Division of Marine Fisheries

Annual Report to Buzzards Bay Coalition

Eelgrass Surveys for Wareham Wastewater Treatment Plant Project

2018-2019

Kathryn Ford

Steven Voss

Introduction

The Wareham Wastewater Treatment Plant currently discharges into the Agawam River. The discharge is proposed to be moved to a site that discharges into the Cape Cod Canal where the water flow is higher, and thus will enable better dilution of the wastewater effluent. The goal is to alleviate eutrophication in the Upper Buzzards Bay. The proposed outfall location is proximal to an eelgrass meadow near the Massachusetts Maritime Academy (MMA). Nutrient over-loading from sources including wastewater, atmospheric deposition, agriculture, and stormwater has known negative effects to eelgrass. The nutrients cause algae blooms that reduce the water clarity and limit light reaching the eelgrass plants. Since eelgrass requires a high amount of light to grow, the algae blooms can reduce eelgrass growth and result in the loss of eelgrass meadows (Costello and Kenworthy 2011).

In order to determine if the new outfall location has an impact on the eelgrass meadow, the permit for the project requires monitoring the area of the meadow and comparing it to a reference meadow. The Massachusetts Division of Marine Fisheries (MA DMF) is conducting the eelgrass monitoring. Multiple eelgrass meadow boundaries were assessed at both an impact site (MMA) and a reference site (Haymeadow). The data quality objectives are to ensure that we consistently assess the presence/absence of the meadows and provide an estimate of the meadow boundary. A pilot study was conducted in 2018 to assess logistics at the impact site and the first year of monitoring at both sites was conducted in 2019. This report is provided to summarize activities done in 2018 and 2019.

Materials and Methods

Study Locations

Site selection for the impact and reference sites was performed in ArcGIS 10.X using Massachusetts Department of Environmental Protection (MADEP) eelgrass layers. MADEP uses a fixed wing aircraft to fly sections of the Massachusetts coast using the NOAA CCAP protocol for monitoring eelgrass (Costello and Kenworthy 2011; NOAA 1995; NOAA Coastal Services Center 2001). In Wareham, eelgrass maps are available for the years of

1995, 2001, 2006, 2013, and 2017. The Massachusetts Maritime Academy (MMA) impact site is located at the southwestern entrance to the Cape Cod Canal (Figure 1). A preliminary side scan survey with groundtruthing was conducted at the impact site on September 24, 2018 to confirm the size and health of the meadow and determine the final study area boundary.

A reference eelgrass meadow was located across the channel and south of Mashnee Island in an area known as Haymeadow (Figure 1). This eelgrass meadow has a similar size and water depth as the MMA impact meadow and is relatively close to the impact site but far enough away that we do not expect it to be impacted by the new wastewater outfall location. Both sites have the same semi-diurnal tide range 6.85 ft or 2.09 m, have sand-dominated sediment, have a depth range of approximately 1 to 5 meters, and both sites have an average depth of 2.5 meters. Using the results of the preliminary 2018 survey, the eelgrass mapping from DEP, and basemap world imagery data from ArcGIS dated September 29, 2018, final survey areas were delineated in ArcGIS 10.7.

