W00274

NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

DESCRIPTIVE REPORT

Type of Survey **Hydrographic Multibeam Survey**
Project No. **OSD-UNH-10**
Registry No. **W00274**

LOCALITY

State **Maine/New Hampshire**

General Locality **Isle of Shoals**

Sub-locality **Smuttynose Island to Duck Island**

2010

UNH Summer Hydrographic Field Course 2010

Andrew A. Armstrong III, Chief of Party

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DATE

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY No
HYDROGRAPHIC TITLE SHEET	**W00274**

State	Maine/New Hampshire
General Locality	Isle of Shoals
Sub Locality	Smuttynose Island to Duck Island
Scale	1:10,000
Date of Survey	10 June 2010 – 22 June 2010
Instructions Dated	
Project No.	OSD-UNH-10
Vessel	*R/V Coastal Surveyor*
Chief of Party	Andrew Armstrong, University of New Hampshire
Surveyed by	UNH Summer Hydrographic Field Course 2010
Soundings by echosounder	Simrad EM 3002 dual head multibeam echosounder
Verification by	***Atlantic Hydrographic Branch***
Soundings in	Meters
Soundings at	MLLW

REMARKS:		

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

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Introduction

This report presents a summary of multibeam sonar data acquisition and processing for the 2010 Hydrographic Field Course at the University of New Hampshire (UNH) Center for Coastal and Ocean Mapping - Joint Hydrographic Center (CCOM-JHC). Data were acquired in the vicinity of Duck Island, part of the Isle of Shoals, New Hampshire during June 2010 on board the R/V Coastal Surveyor. The objective of the survey was to acquire IHO Order 1a quality data for the purpose of improving hydrographic charts in the region.

Table 1 gives a complete list of the staff and students participating in the survey. The students were divided into two groups between the 10th and 22nd June, however, a single, processed multibeam sonar data set was produced for the purposes of this deliverable. The data were acquired and processed in accordance with the National Ocean Service (NOS) Hydrographic Survey Specifications and Deliverables (April 2009). This survey achieves complete multibeam coverage as defined in that specification.

The final survey outputs are:

1. Bathymetric Attributed Grid (BAG) surface at 1.0m resolution.
2. Backscatter Mosaic.
3. Descriptive report, appendices and separates describing survey activities.

Table 1 - Survey Personnel

Group1	Group2	Supervising Faculty
James Daniell	Sean Denny	Andrew Armstrong
Bernice Mahabier	Francis Friere	Semme Dijkstra
Athur Herwindya	Dandan Miao	Vessel Personnel
Yulia Zarayskaya	Carlo Lanzoni	Ben Smith
Xabier Guinda	Naoto Ujihara	Emily Terry

A. PROJECT

The Isles of Shoals and surrounding Portsmouth Harbor area is designated a Priority 1 survey area as established by the 2009 edition of the NOAA Hydrographic Survey Priorities document. The object of the survey was to acquire and process multibeam data for inclusion in future nautical charts for the region and thus assist with the safety of navigation for vessels transiting in the vicinity of Isle of Shoals.

A.1. Previous Work

The data acquired as part of the summer hydrography 2010 course supplements previous multibeam sonar and Lidar surveys in the region (Table 2). The multibeam data acquired in 2010 junctions with all three datasets as shown on Figure 1. The descriptive report for Lidar survey HI11296 made recommendations for further survey work and shoal investigations in the vicinity of Duck Island. Some of the recommended survey work was undertaken within the scope of the 2010 survey.

Table 2 - Previous multibeam sonar and LiDAR surveys in the Isle of Shoals

Survey	*Registry #*	*Date*	*Sounder*	*Location*	*Latitude*	*Longitude*
Summer Hydro 09	W00206	June 2009	EM3002D	Isle of Shoals (south)	N42°58’46.60’’ N42°57’38.22’’	W70°39’01.40” W70°35’27.70”
Summer Hydro 05	W00178	June 2005	EM3002D	Isle of Shoals (west)	N43º05’34.66 “ N43º03’21.56 “	W 70°38’51.71” W70° 41’ 01.05”
Fugro Pelagos	H11296	Sep-Dec 2005	LiDAR	Approaches to Portsmouth, NH	N42º57’02.25” N43º01’03.25”	W70º35’37.75” W70º46’18.25”

A.2. Area Surveyed

The Isle of Shoals is a region of rocky islands and shoals approximately 8 km south east from Portsmouth Harbor, New Hampshire. The survey area is bounded by the approximate coordinates listed in

Table 3 and illustrated by Figure 1, which encompasses the northern region of the Isles of Shoals, primarily between Duck and Appledore Islands and north of Duck Island. Additional north/south directed survey lines were added at the northern and western extents of the survey area to provide junctions with surveys from 2005 and 2009 (Figure 1). Data were acquired on

10, 11, 14-18, 21, 22, June 2010. Further survey statistics are summarized in Table 4. No bottom samples were taken during the survey.

Table 3 - The coordinate extents of the survey area in latitude and longitude

Point Location	*Latitude*	*Longitude*
(1)	N 42° 58’ 11.89’’	W 070° 38’ 55.47’’
(2)	N 42° 58’ 12.04’’	W 070° 38’ 44.89’’
(3)	N 42° 59’ 55.91’’	W 070° 38’ 47.99’’
(4)	N 42° 59’ 57.47’’	W 070° 36’ 58.22’’
(5)	N 42° 59’ 01.33’’	W 070° 36’ 45.17’’
(6)	N 42° 59’ 10.11’’	W 070° 35’ 15.45’’
(7)	N 43° 00’ 50.01’’	W 070° 35’ 23.48’’
(8)	N 43° 01’ 15.70’’	W 070° 36’ 01.67’’
(9)	N 43° 01’ 15.63’’	W 070° 37’ 08.37’’
(10)	N 43° 00’ 46.43’’	W 070° 39’ 05.52’’

Table 4 - Duck Island and surrounding areas survey statistics

2010 survey statistics	
North/south distance	3.24 Nm
East/West distance	2.70 Nm
Survey area	4.3 Nm^2
Minimum depth	-0.7 m
Maximum depth	54.2 m
Total main scheme survey lines	162 Nm
Total survey crosslines	13.5 Nm
Data acquisition start date	06/10/2010
Data acquisition finish date	06/22/2010

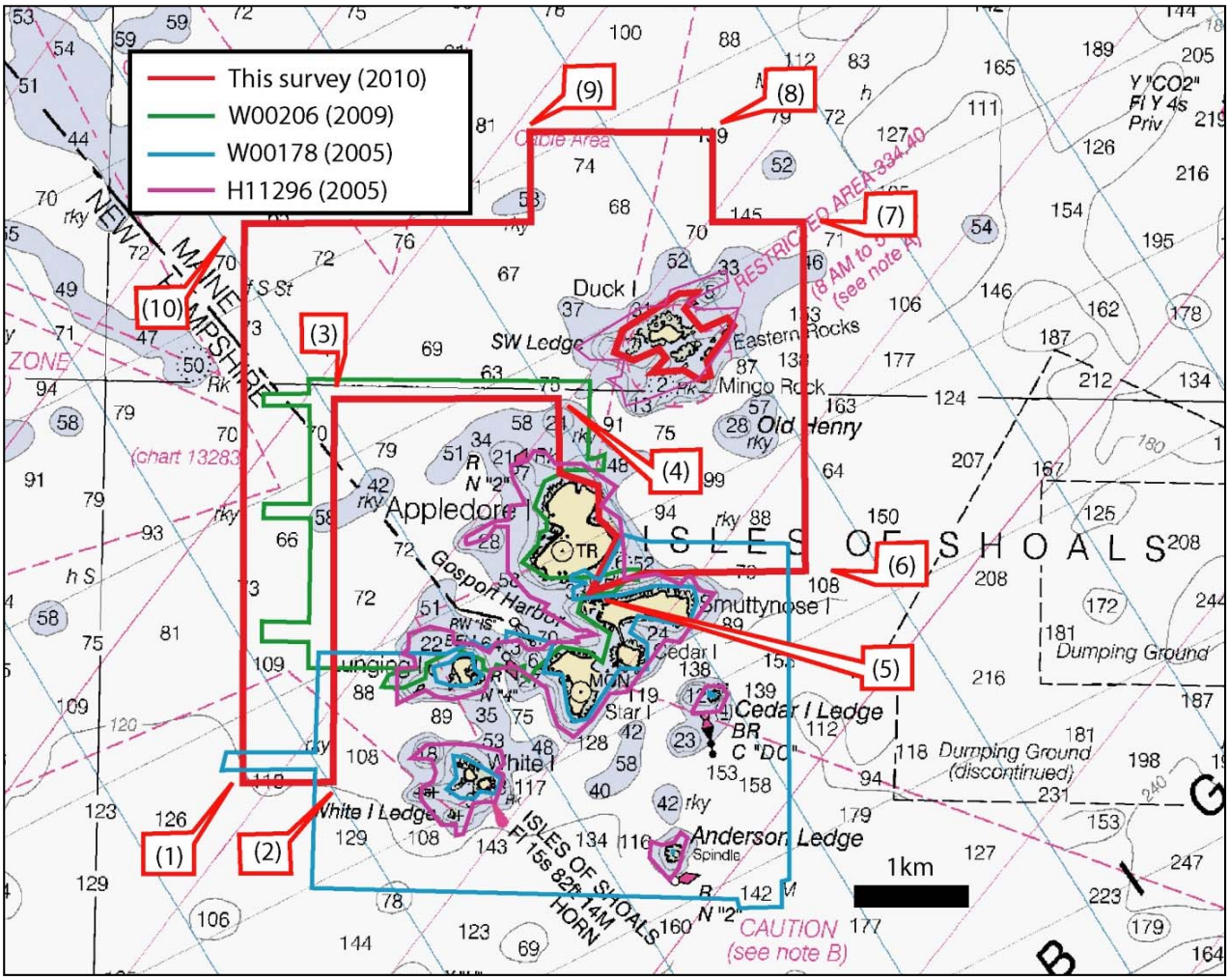

Figure 1 - Subject survey area and previous survey areas in the vicinity of the Isle of Shoals

A.3. Affected charts

Table 5 lists the raster and corresponding electronic charts that may be affected by the Duck Island multibeam sonar survey. The charts range in scale from 1:20,000 to 1:500,000 and Figure 2 indicates the geographical coverage of the affected charts in relation to the survey limits.

