W00268

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:	W00268

LOCALITY

State:	Alaska
General Locality:	Gulf of Alaska
Sub-locality:	Vicinity of Chirikof Island

2012

PROJECT MANAGER
DEAN MOYLES

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Date:

NOAA FORM 77-28 (11-72)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET		**W00268**

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:	**Alaska**
General Locality:	**Gulf of Alaska**
Sub-Locality:	**Vicinity of Chirikof Island**
Scale:	**40,000**
Dates of Survey:	**4 June to 15 June & 11 July to 12 July, 2012**
Instructions Dated:	**N/A**
Project Number:	**OSD-PHB-13**
Field Unit:	**Fugro Pelagos, Inc. PERSONNEL**
Project Manager:	**Dean Moyles**
Soundings by:	**MBES**
Imagery by:	**N/A**
Verification by:	**Pacific Hydrographic Branch**
Soundings Acquired in:	**Meters at Mean Lower Low Water**
H-Cell Compilation Units:	**Meters at Mean Lower Low Water**

Remarks:

Horizontal Coordinate System: UTM Zone 4N. The purpose of this survey was to study locations where Primnoa coral thickets occur or are suspected to occur. The data were re-purposed by OCS to update charted soundings in the vicinity. 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 Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.

NMFS-Alaska Fisheries Science Center
Resource Assessment and Conservation Engineering Division

THE ALASKA CORAL AND SPONGE INITIATIVE (AKCSI)

MULTIBEAM BATHYMETRY AND BACKSCATTER SURVEY GULF OF ALASKA, AK

Survey Period: 4 June to 15 June & 11 July to 12 July, 2012
FPI Report No. FPI-23.00001013-RPT-001-00

Prepared for:	**NMFS-Alaska Fisheries Science Center**
	NOAA NMFS AFSC RACE
	7600 Sand Point Way NE, Bldg. 4
	Seattle WA 98115
	Phone: (206) 526-4689

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Fugro Pelagos Inc., 3574 Ruffin road, San Diego, California 92123-1812

Phone: +1 858 292 8922, Fax: +1 858 292 5308, www.fugro-pelagos.com

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1 INTRODUCTION

Fugro Pelagos, Inc. (FPI) was contracted by NOAA's National Marine Fisheries Service (NMFS), to perform a detailed multibeam echosounder survey of four sites in varying locations within the Gulf of Alaska (GOA). Refer to (**Figure 1-1**); The GOA map shows the distribution of survey sites (roughly positioned from left to right: Chirikof, Fairweather Grounds, Prince of Wales Island, and Dixon entrance). The survey required digital, high-resolution multibeam bathymetry and backscatter.

Survey operations were carried out on June 4 to June 15, and on July 11 to July 12, 2012.

The purpose of this survey was to study locations where Primnoa coral thickets occur or are suspected to occur. Four of these sites have been identified in the Gulf of Alaska.

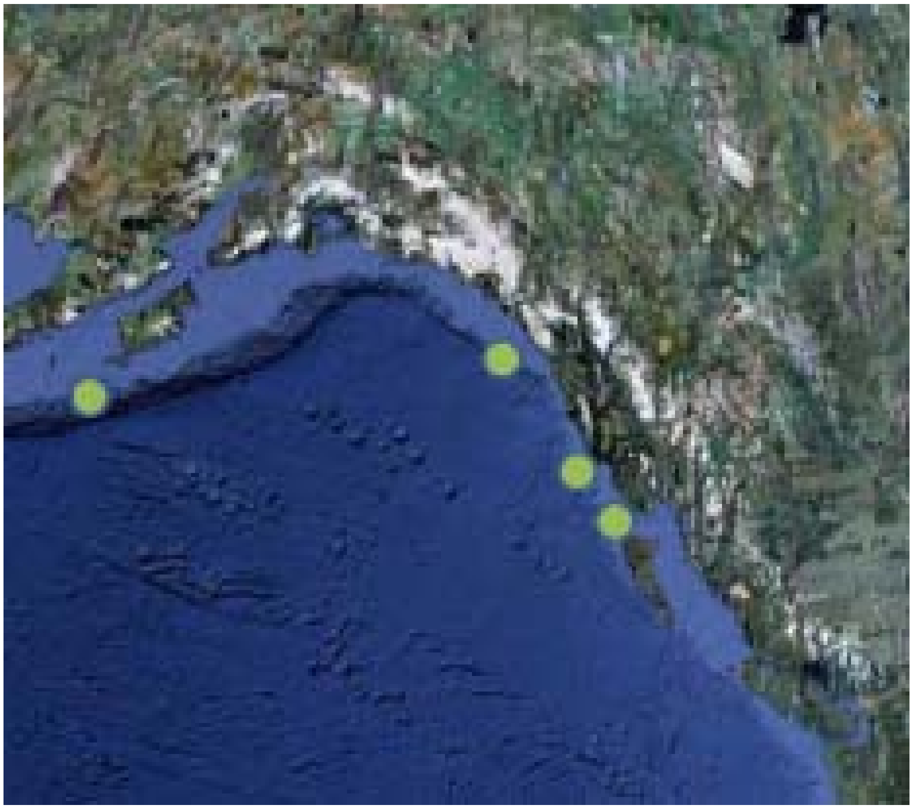


Figure 1-1: General Survey Locations

1.1 AREA SURVEYED

Multibeam bathymetric survey operations were conducted as indicated in **Figure 1-1**. Data were acquired using a high-resolution multibeam bathymetric survey system. Water depths ranged from approximately 110 meters to a depth of 1287 meters.

The survey totaled 522.8 linear nautical miles of multibeam bathymetry over an area of 167.2 square nautical miles.

The survey data were processed and interpreted onboard the F/V Pacific Star. The data are presented on a series of charts that include depth contour plots.

2 DATA ACQUISITION

Detailed daily progress reports (DPR) were prepared each day, as well as an operations DPR to provide a general overview of the project's progress. An example of the daily progress reports is presented in **Appendix A**. All DPRs are included in the digital report, located in the folder 'Logs', specifically in the sub-folder 'Daily Progress Report'. All times quoted in this report are UTC, unless stated otherwise.

2.1 VESSEL

The F/V Pacific Star **(Figure 2-1** & **Figure 2-2),** a former Bering Sea crab fishing vessel is 162 feet in length with a draft of 16 feet. The vessel was modified to accommodate a survey crew, acquisition hardware, and survey launches. Living quarters and office space containers were installed on the back deck. Technical specifications for the F/V Pacific Star are given in **Appendix B**. The vessel was equipped with a Reson SeaBat 7111 (100 kHz) sonar for multibeam data acquisition. The 7111 multibeam data files were logged in the s7k format. All multibeam data files were logged using WinFrog Multibeam v3.09.21. The vessel was also equipped with an Underway CTD (UCTD) for the acquisition of sound velocity profiles. Vessel attitude and position were measured using an Applanix Position and Orientation System for Marine Vessels (POS MV) 320 V4. WaterLOG H3611 (Radar Water Level Sensors) were installed on the port and starboard gunwales of F/V Pacific Star to obtain a more precise static draft measurement.

Figure 2-1: F/V Pacific Star

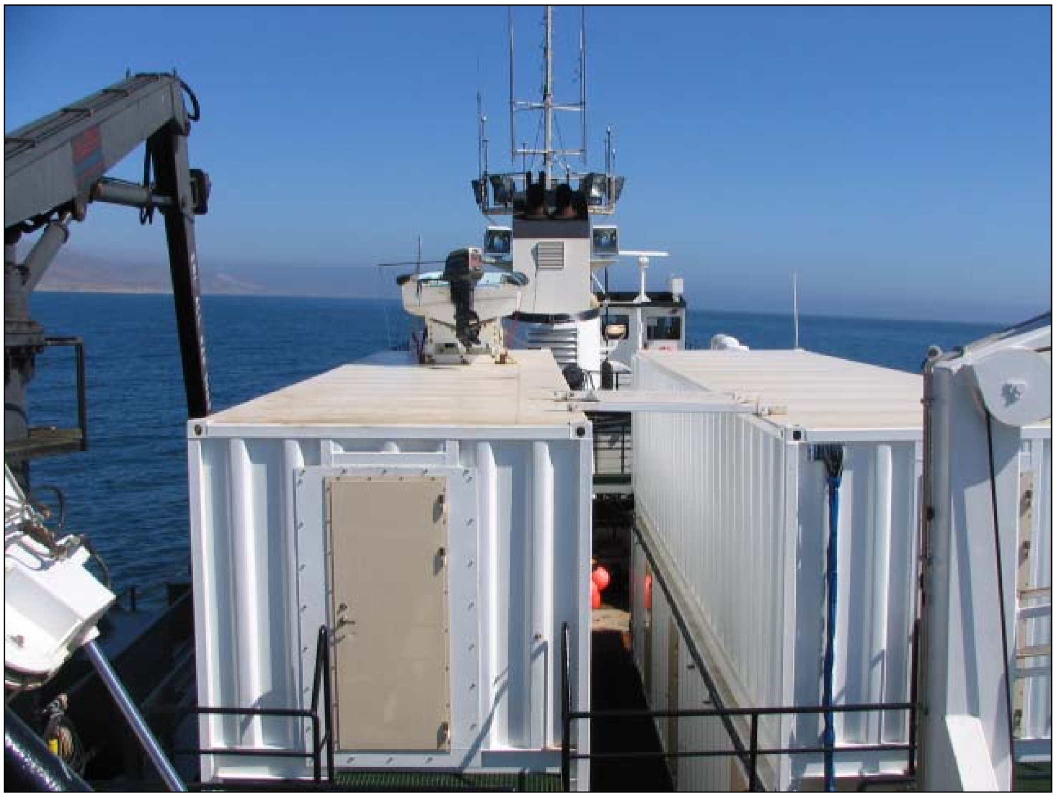


Figure 2-2: F/V Pacific Star Office Containers

2.2 SOUNDING EQUIPMENT

The F/V Pacific Star was equipped with a Reson Seabat 7111 multibeam sonar, the system was hull mounted near the best estimate of the vessel's center of gravity, approximately amidships. A false keel was installed on the vessel and a 7111 sonar with sound velocity probes was mounted within the keel. The false keel provided the sonar protection from damage and limited interference from vessel turbidity and noise (**Figure 2-3**). The Reson 7111 system operates at a frequency of 100 kHz and forms 301 beams at a 1.5° spacing (across-track), with maximum swath coverage of 150°. Operating modes such as range scale, gain, power level, ping rates, etc. were a function of water depth and data quality and were noted on the survey line logs.

Figure 2-3: F/V Pacific Star False Keel with 7111

2.3 POSITIONING EQUIPMENT

For positioning, the vessel was equipped with an Applanix Position and Orientation System for Marine Vessels (POS MV) 320 V4. Position was determined in real-time using a Trimble Zephyr L1/L2 GPS antenna, which was connected to a Trimble BD950 L1/L2 GPS card residing in the POS MV. An Inertial Measurement Unit (IMU) provided velocity values to the POS MV allowing it to compute an inertial position based on DGPS, heading, and motion.

The POS MV was configured to accept differential corrections which were output from a CSI MBX-3 DGPS receiver that was tuned to the closest or strongest USCG DGPS station.

The POS MV controller software's real-time QC displays were monitored throughout the survey to ensure that the specified positional accuracies were achieved. These include, but are not limited to the following: GPS Status, Position Accuracy, Receiver Status (which included HDOP), and Satellite Status.

2.4 MOTION SENSOR AND VESSEL HEADING

Vessel heading and dynamic motion were measured by the Applanix POS MV 320 V4. The system calculated heading by inversing between two Trimble GPS generated antenna positions. An accelerometer block, (the IMU), which measured vessel attitude, was mounted directly above the multibeam transducer. The operational accuracy specifications for this system, as documented by the manufacturer, are as shown in **Table 2-1** below:

Table 2-1: POS MV Specifications

POS MV Accuracy	
Pitch and Roll	*0.02°*
Heading	*0.02°*
Heave	*5% or 5-cm over 20 seconds*

2.5 SOUND-VELOCITY PROFILES

The vessel was equipped with an Underway CTD (UCTD) from OCEANSCIENCE for the acquisition of sound velocity profiles. Sound velocity casts were normally performed every two to three hours on the Pacific Star. The UCTD uses a custom freefall CTD probe manufactured by industry leader Sea-Bird Electronics. Using field-proven and very accurate conductivity, temperature, and pressure sensors, the UCTD delivers extremely high quality results. The internal electronics and exposed sensor components are carefully designed to withstand deployment and recovery at up to 20 kts. Sampling at 16 Hz, overall depth resolution of below 25 cm is attained at a drop speed of approximately 4 m/s. The specifications of the CTD probe sensors are shown below.

Table 2-2: UCTD Specs

	Conductivity (S/m)	Temperature (C)	Depth (dbar)	Salinity (PSU)
Resolution	0.0005	0.002	0.5	0.005
Accuracy - Raw Data	0.03	0.01 - 0.02	4	0.3
Accuracy - Processed Data	0.002-0.005	0.004	1	0.02 - 0.05
Range	0 - 9	-5 - 43	0 - 2000	0 - 42

Fugro Pelagos' MB Survey Tools was used to check the SV profiles graphically for spikes or other anomalies, and to produce an SVP file compatible with CARIS (Computer Aided Resource Information System) HIPS (Hydrographic Information Processing System). The WinFrog Multibeam acquisition package also provided quality control (QC) for surface sound velocity. This was accomplished by creating a real-time plot from the sound velocity probe at the Reson sonar head and notifying the user (via a flashing warning message) if the head sound velocity differed by more than 5m/s from a defined reference sound velocity. This message was used as an indication that the frequency of casts may need to be increased. The reference sound velocity was determined by averaging 50 sound velocities produced at the head. This reference sound velocity was reset when a cast was performed due to a significant deviation from the reference sound velocity, or normally, once a day.

All sound velocity probes were calibrated just prior to the start of survey operations and no probe's calibration exceeded 6 months at the end of survey operations.

Sound velocity profile logs can be found attached to the digital report located under /Logs/SVP.

2.6 STATIC DRAFT MEASUREMENTS

The WaterLOG H3611 (Radar Water Level Sensors) were installed on the port and starboard gunwales of F/V Pacific Star to obtain a more precise static draft measurements. The WaterLOG H3611 produce a sample distance to water surface every second with an accuracy of ±0.003m. Samples were taken over a 10 minute period and averaged to determine the vessel's static draft. Traditional static draft measurement techniques were also employed to supplement the WaterLOG H3611 measurements when required.

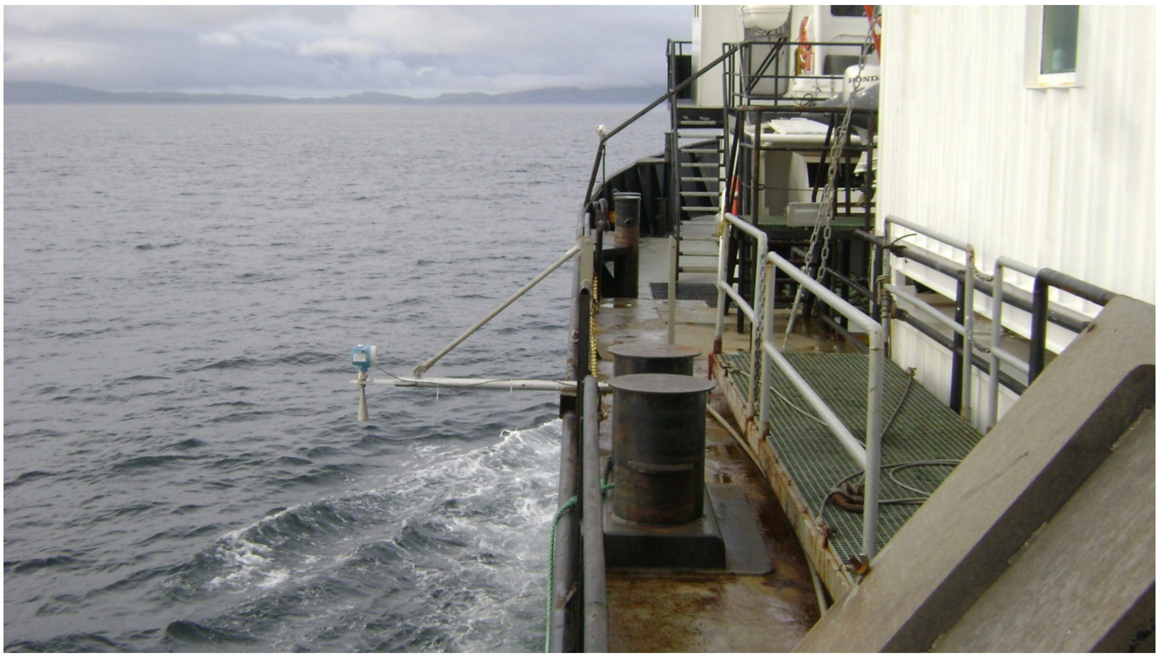


Figure 2-4: Port Radar Water Level Sensor

Figure 2-5: Starboard Radar Water Level Sensor

2.7 SOFTWARE (ACQUISITION)

All raw multibeam data were collected with WinFrog Multibeam v3.09.21 (WFMB). WFMB ran on a Windows 7 PC with a dual-core Intel processor. Data from the Reson 7111 sonar were logged in the s7k file format. The s7k files contain all multibeam bathymetry, position, attitude, heading, and UTC time stamp data required by CARIS to process the soundings. A separate WFMB module (PosMVLogger) on the same PC logged all raw POS MV data for the post-processing of vessel positions in Applanix POSPac MMS software (if required). WFMB also provided a coverage display for real-time QC and data coverage estimation.