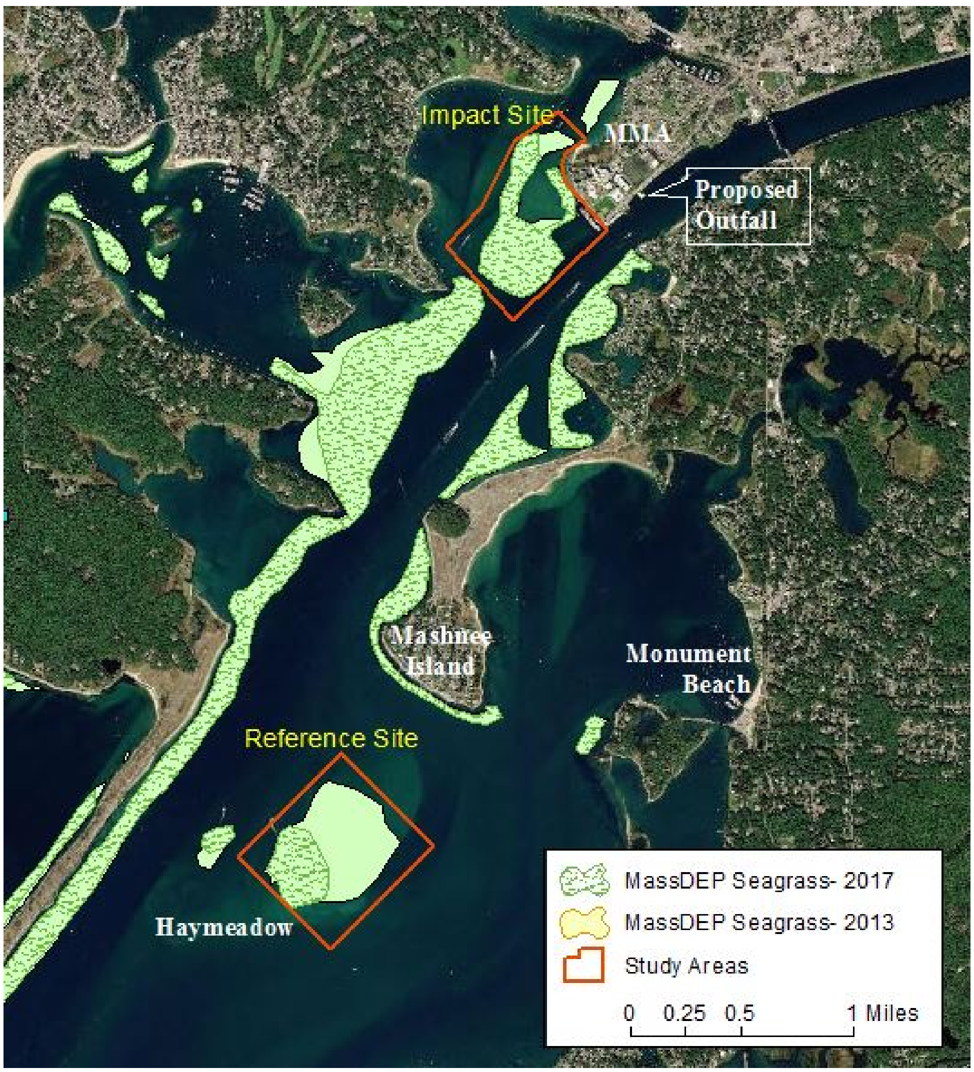

Figure 1. Eelgrass study locations.

In 2019 side scan surveys with drop camera groundtruthing were completed at the MMA impact site on August 20, 2019 and the Haymeadow reference site on August 27, 2019.

Hydroacoustic Equipment

Side scan sonar is an efficient way to survey eelgrass when aerial photography is not available or the water is too deep or turbid for aerial optical imagery to see the eelgrass. The presence of eelgrass is very clear in acoustic imagery due to the air-filled blades of the eelgrass plant. It can be seen clearly in both side scan imagery (Figure 2) and by the downward looking acoustic depth sensors. At the MMA and Haymeadow study sites, eelgrass grows as a monoculture, which was confirmed with groundtruthing. There is some algae, but it is limited and is not visible in the acoustic imagery at these sites.

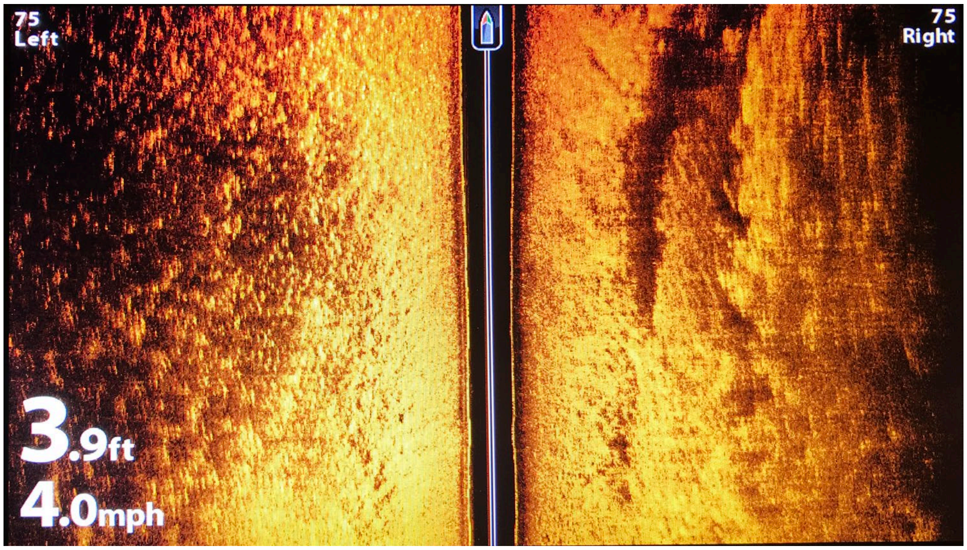

Figure 2. Eelgrass is clearly visible in this side scan sonar imagery as the "puffy" texture.

