Seagrass Dynamics within the Matlacha Pass Aquatic Preserve Along Fixed Transects (1999-2009)

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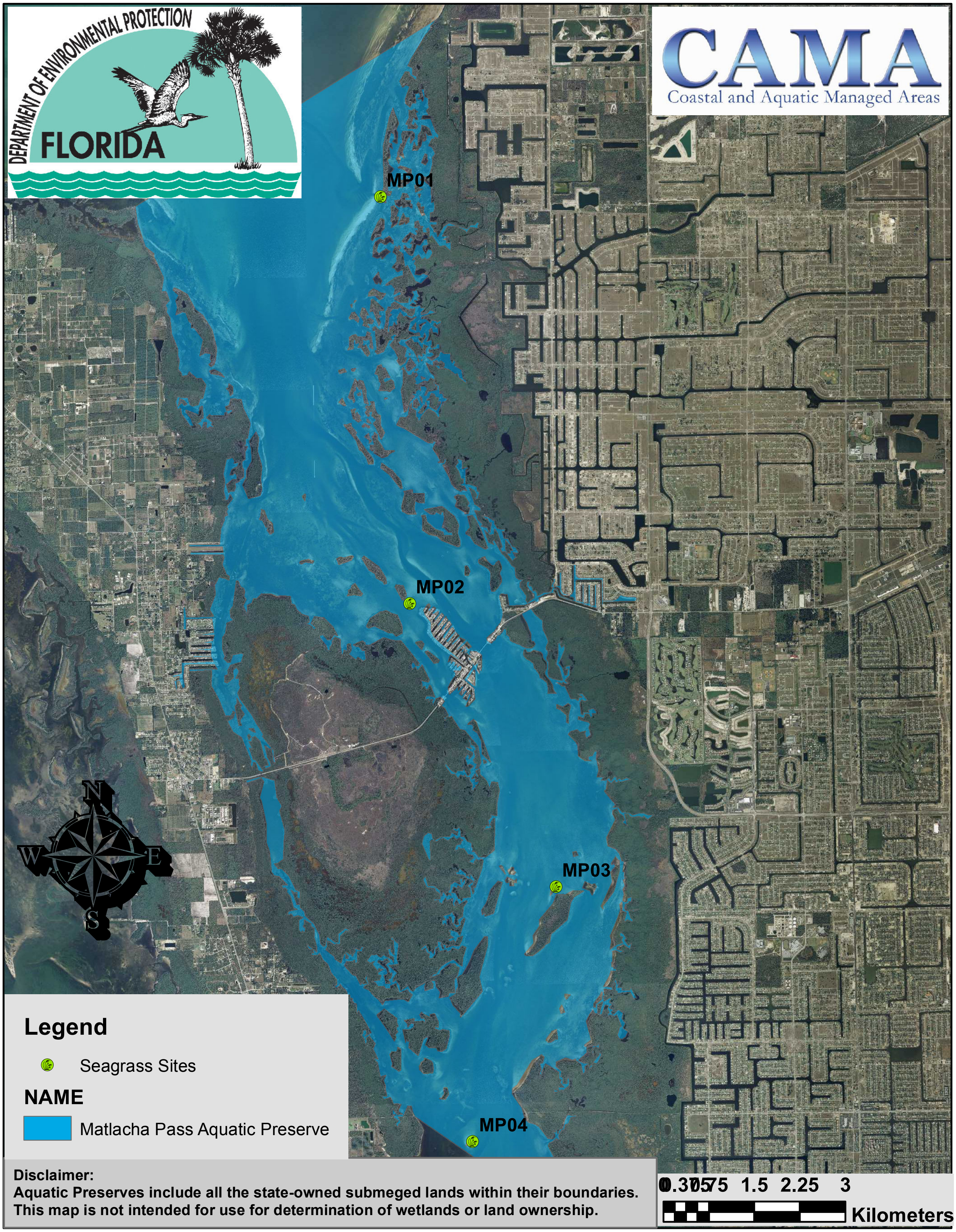
Matlacha Pass Aquatic Preserve Seagrass Transect Monitoring Sites



Abstract:

Since 1998, the Florida Department of Environmental Protection, Charlotte Harbor Aquatic Preserves have monitored seagrass meadows within the Matlacha Pass Aquatic Preserve along four fixed transects. And, in 2003, the Florida Department of Environmental Protection's South District office began monitoring one of these sites, as well. The program is intended to establish baseline conditions of seagrass meadows, track trends, and relate these data to water quality data. Analyses of data from 1999 through 2009 show that the total abundance of seagrasses within the aquatic preserve are increasing, and that Halodule wrightii, the most frequently encountered specie, is the primary driver of this trend. The maximum depth of seagrass growth along site MP01 is increasing, as is the overall bed length. There have been significant declines in seagrass abundance along MP02, with the loss of Thalassia testudinum along this transect between 2004 and 2005. Site MP03 is the longest and most stable of the sites within the study area. And, MP04 had an increasing trend in the abundance of H. wrightii. Continued monitoring is necessary in order to continue to track trends in the region, relate them to water quality, and aid in the management of submerged resources within the region.

