2020 Side Scan Sonar Survey Report
Yarmouth Artificial Reef - ILF Deployment

MA Division of Marine Fisheries
Fisheries Habitat Program

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Overview

Side scan sonar surveys were conducted at the Yarmouth artificial reef site (Figure 1) both before and after material deployments funded by the Department of Fish and Game (DFG) In-lieu Fee Program (ILFP). A pre-deployment survey was conducted on November 5, 2019 to collect baseline background information at the site. A post-deployment survey was conducted on January 23, 2020, nine days after the last load of materials were deployed. The side scan surveys were required monitoring to verify spatial location, total square footage, and bottom elevation profile of coverage of deployed materials. High resolution, spatially referenced survey imagery was used to calculate the value of subtidal mitigation credits for the ILFP. The post-deployment survey will also serve as baseline data for a required five-year post-deployment resurvey. This report describes the methods and results for quantifying location, total area and bottom elevation profile using side scan sonar data collected pre and post material deployments at an artificial reef site.

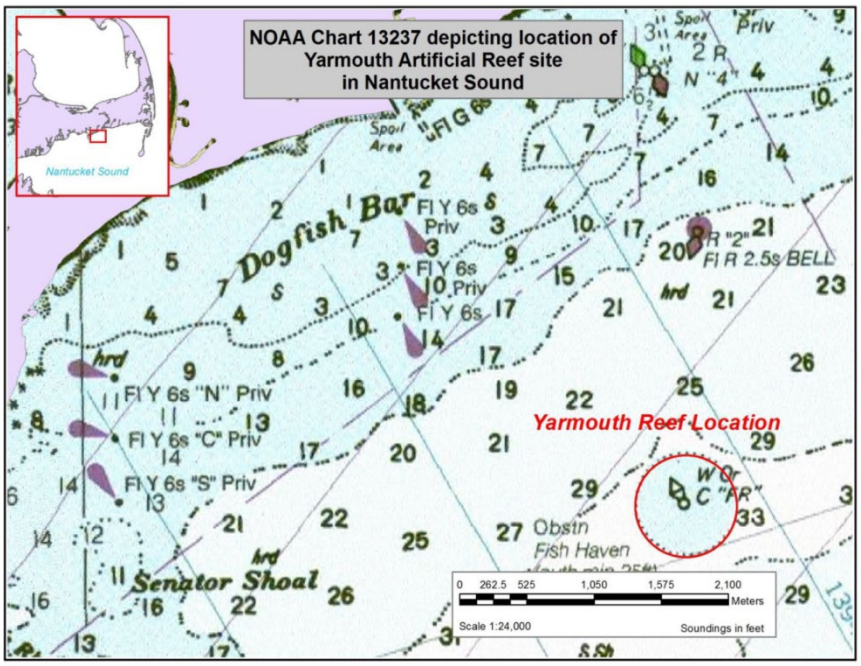


Figure 1. . Location of Permitted Artificial Reef Site (1:24,000 scale).

Methods

Surveys

A pre-deployment survey was conducted aboard the Division of Marine Fisheries (DMF) Research Vessel (RV) Mya on November 5, 2019 using a towed Klein 3000 dual frequency side scan sonar spatially tracked using a Garmin GPS. Twelve meters of cable was deployed from the towing bracket at the center of the tow fish through the boom pulley and tied off at the center mast of the vessel (Figure 2). The weather was overcast with 1-2-foot(ft) seas. Vessel speed during the survey ranged between 4.0 and 5.0 knots. Eleven survey tracks running East <-> West covered the entire extent of the permitted artificial reef site as well as the area beyond the licensed site in all directions. Survey tracks were labeled sequentially from A through K (Figure 3).

Figure 2. Klein 3000 Digital Beam side scan sonar (left). Side scan deployment setup (right).

Material deployments occurred on January 6 and 14, 2020. The DMF RV Alosa was on-site to verify deployment location was within the proposed reef site location. A post-deployment survey was conducted on January 23, 2020 from the DMF RV Alosa towing a Klein 3000 dual frequency side scan sonar spatially tracked using a Garmin GPS. Ten meters of cable was deployed from the towing bracket at the center of the tow fish through the boom pulley and tied off at the center mast of the vessel (Figure 2). The weather was overcast with seas <1 ft. Vessel speed for the survey ranged between 4.7 and 5.0 knots. Ten survey tracks running E<->W covered the entire extent of the permitted site. Survey tracks were labeled sequentially from L through U (Figure 3).

For both surveys, survey track centerline spacing was 300 ft. Sonar image range was set to 200 ft per side (400 ft total width), allowing for 150% coverage per track. Raw image data were processed onboard using SonarPro software and files were saved to a portable hard drive. Post-processing of data occurred in the lab using SonarTRX software to generate high-resolution Master Image track files. Track images were imported into ArcGIS for analysis.

Three pre-survey tracks (Tracks F, G, and H) and three post-survey tracks (Tracks Q, R, and S) provided >100% coverage of the ILF area of interest and were the only tracks utilized in the assessment of spatial extent, structured area delineation, and bottom elevation profiling.

Image Analysis

High resolution, slant range corrected track images were imported into ArcGIS to create survey mosaics. A side by side comparison of mosaicked pre-deployment and post-deployment tracks was analyzed at a 1:4,000 scale to determine the overall extent of ILF deployed materials relative to the proposed deployment area. At this scale, a polygon was generated to delineate the actual extent (versus the proposed extent) of the deployed material (Figure 4). The actual extent was used in the analysis of both pre and post surveys for delineating areas of rugosity.

To quantify new areas of structural complexity/rugosity, high-resolution, slant range corrected track images were analyzed in ArcGIS at a 1:300 scale (see Figure 6). Vector polygon delineation at 1:300 scale was determined as the most appropriate resolution for manually drawing polygons. Resolution below 1:300 generates pixelated imagery with undefinable boundaries and resolution greater than 1:300 can cause an overestimation of area. Manual digitization and classification of features was based on a single reviewer visual interpretation of sonar imagery to

ensure consistent analysis. Vector polygons were generated by outlining rugosity in imagery, creating a two-dimensional vector layer used to calculate the total area and approximate location (+/- 30 ft) of deployed materials. Polygons were generated for both pre and post side scan survey data sets. The total area quantified in the pre-deployment survey was subtracted from the total area quantified in the post-deployment survey to calculate the total area of new structure.

Vector digitization was conducted one survey track at a time. Sonar image generation is inherently variable due to several factors including direction of travel, location of vessel relative to bottom features, changes in bottom elevation and scope of towed instrumentation, vessel speed variability, and other factors. Track overlap assessment is another source of image analysis error. Because of this variability, data from overlapping survey tracks often does not project the same on both tracks and requires interpretation and professional judgment to avoid over counting of material deployment projections from side scan generated imagery. To minimize this, a central track is analyzed as the primary track when possible. An example of the variability in overlapping areas that is subject to interpretation is further explained in Figure 6.

Bottom Elevation Profile Analysis

Bottom elevation is the measurement of the distance from the survey instrument (tow fish) and the seafloor and differs from water column depth profile. Tidal amplitude, sea conditions and cable distance from boat to tow fish can influence bottom elevation information collected by the tow fish. Data from spatially similar pre and post survey tracks (Track R and Track G – see Figure 7) were analyzed to quantify changes in bottom elevation resulting from material deployments. Bottom elevation is a measure Location, direction, time, and bottom elevation data recorded at two-second intervals from Track G (Table 4) and Track R (Table 5) were synchronized for position so that only overlapping track areas were analyzed. Approximately five minutes of data (154 data points) were analyzed from both pre and post survey tracks that traversed the proposed deployment area (Figure 7). Bottom elevation soundings collected by the tow fish were corrected for tide using verified NOAA tide data from tide station Woods Hole, MA, (Table 3). To account for sounding data variability resulting from the 2m difference in survey cable payout from the vessel (12m for pre survey and 10m for post survey), the change in elevation mean between Track R and Track G was calculated from data points outside the deployment area to avoid any influence from changes in bottom elevation resulting from deployed materials. The calculated correction factor of 2.85ft (N = 114 pre-survey data and N=117 post-survey data) was applied to pre-survey data as a correction and graphed. Pre-deployment data (Track G) was collected in a west to east direction. Post-deployment data (Track R) was collected in an east to west direction. Data from bottom elevation analysis is summarized in Table 2.

Results

Spatial Extent

Side-by-side comparison of pre and post survey imagery (1:4000 scale) evaluated the total spatial extent of deployed materials relative to the 1-acre proposed area. Results determined that although a significant amount of material was deployed within the proposed area, the total spatial extent of all materials deployed was much larger, extending in all directions beyond the proposed extent. To calculate the actual extent of deployed materials, a rectangular polygon was drawn around perimeter of the footprint of the deployed materials, totaling 6.1 acres. The full area of extent is referred to as the actual extent, vs. the proposed area extent in this report. Manual vector digitization to calculate the total area of deployed materials was calculated for both the proposed and actual material footprints (Figure 5).

Structured Area

Vector digitization of the pre-deployment survey at 1:300 scale quantified 27 features within the proposed ILF site totaling 106 ft^2 (0.002 acres). Within the actual footprint, 121 features (including all features quantified within the proposed area) totaled 378 ft^2 (0.007 acres). The size of individual mapped polygons ranged from 1 to 46 ft^2, averaging 3.1 ft^2. The composition and origin of existing structures was not determined. Possibilities include fixed fishing gear; lobster buoys were observed and noted during the survey (see attached cruise notes), previously deployed tire units or other unknown structures.

Digitization of post-deployment surveys at 1:300 scale quantified 512 features within the proposed ILF site totaling 14,523 ft^2 (0.33 acres). Within the actual footprint, 1,292 features (including all features quantified within the proposed area) totaled 31,216 ft^2 (0.72 acres). The size of individual mapped polygons ranged from 1 to 2,009 ft^2, averaging 28 ft^2.

Quantified pre-deployment data was subtracted from post-deployment data to calculate the total area of new structure added from ILF funded deployments, resulting in 30,838 ft^2 (0.71 acres) of actual area covered and 14,426 ft^2 (0.33 acres) of covered area within the ILF proposed footprint. The results are summarized in Table 1.

Table 1. Summary of deployment area digitized data and results.