Table 5 - Potentially affected charts

Electronic (ENC)	Raster (RNC)	Scale	Edition Number	Issue Date
US5NH02M	13283	1:20,000	20	10/2007
US4MA19M	13274	1:40,000	27	06/2007
US4MA04M	13278	1:80,000	26	10/2009
US3EC10M	13260	1:378,838	40	05/2007
US3EC05M	13009	1:500,000	34	04/2009

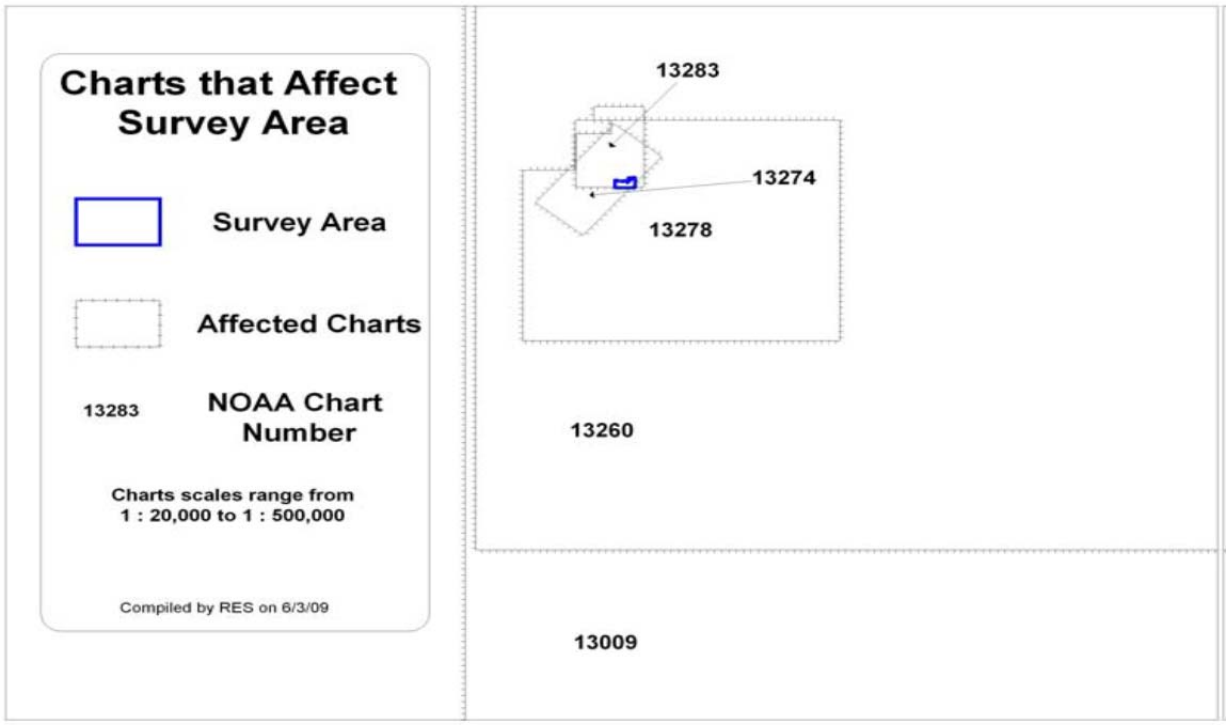

Figure 2 - Graphic of potentially affected charts in the vicinity of the Isle of Shoals

B. DATA ACQUISITION AND PROCESSING

B.1. Equipment

B.1.1. *Survey vessel*

The R/V *Coastal Surveyor* (Figure 3 and Figure 4) was used for multibeam data acquisition. The vessel is 40ft. (12.19m) in length, 12ft. (3.66m) in beam, has a draft of 5.5ft. (1.8m) and is equipped with a mechanical ram affixed to the bow for sonar/ instrument mounting. Refer to Appendix IV (Vessel Description and Offsets) for complete specifications of the R/V Coastal Surveyor.

Figure 3 - RV Coastal Surveyor with bow ram for multibeam installation

Figure 4 - EM3002 sonar heads mounted on the RV Coastal Surveyor

B.1.2. *Hydrographic Survey Equipment*

The primary data acquisition systems used on the R/V Coastal Surveyor are listed in Table 6. Further documentation of this equipment is provided in *Appendix 2*.

Table 6 - Description of the major systems used on the RV Coastal Surveyor

Vessel: R/V *Coastal Surveyor* *LOA*: 12.19m, *BEAM*: 3.66m, *DRAFT*: 1.8m		
	Equipment	*Manufacturer & Model*
Echo Sounding	Multibeam Echosounder	Kongsberg EM 3002 dual head
	Operator Station	Kongsberg HW-S10
	Processing Unit	Kongsberg EM 3002 PU
Attitude/ Positioning	Position Compute System (PCS)	Applanix 320 V.4 POS/MV
	Inertial Motion Unit (IMU)	Applanix IMU-200 POS/MV
	GPS Primary Antenna (Port)	Trimble/Zephyr
	GPS Secondary Antenna (Starboard)	Trimble/Zephyr
Horizontal Positioning	GPS Base Station Receiver	Trimble 5700
	2 Radio Modems	Trimble Trimark 3
Sound Velocity	Surface Sound Speed	AML SV & T Probe
	Sound Velocity Profile	Odom Digibar Pro
		AML SV & T Probe (defunct)
	Moving Vessel Profiler (MVP)	AML Singaround Sound Velocimeter
Water Levels	---	NOAA Water Level Station #8423898 (Fort Point, NH)

B.1.3. *Echo sounding equipment*

A dual-transducer Kongsberg EM3002 multibeam echosounder was used to acquire bathymetry and backscatter data. Specifications for the system are detailed in Table 7. The dual-sounders provided 508 beams in total and were operated with equidistant beam spacing for the duration of the survey. The swath from each head was positioned to cover out to 65 degrees to each side of the vessel and provide 20 degrees of overlap at nadir. A total swath width of 130 degrees was used to obtain a maximum level of coverage while maintaining an acceptable level of sounding uncertainty across the swath.

Table 7 - EM3002D Specifications

EM3002D Specifications	
Serial Numbers	390(port)/ 322(starboard)
Frequency	293/ 307 kHz
Soundings per ping	Max 508
Max Ping Rate	40 Hz
Max Angular Coverage	200 degrees
Pitch stabilization	Yes
Roll Stabilization	Yes
Heave Compensation	Yes
Pulse Length	150 μm
Depth resolution	1 cm
Transducer Geometry	Mills Cross
Beam Spacing	Equidistant or Equiangular

B.1.4. *Position, heading and motion reference systems*

Horizontal positions and vessel attitude were acquired using an Applanix POS/MV 320 v.4. This system incorporates two GPS receivers tightly coupled with an inertial motion sensor to derive a position and attitude solution. A GPS base station was established at Ordione Point, NH which broadcasted real time kinematic (RTK) corrections for position by a Trimble TrimMark 3 radio modem broadcasting corrections using the Trimble cmr+ protocol. The corrections were received by another modem on the R/V Coastal Surveyor which allowed for horizontal position accuracy to the centimeter level. The distance from the base station to the survey vessel was no greater than 14 km (7.5 nm).

B.1.5. *Sound speed measurement systems*

Sound velocity profiles were measured with an Odom Digibar Pro velocimeter at the start, end, and midway though each survey day (i.e. every 3-4 hours). The data were converted to .asvp format through Microsoft Excel and Microsoft NotePad. Metadata for the acquired sound velocity profiles are found in the separates document associated with this survey.

B.1.6. *Data acquisition software*

- *Hypack*
  Software package Hypack 2010 was used for pre-survey line planning. The software was also used onboard the R/V Coastal Survey to direct the survey, update the survey plan, and provide a helmsman's display during survey operations.
- *Seafloor Information Systems (SIS)*
  The Seafloor Information System (SIS) software suite (version 3.6.5) - provided by Kongsberg to provide a user interface and real-time processing system for the Kongsberg instruments - was used for acquisition of multibeam data. The interface provided numerous data visualization and data QC tools. The EM software provided with the system was version 2.032.

B.2. Quality Control

B.2.1. *Survey Planning*

Pre-survey planning was carried out in HYPACK 2010 using the UTM 19N projection on the WGS84 ellipsoid. The initial line plan used a spacing of three times water depth as per Section 2.5.3.1.1 of the NOAA Field Procedures Manual (April, 2010). Test lines - 500 and 501 of Figure 4 - were run with the initial plan and analyzed with CARIS HIPS Compute TPU in order to maximize efficiency. The initial line plan was modified using this information to produce a final line plan with a spacing of four times water depth.

The final pre-survey operations line plan as produced in Hypack and shown in Figure 5, includes 109 lines with a total length of 140.16 nautical miles (259.57 km). The estimated survey time at 6 knots ranged from 20 to 25 hours excluding the time needed for transit, turns, SVP casts, and for surveying freehand around Duck and Appledore Islands. The survey area was further divided into 5 sub-areas in accordance with variations in depth and to maximize efficiency of operations.

Extra lines were added to the original survey plan to cover gaps between swaths in shallow water. The R/V Coastal Surveyor was driven 'freehand' in shallow water to safely acquire data

near islands and shoals in the vicinity of Duck Island and Appledore Island. Actual survey lines are shown in Figure 6. Real time bottom coverage was displayed on the vessel during acquisition to aid in achieving coverage to specifications.

