Project Report Submitted to the RI Sea Grant Program

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Assessing Seagrass Field-Mapping Techniques in the Napatree / Sandy Point Eelgrass Meadow

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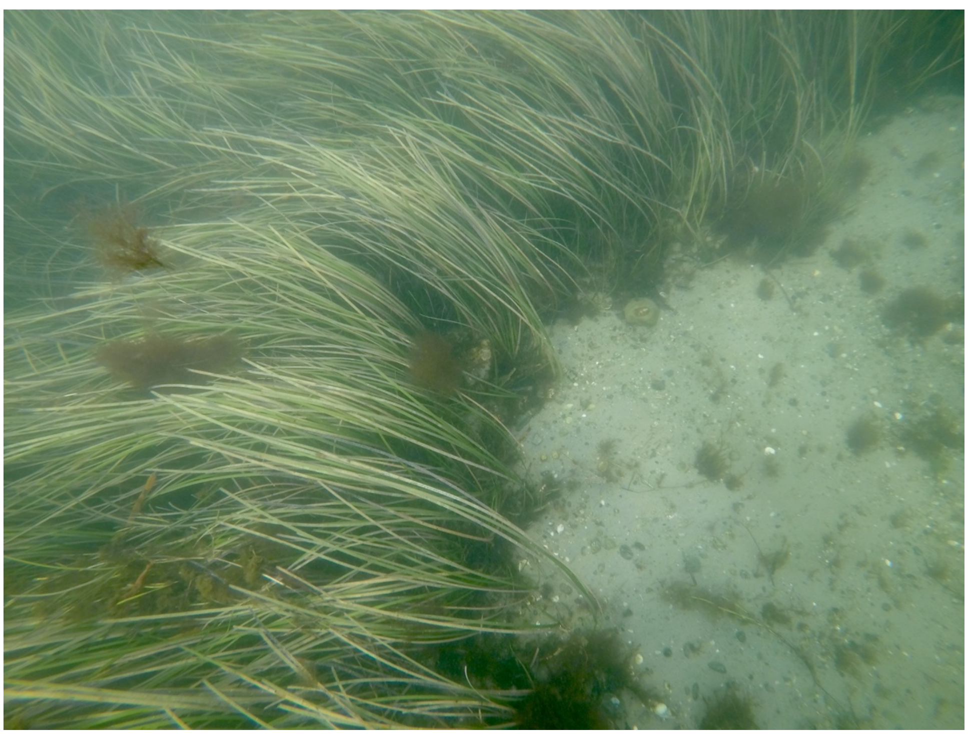

Eelgrass off the Napatree Point Conservation Area

INTRODUCTION: Eelgrass (*Zostera marina*) is a rooted, flowering perennial plant that occurs in shallow waters in the coastal zone. Eelgrass obtains nutrients (especially Nitrogen) from the subaqueous soils that they grow in, as well as removing nutrients from the water column. Through photosynthesis, eelgrass produces large quantities of oxygen. One square meter of eelgrass can produce 10 liters of oxygen in a day. Eelgrass meadows perform many important ecosystem services (Burdick et al., 2020; Reynolds 2018; Bradley et al. 2013). They clean our waters by absorbing nutrients and provide habitat to a host of organisms. Juvenile fish of many species that are important to our commercial and recreational fisheries safely hide from predators in the dense eelgrass vegetation. Invertebrates live on the grass blades and are food for larger animals. The seagrass beds off Napatree are important for our wildlife too. Terns feed on the small fish, Osprey feed on the larger fish, and the Brant Geese that are so abundant off Napatree in the winter are vegetarians and graze on the eelgrass itself. In terms of ecosystem services, seagrass beds are the third most productive ecosystem on the planet (after estuaries, like Little Narragansett Bay, and wetlands).