	Proposed Area of Coverage (ft2)	Pre survey coverage	Post survey coverage	Total coverage (Post – Pre)	Difference
Proposed Area (1.1 acres)	15,246 (0.35 acres)	106 (0.002 acres)	14,523 (0.333 acres)	14,417 ft^2 (0.331 acres)	-829 ft^2 (-0.02 acres)
Actual Area (6.1 acres)	N/A	378 (0.009 acres)	36,216 (0.83 acres)	35,838 ft^2 (0.82 acres)	+20,592 ft^2 (+0.47 acres)

Bottom Elevation

A bottom elevation data analysis summary is compiled in Table 2. All track data from pre (Track G) and post (Track R) deployment surveys across the five-minute track extent (N=154) averaged -0.24 ft indicating a consistent bottom elevation along both pre and post tracks. The larger difference between the minimum and maximum depth range across tracks of 2.79ft is partially explained by a natural gradual slope within the reef site. Site depth increases from north to south and there is a pronounced slope edge running from NNW to SSE within the permitted site (see Figure 4). Additional variability across tracks is explained by the change in bottom elevation resulting from material deployments. Track data comparison outside the deployment area returned an average difference in bottom elevation between tracks of 2.85 ft. Track data comparison from within the deployment area reveal an average bottom elevation difference of 2.50 ft. The calculated bottom elevation range (max – minimum bottom elevation) outside the deployment (N=124) area was 4.88ft pre-deployment and 5.58 ft. post-deployment. Within the deployment area, the calculated bottom elevation range was 1.06 ft. pre-deployment and 3.92 ft. post-deployment.

Discussion

Both pre and post-deployment surveys provided >100% coverage of the entire permitted site with no gaps. One minor difference between the surveys was the use of autopilot for navigating transect lines. Autopilot navigation was not available during the pre-deployment surveys, requiring manual navigation of survey track lines. Autopilot employed for the post-deployment survey generated precise lines and consistent overlap between adjacent lines.

A 6.1-acre rectangular polygon was used to delineate the spatial extent of the area of deployment for analysis consistency, as the materials deployed extended well beyond the proposed 1.1-acre box in all directions. This was a function of both the volume of materials procured for the project and the size of the equipment used for transporting and deploying the materials.

The selection of the size of the area of deployment box was influenced by the deployment of the USCG materials near the southern extent of the ILF deployment area and track overlap variation displayed in post-deployment tracks to the north and west of the material field. Over 99% of all deployed materials are located within the actual deployment area box boundary. The primary function of delineating this extent was to maintain accuracy when generating polygons of material piles for calculating area covered by newly deployed materials. Additionally, delineating the actual extent was necessary to analyze any existing structure present within the footprint of the deployed materials prior to deployment in order to provide a more accurate calculation of area covered by new materials deployed using ILF funds.

Delineating individual structure piles is the most important component of the image analysis for determining ILF subtidal mitigation credits and represents the greatest potential source of analysis error. The central track (Track R) fully covered the 1.1 acres proposed box and did not require assessing track overlap, thereby eliminating this as a source of error within the proposed area. When overlap assessment was necessary, Track R polygons were generated first, then overlaid onto perimeter Tracks Q and S for comparison. Overlapped areas were under-analyzed; if an area could not be determined as a unique structure, a polygon was not generated, and it was not included in the assessment. Additionally, several instances where targets within shadow (black areas in images) and slant range stitched areas could not be clearly defined, and polygons in these areas were not drawn.

Bottom elevation analysis of track data clearly depict a change in elevation resulting from deployment. Analysis of the post-deployment bottom elevation range across the deployment area exhibited a change of 3.24 feet, closely approximating the proposed 3.5 ft. height off bottom projected for material deployments. This is consistent with previous reef deployments of similar materials into Nantucket Sound (i.e. 2016 Harwich Reef deployment) and is within the preferred habitat elevation range of targeted species such as black sea bass, tautog, and scup.

This analysis required some data corrections due to the use of different vessel platforms for each survey. Future efforts involving the comparison of pre and post-deployment survey tracks would benefit from using the same survey vessel to standardize data collection.

Future Recommendations

Future survey and analysis efforts of this type could benefit from:

- A consistent sampling platform – use the same vessel for both pre and post-survey efforts
- Ensure vessel is equipped with autopilot capabilities and the autopilot is functional for the duration of all surveys
- Explore image analysis capabilities and other GIS tools to minimize manual interpretation of survey imagery

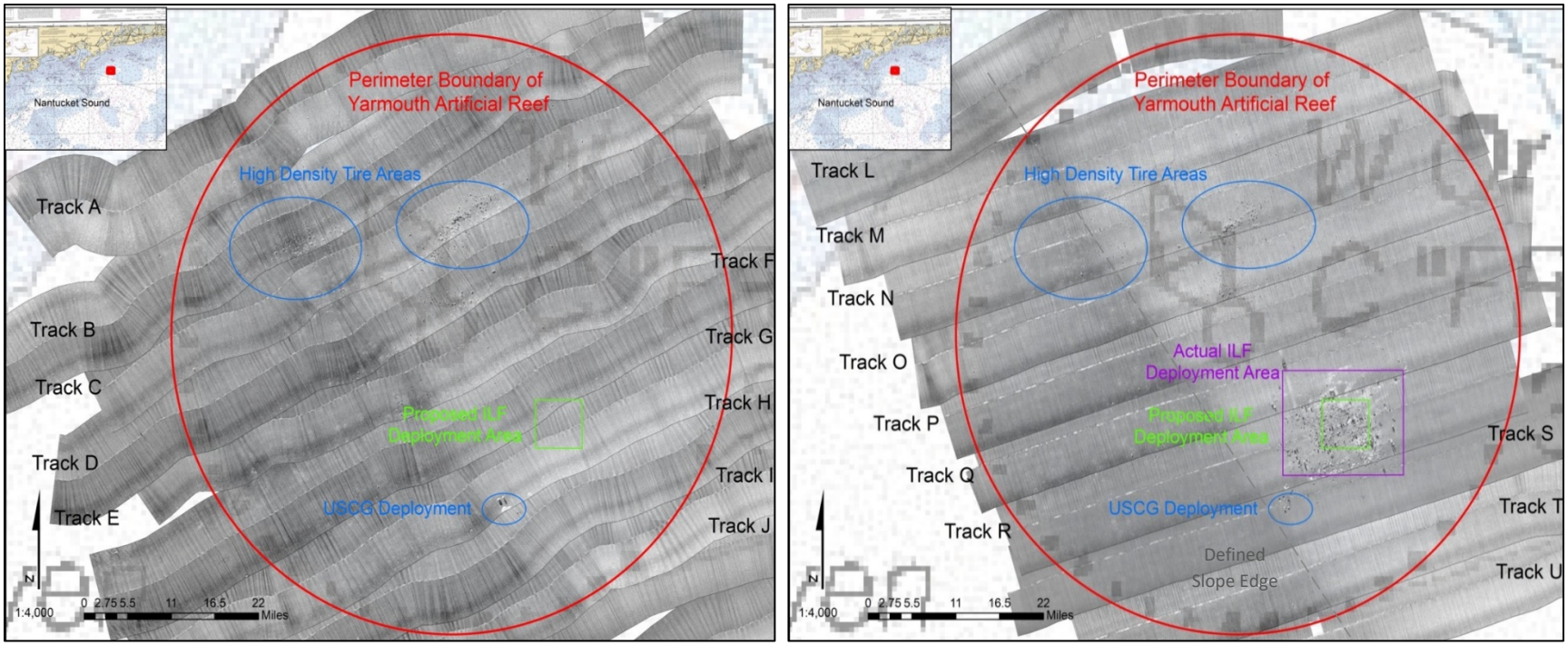


Figure 3. Pre (left) and post (right) side scan survey tracks of permitted reef site. Green box is proposed deployment area (1.1 acres). Purple box is actual extent of deployed materials (6.1 acres). 1:4000 scale.

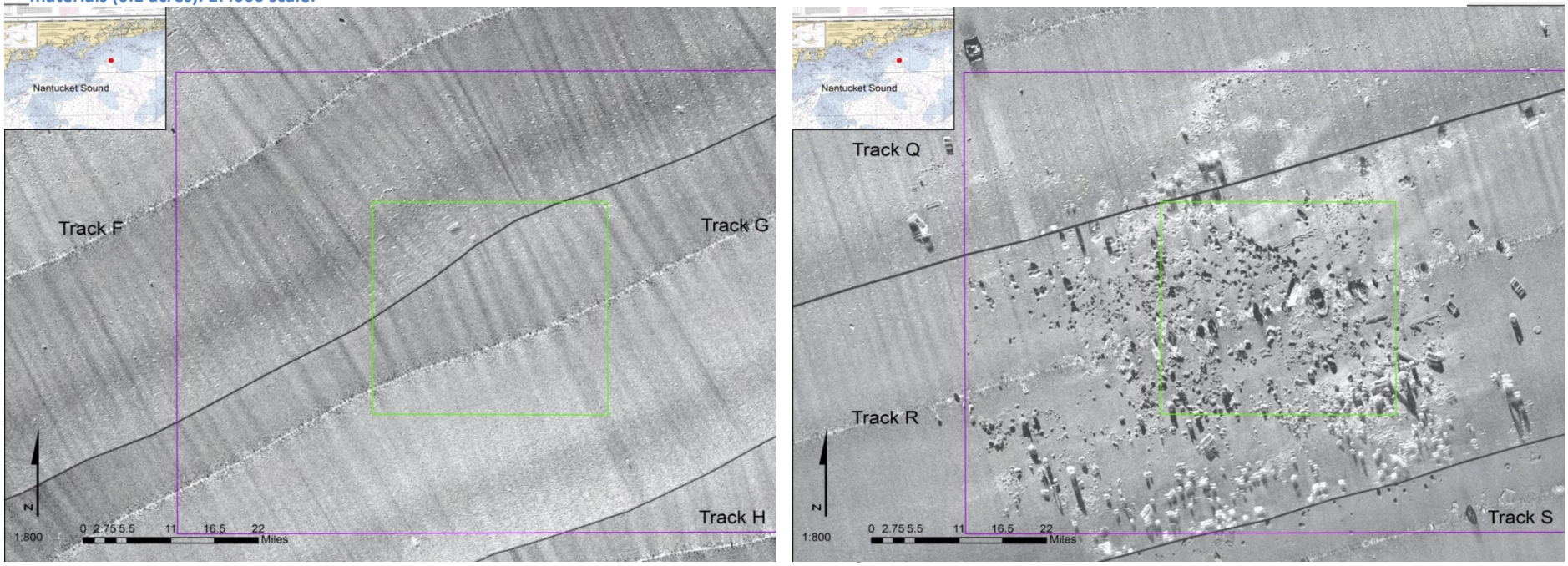
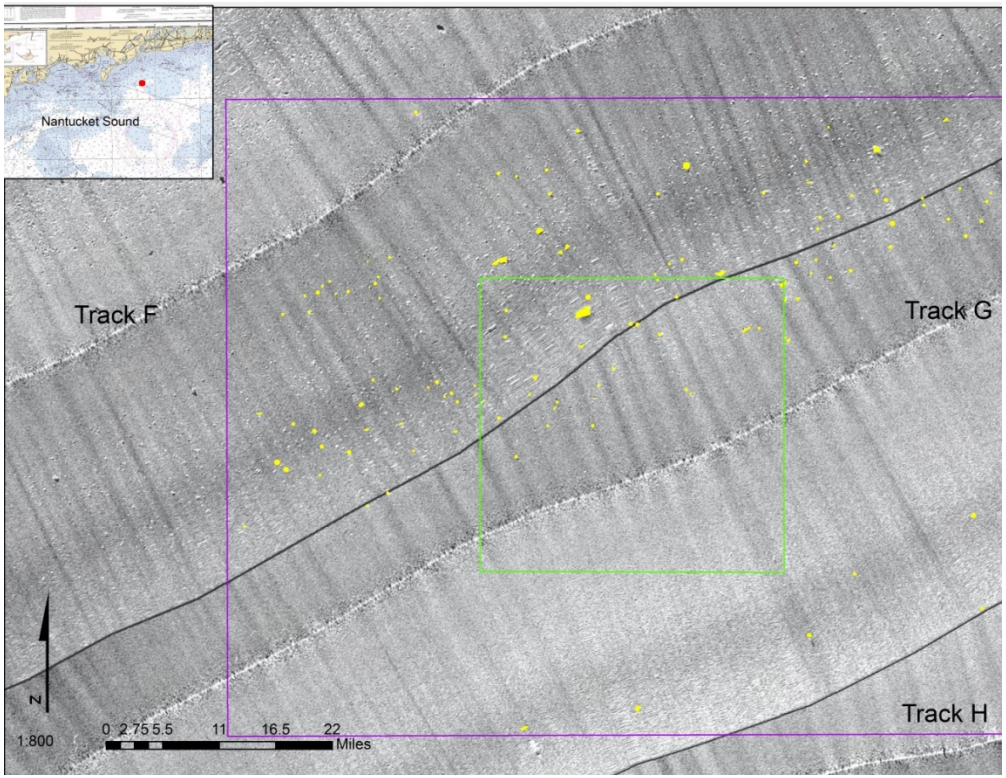


