

# **Ecological Assessment of Mashta Flats, Key Biscayne**

**February 2014**



**Diego Lirman, PhD  
Stephanie Schopmeyer, MS  
Rolando Santos, MS  
Crawford Drury**

**University of Miami  
Rosenstiel School of Marine and Atmospheric Science**

## Introduction

Seagrasses are the only marine plants related to terrestrial flowering plants. Seagrasses commonly occur in shallow bays, lagoons, and coastal waters such as those found in Biscayne Bay, Florida. There are 2.7 million acres of seagrass in South Florida where they commonly form dense beds and are some of the most productive underwater ecosystems in the world. In addition to seagrass growth (known as primary production), these areas provide habitat for many species of fish, crustaceans, and other animals that are both economically and ecologically important such as pink shrimp, blue crab, lobster, conch, stone crab, bonefish, tarpon, barracuda, and various snapper and grunt species. Seagrass beds also serve as important nursery and hunting grounds for animals that live in other nearby environments, like coral reefs and mangroves. Seagrass communities include not only seagrasses but macroalgae, epiphytes (algae that grow on seagrass blades), sponges, urchins, and other invertebrates. These communities provide vital food sources for many marine animals such as sea turtles, manatees, and dolphins, as well as wading birds such as egrets, herons, and osprey. Seagrasses also provide many environmental services to humans such as acting as a natural filters for land runoff, absorbing and transforming nutrients, maintaining water clarity by trapping fine sediments and particles in the water column, oxygenating coastal waters and sediments, preventing erosion by stabilizing sediments, and providing coastal protection from storms.

Florida's seagrass beds consist mainly of three species: turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightii*) and manatee grass (*Syringodium filliforme*) (Appendix, Figure 1). Of these species, turtle grass is the most common and has the largest blades. Shoal grass is usually found close to shore, and manatee grass grows in deeper areas. Unfortunately, seagrass communities are locally and globally threatened due to a variety of disturbances including nutrient additions due to agriculture and waste discharge from coastal human populations, physical damage from boat propellers and hulls (Appendix, Figure 2) and improper anchoring practices, and overfishing that disrupts the food chain required to maintain healthy ecosystems.

Over the recent past, the shallow bank named Mashta Flats, located at the southwest tip of Key Biscayne, FL, has become a focal point for weekend and holiday boating parties. Up to 100 boats at a time anchor or simply run aground on the seagrass beds causing severe physical

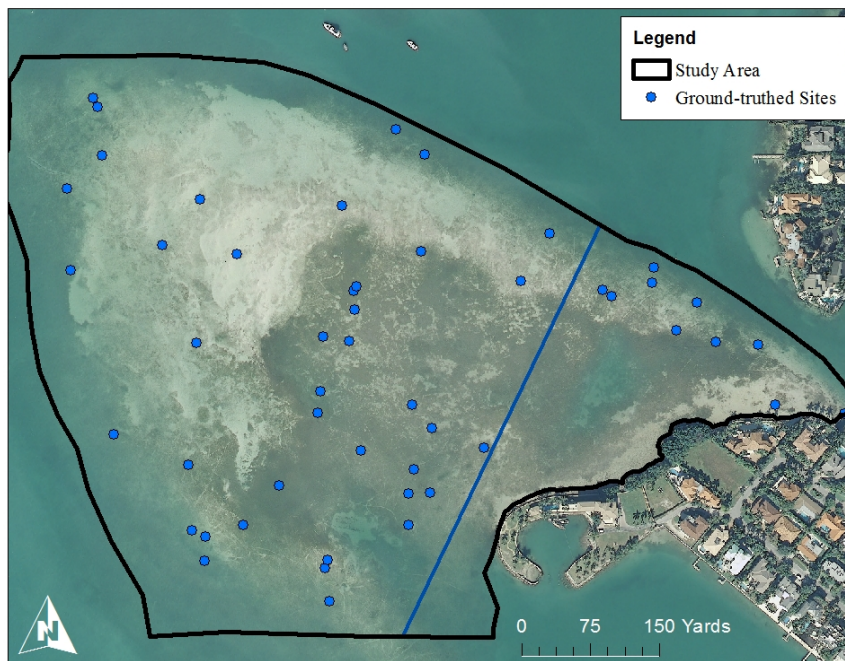
damage to the biological communities that can take decades to recover. Additional damage to the seagrass community occurs when boaters walk around the seagrass beds (Appendix, Figure 3) and discard their trash, leaving behind plastic cups and bags, glass bottles, aluminum cans, and food waste (Appendix, Figure 4).

In this study, the submerged aquatic vegetation (seagrasses plus macroalgae, SAV) and bottom community of the Mashta Flats area were surveyed through analysis of aerial images and a field assessment. The field assessment combined visual observations and percent cover analyses of high-resolution, geo-referenced bottom images. Data collected were used to determine: a) size and boundaries of the survey domain, b) proportion of area occupied by SAV, and c) extent and distribution of seagrass scars. In addition, spatial analyses compared the status of the habitat included within the Village of Key Biscayne limits with areas outside the Village jurisdiction.

## **Methods**

### *Submerged Aquatic Vegetation (SAV) Mapping using Aerial Imagery*

The SAV thematic map was created for the Mashta Flats area using a high-resolution (0.24-meter pixel size) aerial photograph taken in March 2013. Seagrass habitat patches were delineated with trained computerized image classification using ArcGIS v9.3 (ESRI, Redlands, California) and ENVI v4.5 (ITT Visual Information Solutions, Boulder, Colorado). The image classification consisted of an object-based supervised method performed with the ENVI v4.5 Feature Extraction module (ITT 2008). Since objects (i.e., image segments with distinct homogenous spatial, textual, and spectral characteristics) are used instead of individual pixels, results tend to reduce erroneously classified pixels across the image, and help distinguish the borders between different classes more precisely. The seagrass thematic map of the Mashta Flats was limited to 4 distinct bottom classes: (1) high to medium SAV cover (> 50 % cover), (2) medium to low SAV cover (25-50%), (3) low SAV cover (< 25%), and (4) sparse SAV in deeper (> 100 cm) water. Additionally, SAV classes were visually confirmed at 50 random sites in the field to ensure the accuracy of bottom classification (Figure 1).