Introduction:

Seagrasses are considered by many to be an important indicator species of coastal and estuarine health. They provide many ecological services and serve as a nursery for many important shellfish and finfish (e.g.: Larkum et al, 2007; Hemminga and Duarte, 2000; Fourqurean et al, 1999). Many factors, both natural and anthropogenic, control the distribution, abundance and overall health and condition of seagrass meadows. Therefore, the Charlotte Harbor Aquatic Preserves (CHAP), with assistance from the Sanibel-Captiva Conservation Foundation (SCCF), the Florida Department of Environmental Protection's (FDEP) South District, and the Estero Bay Aquatic Preserve (EBAP), have been monitoring seagrasses along fixed transects since 1998, in order to aid in resource management and protection (Stearns, 2007 and Brown et al, 2011).

The Charlotte Harbor watershed, located in southwest Florida, drains into the vast estuarine complex of Charlotte Harbor which is one of the most pristine and socio-economically important ecosystems in the state. Located within this complex are many sub-estuaries, from Lemon Bay in the north to Estero Bay in the south, comprising nearly 250,000 acres of submerged habitat (e.g.: Duffey et al, 2007; Leary, 2009; and Leary 2010). Contained within the estuarine complex are six aquatic preserves. Aquatic preserves are areas of exceptional submerged resources that were set aside by the Florida legislature to be maintained in their essentially natural condition for future generations (Chapter 18-20, FAC). The aquatic preserves are managed by the FDEP Office of Coastal and Aquatic Managed Areas (CAMA). Five of the local aquatic preserves are managed by the Charlotte Harbor Aquatic Preserves' office in Punta Gorda, and include: Lemon Bay, Gasparilla Sound-Charlotte Harbor, Cape Haze, Pine Island Sound, and Matlacha Pass Aquatic Preserves. The sixth local aquatic preserve is the Estero Bay Aquatic Preserve, which is managed from the Estero Bay office located in Fort Myers Beach. These offices administer the Seagrass Transect Monitoring Program for the Charlotte Harbor estuary complex. In addition, they monitor seagrass transects located outside of the aquatic preserves boundaries, in Tidal Peace and Myakka Rivers and in San Carlos Bay, as well as a portion of Matlacha Pass that is not within the Matlacha Pass Aquatic Preserve (Stearns, 2007; Brown, 2011; and Leary, 2010).

Seagrass monitoring along fixed transects by CHAP began in 1998 using protocols established by the Southwest Florida Water Management District and Sheda Ecological, Inc. All sites have been monitored at least annually, with the exception of one in Gasparilla Sound-Charlotte Harbor that was dropped in 2000. Most sites, or transects, monitored by CHAP have remained in the same location over the years, three were relocated in 1999 (one each in Gasparilla Sound-Charlotte Harbor, Pine Island Sound and San Carlos Bay) and five in 2004 due to Hurricane Charley leaving no trace of the original (four in Gasparilla Sound-Charlotte Harbor and one in Pine Island Sound). Six species of seagrass are found within the Charlotte Harbor estuarine complex: *Halodule wrightii*, *Thalassia testudinum*, *Syringodium filiforme*, *Ruppia maritima*, *Halophila decipiens*, and *Halophila engelmannii*; and although not always considered a seagrass by all, *Vallisneria americana*, is included in our database because it is occasionally found in the low salinity regions of the tidal tributaries of Charlotte Harbor. This report explores seagrass dynamics within Matlacha Pass Aquatic Preserve only, and utilizes data collected by both CHAP staff and FDEP South District staff. The data from 1998 for Matlacha Pass is missing, therefore, trends for Matlacha Pass are for 1999 through 2009. In addition, parameters that are influential to seagrass dynamics (i.e.: light attenuation, salinity, rainfall, etc.) are not included in this report.

Methods:

Study Area:

Located in southwest Florida, the Matlacha Pass Aquatic Preserve is located within Lee County between Pine Island and Cape Coral. It extends north-south along the island, and the boundary follows the mean high water line, with the exception of the southwest portion of Matlacha Pass. Its primary tributary is the Caloosahatchee River to the south. Matlacha Pass is approximately 21 km long and 5 km wide. The aquatic preserve encompasses approximately 19,800 acres of submerged habitat and mangrove islands, of which approximately 7,100 acres are seagrass meadows. It is a shallow, micro-tidal bar-built sub-estuary of the greater Charlotte Harbor estuarine system. The Matlacha Pass Aquatic Preserve was established in 1972.

Field Methods (adapted from Stearns, 2007):

At each site, a fixed linear transect was established from the shoreward edge of the seagrass meadow to the waterward edge, where possible. At regular intervals along each transect, detailed information such as seagrass species, abundance, and density were collected using a one square meter quadrat. This quadrat is further divided into 100 squares, each 10x10 centimeters, using bungee cord line for use in collecting abundance data. Quadrat sampling points (stations) were marked with PVC stakes and many have established GPS coordinates used for reference. Site-specific "repeated" quadrats were determined in 2007 to allow for greater long-term consistency in sampling locations and are monitored every year. In addition to these regular intervals, data at the beginning and end of the grass bed were collected. Both end points vary annually and seasonally and can be difficult to determine particularly when seagrass abundances are low. Flagging tape, PVC stakes, GPS coordinates, and fixed landmarks including navigation markers were utilized to reference site locations and assure repeatability. Sites were reached using shallow draft boats. Seagrass observations were made by snorkeling and/or SCUBA depending on water depth. The only time the ends of beds were not determined was when conditions were deemed to be too unfavorable and risky (i.e.: a storm was developing; currents were too strong; the meadow continued into an active channel; etc.).