Figure 4. Pre (left) and post (right) survey of material deployment area. Green box is proposed deployment area (1.1 acres). Purple box is actual extent of deployed materials (6.1 acres). 1:800 Scale.



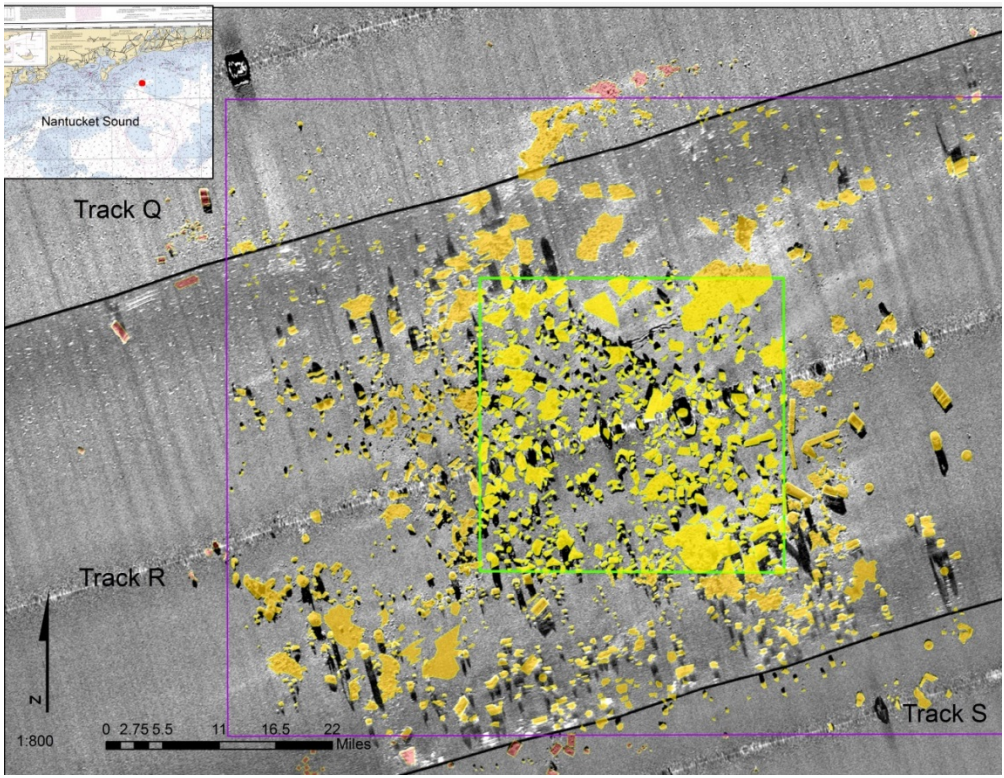
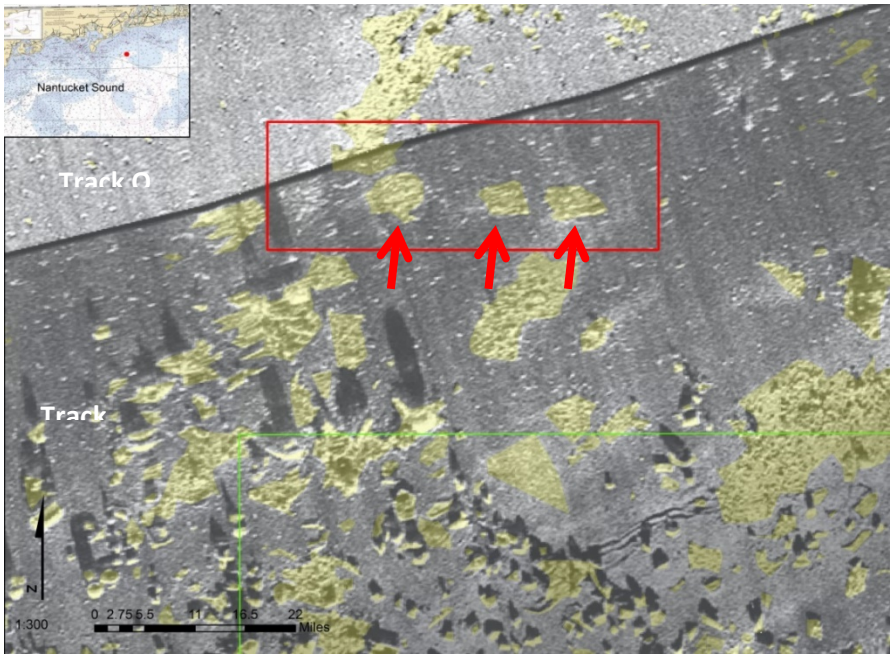


Figure 5. Vector classification of pre and post deployment survey imagery, full deployment area overview of polygon overlay in both proposed and actual area of deployment (1:800 scale).



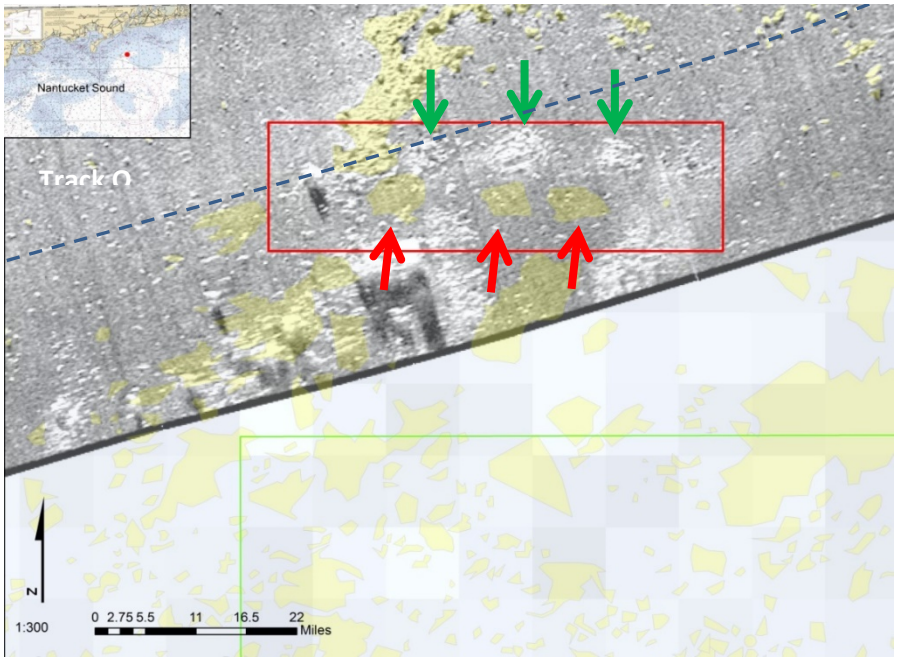


Figure 6. Example of drawn polygons overlaying Track R not aligned with overlap from Track Q. Overlap area (green arrow) are not drawn or included in calculating material deployment area (1:300 scale).