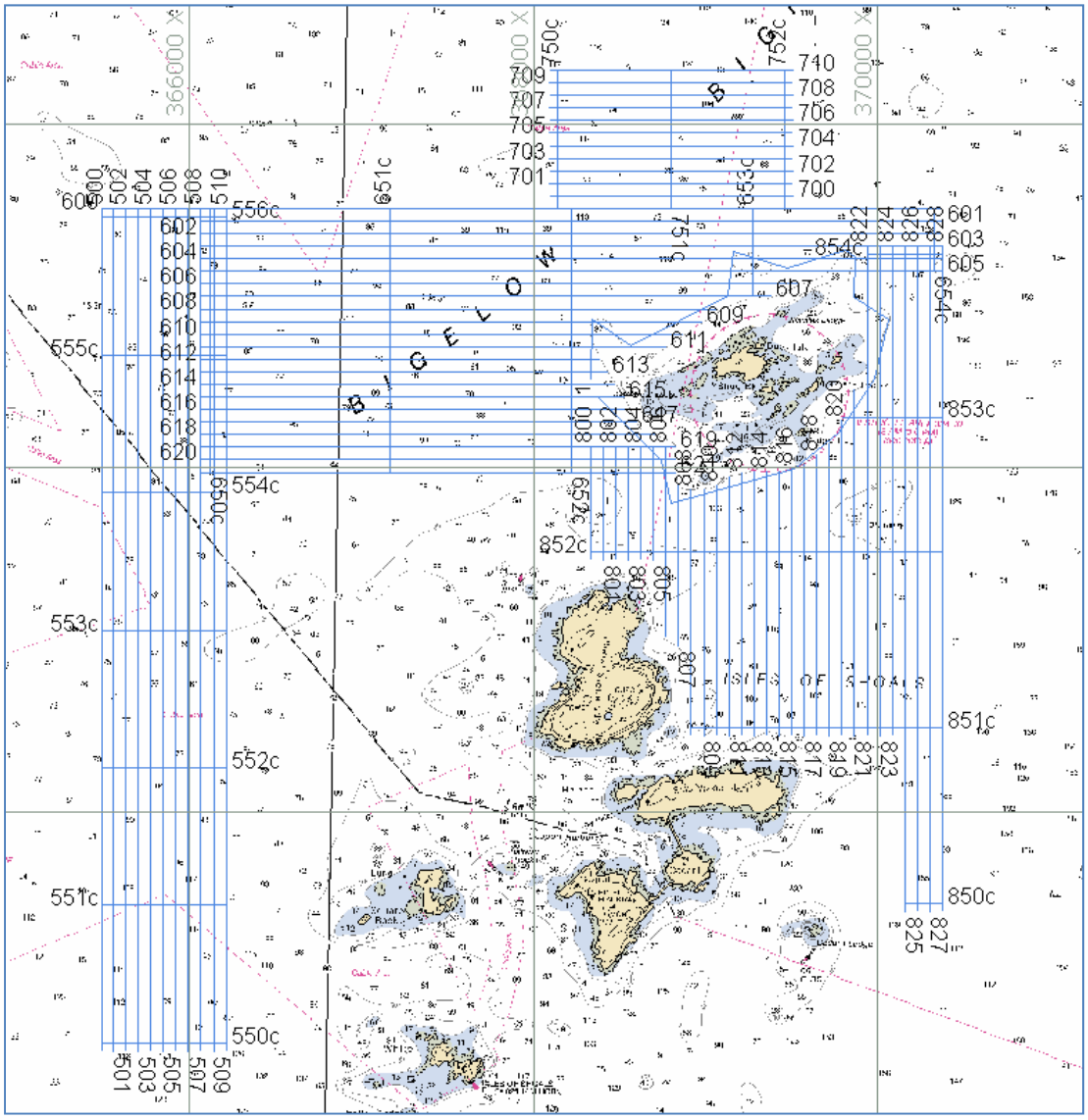

Figure 5 - Planned survey lines

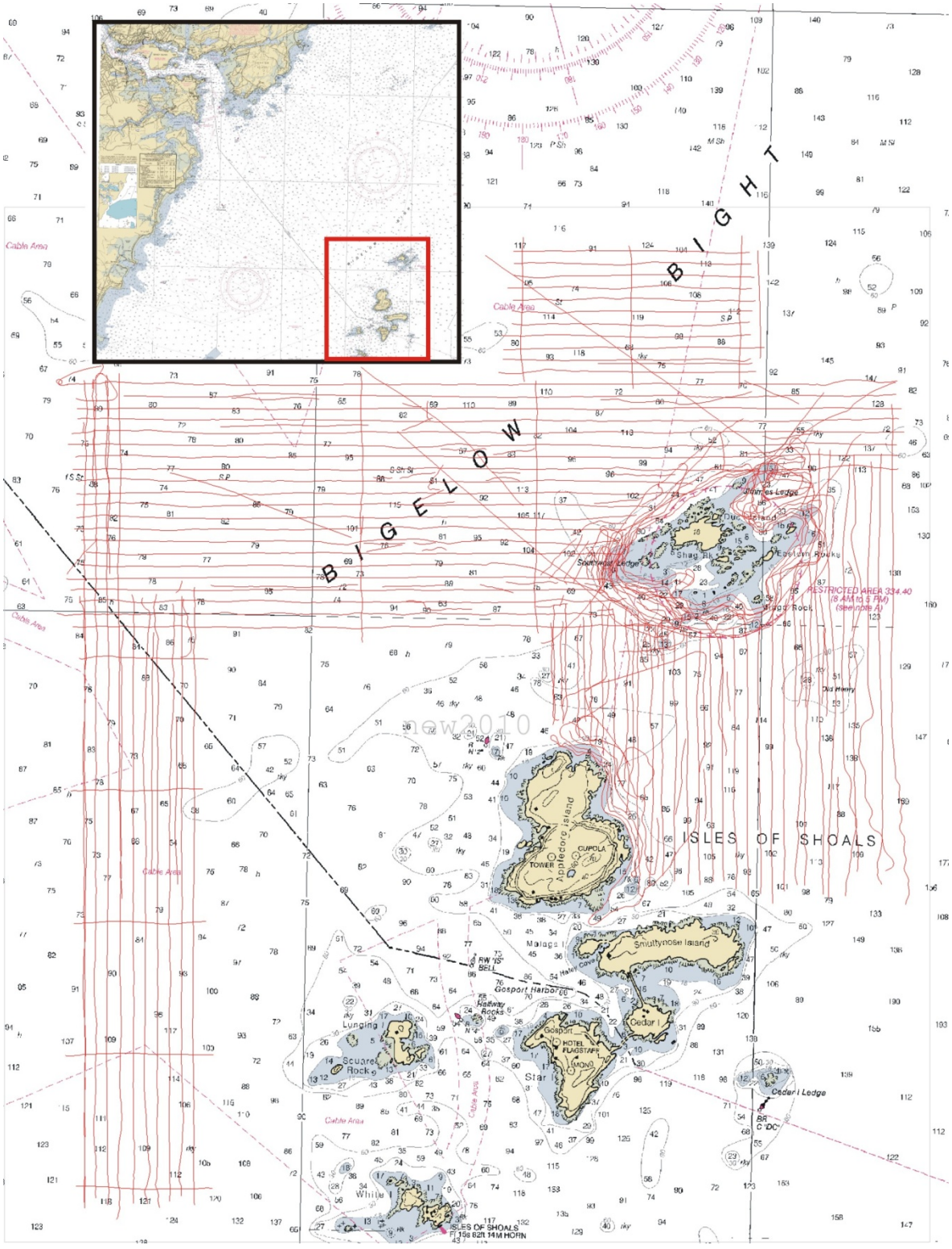

Figure 6 - 2010 Duck Island survey lines. The Isle of Shoals region, relative to Portsmouth Harbor, is shown in inset (chart 13283)

B.2.2. *Crosslines*

Cross line analysis was completed to check for consistency and to validate the accuracy of the sounding measurements using the Crosscheck Application software of IV3 Systems Inc. A total of 19 cross lines were examined (approx. 13.5 nm) as the reference surface for the analysis while 45 main lines (approx. 75.5 nm) were used for comparison (Figure 7). Tidal corrections were applied to all the lines examined. The differences in depths at the junctions between the main and cross lines were computed in order to analyze the depth sounding values at the same point as summarized in Table 11. Results show that the mean depth difference between the main lines and cross lines at their junctions were -0.004 m with a median of -0.006 m and a standard deviation of 0.83. The results indicate that there was consistency in data collection throughout the survey.

Table 11. IVS cross check analysis for Duck Island survey.

Number of points of comparison	21478213
Mean depth of points in main lines	-29.275
Mean depths of points in crosslines	-29.270
Mean difference	-0.0046
Median difference	-0.0065
Std. deviation	0.83

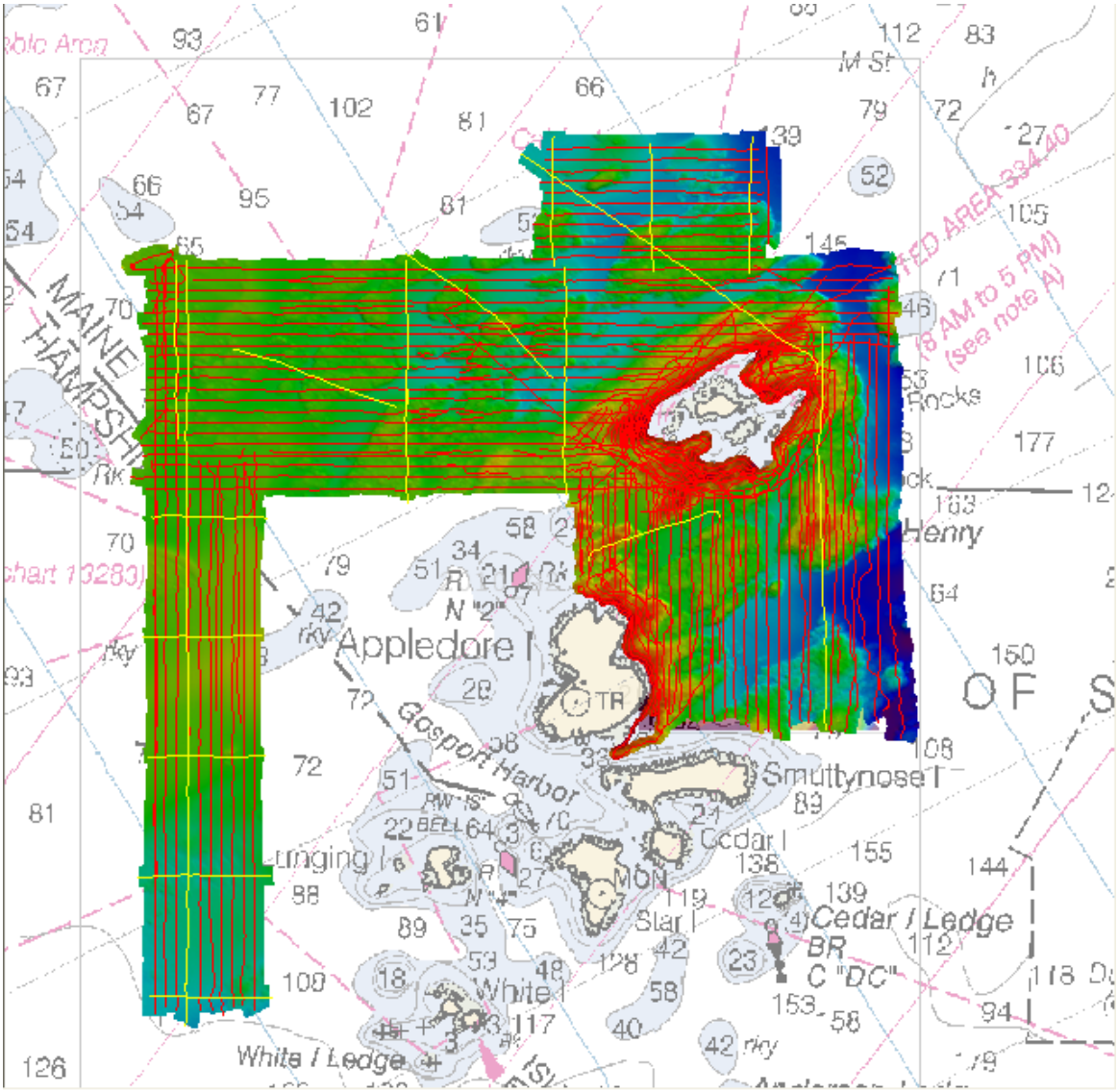

Figure 7 - Intersecting crosslines (yellow) used for crossline analysis

B.2.3. *Uncertainty*

Caris was used to compute the Total Propagated Uncertainty (TPU) for each sounding. The measured tide uncertainty parameter was set to 0.08 m and the zoning to 0.1 m. The measured sound speed parameter was set to 0.5 m/s and the surface sound speed to 0.2 m/s. Final uncertainty was taken as the greater of the propagated uncertainty or the 95% scaled standard deviation. The final uncertainty is within IHO Order 1 tolerances. Areas of high uncertainty are in regions with steep slopes.

