Mapping and measuring eelgrass with a multi-beam sonar in the Great Bay Estuary, New Hampshire

Ashley Norton and Semme Dijkstra
Center for Coastal and Ocean Mapping, University of New Hampshire
anorton@ccom.unh.edu

SUMMARY

Our goal is to develop a data collection and processing methodology for multi-beam sonar data to determine presence/absence, percent cover, maximum depth limit, and canopy height of eelgrass beds. Presented here are the results of our initial processing methods for multibeam echosounder data collected in the summer of 2014. For this we use water column backscatter data collected with a multi-beam echo-sounder. The work is aimed at improving our ability to detect change at the deep edge of eelgrass beds. These areas are most vulnerable to water clarity issues such as eutrophication and increased suspended sediment loads. Acoustic eelgrass mapping is of particular use in deep waters and turbid estuaries, where aerial imagery does not reveal the necessary detail for analysis. Preliminary acoustic mapping of eelgrass beds in the Great Bay Estuary has been performed as one of the components of this study. Data were acquired in three different environments: shallow subtidal (estuarine) eelgrass beds; open-water (coastal) eelgrass beds; and finally, a shallow turbid part of the estuary where eelgrass detection in aerial imagery has proven difficult in the past. Presented here are results from the initial analysis of data collected at the open water site, located in Portsmouth Harbor. These results show a good correlation to interpretation of eelgrass presence from orthorectified imagery.

OBJECTIVES

The final objectives of this study are to:

- **Develop and validate quantitative and repeatable methods for processing water-column backscatter data from a multi-beam echo-sounder for the detection and measurement of eelgrass beds, including canopy height and percent coverage.**
- **Quantify the uncertainties and expected data resolution for our eelgrass measurements and mapping from a multi-beam echo-sounder**
- **Contextualize and synthesize the products of this acoustic method with aerial imagery and in-situ monitoring data also collected in the Great Bay estuary**

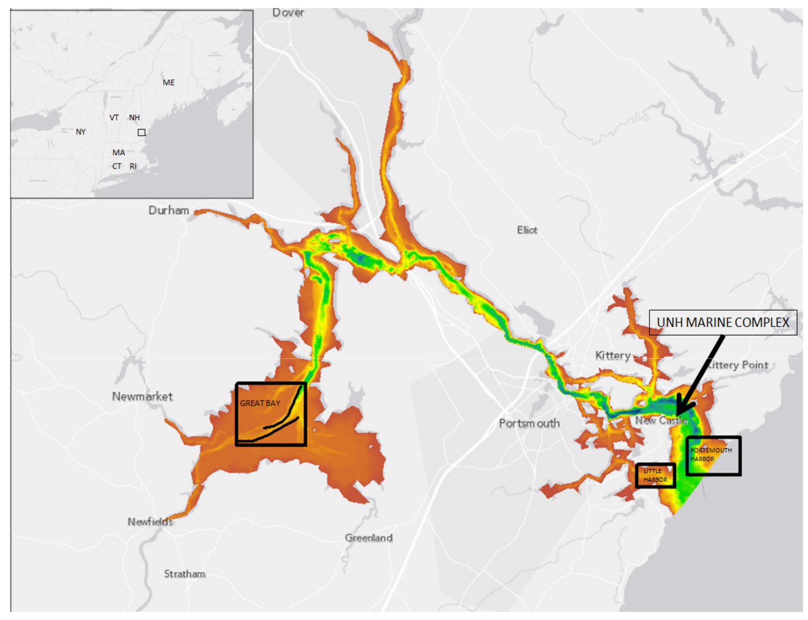

Figure 1: Study Sites
Study sites around the Great Bay estuary, including compiled bathymetric data (color coded) in meters relative to mean lower low water.