**Figure 1.** Random sites surveyed to groundtruth the identity of SAV classes to ensure accuracy of bottom classification based on the analyses of aerial images.

### *Mapping of Seagrass Injuries*

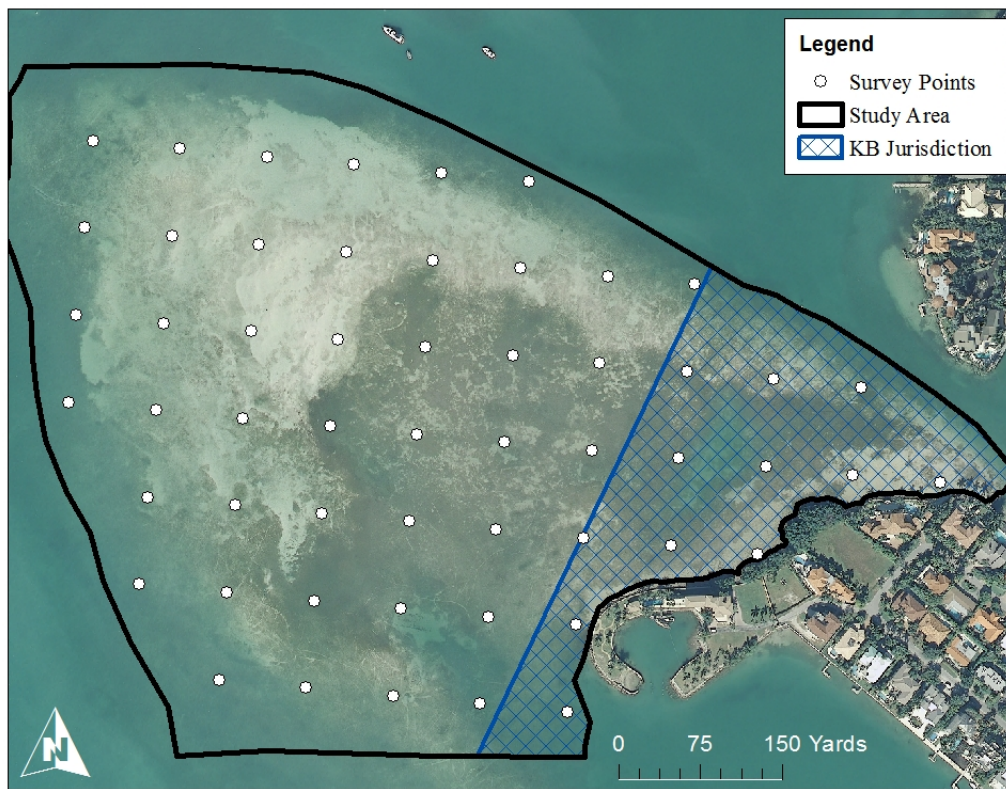
A map of propeller and hull scars was created using the same image utilized in the mapping process described above. The mapping of the seagrass scars consisted of hand-digitizing scars that were identified as contrasting linear/curvilinear features within SAV patches. The digitalization of the scars was performed at a 1:500 map scale and aided with the ArcMap magnifier to control for the precision of the delineation process.

### *Field SAV Community Characterization*

The SAV community of the Mashta Flats was characterized from photographic and visual surveys of 54 sites selected using a regular sampling grid (75-m spacing between survey points) within a the survey domain (430 x 700 m; Figure 2). At each sampling site, 12 non-overlapping digital images of the bottom were collected from a survey skiff at 10-s intervals as the boat drifted. These high-resolution images were analyzed to estimate seagrass and macroalgal abundance (quantified as the proportion of the bottom occupied by each taxon). Cover was

defined as the fraction of the total image frame that was obscured by each taxon when viewed directly from above on a scale from 0 to 100%.

The presence of propeller scars and seagrass blowouts (polygonal features wider and shorter than linear scars devoid of any seagrass biomass) were documented at each site at the time of the field surveys by visually assessing SAV damage within a 5 meter radius of the survey skiff. Additionally, the presence of trash (e.g., cups, cans, bottles) was documented within a 5m radius of the skiff and within photos collected at each site.