B.2.4. ***Junctions***

Junctions were made between adjoining contemporary surveys to ensure completeness and consistency. Refer to Section 2.2 *Previous work* for details of previous surveys. Fledermaus (version 7.1a) provides a cross check analysis module for the comparison of bathymetric surfaces by performing a statistical comparison between survey lines and a reference surface and was used for the comparison of the 2010 survey data and the three older surveys as shown in Table 8.

Table 8 - Junction summary

	Median	Mean	StdDev	Cells compared
2005 Multibeam	-0.22	-0.23	0.19	638508
2005 Lidar	0.20	0.10	0.79	1152600
2009 Multibeam	-0.02	-0.03	0.23	686571

2005 Hydrographic Field Course Junction
The data from the 2005 Hydrographic Field Course were acquired with the same vessel and sonar system. The processed 1-meter resolution CUBE surface from 2005 was compared with the data obtained in this survey and a mean surface difference of 0.23m was determined. It is possible that this difference may be related to a static pitch correction not being applied during the 2005 survey. The static pitch of the R/V Coastal Surveyor measured at the transducer heads is approximately 0.222 m and the application of this correction would ensure a close agreement between the two surfaces.

2005 LiDAR Junction
The processed 1-meter resolution CUBE surfaces of the current survey and the 2005 H11296 LiDAR survey data were compared and a mean surface difference of 0.10m determined. This difference is attributed to the accuracy magnitudes between the bathymetric data (greater accuracy) and the LiDAR data (lesser accuracy). The difference in magnitude accuracy between these two data types arise from instrumentation constraints (primarily for eye safety) and environmental constraints, both atmospheric and bathymetric.

2009 Hydrographic Field Course Junction
The 2010 and 2009 surveys show a good correlation with median and mean differences of -0.02 and -0.03 m respectively. Further analysis has shown this difference to be constant and may be attributed to minor differences in the sonar offsets between the two surveys.

B.2.5. ***Data Density***

The density layer of the CUBE surface created in CARIS was exported in ASCII format and analyzed with the Generic Mapping Tools (GMT) module *pshistogram*. The results show that 99.26% of the nodes have at least five soundings. The analysis shows that the survey meets or exceeds the NOS Hydrographic Survey Specifications and Deliverables (April, 2010) requirements of section 5.2.2.1, that at least 95% of all nodes on the surface are populated with at least five soundings. Data density was lowest in the deeper parts of the survey area, and at its north, south, and eastern extremities. Figure 8 depicts the distribution of data density over the survey area. Sounding data density in the shallow parts of the survey was typically > 10. A histogram of the sound density indicates a modal density of 20 (Figure 9)

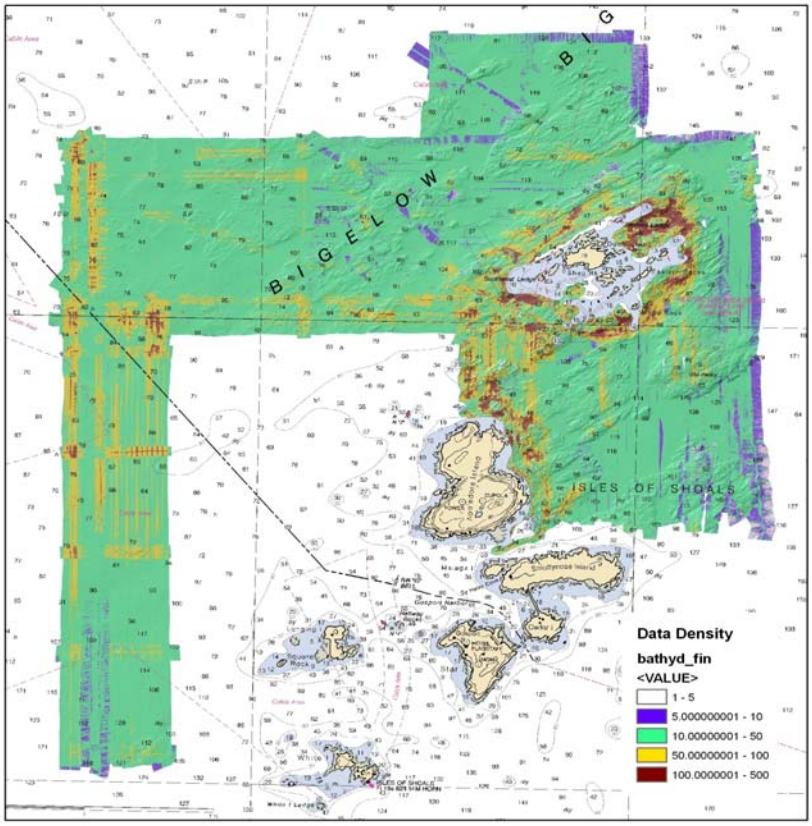

Figure 8 - Sounding data density

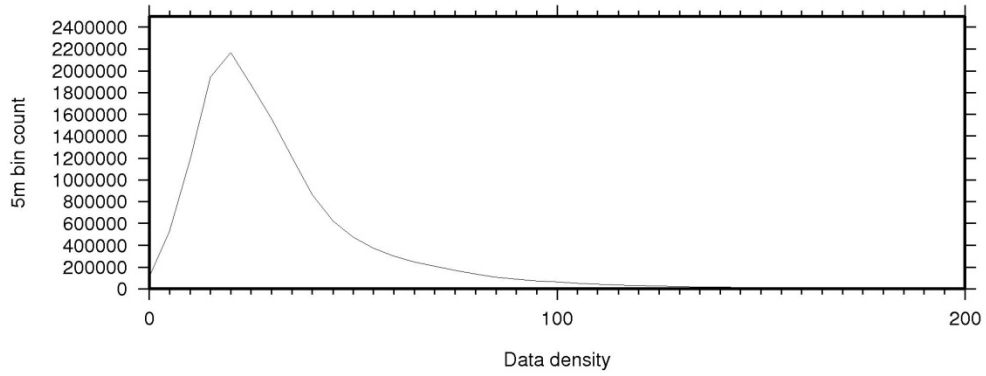

Figure 9 - Histogram of sounding data density using a 5-meter bin size

B.2.6. *Survey Conditions*

Survey conditions with regard to sea state were favorable throughout the survey. However, heavy rain that occurred from 12-13 June created a halocline near the sea surface. The sound speed associated with the halocline appeared to be highly variable throughout out the survey

area. This was observed as differences in sound speed at the transducer and from the applied sound profile (both are monitored in SIS). These differences were commonly on the order of 3 m/s and at times up to 5 m/s. Some additional SVP casts were taken to determine if running N/S survey lines would encounter less variability than running E/W. Surface sound speed was concluded to be 'patchy' with no preference N/S or E/W. The surface sound speed anomalies were most evident on the 14th June and lessened over time due to mixing of the water column. Lobster pots were common in the survey area but were successfully avoided.

B.3. Corrections to echosoundings

B.3.1. *Vessel offsets*

Sensor offsets of the R/V Coastal Surveyor were measured relative to a survey mark on top of the IMU (Table 9). These offsets were documented by previous surveys on the R/V Coastal Surveyor and known to be highly accurate. The sensor offsets were entered into SIS before data acquisition. Patch test offsets, tidal corrections, sound speed corrections, and static draft were all applied in post processing with Caris HIPS/SIPS. No further corrections were applied to the dataset.

Table 9 - Sensor offsets for the RV Coastal Surveyor

	X (starboard is positive)	Y (forward is positive)	Z (down is positive)	Comment
IMU (POS_MV)	0.00	0.00	0.00	IMU is reference point
Transducer1	-0.226	9.007	1.093	Entered into SIS
Transducer2	0.226	9.007	1.093	Entered into SIS
Primary GPS Antenna	-1.103	-0.052	-3.570	Entered into POS

B.3.2. *Patch test*

A patch test for the EM3002D multibeam echosounder was carried out on 10th June 2010, with a subsequent verification patch test conducted the following day. Previous multibeam surveys in the region identified an area suitable for the multibeam patch test on the transit to the Isle of Shoals from Portsmouth (Figure 10). Time delay was determined by running one line at varying speeds over the sloped portion of the test area and pitch values were determined by running the same line in opposite directions. Yaw and roll values were obtained by running two lines at the same speed in opposite directions over a feature and over a flat surface respectively. The patch test data (*Appendix 3*) were processed using the Caris calibration tool and average patch test values from 6 calibrations (Table 10) were input during post-processing. Line logs for the patch test are found in the separates associated with this survey.