WFMB offers the following display windows for operators to monitor data quality:

1. Devices: The Devices window shows the operator which hardware is attached to the PC. It also allows the operator to configure the devices, determine whether they are functioning properly, and to view received data.
2. Graphic: The Graphic window shows navigation information in plan view. This includes vessel position, survey lines, background vector plots, and raster charts.
3. Vehicle: The Vehicle window can be configured to show any tabular navigation information required. Typically, this window displays position, time, line name, heading, HDOP, speed over ground, distance to start of line, distance to end of line, and distance off line. Many other data items are selectable.
4. Calculation: The Calculation window is used to look at specific data items in tabular or graphical format. Operators look here to view the status of the GPS satellite constellation and position solutions.

5. MBES Coverage Map: The Coverage Map provides a graphical representation of the multibeam data in real-time. This allows the user to make judgments and corrections in the data collection process based upon current conditions.
6. MBES QC View: The QC View contains four configurable windows for real-time display of any of the following: 2D or 3D multibeam data, snippets, pseudo-sidescan or backscatter amplitude data. In addition to this, it contains a surface sound speed utility that is configurable for real-time SV monitoring at the sonar head.

Applanix POS MV V4 controller software was used to monitor the POS MV system. The software has various displays that allow the operator to check real-time position, attitude and heading accuracies, and GPS status. POS MV configuration and calibration, when necessary, was also done using this program.

Fugro Pelagos' PosMvLogger v1.2 was used to provide uninterrupted logging of all IMU, dual frequency GPS, and diagnostic data required to produce a Post Processed Kinematic (PPK) GPS solution. This solution was generated using Applanix POSPac MMS software. Additionally, the True Heave data that is applied in post processing is collected concurrently in the same file. The program also provides real-time quality control, and operator alarms for excessive HDOP, PDOP, and DGPS outages.

Fugro Pelagos' MB Survey Tools v2.00.31.00 was used to aid in file administration and reporting during data acquisition. This program created a daily file that contained survey line, SVP, and static draft records. These logs were stored digitally in a database format and were later used to create the log sheets in PDF format. Acquisition and processing logs can be found attached to the digital report located under /Logs/Acquisition and Processing Logs.

2.8 PROJECT DATUM

2.8.1 Horizontal Datum

The horizontal control datum for this survey was the North American Datum of 1983 (NAD83).

For real-time DGPS corrections, a CSI MBX-3 unit was tuned to the Cold Bay, Alaska USCG DGPS site. The unit output differentially corrected positions at 1 Hz to the (POS MV) 320 V4 where it was integrated with inertial data and a position for the top-center of the IMU was generated. It was later corrected for offsets to the multibeam echosounder (MBES) by CARIS HIPS in post-processing.

Positioning system confidence checks were conducted on a daily basis using the PosMvLogger and POS MV controller software's real-time QC displays. The controller software has numerous real-time displays that were monitored throughout the survey to ensure the positional accuracies specified in the National Ocean Service Hydrographic Surveys Specifications and Deliverables Manual (HSSDM), April 2011 were achieved. These include, but are not limited to the following: GPS Status, Positional accuracy, Receiver Status (which included HDOP & PDOP), and Satellite Status.

2.8.2 Vertical Datum

The vertical control datum for this survey was the Mean Lower Low Water (MLLW).

All sounding data were initially reduced to mean lower low water (MLLW) using unverified tidal data from tide stations (**Table 2-3**) located within close proximity of the survey site. Tidal Stations are owned and operated by National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service's (NOS) Center for Operational Oceanographic Products and Services (CO-OPS). Observed tidal data were assembled from the National Water Level Observation Network (NWLON) program accessed through the NOAA tides and currents website (http://tidesandcurrents.noaa.gov/). A cumulative file for the gauge in use was updated daily by appending the new data as it became available.

Table 2-3: Tide Gauge

Gauge	Model	Gauge Type	Location	Latitude	Longitude
9451054	AquaTrak	Acoustic	Port Alexander, AK	56º 14.8'N	134º 38.8' W
9451600	AquaTrak	Acoustic	Sitka, AK	57º 03.1'N	135º 20.5' W
9453220	AquaTrak	Acoustic	Yakutat Bay, AK	59º 32.9'N	139º 44.0' W
9459450	AquaTrak	Acoustic	Sand Point, AK	55º 20.2'N	160º 30.1' W

2.9 CALIBRATIONS AND QUALITY CONTROL

In addition to the online QC tools and displays available in POS MV and WFMB, as described in previous sections, the following calibrations and checks were also performed.

2.9.1 Vessel Offset Survey

All vessel and sensor offsets were derived via conventional survey techniques using total stations, while the vessel was dry docked. The results yielded standard deviations of 0.005m to 0.010m, vessel and survey dependent. Results are given in **Appendix B**.

2.9.2 POS MV GAMS Calibration

Vessel headings were measured by the Applanix POS MV 320 V4, by way of a GPS Azimuth Measurement Subsystem (GAMS). GAMS computes a carrier phase differential GPS position solution of a Slave antenna with respect to a Master antenna position, thereby computing the heading between the two. In order for this to provide a heading accuracy of 0.01º, the system needs to know and resolve the spatial relationship between the two antennas. During the GAMS calibration, since the offset from the IMU to the Master antenna is known (from the vessel offset survey), the location of the Slave antenna is calculated by computing the baselines between the two antennas with respect to the IMU axes.

GAMS Calibration Results:

Two Antenna separation (m) = 1.770

Baseline Vector:

X Component (m) = 0.069

Y Component (m) = 1.768

Z Component (m) = -0.009

2.9.3 MBES Patch Test Calibration

A MBES patch test calibration was performed prior to survey operations to derive the offsets between the sonar head and motion reference unit. The processing methods and patch test results can be found in **Appendix E**.

2.9.4 Crossline Quality Control

To provide another level of quality control, crosslines were acquired approximately perpendicular to the main-scheme lines.

These crosslines were used only for quality control purposes and were not included in the main scheme data set for DTM generation. To verify that the survey meets or exceeds the IHO S-44 Order 1a level of accuracy, the bathymetry from the crosslines is compared to the surface created from the main-scheme lines.

This quality control check is performed through the CARIS QC Report routine. During the quality control check, the bathymetry soundings from the crosslines must fall within an allowable error from the base surface created from the main-scheme lines. The allowable error in this case is set to the IHO S-44 Order 1a confidence. The accuracy specification within the CARIS QC Report routine for IHO Order 1a is as follows:

$$\pm\sqrt{(\boldsymbol{a}^{2} + (\boldsymbol{b} * \boldsymbol{d})^{2})}$$

where a = 0.5 m, b = 0.013 m, and d = depth.

The results of the crossline analysis for the survey area are displayed in **Appendix F**. The majority of QC Reports fall well within the required accuracy specifications. However, the crossline in Fairweather grounds contained beams in the QC report that fall below the 95% confidence level due to a significantly rocky topography. Good conformity was still seen between the main scheme lines and crosslines.

2.10 DATA QUALITY

To ensure data quality throughout the survey; line spacing was set to insure significant overlap of multibeam data to aid in coverage around areas of high noise. Survey speed was kept between 3-5 knots to insure low turbulence around the multibeam false keel.

The procedure for acquisition and processing of the survey data adheres to the "NOS Hydrographic Surveys Specifications and Deliverables Manual (HSSDM), April 2011". . The Hydrographic Surveys Specifications and Deliverables document ("HSSD from NOS April 2011.pdf") can be found attached to the digital report located in the '*From Client*' folder.

Note: Due to deteriorating weather conditions during the survey of the Chirikof site, the southern portion was deemed to be of poor quality and unsuitable for its intended purpose. The southern portion of the site was re-surveyed during the F/V Pacific Star's transit back to Kodiak following the completion of an additional NOAA task order.[2]

3 DATA PROCESSING

Data were processed onboard the vessel to ensure complete data coverage. Final processing and preparation of deliverables was also carried out onboard the vessel.

3.1 BATHYMETRIC PROCESSING[3]

All Soundings were processed using CARIS (Computer Aided Resource Information System) HIPS (Hydrographic Information Processing System) v7.1 which converted the s7k files to HIPS format and corrected soundings for sound velocity, motion, tide, and vessel offsets. These corrected soundings were then examined to reject any noise from the data.

An overview of the data processing flow follows:

In order for the s7k files collected by WFMB to be used by CARIS, they must be converted to HDCS format using the CARIS Reson PDS converter routine. Prior to the files being converted, vessel offsets, patch test calibration values, Total Propagated Uncertainty (TPU) values, delta draft, and static draft were entered into the HIPS Vessel File (HVF).

Once converted, the SVP, Tide, and True Heave data were loaded into each line and the line was SVP corrected in CARIS HIPS. The TPU was then computed for each sounding and the attitude, navigation, and bathymetry data for each individual line were examined for noise, as well as to ensure the completeness and correctness of the data set.

The data were filtered using a swath angle filter and a Reson quality flag filter (**Table 3-1**). The swath angle filter rejected all soundings falling farther from a specified angle from nadir. The Reson quality flag filter rejected soundings based on the colinearity and brightness of each ping. Note that "rejected" does not mean the sounding was deleted – it was instead flagged as bad so that it would not be included in subsequent processing, such as surface creation. Data flagged as rejected did contain valid data but were flagged to remove noise and to speed the processing flow. Valid data were manually reaccepted into the data set occasionally during line and subset editing as required.

Table 3-1: Reson Quality Flags

Quality Flag	Brightness	Colinearity
0	Failed	Failed
1	Pass	Failed
2	Failed	Pass
3	Pass	Pass

Several CARIS filter files were defined in project preplanning (**Table 3-2**). The processor selected the appropriate filter file based on a brief review of the data for environmental noise and bottom topography. Filter settings were sometimes modified based on data quality and sonar used, but all filter settings used were noted on the corresponding line log.

Table 3-2: CARIS Filter File Definitions

File name	Angle from Nadir	Quality Flag
0_1_73deg.hff	73˚	0&1
60_Q_0.hff	60˚	0
60_Q_01.hff	60˚	0&1
65_Q_0.hff	65˚	0
65_Q_01.hff	65˚	0&1
70_Q_0.hff	70˚	0
70_Q_01.hff	70˚	0&1
Quality_0.hff	No Filter	0

A Combined Uncertainty and Bathymetry Estimator (CUBE) surface was then created at varying resolutions, refer to section **3.1.3.1** for additional information.

Subsets Tiles were then created in CARIS HIPS. Adjacent lines of data were examined to identify tidal discrepancies, sound velocity and roll errors, as well as to reject any remaining noise in the data set that adversely affected the CUBE surface.

A statistical analysis of the sounding data was conducted via the CARIS Quality Control Report (QCR) routine. Crosslines were run in each sheet, and for quality control were compared with lines acquired from the main-scheme lines where applicable. The Quality Control Reports can be found attached to the digital report located in the '*Crosslines QC Reports*' folder.

Sounding data that passed the required quality assurance checks were used in the final CUBE surfaces. During final CUBE surface creation in CARIS, the S-44 order option "Order 1a" was selected, having values of a=0.5 m and b=0.013 m. This constrained the area of influence of soundings to those that passed project specifications.

3.1.1 CORRECTIONS TO SOUNDINGS

3.1.1.1 Vessel Offsets

Vessel offsets were used to adjust positions to the transducer head. Offsets are detailed in **Appendix B**. Offsets were entered in to the Vessel Configuration File in CARIS HIPS.

3.1.1.2 Total Propagated Uncertainty

Error estimates for all survey sensors were entered in the CARIS HVF. These error estimates were used in CARIS to calculate the Total Propagated Uncertainty (TPU) at the 95% confidence interval for the horizontal and vertical components for each individual sounding. The values that were entered in the CARIS HVF for the survey sensors are the specified manufacturer accuracy values and were downloaded from the CARIS website **http://www.caris.com/tpu/**. The following is a breakdown and explanation on the manufacturer and Fugro Pelagos-derived values used in the error model:

- Navigation – A value of 0.10 m was entered for the positional accuracy. This value was selected since all positions were post-processed, with X, Y, and standard deviation values better than 0.10 m.
- Gyro/Heading – Vessel was equipped with a (POS MV) 320 V4 and had a baseline < 4 m, therefore, a value of 0.020 was entered in the HVF as per manufacturer specifications.
- Heave – The heave percentage of amplitude was set to 5% and the Heave was set to 0.05 m, as per manufacturer specifications.
- Pitch and Roll - As per the manufacturer accuracy values, both were set to 0.02 degrees.
- Timing – All data were time stamped when created (not when logged) using a single clock/epoch (Pelagos Precise Timing method). Position, attitude (including True Heave), and heading were all time stamped in the POS MV on the UTC epoch. This UTC string was also sent to the Reson 7111 processor ZDA+1 PPS, yielding timing accuracies on the order of 1 ms. Therefore a timing error of 0.001 seconds was entered for all sensors on all vessels.
- All vessel and sensor offsets were derived via conventional survey techniques (total station), while the vessel was dry docked. The results yielded standard deviations of 0.005 m to 0.010 m, vessel and survey dependent.
- Vessel speed – set to 0.10 m/s since a POS MV with a 50 Hz output rate was in use.
- Loading – estimated vessel loading error set to 0.05 m. This was the best estimate of how the measured static draft changed through the survey day.
- Draft – it was estimated that draft could be measured to within 0.01 m to 0.03 m, therefore values in this range were entered.
- Tide error was set to 0.08 m. This value was selected since RMS for GPS altitude was typically better than this.
- Sound Speed Values were determined in MBTools, via the SVP Statistics utility. This utility calculated the Mean, Variance, Standard Deviation, and Min/Max values at a user specified depth interval. A separate value was also taken from the

manufacturers specifications.

- MRU Align StdDev for the Gyro and Roll/Pitch were set to 0.10° since this is the estimated misalignment between the IMU and the vessel reference frame.

The calculated vertical and horizontal error or TPU values were then used to create finalized CUBE surfaces that used only soundings meeting or exceeding project accuracy specifications.

3.1.1.3 Sound Velocity Profiles

Processed sound velocity profiles (SVP) were used to correct the bathymetry for sound refraction, or ray bending within CARIS HIPS.

Fugro's Multibeam Survey Tools 2.00.31.00 software was used to process the SVP data set and generate a smooth interpolation curve that depicted the original profile at the finest resolution available in CARIS. An example of a processed SVP cast from the project area is shown in **Figure 3-1**. Individual processed sound velocity profiles can be found attached to the digital report located in the folder Sound Velocity Profiles.

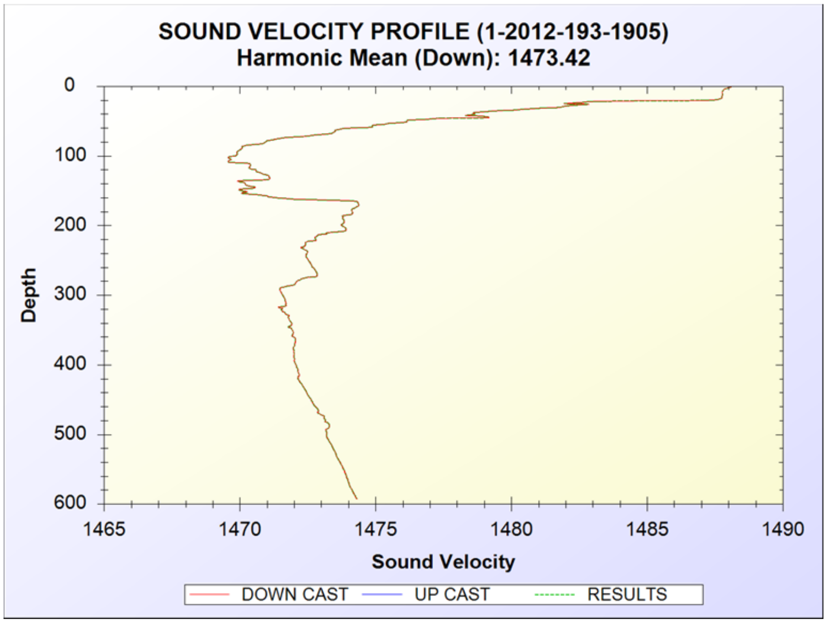


Figure 3-1: Processed SVP Example

3.1.1.4 Static Draft

The static draft was measured using the WaterLOG H3611 (Radar Water Level Sensor) on the F/V Pacific Star. The measurement provides the static draft correction, which was then applied to adjust soundings from the transducer level to the water level (**Table 3-3**).