Once near the site, reference points on shore were located using previous flagging tape, PVC stakes and/or known GPS coordinates. The shoreward extent of the transect was then found by measuring the specified distance (the offset) and direction from the reference point and/or using GPS coordinates to the zero point PVC stake. The zero point of each transect was determined when the site was established in 1998 as the baseline, shoreward edge of seagrass growth. All measurements were made relative to the zero point, therefore if the seagrass meadow begins between the flagging stake (on shore) and the zero point, that station was denoted with a negative distance. From the zero point, a compass heading, point of reference (e.g.: a landmark) and/or GPS coordinates were used to determine the waterward direction of travel along the transect. Each transect was then sampled at regular intervals (stations) specified in the site description using a tape measure to determine a known distance between points.

At each site, the date, observers, start and end times, offset, general site comments, and weather conditions were recorded. At the beginning and end of monitoring each transect, tide levels (relative to the biological mean high water line) were recorded. Tide levels were measured as the height of the water (in feet) above or below the barnacle line on mangrove roots, adjacent navigation markers, or dock pilings. Local tide gauge information was used during data analyses to convert observed water depths to mean water (in meters).

At each station along the transect (except the beginning and end), the quadrat was centered on the PVC stake. Whereas, at the beginning and end of the grass bed, the quadrat was either placed forward of or behind the grass edge, respectively. This ensured that seagrass data were captured inside the seagrass meadow. Each station was denoted as being at the beginning, middle or end of the seagrass meadow, when possible. At each station, water depth (cm), sediment type, species types, abundances, blade lengths, shoot counts, and epiphyte loads were observed and recorded. Seagrass abundance was determined for each species (Species Abundance), as well as for the station as a whole (Total Abundance), using Braun-Blanquet areal coverage classes. The coverage classes are defined as follows: 0.1 = solitary; 0.5 = few; 1 = <5%; 2 = 5 - 25%; 3 = 26 -50%; 4 = 51 - 75%; and 5 = 76 - 100% (e.g.: Fourqurean et al, 1999). Braun-Blanquet coverage was defined as: "The entire shoot system of all the individuals … is thought of as projected on the ground and the area covered thereby is estimated… as areal percentage" (J. Braun-Blanquet, 1932), or as the percent of the quadrat that is obscured when viewed from above (Fourqurean et al, 1999) and all species are considered to be within the same layer, or stratum for Total Abundance. Drift algae information was also collected at each station when present. Drift algae were given their own abundance, and generally described. Drift algae abundance was not included as part of the station's Total Abundance. After abundances have been determined, shoot counts were made for each species in a predetermined number of 10 cm squares. Five random blade lengths (cm) were recorded for each species. For *T. testudinum*, only blades with rounded, healthy, green tips were measured. Epiphytes were quantified as clean, light, moderate, or heavy and briefly described.

All CHAP seagrass transects were monitored annually in the late summer during post-growing season, generally August through November. The exception was site MP04, which is used for annual seagrass monitoring training and standardization. This site was visited an additional time each year, typically from May to July. Since 2007, FDEP South District staff have monitored MP04 quarterly during the year, prior to this they monitored at various times throughout the year.

Statistical Methods (from Leary, 2011):

Statistics were selected based on three criteria. First, it's power (β) which is a statistic's ability to detect differences amongst the data (i.e.: the probability of rejecting the null when it is in fact false). Next, accuracy, which is a measure of the confidence interval (i.e.: the smaller the confidence interval, the greater the accuracy). And robustness, which is how sensitive a particular statistic is to outliers. For all statistics, *a* (i.e.: the probability of accepting the null when it is in fact true; the significance) was set at 0.05 (e.g.: Wilcox, 2001).

A priori power analyses were run based on Cohen's D and adjusted to R^2 in order to determine the minimum number of results (samples) required for statistical analyses (α=0.05; β= 0.05; and two tailed). It was determined that a minimum of 28 samples are required for regression analyses in order to detect a large effect size (i.e.: something that is grossly visible to the naked eye when observed; $R^2 \geq 0.49$). This criterion was ignored for Deep Edge, Beginning of Bed, End of Bed, and Bed Length, because they are collected only once at each site visit. This was also ignored for frequencies, since it was calculated as the percentage per year. Afterwards, *post hoc* power analyses were run to measure effect size (the strength of the relationship or the magnitude of difference; for example: regressions use R^2 to measure effect size, the larger the R^2 value, the greater the percentage of variability is explained and the greater the association). Exploratory statistics were then run. Multiple tests were then run in order to test the assumption of normality, including: Johnson's SU transformation for skew; Anscombe & Glynn's transformation for kurtosis; and Jarque & Bera LM test. Outliers were identified using Mahalanobis D^2. The assumption of homoscedasticity was tested using Levene's test of homogeneity of variance.

From these statistics, assumptions of normality and homoscedasticity can be assessed in order to determine if and when data need to be screened or transformed. In addition, assumptions of linearity were examined using plots of observed versus predicted values and residuals versus predicted values. Assumptions of independence were assessed using autocorrelation function (ACF), combined with the Durbin-Watson d test. Where the assumptions were violated, three sets of methods were used to address this issue. Transforming the data was attempted first. Next, 20% trimming of the data was attempted. If neither of these worked, robust nonparametric regressions based on the Theil-Sen Estimator (Theil-Kendall regression) were used for detection of trends. However, if assumptions were met, linear regression was used.