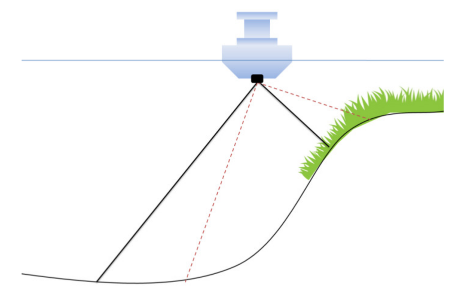

Figure 2: Conceptual diagram of a normally-mounted transducer (black) and 30-degree tilted transducer (red).

Survey Components	
Multi-beam echo-sounder	Odom MB1
RTK GPS	Applanix POS MV 320 Trimble base station
Vessel motion sensor	Applanix POS MV 320
Sound speed	MB1 internal sensor YSI Castaway CTD for profiles
Ground-truthing	Drop Camera, divers, aerial imagery

Table 1: Survey equipment

SURVEY DESIGN

- Three different locations, three representative environments for eelgrass mapping (Figure 1) :
  - Portsmouth Harbor: Coastal eelgrass beds to 10 meters depth; mixed substrates
  - Great Bay: Shallow estuary; subtidal eelgrass largely restricted to <5 meters depth
  - Little Harbor: Shallow, turbid harbor; often difficult to detect eelgrass in aerial imagery
- Multi-beam mapping conducted from Substructure Inc.'s survey vessel *Orion*, July 15th – July 19th, 2014 (see Table 1 for equipment used)
- Two different sonar transducer mounting configurations tested: vertical and tilted to port (Figure 2)

PRELIMINARY RESULTS

Water column data were collected over eelgrass beds at all 3 locations. The most variability in patchiness, and canopy height was encountered in Portsmouth Harbor, and preliminary visual analysis suggests that we should be able to detect patches on the order of ~1m and canopy heights as small as 20 cm (Figures 3 & 4). Data analysis thus far has focused on extracting the locations of the seafloor and the canopy at nadir (i.e., directly beneath the transducer). The assumption is often made that the seafloor is the strongest acoustic reflector in a sonar ping, and therefore it is picked out as the maximum energy in a return; however, there are some pings in which the maximum energy is in the canopy. For these reasons, successive pings are averaged and filtered, and a robust bottom detection is obtained through statistical analysis of the return from the seafloor.