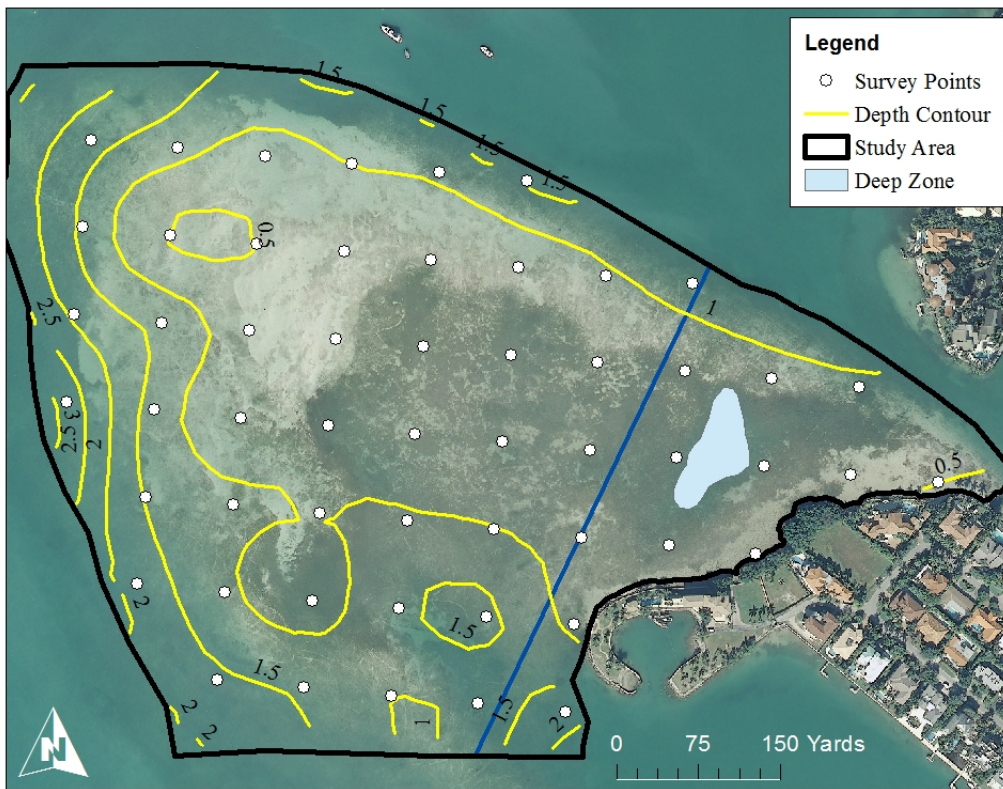


**Figure 2.** Location of field survey points and the area under the Village of Key Biscayne jurisdiction.

## Results

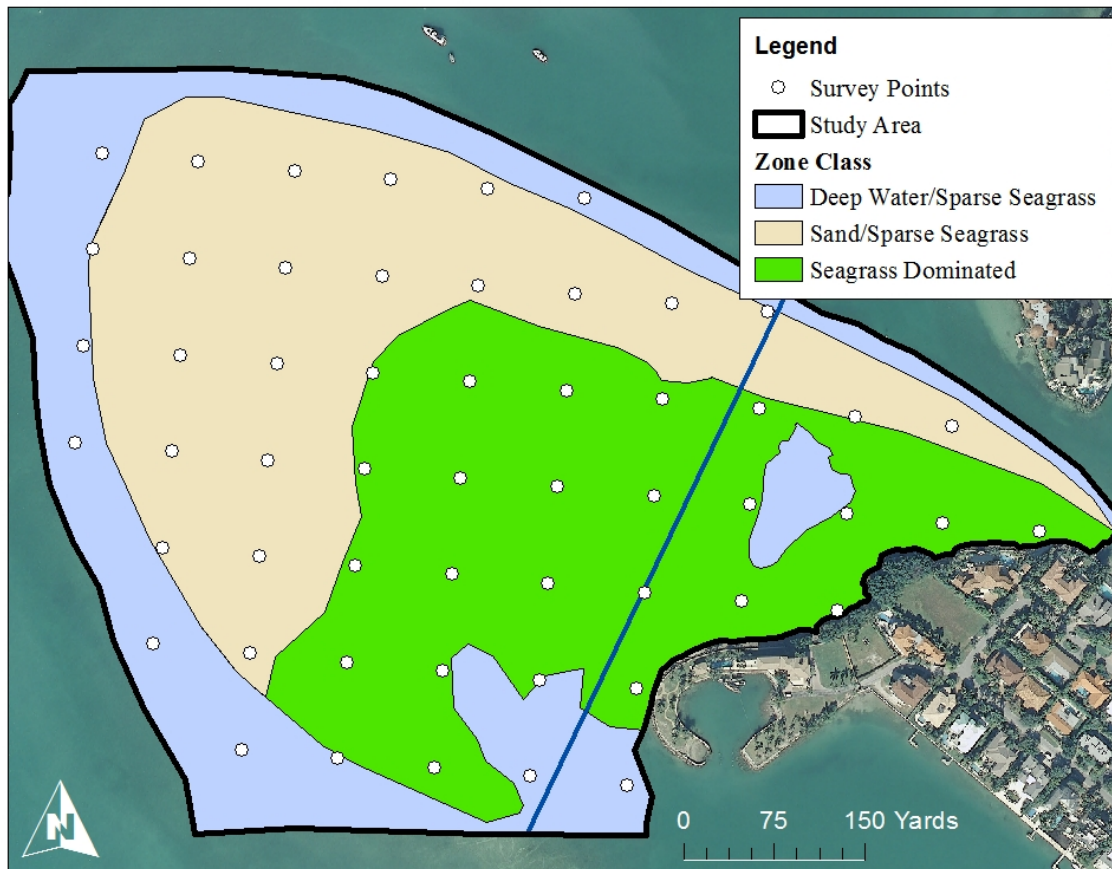
### *Submerged Aquatic Vegetation (SAV) Mapping*

The total area of the Mashta Flats is 82.8 acres with a depth range of 0.5 to 3.0 meters (Figure 3). The Mashta Flats can be separated into three major zones based on bottom type and depth: 1) the SAV-dominated zone located in the central and eastern portions of the flats, 2) a sand and sparse SAV zone located in the northern and western portions, and 3) a deep and sparse SAV fringe zone surrounding the Flats area (Figure 4). The SAV dominated zone covers 24.9 acres (30.1% of total area), the sand/sparse SAV zone covers 42.2 acres (50.8%), and the deep/sparse SAV fringe zone covers 15.8 acres (19.1%) (Figure 4).



**Figure 3.** Depth contours of Mashta Flats. The "blue hole" is shown in blue.

From the total mapped area, 16.6 acres (20% of the total area) are located within the Village of Key Biscayne jurisdiction. The KB area is characterized by high SAV cover over 7.9 acres (47.7% of the KB area), sand/sparse SAV over 5.1 acres (30.9%), and deep water/sparse SAV over 3.5 acres (21.4%).