The Humminbird Helix9 which supports the sonar frequencies of 50/83/200/455/800 kHz includes down imaging, dual beam, and side imaging. For these surveys we used 800 kHz for the side imaging. The Humminbird transducer was pole mounted on the starboard side gunwale of the R/V Flatfish using a trolling motor mount (Figure 3). GPS is incorporated into the Humminbird system in the display unit. Data was recorded to an SD card in DAT format using the Humminbird data display unit. Due to the shallow and well-mixed nature of the study areas, no sound velocity corrections were needed.

Figure 3. Humminbird Helix9 side scan sonar onboard the R/V Flatfish

To confirm the side scan is operating properly, it is turned on to observe the data stream and verify proper transducer depth and data quality. The transducer depth is adjusted to ensure there is no interference in the acoustic return signal from the boat or boat wake. The range setting is checked to achieve high quality imagery at the far edge of the swath. For this survey, a range of 100 feet was determined to be appropriate during the pilot survey in 2018. The range is the distance the side scan sonar will image on each side of the sonar unit. The total swath width was 200 feet.

Survey transect lines were positioned 150 feet apart. This was to ensure 150% spatial coverage of the seafloor (Figure 4). This is the operating standard used to improve interpretation of side scan sonar since imagery at the outer edge of the range is often compromised due signal attenuation (Kaeser and Litts 2013). The planned survey lines were oriented to optimize the best direction for data collection based on typical wind conditions (Figure 5).

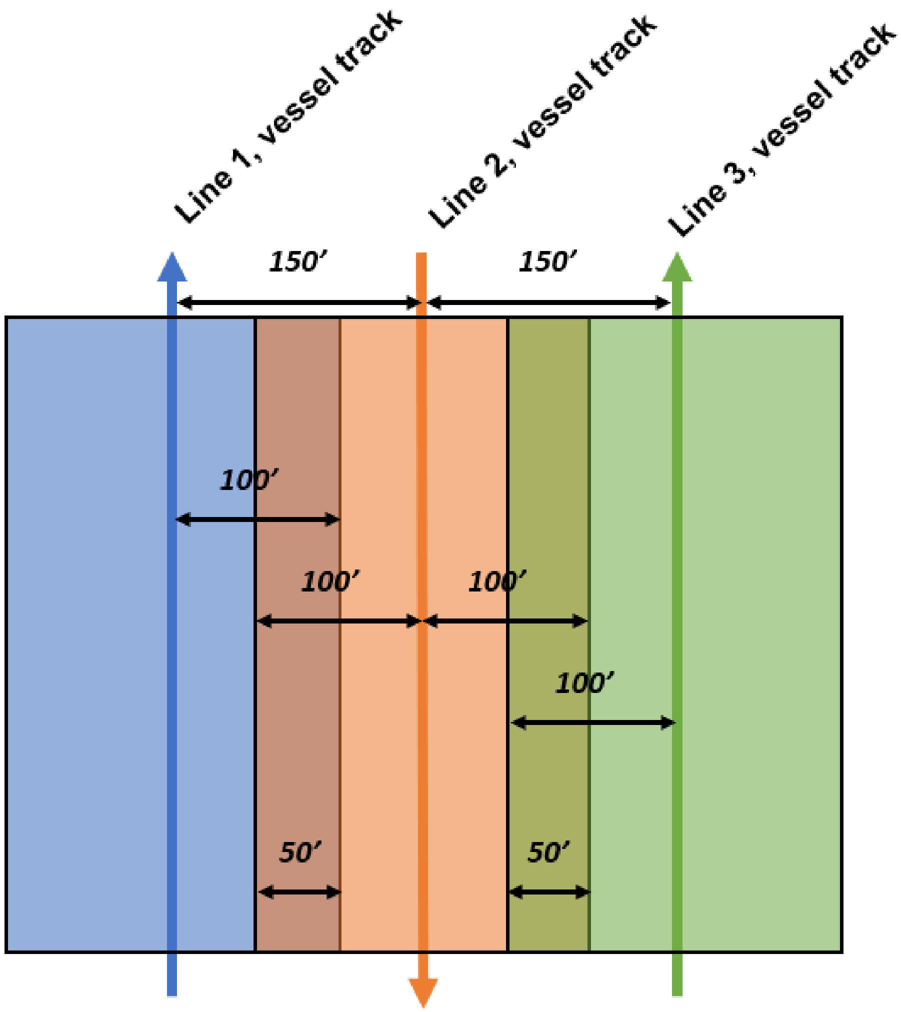

Figure 4. Schematic of overlap. For Line 2, 100’ of the original 200’ of seafloor imaged is also imaged on Line 1 and Line 3 passes. The overlap is the darker shaded sections of the diagram.