ACKNOWLEDGEMENTS

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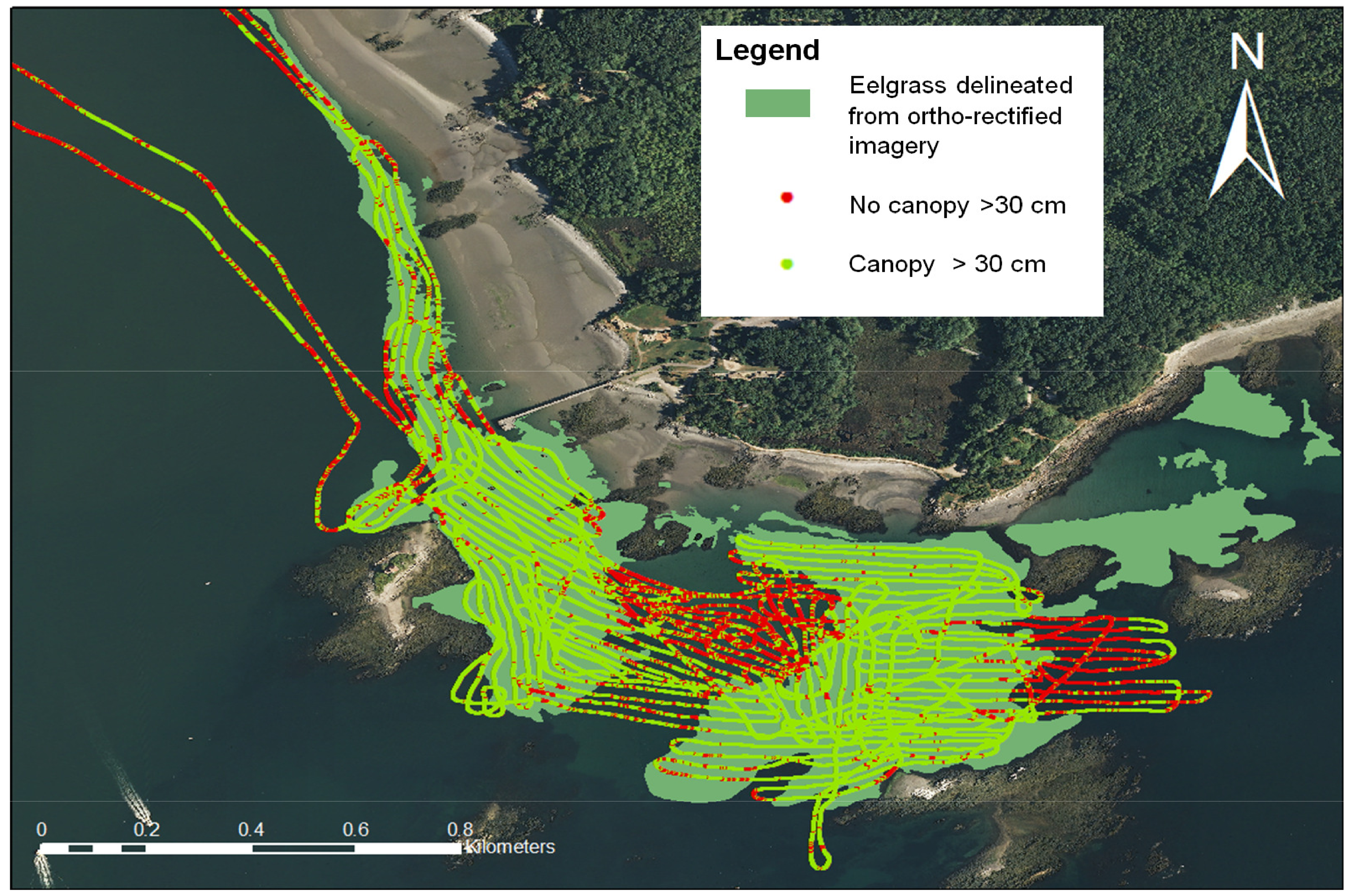

Figure 3: Eelgrass Presence Map
Map of canopy presence (higher than 30 cm) created from nadir water column data from Portsmouth Harbor