The static draft value was entered into the HVF file within CARIS. It should be noted that draft is actually the distance from the common reference point (CRP) to the water level; CARIS takes into account the distance from the CRP to the transducer head in its calculations as well.

Table 3-3: Static Draft Measurements

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
1	161	6/9/2012	13:38	-1.9
2	165	6/13/2012	19:36	-1.81
3	168	6/16/2012	22:22	-1.76
4	191	7/9/2012	18:30	-1.59

3.1.1.5 Tides[4]

On July 15, 2012, verified tide data was acquired from the NWLON program accessed through the NOAA tides and currents website (http://tidesandcurrents.noaa.gov/). The verified data were smoothed and applied to all sounding data in CARIS HIPS using tidal zones provided by NOAA. All sounding data were then remerged. Verified tidal data were used for all final CUBE Surfaces and soundings.

3.1.1.6 Patch Test

A patch test was completed for the MBES using seafloor topology for data to be corrected for navigation timing, pitch, azimuth, and roll offsets, which may exist between the MBES transducer and the Motion Reference Unit (MRU).

The patch test was run prior to survey operations to calibrate the MBES and MRU for different vessel configurations.

No adjustment was required for navigation timing error. Fugro Pelagos has implemented a specific timing protocol for multibeam data acquisition. In this method, UTC time tags generated within the POS MV are applied to all position, heading, and attitude data. The POS MV ZDA+1 PPS (pulse per second) string is also sent to the Reson SeaBat sonar system, where the ping data are tagged. The architecture of the POS MV ensures that there is zero latency between the position, heading, and attitude strings. The only latency possible is in the ping time. In addition, the navigation-to-ping latency will be identical to the attitude-to-ping and heading-to-ping latencies.

Navigation latency is generally difficult to measure using standard timing and patch testing techniques. However, using Fugro Pelagos' timing protocol, the navigation latency will be the same as the roll latency. Fortunately, roll latencies are very easy to identify. Data with a roll timing latency will have a rippled appearance along the edge of the swath. During patch test analysis, the roll latency is adjusted until the ripple is gone. This latency value is then applied to the ping time, synchronizing it with the position, attitude, and heading data.

The pitch error adjustment was performed on sets of two coincident lines, run at the same velocity, over a conspicuous object, in opposite directions. The nadir beams from each line were compared and brought into alignment, by adjusting the pitch error value.

The azimuth error adjustment was performed on sets of two lines, run over a conspicuous topographic feature. Lines were run in opposite directions, at the same velocity with the same outer beams crossing the feature. Since the pitch error has already been identified, data from the same outer beams for each line were compared and brought into alignment, by adjusting the azimuth error value.

The roll error adjustment was performed on sets of two coincident lines, run over flat terrain, at the same velocity, in opposite directions. The pitch error and azimuth error were already identified. Data across a swath were compared for each line and brought into agreement by adjusting the roll error value.

Patch test data were then corrected using the identified values, and the process repeated to check their validity.

Patch test values were obtained in CARIS HIPS calibration mode. Calculated values were then entered in to the HVF so that data could be corrected during routine processing.

A patch test report is presented in **Appendix E**.

Table 3-4: Patch Test Results

Calibration	Navigation Timing Error	Pitch Offset	Azimuth Offset	Roll Offset
Julian Day 152	0.00 sec	-0.400°	-0.600°	-0.535°
Julian Day 191	0.00 sec	-0.400°	-0.600°	-0.590°

3.1.2 DATA CLEANING

The raw multibeam files were collected in s7k format and converted to CARIS HIPS format for bathymetry processing. Prior to each survey line being converted from s7k to CARIS HIPS format, the vessel offsets, patch test calibration values, and static draft measurements were entered into the HVF. Once converted, post-processed navigation and altitude data were inserted for every line. The SVP file was then loaded into each line, and the line corrected for sound refraction. During SVP correction, CARIS also corrects the bathymetry for dynamic heave and vessel pitch and roll. The attitude, heading, navigation, and bathymetry data were examined for noise and data gaps. Nadir beam filters were used to reject data from the outer reaches of the swaths. It should be noted that rejection does not mean deletion from the data set; soundings were simply flagged as ‘rejected’, and could be re-accepted if necessary.

After each individual line was examined and cleaned in CARIS Swath Editor (**Figure 3-2**), the tide file was loaded, and the lines were merged. During merging, tide and draft corrections were applied. Subsets were then created in CARIS Subset Edit mode (**Figure 3-3**) and adjacent overlapping lines of corrected bathymetry data examined to identify any tidal busts, sound velocity errors, motion errors, or data gaps. Any residual noise in the data set was also rejected at that time.

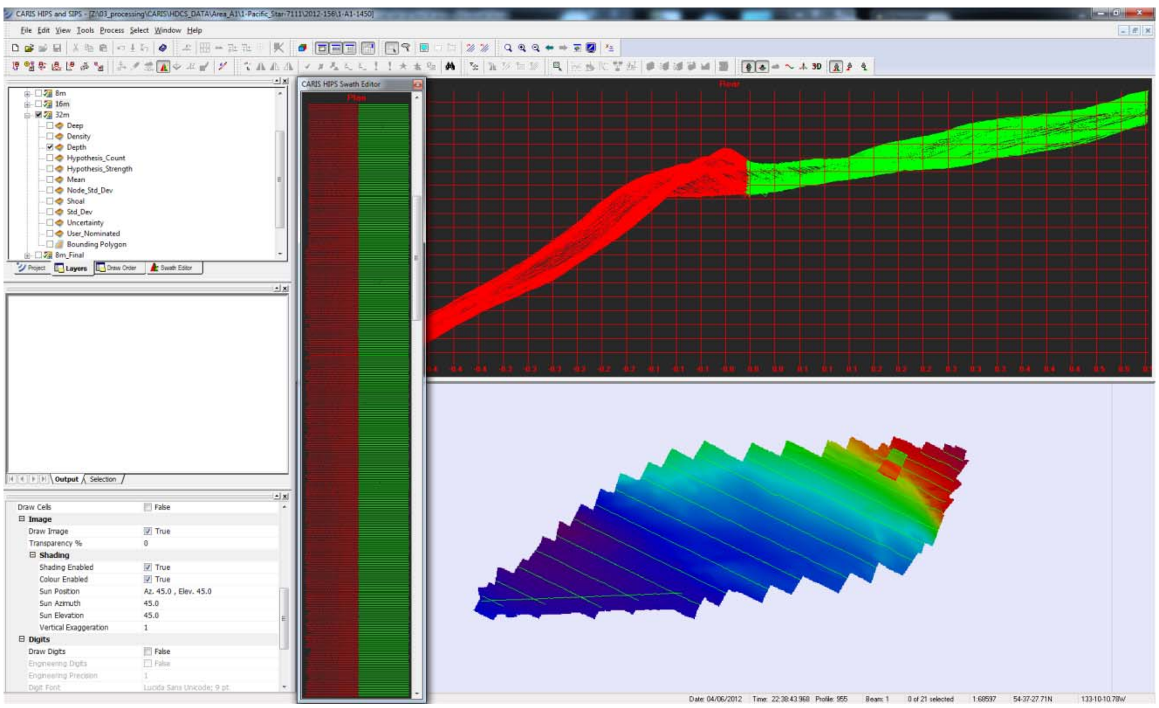


Figure 3-2: CARIS Swath Editor

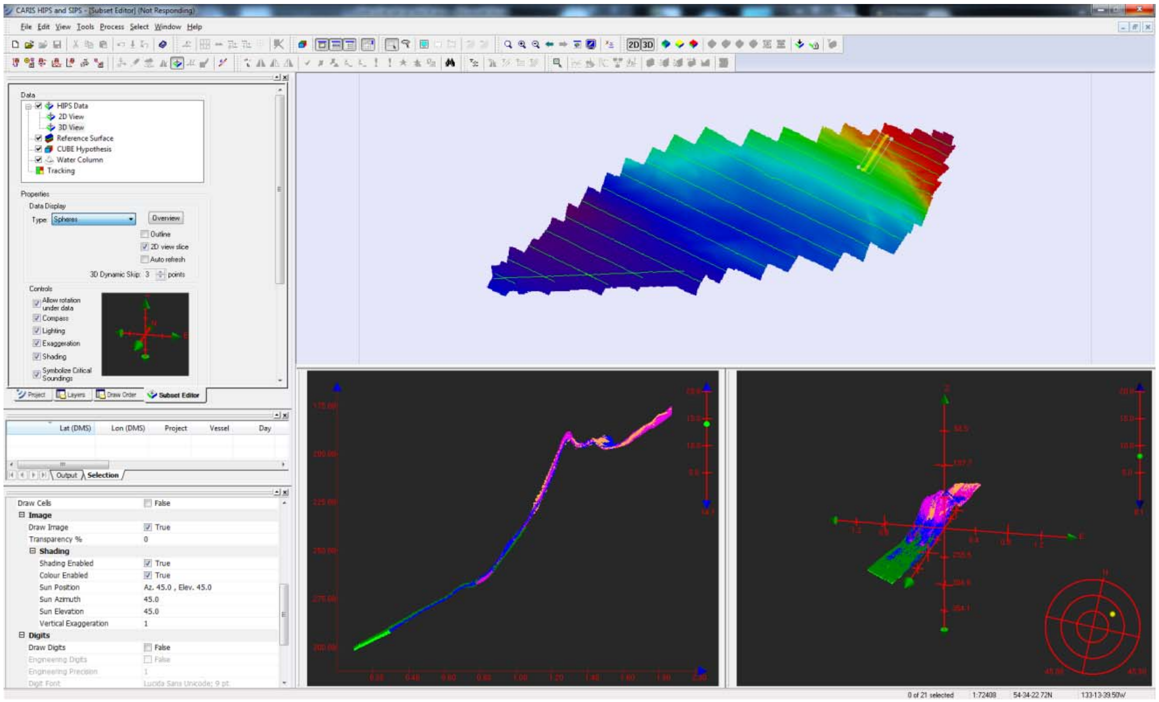


Figure 3-3: CARIS Subset Editor

3.1.3 PRODUCT GENERATION

Final processing and preparation of deliverables was also carried onboard the vessel.

3.1.3.1 Digital Terrain Model Generation

After data were cleaned in both Swath Editor and Subset Mode, CUBE surfaces were created at varying resolutions (**Table 3-5**). The resolutions were based on depth ranges that are outlined in the "NOS Hydrographic Surveys Specifications and Deliverables Manual (HSSDM), April 2011".

CUBE transforms measured points at relatively random locations into regularly spaced depth estimates in a grid. On each grid node, four values are produced: depth, uncertainty, (from depth TPU value), number of hypotheses generated, and hypothesis strength. Depending on how close or sparse vertically contributing depths are to resulting node values, the algorithm develops more than one potential depth candidate but selects only one as the most likely.

Table 3-5: CUBE Resolutions

Depth Range (m)	Resolution (m)
0-20	1
18-40	2
36-80	4
72-160	8
144-320	16

3.1.3.2 Contour and Sounding Generation

Once DTMs were generated, they were utilized to create contours at 10 m intervals using the CARIS Bathy DataBASE Editor 3.2. Contours were exported from CARIS Bathy DataBASE Editor 3.2 in DXF format and imported into ArcMap10 for labeling and final chart production.

3.1.3.3 ASCII Files

Two sets of ASCII files were exported from CARIS HIPS; one with XYZ for all DTM grid nodes (based on best resolution), and another with XYZ containing all of the accepted soundings for later slope analysis.

3.2 BACKSCATTER PROCESSING

Backscatter data were processed and mosaicked using GeoCoder. GeoCoder was developed by Dr. Luciano Fonseca of the University of New Hampshire. The program is licensed by the University of New Hampshire, but Fugro has modified it for our processing needs.

3.2.1 CORRECTIONS TO BACKSCATTER DATA

Multibeam echo sounder and backscatter data were processed onboard the F/V Pacific Star where the client representative reviewed the preliminary data (excluding the Chirikof site).

Next, data from the outer edges of the swath were clipped, leaving only higher quality, near range data, and GSF files were created. The data was then run through the Auto Process within GeoCoder. Some of the steps and functionality are as follows:

- Slant range Correction – Backscatter samples are added based on the time and range of bottom detect point to assemble the trace.
- Radiometric Correction – Each raw backscatter sample is corrected for removal of acquisition gain and power levels and normalized for strength per unit of area.
- Angular Response Filter- To remove beam pattern residuals.
- Speckle Removal – A median filter is used to dampen speckle.
- Image creation – Each backscatter point is mapped to a vertex of a quadrilateral and pixel values are determined by the average of the vertex values weighted by the distance.
- Anti-Aliasing, Feathering and Overlap

3.2.2 MOSAIC CREATION

Backscatter mosaics were created using GeoCoder (**Figure 3-4**). Resolutions were determined by GeoCoder, where the program determines the average across track distance in snippet samples. The default pixel size is the across track range in meters divided by the sample count.

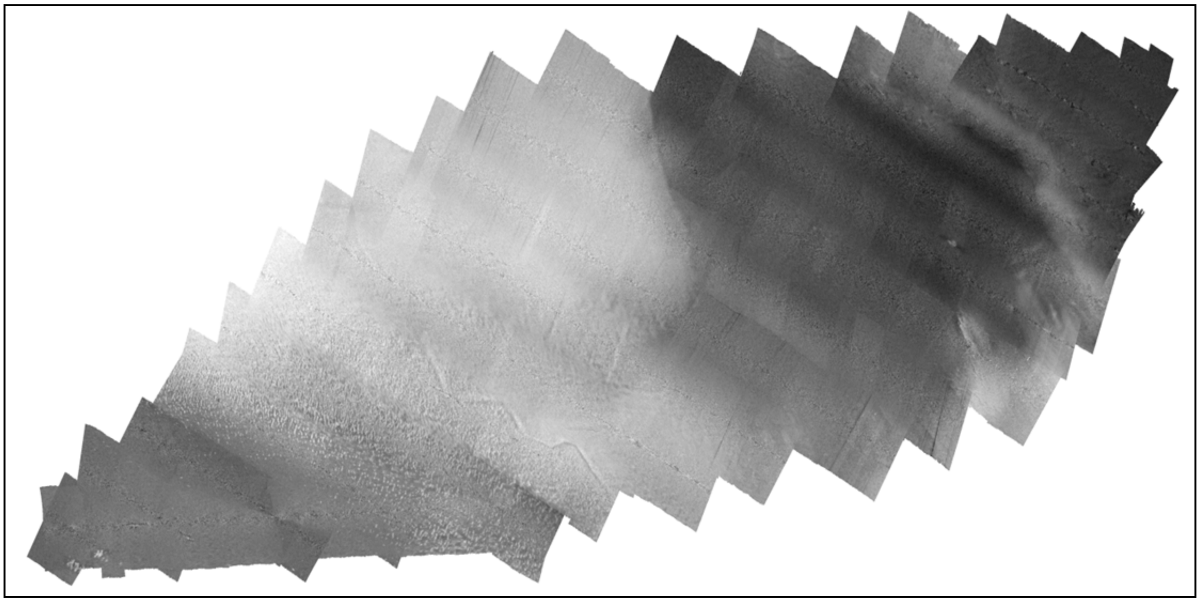


Figure 3-4: Dixon Backscatter Mosaic

4 CHARTING AND DATA PRODUCTS

The charting was carried out using ArcMap 10 software. ArcMap 10 was used to generate chart backgrounds and legends. CARIS HIPS and SIPS along with CARIS Bathy DataBASE were used to create all vector data layers.

