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DATA ACQUISITION AND PROCESSING REPORT

Project No. **OPR-A397-WH**

LOCALITY

State/Territory **Massachusettes**

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2001

CHIEF OF PARTY
Steven R. Barnum, CDR, NOAA

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DATA ACQUISITION AND PROCESSING REPORT

to accompany

PROJECT OPR-A397-WH

NOAA Ship WHITING
CDR Steven R. Barnum, Commanding

A. EQUIPMENT

All hydrographic data were acquired by WHITING and survey Launches 1005 and 1014. WHITING acquired side scan sonar (SSS) data, vertical beam echosounder data (VBES), and sound velocity profiles (SVP) data. Launch 1005 acquired shallow water multibeam (SWMB) data, SSS data, VBES data, and SVP data. Launch 1014 acquired SSS and VBES data, and also supported diver least-depth investigations. All vessels acquired detached positions (DPs) and bottom samples. No unusual vessel configurations or problems were encountered on this project. Vessel descriptions and offset measurements are included in **Appendix III** of this report.

The methods and systems used to meet full-coverage requirements for this project were determined by the Hydrographer and are in accordance with guidance provided in the Hydrographic Survey Letter Instructions and the Field Procedures Manual. Other considerations included system performance limitations, complexity of bathymetry, water depth, and ability of vessels to safely navigate a particular area.

SOUNDING EQUIPMENT

Odom Echotrac Echosounder – Vertical Beam Echosounder (VBES)

All vessels are equipped with Odom Echotrac DF3200 MKII echosounders. The Odom Echotrac is a dual-frequency digital-recording echosounder with an analog paper record. The high frequency transducer operates at a frequency of 100 kHz with a circular beam footprint of 7.5° at the –6 dB point. The low frequency operates at a frequency of 24 kHz with a rectangular beam of 27° (fore-aft direction) by 47° (athwartship direction) at the –6 dB point. Soundings were acquired in meters on both frequencies, with the high frequency selected for all sounding data.

Reson Seabat 8101 - Shallow Water Multibeam (SWMB)

Launch 1005 is equipped with a hull-mounted Reson SeaBat 8101 multibeam echosounder. The SeaBat 8101 is a 240 kHz SWMB system which measures relative water depths across a 150º swath; each swath consisting of 101 individually formed 1.5º x 1.5º beams. This system was used to obtain full-bottom bathymetry coverage in depths generally from 5 meters to 125 meters, with range scale set between 75 meters and 500 meters, depending on water depth and across-track slope.

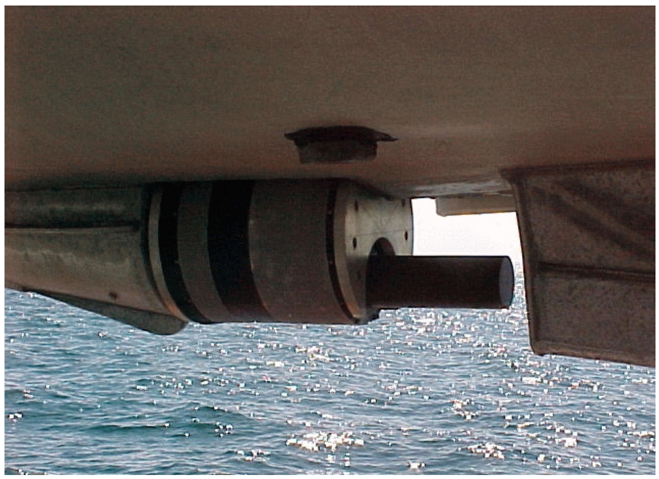

Figure 2: Reson SeaBat 8101 hull mounted in keel cut-out of Launch 1005.

SWMB data are monitored in real-time using the 2-D and 3-D data display windows in **ISIS**, and the on-screen display for the Reson SeaBat 8101 sonar processor. Adjustable parameters used to control the Reson from the **ISIS** software include range scale, power, gain, and pulse width. These parameters were adjusted as necessary to ensure best data quality. Additionally, vessel speed was adjusted as necessary, and in accordance with the NOS Specifications and Deliverables and Standing Project Instructions, to ensure the required along-track coverage for object detection. SWMB operations were limited to a speed-over-ground of six knots.

