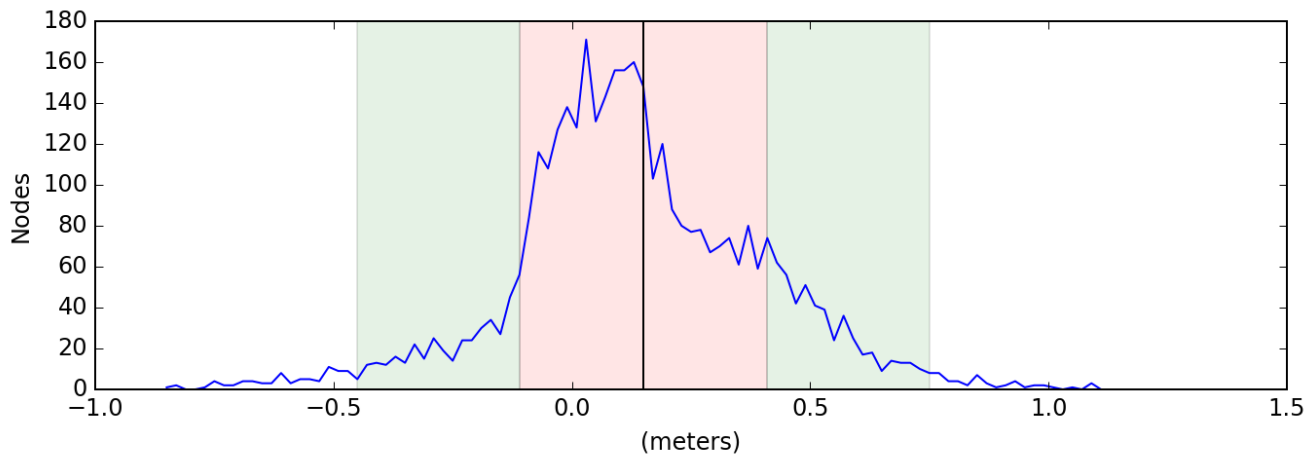


Figure 15: Pydro derived plot showing percentage-pass value of H12991 object detection mainscheme to crossline data.

H12991_MS_VR_MLLW_Object_Detection_Final-H12991_XL_VR_MLLW_Complete_Coverage_Final
 Mean: 0.15 | Mode: 0.03 | One Standard Deviation: 0.29 | Bin size: 0.02



Percent of nodes	Deviation (m)
50%	+/- 0.15
60%	+/- 0.19
70%	+/- 0.23
80%	+/- 0.31
90%	+/- 0.43
95%	+/- 0.56

Figure 16: Pydro derived plot showing absolute difference statistics of H12991 object detection mainscheme to crossline data.

Node Depth vs. Allowable Error Fraction

H12991_MS_diff_XL_VR_Object_Detection_fracAllowErr.csar, total comparisons 3836

Failed Stats [-inf,-1): N/A

Failed Stats (+1,+inf): N/A

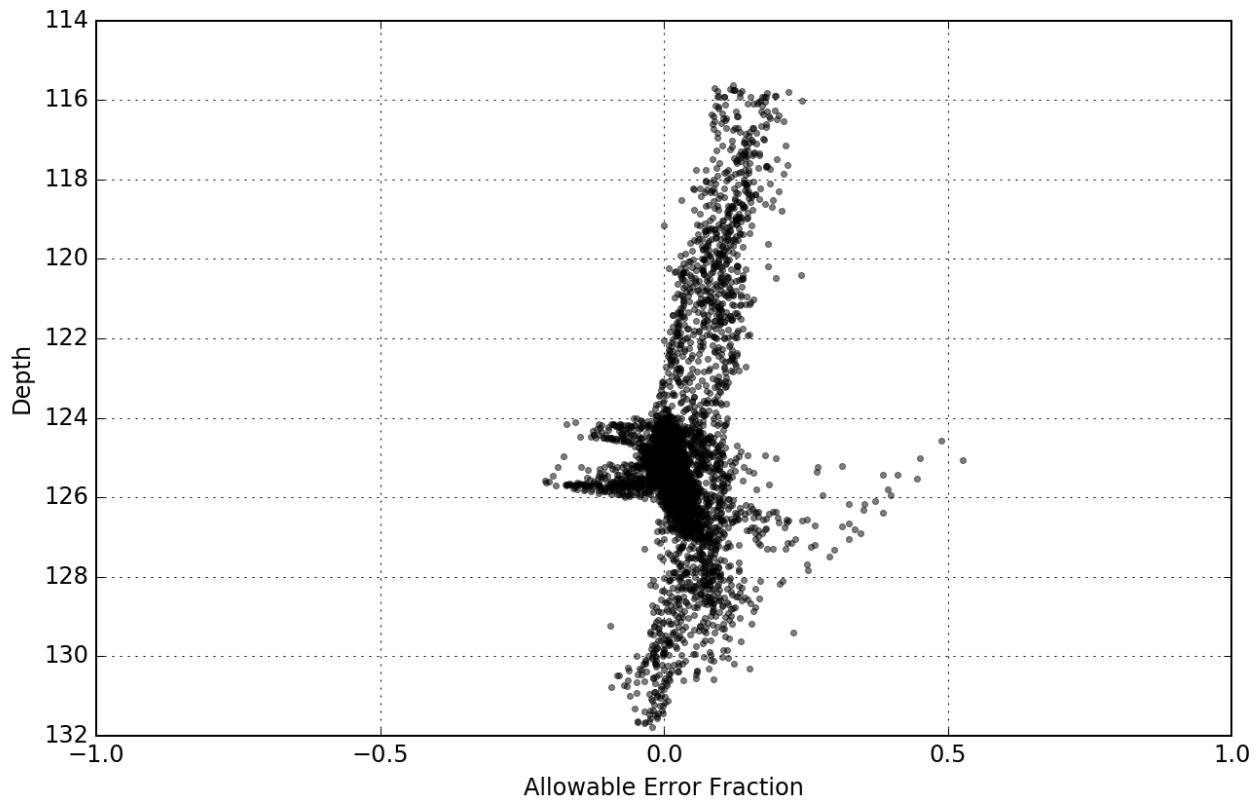


Figure 17: Pydro derived plot showing node depth vs. allowable error fraction of H12991 object detection mainscheme to crossline data.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0 meters	0.135731 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Surface
2801, 2802, 2803	3 meters/second	N/A meters/second	0.05 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

Total Propagated Uncertainty (TPU) values for survey H12991 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 zoning uncertainty of 0.135731 meters was provided in the Project Instructions as part of VDatum. See the 2018 DAPR for further information.

In addition to the usually a priori estimates of uncertainty, some real-time and post-processing uncertainty sources were also incorporated into the depth estimates of this survey. Real-time uncertainties from Kongsberg MBES sonars were recorded and applied in post-processing. Applanix TrueHeave (POS) files, which record estimates of heave uncertainty, were applied during post-processing. Finally, the post-processed uncertainties associated with vessel roll, pitch, yaw, and position were applied in Caris HIPS using SBET and RMS files generated using POSpac MMS software.

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 Pydro QC Tools 2 was used to analyze H12991 TVU compliance (Figures 18 and 19).