Digital Deliverables are summarized as follows:

- Final Report (PDF)
- All Raw s7k files containing Multibeam and Backscatter Data
- All Processed and CARIS HDCS data
- ASCII XYZ of grid nodes at best resolution
- All Accepted Soundings in ASCII format for slope analysis
- Bathymetric contours in ArcMap SHP format
- GeoTiffs of Backscatter at best resolution
- GeoTiffs of Backscatter at best resolution draped over bathymetry
- Grey-Scale and Color Geo Tiffs of sun-illuminated bathymetry

A list of charts is provided below in Table 4-1:.

Table 4-1: Delivered Charts

CORAL & SPONGE HABITAT SURVEY				
Chart Name	**Sheet**	**Chart Location**	**Chart Scale**	**Chart No.**
Dixon_Overview	Dixon	Dixon	1:40000	N/A
POW_Overview	POW	POW	1:45000	N/A
Fairweather_Overview	Fairweather Ground	Fairweather Ground	1:40000	N/A
Chirikof_Overview	Chirikof	Chirikof	1:40000	N/A

Appendix A: DAILY PROGRESS REPORT SAMPLES

Below is an example of the Operational Overview DPR:

Fugro Pelagos, Inc.
NMFS Coral Sponge Initiative, AK

Daily Progress Report
NMFS Coral Sponge Initiative, AK
As of 23:59 (Note: Times are in Local Time Zone)

Date: 06/06/2012 Julian Day: 157/158
Summary of Day's Activities**:**

Pacific Star: Completed POW survey area at 16:14 and started transit north to Fairweather grounds site

Estimated Percentage Complete: **40% overall**

Area 1 (Dixon): *100 % completed*
Area 2 (POW): *100 % completed*
Area 3 (Fairweather): *0 % completed*
Area 4 (Chirikof): *0 % completed*

Note: These percentages are simple estimates.

Vessel Operations:

Pacific Star	Survey Operations	Downtime		
		Weather	Survey Equip	Vessel/Mic.
Today	16.14	0	0	0
Project	43.46	0	0	0
Project %	100.0%	0.0%	0.0%	0.0%

Vessel Concerns:

Pacific Star: Refrigerator in Galley has stopped working it needs to be replaced or fixed in Kodiak, Spare bushings for davits need to arrive in Kodiak.

R2: Vessels GPS needs to be replaced in Kodiak, It was discovered on transit.

D2: None to Note.

.

Outstanding Technical, Personnel or Equipment Issues: *none to note*

Personnel, Logistics and Safety:

Fugro Pelagos, Inc.
NMFS Coral Sponge Initiative, AK

A. Personnel on Site

Pacific Star:

Survey Crew:
Dale Reynolds (FPI)-Party Chief
Jenny Tixier (FPI) – Acquisition –Pacific Star-Day
Michael Lydon (FPI) – Acquisition –Pacific Star – Night
Mila Cox (FPI) – Processing –Pacific Star-Day
Dawn Bugden (FPI) – Processing-Pacific Star-Night

Vessel Crew (Ocean Services - Stabbert Maritime):
John Seville (Captain)
Rod Brumbaugh (1st mate)
Rich Soderblom (2nd mate)
Bill Bartunek (Chief Engineer)
Ivan Lesley (Asst. Engineer)
Isac James (Wiper)
Dave Aus (AB)
Crystal Nailor (Cook)
David Redding (OS)
Rod Purves (AB)
John Anderson (AB)

B. Logistics

Next Rotation Date: *None to Note*
Personnel Off: *None to Note*
Personnel On: *None to Note*

Equipment/Supplies Departing: *None to Note*
Arriving: *2-Protection collars for the UTCD probe*

C. Safety Incidents to Report: *None to Note*

Morning Update and Toolbox Talk Conducted at 0650 and 19:00.

	Induction	Toolbox Meeting	Ships Drill	1st Aid	Illnes s	Medical Treatmt.	Near Miss	Restricted Work	Lost Work	Incidents
Today	0	2	0	0	0	0	0	0	0	0
This Month	0	5	2	0	0	0	0	0	0	0
Project	0	5	2	0	0	0	0	0	0	0

Fugro Pelagos, Inc.
NMFS Coral Sponge Initiative, AK

Weather:

PKZ041-070100-
DIXON ENTRANCE TO CAPE DECISION-
400 AM AKDT WED JUN 6 2012

...SMALL CRAFT ADVISORY THROUGH TONIGHT...
.**TODAY**...SE WIND 25 KT SHIFTING TO THE E IN THE AFTERNOON. SEAS 6 FT BUILDING TO 10 FT IN THE AFTERNOON.
.**TONIGHT**...E WIND 20 KT DIMINISHING LATE. SEAS 10 FT.
.**THU**...NE WIND 10 KT BECOMING NW 15 KT IN THE AFTERNOON. SEAS 7 FT. SW SWELL.
.**THU NIGHT**...NW WIND 15 KT. SEAS 7 FT.
.**FRI**...NW WIND 20 KT. SEAS 6 FT.
.**SAT**...W WIND 25 KT. SEAS 7 FT.
.**SUN**...SE WIND 25 KT. SEAS 8 FT.

Survey Plan:

A. Survey Plan/weather impact expected for next 24 hours

- ***Pacific Star*** *– Complete POW site and start transit to the Fairweather grounds.*

B. General Plan/Priorities for the next week.

We complete the Fairweather grounds site survey and then make a port call in Kodiak. The 4th location will be completed after Kodiak, on route to the Krenitzin Islands.

Signed

Dale Reynolds
Lead Hydrographer

Below is an example of a online detailed DPR :

Daily Progress Report

Vessel: Pacific Star

Date: 07/11/2012

Breakdown of Daily Operations

Survey Operations:

Downtime Due To Weather:

Downtime Due To Equipment:

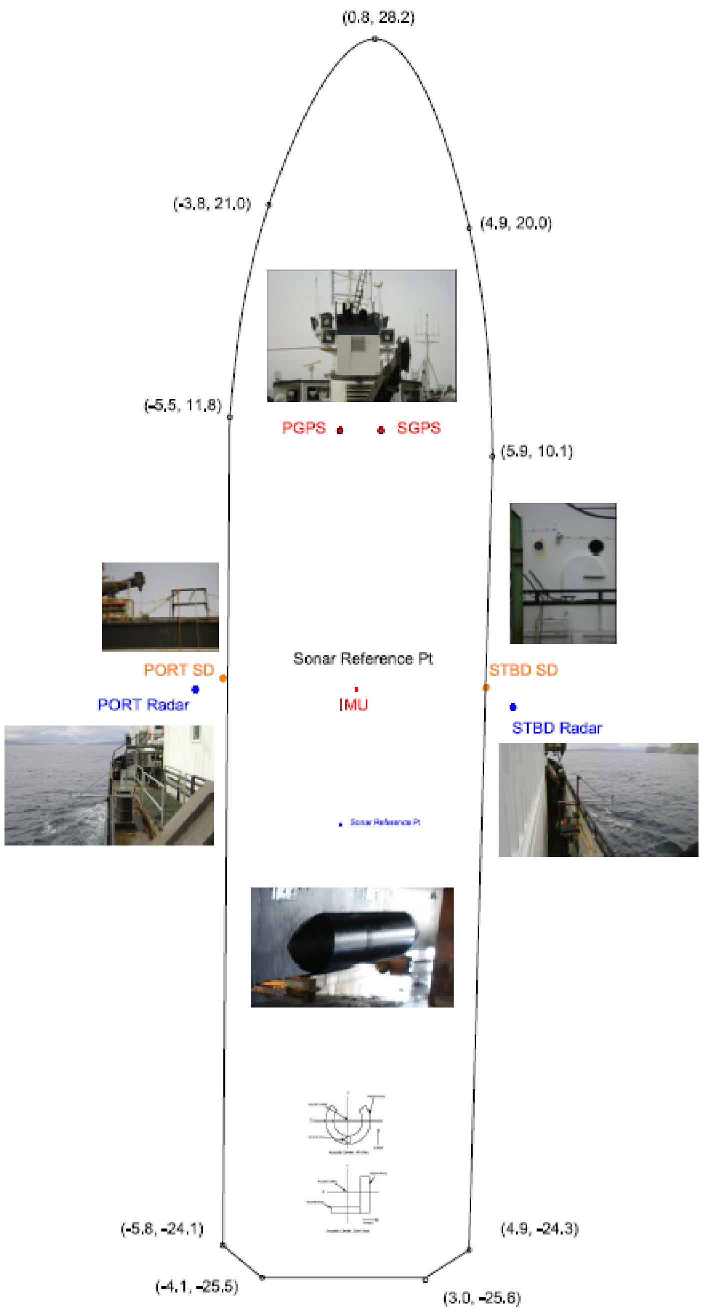
Downtime Due To Vessel:

TIME	SUMMARY
14:51:10	SOL - 1D1-200000 (Single 8111 - 100KHz, 101 beams)
15:26:29	EOL - 1D1-200000 (POS/MV File = 1-2012-193-1420)
15:31:06	SOL - 1D1-20250 (Single 8111 - 100KHz, 101 beams)
16:08:22	EOL - 1D1-20250 (POS/MV File = 1-2012-193-1420)
16:14:34	SOL - 1D1-21150 (Single 8111 - 100KHz, 101 beams)
16:40:01	SVP Conducted (Latitude: 55-05-37.04N Longitude:156-47-44.12W WD=418.5m)
16:49:14	EOL - 1D1-21150 (POS/MV File = 1-2012-193-1420)
17:02:02	SOL - 1D1-21950 (Single 8111 - 100KHz, 101 beams)
17:35:55	EOL - 1D1-21950 (POS/MV File = 1-2012-193-1420)
17:40:46	SOL - 1D1-22600 (Single 8111 - 100KHz, 101 beams)
18:12:12	EOL - 1D1-22600 (POS/MV File = 1-2012-193-1420)
18:18:58	SOL - 1D1-23200 (Single 8111 - 100KHz, 101 beams)
18:50:09	EOL - 1D1-23200 (POS/MV File = 1-2012-193-1420)
18:55:56	SOL - 1D1-23750 (Single 8111 - 100KHz, 101 beams)
19:07:30	SVP Conducted (Latitude: 55-07-24.29N Longitude:156-43-52.00W WD=745.3m)
19:30:32	EOL - 1D1-23750 (POS/MV File = 1-2012-193-1420)
19:38:53	SOL - 1D1-24300 (Single 8111 - 100KHz, 101 beams)
20:16:56	EOL - 1D1-24300 (POS/MV File = 1-2012-193-1420)
20:21:13	SOL - 1D1-24850 (Single 8111 - 100KHz, 101 beams)
20:56:21	EOL - 1D1-24850 (POS/MV File = 1-2012-193-1420)
21:03:36	SOL - 1D1-25400 (Single 8111 - 100KHz, 101 beams)
21:04:47	SVP Conducted (Latitude: 55-05-02.03N Longitude:156-43-50.59W WD=906.6m)
21:43:13	EOL - 1D1-25400 (POS/MV File = 1-2012-193-1420)
21:48:29	SOL - 1D1-25950 (Single 8111 - 100KHz, 101 beams)
22:18:54	EOL - 1D1-25950 (POS/MV File = 1-2012-193-1420)
22:38:54	SOL - 1D1-26500 (Single 8111 - 100KHz, 101 beams)
23:17:04	EOL - 1D1-26500 (POS/MV File = 1-2012-193-2225)
23:21:14	SOL - 1D1-11000 (Single 8111 - 100KHz, 101 beams)
23:57:19	EOL - 1D1-11000 (POS/MV File = 1-2012-193-2225)

Appendix B: VESSEL SPECIFICATIONS & OFFSETS

F/V Pacific Star

SURVEY VESSEL F/V PACIFIC STAR	
Owner	Pacific Star Fisheries, LLC
Official Number	556510
Length	162’
Breadth	38’
Depth	14’
Max Draft	16’
BHP Main Engines	3,000 combined BHP (1500 ea) Two Electromotive Diesels
Gross Tonnage (US)	194
Fresh Water Capacity	24,399 Gallons
Fuel Capacity	90,112 Gallons



F/V Pacific Star

Sensor	X	Y	Z
IMU (CRP)	0.000	0.000	0.000
Sonar Reference Point	-0.157	-4.186	-2.682
PGPS (Phase Center - High Gain Ant)	-0.709	11.216	13.329
PGPS (Phase Center - Trimble)	-0.709	11.216	13.303
SGPS (Phase Center - Trimble)	1.067	11.218	13.293
Port Static Draft	-5.798	0.486	5.971
Stbd Static Draft	5.625	0.076	5.914
Port Radar Draft Device (SN 1581)	-6.983	-0.002	6.143
Stbd Radar Draft Device	6.807	-0.786	5.974

Notes:
Z value for the Radars have been adjusted to their Acoustic Center.
All coordinates are on the IMU reference Frame.
X is positive to Stbd
Y is positive towards Bow
Z is positive Up

POS M/V Reference Frame

Sensor	X	Y	Z
PGPS (Phase Center)	11.216	-0.709	-13.329

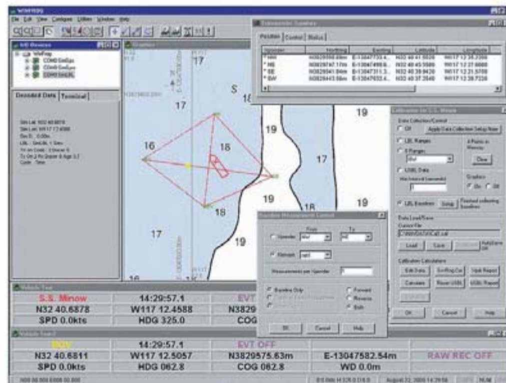
Note:
X is positive to Bow
Y is positive towards Stbd
Z is negative above Ref

F/V Pacific Star Offset Diagram

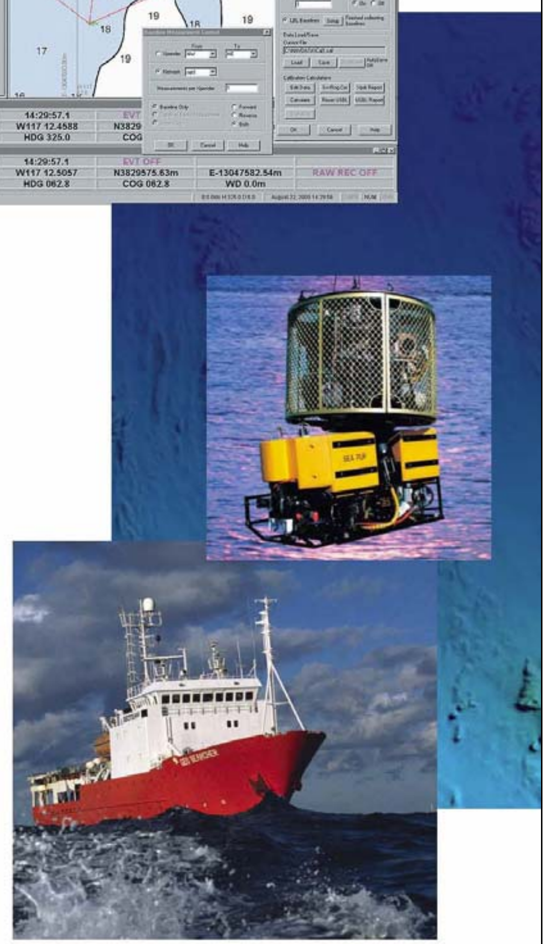
Appendix C: EQUIPMENT SPECIFICATIONS

WinFrog Integrated Navigation System

Fugro Pelagos, Inc., a member of the Fugro Group, specializes in providing services and software for the marine survey and positioning industry. We employ the most experienced professionals in the industry, and as a company have more than 25 years of success worldwide. We specialize in integrating systems to provide advanced solutions to handle all of your survey and positioning needs.



We take pride in our ability to give customers the personalized attention of a small company while providing them with the resources and infrastructure of a large, global organization. Our customers benefit from the fact that we develop and test our own solutions, on our own projects, before releasing them commercially. Our clients know they are receiving a system that has been proven in the field.



At Fugro Pelagos, we understand our customers' needs because we work alongside them. Our project managers and their teams maintain full control of a project from beginning to end to ensure a project's technological and commercial success. Whether in the field or at the drawing board, our customers are confident that they are receiving a product that meets their needs.