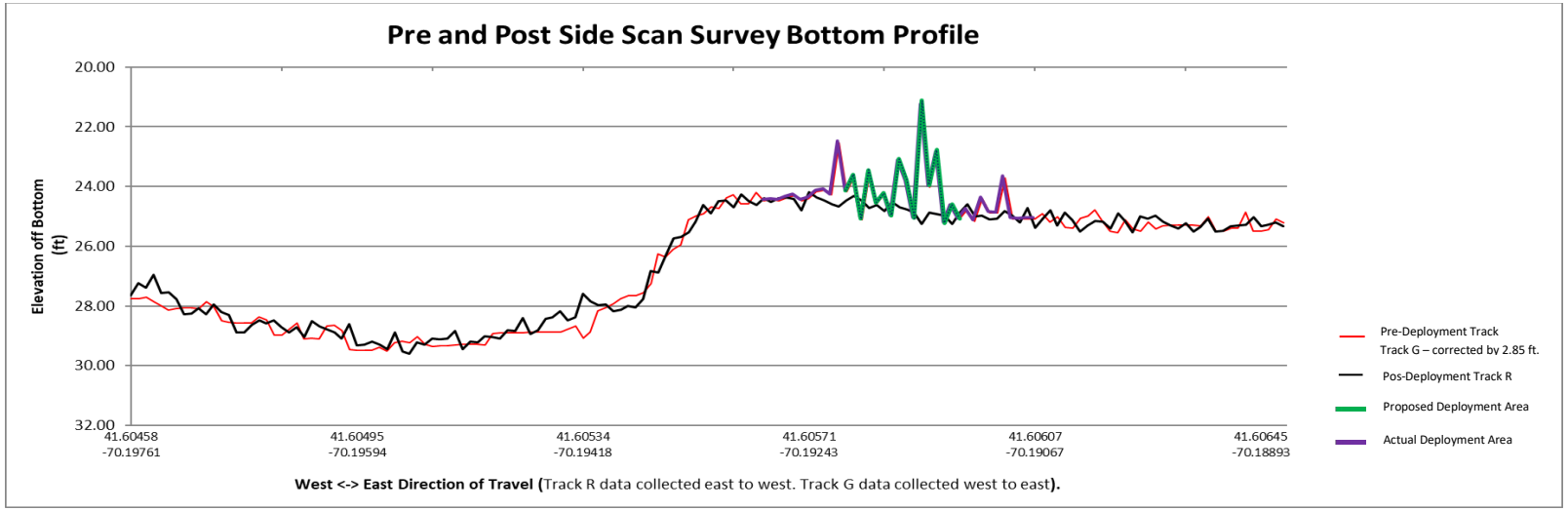


Figure 7. Sonar tracks (G and R) used in bottom elevation profile analysis.

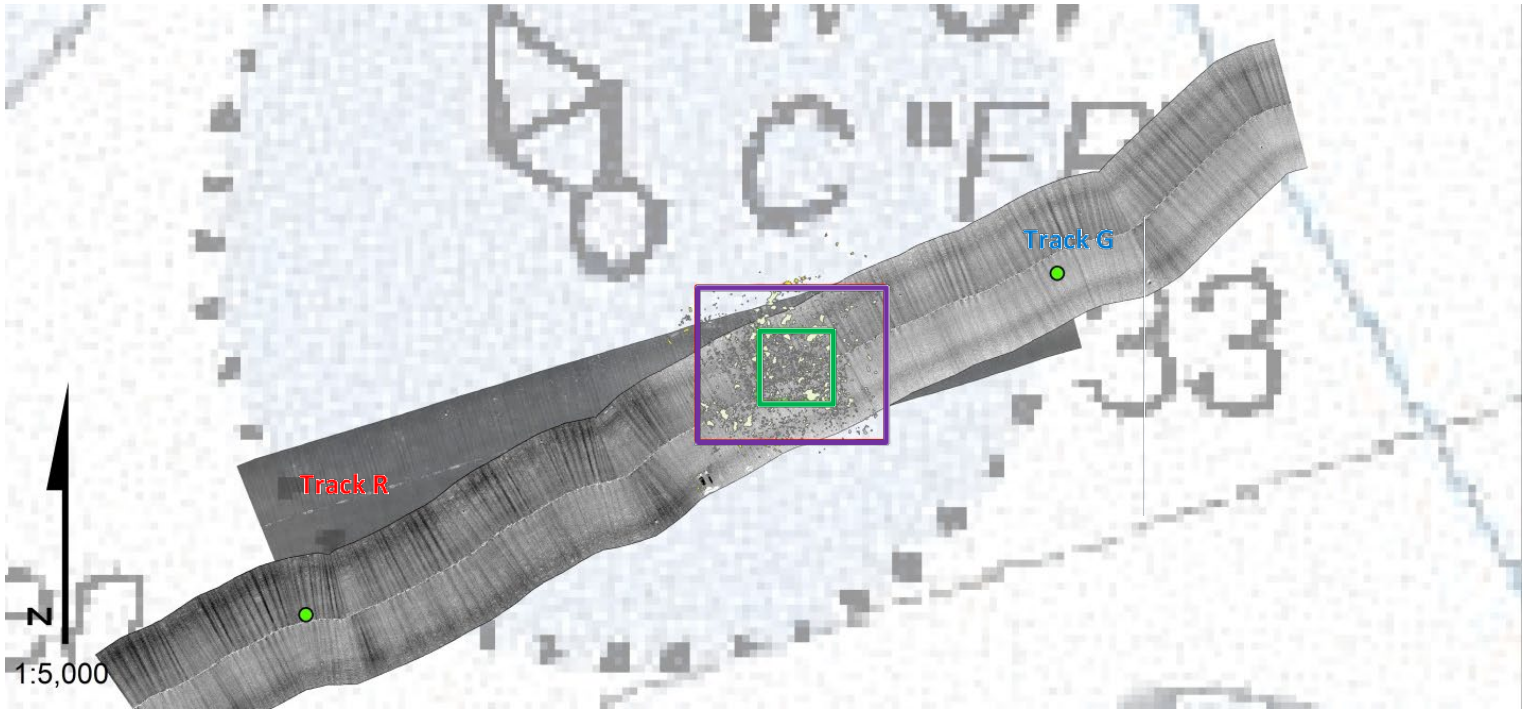


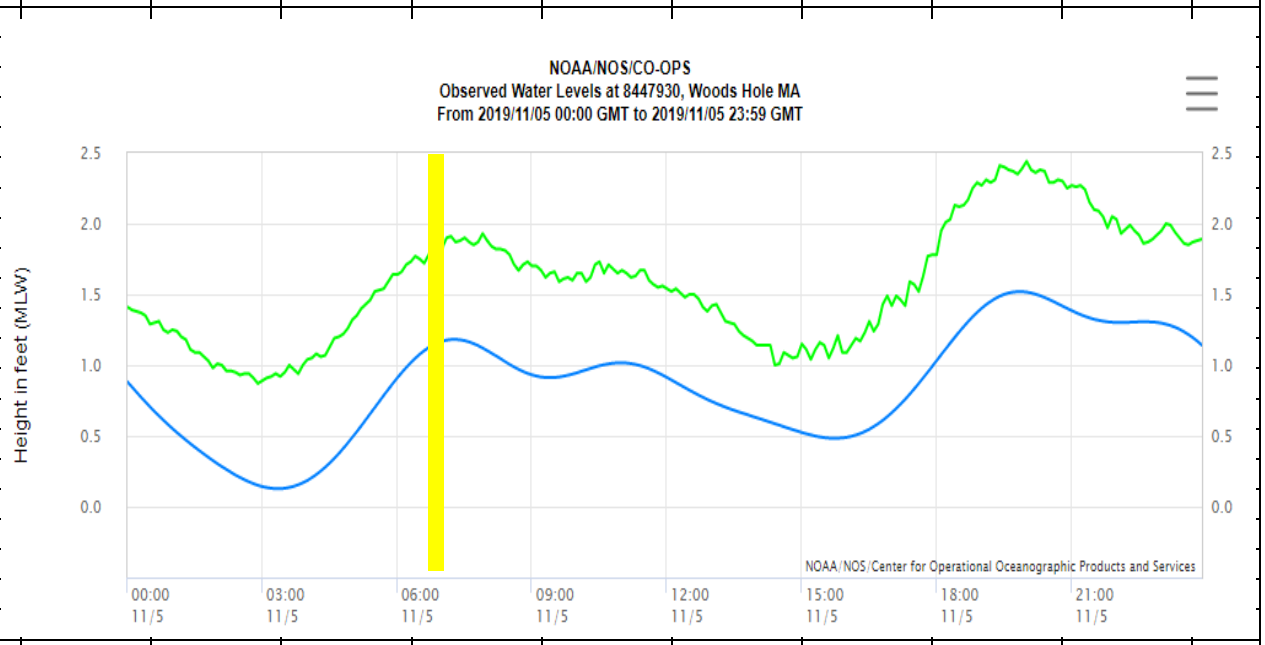
Figure 8. Pre and Post survey track bottom elevation profiles. Purple segment is actual deployment area. Green segment is proposed deployment area.

Table 2. Summary of Pre (Track G) and Post (Track R) Bottom Elevation Data.

		Pre (Track G)	Post (Track R)	Δ	Notes
Full Track - all data	N	154	154		
	Minimum Bottom Elevation (ft)	23.92	21.31	2.61	Some of this variability is explained by a natural gradual slope within the reef site. Site depth increases from north to south and there is a pronounced slope edge running from NNW to SSE within the permitted site (see Figure 4). Other variability is explained by the inclusion of materials deployed from the post survey (Track R).
	Maximum Bottom Elevation (ft)	29.32	29.51	-0.19	
	Max- Min Difference (ft)	5.41	8.20	-2.79	
	Mean	26.33	26.57	-0.24	
Actual Deployment Area	N	40	37		
	Minimum Bottom Elevation (ft)	21.35	21.31	0.04	Corrected data exhibiting similar minimum elevations throughout the actual deployment area. The change in the mean elevation of 2.5ft, and the maximum change in elevation of 2.86 ft is explained by post survey data from deployed materials.
	Maximum Bottom Elevation (ft)	22.41	25.23	-2.82	
	Max- Min Difference (ft)	1.06	3.92	-2.86	
	Mean	21.82	24.32	-2.50	
Proposed Deployment Area	N	17	16		
	Minimum Bottom Elevation (ft)	21.35	21.31	0.04	Corrected data exhibiting similar minimum elevations throughout the proposed deployment area. The change in the mean elevation is 2.37ft, and the maximum change in elevation of 3.24ft is explained by post survey data from deployed materials.
	Maximum Bottom Elevation (ft)	22.03	25.23	-3.20	
	Max- Min Difference (ft)	0.68	3.92	-3.24	
	Mean	21.73	24.10	-2.37	
Outside Deployment Area	N	114	117		
	Minimum Bottom Elevation (ft)	21.87	23.93	2.06	Average elevation difference between tracks not influenced by material deployments. Mean change between track G and track R (2.85ft) used as a correction factor to account for variation in cable deployment lengths across both surveys. This factor is applied to pre-survey data (Track G) for graphing differences between pre and post-deployment tracks.
	Maximum Bottom Elevation (ft)	26.75	29.51	2.76	
	Max- Min Difference (ft)	4.88	5.58	0.70	
	Mean	24.44	27.28	**2.85**	

Table 3. Historic tide data from Woods Hole, MA tide station. Highlighted data represents tide data at time of survey. Verified data was used to correct bottom elevation during surveys.