Uncertainty Standards

Grid source: H12991_MB_VR_MLLW_Complete_Coverage_Final
99.5+% pass (11,310,830 of 11,333,609 nodes), min=0.03, mode=0.11, max=5.76
Percentiles: 2.5%=0.06, Q1=0.13, median=0.21, Q3=0.33, 97.5%=0.65

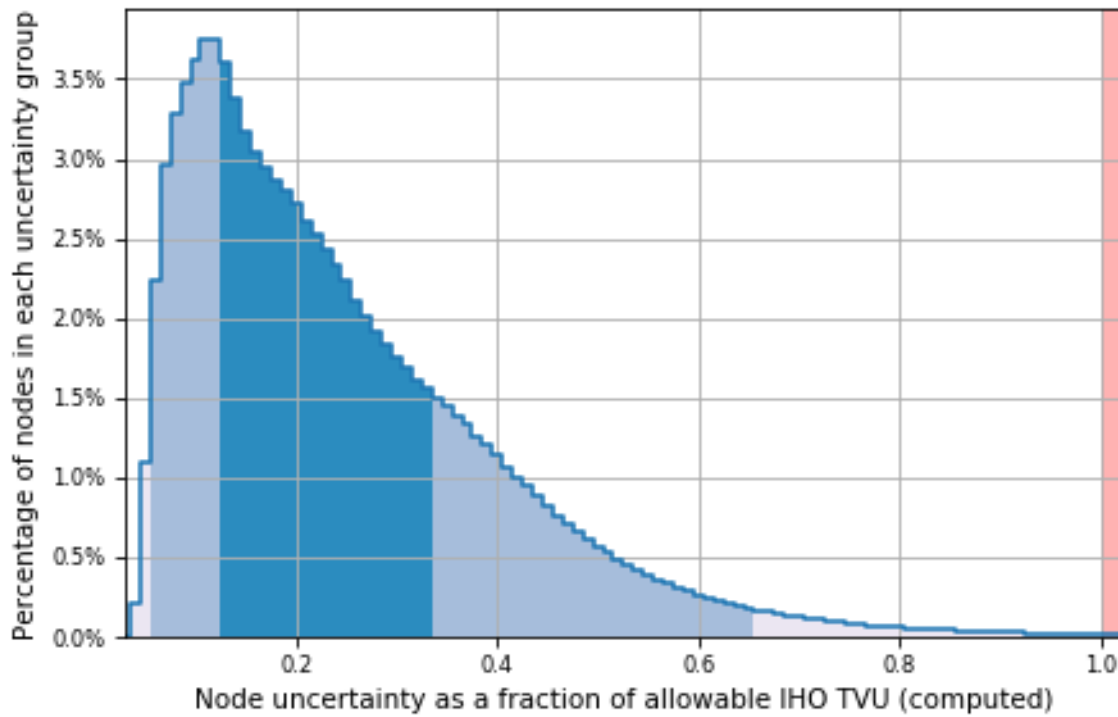


Figure 18: Pydro derived plot showing TVU compliance of H12991 finalized variable-resolution complete coverage MBES data.

Uncertainty Standards

Grid source: H12991_MB_VR_MLLW_Object_Detection_Final
 99.5+% pass (14,011,190 of 14,038,289 nodes), min=0.02, mode=0.07, max=10.82
 Percentiles: 2.5%=0.04, Q1=0.08, median=0.12, Q3=0.21, 97.5%=0.52

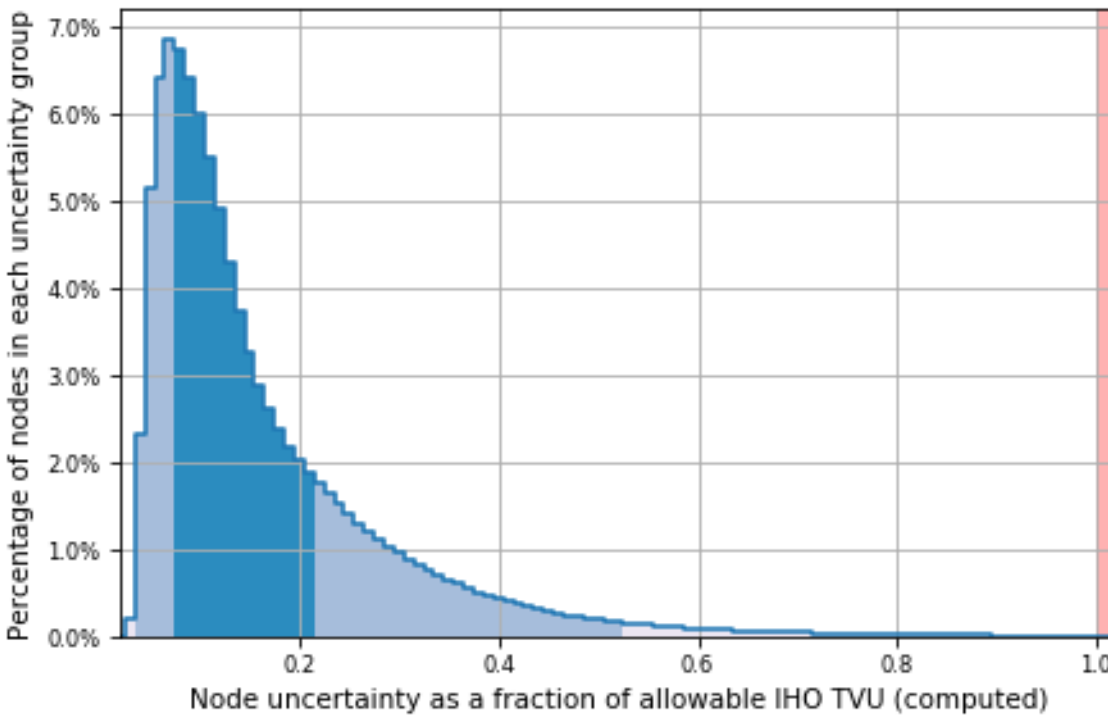


Figure 19: Pydro derived plot showing TVU compliance of H12991 finalized variable-resolution object detection MBES data.

B.2.3 Junctions

There are no junctions for survey H12991.

There are no contemporary surveys that junction with this survey.

The junction assignments in the Project Instructions require H12991 to be compared with prior survey H12563 (NOAA Ship FAIRWEATHER, 2013). This junction was completed during survey review, with over 99% of nodes passing their depth comparison compliance check.

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: Launches took casts at least once every four hours (before MBES acquisition, middle of the day, and near the end of the day).

Additional casts were taken when significant changes to surface sound speed were observed or when operating in a new area. Sound speed profiles were acquired using Sea-Bird 19plus SEACAT Profilers. All casts were concatenated into a master file and applied to MBES data in Caris HIPS using the "Nearest in distance within time " (4 hours) profile selection method.