Mainscheme SWMB sounding lines were generally run parallel to the contours at a line spacing approximately three times the water depth. For discrete item developments, line spacing was often reduced to two-times water depth to ensure least-depth determination by SWMB near-nadir beams.

Diver Least Depth Gauge

Dive investigations were primarily for contact/AWOIS verification and/or least depth confirmation of selected contacts. Least depths of investigated items were determined with SWMB. Diver Least-Depth Gauges (DLDG) were used by divers during item investigations to acquire least depths over selected rocks and features. The DLDG measures pressure, and together with a CTD cast, is processed using HSTP's (N/CS11) **VELOCWIN** software to compute a fully-corrected depth. These depths were compared to SWMB least depths processed in **PYDRO**. DLDG (serial no.'s 68338 and 68332) were calibrated January 25, 2001. A copy of the calibration reports is included in **Appendix IV.**

Leadline

Leadlines were used for echosounder calibrations or for acquiring least depths. Leadline calibrations were conducted on March 26, 2001; leadline errors were negligible. Calibration reports are included in **Appendix IV** of this report.

SIDE SCAN SONAR EQUIPMENT

General Operations

Line spacing for side scan sonar (SSS) operations is determined by the required range scale. Typically, to acquire two hundred percent coverage, 40 meter line spacing is used at the 50 m range scale, 60 meter line spacing is used at the 75 m range scale, and 80 m line spacing is used at the 100 meter range scale. A towfish altitude of eight to twenty percent of the range scale was maintained during data acquisition. Nearly all SSS operations were conducted using the 100-meter range scale. SSS altitude for towed operations is adjusted by the amount of deployed tow cable, and to a lesser degree by vessel speed.

Imagery was monitored in real time using the side scan sonar waterfall display window in the **ISIS** acquisition software. Vessel speed was adjusted to ensure 100% along-track coverage for each SSS type used.

Edgetech 272-T Side Scan Sonar System

The Edgetech Side Scan Sonar System includes the Model 272-T, 100 kHz side scan sonar, configured with a 20° vertical beam depression, and the Edgetech Analog Control Interface (ACI) installed in the **ISIS** computer. The ACI acts as an interface between the **ISIS** sonar processor and the 272-T tow fish, converting the analog imagery signal from the tow fish to a digital signal. The ACI also controls the tow fish pulse width, trigger and data sampling rate. A power converter is mounted external to the **ISIS** computer which takes the 12 vdc power of the host computer and converts it to 800 vdc to supply the power to the tow fish. User-operable controls for the ACI include SSS range scale and two types of receiver gain: master gain and fine gain. Master gain adjusts port and starboard channels simultaneously and ranges from G1 (3db) to G4 (12db). Fine gain allows the operator to change individual port and starboard gains in 1.5db increments. Adjusting the master gain settings will affect the recorded SSS imagery data.

The **ISIS** computer records digital side scan data along with other data such as position, depth, and heading data in the **ISIS** XTF file format. Additionally, **ISIS** forwards range scale data and sonar altitude data to the **HYPACK** acquisition computer via a serial connection.

Edgetech Towed Operations

WHITING's SSS is deployed using a hydraulic winch spooled with armored cable. The tow cable is led from the winch through the stern A-frame over a snatch block with a metered sheave. The tow cable at the winch is connected to a deck cable through a slip ring assembly mounted coaxially on the winch. Cable-out is controlled remotely at the acquisition station (or locally at the winch) and is monitored on an MD-TOTCO cable counter. This sensor computes cable out by the number of revolutions of the block's sheave. The MD-TOTCO cable counter provides a serial message to the **HYPACK** and **ISIS** acquisition computers. The cable-out value was checked, and if necessary, adjusted, for every SSS deployment. The MD-TOTCO cable counter was periodically calibrated throughout the project.

Launches 1005 and 1014 are equipped with a J-arm and electric Superwinch on their aft quarter. The Superwinch is spooled with a lightweight Kevlar-jacketed tow cable lead overboard to the SSS tow fish through a block with a nylon sheave. The tow cable at the winch is connected to a deck cable via a slip ring assembly mounted coaxially on the winch. This method of deploying the SSS is typically used in water depths of 7 meters to 20 meters.