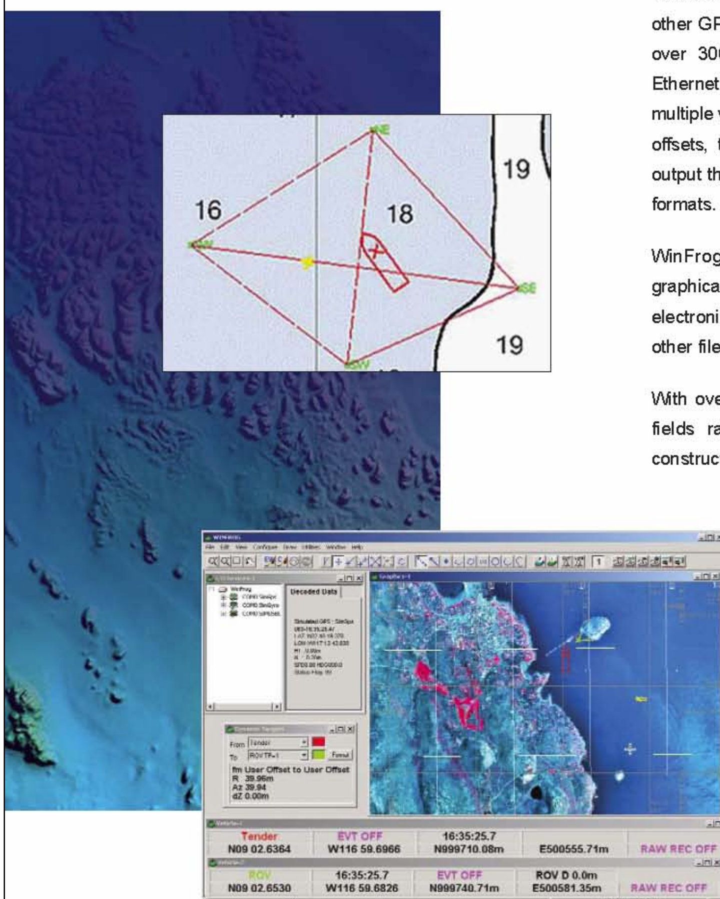
Fugro Pelagos provides you with the latest innovations in integrated navigation and data management system software.

WinFrog is a complete Integrated Navigation System that combines surface navigation and underwater positioning into one cost-effective package. Its modular design allows customization to meet users' various needs.

The core program provides you with real-time position and navigation information, and can simultaneously collect data from up to 25 types of devices, including other GPSs and sounders. WinFrog currently supports over 300 different devices through either serial or Ethernet communications. It also allows you to define multiple vehicles, each having its own devices, names, offsets, tracks and shapes. In addition, data can be output through industry standard NMEA or customized formats.

WinFrog also supports multiple file formats for graphical display, including C-MAP, ARCS and BSB electronic charts, as well as DXF, DWG, DGN and other file formats.

With over 500 licenses in operation for customers in fields ranging from marine survey to underwater construction, WinFrog is today's integrated navigation and data management system solution. Our success in many industries stems from our commitment to delivering complete solutions based on customers' needs and tailoring our systems to ensure complete satisfaction.



SeaBat® 7111

MULTIBEAM ECHOSOUNDER SYSTEM

The SeaBat 7111 produces bathymetry data suitable for the generation of high resolution hydrographic charts exceeding international standards in water depths from 3 to 1000m. Operating at 100kHz, the system forms 101, 201 high-density, equi-angle or 301 equi-distant beams to cover a total receive sector of 150°.

The SeaBat 7111 transducer array is comprised of a cylindrical receive array and a linear transmitter array, mounted together on a support cradle that provides mounting points to the vessel. Lightweight and portable, the array can be installed temporarily over the side of a vessel of opportunity a first for a system in this frequency range.

The SeaBat 7111 is controlled by a high performance sonar processor that manages data flow and signal processing using a state-of-the-art FPGA architecture. The sonar processor provides a Windows®-based GUI user interface, allowing system configuration, control, data output, storage and built-in test environment (BITE) displays to assist the operator.

Equi-distant or equi-angular beam spacing across the entire swath is selectable by the operator to provide uniform sounding density and maximize usable outer swath. Data outputs include bathymetry, sidescan, snippets & beamformed water column data.

PRODUCT LOGBOOK

RESON

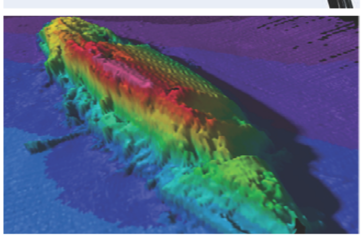
INSTALLATION	Unique portable system
MOUNTING	Suitable for vessel over-the-side, bow or hull mounting
FREQUENCY	100kHz frequency
BEAMS	101, 201 EA / 301 ED focused beams
SWATH	150° swath coverage (7.5X depth)
BATHYMETRY	Bathmetry & imagery from 3m to 1000m
OPERATION	Automatic operation
STABILISATION	Pitch stabilisation
IHO	IHO compliant
OPTIONS	19" marine grade monitor
	1 TB external RAID drive
	SVP-70 sound velocity profiler with 25m cable
	Service & maintenance agreement
	7111 30m transducer cables
	7111 spares kit

PLD13774-4

RESON

SEABAT 7111 SYSTEM SPECIFICATIONS

FREQUENCY	100kHz
PULSE LENGTH	0.08ms to 3.04ms (selectable)
TYPICAL DEPTH	1m to 900m
MAX DEPTH	1000m
DEPTH RESOLUTION, SECTOR COVERAGE,	3cm, 150°
NUMBER OF BEAMS	101, 201 EA or 301 ED
ALONG-TRACK, ACROSS-TRACK BEAMWIDTH	1.9° , 1.5° ± 0.05° (3.0°, 4.5°, 6.0° operator selectable)
BOTTOM DETECTION METHOD	Center-of-energy and phase-zero-crossing algorithm
PITCH STABILISATION	±10° (motion sensor required)
MAX UPDATE RATE	20Hz (range selection dependent)
SYSTEM SUPPLY	90 to 260 VAC 50/60 Hz, 350 W
SYSTEM CONTROL	Trackball or from ethernet
TEMPERATURE: OPERATING, STORAGE	-5°C to +40°C, -30° to 55°C
DATA OUTPUT	Gigabit ethernet
TRANSDUCER ARRAY: WEIGHT	72kg (air), 59 kg (water) with cables
SONAR PROCESSOR: DIMENSIONS, WEIGHT	431.4mm x 220.8mm x 559.5mm, 30kg
TRANSCEIVER: DIMENSIONS &, WEIGHT	267mm x 483mm x 489mm, 13.6kg
HYDROPHONE & PROJECTOR DIMENSIONS	636mm x 118mm (Diameter/ Length), 113mm x 650mm (Diameter/Length)
CABLE LENGTH	15m, 30m (optional)



WHY CHOOSE A SEABAT 7111 SYSTEM?

- Lightweight and portable system, which can be installed temporarily over the side of a vessel
- Sidescan and snippet, assisting with determination of detected features
- Advanced signal processing and bottom detect routines deliver second-to-none data quality
- Services and Support Agreement (SSA)

RESON A/S
Denmark
Tel: +45 4738 0022
reson@reson.com

RESON Inc.
U.S.A.
Tel: +1 805 964-6260
sales@reson.com

RESON OFFSHORE Ltd.
Scotland U.K.
Tel: +44 1224 709 900
sales@reson.co.uk

RESON GmbH
Germany
Tel: +49 (0) 431 720 7180
reson@reson-gmbh.de

RESON B.V.
The Netherlands
Tel: +31 (0) 10 245 1500
info@reson.nl

RESON Pte. Ltd.
Singapore
Tel: +65 6725 9851
singapore@reson.com

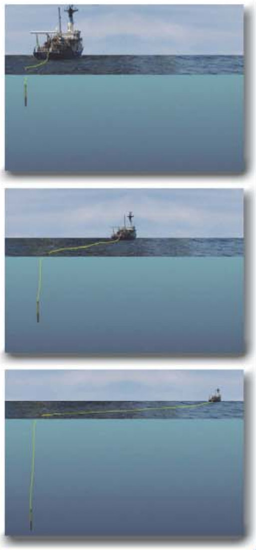
www.reson.com

Front cover photograph © Marine Scotland

OCEANSCIENCE

UnderwayCTD

CTD Profiling From A Moving Vessel



CTD Profiling From A Moving Vessel

The Oceanscience UnderwayCTD provides research-quality CTD profiles while underway at up to 20kts. The unique freefall CTD probe, manufactured by Sea-Bird Electronics affords vertical profiles to a maximum depth of 1250m while underway, with stationary casts possible down to 1500m. The probe is tethered to the ship by up to 2km of high strength line, with a unique deployment winch and re-spooling mechanism that allows the probe to be recovered and relaunched time after time without ever needing to stop or slow down. At a constant 10kts, CTD profiles down to 600m are possible. Bluetooth communications make data handling easy, and provide a fast turnaround between casts.

Maximize Productivity

Save hours of valuable ship time by reducing the necessity to stop the ship for a conventional CTD station, or avoid the use of labor intensive or depth-limited towed CTD profilers. Benefit from greatly improved data quality compared to expendable probes.

Versatile And Simple To Use

The UnderwayCTD can be installed on practically any vessel. The small footprint winch can be mounted on a post or rail, and can be set up and operated by one person. The UnderwayCTD components can be transported from ship to ship with ease, making the system ideal for gathering high quality data from vessels of opportunity.

Online Viewers Click For Video

Open Ocean or Shallow Water Options

The UnderwayCTD is available in deep water “free cast” or shallow “tow-yo” configurations. Shallow water “tow-yo” operation offers CTD profiles to 200m every 10 mins at 6kts.

No Expendable Components

UnderwayCTD users leave no sea floor waste behind them, and benefit from temperature and salinity data quality impossible to achieve with single-use profilers.

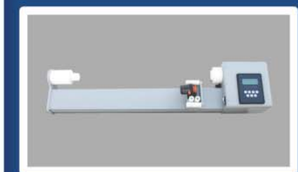
WWW.OCEANSCIENCE.COM

Underway CTD

UnderwayCTD Components

Main Winch

The UnderwayCTD winch features a large capacity reel with a high-torque DC drive unit and motorized levelwind, for fast and safe probe deployment and retrieval. The reel holds up to 2000m of high strength line for maximum profiling flexibility. The main winch not only pays out line during deployment as the probe drops through the water column, but is rotated to provide line for re-spooling onto the probe tail using the rewinder. A compact 1500 W power supply (110/220 VAC, 50/60 Hz input) supplies power to all system components.

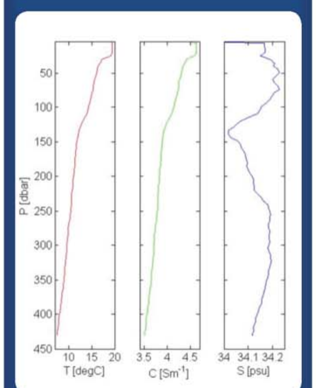


Rewinder

The microprocessor controlled UnderwayCTD tail spool rewinder precisely loads the CTD probe tail spool with high strength line, typically 300m to 700m of line is added from the main winch, usually equivalent to the desired cast depth. The unit may be programmed for different profile depths and is automated for quick turnaround.

Probe System

The UnderwayCTD probe consists of a ruggedized and streamlined Sea-Bird CTD with Bluetooth wireless communication. The probe and its attached tail spool loaded with high-strength line is simply dropped from the vessel, reaching its target depth rapidly at a 4m/s drop speed. Profiles are stored on the probe and periodically downloaded as desired during operation. A "gravity pumped" conductivity cell and extremely accurate pressure and temperature sensors offer research quality data during freefall, sampled at 16Hz.



Configuration Options

Select up to 2km of high strength line for maximum depth operation (A), or use thicker line for maximum probe retrievability at higher vessel speeds (B). Use the basic "tow-yo" system for shallow water profiling with target depths of 50m to 300m (C).

	Vessel Speed					
	0kts	2kts	4kts	6kts	8kts	10kts
A. Maximum Depth	1300m	1000m	800m	700m	700m	600m
B. Multi Purpose	1000m	800m	650m	600m	550m	500m
C. Shallow "Tow-yo" (Max)	1000m	700m	550m	450m	400m	350m

Order Codes

UC-WIN - Main Winch
UC-REW - Rewinder
UC-PS - Power Supply
UC-DV - Universal Davit
LINE - Spare line

Contact Information

The Oceanscience Group
4129 Avenida de la Plata
Oceanside, CA 92056

Phone (760) 754-2400
Fax (760) 754-2485
info@oceanscience.com

OCEANSCIENCE

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POS MV™ 320

Performance

	RTK	DGPS
Position (m)	0.02 - 0.10	0.5 - 4.0
Velocity (m/s)	0.03	0.03
Roll and Pitch	0.01û	0.02û
True Heading	4m baseline: 0.01, 2m baseline: 0.02û	
Heave	5% of heave amplitude or 5cm	

Physical Specifications

Size	IMU	204 x 204 x 168mm
	PCS	441 x 111 x 346mm, 2.5U 19" rack mount
	Antenna	178 Ø x 77mm (2x)
	Choke Ring	360 Ø x 61mm (2x)
Weight	IMU	3.5 Kg
	PCS	7 Kg
Power		110/220 VAC, 60/50 Hz, 60W
Operating Temperature	IMU & Antennas	-40û to +60ûC
	PCS	0û to +60ûC
Humidity	IMU & Antennas	0 to 100%
	PCS	5 to 95% RH non-condensing
Cables	IMU	8m standard
	Antennas	15m standard (2x)

Interfaces

Ethernet Interface (10base-T)	Function	Operate POS MV™ & record data
	Data	Position, attitude, heading, velocity, track and speed, acceleration, status and performance, raw data. All data has time and distance tags
	UDP Ports	Display port - low rate (1Hz) data
		Data port - high rate (1-200Hz) data
	IP Ports	Control port - used by POS™ controller
RS232 Interface (DB9 males)	NMEA Port	GGA, HDT, VTG, GST, ZDA, PASHR, PRDID (1-50Hz), GGK
	High rate attitude data port	Roll, pitch, true heading and heave in all multibeam proprietary formats (1-200 Hz)
	Auxillary GPS input	GGA, GST, GSA, GSV from Auxilliary DGPS, P-code or RTK reciever
Options	Internal RTK GPS receiver; analog interface (roll, pitch & heave); field support kit	

All performance figures are RMS, unless otherwise noted. Specifications subject to change without notice.

APPLANIX®
MARINE

Applanix LLC 17461 Village Green Drive, Houston, TX, 77040
tel: 713-896-9900 fax: 713-896-9919 email: info@applanix.com

CARIS

HIPS and SIPS

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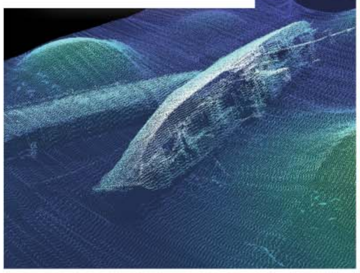
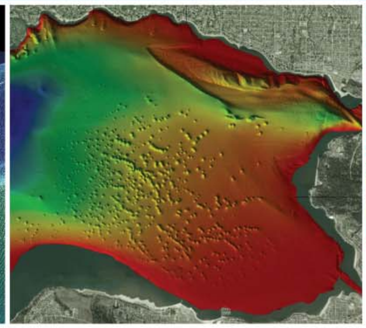
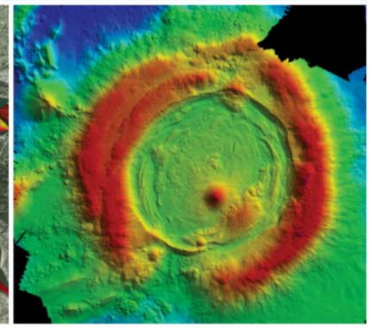






CARIS knows that accuracy and efficiency are all-important in your business, which is why the HIPS and SIPS solution integrates the processing of bathymetry, water column and seafloor imagery in a single application.

With HIPS and SIPS vast amounts of sonar data can be interrogated at speed, making full use of the latest computing power and saving you valuable time.

The software also includes the latest seafloor classification tools and workflows, allowing more information to be extracted from your seafloor measurements.

TRUST THE MOST COMPREHENSIVE DATA PROCESSING SYSTEM

Number One

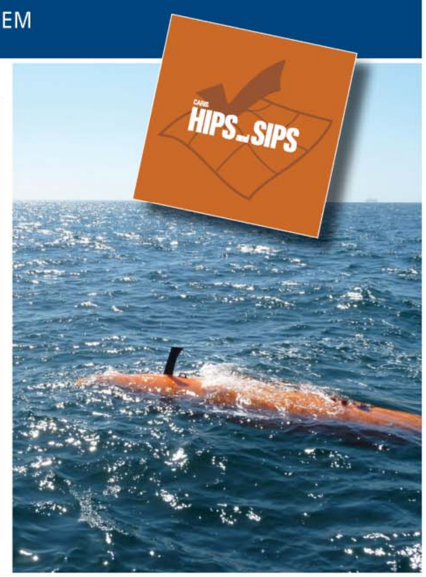
HIPS and SIPS is recognized in the global marine community as the number one hydrographic data processing system. By supporting over 40 sonar formats, it can process data from virtually any system configuration.