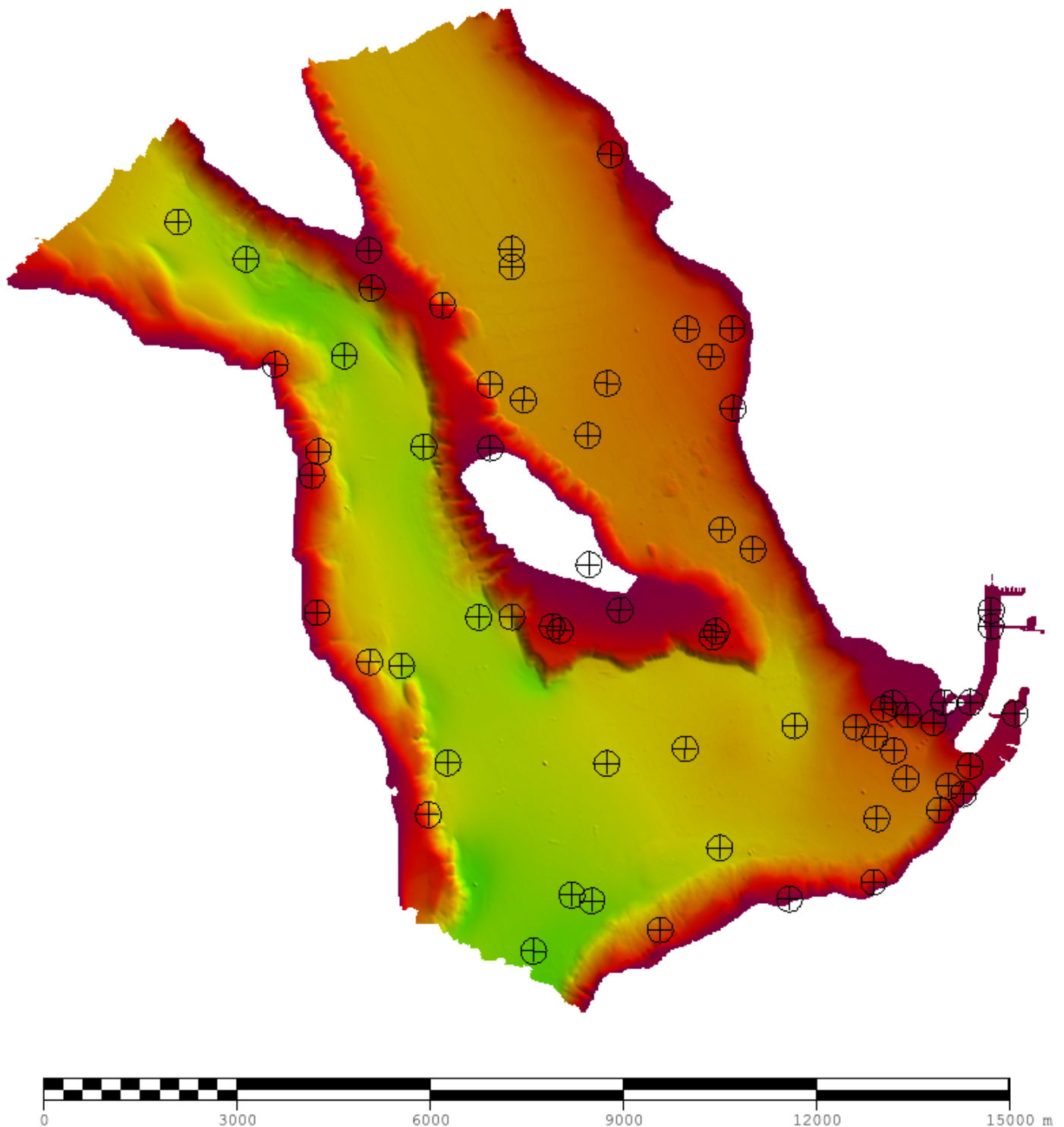


Figure 20: H12991 sound speed cast locations.

Sound speed correctors in the Entrance to Settling Basin exceed error budgets for both sound velocity ($0.3\text{m} + 0.5\%$ of depth = 3.5m) as well as the total error budget for the depths (total error budget = 0.52m). The area was closely reviewed and it was determined that there are no significant features whose depths

are put into question as a result of these errors. These errors occur from the opening of Entrance to Settling Basin (47-58-53.362N, 122-14-04.527W) to the area of Anthony's Lighthouse at (47-59-42.829N, 122-13-22.845W).

B.2.8 Coverage Equipment and Methods

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

B.2.9 Detect Fliers

Pydro QC Tools 2 v2.7.1 Detect Fliers v7 was used to find fliers in separate complete coverage and object detection finalized VR surfaces. Detect Fliers parameters included Gaussian Curvature, Adjacent Cells, Edge Slivers, and Isolated Nodes. Flier heights were not restricted. Obvious noise was rejected by the hydrography in Caris subset editor. After data cleaning, Detect Fliers was run again and found 2 fliers in the object detection surface; these were investigated and found to be false positives. The results of the Detect Fliers tool are included as .000 files in the Separates section of this report.

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 logged as .all files for delivery to NOAA's Pacific Hydrographic Branch. The field unit processed the backscatter data and generated backscatter mosaics. One mosaic per vessel per frequency was generated for H12991. To create the mosaics, processed HDCS lines were paired with the raw .all files in Fledermaus Geocoder Toolbox version 7.8.1.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following Feature Object Catalog was used: NOAA Extended Attribute File V_5_7.

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
H12991_MB_VR_MLLW_Complete_Coverage	CARIS VR Surface (CUBE)	Variable Resolution	0.3 meters - 202.6 meters	NOAA_VR	Complete MBES
H12991_MB_VR_MLLW_Complete_Coverage_Final	CARIS VR Surface (CUBE)	Variable Resolution	0.3 meters - 202.6 meters	NOAA_VR	Complete MBES
H12991_MB_VR_MLLW_Object_Detection	CARIS VR Surface (CUBE)	Variable Resolution	1.2 meters - 138.4 meters	NOAA_VR	Object Detection
H12991_MB_VR_MLLW_Object_Detection_Final	CARIS VR Surface (CUBE)	Variable Resolution	1.2 feet - 138.4 meters	NOAA_VR	Object Detection

Table 9: Submitted Surfaces

Submitted surfaces were generated using the recommended parameters for depth-based (Ranges) Caris variable-resolution bathymetric grids as specified in HTD 2018.

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 Mean Lower Low Water.

ERS Methods Used:

ERS via VDATUM

Ellipsoid to Chart Datum Separation File:

OPR-N305-RA-17_VDatum_SEP.csar

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD83).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 10 North.

The Wide Area Augmentation System (WAAS) was used for real-time horizontal control for this survey.

Precise Positioning-Real-Time Extended (PP-RTX) processing methods were used in Applanix POSPac MMS 8.2.1 software to produce SBETs for post-processing horizontal correction.

D. Results and Recommendations

D.1 Chart Comparison

H12991 survey data was compared to Electronic Navigation Charts (ENC) US5WA51M, US5WA50M, US5WA17M, and US5WA11M using a variable resolution CUBE surface, selected soundings, and contours created in CARIS. Multiple charts were required to gain full coverage of the survey area for comparison. Areas of chart overlap compared survey contours with the highest resolution chart for that location.