Analyses were run for the Matlacha Pass Aquatic Preserve as a whole, by species, and by site, as well as frequencies by year. The ends of the seagrass beds were considered to be advancing if they were progressing waterward; whereas the beginnings of beds were considered to be advancing if they were moving shoreward. Density calculations were based upon shoot counts per meter squared. Density data prior to 2005 will not be included nor will total abundance data from prior to 2004, due to differences in sampling design. Lastly, due to the rarity of encounters with the two *Halophila* species, they will be combined as one (*Halophila spp.*) in the analyses. For detailed statistics and site specific results, see the appendices contained within Leary, 2011.

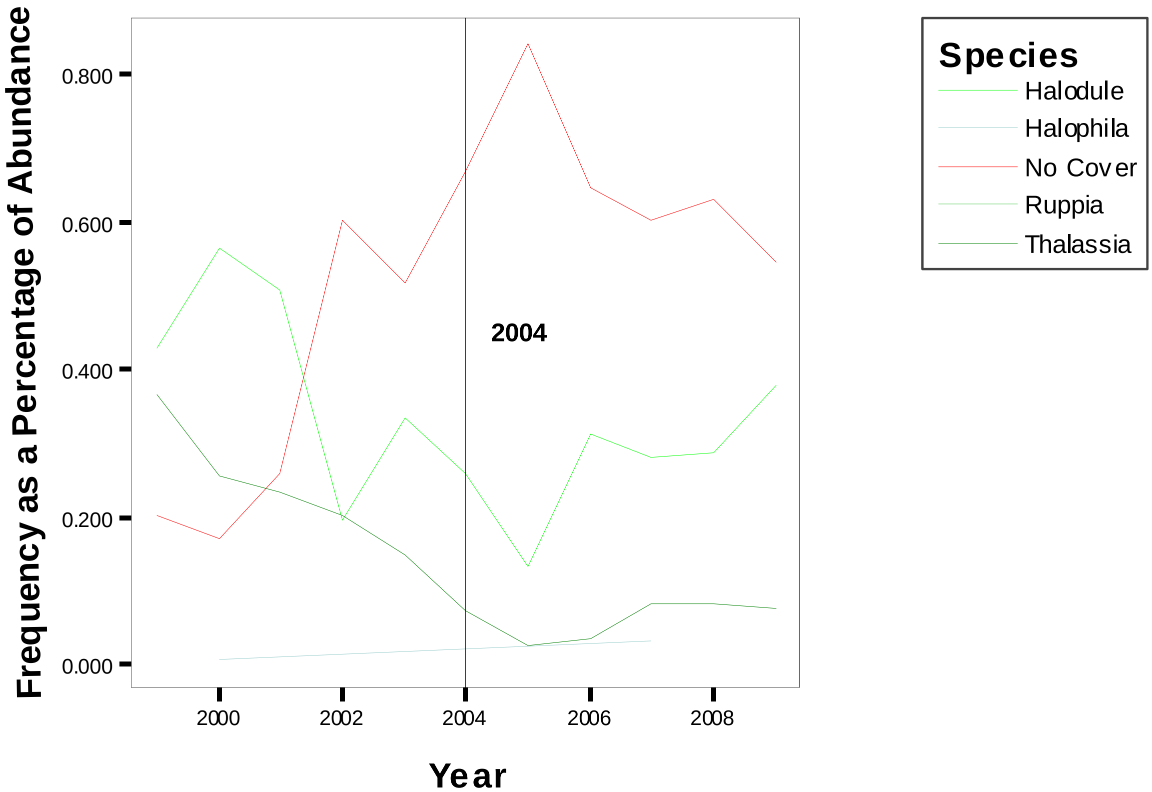
Results:

Frequencies:

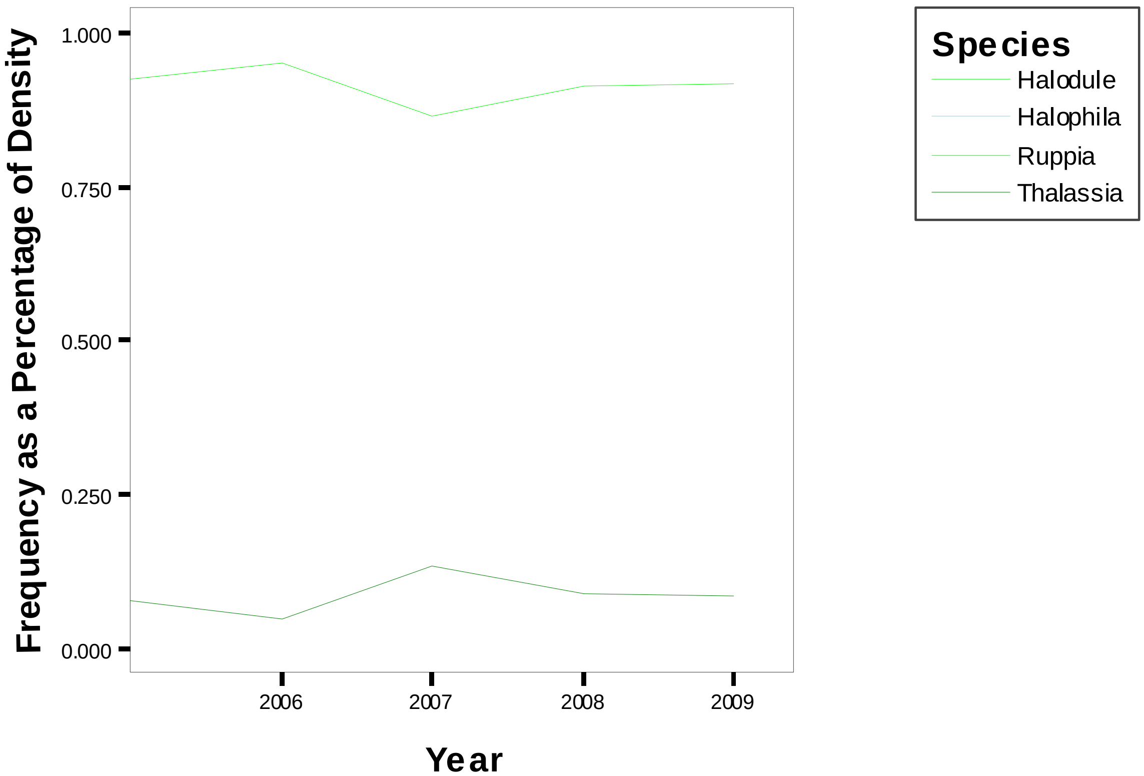
For the Matlacha Pass Aquatic Preserve as a whole for 2005 through 2009, frequencies using shoot densities, from 2005 to 2009, *H. wrightii* accounted for 91.4% and *T. testudinum* 8.6% of shoot counts (both *Halophila spp.* and *R. maritima* were less than 0.1%). *S. filiforme* and *V. americana* were not encountered along transects within the Matlacha Pass Aquatic Preserve, and attached algae was not used in calculating frequencies.

