FIELD RESEARCH FACILITY
DUCK, NC

COASTAL AND HYDRAULICS LABORATORY
FIELD DATA COLLECTION AND ANALYSIS BRANCH

US Army Corps
of Engineers®
Engineer Research and
Development Center

Old House Channel Bathymetric and Side Scan Survey

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View looking over the antennas of the motion and bathymetry sensor, south towards Old House Channel, Pamlico Sound, North Carolina.

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1. Introduction

The U.S. Army Corps of Engineers Wilmington District and the State of North Carolina are partnering to develop a Beneficial Use of Dredged Material project. The project would address operational dredging needs for the Old House Channel portion of the Manteo, Shallowbag Bay project (**Figure 1**). This proposal would also address oyster reef restoration needs in North Carolina's Pamlico Sound, part of the Albemarle-Pamlico National Estuary. The Manteo Shallow Bag Bay – Old House Channel Project would use sandy material dredged from Old House Channel to build submerged shoals to be topped with cultch for oyster reefs. Accurate bathymetry and mapping of the existing submerged aquatic vegetation (SAV) was required for assisting in the design of this project.

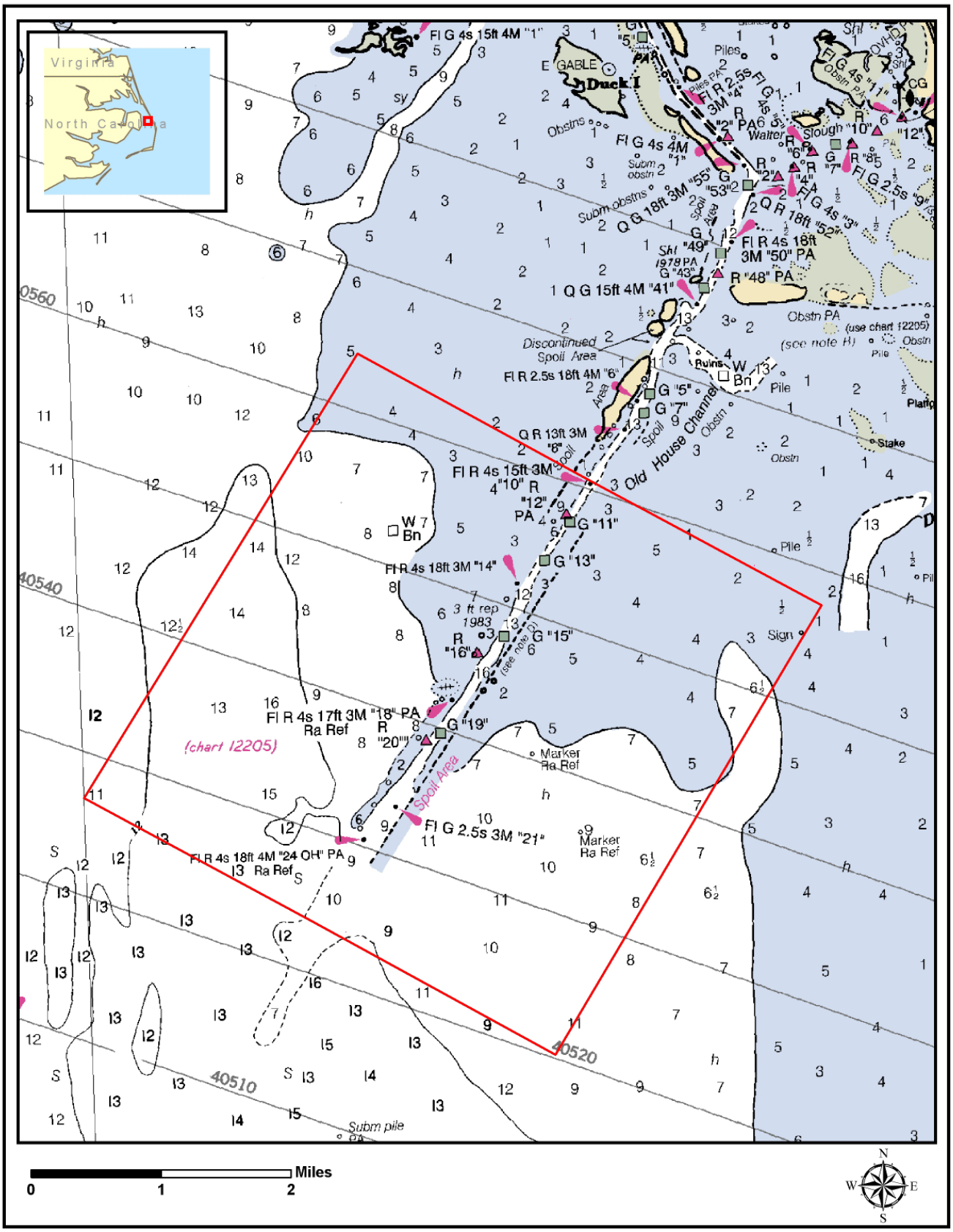

Figure 1. Old House Channel Project Survey Area (Red box = 17.25 square miles)