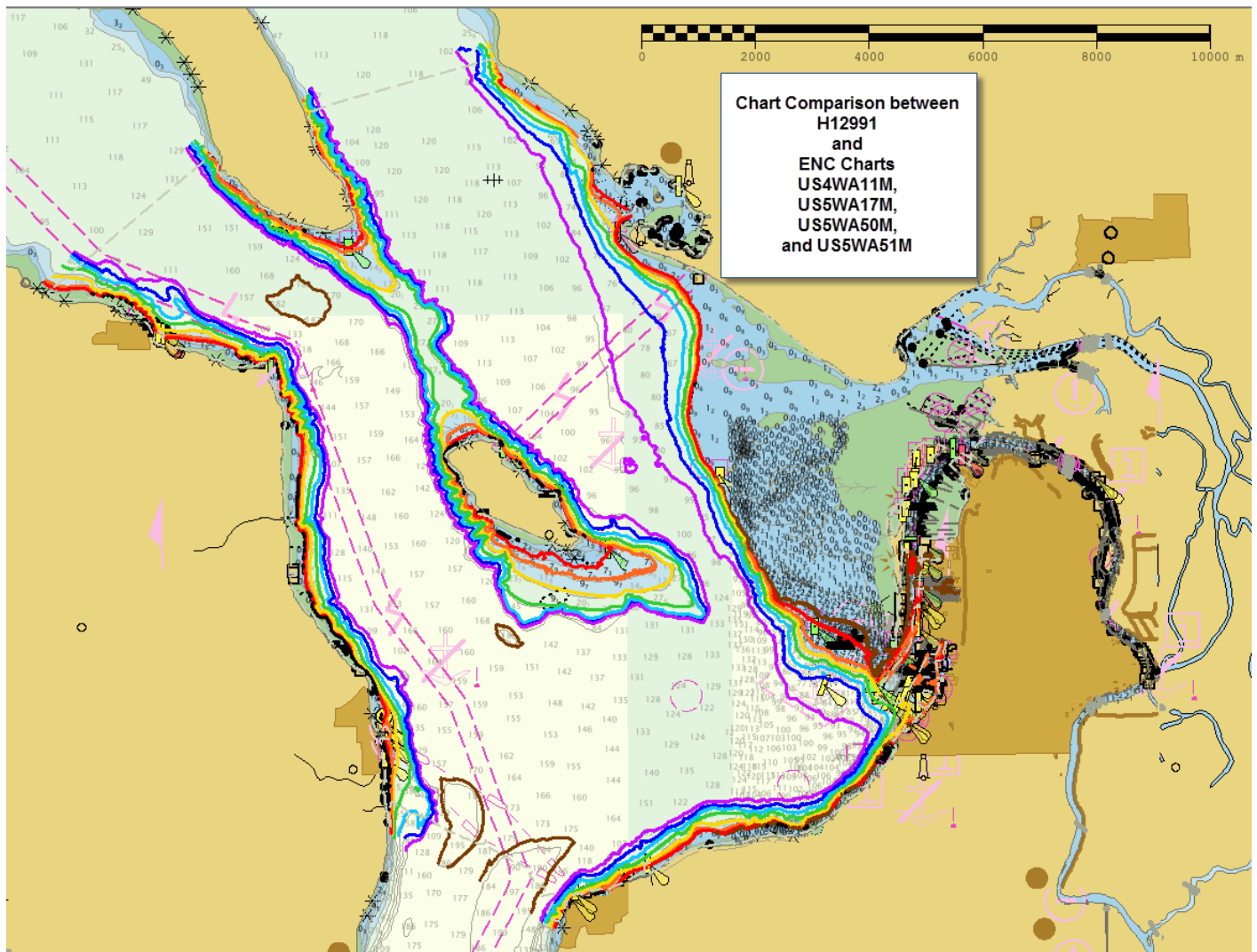


Figure 21: Survey H12991 contours overlaid on ENCs US5WA51M, US5WA50M, US5WA17M, and US4WA11M.

D.1.1 Electronic Navigational Charts

The following are the largest scale ENC's, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date	Preliminary?
US5WA51M	1:10000	22	11/20/2017	01/17/2018	NO
US5WA17M	1:40000	27	05/29/2018	05/29/2018	NO
US5WA50M	1:40000	18	01/23/2018	04/26/2018	NO
US4WA11M	1:80000	37	04/27/2018	07/10/2018	NO

Table 10: Largest Scale ENC's

US5WA51M

There are no significant deviations from the charted depth curves.

US5WA17M

- Survey data determined that the 30, 40, and 50 fathom depth curves are 100-200 meters inshore of their charted depth curves area south of Gedney Island (Figure 22).
- Multibeam data disproved a charted 50 fathom depth area northeast of Gedney Island (Figure 23).
- Multibeam data disproved a charted 3 fathom shoal east of Sandy Point (Figure 24).
- Survey data determined that the 100 fathom depth curves are 100-200 meters larger than charted (Figures 22 and 25).

ENCs US5WA17M and US5WA50M are the same scale but charted contours are not continuous (Figure 22).

RNC 18443 is more accurate than ENC US5WA17M, most noticeably on the western side of H12991. An example of the charts' discrepancies is shown by the Clinton ferry dolphins (Figure 26).

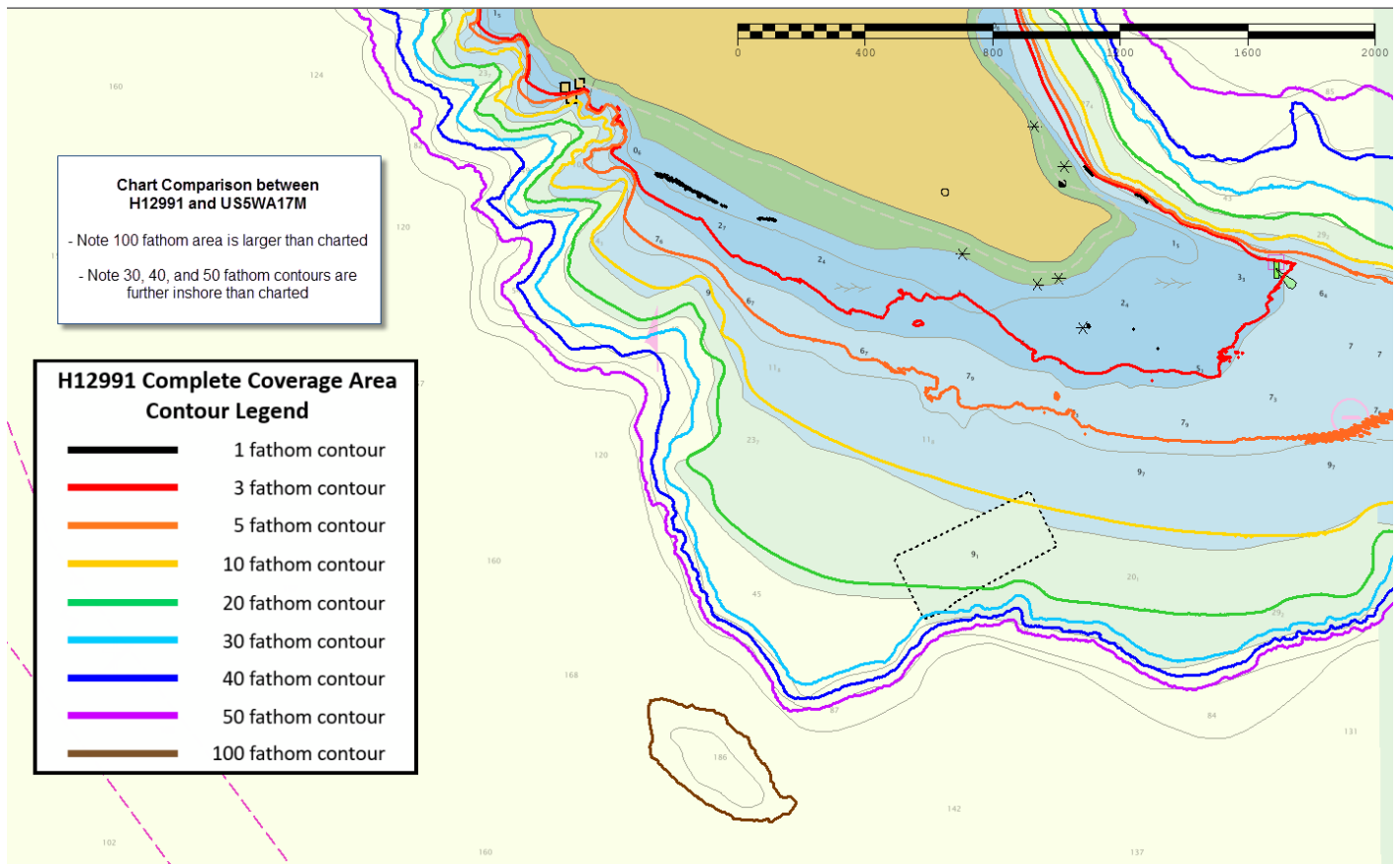


Figure 22: Example 1 of contour offsets between H12991 and US5WA17M.