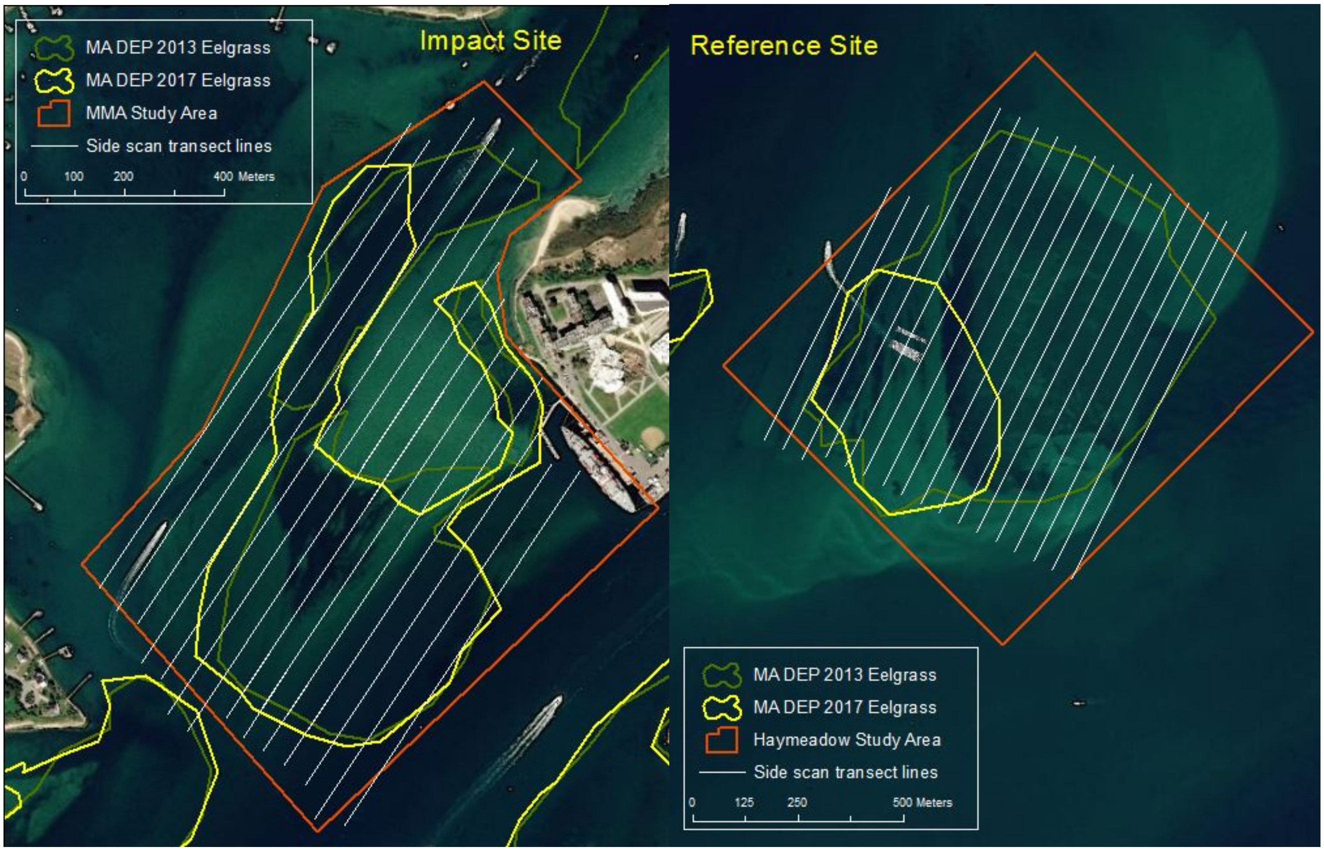

Figure 5. Planned transect lines at the MMA impact and Haymeadow reference eelgrass meadow sites on Sept 2019 aerial imagery basemap.