2. Methods

The U.S. Army Corps of Engineers Field Research Facility (USACE FRF) used a 26-ft pontoon boat that is capable of surveying in water as shallow as ~0.5 ft. A Real-Time Kinematic Global Positioning Satellite (RTK-GPS) system was used to correct incoming satellite information at a known location (Base-Station) and then transmit the corrections in real time to the vessel via radio transmission (**Figure 2**). RTK-GPS error range is typically less than 3 inches in the x, y, and z planes. Depth soundings were directly referenced to the North American Vertical Datum of 1988 (NAVD88) and any variations in the water level surface during the survey had no impact. NAVD88 is approximately 0.66 ft above Mean Lower Low Water (MLLW) at the National Oceanic & Atmospheric Administration's Tidal Station (8652587) Oregon Inlet Marina, Pamlico Sound, NC.

A control monument was established and surveyed in at U.S. Coast Guard Facility Oregon Inlet. The station served as the reference (GPS Base Station) for the entire survey region. The control station provided a clear line of sight between the base station and the vessel. Accuracy checks were performed daily throughout the survey on surrounding NGS survey monuments to verify the position data. The accuracy checks did not exceed (+/- 2.5 inches) during the entire survey.

The pontoon boat was outfitted with Geo-Acoustics' GeoSwath® Phase measuring bathymetry system which measures both bathymetry and seabed acoustic backscatter from a hull mounted transducer, providing co-registered depth soundings and side scan sonar information in water depths ranging from 1.5 to 300ft. An Applanix Position & Orientation for Marine Vessels (POSMV®) inertial measurement unit was used to record vessel motion and heading. An Ocean Sensors® conductivity, temperature, density (CTD) sensor was used to measure the speed of sound through the water column (Figure 2) in order to adjust the Geoswath data for water temperature and density. Hypack survey software was used to navigate the boat along 132 pre-programmed survey lines and to log the position data. During the survey, which began on 18 June and was completed on 14 September 2009, approximately 480 miles of data were recorded. Although the survey spanned nearly 4 months only 16 field days were necessary to complete the field data collection. Windy conditions creating choppy seas, and summertime thunderstorms were the cause of many down days. Having a vessel that could operate in very shallow waters (~0.5ft) and be seaworthy posed a challenge for this field survey region.