In water depths greater than 20 meters, a large two-headed bitt (colloquially referred to as a clam-steamer) was outfitted with 100 meters of lightweight Kevlar-jacketed tow cable. With this system, the cable is lead through the block on the J-arm, and cable-out is controlled manually. No slip ring assembly is required.

For both launches, cable-out must be entered manually into the **HYPACK** acquisition software by reading colored markings on the cable, spaced in five-meter increments. All lightweight Kevlar-jacketed tow cables were calibrated at the beginning of the field season, or when replaced.

Edgetech SSS operations are limited to a speed-over-ground of five knots on all vessels.

Klein 5500 High Speed, High Resolution Side Scan Sonar

The Klein System 5500 (S/N 101) includes the Model 5250 High Speed High Resolution Side Scan Sonar (HSHRSSS) tow fish and the T5100 Transceiver Processing Unit (TPU). The 5250 HSHRSSS operates at a frequency of 455 KHz and has a vertical beam angle of 40°. The HSHRSSS contains the transducers, sonar processing and control electronics, attitude and heading sensors, the down-link de-multiplexer (for control signals), and the up-link multiplexer (for sonar and auxiliary sensor data). The T5100 TPU contains electronics to demultiplex the sonar signal from the HSHRSSS and multiplex the control signals transmitted to the HSHRSSS via the coaxial tow cable. The T5100 also contains a network card for transmission of the sonar data to the **ISIS** acquisition computer. The Klein System 5500 is unique in that each transducer simultaneously forms five dynamically focused beams per side (channel), allowing increased resolution along track (20–75 cm) and across track (7.5cm). The Klein System 5500 multibeam transducer technology also enables higher tow speeds of up to ten knots.

There are two standard configurations for using the Klein System 5500 aboard WHITING and Launch 1014.

Configuration 1: Klein System 5500 Towed Operations

Towed Klein System 5500 operations are unique to the WHITING due to the weight of the 5250 HSHRSSS, and the required winch size. The 5250 HSHRSSS is deployed using a SeaMac electric- hydraulic winch spooled with approximately 200 meters of armored coaxial cable. The tow cable is lead from the winch through the stern A-frame over a snatch block with a metered sheave. The tow cable at the winch is connected to a deck cable through a slip ring assembly mounted coaxially on the winch. Cable-out is controlled remotely at the acquisition station (or locally at the winch) and is monitored on an MD-TOTCO cable counter. This sensor computes cable out by the number of revolutions of the block's sheave. The MD-TOTCO cable counter provides a serial message to the **HYPACK** and **ISIS** acquisition computers. The cable-out value was checked, and if necessary adjusted, for every SSS deployment. The MD-TOTCO cable counter was periodically calibrated throughout the project period.

Klein System 5500 towed operations are typically limited to seven or eight knots, speed-over-ground aboard WHITING. This is to allow am increased margin for safe navigation, to optimize vessel fuel consumption, minimize towing gear stress, and reduce "strumming" in the tow cable which can interfere with the side scan imagery.

Configuration 2: Hull-mounted Side Scan

This configuration is unique to Launch 1014. The launch is outfitted with a hull-mounted sled to which the 5250 HSHRSSS is attached by a pair of omega brackets. The 5250 HSHRSSS is connected to the T5100 TPU by a 10-meter lightweight Kevlar-jacketed deck cable passed through a watertight hull penetration. In this configuration, the 10-meter cable is fitted with a 6db inline attenuator to compensate for the shortened cable length.

The hull-mounted 5250 HSHRSSS is used primarily in shallow water (less than 20 meters) or along shore to locate shoreline features (piers, bulkheads, etc.). This configuration eliminates offset, layback, and heading errors associated with a towed system, thereby increasing the accuracy of the processed imagery. An added benefit of this configuration is its ability to avoid entanglement with lobster and crab trap floats as compared to the towed configuration.

Speed over ground in this configuration is typically limited by the launch's top speed of ten knots or prevailing sea condition. Wave heights in excess of generally one-half meter cause excessive aeration and signal quenching at the 5250 HSHRSSS transducer, consequently degrading the sonar imagery. In these cases, launch speed is reduced, or line direction reversed, to preserve image quality.