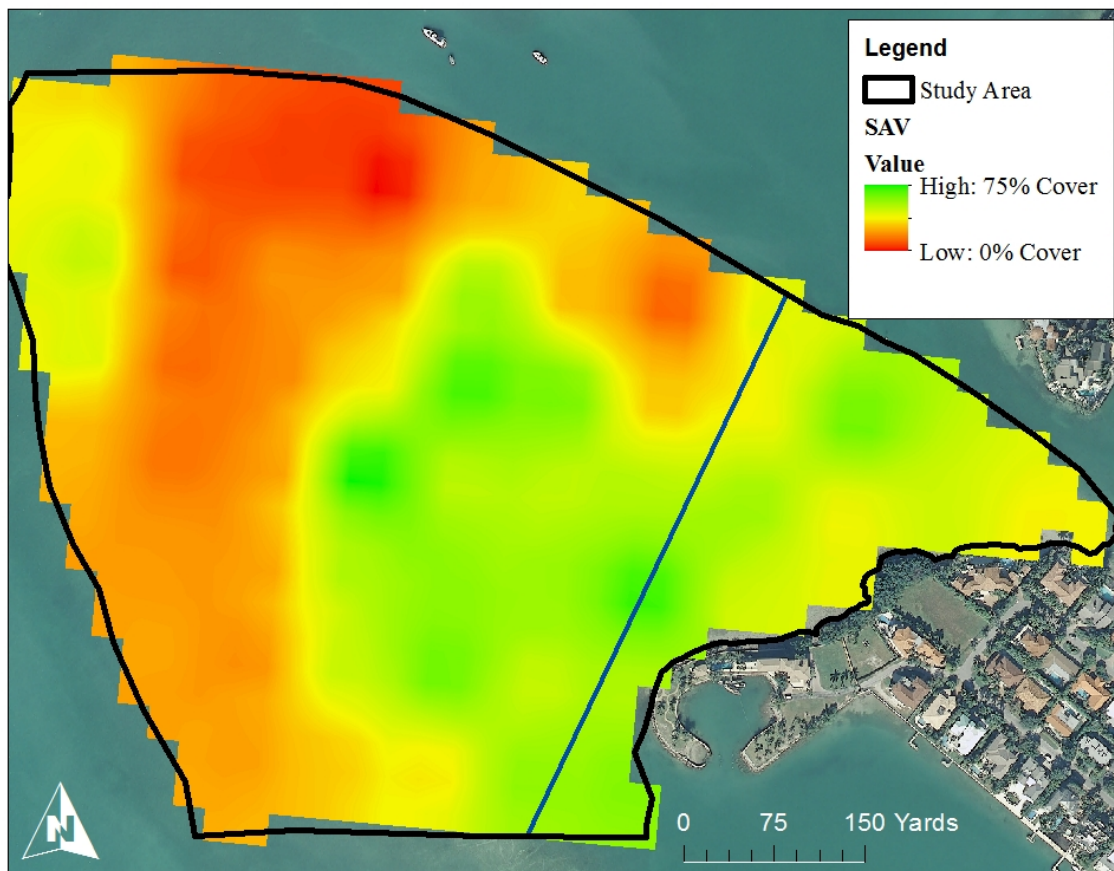


**Figure 4.** Bottom classes defined within the Mashta Flats: deep water/sparse SAV, sand/sparse SAV, and SAV dominated zones. Boating scars are represented by red lines.

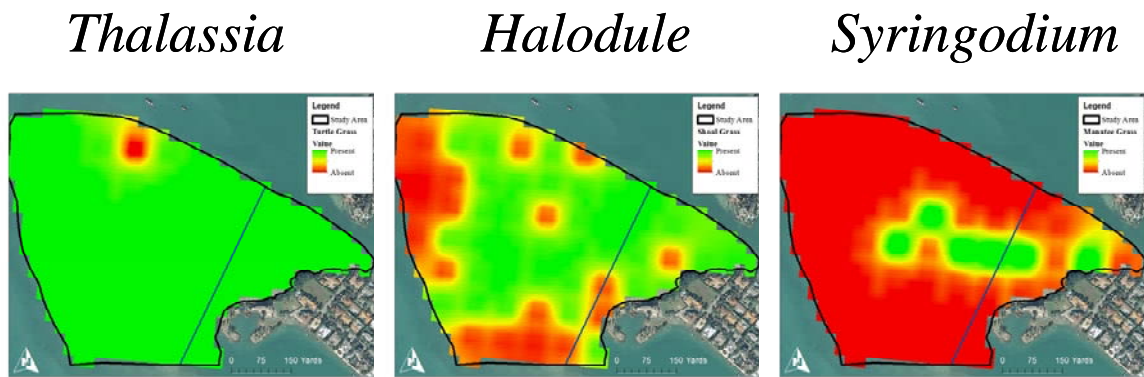
*Bottom Communities of Mashta Flats*

Submerged aquatic vegetation (SAV) communities comprised of both seagrasses and macroalgae were observed at 53 of the 54 sites surveyed in January 2014 (Figure 5). Seagrasses were found throughout the study area and were observed at 98.1% of sites. High seagrass cover (35-55%) was observed at 22.2% of sites, medium cover (15-35%) was documented at 59.3% of

sites, and low seagrass cover (0-15%) was found at 18.5% of sites. Turtle grass (*Thalassia testudinum*) was the most commonly observed species and was found at 98.1% of sites (Figure 6). Shoal grass (*Halodule wrightii*) occurred at 66.7% of sites (Figure 6), and manatee grass (*Syringodium filliforme*) was observed at 11.1% of sites (Figure 6). Species composition varied among sites, with 30.2% of sites containing turtle grass only, 60.4% of sites having a mix of turtle and shoal grass, and 9.4% of sites having all three seagrass species.