Frequency as a Percentage of Density (2005-2009)					
Species	MP01	MP02	MP03	MP04	All Sites
H. wrightii	57.34%	100.00%	99.66%	99.96%	91.42%
T. testudinum	42.66%	0.00%	0.34%	0.00%	8.56%
Halophila spp.	0.00%	0.00%	0.00%	0.01%	<0.01%
R. maritima	0.00%	0.00%	0.00%	0.03%	0.02%

From 2004 to 2009, the frequency based on abundance for *H. wrightii* and *T. testudinum* increased, however these were not significant ($p=0.095$ and $p=0.073$, respectively). Data for *Halophila spp.* and *R. maritima* based upon abundance were insufficient. No data for *S. filiforme*, *V. americana*, and attached alga frequencies were collected for Matlacha Pass Aquatic Preserve. When using densities from 2005 through 2009 to calculate frequencies, *H. wrightii* was decreasing, but was not statistically significant ($p=0.171$); and *T. testudinum* was increasing, but was not statistically significant ($p=0.661$). Data were insufficient for, or the species were not present, in the aquatic preserve for the remaining species.



The same trends were typically found for frequencies based on abundance for individual sites as for the Matlacha Pass Aquatic Preserve as a whole, as for individual sites. *H. wrightii* was the only seagrass increasing significantly at MP04 (p=0.005); and there was also a significant increase in *T. testudinum* for MP01 (p=0.027) based upon abundance. *T. testudinum* was no longer observed along MP02 after 2004, nor was *Halophila spp.* along MP04 after 2007. *R. maritima* was observed within MP04 only during 2006. There were no other significant changes in frequencies based upon abundance. MP01 was the only site where *H. wrightii* did not represent 100% (or nearly so) of the seagrasses based on shoot counts, and therefore was the only site that regression analyses could be performed. There were no significant changes in seagrass frequencies based on densities at any of the individual sites.

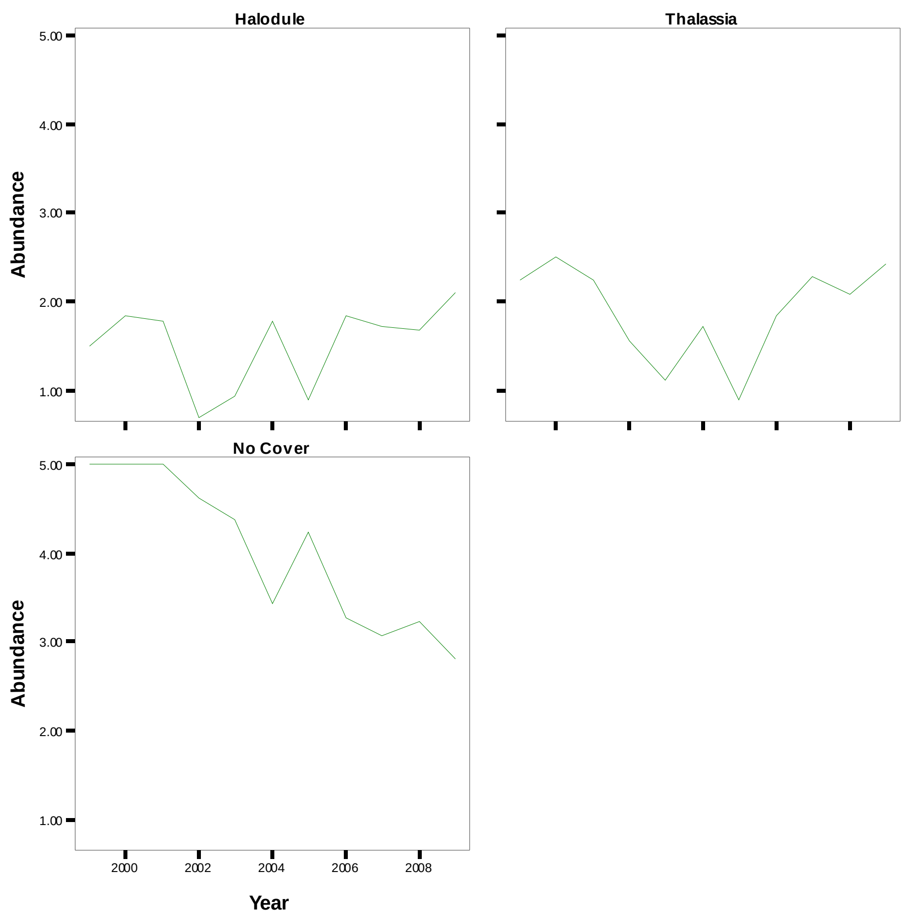


Abundances:

Total abundance data for Matlacha Pass Aquatic Preserve were found to be non-normal and heteroscedastic and were square root transformed in order to satisfy these criteria (Jarque & Bera LM=4.7097; p=0.0949; Levene's=1.545; p=0.153). For the entire Matlacha Pass Aquatic Preserve, total abundance had increased significantly ($p<0.001$) for the time period of 2004 to 2009. This was the same general trend for most of the individual sites as well. As for the abundances of individual species for the period of record (1999 – 2009), *H. wrightii* was the only species abundance to increases significantly ($R^2=0.030$; $F(1,252)=7.70$; $p=0.006$); and *T. testudinum* increased, but was not significant ($p=0.673$). Data for MP02 were found to be non-normal and heteroscedastic and were square root transformed in order to satisfy these criteria (Jarque & Bera LM=0.6578; p=0.7197; Levene's=1.006; p=0.434) and at MP04 (Jarque & Bera LM=0.5564; p=0.7572; Levene's=1.464; p=0.189). Total abundance significantly increased at MP01 and MP04 ($p=0.011$ and $p<0.001$, respectively); whereas it decreased at MP02 ($p=0.006$). *H. wrightii* was the primary driver of these trends at these three sites; increasing at MP01 and MP04 ($p=0.043$ and $p<0.001$, respectively), and decreasing at MP02 ($p=0.003$). There were no other significant site-specific trends for Matlacha Pass Aquatic Preserve.

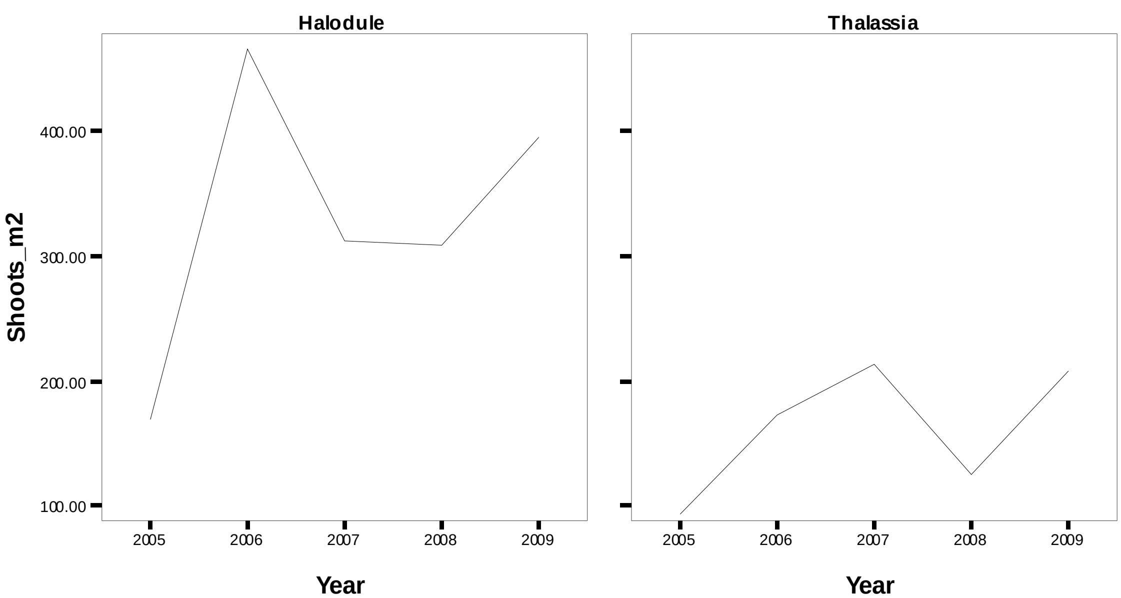
Average Total Abundance Cover Class (2004 - 2009)					
Year	MP01	MP02	MP03	MP04	All Sites
2004	0 - 5%	5 - 25%	5 - 25%	0 - 5%	5 - 25%
2005	0 - 5%	0 - 5%	0 - 5%	0 - 5%	0 - 5%
2006	25 - 50%	0 - 5%	25 - 50%	0 - 5%	5 - 25%
2007	25 - 50%	0 - 5%	5 - 25%	5 - 25%	5 - 25%
2008	25 - 50%	0 - 5%	5 - 25%	5 - 25%	5 - 25%
2009	25 - 50%	0 - 5%	25 - 50%	5 - 25%	5 - 25%
Total	25 - 50%	0 - 5%	5 - 25%	5 - 25%	5 - 25%

Average Species Abundance Cover Class (1999 - 2009)					
Species	MP01	MP02	MP03	MP04	All Sites
H. wrightii	5 - 25%	0 - 5%	5 - 25%	5 - 25%	5 - 25%
T. testudinum	5 - 25%	5 - 25%	0 - 5%	N/A	5 - 25%
Halophila spp.	N/A	N/A	N/A	0 - 5%	0 - 5%
R. maritima	N/A	N/A	N/A	0 - 5%	0 - 5%