A large area of eelgrass (93 acres) occurs in the shallow waters between Sandy Point and Napatree Point (August et al. 2020). Indeed, the single largest contiguous patch of eelgrass in the state of Rhode Island (78 acres) dominates this seagrass meadow (Figure 1). Because of the importance of eelgrass beds to the marine and terrestrial biodiversity of the region, we have been monitoring this habitat for a number of years (August et al. 2018). In addition, a consortium of environmental organizations (CRMC, Save the Bay, URI, USFWS, Narragansett Bay Estuary Program) map and monitor eelgrass in all of Rhode Island's coastal waters at 5 to 6 year intervals. This provides evidence that seagrass habitats are increasing or decreasing in extent throughout the state. A complete remapping of Rhode Island's seagrass beds will be undertaken in 2021.

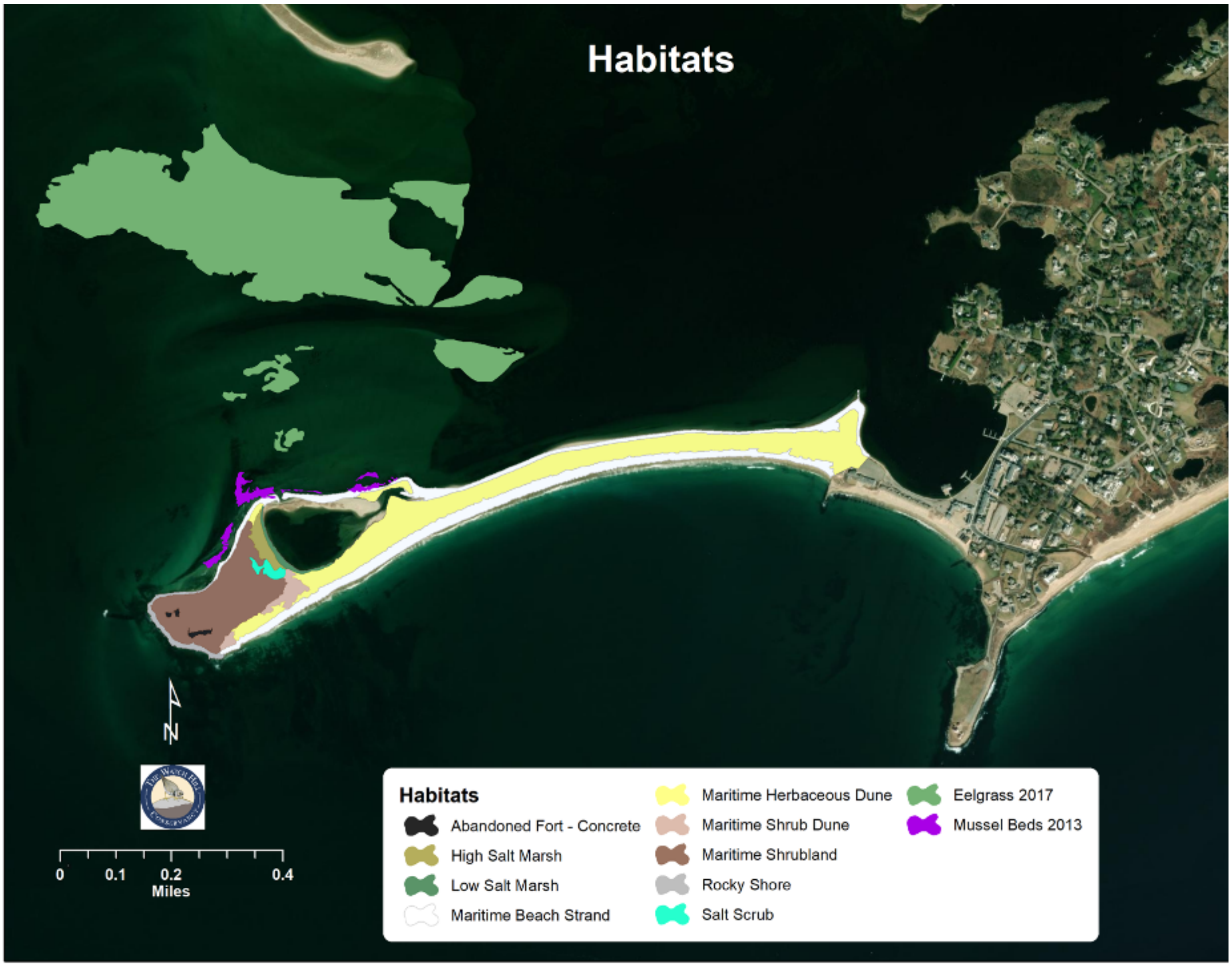

Figure 1. Eelgrass meadows between Sandy Point and the Napatree Point Conservation Area.