Date	Time (EDT)	Predicted (ft)	Verified (ft)
11/5/2019	10:06	0.95	1.66
11/5/2019	10:12	0.98	1.71
11/5/2019	10:18	1.02	1.73
11/5/2019	10:24	1.05	1.77
11/5/2019	10:30	1.08	1.75
11/5/2019	10:36	1.10	1.72
11/5/2019	10:42	1.12	1.78
11/5/2019	10:48	1.14	1.83
11/5/2019	10:54	1.16	1.81
11/5/2019	11:00	1.17	1.83
11/5/2019	11:06	1.18	1.9
11/5/2019	11:12	1.18	1.91
11/5/2019	11:18	1.18	1.87
11/5/2019	11:24	1.18	1.88
11/5/2019	11:30	1.17	1.9
11/5/2019	11:36	1.16	1.87
11/5/2019	11:42	1.15	1.85
11/5/2019	11:48	1.14	1.87
11/5/2019	11:54	1.12	1.93
11/5/2019	12:00	1.10	1.88
11/5/2019	12:06	1.08	1.84
11/5/2019	12:12	1.07	1.82
11/5/2019	12:18	1.05	1.82



Date	Time (EST)	Predicted (ft)	Verified (ft)
1/23/2020	10:36	-0.092	0.24
1/23/2020	10:42	-0.101	0.22
1/23/2020	10:48	-0.11	0.21
1/23/2020	10:54	-0.118	0.23
1/23/2020	11:00	-0.126	0.27
1/23/2020	11:06	-0.133	0.24
1/23/2020	11:12	-0.14	0.22
1/23/2020	11:18	-0.146	0.24
1/23/2020	11:24	-0.151	0.27
1/23/2020	11:30	-0.155	0.27
1/23/2020	11:36	-0.158	0.24
1/23/2020	11:42	-0.16	0.24
1/23/2020	11:48	-0.16	0.25
1/23/2020	11:54	-0.159	0.26
1/23/2020	12:00	-0.155	0.28
1/23/2020	12:06	-0.15	0.32
1/23/2020	12:12	-0.142	0.32
1/23/2020	12:18	-0.132	0.34
1/23/2020	12:24	-0.119	0.41

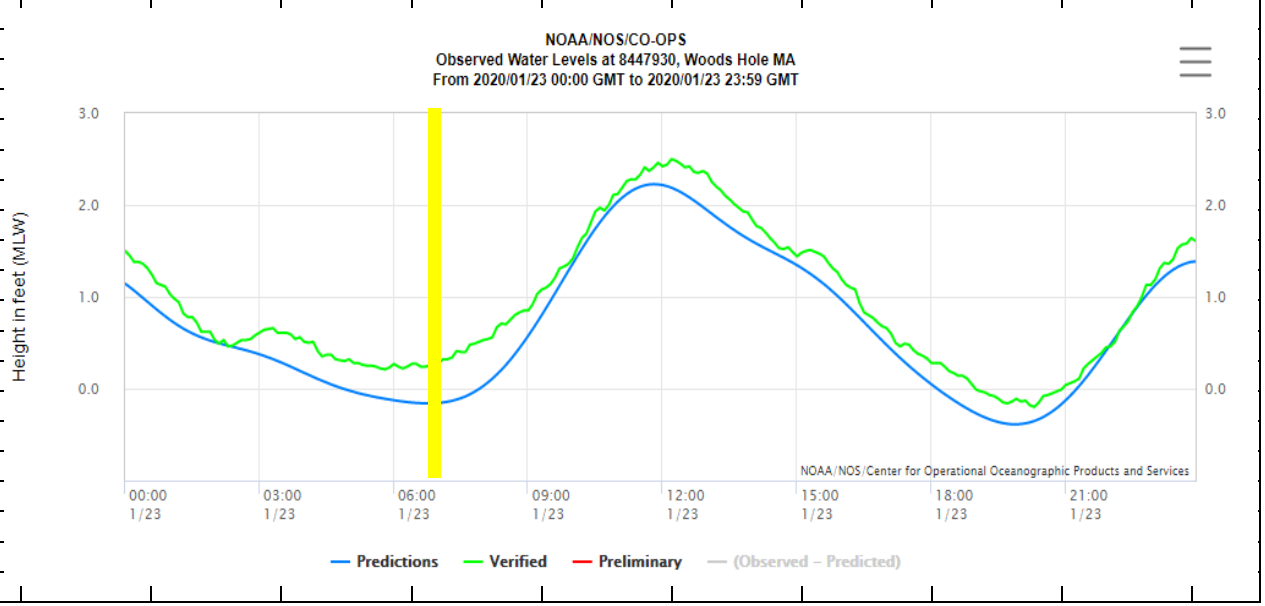


Table 4. Side scan data. Post-deployment side scan data (Track R – 111430). Highlighted values are graphed data points for Actual (red) and Proposed (green) deployment areas.

Longitude	Latitude	Elevation Bottom (M)	(Ft)	Tide adjust (+1.83)	Differential adjust (+2.85)	Date	Time	Direction
-70.19671	41.60381	-7.00	22.97	24.80	27.65	11/5/2019	10:47:28	W to E
-70.19666	41.60383	-6.87	22.55	24.38	27.23	11/5/2019	10:47:30	W to E
-70.19661	41.60384	-6.92	22.70	24.53	27.38	11/5/2019	10:47:32	W to E
-70.19656	41.60387	-6.79	22.29	24.12	26.97	11/5/2019	10:47:34	W to E
-70.19651	41.60389	-6.98	22.89	24.72	27.57	11/5/2019	10:47:36	W to E
-70.19646	41.60391	-6.97	22.87	24.70	27.55	11/5/2019	10:47:38	W to E
-70.19640	41.60392	-7.04	23.09	24.92	27.77	11/5/2019	10:47:40	W to E
-70.19634	41.60394	-7.19	23.61	25.44	28.29	11/5/2019	10:47:42	W to E
-70.19629	41.60395	-7.19	23.58	25.41	28.26	11/5/2019	10:47:44	W to E
-70.19623	41.60397	-7.13	23.39	25.22	28.07	11/5/2019	10:47:46	W to E
-70.19618	41.60399	-7.19	23.59	25.42	28.27	11/5/2019	10:47:48	W to E
-70.19612	41.60401	-7.10	23.28	25.11	27.96	11/5/2019	10:47:50	W to E
-70.19608	41.60402	-7.17	23.51	25.34	28.19	11/5/2019	10:47:52	W to E
-70.19601	41.60404	-7.20	23.63	25.46	28.31	11/5/2019	10:47:54	W to E
-70.19597	41.60406	-7.38	24.20	26.03	28.88	11/5/2019	10:47:56	W to E
-70.19591	41.60408	-7.38	24.20	26.03	28.88	11/5/2019	10:47:58	W to E
-70.19586	41.60411	-7.30	23.96	25.79	28.64	11/5/2019	10:48:00	W to E
-70.19581	41.60413	-7.26	23.81	25.64	28.49	11/5/2019	10:48:02	W to E
-70.19576	41.60415	-7.28	23.89	25.72	28.57	11/5/2019	10:48:04	W to E
-70.19570	41.60417	-7.25	23.80	25.63	28.48	11/5/2019	10:48:06	W to E
-70.19565	41.60419	-7.33	24.04	25.87	28.72	11/5/2019	10:48:08	W to E
-70.19560	41.60421	-7.38	24.21	26.04	28.89	11/5/2019	10:48:10	W to E
-70.19554	41.60423	-7.32	24.02	25.85	28.70	11/5/2019	10:48:12	W to E
-70.19548	41.60426	-7.42	24.36	26.19	29.04	11/5/2019	10:48:14	W to E
-70.19543	41.60428	-7.26	23.82	25.65	28.50	11/5/2019	10:48:16	W to E
-70.19538	41.60430	-7.32	24.00	25.83	28.68	11/5/2019	10:48:18	W to E
-70.19533	41.60432	-7.34	24.10	25.93	28.78	11/5/2019	10:48:20	W to E
-70.19527	41.60435	-7.38	24.20	26.03	28.88	11/5/2019	10:48:22	W to E
-70.19522	41.60438	-7.44	24.41	26.24	29.09	11/5/2019	10:48:24	W to E
-70.19518	41.60440	-7.30	23.94	25.77	28.62	11/5/2019	10:48:26	W to E
-70.19513	41.60443	-7.51	24.64	26.47	29.32	11/5/2019	10:48:28	W to E
-70.19509	41.60446	-7.50	24.61	26.44	29.29	11/5/2019	10:48:30	W to E
-70.19504	41.60448	-7.47	24.52	26.35	29.20	11/5/2019	10:48:32	W to E
-70.19499	41.60451	-7.51	24.63	26.46	29.31	11/5/2019	10:48:34	W to E
-70.19495	41.60453	-7.55	24.77	26.60	29.45	11/5/2019	10:48:36	W to E
-70.19489	41.60456	-7.38	24.20	26.03	28.88	11/5/2019	10:48:38	W to E
-70.19484	41.60458	-7.57	24.85	26.68	29.53	11/5/2019	10:48:40	W to E
-70.19479	41.60460	-7.60	24.92	26.75	29.60	11/5/2019	10:48:42	W to E
-70.19474	41.60462	-7.48	24.54	26.37	29.22	11/5/2019	10:48:44	W to E
-70.19468	41.60464	-7.50	24.61	26.44	29.29	11/5/2019	10:48:46	W to E
-70.19463	41.60466	-7.44	24.41	26.24	29.09	11/5/2019	10:48:48	W to E