Table 10 - Patch test offsets

	Port Head	Starboard Head
Time	0.058	0.058
Pitch	1.938	1.512
Roll	-0.761	-1.426
Yaw	-0.210	-1.575

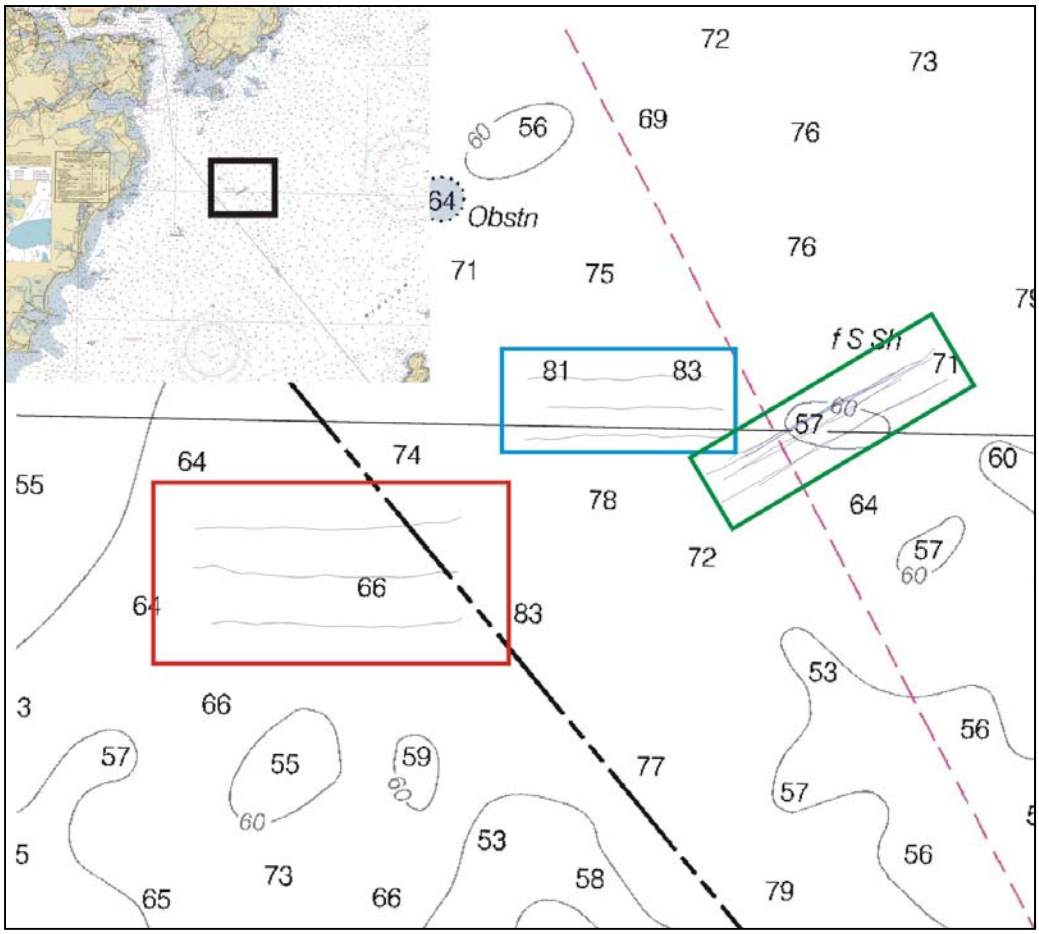

Figure 10 - Patch test lines. Pitch and latency (green), roll (red) and yaw (blue)

B.3.3. *Static draft*

A static draft measurement was taken at the start each day when the vessel had reached the survey area. The waterline measurement was made from the top of the POS/MV sensors to the waterline observed within an adjacent draft tube. Daily measurements are summarized in Table 11. The static draft measurements were applied during post processing with Caris HIPS/SIPS.

An incorrect waterline measurement input into SIS (0.782 m) at the start of surveying was corrected in post processing with Caris using the data in Table 11.

Table 11 - Daily static draft measurements

Julian Day	Date	Draft (m)	Caris Waterline
165	14/06/10	0.523	-0.259
166	15/06/10	0.523	-0.259
167	16/06/10	0.536	-0.246
168	17/06/10	0.530	-0.252
169	18/06/10	0.528	-0.254
172	21/06/10	0.523	-0.259
173	22/06/10	0.513	-0.269
	Average	0.525	-0.257

B.3.4. *Dynamic draft*

In 2006 a study was undertaken to determine the dynamic draft characteristics of the R/V Coastal Surveyor. A report detailing the study and its results are presented in the separates associated with this survey. The draft characteristics as determined by the study are presented in Table 9 and corrections were applied in post processing using Caris HIPS/SIPS. Typical survey speeds were in the order of 6 knots, resulting in a dynamic draft correction of approximately 1.5 cm.
A positive draft indicates that the vessel is lower in the water at the corresponding speed than it is at rest.

Table 12 - Dynamic draft corrections

Speed (kts)	Speed (m/s)	Dynamic Draft (m)
0	0.000	0.000
1	0.514	-0.025
2	1.029	-0.040
3	1.543	-0.043
4	2.058	-0.035
5	2.572	-0.017
6	3.087	0.012
7	3.601	0.053
8	4.114	0.104
9	4.603	0.166
10	5.144	0.239

B.3.5. *Heave*

Heave was acquired by the Applanix POS/MV 320 v4 and applied to the sonar data within the SIS acquisition software. No additional corrections or further processing was undertaken. Raw data from the POS/MV was saved to disk for further reprocessing if required.

B.3.6. *Sound speed corrections*

Sound velocity profile (SVP) casts were measured once prior to survey operations, once at the end of survey operations, and every three hours in between each day. The SVPs were loaded into SIS and applied to the survey acquisition in SIS.

Additional sound velocity profiles were acquired using an ODIM Moving Vessel Profiler (MVP), a device that produces continuous profile of the water column. The MVP was installed on the R/V Cocheco and acquired data from the 14-18 June 2010 over the same area covered by the R/V Coastal Surveyor. The data acquired by the Odom Digibar Pro were checked against that acquired by the MVP30 in order to ascertain any discrepancies in sound velocity of the water column. These data have not been incorporated into the present survey.

Figure 11 illustrates a comparison of the SVPs measured by the Odom Digibar Pro onboard the R/V *Coastal Surveyor* and the by MVP30 onboard the R/V *Cocheco*. Analysis of the two casts gives a shallow-water sound speed difference of less than 3m/s, while in deeper water the difference is negligible.

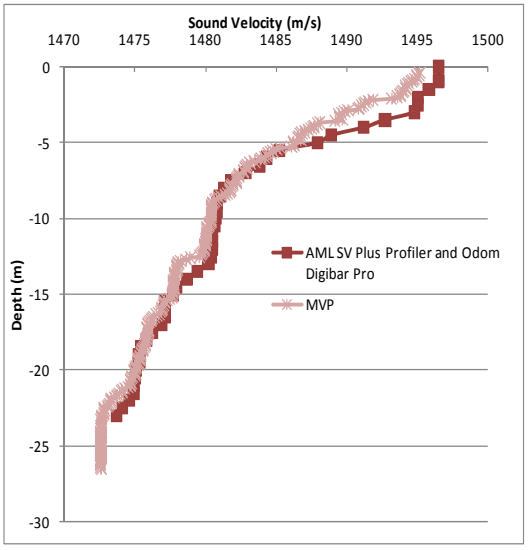

Figure 11 – Comparison of the SVP acquired by the Odom Digibar Pro with that of the MVP30

C. VERTICAL AND HORIZONTAL CONTROL

C.1. Vertical control

All sounding data were related to Mean Lower Low Water (MLLW) using observed water levels recorded by the NOAA CO-OPS tide station 8423898 located at Fort Point, NH (Table 13), using the zone corrector NA169 as computed by NOAA CO-OPS (Table 14). These data were converted to .tid format for use with CARIS HIPS using MATLAB R2008a.

Table 13 - Tide gauge information

GaugeID	*Model*	*Gauge Type*	*Location*	*Latitude*	*Longitude*	*Operation*
8423898	NOAA Primary	Acoustic	Fort Point, NH	43°04.3' N	70°42.7' W	Permanent

Table 14 - Tide zone from Fort Point, NH

Zone	*Site*	*Station number*	*Time*	*Range Ratio*
NA169	Fort Point	8423898	-6 min	1.00

C.2. Horizontal control

The North American Datum of 1983 (NAD83) was used for horizontal control. All raw positions were collected in WGS84 and transformed to NAD83 during post-processing in CARIS HIPS.

D. RESULTS AND RECOMMENDATIONS

The survey, as shown in Fig. 10, meets NOAA specification and should be used to update the affected charts (Table 4). The chart comparisons and DTON report indicates that there are significant discrepancies between the charted depths and the newly acquired multibeam bathymetry data including many previously unknown shoals, some of which may pose a danger to navigation. It is suggested that charts covering Duck Island be updated to reflect these differences.

D.1. Chart comparison

The final base surface (Figure 12) was compared to chart 13283 (20th ed., scale 1:20,000). An initial comparison highlighted a number of shoals, hazards and discrepancies between the survey datasets and the chart. All flagged dangers and discrepancies are reported in the following section. For the comparison, the final base surface was converted from depth in meters to US survey feet. The color table in Table 15 is used for contouring in the following section. Numerous erroneous soundings, uncharted shoals, and misleading depth curves exist in the current chart. It is recommended that updates to all the affected charts are made based on the newly acquired multibeam bathymetry data.