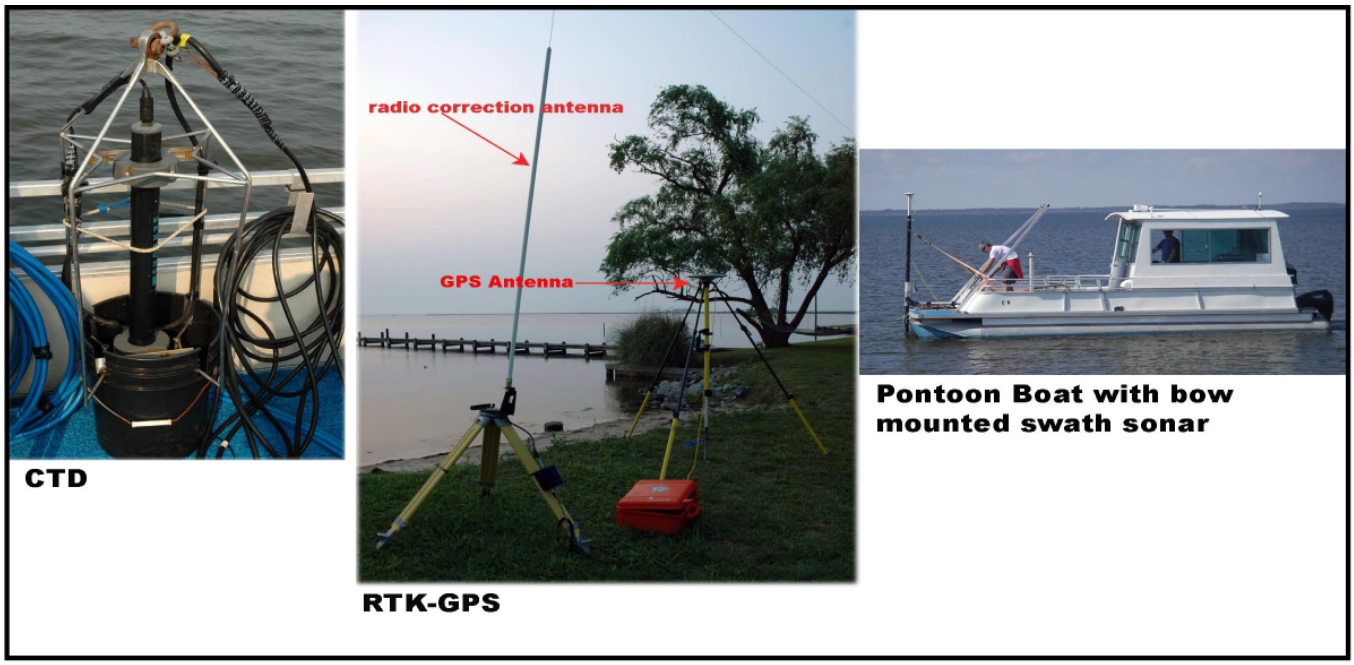

Figure 2. Equipment used during survey

3. Data Processing

The GeoSwath data were processed using Geo-Acoustics Geo-Swath Plus software that combines the GeoSwath, motion, and positioning data. The software corrects for errors associated with speed of sound and vessel motion, then incorporates these into the depth measurements. The resulting depths are relative to NAVD88, which can be related to MLLW level in Pamlico Sound. Processed swath sonar files were then gridded within Geo-Swath Plus using the weighted mean gridding algorithm, which computes depths in a regularly spaced 15 × 15 ft rectilinear grid. These data were then imported into IVS 3-D Fledermaus using a natural neighbor weighted gridding algorithm which yielded the final position and depth data.

The side-scan data were processed using Geo-Acoustics Geo-Texture® software to remove the effects of things other than seabed material from the image, thus improving the interpretability of the texture information in the image. Swath files were imported into the software at a resolution of 2.5 ft and a series of process steps were applied. These processes included: seabed locate, filter bathymetry, trace normalization, and finally a slant range correction to remove the nadir and the water column effects. **Figure 3** is a close-up detail of processed side-scan data. Swaths from individual days were merged to create a mosaic of the entire survey area. The mosaic was then exported out of the software as a geo-referenced jpeg for analysis in GIS. **Figure 4** shows the bathymetry and **Figure 5**, the side-scan mosaic.

Figure 3. Processed side-scan mosaic of multiple survey lines showing areas of SAV (darker rough areas) and fine sand (light colored smooth areas)