-70.19458	41.60468	-7.45	24.44	26.27	29.12	11/5/2019	10:48:50	W to E
-70.19452	41.60470	-7.44	24.40	26.23	29.08	11/5/2019	10:48:52	W to E
-70.19447	41.60473	-7.36	24.15	25.98	28.83	11/5/2019	10:48:54	W to E
-70.19443	41.60475	-7.55	24.77	26.60	29.45	11/5/2019	10:48:56	W to E
-70.19437	41.60477	-7.47	24.50	26.33	29.18	11/5/2019	10:48:58	W to E
-70.19433	41.60479	-7.48	24.54	26.37	29.22	11/5/2019	10:49:00	W to E
-70.19427	41.60481	-7.41	24.33	26.16	29.01	11/5/2019	10:49:02	W to E
-70.19422	41.60483	-7.43	24.36	26.19	29.04	11/5/2019	10:49:04	W to E
-70.19417	41.60485	-7.44	24.40	26.23	29.08	11/5/2019	10:49:06	W to E
-70.19411	41.60486	-7.36	24.14	25.97	28.82	11/5/2019	10:49:08	W to E
-70.19406	41.60487	-7.36	24.15	25.98	28.83	11/5/2019	10:49:10	W to E
-70.19400	41.60488	-7.23	23.72	25.55	28.40	11/5/2019	10:49:12	W to E
-70.19395	41.60490	-7.39	24.26	26.09	28.94	11/5/2019	10:49:14	W to E
-70.19388	41.60491	-7.35	24.12	25.95	28.80	11/5/2019	10:49:16	W to E
-70.19383	41.60491	-7.24	23.76	25.59	28.44	11/5/2019	10:49:18	W to E
-70.19376	41.60492	-7.23	23.71	25.54	28.39	11/5/2019	10:49:20	W to E
-70.19371	41.60492	-7.16	23.50	25.33	28.18	11/5/2019	10:49:22	W to E
-70.19366	41.60493	-7.25	23.80	25.63	28.48	11/5/2019	10:49:24	W to E
-70.19359	41.60495	-7.22	23.69	25.52	28.37	11/5/2019	10:49:26	W to E
-70.19354	41.60497	-6.98	22.91	24.74	27.59	11/5/2019	10:49:28	W to E
-70.19350	41.60500	-7.06	23.18	25.01	27.86	11/5/2019	10:49:30	W to E
-70.19344	41.60503	-7.10	23.30	25.13	27.98	11/5/2019	10:49:32	W to E
-70.19340	41.60506	-7.09	23.27	25.10	27.95	11/5/2019	10:49:34	W to E
-70.19336	41.60509	-7.16	23.49	25.32	28.17	11/5/2019	10:49:36	W to E
-70.19332	41.60512	-7.14	23.44	25.27	28.12	11/5/2019	10:49:38	W to E
-70.19328	41.60515	-7.11	23.33	25.16	28.01	11/5/2019	10:49:40	W to E
-70.19323	41.60518	-7.13	23.38	25.21	28.06	11/5/2019	10:49:42	W to E
-70.19318	41.60520	-7.04	23.09	24.92	27.77	11/5/2019	10:49:44	W to E
-70.19313	41.60523	-6.75	22.16	23.99	26.84	11/5/2019	10:49:46	W to E
-70.19309	41.60525	-6.77	22.21	24.04	26.89	11/5/2019	10:49:48	W to E
-70.19304	41.60527	-6.59	21.62	23.45	26.30	11/5/2019	10:49:50	W to E
-70.19298	41.60529	-6.42	21.07	22.90	25.75	11/5/2019	10:49:52	W to E
-70.19293	41.60531	-6.41	21.01	22.84	25.69	11/5/2019	10:49:54	W to E
-70.19287	41.60533	-6.35	20.85	22.68	25.53	11/5/2019	10:49:56	W to E
-70.19282	41.60535	-6.25	20.50	22.33	25.18	11/5/2019	10:49:58	W to E
-70.19277	41.60537	-6.08	19.94	21.77	24.62	11/5/2019	10:50:00	W to E
-70.19271	41.60539	-6.16	20.21	22.04	24.89	11/5/2019	10:50:02	W to E
-70.19265	41.60541	-6.04	19.81	21.64	24.49	11/5/2019	10:50:04	W to E
-70.19260	41.60543	-6.03	19.79	21.62	24.47	11/5/2019	10:50:06	W to E
-70.19254	41.60546	-6.10	20.03	21.86	24.71	11/5/2019	10:50:08	W to E
-70.19249	41.60548	-5.97	19.58	21.41	24.26	11/5/2019	10:50:10	W to E
-70.19244	41.60550	-6.04	19.81	21.64	24.49	11/5/2019	10:50:12	W to E
-70.19238	41.60553	-6.08	19.95	21.78	24.63	11/5/2019	10:50:14	W to E
-70.19234	41.60555	-6.01	19.72	21.55	24.40	11/5/2019	10:50:16	W to E
-70.19228	41.60557	-6.04	19.83	21.66	24.51	11/5/2019	10:50:18	W to E
-70.19224	41.60559	-6.00	19.70	21.53	24.38	11/5/2019	10:50:20	W to E

-70.19218	41.60561	-6.00	19.68	21.51	24.36	11/5/2019	10:50:22	W to E
-70.19213	41.60563	-6.02	19.74	21.57	24.42	11/5/2019	10:50:24	W to E
-70.19208	41.60565	-6.13	20.12	21.95	24.80	11/5/2019	10:50:26	W to E
-70.19203	41.60567	-5.95	19.52	21.35	24.20	11/5/2019	10:50:28	W to E
-70.19197	41.60568	-6.00	19.69	21.52	24.37	11/5/2019	10:50:30	W to E
-70.19192	41.60570	-6.03	19.78	21.61	24.46	11/5/2019	10:50:32	W to E
-70.19186	41.60571	-6.07	19.92	21.75	24.60	11/5/2019	10:50:34	W to E
-70.19180	41.60573	-6.09	20.00	21.83	24.68	11/5/2019	10:50:36	W to E
-70.19175	41.60574	-6.03	19.78	21.61	24.46	11/5/2019	10:50:38	W to E
-70.19169	41.60575	-5.99	19.64	21.47	24.32	11/5/2019	10:50:40	W to E
-70.19163	41.60576	-6.03	19.80	21.63	24.48	11/5/2019	10:50:42	W to E
-70.19158	41.60578	-6.11	20.05	21.88	24.73	11/5/2019	10:50:44	W to E
-70.19152	41.60579	-6.08	19.94	21.77	24.62	11/5/2019	10:50:46	W to E
-70.19146	41.60581	-6.14	20.15	21.98	24.83	11/5/2019	10:50:48	W to E
-70.19141	41.60583	-6.05	19.84	21.67	24.52	11/5/2019	10:50:50	W to E
-70.19136	41.60585	-6.10	20.03	21.86	24.71	11/5/2019	10:50:52	W to E
-70.19130	41.60587	-6.13	20.10	21.93	24.78	11/5/2019	10:50:54	W to E
-70.19125	41.60589	-6.16	20.20	22.03	24.88	11/5/2019	10:50:56	W to E
-70.19120	41.60591	-6.27	20.58	22.41	25.26	11/5/2019	10:50:58	W to E
-70.19116	41.60593	-6.15	20.19	22.02	24.87	11/5/2019	10:51:00	W to E
-70.19111	41.60595	-6.17	20.25	22.08	24.93	11/5/2019	10:51:02	W to E
-70.19106	41.60597	-6.19	20.31	22.14	24.99	11/5/2019	10:51:04	W to E
-70.19101	41.60599	-6.27	20.56	22.39	25.24	11/5/2019	10:51:06	W to E
-70.19096	41.60601	-6.15	20.19	22.02	24.87	11/5/2019	10:51:08	W to E
-70.19091	41.60603	-6.07	19.92	21.75	24.60	11/5/2019	10:51:10	W to E
-70.19086	41.60605	-6.19	20.31	22.14	24.99	11/5/2019	10:51:12	W to E
-70.19080	41.60607	-6.19	20.30	22.13	24.98	11/5/2019	10:51:14	W to E
-70.19075	41.60610	-6.22	20.42	22.25	25.10	11/5/2019	10:51:16	W to E
-70.19070	41.60611	-6.22	20.40	22.23	25.08	11/5/2019	10:51:18	W to E
-70.19064	41.60613	-6.14	20.14	21.97	24.82	11/5/2019	10:51:20	W to E
-70.19057	41.60615	-6.19	20.30	22.13	24.98	11/5/2019	10:51:22	W to E
-70.19052	41.60617	-6.25	20.51	22.34	25.19	11/5/2019	10:51:24	W to E
-70.19046	41.60619	-6.11	20.04	21.87	24.72	11/5/2019	10:51:26	W to E
-70.19040	41.60620	-6.31	20.69	22.52	25.37	11/5/2019	10:51:28	W to E
-70.19034	41.60622	-6.22	20.40	22.23	25.08	11/5/2019	10:51:30	W to E
-70.19028	41.60624	-6.13	20.11	21.94	24.79	11/5/2019	10:51:32	W to E
-70.19023	41.60625	-6.29	20.63	22.46	25.31	11/5/2019	10:51:34	W to E
-70.19018	41.60627	-6.16	20.20	22.03	24.88	11/5/2019	10:51:36	W to E
-70.19013	41.60629	-6.23	20.44	22.27	25.12	11/5/2019	10:51:38	W to E
-70.19008	41.60631	-6.35	20.83	22.66	25.51	11/5/2019	10:51:40	W to E
-70.19003	41.60633	-6.29	20.64	22.47	25.32	11/5/2019	10:51:42	W to E
-70.18997	41.60635	-6.24	20.48	22.31	25.16	11/5/2019	10:51:44	W to E
-70.18992	41.60636	-6.25	20.51	22.34	25.19	11/5/2019	10:51:46	W to E
-70.18986	41.60638	-6.32	20.74	22.57	25.42	11/5/2019	10:51:48	W to E
-70.18981	41.60639	-6.16	20.21	22.04	24.89	11/5/2019	10:51:50	W to E
-70.18975	41.60640	-6.24	20.47	22.30	25.15	11/5/2019	10:51:52	W to E

-70.18969	41.60642	-6.35	20.85	22.68	25.53	11/5/2019	10:51:54	W to E
-70.18964	41.60643	-6.20	20.33	22.16	25.01	11/5/2019	10:51:56	W to E
-70.18958	41.60644	-6.22	20.40	22.23	25.08	11/5/2019	10:51:58	W to E
-70.18951	41.60647	-6.19	20.30	22.13	24.98	11/5/2019	10:52:00	W to E
-70.18947	41.60648	-6.24	20.49	22.32	25.17	11/5/2019	10:52:02	W to E
-70.18940	41.60651	-6.29	20.63	22.46	25.31	11/5/2019	10:52:04	W to E
-70.18936	41.60653	-6.32	20.72	22.55	25.40	11/5/2019	10:52:06	W to E
-70.18930	41.60656	-6.26	20.55	22.38	25.23	11/5/2019	10:52:08	W to E
-70.18925	41.60657	-6.34	20.82	22.65	25.50	11/5/2019	10:52:10	W to E
-70.18919	41.60659	-6.31	20.69	22.52	25.37	11/5/2019	10:52:12	W to E
-70.18914	41.60661	-6.22	20.41	22.24	25.09	11/5/2019	10:52:14	W to E
-70.18908	41.60663	-6.35	20.83	22.66	25.51	11/5/2019	10:52:16	W to E
-70.18904	41.60665	-6.34	20.80	22.63	25.48	11/5/2019	10:52:18	W to E
-70.18898	41.60668	-6.30	20.66	22.49	25.34	11/5/2019	10:52:20	W to E
-70.18894	41.60670	-6.28	20.62	22.45	25.30	11/5/2019	10:52:22	W to E
-70.18888	41.60672	-6.28	20.61	22.44	25.29	11/5/2019	10:52:24	W to E
-70.18883	41.60674	-6.20	20.35	22.18	25.03	11/5/2019	10:52:26	W to E
-70.18878	41.60676	-6.30	20.66	22.49	25.34	11/5/2019	10:52:28	W to E
-70.18873	41.60677	-6.28	20.61	22.44	25.29	11/5/2019	10:52:30	W to E
-70.18867	41.60679	-6.26	20.52	22.35	25.20	11/5/2019	10:52:32	W to E
-70.18862	41.60681	-6.29	20.65	22.48	25.33	11/5/2019	10:52:34	W to E

Table 5. Side scan data. Post-deployment survey (TrackG-11430). Highlighted values are graphed data points for Actual (red) and Proposed (green) deployment areas.