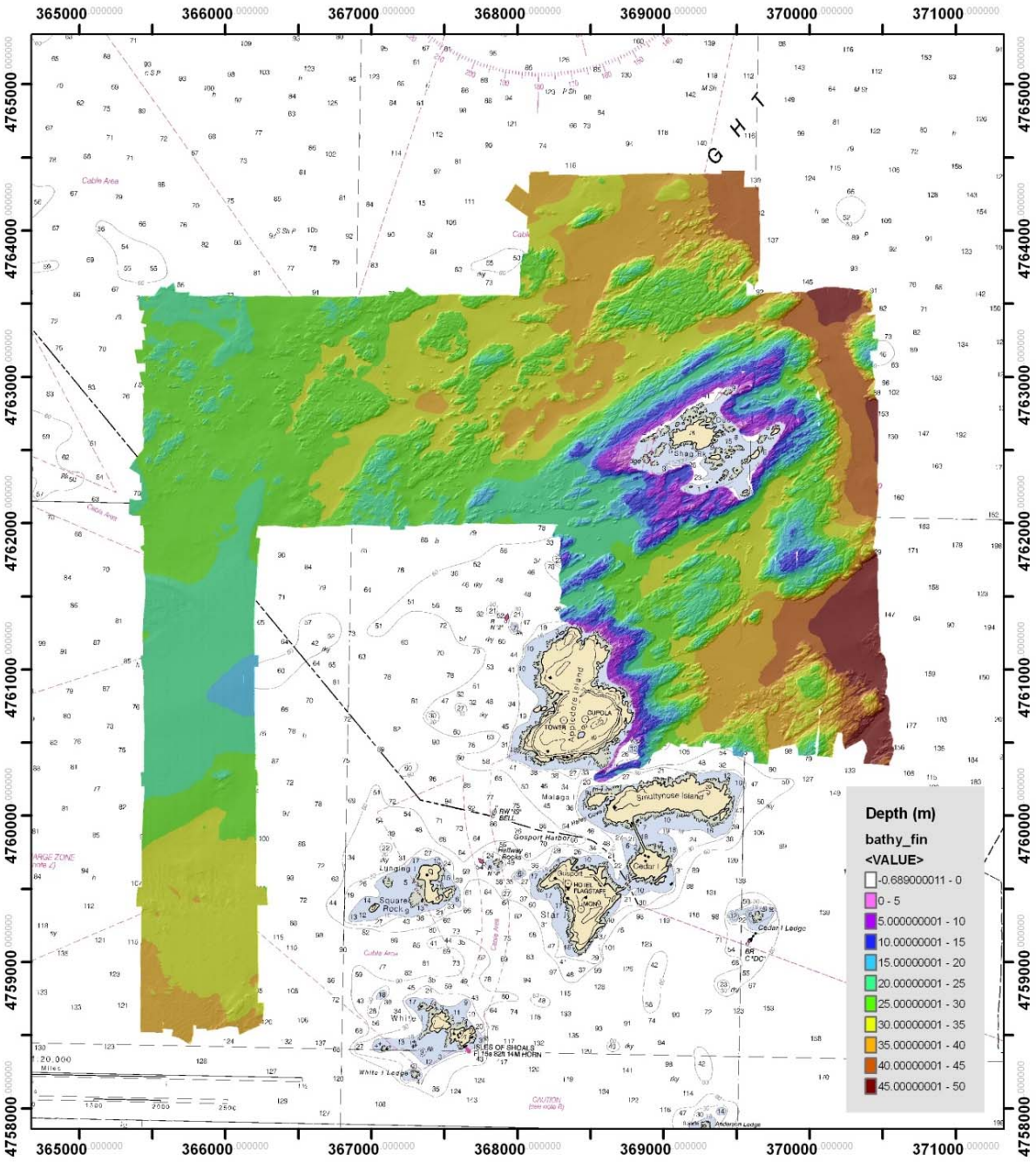

Figure 12 - Final 1 m CUBE Surface (depth in meters)

Table 15- Contour color designation (in US survey feet) for chart comparison.

-3 - 0	**0 - 3**	**3 - 6**	**6 - 9**	**9 – 12**
12 - 15	**15 – 18**	**18 - 21**	**21 - 24**	**24 – 27**
27 – 30	**30 – 60**	**4. >60**		

Figure 13 is presented to illustrate the differences in depth curves in chart 13283 and observed contours in the 2010 Duck Island survey data. The 60ft depth curve on chart 13283 bears no resemblance to the 60 ft contour from the survey data. The survey area has a strong northeast/southwest bathymetric trend. This trend is only likely to be obvious within multibeam sonar datasets (and probably Lidar). Future editions of charts from this area should take into account this trend when contouring.

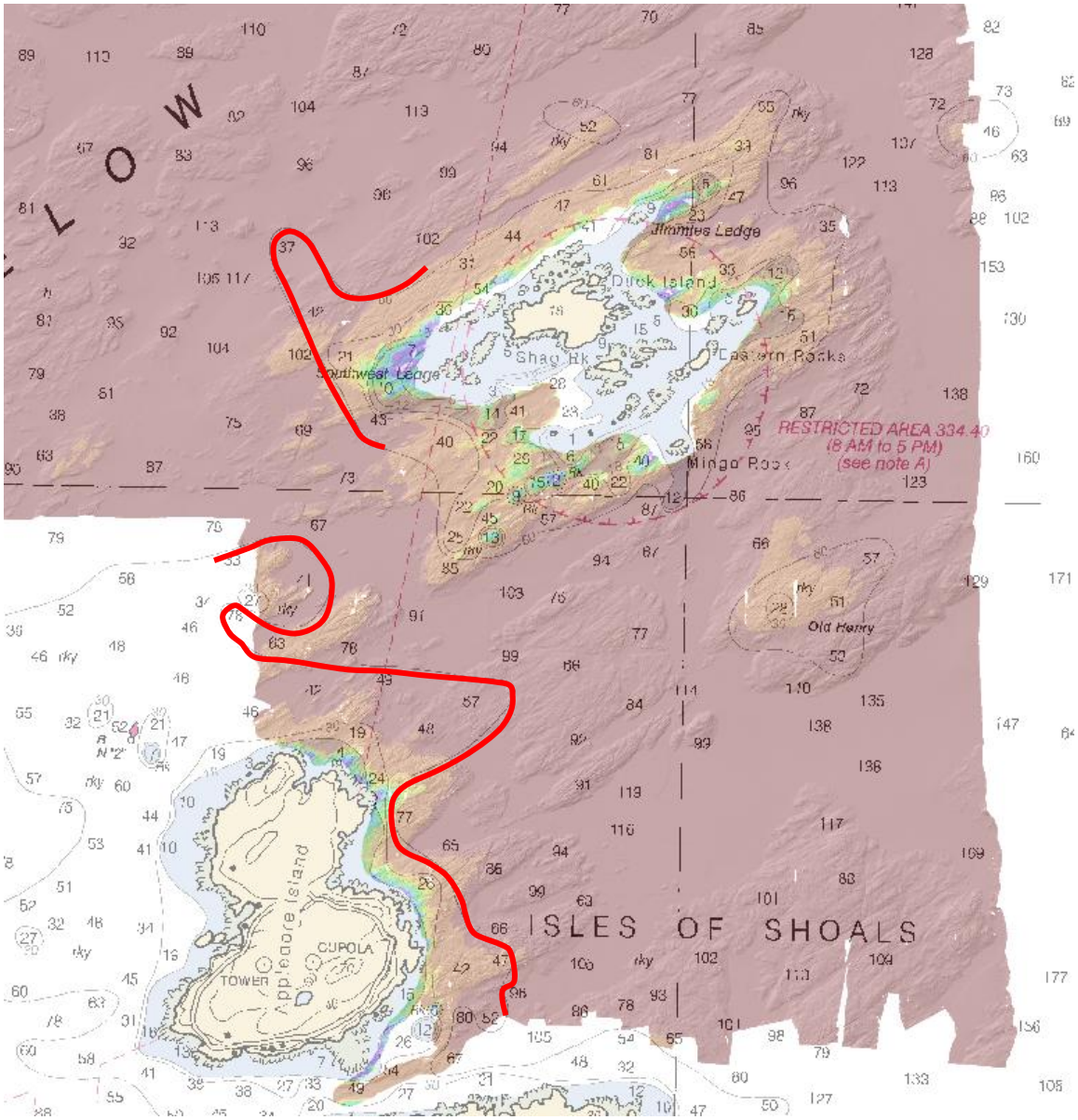

Figure 13- Comparison of charted depth curves and multibeam bathymetry data. Note the discrepancy between the charted 60 ft depth curve (red) and the 60 ft multibeam contour (light/dark brown)

The differences in bathymetry contours around Duck Island were previously reported during the 2005 Lidar survey (DR_H11296). Some of the errors in contouring on chart 13283 appear to be the result of erroneous soundings. Figure 14 highlights an area west of Duck Island where four particular soundings prevented accurate contouring.

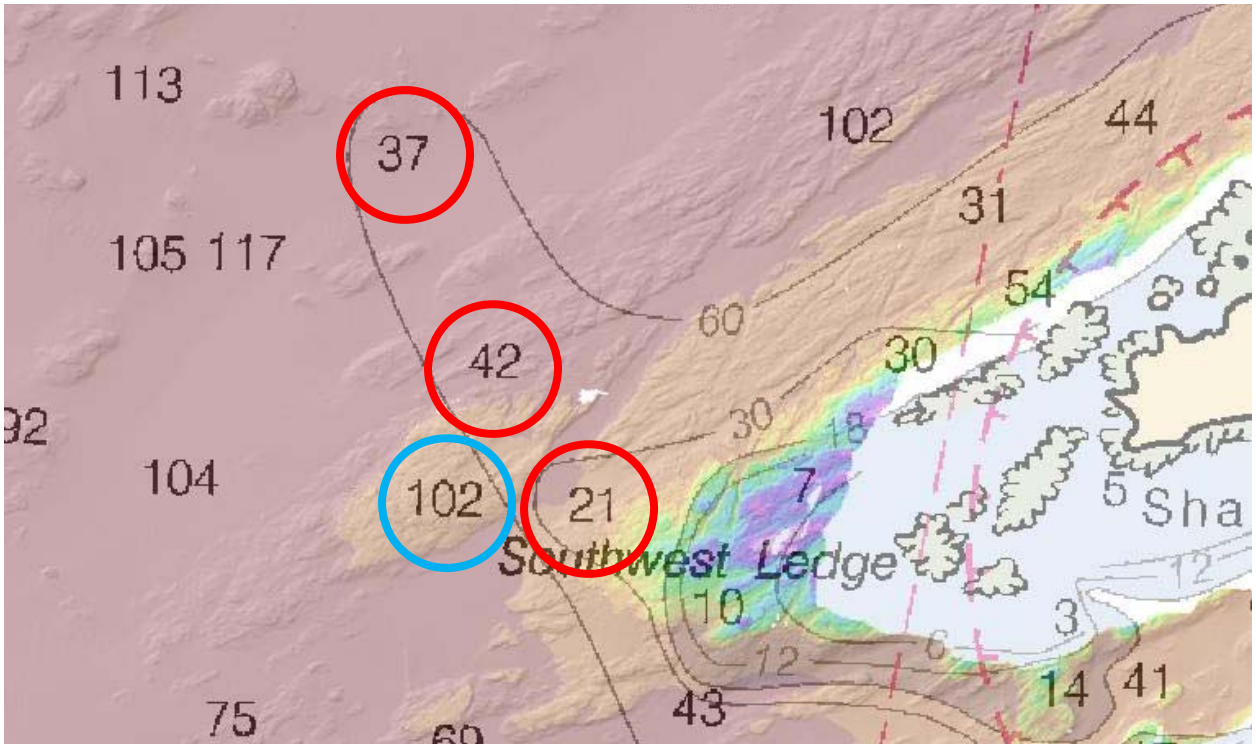

Figure 14 - . Erroneous soundings west of Duck Island. Soundings circled in red are too shallow, soundings circled in blue are too deep.