POSITIONING EQUIPMENT

Trimble DSM212L DGPS Receivers

All vessels are equipped with Trimble DSM212L DGPS receivers for horizontal position control. The DSM212L DGPS receiver is the primary positioning system used aboard WHITING and Launch 1014. Launch 1005 used the DSM212L as a beacon receiver only, relying on the TSS POS/MV for primary positioning (see next section). The DSM212L is an integrated 12-channel GPS receiver and dual-channel differential beacon receiver. The beacon receiver can simultaneously monitor two U.S. Coast Guard (USCG) differential GPS (DGPS) beacon stations. The Trimble DSM212L was configured in manual mode to allow reception of only one beacon station during data acquisition.

DSM212L parameters were configured using Trimble **TSIPTalker** software. Configuration was checked frequently throughout the project period. Parameters set included number of visible satellites ($\geq$4 SV's), positional dilution of precision (PDOP < 8), maximum pseudo range corrector age ($\leq$30 sec), and satellite elevation mask ($\geq 8^\circ$).

Position quality was monitored real time in the **HYPACK** data acquisition software. The primary positional quality monitored was HDOP. Where HDOP exceeded 4.0, the data were examined during post-processing, and if necessary, positions interpolated or rejected. The **HYPACK** nmea.dll configuration includes a 1000-ms update rate and a non-differential alarm in the acquisition window to alert the operator when the signal is lost.

TSS POS/MV Position and Orientation Sensor

Launch 1005 is equipped with a TSS POS/MV Model 320 (Position and Orientation System for Marine Vessels, serial number 020, version 2) to determine position. The POS/MV, an aided strapdown inertial navigation system, provides a composite position solution derived from both an Inertial Measurement Unit (IMU) and dual-frequency GPS receivers. The IMU and GPS receivers are complementary sensors; data from one are used to filter and constrain errors from the other resulting in high position accuracy.

Position accuracy and quality were monitored in real time using the POS/MV Controller software, as well as the **HYPACK** data acquisition software, to ensure positioning accuracy requirements in the NOS Hydrographic Surveys Specifications and Deliverables were met. The POS/MV Controller software provides clear visual indications whenever accuracy thresholds are exceeded. The POS/MV was configured to alert whenever horizontal positioning accuracy of three meters was exceeded.

HEADING AND ATTITUDE EQUIPMENT

Sperry Mark 227 Gyrocompass

WHITING is equipped with a Sperry Mark 227 gyrocompass that serves as its primary heading sensor for survey operations and vessel navigation. This gyro has a heading accuracy of +/- 0.5˚. Heading data are output as a serial message from a synchronous repeater to the **HYPACK** and **ISIS** acquisition computers with a 1-Hz update rate.

S G Brown Meridian Surveyor Gyrocompass

Launch 1014 is equipped with a Meridian Surveyor gyrocompass that serves as its primary heading sensor for survey operations and vessel navigation. This gyro has a static error of 0.1° sec latitude (RMS) and a dynamic heading accuracy of 0.6° sec latitude (Scorsby and Intercardinal motion tests). Heading data are output as a NMEA 0183 serial message to the **HYPACK** and **ISIS** acquisition computers with a 10-Hz update rate.

TSS DMS-05 Motion Sensor

WHITING and Launch 1014 are equipped with a TSS Dynamic Motion Sensor Model 05 (DMS-05) for vessel attitude determination (heave, roll, and pitch). The DMS-05 consists of an array of solid state sensing elements which measure instantaneous linear accelerations and angular rates affecting the sensor in the roll, pitch and yaw directions. These measurements allow the system to compute the attitude of the vessel to which the sensor is attached with respect to the true gravitational vertical. Changes in these values are used to compute the vertical translation, or vessel heave.

Data are passed to the **HYPACK** acquisition computer as a serial message string with a 25-Hz update rate. The DMS-05 has the capability to measure attitude to 5% of the translation in question assuming an installation at the vessel's center of motion. This accuracy is degraded if the sensor is mounted further from the vessel's center of motion. Both vessels have their DMS-05 units mounted within two meters of the assumed center of motion (reference point, or RP), which keeps their attitude measurements within the desired 5% envelope. The following are the accuracy and resolution specifications for the DMS-05:

Type of Motion	Accuracy	Resolution	Range
Heave	5 cm or 5%	1 cm	+/- 10 m
Roll	+/- 0.05°	0.01°	+/- 30°
Pitch	+/- 0.05°	0.01°	+/- 30°

TSS POS/MV Position and Orientation System

Launch 1005 is equipped with a TSS POS/MV Model 320 for vessel heading and attitude determination. The POS/MV is an aided strapdown inertial navigation system (INS); it consists of an Inertial Measurement Unit (IMU) sensor and two GPS receivers. The IMU senses linear acceleration and angular motion along the three major axis of the vessel. The POS/MV's two GPS receivers determine vessel heading using carrier-phase differential position measurements.