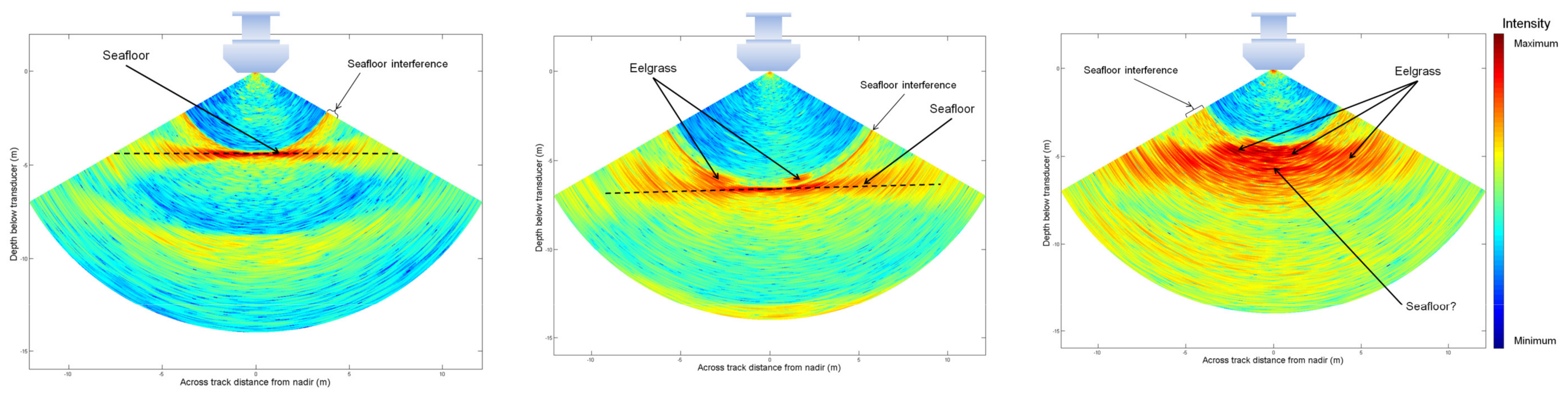

Figure 4 (above): Multibeam Sonar Data Visualization
Similar to medical ultrasound imagery, displayed here are individual pings of water column backscatter data, with (a) no eelgrass present, (b) small (~1m) eelgrass patches and (c) continuous and 'dense' eelgrass

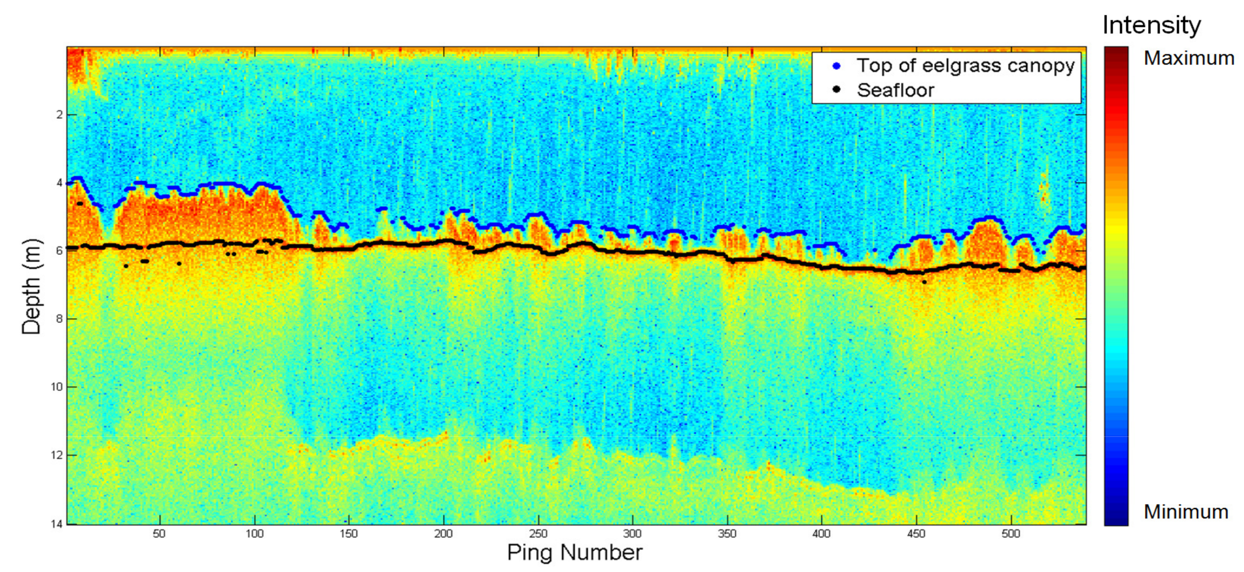

Figure 5 (left): Bottom and Canopy Identification.
Nadir water column data (analogous to a single-beam echogram) from Portsmouth Harbor, with canopy and bottom detections

CONCLUSIONS & FUTURE WORK

Preliminary data analysis has already produced encouraging results for the further development of our eelgrass mapping method utilizing multibeam sonar data. We are largely able to detect both the seafloor and the eelgrass canopy near the central of our swath (nadir); we are expanding our approach to also automatically delineate the bottom and canopy off-nadir. The approach for this problem will be to test different image-processing methods similar to those used for automated tissue boundary detection in medical ultrasound imagery. A more geographically-complete dataset will be collected in the summer of 2015 in the estuary. We will synthesize these acoustic datasets with aerial imagery and in-situ sampled datasets from the study sites to assess relative accuracies. The final goal will be to establish best-practices for acoustic eelgrass mapping under differing environmental conditions depending on the monitoring objectives.