Mapping and monitoring seagrass habitats requires high resolution orthophotography obtained in spring or early summer under calm wind conditions and low levels of glint on the ocean surface. These requirements are quite exacting and the time window to obtain high-quality imagery can be very short. Once the imagery is obtained, expert aerial photo interpreters examine the orthophotography for the unique visual signature of seagrass beds. Polygons are digitized to mark the extent of eelgrass patches in a Geographic Information System (GIS). Co-author Michael Bradley has been doing the air photo interpretation of seagrass habitats in Rhode Island for the past 20 years.

Once the seagrass beds have been delineated, most of the patches are chosen for in-the-field validation and verification. This involves navigating to an eelgrass patch in a boat, and with divers or an underwater video camera, examining the seafloor to determine if seagrass actually occurs there and if the GIS polygon accurately depicts the extent of the habitat. Macroalgae has a very similar visual signature as eelgrass and can be hard to distinguish on the aerial photography (August et al. 2018). The field validation part of the project is a critical step but can require considerable time and effort. Field verification using divers is slow and exhausting. Underwater video recording systems, such as the Sea Viewer Pro device used for seagrass mapping in Rhode Island, are expensive, complex, and requires towing behind a boat.

The purpose of this study was to determine the efficacy of using an inexpensive underwater drone to video record the eelgrass around a point location. The results of the drone surveys are compared to video recordings obtained by divers at the same locations. If the underwater drone is proven to be a viable method of field-verifying eelgrass beds, this technology might be considered for use in the 2021 statewide seagrass mapping project.

METHODS: We used a Trident Underwater drone system (www.sofarocean.com/products/trident) to video record the extent of eelgrass around a sampling location (Figure 2). The system is relatively inexpensive (<$2,000), can operate for 3 hours on a single charge, records 1080p (30 fps) video, and is tethered to a small controller system on the boat by a 25 m cable (Figure 2). Three thruster engines on the Trident are used to move the drone through the water column. The operator controls the device using a hand-held Android-based JXDs192k game controller which, through a wifi link, communicates to the controller system on the tether case. Video recorded by the Trident can be stored on the controller or the Trident itself. In dark filming conditions, the drone has six LED lights to illuminate the scene.