The survey lines were generated in ArcGIS 10.7. The resulting shapefiles were converted to kml files and exported to the Humminbird side scan system using the proprietary software HummViewer. The transect lines were organized and renamed in the Humminbird display unit for easy access once in the field. Side scan data was recorded along the planned lines at a speed of 3 to 4 kts.

Groundtruthing

The side scan data stream was watched live on the Humminbird display unit during the survey. Indiscernible bottom signatures and random locations in and outside of the eelgrass meadows were flagged for groundtruthing. Once all the transect lines were surveyed with the side scan sonar, the groundtruthing was conducted. Positioning for groundtruthing during the 2018 pilot study was performed using a handheld Garmin GPS unit that has an average error of 1.3 meters (https://gpsinformation.us/gps60c/g76Creview.html). For the 2019 surveys, the Humminbird system was used for marking the groundtruthing sites which has an accuracy of 4.5 meters (Humminbird 2013).

In-water groundtruthing at each selected site was done with an underwater drop camera that included an Aqua-Vu Micro 5 1-MP resolution camera and a GoPro Hero 5 camera with 12-MP resolution in an underwater housing (Figure 6). Both cameras were affixed to a diver weight and lowered from the R/V Flatfish with a rope.

The Aqua-Vu camera was connected to a monitor at the surface and was used as a live video stream to confirm altitude off the bottom and water clarity. The GoPro was set to capture high definition still images at a 2 second interval. When water clarity allowed, groundtruthing was done by looking over the side of the boat. This system is set up to give information about the presence or absence of eelgrass (Figure 7).

Figure 6. GoPro & Aqua-Vu camera system mounted on weight. The Aqua-Vu camera includes the screen seen in the image. The AquaVu has a live feed to the surface so we can verify that the camera made it to the bottom and we can assign a preliminary seafloor interpretation.

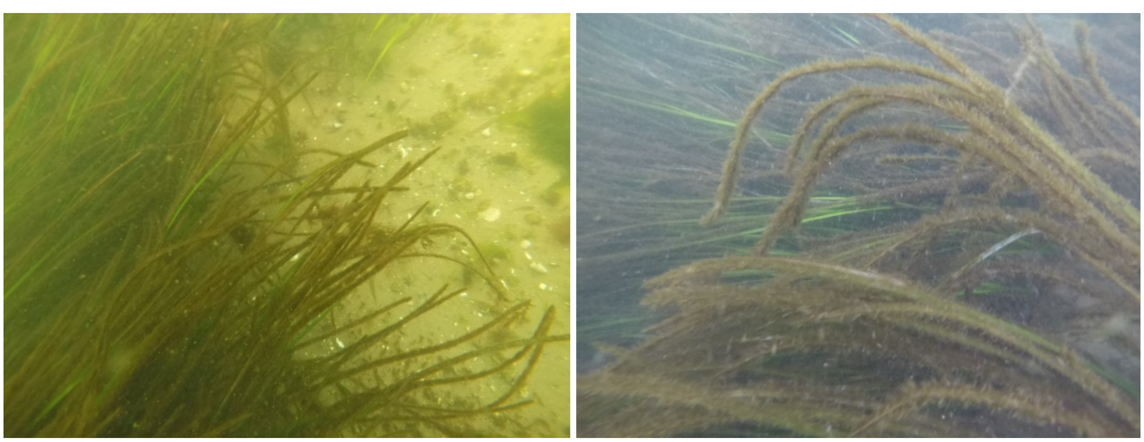

Figure 7. Sample groundtruthing images.

Hydroacoustic Processing

The side scan sonar data from the Humminbird Helix9 was processed with SonarTRX Pro Ver. 15.1.5859.19587. SonarTRX is a software system that can view and process both 2D and 3D hydroacoustic data from multiple low- and high-end side scan sonar units. The primary processing steps included beam angle, slant range, and removal of the water column corrections. The corrections place each sonar ping in the correct geographic space on the seafloor. The processing workflow followed DMF standard operating procedures for SonarTRX processing. Positional error is related to several variables such as survey speed, GPS signal quality, and variation in vessel and transducer heading relative to course made good. The extent of this error has not been tested at this time but based on in-field experience we estimate it to be approximately 10 feet.