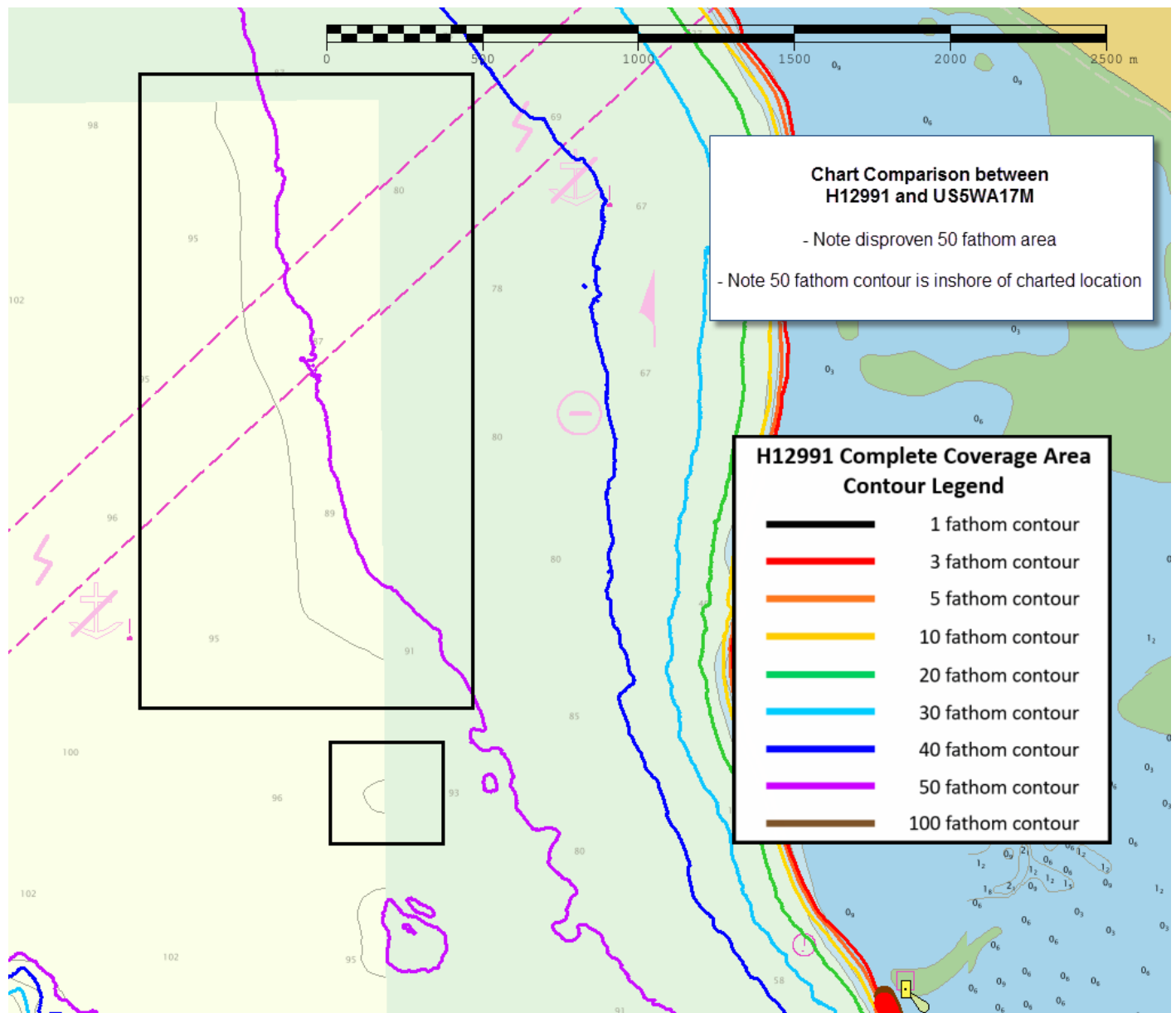


Figure 23: Example 2 of contour offsets between H12991 and US5WA17M.

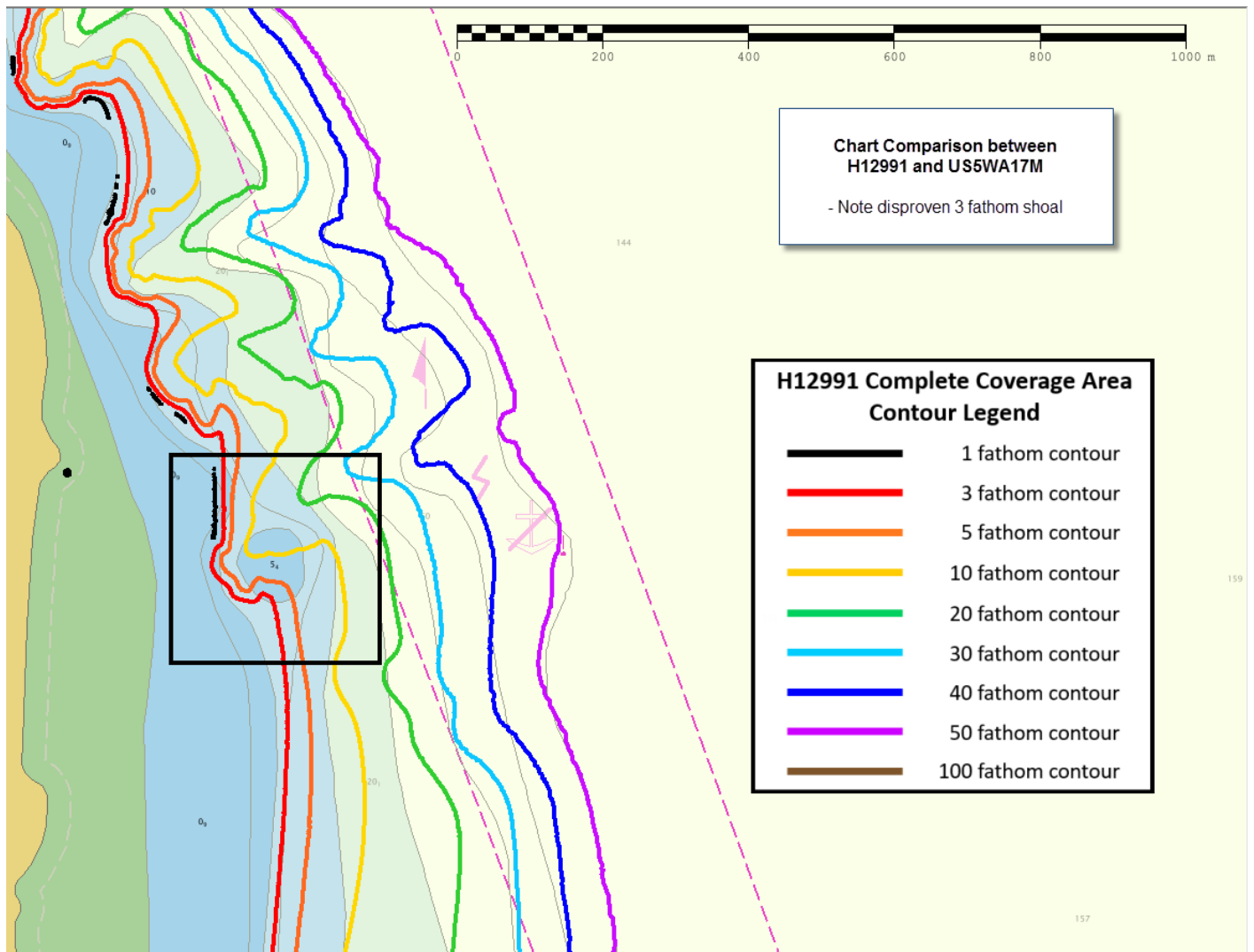


Figure 24: Example 3 of contour offsets between H12991 and US5WA17M.