Latest Processing Techniques

The latest processing techniques can easily be applied to your high volume sonar data, ensuring efficient and repeatable results. This includes total propagated uncertainty, CUBE processing, statistical surface cleaning, dynamic 3D data editing, and an array of geodetic and quality gate filters.

"My first task when joining the UKHO (in 2002) was to assess all current bathymetry software to help select the primary tool to be used by our staff and the UK Royal Navy for multibeam data processing. Based on our assessment criteria, HIPS and SIPS was the clear winner. Eight years on, we have not regretted that decision."

-David Parker, UKHO Civil Hydrography Manager



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www.caris.com

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HIPS AND SIPS

CARIS
115 Waggoners Lane
Fredericton, New Brunswick
E3B 2L4 Canada
Tel +1.506.458.8533
Fax +1.506.459.3849
info@caris.com

CARIS BV
Mgr. van Oorschotstraat 13
PO Box 47 5473 ZG
Heeswijk, The Netherlands
Tel +31.413.296010
Fax +31.413.296012
info@caris.nl

CARIS USA
415 N Alfred Street
Alexandria VA 22314
United States
Tel +1.703.299.9712
Fax +1.703.299.9715
carisusa@caris.com

CARIS Asia Pacific
Suite 1, Innovation House
Mawson Lakes Boulevard
Mawson Lakes SA 5095
Australia
Tel +61.0.8.8260.8180
Fax +61.0.8.8260.8100
info@caris.com

Meeting Your Needs

Whether your survey is for safety of navigation, oceaneering, or scientific purposes, you can be confident that HIPS and SIPS converts your survey data into information you will use.

Digital elevation models, geological mosaics, contours, profiles, and 3D fly-throughs are among the many outputs that can be generated from your processed data. In addition, the integrated Plot Composer application allows you to rapidly create paper plots and charts in the field.

Size No Object

HIPS and SIPS can handle today's high volume surveys with ease through the use of the highly scaleable CSAR™ framework. From a single line of echosounder data to a multi-platform, multi-sensor survey project, the efficient storage mechanisms will ensure robust data management and optimal access to data.

Industry Standards

HIPS and SIPS makes full use of industry standards. Bathymetry can be tested for quality against the International Hydrographic Organization standards and exported for use in other applications through open exchange formats.

Easy to Use Interface

The HIPS and SIPS application has been evolving for 20 years. As well as striving to incorporate the latest algorithms and tools, CARIS is committed to making the application more intuitive with every release.

Ping-to-Chart™

As a standalone system, HIPS and SIPS is recognized as the industry leading processing tool. But when used in conjunction with other Ping-to-Chart products even more value from your data can be realized. CARIS offers the functionality to streamline your operation, from Ping-to-Chart.

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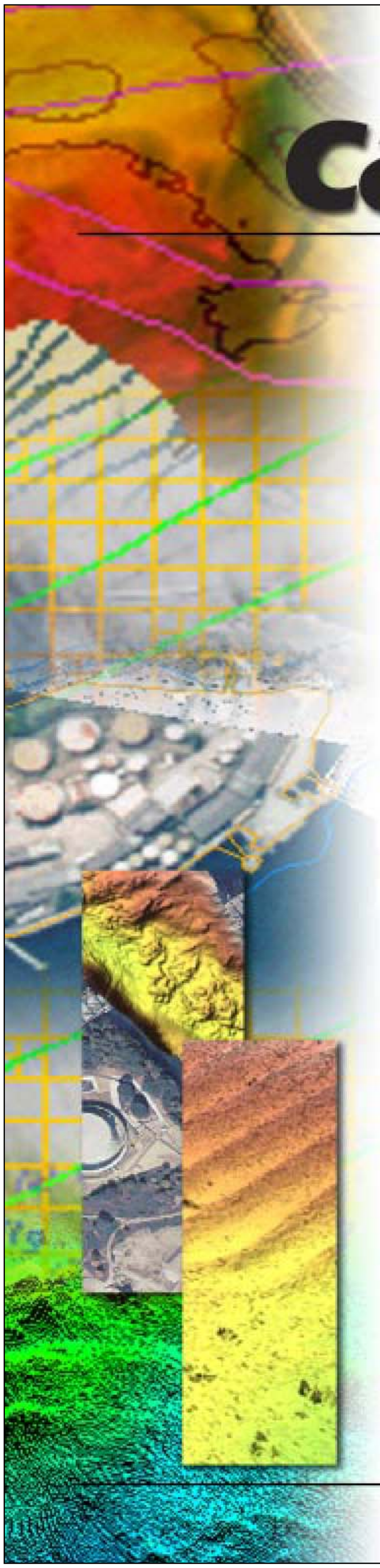


caris®

Bathymetric and Sonar Data Processing and Production

CARIS HIPS & CARIS SIPS

Hydrography. Cable and Pipeline Routing. Minecountermeasures. Side Scan search and recovery. Geophysical Exploration. Management of Fisheries. No matter what the application, the reliability and usability of your cleaned bathymetric and side scan sonar survey data is critical.

Based on its reputation for rigorous and proven algorithms, CARIS HIPS, for processing large bathymetric datasets, and CARIS SIPS, for processing side scan sonar imagery and multibeam backscatter data, have been selected number one among marine and hydrographic specialists for over 10 years.

PURPOSE-BUILT PROCESSING

Area and line based cleaning, 3D visualization, integrated sensor cleaning tools. These are but a few of the features that clearly suggest one thing: CARIS HIPS and CARIS SIPS are purpose-built processing and production systems.

INFORMATION YOU CAN USE

Tiling, contours, depth areas, shoal-biased sounding selection and an interactive dynamic profile are among the multitude of outputs that can be generated from your clean bathymetry and sonar data. Bottom line, CARIS software turns your survey data into information you can use.

ENGINEERED TO WORK TOGETHER

CARIS software systems are engineered to work together. CARIS HIPS and CARIS SIPS are standalone systems but are also capable of operating in unison offering the functionality and format support allowing you to take your clean data further.

BUILT TO GROW ON

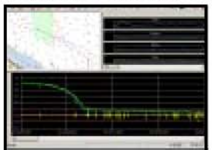
Open an S-57 ENC file and display the data with other data types such as BSB, HCRF, and GeoTIFF as well as vector CARIS map data. Regardless of your current workflow, CARIS HIPS and CARIS SIPS are built to grow on.

CARIS HIPS and CARIS SIPS are backed by training from subject matter experts, assistance in data production flowline implementation, and by knowledgeable and responsive support personnel.

Review the suite of CARIS HIPS and CARIS SIPS products described on the reverse side and contact CARIS today about a solution that is right for you.

turning data into information

CARIS HIPS & CARIS SIPS Product Suite

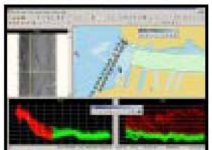


HIPS Singlebeam

Supported Formats:
- Hypack, Winfrog
- Generic ASCII Data

Data Cleaning:
- Interactive singlebeam depth cleaning
- Automatic singlebeam spike filters

Data Processing:
- Apply tides / zoning
- Apply SV corrections

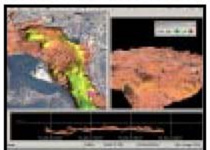


HIPS Multibeam Lite

Supported Formats:
- *HIPS Singlebeam, PLUS*
- Atlas, Furuno, GSF, LADS, Seabeam / Elac, SeaFalcon, Simrad, UNB, XTF

Data Cleaning:
- *HIPS Singlebeam, PLUS*
- Interactive swath cleaning
- Automatic swath filters
- Refraction repair
- Integrated side scan display

Data Processing:
- Apply tides / zoning
- Apply SV corrections

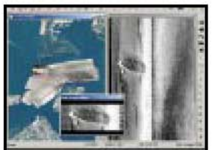


HIPS Multibeam Professional

Supported Formats:
- *same as HIPS Multibeam Lite*

Data Cleaning:
- *HIPS Multibeam Lite, PLUS*
- 3D subset area cleaning
- Statistical surface cleaning

Data Processing:
- *HIPS Multibeam Lite, PLUS*
- Weighted gridding

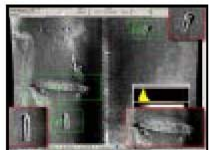


SIPS Lite

Supported Formats:
- Cmax, Coda, EdgeTech, GSF, MarineSonics, Qmips, Segy, XTF
- Generic ASCII Data

Data Cleaning:
- Side Scan viewing and cleaning
- Digitize towfish altitude

Data Processing:
- Re-compute towfish navigation
- Slant range correction
- Mosaic



SIPS Professional

Supported Formats:
- *same as SIPS Lite*

Data Cleaning:
- *same as SIPS Lite*

Data Processing:
- *SIPS Lite, PLUS*
- Generate side scan contacts database

HIPS & SIPS Common

Data Tools:
- Vessel configuration
- Tide / Svp preparation
- Attitude / Navigation cleaning
- GPS RTK Tide
- Background displays (CARIS, S-57, BSB, HCRF, TIF...)

Mapping Tools:
- Variable depth tiling
- Sounding selection
- Contouring
- Plotting

For more information on **CARIS HIPS** and **CARIS SIPS** contact:

CARIS
264 Rookwood Avenue
Fredericton, New Brunswick
E3B 2M2 Canada
Tel +1.506.458.8533
Fax +1.506.459.3849
info@caris.com
www.caris.com

CARIS BV
Mgr. van Oorschotstraat 13
PO Box 47 5473 ZG
Heeswijk The Netherlands
Tel +31.413.296010
Fax +31.413.296012
sales@caris.nl
www.caris.nl

CARIS USA
11750 Frederick Road
Ellicott City, MD
21042 USA
Tel +1.410.531.5129
Fax +1.410.531.5759
info@caris.com
www.caris.com

www.caris.com

CARIS

BASE Editor

caris
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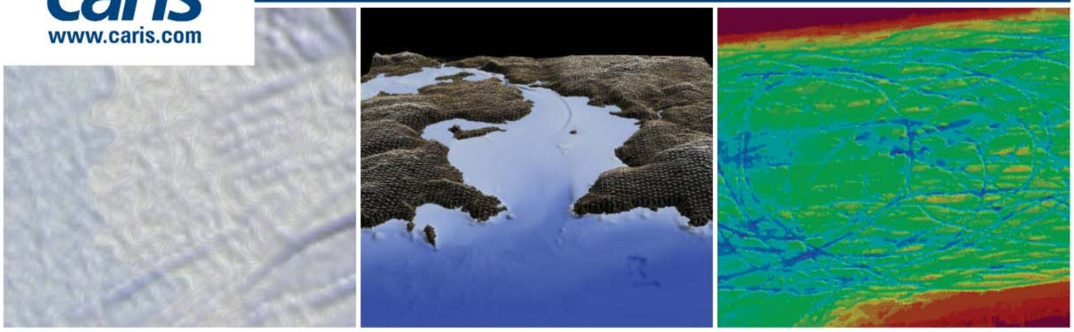

Analyze and manipulate your processed bathymetry data with this highly intuitive desktop solution.

BASE Editor supports bathymetry processed in the HIPS application, as well as many other common grid formats, and allows for the easy import of generic XYZ data.

Once in the system, data can be easily contoured, decimated, interpolated and transformed.

POWERFUL DEM CREATION AND ANALYSIS

Flexible Format Support

BASE Editor provides native support for a wide range of common gridded data formats including ESRI Grids, USGS DEMs, NetCDF, as well as BAG and BASE Surfaces created in the HIPS and SIPS software. It also allows the import of generic XYZ data and many other bathymetry and elevation formats such as GSF, HTF, HYD93 and LAS into CARIS' powerful and highly scaleable CSAR™ framework.

3D Visualization

Visualize and interrogate DEMs as surfaces or point clouds in full 3D. Apply dynamic lightning and exaggeration, overlay or clip raster and vector background layers to the DEM, and record your own 3D fly-throughs as movies to share with your clients or use in your presentations.

Powerful Analysis

Perform powerful analysis on your datasets such as surface differencing to determine changes. Combine multiple datasets together based on user definable rules. Interpolate or decimate, generate profiles and calculate slope and aspect for the terrain models in question.

Seamlessly Model Land and Sea

Reconcile differences in coordinate reference systems and fuse together land and sea DEMs to allow seamless analysis and product creation in the littoral zone. BASE Editor allows land and sea datasets to be treated appropriately, as it understands elevation measurements both above and below sea level.

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www.caris.com

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BASE EDITOR

CARIS
115 Waggoners Lane
Fredericton, New Brunswick
E3B 2L4 Canada
Tel +1.506.458.8533
Fax +1.506.459.3849
info@caris.com

CARIS BV
Mgr. van Oorschotstraat 13
PO Box 47 5473 ZG
Heeswijk, The Netherlands
Tel +31.413.296010
Fax +31.413.296012
info@caris.nl

CARIS USA
415 N Alfred Street
Alexandria VA 22314
United States
Tel +1.703.299.9712
Fax +1.703.299.9715
carisusa@caris.com

CARIS Asia Pacific
Suite 1, Innovation House
Mawson Lakes Boulevard
Mawson Lakes SA 5095
Australia
Tel +61.0.8.8260.8180
Fax +61.0.8.8260.8100
info@caris.com

Ports and Waterway Management

The Engineering Analysis Module for BASE Editor provides essential engineering extensions for port and waterway management, including building and maintaining the theoretical channel model using the Reference Model Editor. By using the channel model, in conjunction with the bathymetric surfaces created in BASE Editor, the module allows you to perform sophisticated volume computations for dredging analysis. Shoal management is another important feature of the software. Seafloor areas that are shallower than the channel model can be automatically detected, providing the latest snapshot of navigable water to pilots.

Product Generation

It is easy to derive vector representations of the DEMs created with the BASE Editor, including high precision contours, depth area polygons and soundings. In addition, profiles, high resolution georeferenced raster images and XYZ extractions of your validated data are available for export. The integrated Plot Composer software allows you to rapidly create paper plots, reports and posters from the various datasets available to you in BASE Editor.

Interoperability / Data Exchange

The data created in BASE Editor can be exported in many open formats for use in other third party applications. Derived vector products such as contours can be exported to GML, KML, SHP and DXF formats among others. CSAR surfaces and point clouds can be exported to ESRI or USGS grids, as well as the BAG format and ASCII XYZ with accompanying ISO 19115 metadata.

Ping-to-Chart™

As a standalone system, BASE Editor is a powerful and scaleable DEM creation and analysis tool. When used in conjunction with other Ping-to-Chart products it forms part of a turnkey solution for survey data management. CARIS offers the functionality to streamline your operation, from Ping-to-Chart.

FOR MORE INFORMATION VISIT OUR WEBSITE | **WWW.CARIS.COM**

Appendix D: MBES ACQUISITION AND PROCESSING LOGS

Acquisition and processing records were maintained using Fugro Pelagos MBTools 2.00.31.00 on a line by line basis. MBTools documented specific information on how each line was logged and processed.

FPI Project # : FP1013_001 Multibeam Log : 1D1-23750

PROJECT INFORMATION

Client :	NOAA NMFS		
Project :	Multibeam	Location :	Alaska

GEODETICS

Horizontal Datum :	NAD83	Projection :	UTM
Vertical Datum :	MLLW	Zone / Units :	Zones 5 through 8 Meter

EQUIPMENT

Vessel :	F/V Pacific Star	Positioning :	POS M/V
Sounder :	Reson Seabat 7111	Timing Source :	POS M/V
Motion Reference :	POS M/V	Acquisition System :	Winfrog Multibeam

SURVEY DATA Survey Crew : AT Vessel Crew : John Logged By : AT

Line Name :	1D1-23750
MBES File Name :	1D1-23750
POS/MV File Name :	1-2012-193-1420
WFrog RAW File Name :	1D1-23750
Weather / SeaState :	Foggy Day / 2 - 4 m Swells
Max Ping Rate / Sec :	15
DGPS Station ID :	289
Depressors :	N/A

Date :	11-Jul-12
Julian Day :	2012 - 193
Heading :	201.7°
Length of Line :	~7.70 Km
Sonar Parameters :	8111 (100KHz, 101 beams)

SINGLE HEAD SETUP ☑ ISIS TIMING ☐
DUAL HEAD SETUP ☐ POS/MV TIMING ☑

TIME	RPM	SPEED	HDOP	POWER	RANGE	GAIN	PULSE	COMMENT
19:18:08	520	7.3	0.6	225	900	-65	3	
19:22:01	520	7.3	0.6	225	1000	-65	3	
19:30:10	520	7.3	0.6	225	1000	-65	0.5	
19:30:32	520	7.5	0.8	225	1000	-65	0.5	

Comments :

LINE QUALITY ☑ GOOD ☐ BAD

PROCESSING

Project :	D-1
Date :	2012 - 193
Convert :	DR

Draft File :		☐ LOADED
SVP File :	Area_D1.svp	☑ LOADED
Tide File :	Sand_Point_9459450_	☑ LOADED

LINE EDIT:

GHPR :	DR
Nav :	
Draft :	
Bathy :	DR
Merge :	DR
TPE :	DR

True Heave :		☑ POS	☐ GDP
PPK :		☐ POS	☐ GDP
Settings File :	01_50.hff		

Comments:

Additional Filters

Depth	Min :	
	Max :	
Nadir	Port :	
	Stbd :	
Across Track	Port :	
	Stbd :	

LINE QUALITY ☑ GOOD ☐ BAD

Appendix E: PATCH TEST PROCESSING REPORT

PATCH TEST REPORT
(Multibeam and Motion Reference Unit Calibration)

A patch test was completed using seafloor topology to bring multibeam swaths run at varying headings and overlaps into coincidence. Patch tests are employed so that data can be corrected for timing latency, pitch, azimuth, and roll offsets, which may exist between the MBES transducer and the MRU.