The charted 102 foot sounding (circled in blue), was found to have a depth value of 34.78 feet from the full-coverage multibeam survey. It is recommended that the charted value be updated to reflect this discrepancy.

Chart 13283 indicates a 37 foot sounding within the 60 foot depth curve surrounding Duck Island (circled in red), however, the least depth value from the full-coverage multibeam survey was 119.19 feet in this region. It is recommended that the charted value and the 60 foot depth curve be updated to reflect this discrepancy.

The 2005 Lidar survey (DR_H11296) noted **a**n erroneous sounding of 12 ft near Mingo Rock. The 2010 multibeam survey shows that this sounding can be confirmed as erroneous and should be removed from future charts of the region (Figure 15).

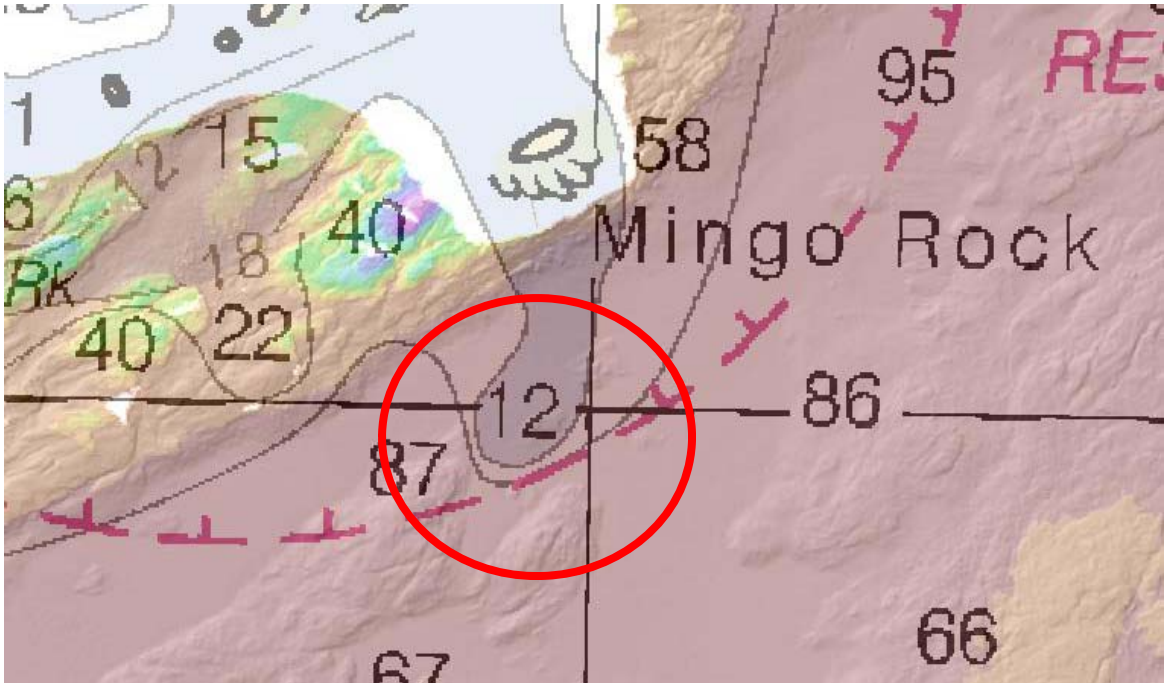

Figure 15 - Erroneous 12 ft shoal (red) near Mingo Rock. Sounding was initially suggested to be erroneous by the 2005 Lidar survey.

The 2005 Lidar survey (DR_H11296) noted **a**n erroneous sounding of 5 ft near Mingo Rock. The 2010 multibeam survey indicates that this sounding is erroneous and should be removed from future charts of the region (Figure 16, red circle). However, a shallow (< 3 ft) shoal is located southwest of this erroneous sounding (Figure 14, yellow circle). This shoal may pose a threat to navigation and should be included in future chart revisions**.**

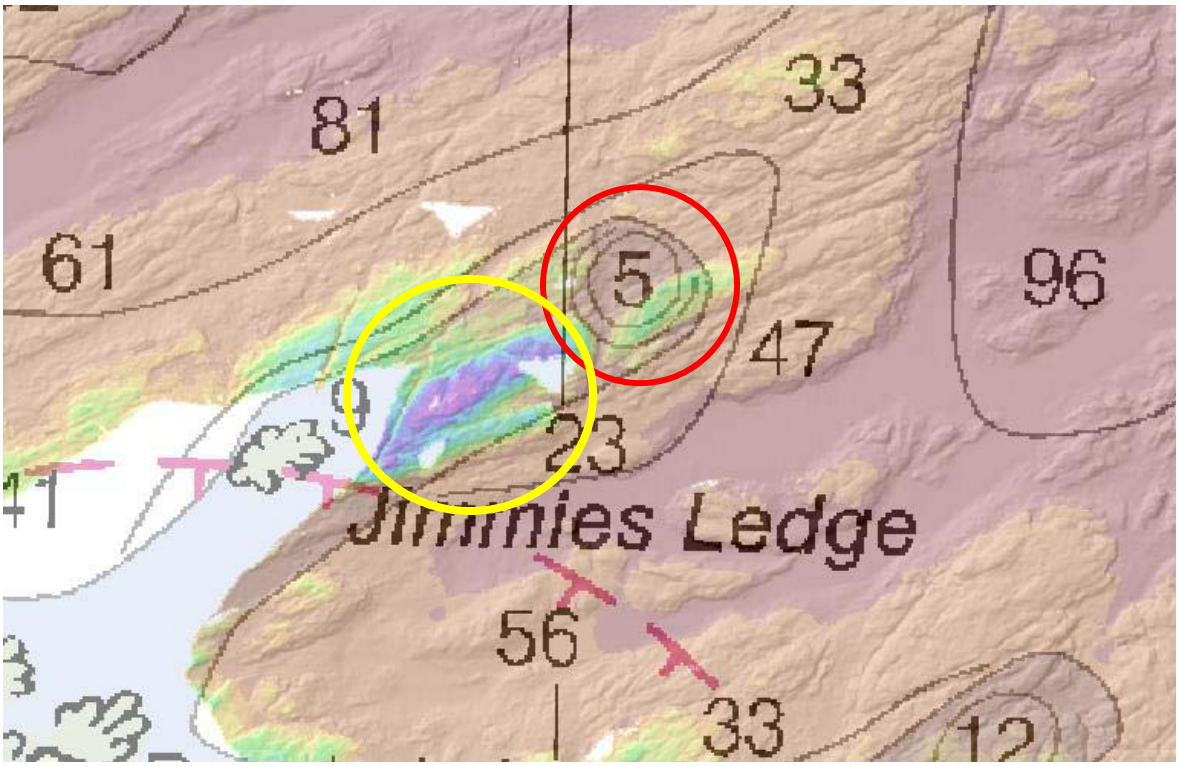

Figure 16 - Shoal areas near Jimmies Ledge (from Lidar report). The red circle indicates an erroneous 5ft sounding. The yellow circle shows a shallow < 3ft rock which may pose a threat to navigation

An erroneous sounding can be observed at the northeast of Appledore Island. This sounding **(**77 ft) is shown in the red circle in Figure 17and should be removed from future chart revisions. There are two shoals (Figure 17, yellow circles) with depths of ~ 3 ft which may pose a threat to navigation and are not delineated with the current chart contours. Future chart revisions should include these features to ensure safety of navigation.

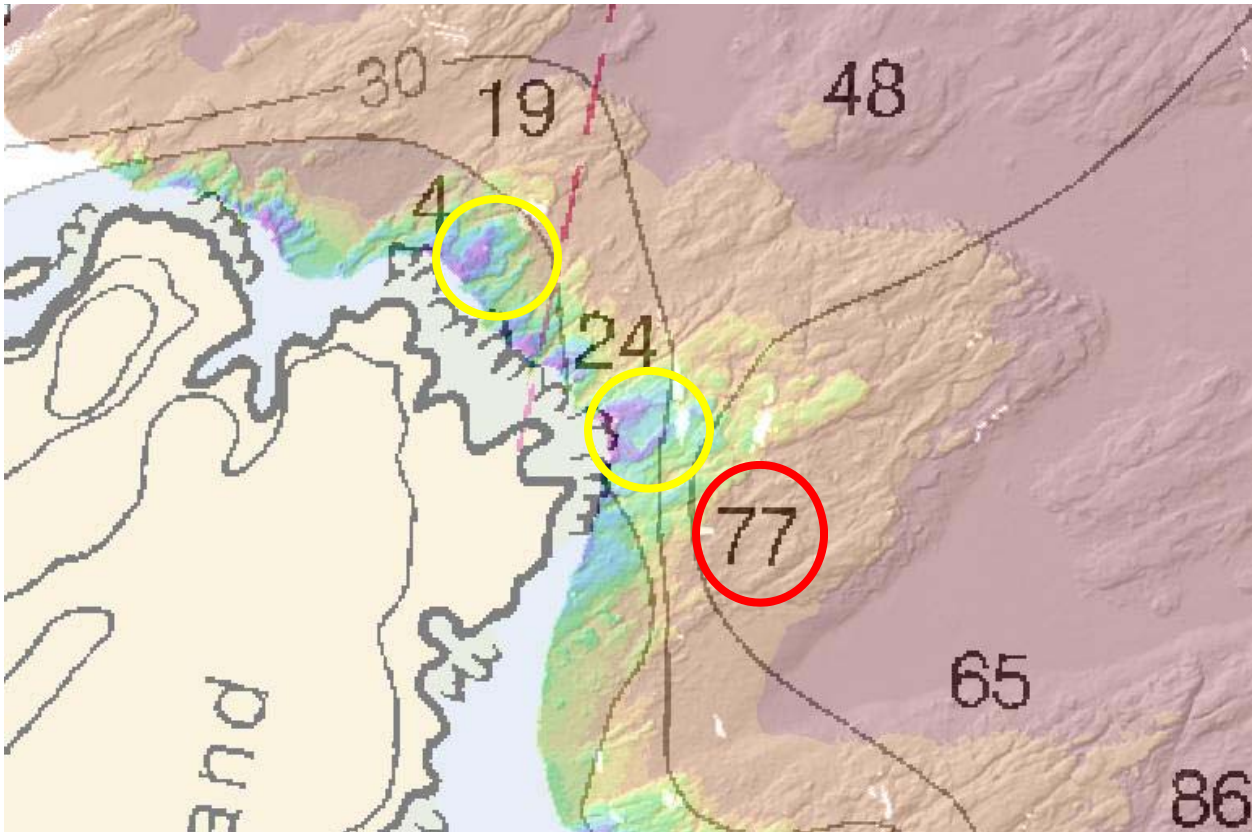

Figure 17 - Erroneous 77 ft sounding northeast of Appledore Island (red circle). Yellow circles indicate shoals that are potential hazards to navigation that are not shown on the chart.