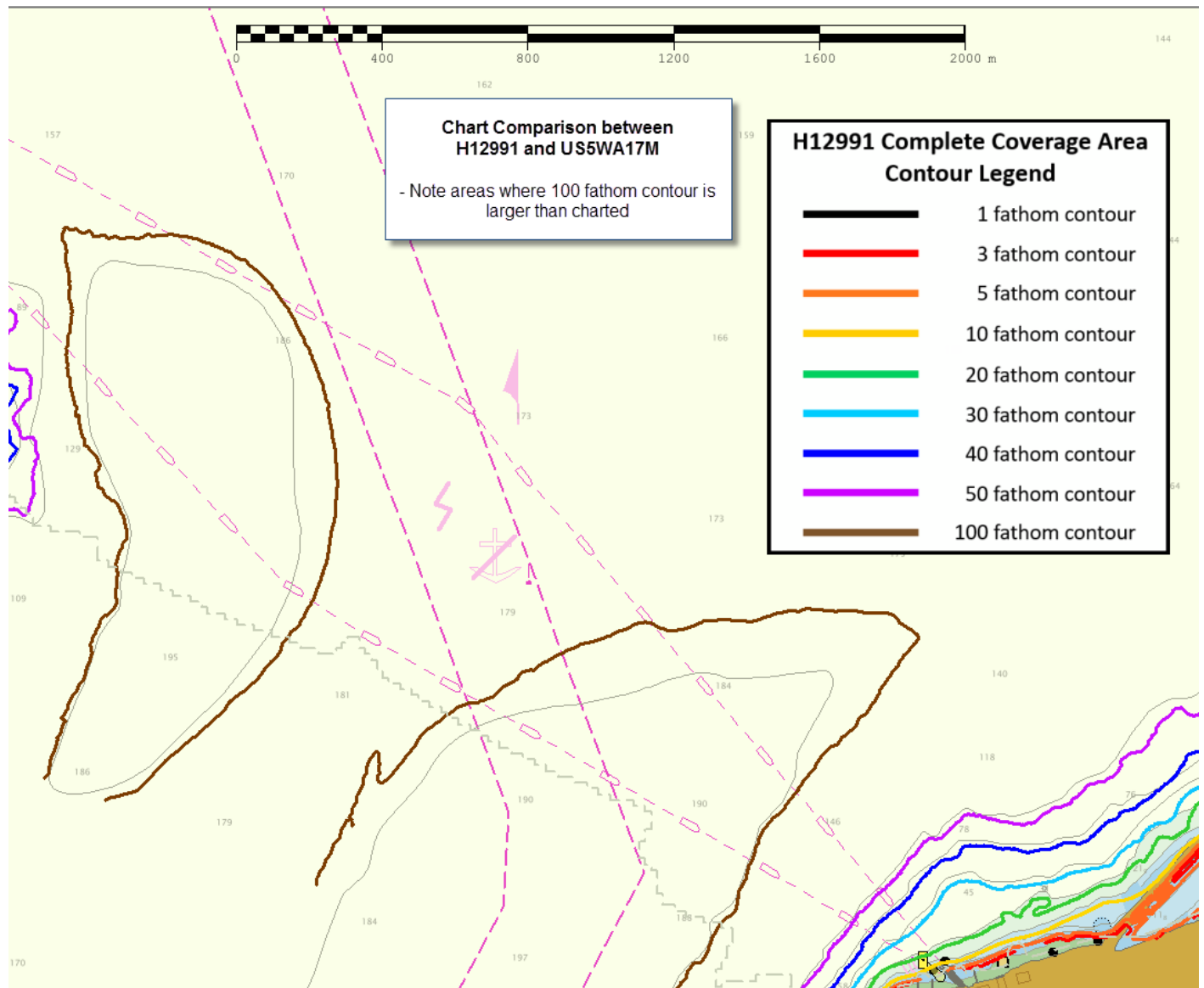


Figure 25: Example 4 of contour offsets between H12991 and US5WA17M.

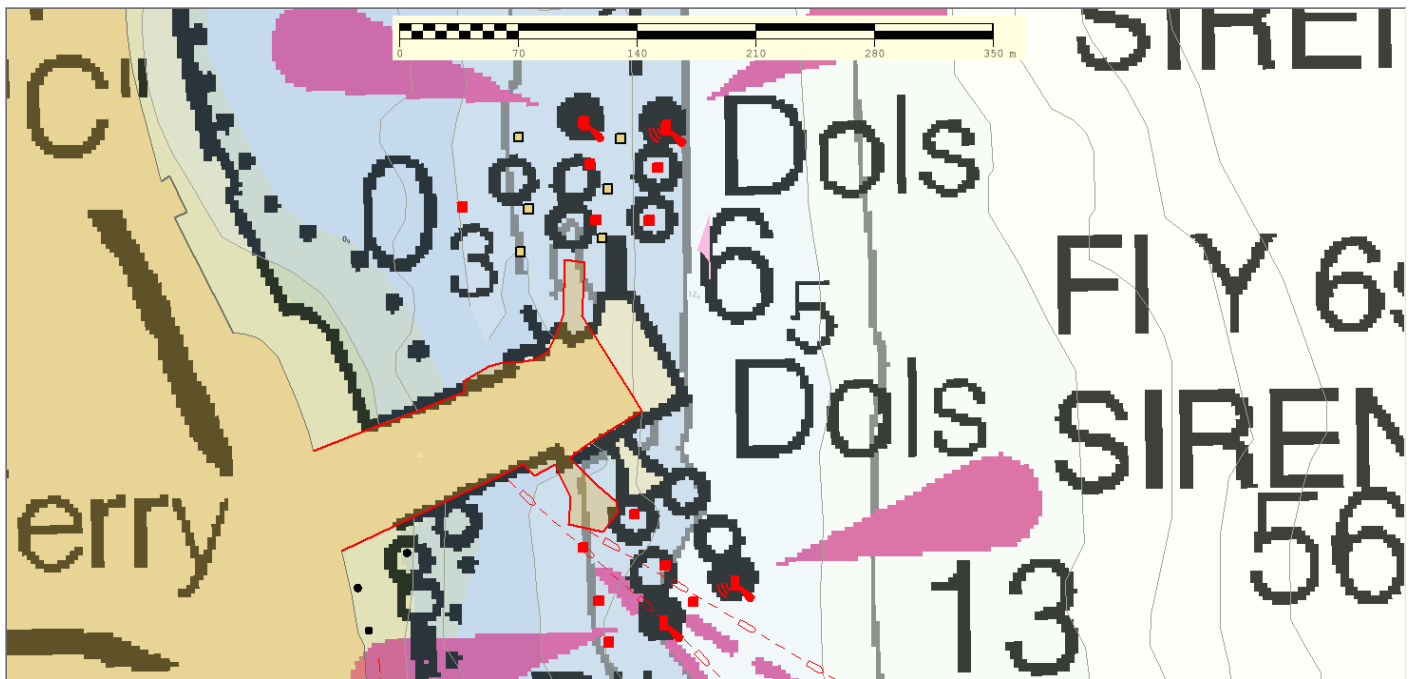


Figure 26: Example of RNC 18443 and ENC US5WA17M discrepancies. Red square features indicate actual locations of ferry dolphins as seen in MBES data.

US5WA50M

There are no significant deviations from the charted depth curves.

US4WA11M

There are no significant deviations from the charted depth curves.

D.1.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.1.3 Charted Features

See Final Feature File.

D.1.4 Uncharted Features

See Final Feature File.