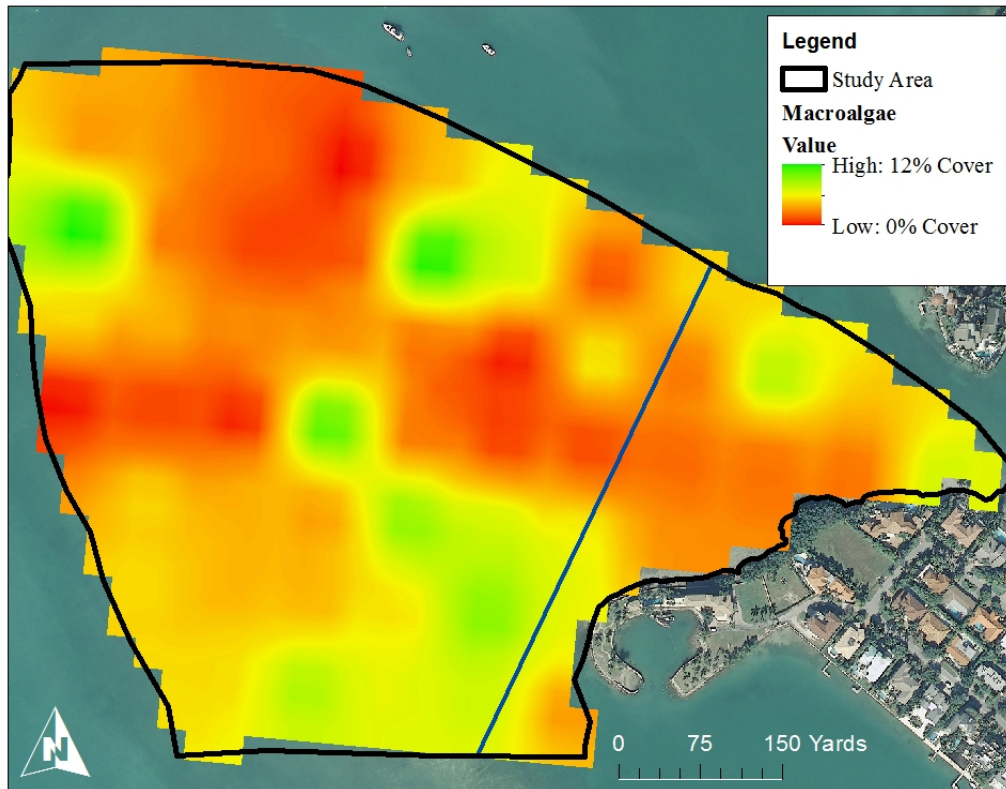


**Figure 5.** Abundance and distribution of submerged aquatic vegetation (seagrasses plus macroalgae, SAV). Areas with high SAV cover are represented in green, medium SAV cover in yellow, and low SAV cover in red.



**Figure 6.** Patterns of occurrence of turtle grass (b), shoal grass (c), and manatee grass (d). Presence is represented in green absence in red.

Macroalgae are important components of the SAV communities of Mashta Flats. Macroalgae were observed at 79.6% of sites (Figure 7) with high macroalgal cover (8-12%) observed at 13.0% of sites, medium cover (4-8%) at 38.9% of sites, and low cover (0-4%) at 48.1% of sites. Five species of macroalgae were documented. The most common macroalgae observed is *Batophora* (51.9% of sites), a green algae commonly found throughout Biscayne Bay. *Halimeda*, a calcareous green alga that produced the bulk of the sediments in the bay, occurs at 44.4% of sites. The other dominant components of the macroalgal community were the green taxa *Penicillus* (found at 38.9% of sites), *Udotea* (5.6% of sites), and *Acetabularia* (1.9% of sites).



**Figure 7.** Abundance and distribution of macroalgae, with high cover (8-12%) represented in green, medium cover (4-8%) in yellow, and low cover (<4%) in red.

Types of trash observed during our surveys include plastic cups, fishing and boating lines, bottles, cans, and bottle caps (Appendix, Figure 4). Sponges were found at 27.8% of all sites, urchins at 18.5% of sites, and other invertebrates such as sea stars and tubeworms were each found at 1.9% of sites (Appendix, Figure 5).

#### *Bottom Communities Within the Village of Key Biscayne Jurisdiction*

A total of 12 survey sites were located within the jurisdiction of the Village of Key Biscayne. Total SAV cover was 48.1% with seagrass observed at 100% of sites (25% turtle grass only, 58.3% turtle and shoal grass, and 16.7% turtle, shoal, and manatee grass). The total seagrass cover was 29.8%. Macroalgae was documented at 66.7% of sites with a total cover of

4.1%. The algal genera observed include *Halimeda*, *Batophora*, *Penicillus*, and *Udotea*. Drift algae (mainly *Laurencia*) occurred at 91.7% of sites for a total cover of 4.6%. Invertebrates were observed at 50% of sites with sponges occurring at 33.3% of sites and urchins at 25% of sites. Trash was observed at 1 site (8.3%).