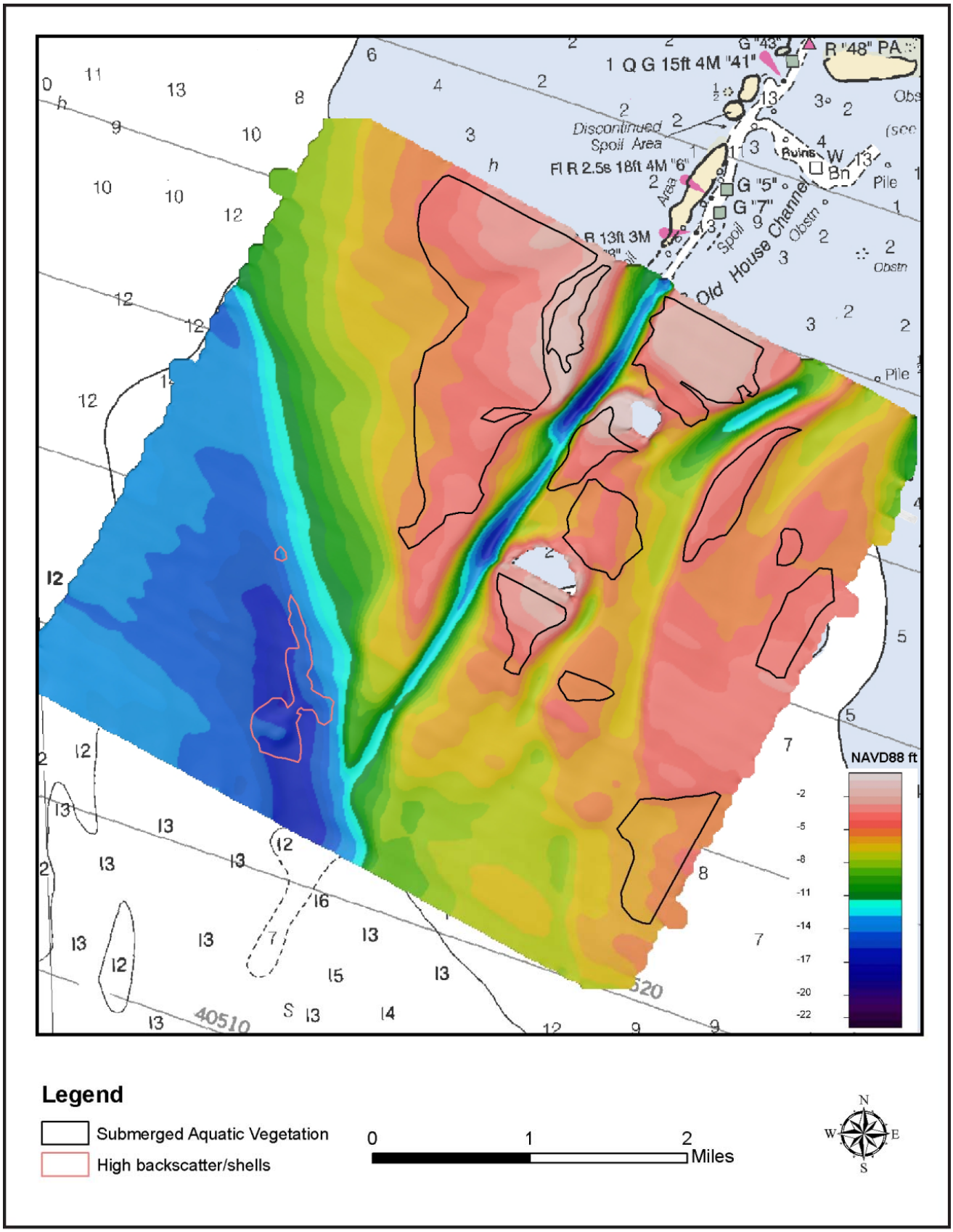

Figure 4. Old House Channel Bathymetry with areas of SAV and high backscatter identified by polygons