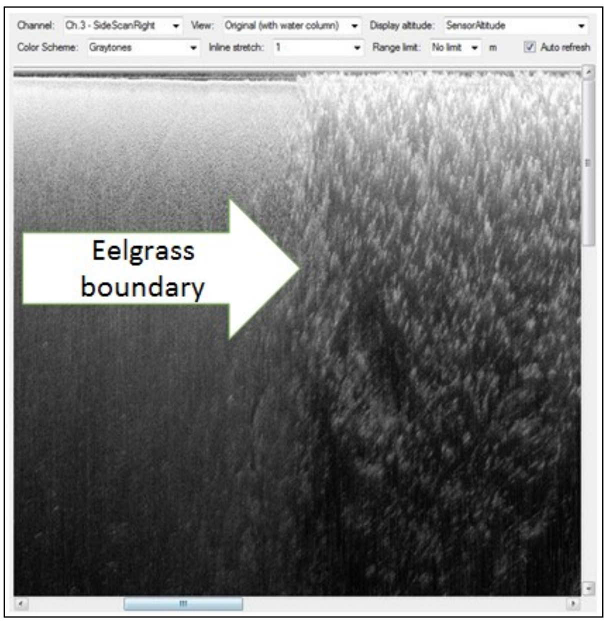

Figure 8. Humminbird data in playback view in SonarTRX showing eelgrass boundary.

Each georeferenced transect line was exported for viewing in ArcGIS 10.7 as GeoTIFFs. The assemblage of transect lines in the GIS software were used to create a mosaic of the whole study area and delineate the boundary of the eelgrass meadows (Figure 9). Habitat delineation was done in ArcGIS 10.7 at a range of scales from 1:500 to 1:2,000.

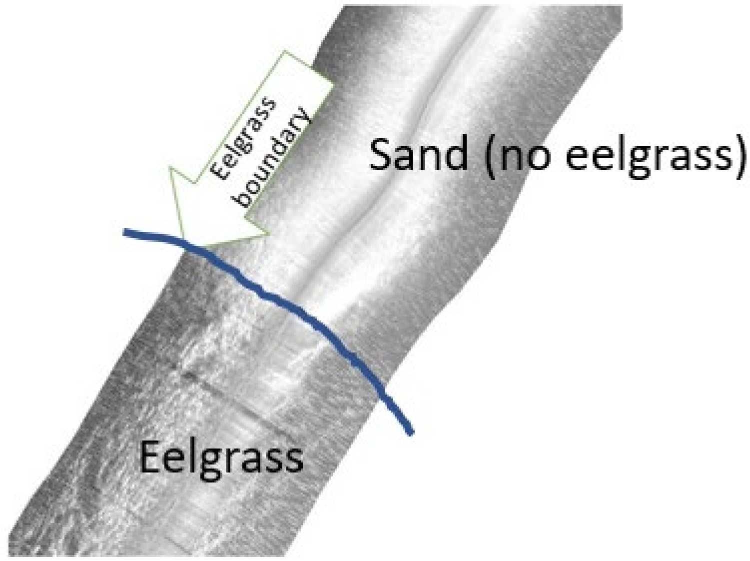

Figure 9. Humminbird data as a geo-referenced mosaic in ArcGIS showing eelgrass boundary

Results

Impact Site

The 2018 pilot study of the MMA impact site helped us define the boundary for the final impact site survey area. Using the side scan sonar mosaic and groundtruth points, we reduced the original planned survey area by approximately 61.4 acres (Figure 10). We also confirmed some logistical details including that the site was a suitable area for surveying in a single day and that a second day would be needed to survey the reference site due to the distance from the impact site. Both sites were confirmed to have accessible boat ramps to enable safe and efficient access to the sites.