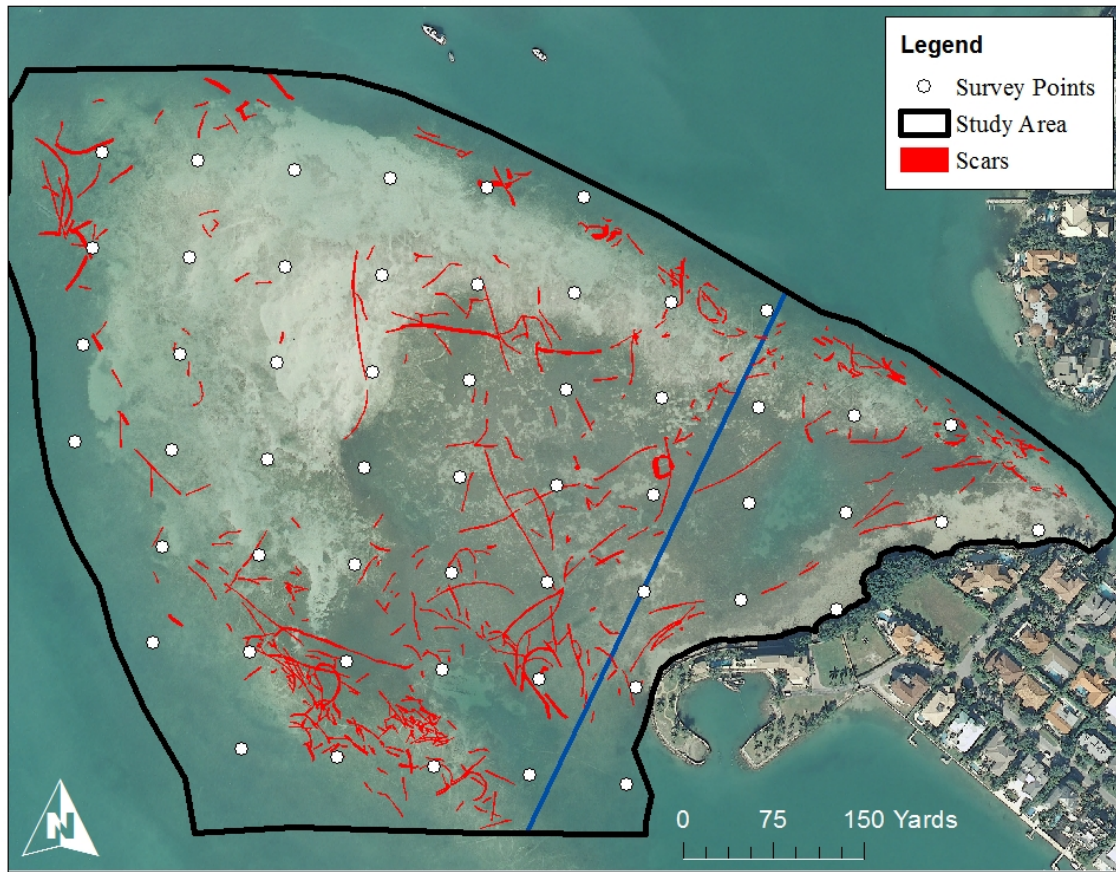
Of special interest is the deeper section within the Village boundary that is surrounded by high cover of SAV (Figure 3). This “blue hole” covers 0.8 acres with a depth of 1.8-2.5 meters. This is a natural feature that attracts a large number of bait fish and seabirds, particularly pelicans, often seen feeding in the area. Bait fishermen were observed collecting bait in this area during our surveys.

#### *Bottom Communities Outside the Village of Key Biscayne Jurisdiction*

A total of 42 survey sites were located outside of the Village of Key Biscayne jurisdiction. The total benthic cover was 35.8%, with seagrass documented at 97.6% of sites (31.7% turtle grass only, 58.5% turtle and shoal grass, 9.8% turtle, shoal, and manatee grass). The total seagrass cover was 24%. Macroalgae were documented at 83.3% of sites with a total cover of 4.3%. Algal genera observed included *Halimeda*, *Batophora*, *Penicillus*, *Acetabularia*, and *Udotea*. Other benthic cover including drift algae was found at 50% of sites with a total cover of 3.5%. Invertebrates were observed at 42.8% of sites with sponges occurring at 23.8% of sites and urchins at 19% of sites. Trash was observed at 26.2% of sites.

#### *Seagrass Injuries*

A total of 543 scars and blowouts (polygonal features) were delineated from aerial photos (Figure 8). These scars cover 1.5 acres (1.7% of the total area) (Figure 4). The majority (45.9%) of scars occur within the SAV dominated zone covering 0.7 acres where SAV cover is highest. In addition, 23.0% of scars are located in the sand/sparse SAV zone (0.3 acres) and 16.2% of scars occurred in the deeper fringe zone. Scars occurring within the KB jurisdiction cover 0.07 acres (46.5%) in the SAV dominated zone, 0.06 acres (46.1%) in the sand/sparse SAV zone, and 0.01 acres (7.4%) in the fringe zone.



**Figure 8.** Seagrass injuries delineated using aerial imagery and GIS analyses.

Two types of scars are evident within the KB jurisdiction based on the orientation of the injuries. The scars delineated in the fringe zone lack any distinct direction and appear to be caused by boats anchoring or hulls running aground. In contrast, the scars delineated on the shallower portion dominated by dense seagrass are oriented parallel to shore and are likely caused by boats trying to cut across the flats on the way in or out of the navigation channel (Figure 9). Boats and personal watercraft were observed trying to cut across these shallows during the ecological surveys conducted in January 2014.



**Figure 9.** High-contrast image of a section of Mashta Flats highlighting the seagrass scars found in the shallow habitats. The red box shows scars parallel to shore within the jurisdiction of the Village of Key Biscayne. A seagrass blowout (a polygonal feature) can be seen in the location where these scars coalesce.

## Summary and Recommendations

- The total area of the Mashta Flats is 82.8 acres with a depth range of 0.5 to 3.0 meters. **16.6 acres (20% of the total area) are located within the Village of Key Biscayne jurisdiction.**
- Remote sensing based on aerial imagery as well as field ecological surveys conducted by seagrass experts from the University of Miami has identified that **98.1% of the Mashta Flats area contains SAV (seagrasses and macroalgae) communities.** High seagrass cover (> 35% of the bottom occupied by seagrasses) was documented at 30% of sites.
- Both SAV cover (48.1%) and cover of seagrasses (29.8%) are **higher inside the Village of Key Biscayne jurisdiction** than outside (35.8% and 24.0%, respectively) indicating that **this area still contains abundant and important seagrass and macroalgal habitat that can clearly benefit from protection** from further damage caused by boating activities.
- **Significant damage to the seagrass communities of Mashta Flats due to boating activities was documented.** Over 500 propeller and hull scars were delineated, covering 1.5 acres (1.7% of total area). The highest prevalence of scars was found in the seagrass-dominated shallow habitats.
- Damage to the KB jurisdiction consists of injuries caused by anchoring and grounding hulls as well as boats trying to cut across the flats as they try to get in or out of the channel
- A comprehensive seagrass protection and restoration program for Mashta Flats is needed to prevent further degradation of these key resources, restore damaged seagrass beds, enhance community involvement, and develop a comprehensive education program for all ages.

### *Seagrass Protection*

- Any future protection activities should concentrate in the areas of the flats that presently contain high abundance of seagrasses and macroalgae (green zone in Figure 4). Over on third of this habitat type resides within the jurisdiction of the Village of Key Biscayne.