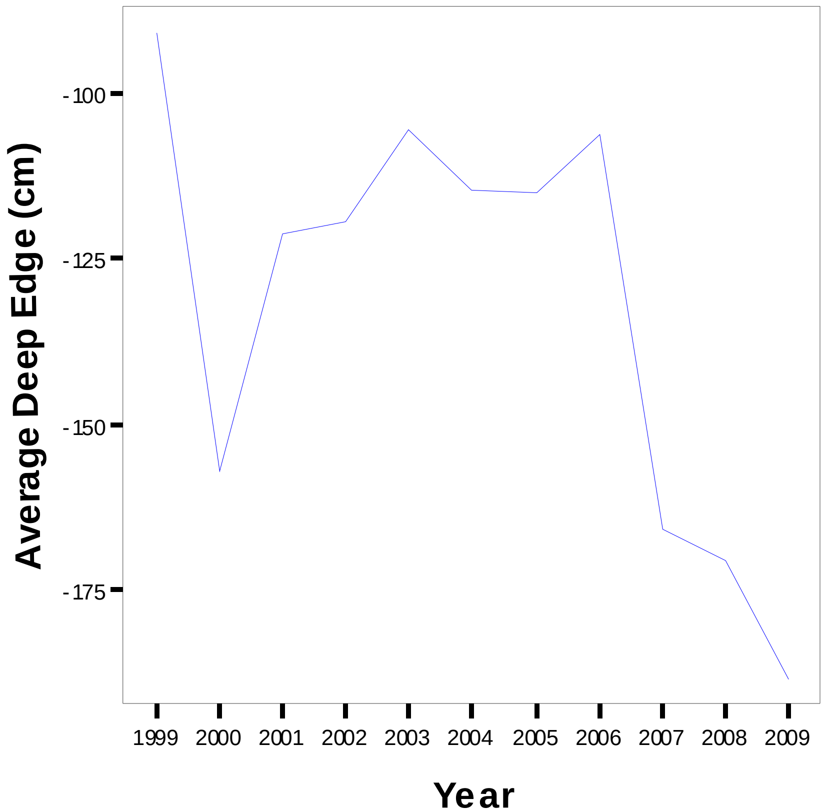
Density:

During the study period for density (2005 – 2009; shoots per m^2), shoot counts for all seagrass species combined within Matlacha Pass Aquatic Preserve increased, but were not significant (p=0.112). The same results were noted for *H. wrightii* and *T. testudinum*; increasing, but not significantly (p=0.651 and p=0.650, respectively). Data for each individual site were found to be non-normal and heteroscedastic and were Log transformed in order to satisfy these criteria at MP01 (Jarque & Bera LM=4.7369; p=0.0936; Levene's=0.480; p=0.750) and at MP02 (Jarque & Bera LM=1.0193; p=0.6007; Levene's=1.357; p=0.288), and square root transformed at MP03 (Jarque & Bera LM=1.1966; p=0.5497; Levene's=0.588; p=0.673) and at MP04 (Jarque & Bera LM=5.2974; p=0.0707; Levene's=0.242; p=0.973). In addition, MP02 failed to meet 28 minimum sample size (N=24). There were no significant trends at any of the individual sites.

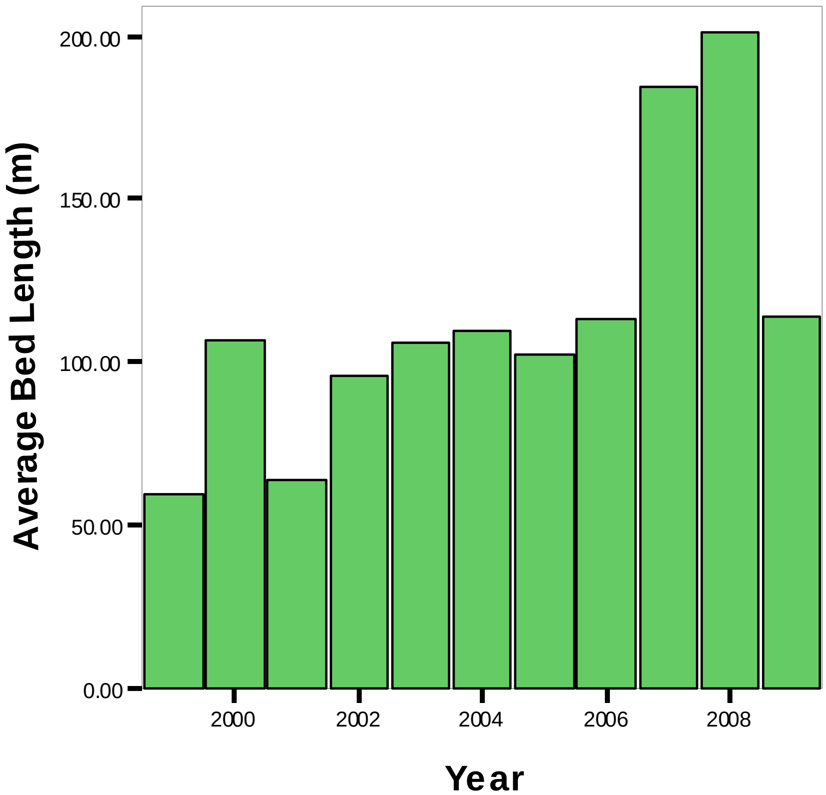


Bed Dynamics:

The deep edges of seagrass beds within the entire Matlacha Pass Aquatic Preserve as a whole trended significantly deeper within the study period (R^2=0.193; F(1,55)=13.125; p=0.001). Deep edge measurements also trended significantly deeper at MP01 (p<0.001). There were no other significant trends for deep edge.