Multiple uncharted submerged obstructions were discovered in the multibeam data. They are represented by a new obstruction area with a shoalest sounding in the Final Feature File (Figure 27). The area appears to be have some traffic. Recommend review new obstruction area.

Concur, review of the bathymetry supports charting a new obstruction area.

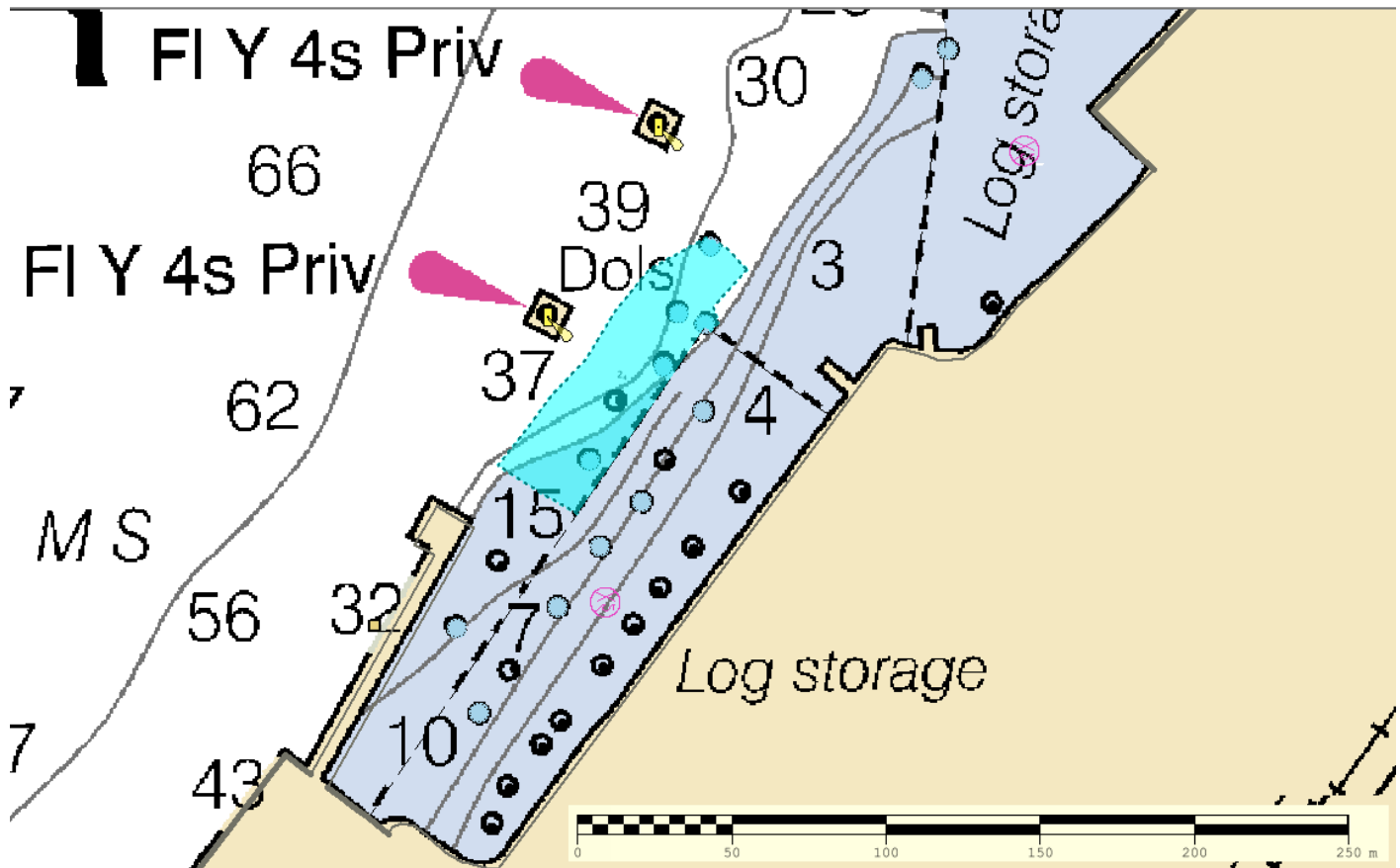


Figure 27: Image of new obstruction area depicted in File Feature File overlaid on RNC 18444.

D.1.5 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey.

D.1.6 Channels

Depths of dredged channels were consistent with attributed depths.

D.1.7 Bottom Samples

Bottom samples were acquired throughout the survey and are attributed in the Final Feature File.

D.2 Additional Results

D.2.1 Shoreline

Limited shoreline verification was conducted in accordance with applicable sections of NOAA HSSD and FPM using the Project Reference File (PRF) and Composite Source Files (CSF) provided with the Project Instructions. In the field, all assigned features that were safe to approach were addressed as required with S-57 attribution and recorded in the H12991 Final Feature File to best represent the features at chart scale. This file also includes new features found in the field as well as recommendations to update, retain, or delete assigned features.

D.2.2 Prior Surveys

Prior survey comparisons exist for this survey, but were not investigated.

D.2.3 Aids to Navigation

All ATONS were investigated and found to be on station and functioning while serving their intended purpose. See Final Feature File for more information.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

Submerged pipelines seen in multibeam data appear to be charted correctly. See Final Feature File for more information.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

The Washington Ferry from Clinton to Mukilteo is active and charted correctly. The Hat Express, a private ferry between Port of Everett Marina and Hat Island (also known as Gedney Island) Marina is operational but not charted.

Refer to chart comparison for more information about offset ferry terminal locations.

D.2.8 Abnormal Seafloor and/or Environmental Conditions

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

D.2.9 Construction and Dredging

A jetty east of the Mukilteo ferry terminal appears to be under new construction. See Final Feature File for more information.

Depths of dredged channels were consistent with attributed depths.

D.2.10 New Survey Recommendation

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

D.2.11 Inset Recommendation


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.

Approver Name	Approver Title	Approval Date	Signature
Benjamin K. Evans, CDR/NOAA	Commanding Officer, NOAA Ship RAINIER	09/21/2018	 Digitally signed by EVANS.BENJAMIN.K.1237217094 Date: 2018.09.24 15:43:48 -07'00'
Andrew R. Clos, LT/NOAA	Field Operations Officer, NOAA Ship RAINIER	09/21/2018	 2018.09.24 10:44:38 -07'00'
James B. Jacobson	Chief Survey Technician, NOAA Ship RAINIER	09/21/2018	 JACOBSON.JAMES.BRY AN.1269664017 I have reviewed this document 2018.09.24 08:50:47 -07'00'
Amanda M. Finn	Sheet Manager, NOAA Ship RAINIER	09/21/2018	FINN.AMANDA.M ARIA.1540474253 Digitally signed by FINN.AMANDA.MARIA.1540474253 Date: 2018.09.24 10:15:33 -07'00'



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Silver Spring, Maryland 20910

PROVISIONAL TIDE NOTE FOR HYDROGRAPHIC SURVEY

DATE : June 26, 2018

HYDROGRAPHIC BRANCH: Pacific

HYDROGRAPHIC PROJECT: OPR-N305-RA-18

HYDROGRAPHIC SHEET: H12991

LOCALITY: Approaches to Everett, Puget Sound, WA

TIME PERIOD: May 09 - 24, 2018

TIDE STATION USED: 9444900 Port Townsend, WA

Lat. 48° 6.8' N Long. 122° 45.6' W

PLANE OF REFERENCE (MEAN LOWER LOW WATER): 0.000 meters

HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 2.389 meters

TIDE STATION USED: 9447130 Seattle, WA

Lat. 47° 36.1' N Long. 122° 20.3' W

PLANE OF REFERENCE (MEAN LOWER LOW WATER): 0.000 meters

HEIGHT OF HIGH WATER ABOVE PLANE OF REFERENCE: 3.199 meters

REMARKS: RECOMMENDED GRID

Please use the TCARI grid "H12991.tc" as the final grid for project OPR-N305-RA-18, Registry No. H12991, during the time period between May 09 and 24, 2018.