- If continued access and use of the flats is allowed, **a multiple-use zoning system may be required for its protection**. The shallow/sparse SAV habitats (pink zone in Figure xx) have remained historically (at least since 1995 based on observations of aerial imagery, Appendix, Figure 6) largely devoid of seagrass due to its shallow depth and high water motion (white caps are commonly observed on this zone). This zone can still be used for recreational activities (anchoring and walking) if desired.

- The boundaries of the dense SAV habitat need to be clearly demarcated for its protection and **no boating or walking access should be allowed**. Kayaks, canoes, and paddleboards should be allowed in this areas as these activities do not cause damage to SAV.

Access to this area should be limited to kayaks, canoes, and paddleboards. A **clear demarcation of this protected area should be implemented** to prevent boats from cutting across the flats on the way in and out of the channel.

- **All of the habitat within the jurisdiction of the Village of Key Biscayne is presently classified as high SAV cover and should be included in a boating-free zone**. This area still has a vibrant seagrass community but has experienced heavy damage, mainly caused by boats trying to cut across the flats on their way in and out of the channel adjacent to the bank. The protected area will prevent future damage by motorboats but will still provide full access by non-motorized vessels (kayaks, paddleboards, canoes).

- Additionally, the “**blue hole**” habitat found within the Village boundaries will benefit from protection from boating and the prohibition of cast-netting by bait fisherman.

- **Educational materials** for diverse audiences (K-12, boaters, and the general public) should be designed and disseminated to the local community on the value, conservation, and restoration of seagrass habitat to promote marine ecosystem protection and smart boating practices.

- Local stakeholders and citizens should conduct **clean-up activities** (via snorkeling, kayaking, canoeing or paddle boarding) of the Mashta Flats area during and after popular weekends to remove trash. Finally, “no littering” signs may be placed in conjunction with zone markers to discourage boaters from discarding their trash in the water.

- Finally, **frequent enforcement** will be required to make sure boaters are aware of these regulations and can correct their behavior accordingly.

### *Seagrass Restoration*

- Often, **if unrestored, seagrass scars can become erosional** features that expand over time. Thus, it is recommended that, in addition to a conservation plan, active seagrass restoration activities be planned for injured habitats of Mashta flats.
- **Seagrass restoration activities should be concentrated initially in areas with high SAV cover** and expand to more marginal areas if funds become available.
- A common and inexpensive method of scar restoration involves the deployment of bird roosting stakes. **Bird stakes can enhance the recovery of existing seagrass propeller and hull scars** and engine blow-outs. The deployment of bird stakes has become a common seagrass restoration practices in south Florida where seagrass scarring is a widespread problem. The purpose of the bird stakes is to allow birds (mainly cormorants) to perch and defecate directly into the water. **Bird feces are rich in phosphorus, a limited nutrient within shallow lagoons with carbonate sediments and effectively fertilize the area in the vicinity of the stakes.** The additional source of nutrients increases the growth of seagrass and enhances the recruitment of macroalgae and seagrasses into bare spots.
- To assess the efficacy of bird stakes as a seagrass scar restoration method, we recommend that **a monitoring program that includes assessment within restored and control unrestored areas** be undertaken.
- The demarcation and restoration activities to be permitted should be conducted by reputable consulting firms with ample marine ecosystem restoration experience in the Miami area.

## Appendix

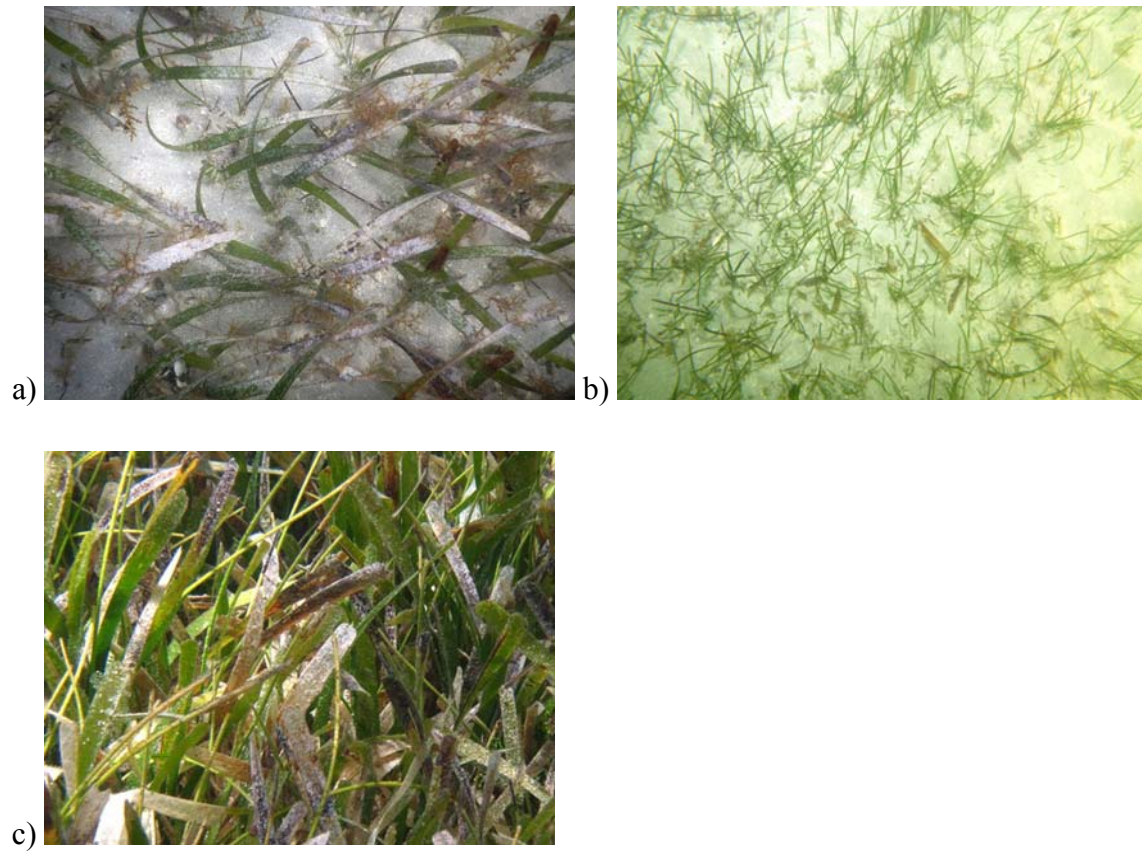


Figure 1. Seagrass species found on Mashta Flats: a) turtle grass (*Thalassia testudinum*), b) shoal grass (*Halodule wrightii*), and c) manatee grass (*Syringodium filliforme*) mixed with turtle grass.