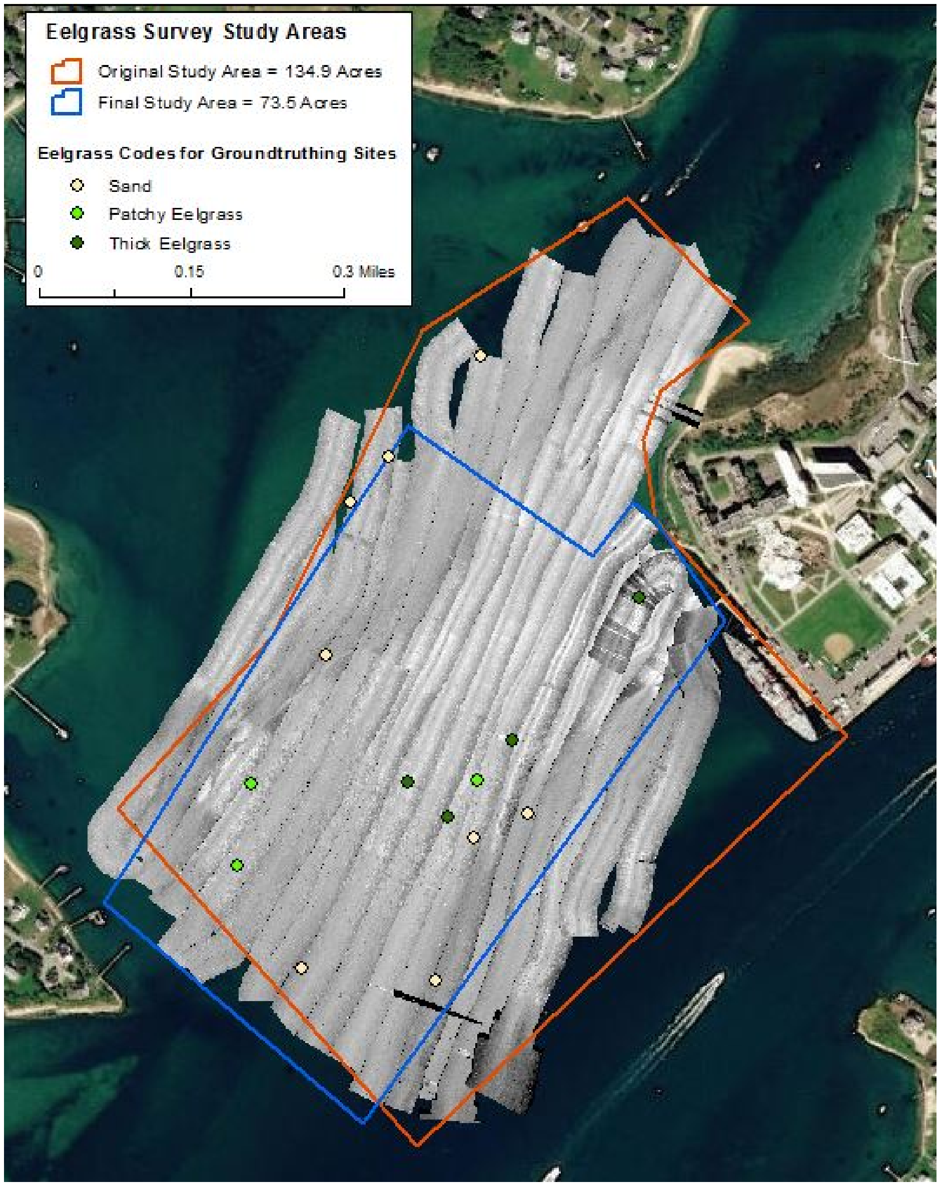

Figure 10. Side scan sonar mosaic and groundtruth points from pilot study in 2018 at the MMA impact site.

The eelgrass boundaries at the MMA impact site are shown in Figure 11. The area of eelgrass was 55.1 acres in 2018 and 54.4 acres in 2019.

Figure 11. Eelgrass delineation in 2018 and 2019 at the MMA impact site.

Reference Site

The eelgrass boundary at the Haymeadow reference site is shown in Figure 12. The area of eelgrass was 96.9 acres in 2019.