POS/MV Heading Computation

The POS Computer System (PCS) blends data from both the IMU and the two GPS receivers to compute highly accurate vessel heading. The IMU determines accurate heading during aggressive maneuvers and is not subject to short-period noise. However, IMU accuracy characteristically diminishes over time. The GPS receivers compute a vector between two fixed antennas and provide azimuth data using the GPS Azimuth Measurement Subsystem

(GAMS). GPS heading data is accurate over time, but is affected by short-period noise. The POS/MV combines both heading measurement systems into a blended solution with accuracies greater than either system could achieve alone. Heading accuracy in the POS/MV Controller software was set to 0.5 degrees.

POS/MV Heave, Pitch, and Roll Computation

Heave is computed in the POS/MV by performing a double integration of the IMU-sensed vertical accelerations. The heave period was left at the TSS default of 200 seconds; the recommended heave damping coefficient of 0.71 was used.

Both roll and pitch measurements are computed by the IMU after sensor alignment and leveling. The IMU mathematically simulates a gimbaled gyro platform and applies the sensed angular accelerations to this model to determine roll and pitch. Roll and pitch measurement accuracy in the POS/MV Controller software was set to 0.05 degrees.

SOFTWARE

Coastal Oceanographic's HYPACK MAX version 10.10 was used for vessel navigation and line tracking during acquisition of SWMB, side scan sonar, and VBES data. All VBES data were acquired in HYPACK in the "RAW" format. Detached positions (DPs) were acquired with HYPACK MAX using coastal Oceanographics target file (*tgt) format and converted into **PYDRO** using the "Insert/Convert HYPACK DP" tool.

Shallow water multibeam (SWMB), and side scan sonar data were acquired using Triton-Elics' **ISIS** software version and logged in the Extended Triton Format (XTF). All SWMB data were acquired using **ISIS** version 5.29 and all SSS data were acquired using **ISIS** version 5.0. SWMB data were processed using **CARIS** Hydrographic Information Processing System (HIPS) and Hydrographic Data Cleaning System (**HDCS**) software version 4.3.2. Side scan sonar data were processed using **CARIS** Sonar Information Processing System (SIPS) and Side Scan Mosaic (SSMOS).

All processes were run on a Silicon Graphics Origin 2000 with the Irix 6.5.2 operating system.

All Detached Positions, SWMB and VBES soundings, and side scan and SWMB features were analyzed during post-processing using **PYDRO** version 1.0 through 1.8. **PYDRO** is an extension package created by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP) using the Python 20 programming language to interface with the **CARIS HDCS** data directly.

Soundings and features were exported from **PYDRO** in MIF/MID (**MapInfo** Interchange) format, and imported into **MapInfo**. **MapInfo** 5.0 and **Vertical Mapper** 2.5 were used for final data analysis and for creating final plots. The HYDRO_MI **MapInfo** application by HSTP was used for drawing features, tracks, depths, and Preliminary Smooth Sheets.

Raw sound velocity data were processed using **VELOCWIN** 6.05 supplied by HSTP. **VELOCWIN** 6.05 uses raw salinity, temperature, and pressure measurements to create a sound velocity profile.

A complete list of software and versions is included in **Appendix I**.