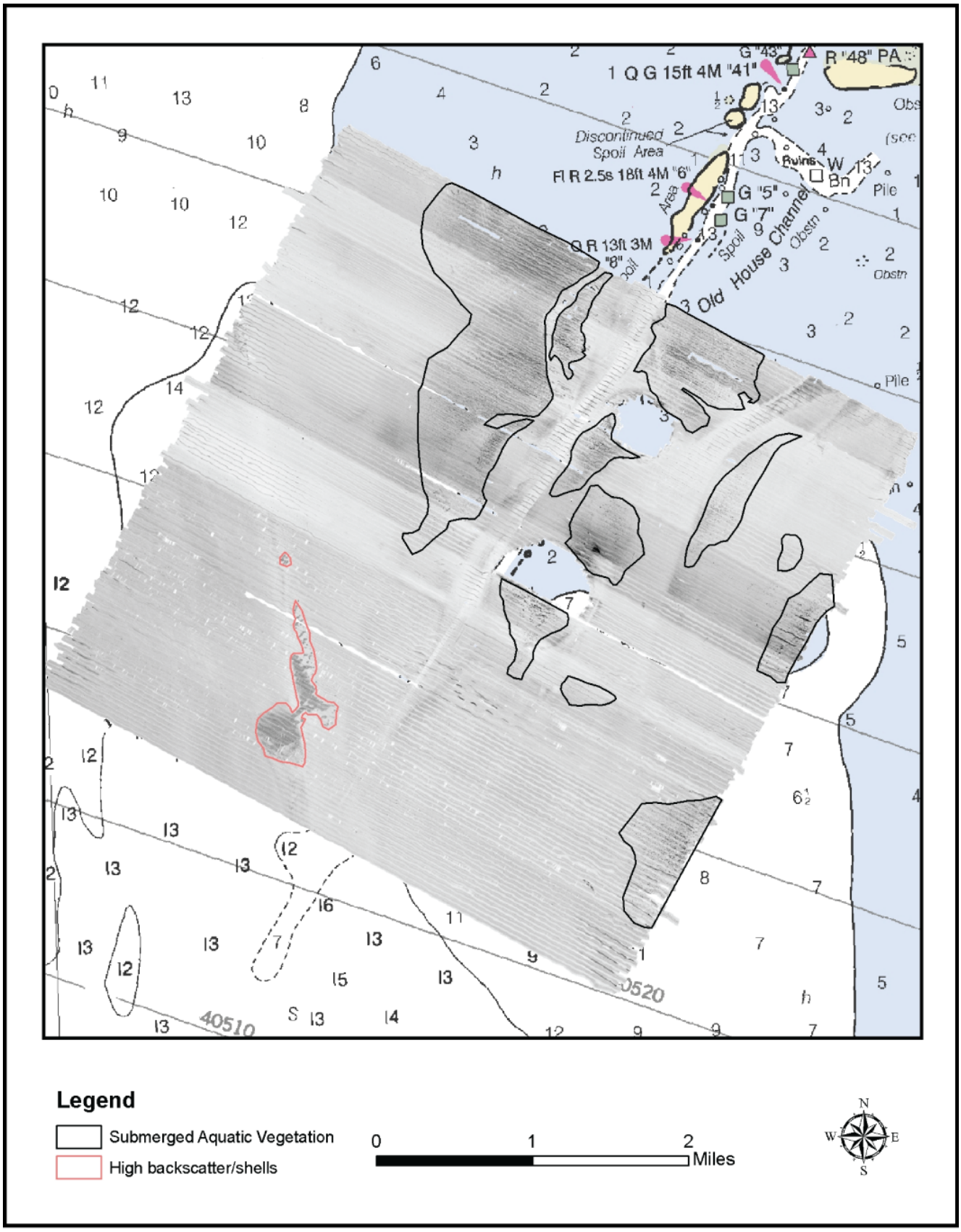

Figure 5. Old House Channel Side-Scan mosaic with areas of SAV and high backscatter identified by polygons

4. Results and Conclusions

Table 1 shows bottom type and percent coverage found throughout the survey area. Approximately 2.25 square miles of SAV (13 percent) were identified and marked by color coded polygons in GIS (**Figure 5**, black polygons). The SAV produced a distinct signature on the side-scan record and was easily identified during analysis. In certain areas during the survey, the hydrographer could see the top of the grasses at the water surface, thus confirming that the side-scan return was detecting SAV. There appears to be a correlation between depth and SAV as displayed in **Figure 4**. SAV is generally found in depths less than 6 ft. SAV growth is often light limited and thus correlates with water depth.

There was an estimated 0.19 square miles (1 percent) of "high-backscatter" area that likely contains oyster shells or coarse sediment material (**Figure 5**, pink polygons). These areas were found in deeper water (14 to 17ft).

The majority (86 percent) of the survey area had a uniform bottom composed primarily of fine sands, which has a "low backscatter" due to signal absorbance. These areas are the more uniform light colored regions in **Figure 5**.

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Table 1. Bottom Type And Coverage Percentage		
Material Type	Area (sq mi)	Coverage (%)
SAV	2.26	13
High backscatter/shells	0.20	1
Fine Sand	14.79	86
Project area	17.25	

Appendix A (Deliverables)

The survey data are referenced to the North American Datum of 1983 (NAD83) State Plane North Carolina Zone 3200 with units of survey feet. Depths are referenced to NAVD88 with units of survey feet. A Federal Geographic Data Committee approved metadata file has been created for the survey, which documents the geodetic parameters of the survey and provides a reference for the data.

The report and data files have been uploaded to the following ftp site. ftp://134.164.34.99/SAW/OHC_2009 . A list of the final files on the ftp site is provided below. For more information regarding this project or to provide comments or recommendations, contact Mr. Michael Forte, Research Physical Scientist, at 252-261-6840, ext. 228, or by email: Michael.f.forte@usace.army.mil.

Final Files

1. OHC_2009_ss_mosaics.zip – Old House Channel side scan mosaic geo-referenced jpegs at high (1200dpi) and low (300dpi) resolutions.

2. OHC_2009_NAD83sp_NAVD88_feet.shp.zip – ESRI shape file of Old House Channel Bathymetry point data at the 15ft resolution

3. OHC_2009_shape_files – ESRI shape file polygons of Old House Channel SAV and high backscatter areas.

4. OHC_2009_report.pdf – Written survey report describing acquisition methodology, data processing techniques, and results.

5. OHC_2009_metadata.met – Old House Channel metadata file

6. SAV_sidescan.jpg – image of sidescan mosaic with areas of SAV and high backscatter identified by polygons

7. SAV_bathy.jpg – image of bathymetry data with areas of SAV and high backscatter identified by polygons