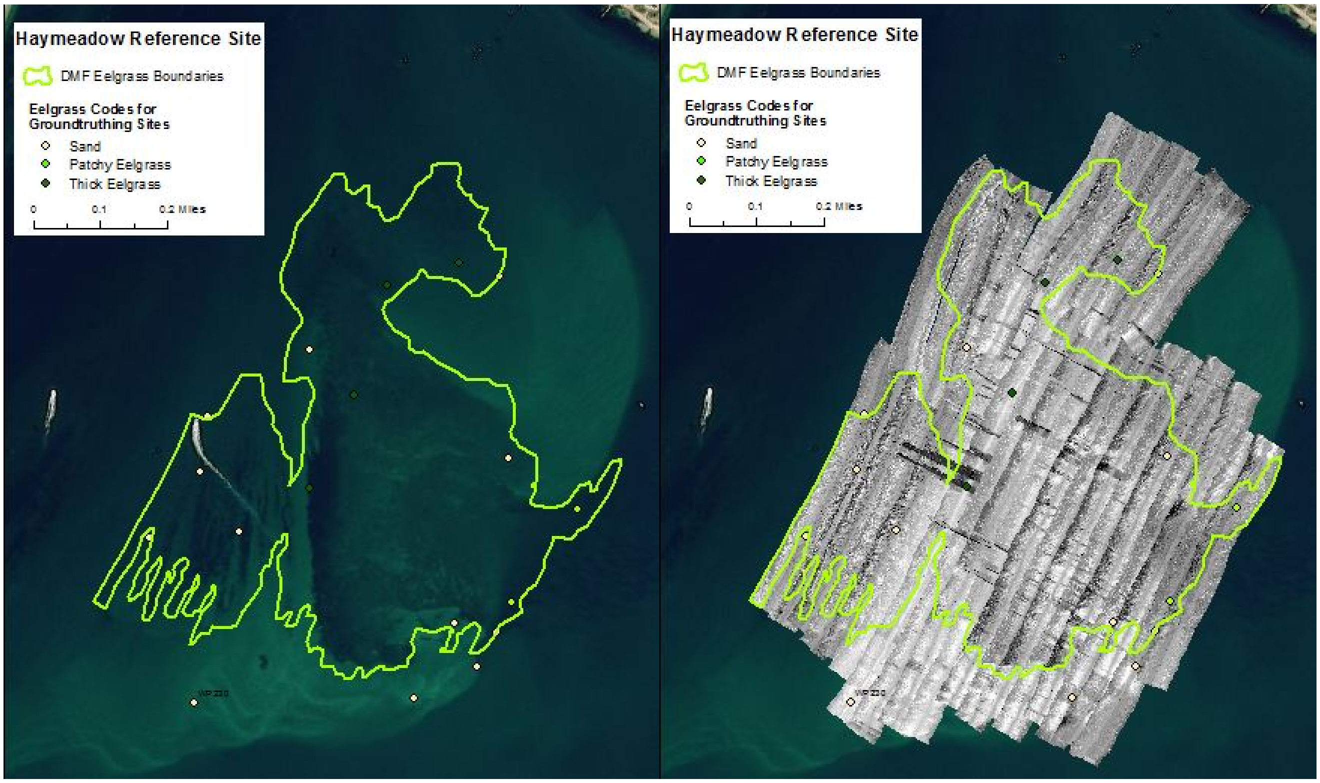

Figure 12. Aerial imagery from Sept 2018 (left) and the sonar mosaic with groundtruthing points from Aug 2019 (right). The eelgrass delineation done with the 2019 side scan sonar data is overlaid on both images as a green line.

We found that the area that was surveyed in the originally designated study area box did not fully encompass the northern extent of the meadow so we extended the survey lines to cover that portion of the meadow. Delineating the boundary for this meadow was difficult due to a complicated edge pattern and large bare patches within the meadow making some boundary decisions challenging. The aerial photo does not portray as much eelgrass as was evident in the side scan sonar and the eelgrass boundary we delineated is similar to the DEP delineation from 2013 and larger than the DEP delineation in 2017 (Figure 5).

Discussion

The acreage of the eelgrass meadow at the MMA impact site was 0.7 acres less in 2019 than in 2018. The overall size, shape and acreage of the eelgrass meadow suggests that little change occurred and that the difference is due to error associated with boundary delineation. Comparing the aerial imagery with the side scan imagery confirms that the side scan sonar imagery had good geographic positioning since eelgrass meadow edges measured in each method were comparable. Our delineations are broadly comparable to the DEP delineations in 2013 and 2017, suggesting limited change in the overall areal extent of this eelgrass meadow between 2013 and 2019. The main difference is that DEP has the meadow extending to the north into the river channel. Based on our pilot work, we do not think that eelgrass is growing into the river channel. If it does, then there is a considerable gap of hundreds of feet between a potential river channel eelgrass meadow and the main meadow that is the primary focus of this investigation.

At the Haymeadow reference site, delineating the boundary of the eelgrass was challenging due to the patchiness of the meadow edges. Therefore, comparisons year over year of the specific boundary may be more approximate. Our delineation was more similar to the DEP delineation from 2013 than 2017. We also found more eelgrass to the north of the meadow than DEP delineated in either year. The northern eelgrass is hard to see in aerial images since it is in deeper water. In order to confirm if the differences with the DEP delineations were due to changes in the meadow or are a result of imagery quality or scale differences needs to be assessed.

Because of the mixed aerial imagery quality and depth of the northern section of the Haymeadow reference site, we recommend continuing to measure the boundaries of the impact and reference sites using both aerial and side scan sonar imagery. We also recommend ensuring that future surveys are done at the same time (late August), to minimize any differences in areal coverage of eelgrass due to seasonal growth patterns.

References

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