The physical offsets were determined in the following order: Latency (Timing), Pitch, Yaw and Roll.

Patch Test Results:

Calibration	Navigation Timing Error	Pitch Offset	Azimuth Offset	Roll Offset
Julian Day 152	0.00 sec	-0.400°	-0.600°	-0.535°
Julian Day 191	0.00 sec	-0.400°	-0.600°	-0.590°

Note: An additional Patch Test was conducted on JD 191 because the IMU on the Pacific Star had to be installed on the M/V D2 (D2's IMU had failed) during a different NOAA Task order. Upon completion of that Task order the IMU was re-installed and the Pacific Star to complete the Chirikof site.

Below is a presentation of the calibration procedure for the Patch Test.

Latency

Fugro Pelagos has implemented a timing protocol for multibeam data acquisition. In this scheme, UTC time tags generated within the POS MV are applied to all position, heading and attitude data. The POS MV UTC string is also sent to the SeaBat, where the ping data are tagged. The architecture of the POS MV ensures that there is zero latency between the position, heading and attitude strings. The only latency possible is in the ping time. In addition, the navigation-to-ping latency will be identical to the attitude-to-ping and heading-to-ping latencies.

Navigation latency is generally difficult to measure using standard timing and patch testing techniques. However, using Fugro Pelagos' timing protocol, the navigation latency will be the same as the roll latency. Fortunately, roll latencies are very easy to identify. Data with a roll timing latency will have a rippled appearance along the edge of the swath. During patch test analysis, the roll latency is adjusted until the ripple is gone.

This latency value is then applied to the ping time, synchronizing it with the position, attitude and heading data.

Pitch

The Pitch error adjustment was performed on a set of two coincident lines, run at the same velocity, but in opposite directions, over a conspicuous topographic feature. The latency error was already identified as 0.00. The nadir beams from each line were compared and brought into alignment by adjusting the pitch error value.

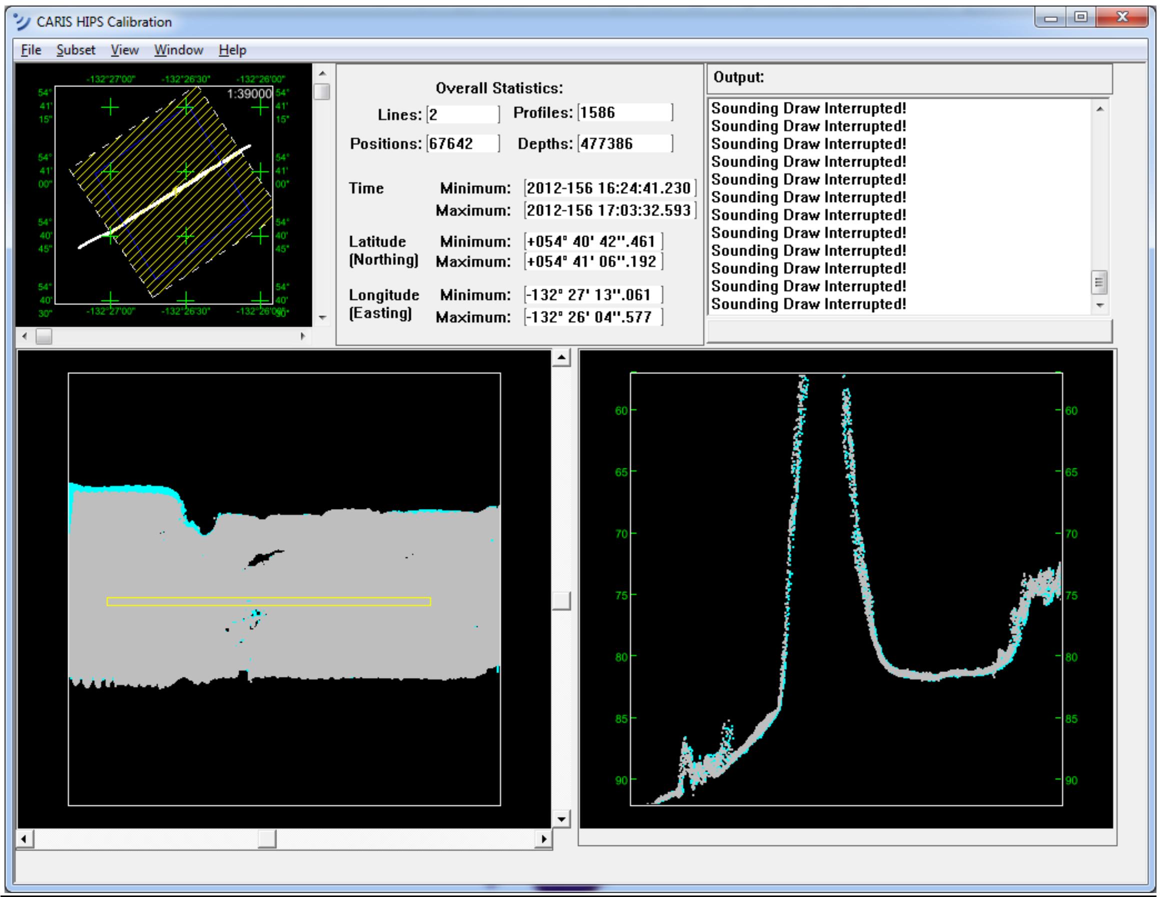

IMAGE WITH NO PITCH CORRECTION APPLIED

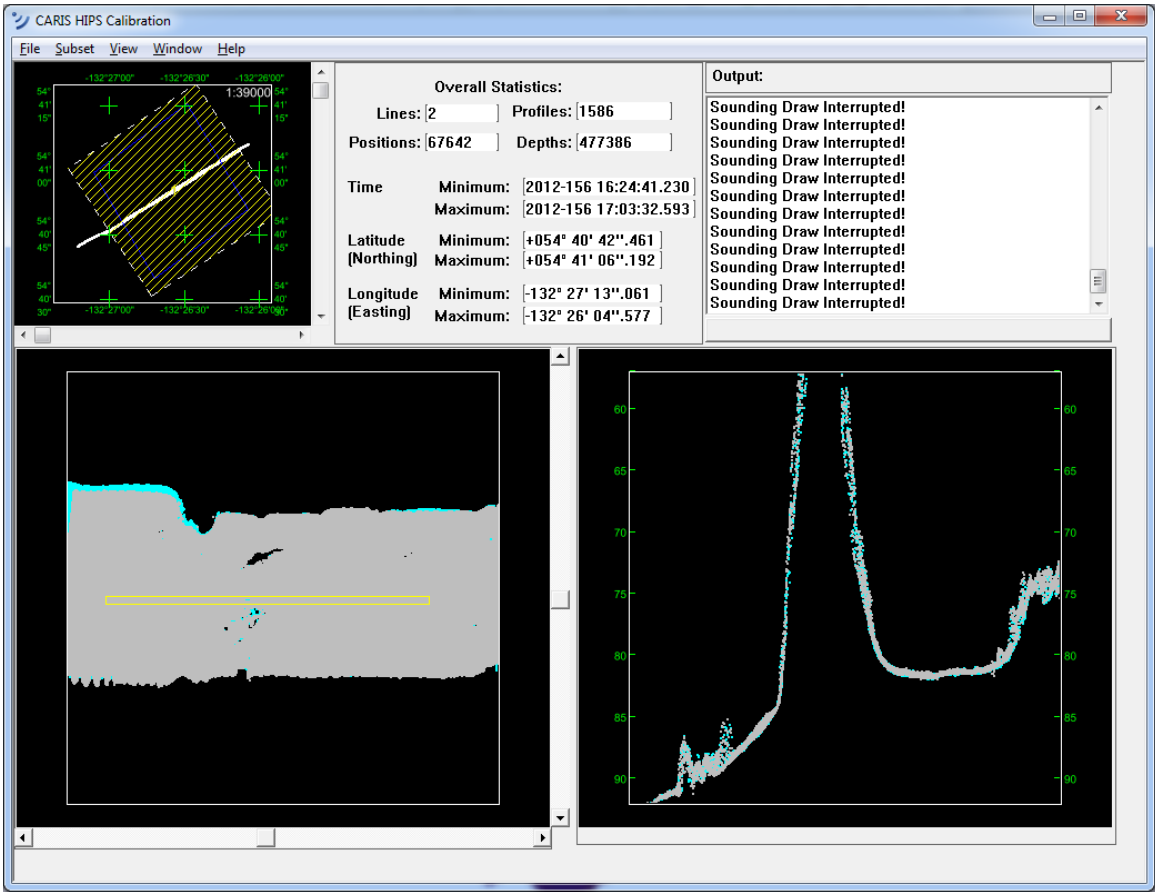

IMAGE WITH PITCH CORRECTION APPLIED (-0.40°)

Yaw

The azimuth error adjustment was performed on a set of two lines, each offset from the other, and run past a conspicuous topographic feature. Lines were run in opposite directions, at the same velocity, with the same outer beams crossing the feature. The latency error and pitch error were already identified. Data from the same outer beams of each line were compared and brought into alignment. In this case there was no azimuth correction required.

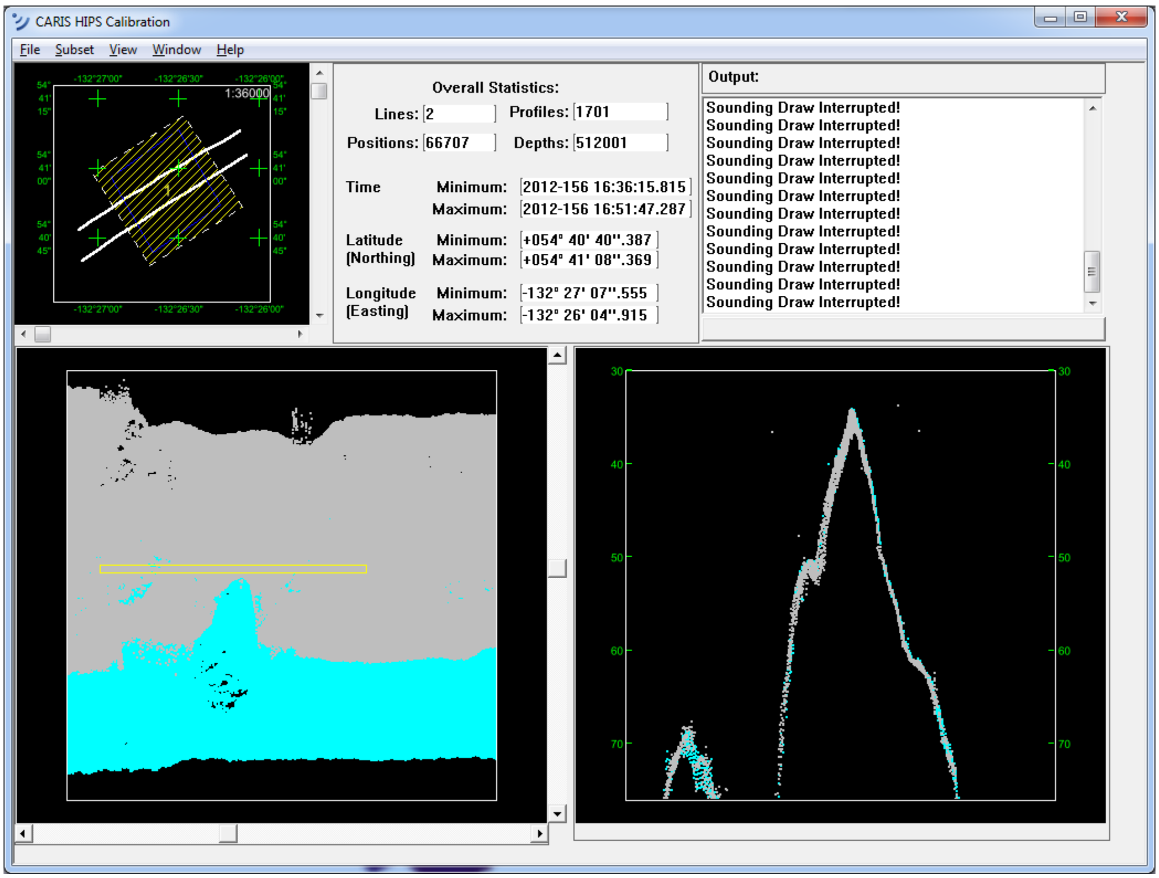

IMAGE WITH NO YAW CORRECTION APPLIED

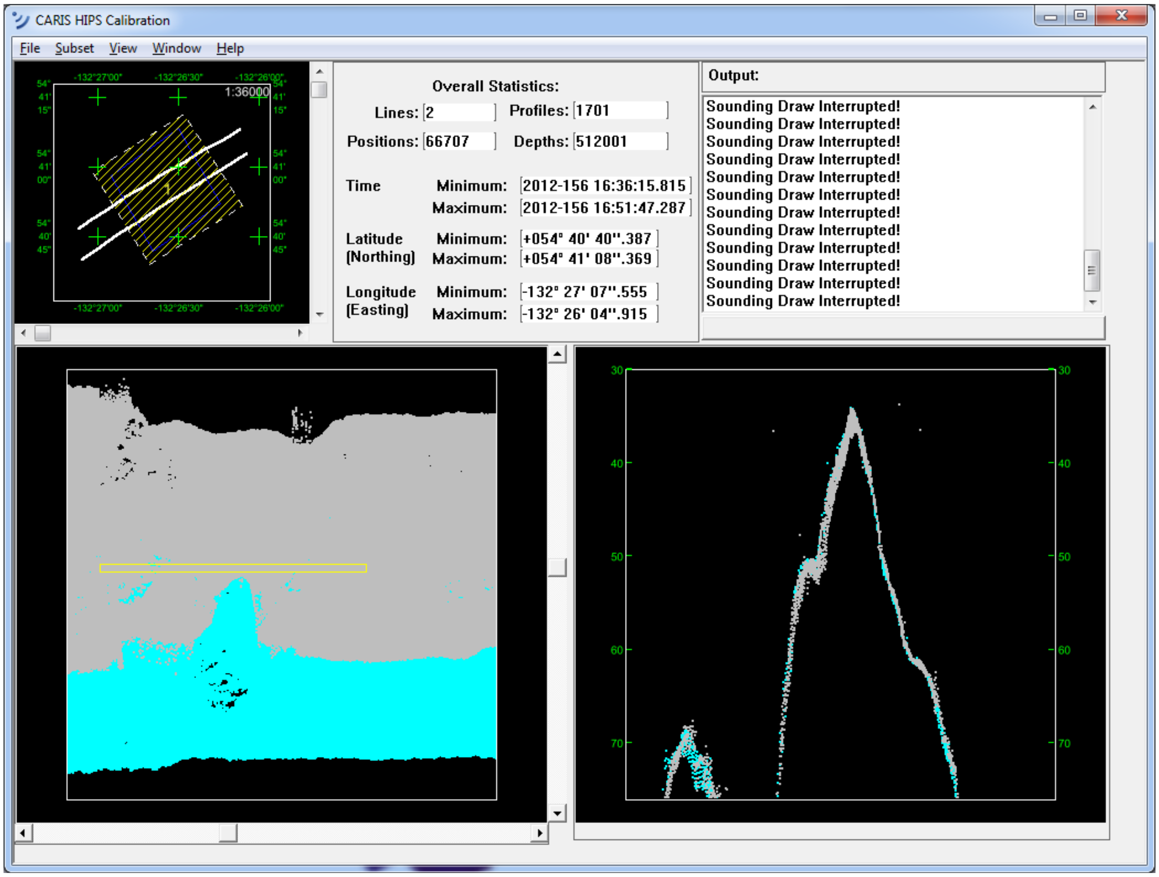

IMAGE WITH YAW CORRECTION APPLIED (-0.60°)

Roll

The roll error adjustment was performed on a set of two lines, run at the same velocity, in opposite directions. The latency error, pitch error and azimuth error were already identified. Data across a swath was compared for each line and brought into agreement, by adjusting the roll error value.