B. DATA PROCESSING AND QUALITY CONTROL

SHALLOW WATER MULTIBEAM DATA

SWMB data were converted from **ISIS xtf** to **CARIS HDCS** using the **CARIS xtfToHDCS** program. Post-processing SWMB data was accomplished using the **CARIS HIPS** programs **HDCS** and **Swath Editor**. Vessel heading, attitude, and navigation data were reviewed and edited in **HDCS** line mode (viewed as time series data). Fliers or gaps in heading, attitude, or navigation data were manually rejected or interpolated for small periods of time. Data were then SVP corrected to compute processed depths. Using **Swath Editor**, all depth data were reviewed line-by-line and ping-by-ping as a time series. Obvious depth fliers were rejected. All data more than 60° to either side of nadir after application of roll data were filtered out, reducing effective swath width to 120°. This is in accordance with the draft Standing Project Instructions to reduce potential refraction errors in beams more than 60° off nadir. After all data types (navigation, attitude, heading, and depth) were reviewed and edited, the **HDCS** line files were merged. The merge process applies the proper vessel configuration file and tide file, and rotates the processed depths from the time domain into the earth reference frame. Merged lines were then reviewed in the **HDCS** subset mode. It is in subset mode when the soundings can be reviewed and cleaned in a geographically correct display.

Sun-illuminated Digital Terrain Models (DTMs) were created in **CARISNT Spatial Editor** to demonstrate SWMB coverage and to further check for systematic errors such as tide, sound velocity, or attitude and timing errors. The **Spatial Editor** grids full density multibeam bathymetry. It generates mean seabed surfaces by applying weighting schemes according to sonar footprint dimensions and grazing angles. Sun-illumination is used to highlight the seabed features. **Spatial Editor** DTMs were created as specified in the NOS Hydrographic Surveys Specifications and Deliverables. The **WorldReg MapBasic** application was used to register **Spatial Editor** DTM's for analysis in **MapInfo**.

A statistical analysis of all SWMB data were performed using the **CARIS** (UNIX) Quality Control Report (QCR) function. SWMB crosslines were compared with mainscheme soundings, beam-by-beam, in order to statistically determine the accuracy of each beam. Beams not meeting accuracy requirements as described in the NOS Hydrographic Surveys Specifications and Deliverables were further filtered and rejected. Results from each survey's QCR can be found in the respective Descriptive Report. Crosslines were only run in areas of regular and even bathymetry to utilize the lowest variance in the analysis and to eliminate possible skew of the results due to irregular bathymetry.

VERTICAL-BEAM ECHOSOUNDER DATA

Following acquisition, vertical-beam echosounder data were converted from HYPACK "Raw" format to **HDCS** using **CARIS "genericToHDCS"** (Generic Data Parser) program. Date, timestamp, depth, event number, navigation, and gyro information are parsed out of the Hypack "Raw" file using the Generic Parser Definition file, exclusive to each vessel, and converted into **HDCS**. Each line is viewed in **HIPS** Single Beam Editor. Selected soundings were scanned for missed depths. Additional selected soundings were inserted where necessary to define peaks and abrupt changes in slope. Vertical-beam echosounder data were acquired in conjunction with side scan sonar and multibeam data. Vertical-beam echosounder data acquired with side scan sonar data were fully scanned and processed. Analog paper VBES data was acquired and scanned along with the digital VBES data.

After review and cleaning in **HIPS Single Beam Editor**, **HDCSLineMerge** was used to merge depth, position and attitude data with sound velocity, tide, vessel offset, and dynamic draft correctors to compute the corrected depth and position of each sounding. All soundings were reviewed again in **HDCS** Subset Mode. Data were compared with adjacent lines and crosslines, for systematic errors such as tide or sound velocity errors.

In addition, VBES data were acquired concurrently with Launch 1005 multibeam data and were compared to Reson 8101 nadir beams in real-time during data acquisition to ensure multibeam data quality. **Vertical-beam echosounder data acquired concurrently with multibeam data were not processed.** The raw **HYPACK** VBES data which was acquired concurrently with SWMB was moved to the ships RAID system and backed up to DLT tapes with the other raw HYPACK and **ISIS** data for that particular survey. This data should not be used for smooth sheet compilation. Data processing flow diagrams are included in **Appendix II** of this report.

To produce the final reduced data set, all non-rejected VBES and SWMB soundings having passed all other quality-assurance checks were imported into **PYDRO** using the "Insert Caris Line Bathy tool". Depths were inserted into **PYDRO** using a 1.5 mm grid size at the scale of the survey and an over-plot removal (excessing) character size of 3 meters, ensuring that the largest spacing between selected soundings would not exceed 7 millimeters at the survey scale.