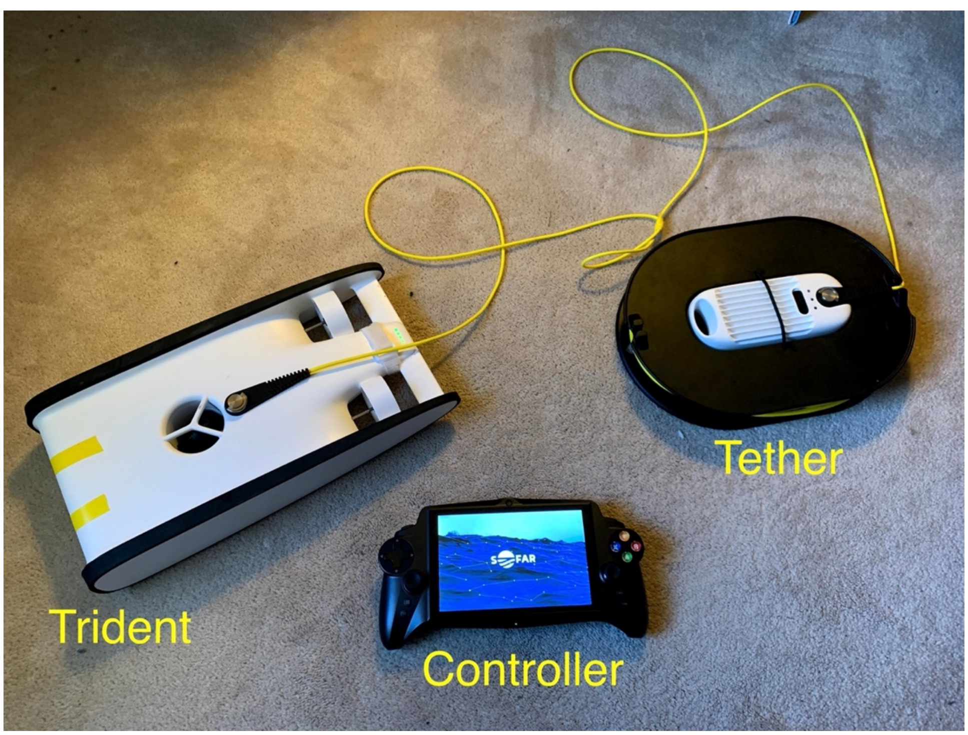

Figure 2. Trident underwater drone system.

The eelgrass meadow off Napatree was mapped in 2017. Additional work on the site in 2018 and 2019 showed very little change since the 2017 mapping. We chose 11 locations to examine the extent of eelgrass. Sites were chosen to maximize variation in eelgrass cover. Four of the locations were in dense patches of eelgrass, four locations had little to no eelgrass, and three locations in moderate cover eelgrass. The 11 sites were uploaded into an ArcGIS.com web mapping application and this was used to navigate to the locations in the field.

At each validation site, the Trident was run along the seafloor for 32 feet (10 m) on the starboard, port, and stern sides of the boat (18-foot Grady-White center console). Approximately 2-3 minutes of video were recorded during each of the three transects. Concurrently, a diver (snorkel) with a handheld GoPro camera (both Hero3 and Hero5 models were used) swam along each of the three transects and recorded photographs of the bottom at 5-second intervals using the time-lapse mode of the GoPro cameras. The position of the GoPro images were logged using a Bad Elf Differential GPS towed behind the diver as part of the dive float. Two individuals (Bradley and August) estimated the percent cover of eelgrass in each of the Trident videos. The mean percent cover of the transects at each site was used as the overall eelgrass cover score for a location. Similarly, each GoPro image obtained by the diver was examined and an overall percent eelgrass cover score was assigned for each validation site. A Pearson coefficient of correlation (r) was computed to assess the relationship between the two methods of measuring eelgrass cover. An r value of 1 indicates both measures yield identical estimates. An r value of 0 indicates no relationship between the two measures.

As part of another study, the Napatree/Sandy Point eelgrass meadow was imaged using side-scan sonar and a small Unmanned Aerial System (sUAS drone aircraft) (Figure 3). A DJI Phantom 4 Pro sUAS with a 20-megapixel camera in video mode was used for this project. The side scan imagery was obtained using an EdgeTech 4125 dual-frequency side-scan sonar system. Eelgrass will be delineated from both sources in 2021. These were going to be student projects during the summer of 2020 but had to be postponed because of the Covid-19 pandemic. These projects will continue in the 2020-2021 academic year.