Figure 2. Example of propeller scar observed on Mashta Flats.



Figure 3. Boats anchored and boaters walking on Mashta Flats.

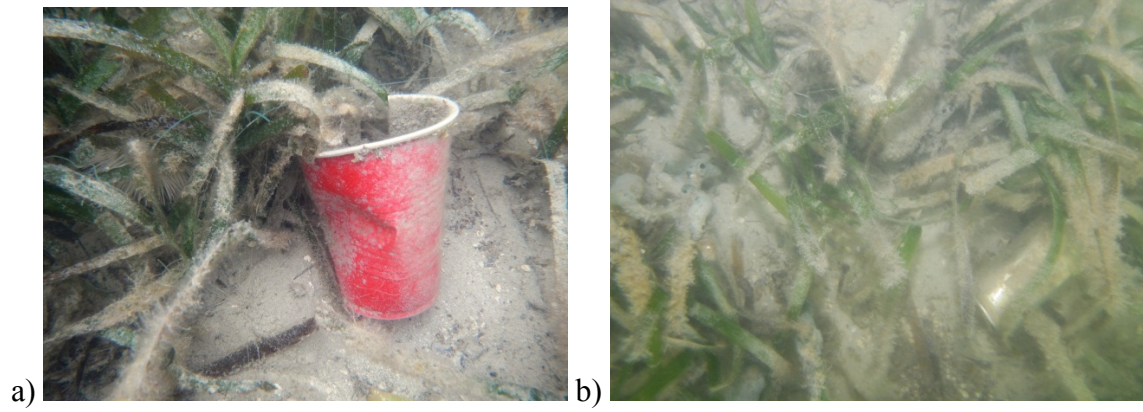


Figure 4. Plastic cup (a) and aluminum can (b) discarded on Mashta Flats.

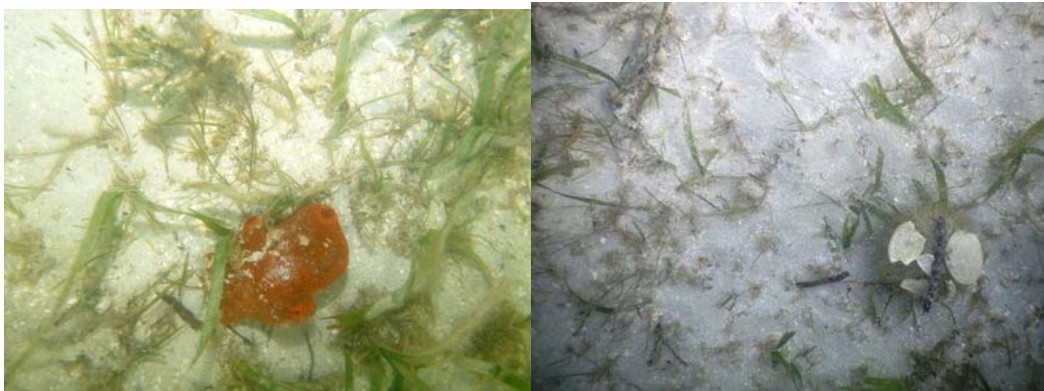


Figure 5. Examples of sponges (right) and collector urchins (left) found within the seagrass community of Mashta Flat

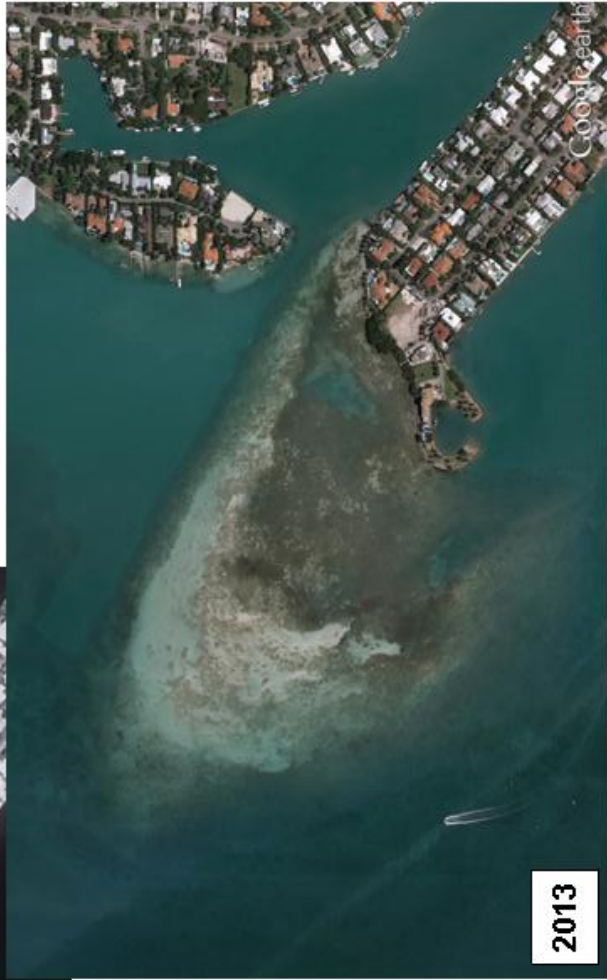


Figure 6. Aerial (1995) and satellite (2013) images of Mashita Flats.