Lon	Lat	Elevation Bottom (M)	(Ft)	Tide adjust (+0.27)	Date	Time	Direction
-70.19761	41.60458	-8.38	27.48	27.75	1/23/2020	11:28:06	E to W
-70.19761	41.60459	-8.38	27.50	27.77	1/23/2020	11:28:04	E to W
-70.19757	41.60460	-8.36	27.44	27.71	1/23/2020	11:28:02	E to W
-70.19749	41.60461	-8.41	27.60	27.87	1/23/2020	11:28:00	E to W
-70.19745	41.60463	-8.45	27.72	27.99	1/23/2020	11:27:58	E to W
-70.19739	41.60464	-8.49	27.86	28.13	1/23/2020	11:27:56	E to W
-70.19734	41.60465	-8.48	27.81	28.08	1/23/2020	11:27:54	E to W
-70.19728	41.60466	-8.47	27.79	28.06	1/23/2020	11:27:52	E to W
-70.19722	41.60468	-8.47	27.79	28.06	1/23/2020	11:27:50	E to W
-70.19717	41.60469	-8.48	27.81	28.08	1/23/2020	11:27:48	E to W
-70.19711	41.60470	-8.41	27.60	27.87	1/23/2020	11:27:46	E to W
-70.19706	41.60471	-8.46	27.77	28.04	1/23/2020	11:27:44	E to W
-70.19698	41.60473	-8.60	28.23	28.50	1/23/2020	11:27:42	E to W
-70.19694	41.60474	-8.62	28.28	28.55	1/23/2020	11:27:40	E to W
-70.19688	41.60475	-8.63	28.30	28.57	1/23/2020	11:27:38	E to W
-70.19682	41.60476	-8.63	28.30	28.57	1/23/2020	11:27:36	E to W
-70.19676	41.60478	-8.63	28.31	28.58	1/23/2020	11:27:34	E to W
-70.19670	41.60479	-8.56	28.09	28.36	1/23/2020	11:27:32	E to W

-70.19664	41.60480	-8.59	28.19	28.46	1/23/2020	11:27:30	E to W
-70.19659	41.60481	-8.75	28.71	28.98	1/23/2020	11:27:28	E to W
-70.19653	41.60482	-8.75	28.72	28.99	1/23/2020	11:27:26	E to W
-70.19647	41.60484	-8.69	28.50	28.77	1/23/2020	11:27:24	E to W
-70.19641	41.60485	-8.63	28.31	28.58	1/23/2020	11:27:22	E to W
-70.19635	41.60486	-8.79	28.83	29.10	1/23/2020	11:27:20	E to W
-70.19629	41.60488	-8.78	28.81	29.08	1/23/2020	11:27:18	E to W
-70.19623	41.60489	-8.79	28.83	29.10	1/23/2020	11:27:16	E to W
-70.19617	41.60490	-8.66	28.40	28.67	1/23/2020	11:27:14	E to W
-70.19612	41.60491	-8.65	28.38	28.65	1/23/2020	11:27:12	E to W
-70.19605	41.60492	-8.70	28.55	28.82	1/23/2020	11:27:10	E to W
-70.19600	41.60494	-8.89	29.18	29.45	1/23/2020	11:27:08	E to W
-70.19594	41.60495	-8.91	29.22	29.49	1/23/2020	11:27:06	E to W
-70.19588	41.60496	-8.91	29.22	29.49	1/23/2020	11:27:04	E to W
-70.19582	41.60498	-8.91	29.22	29.49	1/23/2020	11:27:02	E to W
-70.19576	41.60499	-8.88	29.12	29.39	1/23/2020	11:27:00	E to W
-70.19570	41.60500	-8.91	29.24	29.51	1/23/2020	11:26:58	E to W
-70.19565	41.60501	-8.83	28.96	29.23	1/23/2020	11:26:56	E to W
-70.19559	41.60503	-8.81	28.91	29.18	1/23/2020	11:26:54	E to W
-70.19553	41.60504	-8.83	28.97	29.24	1/23/2020	11:26:52	E to W
-70.19548	41.60506	-8.77	28.76	29.03	1/23/2020	11:26:50	E to W
-70.19541	41.60507	-8.85	29.02	29.29	1/23/2020	11:26:48	E to W
-70.19536	41.60509	-8.86	29.09	29.36	1/23/2020	11:26:46	E to W
-70.19530	41.60509	-8.86	29.07	29.34	1/23/2020	11:26:44	E to W
-70.19524	41.60511	-8.85	29.05	29.32	1/23/2020	11:26:42	E to W
-70.19518	41.60512	-8.85	29.04	29.31	1/23/2020	11:26:40	E to W
-70.19513	41.60513	-8.84	29.02	29.29	1/23/2020	11:26:38	E to W
-70.19505	41.60514	-8.84	29.02	29.29	1/23/2020	11:26:36	E to W
-70.19501	41.60516	-8.84	29.02	29.29	1/23/2020	11:26:34	E to W
-70.19495	41.60517	-8.85	29.03	29.30	1/23/2020	11:26:32	E to W
-70.19489	41.60518	-8.73	28.65	28.92	1/23/2020	11:26:30	E to W
-70.19483	41.60520	-8.73	28.64	28.91	1/23/2020	11:26:28	E to W
-70.19477	41.60521	-8.73	28.64	28.91	1/23/2020	11:26:26	E to W
-70.19471	41.60522	-8.73	28.63	28.90	1/23/2020	11:26:24	E to W
-70.19464	41.60523	-8.72	28.62	28.89	1/23/2020	11:26:22	E to W
-70.19459	41.60525	-8.72	28.62	28.89	1/23/2020	11:26:20	E to W
-70.19453	41.60526	-8.72	28.61	28.88	1/23/2020	11:26:18	E to W
-70.19448	41.60527	-8.72	28.61	28.88	1/23/2020	11:26:16	E to W
-70.19441	41.60528	-8.72	28.61	28.88	1/23/2020	11:26:14	E to W
-70.19435	41.60530	-8.72	28.61	28.88	1/23/2020	11:26:12	E to W
-70.19430	41.60531	-8.69	28.51	28.78	1/23/2020	11:26:10	E to W
-70.19424	41.60532	-8.65	28.39	28.66	1/23/2020	11:26:08	E to W
-70.19418	41.60534	-8.78	28.82	29.09	1/23/2020	11:26:06	E to W
-70.19413	41.60535	-8.72	28.61	28.88	1/23/2020	11:26:04	E to W
-70.19407	41.60536	-8.50	27.89	28.16	1/23/2020	11:26:02	E to W
-70.19402	41.60537	-8.47	27.79	28.06	1/23/2020	11:26:00	E to W

-70.19394	41.60538	-8.43	27.66	27.93	1/23/2020	11:25:58	E to W
-70.19389	41.60540	-8.38	27.49	27.76	1/23/2020	11:25:56	E to W
-70.19384	41.60541	-8.34	27.38	27.65	1/23/2020	11:25:54	E to W
-70.19378	41.60542	-8.35	27.39	27.66	1/23/2020	11:25:52	E to W
-70.19372	41.60543	-8.32	27.30	27.57	1/23/2020	11:25:50	E to W
-70.19366	41.60545	-8.22	26.99	27.26	1/23/2020	11:25:48	E to W
-70.19360	41.60546	-7.92	26.00	26.27	1/23/2020	11:25:46	E to W
-70.19354	41.60547	-7.95	26.09	26.36	1/23/2020	11:25:44	E to W
-70.19349	41.60548	-7.87	25.84	26.11	1/23/2020	11:25:42	E to W
-70.19343	41.60550	-7.83	25.69	25.96	1/23/2020	11:25:40	E to W
-70.19337	41.60551	-7.57	24.85	25.12	1/23/2020	11:25:38	E to W
-70.19332	41.60552	-7.53	24.71	24.98	1/23/2020	11:25:36	E to W
-70.19324	41.60553	-7.51	24.64	24.91	1/23/2020	11:25:34	E to W
-70.19319	41.60554	-7.44	24.41	24.68	1/23/2020	11:25:32	E to W
-70.19313	41.60556	-7.46	24.47	24.74	1/23/2020	11:25:30	E to W
-70.19308	41.60557	-7.35	24.12	24.39	1/23/2020	11:25:28	E to W
-70.19302	41.60558	-7.31	24.00	24.27	1/23/2020	11:25:26	E to W
-70.19295	41.60559	-7.41	24.30	24.57	1/23/2020	11:25:24	E to W
-70.19289	41.60561	-7.41	24.31	24.58	1/23/2020	11:25:22	E to W
-70.19283	41.60562	-7.29	23.93	24.20	1/23/2020	11:25:20	E to W
-70.19278	41.60563	-7.38	24.20	24.47	1/23/2020	11:25:18	E to W
-70.19271	41.60565	-7.37	24.17	24.44	1/23/2020	11:25:16	E to W
-70.19266	41.60566	-7.38	24.20	24.47	1/23/2020	11:25:14	E to W
-70.19260	41.60568	-7.35	24.11	24.38	1/23/2020	11:25:12	E to W
-70.19254	41.60569	-7.33	24.04	24.31	1/23/2020	11:25:10	E to W
-70.19248	41.60570	-7.38	24.21	24.48	1/23/2020	11:25:08	E to W
-70.19243	41.60571	-7.35	24.13	24.40	1/23/2020	11:25:06	E to W
-70.19238	41.60572	-7.28	23.90	24.17	1/23/2020	11:25:04	E to W
-70.19232	41.60573	-7.27	23.86	24.13	1/23/2020	11:25:02	E to W
-70.19226	41.60574	-7.32	24.02	24.29	1/23/2020	11:25:00	E to W
-70.19221	41.60575	-6.79	22.27	22.54	1/23/2020	11:24:58	E to W
-70.19215	41.60577	-7.29	23.92	24.19	1/23/2020	11:24:56	E to W
-70.19209	41.60578	-7.13	23.41	23.68	1/23/2020	11:24:54	E to W
-70.19204	41.60579	-7.57	24.84	25.11	1/23/2020	11:24:52	E to W
-70.19196	41.60580	-7.09	23.27	23.54	1/23/2020	11:24:50	E to W
-70.19191	41.60581	-7.41	24.31	24.58	1/23/2020	11:24:48	E to W
-70.19186	41.60582	-7.32	24.00	24.27	1/23/2020	11:24:46	E to W
-70.19179	41.60584	-7.54	24.72	24.99	1/23/2020	11:24:44	E to W
-70.19174	41.60585	-6.98	22.91	23.18	1/23/2020	11:24:42	E to W
-70.19168	41.60586	-7.19	23.57	23.84	1/23/2020	11:24:40	E to W
-70.19162	41.60587	-7.56	24.81	25.08	1/23/2020	11:24:38	E to W
-70.19157	41.60588	-6.41	21.04	21.31	1/23/2020	11:24:36	E to W
-70.19149	41.60590	-7.24	23.75	24.02	1/23/2020	11:24:34	E to W
-70.19145	41.60591	-6.89	22.62	22.89	1/23/2020	11:24:32	E to W
-70.19139	41.60592	-7.61	24.96	25.23	1/23/2020	11:24:30	E to W
-70.19134	41.60593	-7.43	24.37	24.64	1/23/2020	11:24:28	E to W