SIDE SCAN SONAR DATA

Side scan sonar data were converted from **XTF** (**ISIS** raw format) to **HDCS** using the **CARIS xtfToHDCS** program. Side scan data were post-processed using **CARIS SSMOS** and **SSEDIT** (sub-programs of **SIPS**).

Post-processing **HDCS** side scan data includes examining and editing fish height, vessel heading (gyro), and vessel navigation records. Fish navigation is recalculated using the **CARIS SSEDIT Recompute SSS Navigation** sub-program. During **Recompute SSS Navigation**, tow point measurements (A-frame and cable out), fish height, and depth are used to calculate horizontal layback.

After fish navigation is recalculated, side scan imagery data are slant-range corrected using **CARIS SSEDIT**. The slant-range corrected side scan imagery data are closely examined for any targets. Targets-of-interest are evaluated as potential contacts based on apparent shadow length and appearance; particularly targets which do not appear to be natural in origin. Contacts are selected and saved to a **CARIS** contact file for each line of **HDCS** data. Contact selection includes measuring apparent height, selecting contact position, and creating a contact snapshot (*.tif) image.

All contacts were imported into **PYDRO** using the “Insert Caris Line Features” tool. Contacts were arranged by day and line and could be selected in the data “Tree” window. Information concerning a specific contact was displayed in **PYDRO**’s “Editor Notebook Window” including contact position, AWOIS item positions, surrounding depths, contact cross references., and charting recommendations. Each contact was reviewed, and information flags were set accordingly. The available flags were “Resolved”, “Rejected”, “Primary Hit”, “Significant”, “Chart”, and “DTON”. “Resolved” was chosen after the contact had been reviewed by the Sheet OIC. If the contact was significant, then the “Significant” flag was chosen. If there were multiple contacts for a single feature, then the one providing the best SSS image of the feature was chosen as the “Primary Hit”. Any items that were to be addressed in the Item Investigation section of the Descriptive Report were flagged as “Chart”. Items which had the “Chart” flag set could also be further designated for inclusion in the Danger To Navigation Report by choosing the “DTON” flag. “Snapshots” of contacts were displayed in **PYDRO**’s “Image Notebook Editor”. Contacts appearing significant were further investigated by multibeam. Final positioning and least depth determination of significant items was accomplished using multibeam and/or diver investigation.

Side scan sonar coverage was determined by using mosaics generated in **SIPS** and imported into **MapInfo**. Any deficiencies in the side scan sonar data were found, and a holiday line file was created from the mosaics, and swath plots to complete the 200 percent requirement.

Confidence checks were performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image, and by passing aids to navigation. These features were identified during processing in **CARIS SIPS**.

PRELIMINARY SMOOTH SHEET

Once all sounding data and features were reviewed and analyzed using **PYDRO**, the data was saved into a Preliminary Smooth Sheet (PSS). The PSS is a working file, that does not actually contain data, but contains links to the data with specific path information as well as ancillary data flag information which is not supported in the **HDCS** file structure. There are five files which make up a PSS; an .fsl file (Field Sheet Layer) for bathymetry, a .xml file (Extended Markup Layer) for features, a .charts file (contains a list of raster charts for display in the Chart Window), a .treestate file (contains configuration information about the Data Tree Window), and a .txt file (which contains the text entered into the Notes Window).

C. CORRECTIONS TO ECHO SOUNDINGS

SOUND VELOCITY

Sound velocity profiles were acquired with Sea-Bird Electronics SeaCat SBE19 Conductivity, Temperature, and Depth (CTD) profilers (S/N 280 and 1060). Raw conductivity, temperature, and pressure data were processed using the program **VELOCWIN** which generates sound velocity profiles for **CARIS**. Sound velocity correctors were applied to SWMB and VBES soundings in **CARIS** during post processing only. Calibration reports and dates are included in Appendix IV of this report.

The speed of sound through water was determined by a minimum of one cast every four hours of SWMB acquisition, and one cast every week for VBES acquisition, in accordance with the Draft Standing Project Instructions and NOS Specifications and Deliverables for Hydrographic Surveys. Casts were conducted more frequently when changing survey areas, or when it was felt that conditions, such as a change in weather, tide, or current, would warrant additional sound velocity profiles.

VESSEL OFFSETS AND DYNAMIC DRAFT CORRECTORS

Each vessel was assigned a **CARIS** Vessel Configuration File (VCF) for each survey system utilized. The following table lists each Vessel Configuration File.