The 2010 survey observed numerous shoals to the south of Duck Island. Three shoals were found to have erroneous soundings (Figure 18, red circles). The shoals have charted depths of 40, 40, and 45 ft. The two westernmost shoals are ~20 ft, while the easternmost shoal is ~ 3 ft. The easternmost shoal poses an immediate threat to navigation due to its shallow nature. Four other uncharted shoals (Figure 18, yellow circles) were also observed, which are all at ~20 ft depth and pose less of a threat to navigation but should assist with deriving bathymetric contours around Duck Island in future chart revisions.

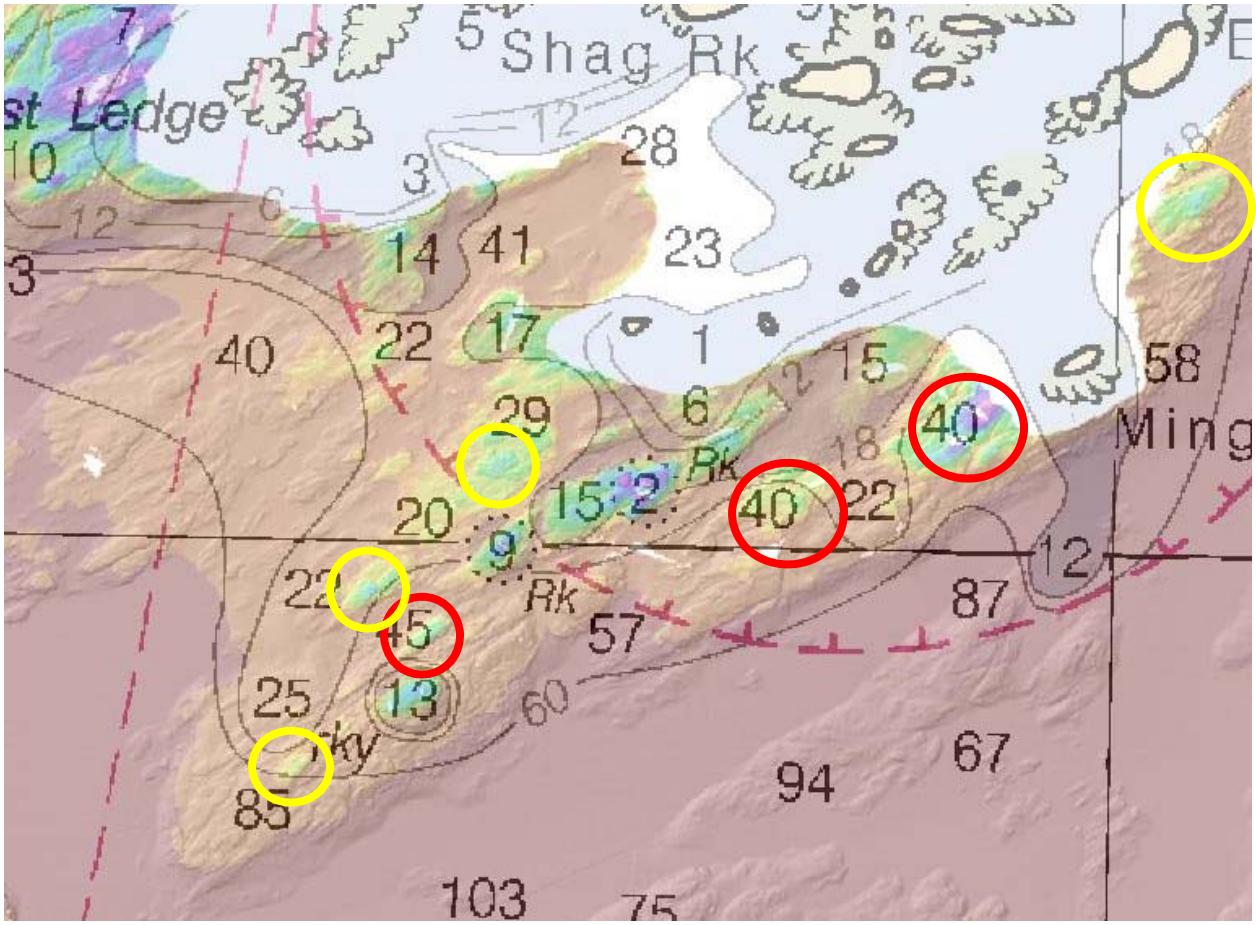

Figure 18 - Shoals south of Duck Island. Shoals with no chart soundings are circled in yellow, shoals with erroneous soundings are circled in red.

The 2010 multibeam survey indicates that Southwest Ledge around Duck Island is poorly charted and in need of revision. The dark purple regions within Figure 19 indicate depths of 3-6 ft. These depths commonly occur outside the existing 6 ft depth curve, and in places, beyond the 18 ft depth curve. It is recommended that the contours around Southwest Ledge are revised as the ledge is more expansive than shown in the current chart and observed depths may pose a risk to safety of navigation.

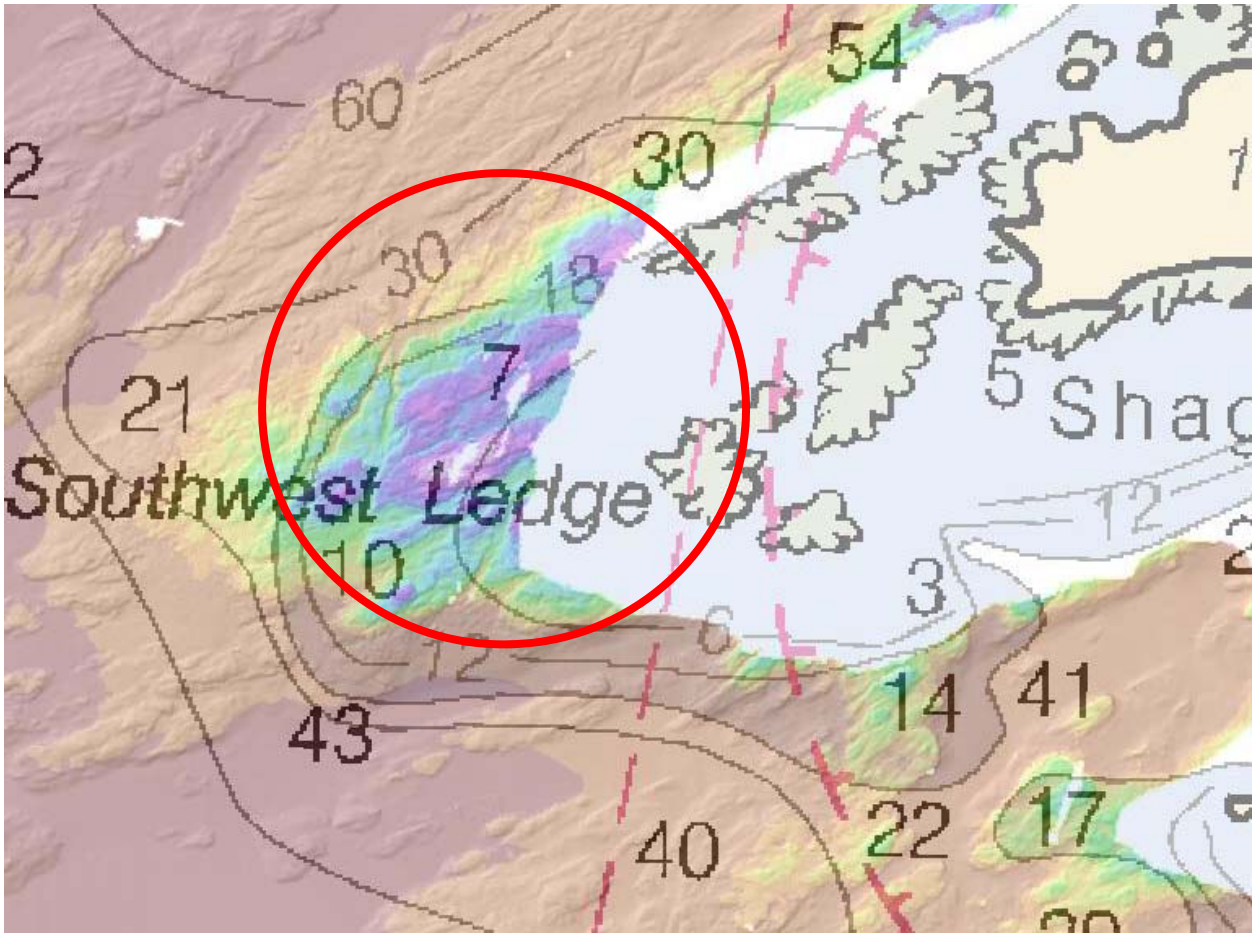

Figure 19 – Shoals southwest of Duck Island

E. **APPROVAL SHEET**

Letter of Approval

State: New Hampshire

General Locality: Isle of Shoals

Sub Locality: Duck Island

Year: 2010

Field Operations contributing to the accomplishment of this survey were conducted under my direct supervision with frequent checks of progress and adequacy. All surfaces and their reports were reviewed in their entirety.

This survey was completed with 100% multibeam coverage. It meets all applicable specifications and requirements and should supersede all prior surveys in common areas. The survey is considered complete and adequate for nautical charting.

_____

CAPT. Andrew Armstrong, NOAA (ret.)
Director, Joint Hydrographic Center
Durham, NH

APPENDIX I

TIDE NOTE AND GRAPHICS

(No Tide Notes or Graphics submitted)

APPENDIX II

SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

(No supplemental Correspondence)

APPENDIX III

FEATURES REPORT

(NO AWOIS ITEMS, DTONS, WRECKS, OR MARITIME BOUNDARIES)

APPROVAL PAGE

W00274

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

- W00274_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- W00274_GeoImage.pdf

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

Approved: 

Lieutenant Matthew Jaskoski, NOAA
Chief, Atlantic Hydrographic Branch