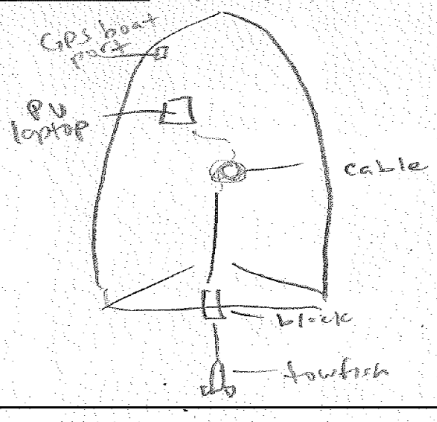
-70.19127	41.60595	-7.57	24.82	25.09	1/23/2020	11:24:26	E to W
-70.19121	41.60596	-7.47	24.51	24.78	1/23/2020	11:24:24	E to W
-70.19115	41.60598	-7.58	24.89	25.16	1/23/2020	11:24:22	E to W
-70.19108	41.60599	-7.36	24.13	24.40	1/23/2020	11:24:20	E to W
-70.19104	41.60600	-7.50	24.62	24.89	1/23/2020	11:24:18	E to W
-70.19097	41.60601	-7.50	24.62	24.89	1/23/2020	11:24:16	E to W
-70.19092	41.60602	-7.14	23.44	23.71	1/23/2020	11:24:14	E to W
-70.19086	41.60603	-7.56	24.82	25.09	1/23/2020	11:24:12	E to W
-70.19080	41.60605	-7.56	24.82	25.09	1/23/2020	11:24:10	E to W
-70.19074	41.60606	-7.56	24.81	25.08	1/23/2020	11:24:08	E to W
-70.19067	41.60607	-7.56	24.81	25.08	1/23/2020	11:24:06	E to W
-70.19063	41.60608	-7.51	24.63	24.90	1/23/2020	11:24:04	E to W
-70.19057	41.60610	-7.59	24.92	25.19	1/23/2020	11:24:02	E to W
-70.19051	41.60611	-7.54	24.75	25.02	1/23/2020	11:24:00	E to W
-70.19045	41.60612	-7.65	25.09	25.36	1/23/2020	11:23:58	E to W
-70.19039	41.60613	-7.66	25.13	25.40	1/23/2020	11:23:56	E to W
-70.19034	41.60614	-7.56	24.81	25.08	1/23/2020	11:23:54	E to W
-70.19027	41.60616	-7.53	24.71	24.98	1/23/2020	11:23:52	E to W
-70.19022	41.60617	-7.47	24.51	24.78	1/23/2020	11:23:50	E to W
-70.19015	41.60618	-7.59	24.91	25.18	1/23/2020	11:23:48	E to W
-70.19010	41.60619	-7.69	25.23	25.50	1/23/2020	11:23:46	E to W
-70.19005	41.60620	-7.70	25.27	25.54	1/23/2020	11:23:44	E to W
-70.18999	41.60621	-7.57	24.84	25.11	1/23/2020	11:23:42	E to W
-70.18993	41.60623	-7.67	25.15	25.42	1/23/2020	11:23:40	E to W
-70.18985	41.60624	-7.69	25.24	25.51	1/23/2020	11:23:38	E to W
-70.18981	41.60625	-7.60	24.92	25.19	1/23/2020	11:23:36	E to W
-70.18975	41.60626	-7.66	25.14	25.41	1/23/2020	11:23:34	E to W
-70.18969	41.60628	-7.63	25.05	25.32	1/23/2020	11:23:32	E to W
-70.18964	41.60629	-7.63	25.03	25.30	1/23/2020	11:23:30	E to W
-70.18958	41.60631	-7.63	25.02	25.29	1/23/2020	11:23:28	E to W
-70.18952	41.60632	-7.63	25.02	25.29	1/23/2020	11:23:26	E to W
-70.18945	41.60633	-7.63	25.02	25.29	1/23/2020	11:23:24	E to W
-70.18940	41.60635	-7.63	25.04	25.31	1/23/2020	11:23:22	E to W
-70.18934	41.60636	-7.54	24.74	25.01	1/23/2020	11:23:20	E to W
-70.18928	41.60638	-7.69	25.22	25.49	1/23/2020	11:23:18	E to W
-70.18922	41.60639	-7.69	25.23	25.50	1/23/2020	11:23:16	E to W
-70.18916	41.60641	-7.66	25.12	25.39	1/23/2020	11:23:14	E to W
-70.18910	41.60642	-7.66	25.13	25.40	1/23/2020	11:23:12	E to W
-70.18904	41.60643	-7.50	24.59	24.86	1/23/2020	11:23:10	E to W
-70.18899	41.60644	-7.69	25.22	25.49	1/23/2020	11:23:08	E to W
-70.18893	41.60645	-7.69	25.23	25.50	1/23/2020	11:23:06	E to W
-70.18887	41.60647	-7.67	25.17	25.44	1/23/2020	11:23:04	E to W
-70.18881	41.60648	-7.57	24.83	25.10	1/23/2020	11:23:02	E to W
-70.18871	41.60650	-7.60	24.95	25.22	1/23/2020	11:23:00	E to W

Table 6. Cruise notes, November 5, 2019.

SIDE SCAN SONAR SET UP

Date	11/5/19
Weather	cloudy, a bit rough
Survey Area	Yarmouth Reef Site
Personnel	S. Voss + M. Rousseau
SSS & GPS System	Klein SSS / mya boat GPS

Vessel Name	R/V MYA
Vessel Diagram	R/V MYA Pre Reef Deployment Side Scan Survey



Frequency	
Range	200' = 61m
Other	400' swath 300' line spacing

SIDE SCAN SONAR LOGSHEET

Date: 11/5/19

Page no: 2

Line #	Time Start	Time End	Filename	Notes 61m range/200ft	
1	10:04	10:14	xtf file sdf 1/2 way	↗ south end 12m cable out	4 kts
2	10:16	10:24		↙	
3	10:26	10:34		↗	4.5 kts
4	10:36	10:44		↙ CG sinkers? passed lob buoy	↓
5	10:46	10:54		↗	
6	10:56	11:04		↙	
7	11:06	11:14		↗	
8	11:16	11:24		↙	
9	11:26	11:33		↗ passed by lob buoy	
10	11:35	11:42		↙	
11	11:44	11:52		↗ off line to avoid buoys @ start of line	5 kts
12	11:53	12:00		↙ ↳ again @ end of line	↓
13	12:04	12:11		↗	
14	12:13	12:20		↙	

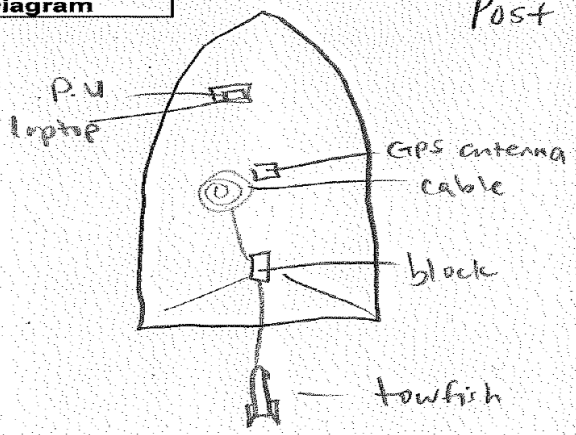
Table 10. Cruise notes, January 23, 2020.

SIDE SCAN SONAR SET UP

Date	1/23/20
Weather	Calm 40°s
Survey Area	Yarmouth Reef
Personnel	S. Voss, M. Rousseau
SSS & GPS System	Klein SS / Garmin GPSMap 76

Vessel Name	Alosa
Vessel Diagram	

Post Reef Deployment Side Scan Survey



Frequency	
Range	200' = 61 m.
Other	

400' swath
300' line spacing

SIDE SCAN SONAR LOGSHEET Date: 1/23/20

(laptop time 12 min fast) Page no: 1

Line #	Time Start	Time End	Filename	Notes 10m Cable out
1	10:35	10:41	↙	data time 12min fast 4.7 kts
2	10:43	10:49	↗	7m off bottom ↓ ↓
3	10:51	10:57	↙	
4	10:58	11:05	↗	
5	11:06	11:12	↙	
6	11:14	11:21	↗	
7	11:23	11:28	↙	
8	11:29	11:36	↗	
9	11:38	11:44	↙	
10	11:45	11:52	↗	
11	11:58	11:59	↑	Right on reef side (N/S direction)
12	12:00	12:03	↓	
13	12:05	12:06	↑	
14	12:07	12:10	↓	