Refer to attachments for grid information.

Note 1: Provided time series data are tabulated in metric units (meters), relative to MLLW and on Greenwich Mean Time on the 1983-2001 National Tidal Datum Epoch (NTDE).

Note 2: Annual leveling for 9444900 Port Townsend, WA and 9447130 Seattle, WA was not completed in the past year. A review of the verified leveling records from June 2008 to June 2018 shows the tide station benchmark network to be stable within an allowable 0.009 m tolerance. This Tide Note may be used as final stability verification for survey OPR-N305-RA-18, H12991. CO-OPS will immediately provide a revised Tide Note should subsequent leveling records indicate any benchmark network stability movement beyond the allowable 0.009 m tolerance.

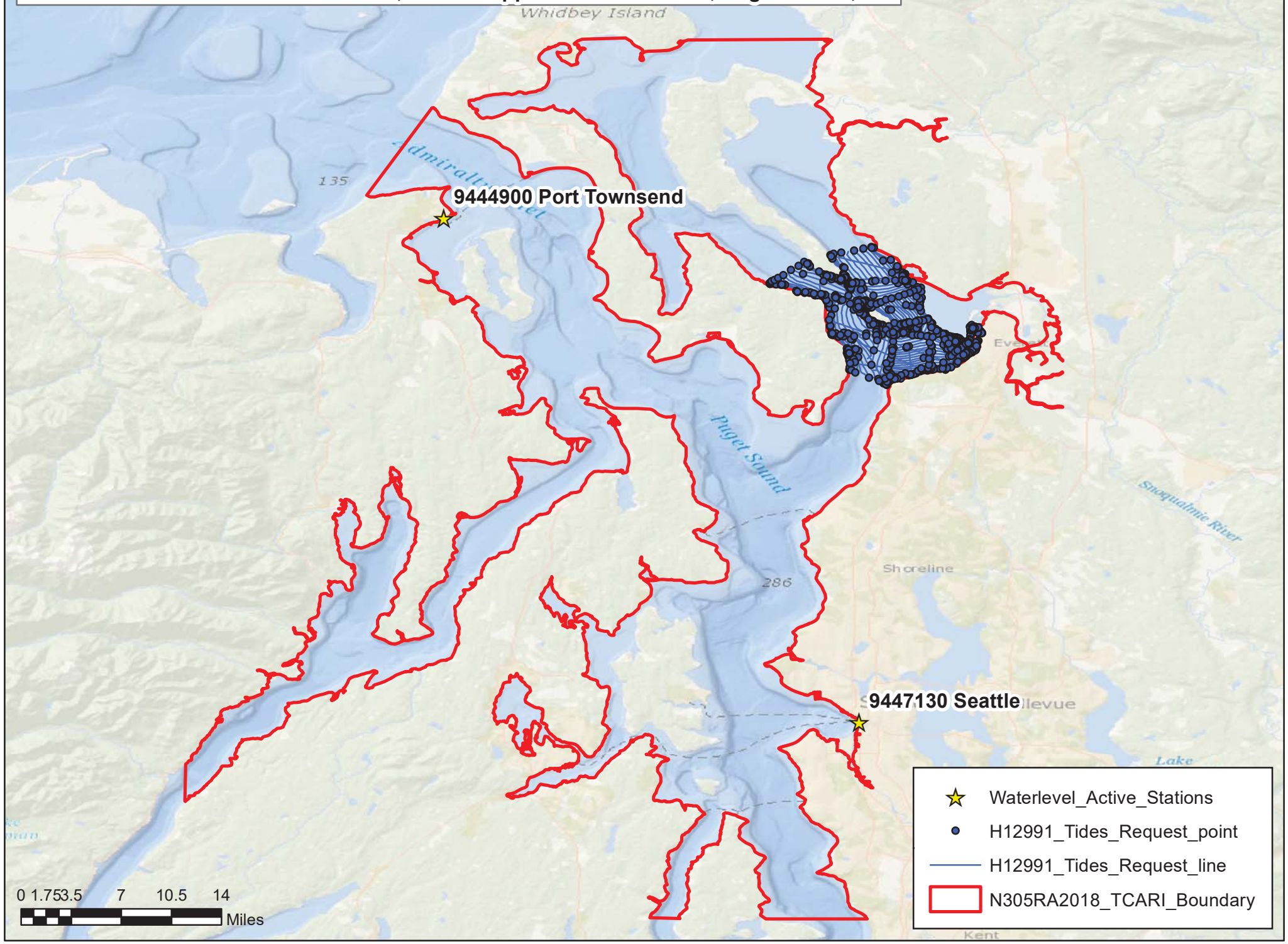
Note 3: Due to an inaccurate shoreline around Everett, Puget Sound, Washington, survey track lines fall outside of the TCARI grid boundaries in some areas. TCARI will extrapolate the tide corrector to cover these soundings.

HOVIS.GERALD.THOMAS.JR.1365860250 Digitally signed by
HOVIS.GERALD.THOMAS.JR.1365860250
Date: 2018.06.26 11:18:45 -04'00'

CHIEF, PRODUCTS AND SERVICES BRANCH



Final TCARI Grid for OPR-N305-RA-18, H12991 Approaches to Everett, Puget Sound, WA



- ★ Waterlevel_Active_Stations
- H12991_Tides_Request_point
- H12991_Tides_Request_line
- N305RA2018_TCARI_Boundary

0 1.753.5 7 10.5 14
Miles

Marine Mammals Training

Jim Keuger

Christopher Dunn ^{ENS} ^{NOAA}

Carl Stedman

Christian Hempstead

WILLIAM WINDER

WILE I ROBRINS

B. JACKSON

James Jacobson

Greg Gahlinger

ALLAN QUINTANA DECK

Nick Azzopardi

Tyler Medley

DECK

Amuneka Finn

Survey

MICHAEL HEWLETT

SURVEY

Charlene Fellows

DECK

Andrew Clos

Jonathan Wither

Survey

SHAWN BAKER

DECK

Scott Broo

AIZLIE PICKETT

WARDROOM

Audrey Jerauld

MICHELLE LEVANO

MARK BRIGGS

DECK

Collin Walker

Marine Mammals Training

Ben Evans - Command
Scott Broo - Command
Jason Kinyon - DECK
Matthew C Shriner - Deck
MARK BRIGGS - DECK
Mike Alford Deck

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	Continually 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
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
HSSD	Hydrographic Survey Specifications and Deliverables

Acronym	Definition
HSTP	Hydrographic Systems Technology Programs
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
NAIP	National Agriculture and Imagery Program
NALL	Navigable Area Limit Line
NM	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
PST	Physical Science Technician
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
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
TPE	Total Propagated Error
TPU	Topside Processing Unit
USACE	United States Army Corps of Engineers
USCG	United Stated Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDA	Global Positioning System timing message
ZDF	Zone Definition File

APPROVAL PAGE

H12991

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

The following products will be sent to NCEI for archive

- Descriptive Report
- Collection of Bathymetric Attributed Grids (BAGs)
- Collection of backscatter mosaics
- Processed survey data and records
- Bottom samples
- GeoPDF of survey products

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

Approved: _____

Commander Olivia Hauser, NOAA
Chief, Pacific Hydrographic Branch