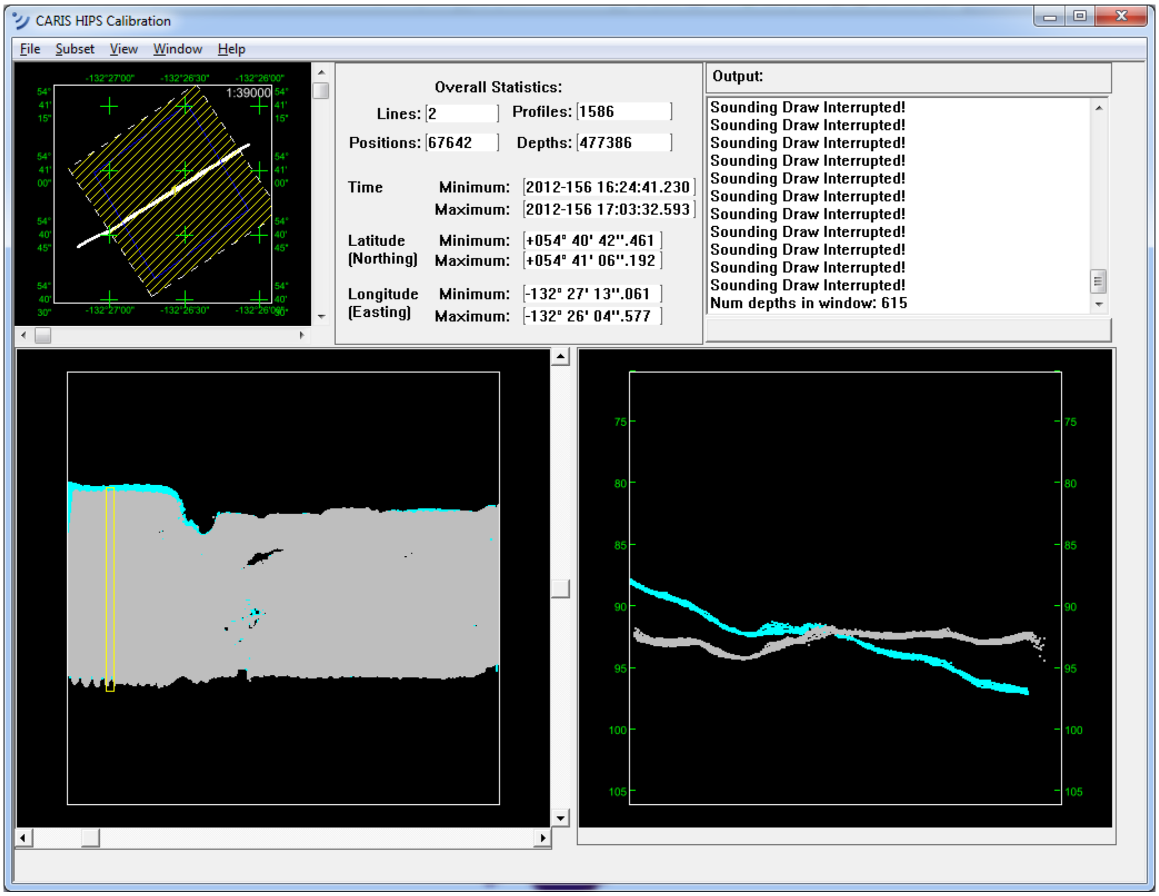

IMAGE WITH NO ROLL CORRECTION APPLIED

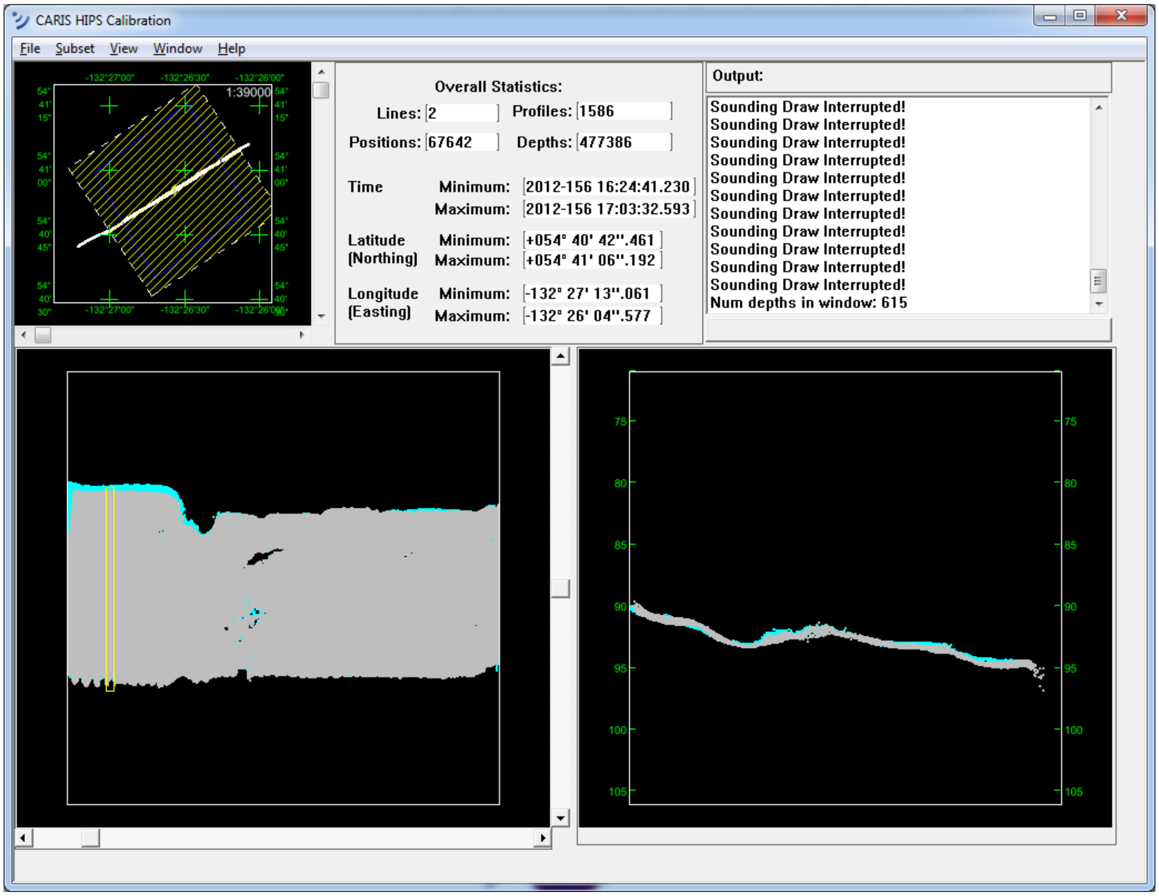

IMAGE WITH ROLL CORRECTION APPLIED (-0.535°)

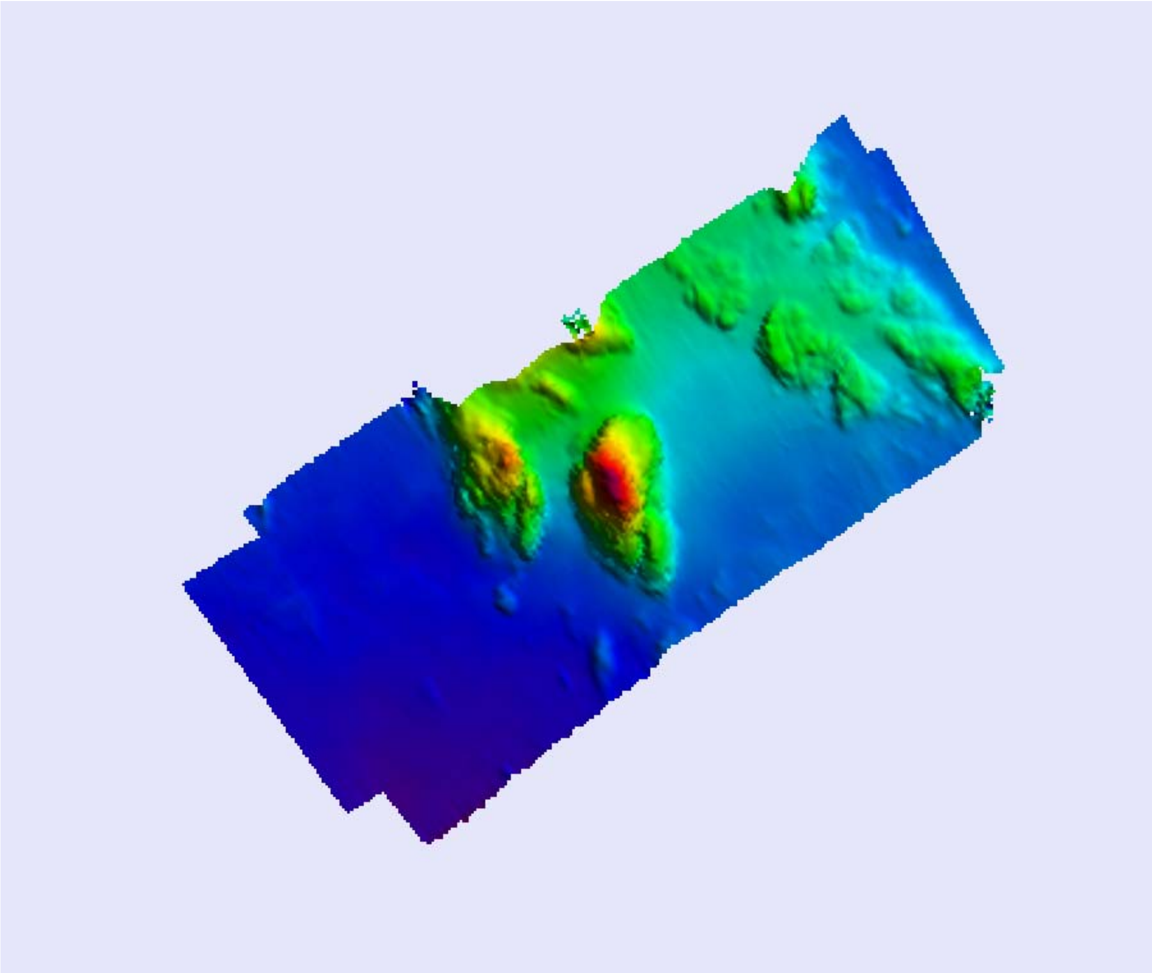

IMAGE OF PATCH TEST JULIAN DAY 2012-156 WITH CORRECTIONS APPLIED

Appendix F: CROSSLINE QUALITY CONTROL

The QC reports were generated based on Order 1a accuracy specification of:

$$\pm\sqrt{(a^2 + (b * d)^2)}$$

where a = 0.5 meters, b = 0.013 meters, and d = depth.

For this survey, crosslines were planned and well distributed throughout the area to ensure adequate quality control. Total crossline length was 23.1 nautical miles, or 4.4% of the total main scheme line length.

The majority of QC Reports fall well within the required accuracy specifications. However, the crossline in Fairweather grounds contained beams in the QC report that fall below the 95% confidence level due to a significantly rocky topography. Good conformity was still seen between the main scheme lines and crosslines.

Below is an example of a QC check performed on a crossline and analyzed for each sonar beam. Note that the far right column designates the confidence level achieved for each beam at the IHO S-44 Order 1a level, as described in the equation above. The Quality Control Reports can be found attached to the digital report located in the folder *Crosslines QC Reports*.

Beam Number	Count	Max (+)	Min (-)	Mean	Std Dev	Order 1a (%)
89	2	1.491	0	1.029	0.654	100
90	5	1.461	0	0.794	0.44	100
91	28	2.187	0.101	0.996	0.502	100
92	90	2.602	0.124	1.09	0.512	100
93	235	3.962	0.088	1.117	0.569	100
94	551	2.724	0.247	1.12	0.543	100
95	997	3.957	2.537	1.211	0.59	100
96	1,535	3.907	3.99	1.192	0.595	100
97	2,044	4.021	3.816	1.26	0.583	100
98	2,461	3.866	4.098	1.176	0.58	100
99	2,649	2.991	3.561	1.138	0.574	100
100	2,752	3.073	3.388	1.044	0.545	100
101	2,794	3.756	3.491	1.03	0.538	100
102	2,812	3.318	3.228	0.99	0.524	100
103	2,827	2.813	2.517	0.918	0.514	100
104	2,833	2.823	2.467	0.868	0.501	100
105	2,841	2.494	1.714	0.779	0.5	100
106	2,850	3.589	1.714	0.746	0.489	100
107	2,854	2.267	2.195	0.704	0.479	100
108	2,862	2.255	1.601	0.653	0.469	100
109	2,874	4.632	1.521	0.584	0.479	100
110	2,883	2.097	1.679	0.509	0.457	100
111	2,894	2.433	2.093	0.472	0.46	100
112	2,906	2.293	1.954	0.421	0.441	100
113	2,915	2.243	1.852	0.356	0.443	100
114	2,923	2.665	1.799	0.32	0.444	100
115	2,926	2.4	1.474	0.279	0.436	100
116	2,935	2.252	2.397	0.171	0.428	100
117	2,949	2.592	1.898	0.158	0.413	100
118	2,960	2.149	1.967	0.091	0.397	100
119	2,964	2.319	1.875	0.092	0.385	100
120	2,981	2.451	1.266	0.037	0.384	100
121	2,993	1.958	1.117	0.033	0.379	100
122	3,004	1.469	1.369	0.011	0.374	100
123	3,005	2.142	1.265	-0.002	0.369	100
124	3,009	1.204	1.541	-0.01	0.354	100
125	3,009	1.472	1.529	0.006	0.345	100
126	3,006	1.941	1.381	0.053	0.347	100
127	3,010	1.385	1.503	0.049	0.337	100
128	3,012	2.278	2.074	0.076	0.338	100
129	3,014	1.699	2.75	0.076	0.333	100
130	3,011	1.156	1.238	0.12	0.307	100
131	3,013	1.103	1.374	0.104	0.306	100
132	3,014	1.609	1.137	0.111	0.31	100
133	3,011	1.316	1.347	0.132	0.307	100
134	3,012	1.805	1.703	0.137	0.305	100

Appendix G : PERSONNEL

Fugro Pelagos, Inc. – Offshore Personnel	
Project Manager / Senior Hydrographer	Dean Moyles
Party Chief / Lead Hydrographer	Dale Reynolds
Surveyor/Processor	Jenny Tixier
Surveyor	Michael Lydon
Surveyor	Matt Farley
Surveyor	Honza Rokyta
Data Processor	Mila Cox
Data Processor	Dawn Bugden
Data Processor	Chelsea Fairbanks
Data Processor	Amey Mount
Fugro Pelagos, Inc. – Onshore Personnel	
President	David Millar
Datacenter Manager	Jose Martinez

Revisions and corrections performed during office processing and certification

[1] A signed copy of this report was not submitted; however, the contents of the report have been reviewed and validated by the Pacific Hydrographic Branch.
[2] The data is adequate to supersede charted data in the common area.
[3] No HDCS data was delivered, XYZ ASCII files were processed in Bathy Database in order to create point cloud base surfaces for the Survey Acceptance Review and cartographic compilation.
[4] No Tide data was delivered.

APPROVAL PAGE

W00268

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 NGDC for archive

- W00268 DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- W00268_GeoImage.pdf

The survey evaluation and verification has been conducted according current OCS Specifications.

Digitally signed by HOLMBERG.PETER.SCOTT.1365886101
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OTHER, cn=HOLMBERG.PETER.SCOTT.1365886101
Date: 2015.06.30 13:39:10 -07'00'

Approved:______________________________

Peter Holmberg
Cartographic Team Lead, Pacific Hydrographic Branch

The survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Digitally signed by EVANS.BENJAMIN.K.1237217094
Reason: I am approving this document
Date: 2015.06.30 12:54:55 -07'00'

Approved:______________________________

CDR, Benjamin K. Evans, NOAA
Chief, Pacific Hydrographic Branch