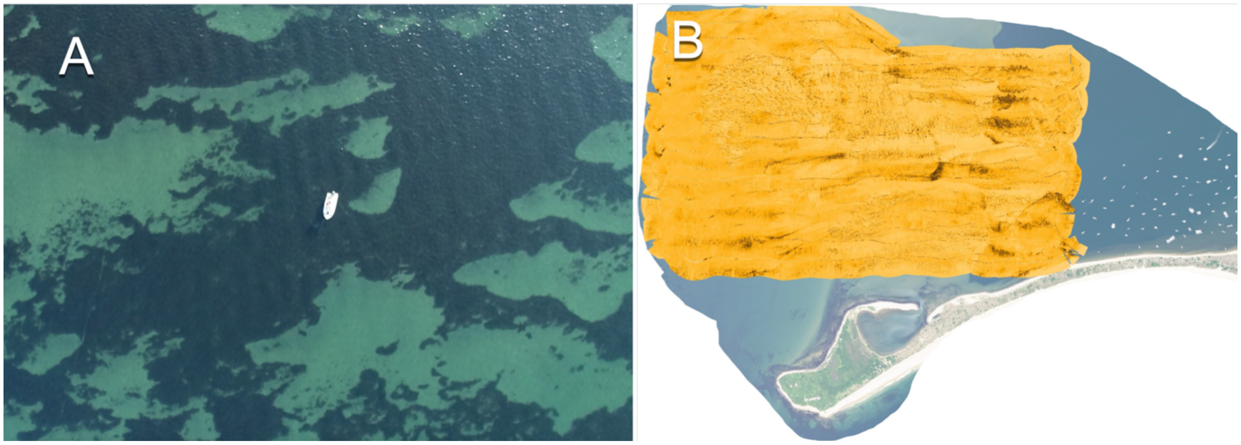

Figure 3. Additional imagery of the Napatree/Sandy Point eelgrass patch. (A) Single frame from sUAS video. Dark patches are eelgrass, light patches are sand. Project boat (18 feet long for scale) is in the center. (B) Extent of side-scan imagery obtained in the summer of 2020.

RESULTS & DISCUSSION: For each of the 11 sampling sites, we obtained an average of 93 GoPro photographs and 7.5 minutes of Trident video. It took 10 minutes per station to collect the Trident video data. Estimates of eelgrass cover made by the diver-based GoPro images and the Trident video recording were highly correlated (r = 0.95, Figure 4). Both methods yielded very similar estimates of the extent of seagrass at a site. The results shown here were based on the observations of Michael Bradley, a very experienced eelgrass ecologist. The results obtained by Peter August were essentially identical (correlation between Trident and GoPro, r = 0.96).