VCF NAME	SURVEY SYSTEM
05MB	1005 Shallow Water Multibeam
05TS	1005 Towed Edgetech Side Scan Sonar
05VB	1005 Vertical Beam Echosounder
14HS	1014 Hull-mounted Klein 5250 HSHRSSS
14TS	1014 Towed Edgetech Side Scan Sonar
14VB	1014 Vertical Beam Echosounder
WHVB	Whiting Vertical Beam Echosounder
WHTS	Whiting Towed Klein 5250 HSHRSSS

Static draft corrections for WHITING were measured on April 7, 2001 at Atlantic Marine Center. The historical value of 3.2 meters was maintained for ships draft in the **CARIS** Vessel Configuration Files (WHVB) and was applied to all VBES data acquired in conjunction with side scan sonar data. Static draft corrections for launch 1005 and 1014 were measured on April 27, 2001. The Reson Seabat 8101 sensor offsets were stored in the **CARIS** Vessel Configuration File (05MB) and were applied to SWMB data acquired with Launch 1005. The Edgetech and Klein side scan sonar sensor offsets were stored in the **CARIS** Vessel Configuration Files (05TS, 14TS) and were applied to side scan data during the Recompute SSS Navigation Program in **CARIS**. Vessel Configuration Files 05VB, 14VB, and WHVB were applied during data processing only for VBES data acquired with all survey vessels. See Separate IV for data records.

Settlement and squat values for WHITING were determined in April 2000 and entered into WHITING Vessel Configuration Files. Settlement and Squat values for Launch 1005 were determined July 26, 2000 using OTF ("On-the-fly") GPS techniques and entered into 1005 Vessel Configuration Files. These values were confirmed on April 27, 2001 using rod level techniques. Settlement and squat values for Launch 1014 were determined April 27, 2001 and were entered into 1014 Vessel Configuration Files. Settlement and squat values were applied to all SWMB and VBES data during the **HDCSLineMerge** process. Refer to Separate I for data records

Vessel offset diagrams and dynamic draft tables are included in Appendix III of this report. The Vessel Configuration Files themselves are included with the digital **HDCS** data.

HEAVE, PITCH, ROLL AND HEADING, INCLUDING BIASES AND NAVIGATION TIMING ERRORS

Heave, pitch, roll, and navigation latency biases for Launch 1005 were determined during Patch Tests conducted off Delaware Bay, DE, July 26, 2000. SWMB vessel offsets, dynamic draft correctors, and system bias values are contained in **CARIS** Vessel Configuration Files (VCFs) and were created using the program "**VCFEDIT**" in **CARIS**. These offsets and biases are applied to the sounding data during processing in **CARIS**. The VCFs and Patch Test data are included with the digital **HDCS** data.

WATER LEVEL CORRECTORS

Soundings were reduced to Mean Lower-Low Water (MLLW) using verified tide data for station Boston, MA (844-3970) obtained from the Center for Operational Oceanographic Products and Services (CO-OPS) web site. For this project, a simple predicted tide table was applied to SWMB data in **CARIS** during the Merge process. Upon completion of this project, a zone-corrected verified tide file was created using **HPTools** Tide utility. Verified tides were reapplied to all SWMB and VBES data using the **HDCSLineMerge** program in **CARIS**. Refer to individual Descriptive Reports for further information regarding water level correctors specific to each survey.

Refer to the *OPR-A397-WH Vertical and Horizontal Control Report* for information on the gauges used for this project. All maintenance for the Boston, MA (844-3970) was conducted by the Field Operations Division of the Center for Operational Oceanographic Products and Services (CO-OPS).

D. APPROVAL

As Chief of Party, I have ensured that standard field surveying and processing procedures were adhered to during this project in accordance with the Hydrographic Manual, Fourth Edition; Hydrographic Survey Guidelines; Field Procedures Manual, and the NOS Hydrographic Surveys Specifications and Deliverables, as updated for 2000.

I acknowledge that all of the information contained in this report is complete and accurate to the best of my knowledge.

Submitted:

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LT Richard T. Brennan, NOAA
Field Operations Officer

Approved and Forwarded:

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CDR Steven R. Barnum, NOAA
Commanding Officer