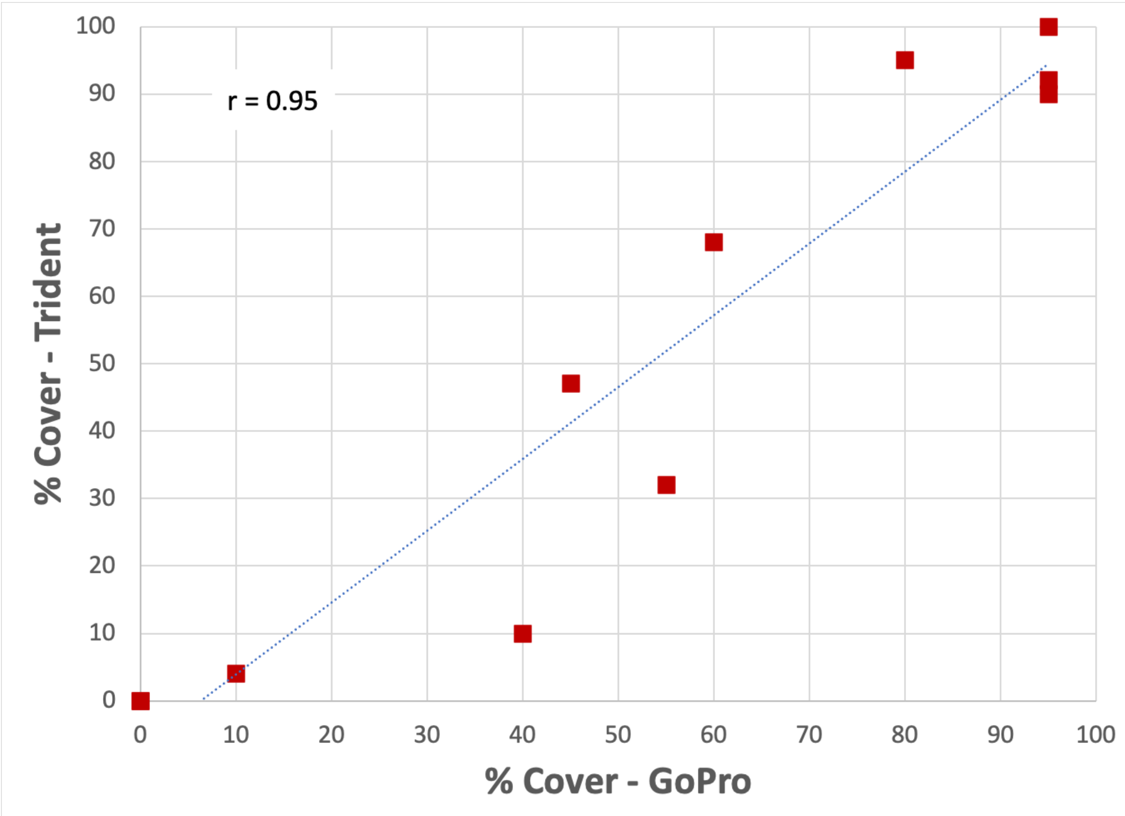

Figure 4. Scatterplot of the relationship between estimates of eelgrass cover based on diver GoPro photographs and Trident video imagery. The blue dashed line is the best fit regression line.

The strong positive correlation between the two assessment methods has important practical implications. The timetable for 2021 Rhode Island eelgrass mapping mission will require field validation of the polygons delineating seagrass beds in the Fall months. Diver surveys will be difficult when water temperatures drop. The Trident-based assessment will be safer and faster.

The quality of the Trident video images was excellent. Each frame was stamped with the date, time, depth, heading, and water temperature (Figure 5).

Figure 5. A frame from the Trident video imagery.

We are able to make a number of observations on the operation and use of the Trident drone.

1. Getting skilled at controlling the Trident in the water requires practice. Anyone who uses a computer game control device will be adept, but if the operator is not a video gamer, it will take some time (4-5 hours) to master the controls.

2. The Trident thrusters can be overwhelmed by strong tidal velocities. Operating at slack tides can be desirable. We found that in Little Narragansett Bay water clarity was best during flood (incoming) tides. At ebb tides (outgoing) water clarity declined due to tannins and sediments from the Pawcatuck River.

3. The Trident can dive up to 100 m (330 feet). Most of our eelgrass sites were in very shallow water (< 2 m, 6.5 feet). One of our challenges was accessing sample sites. The Grady-White has a draft of 0.6 m (2 feet). The mean tidal range in little Narragansett Bay is approximately 0.7 m (2.5 feet). Working near high tide was beneficial when sampling points were in shallow water.

4. The thruster propellers would frequently become entangled in eelgrass blades and stop turning. This was easy to discern since the operator would lose control of the Trident. The drone could easily be retrieved with the tether and the propellers cleared of eelgrass.

5. The controller screen shows a real-time video image of what the Trident is “seeing.” The image, however, is quite dim and in full sun, hard to make out detail. This was not a

major problem since the only important information the operator needed to know was if the device was on the bottom. It was easy to control the direction of the Trident by focusing on the bright yellow tether cable.

6. A 100 m tether cable might be a good investment if operating the Trident in deep water.
7. If the validation protocol requires a linear transect of video imagery rather than a point sample, a towable underwater video system, such as the aforementioned SeaViewer system, might be a better solution. Point versus transect validation protocols is a large, complex issue and beyond the scope of this study.

CONCLUSIONS: The Napatree/Sandy Point eelgrass complex is important for many reasons. It is very high value marine habitat for fish, shellfish, and nutrient removal from the water column. The eelgrass meadow is easily accessible and because of the shallow depth of most of the site, boat traffic is light. It is an excellent location to experiment with various mapping and monitoring systems (Montello et al, 2017).

The results of this study indicate that a Trident underwater drone system provides video imagery that can be used to assess the extent of seagrass cover at a site. Cover estimates were almost identical to those obtained from a diver. It appears to be a viable method to assess the accuracy of eelgrass maps derived from digital orthophotography.

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