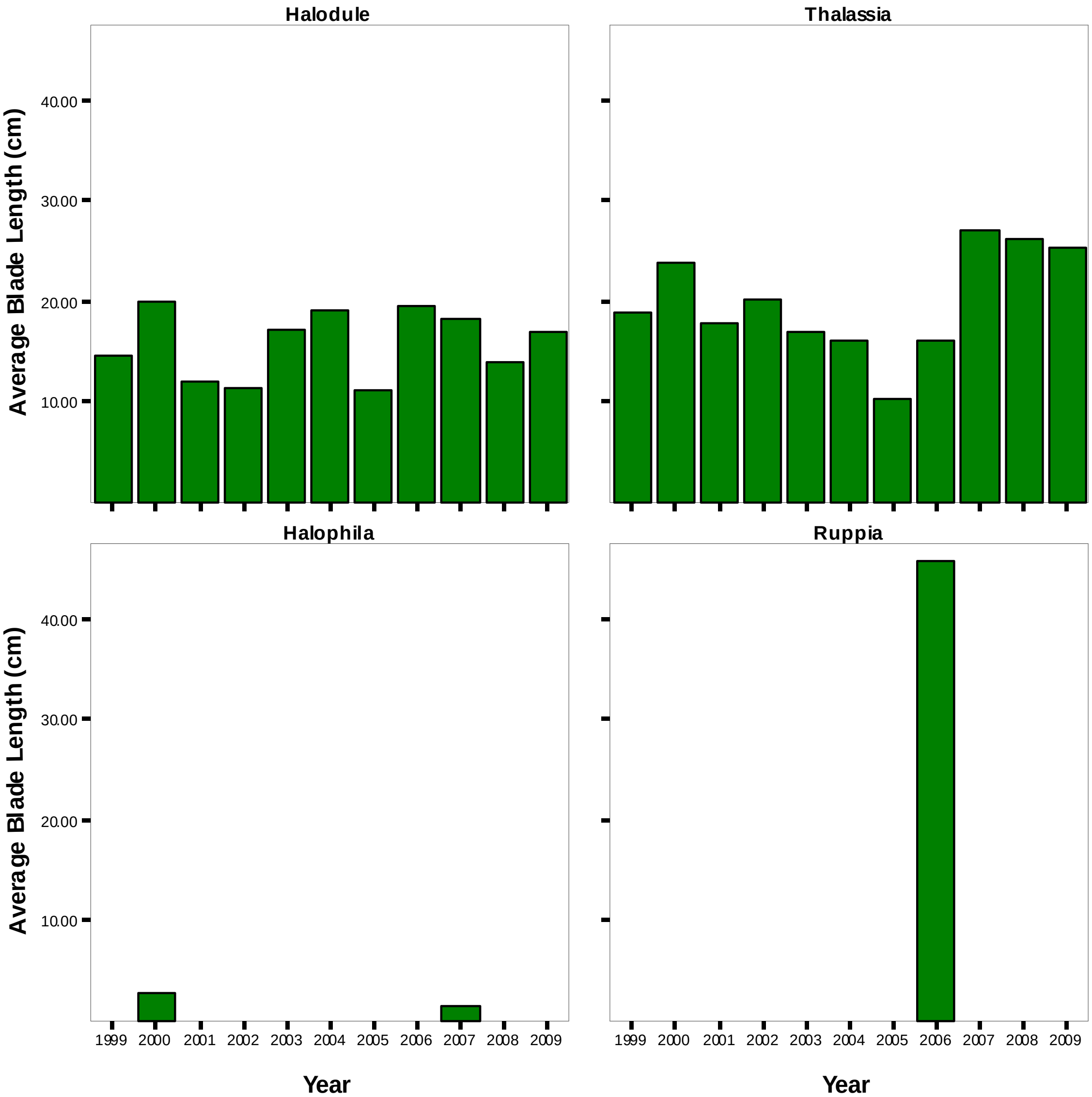


The location of the beginning of the beds in Matlacha Pass were advancing shoreward (R^2=0.134; F(1,54)=8.337; p=0.006) for the region as a whole; the location of the end of bed advanced seaward, but was not significant (p=0.131) nor was there a significant increase in the overall bed lengths (p=0.083). However, the overall bed lengths are increasing significantly at the individual sites: MP01 (p=0.001), MP02 (p<0.001), MP03 (p=0.026) and MP04 (p=0.004). The beginning of the beds in both MP03 and MP04 are advancing shoreward (p=0.024 and p<0.001, respectively). In addition, the end of beds for all individual sites were advancing seaward (p=0.001, p=0.001, p=0.027, and p=0.014, respectively). However, *post hoc* analyses were run on Matlacha Pass Aquatic Preserve because of the apparent discrepancy with all the individual sites showing statistically significant increases in both ends of bed and bed lengths. These analyses showed that when FDEP South District and CHAP's data were separated, both agencies showed significant increases in ends of beds (p=0.035 and p=0.044, respectively) and for bed lengths (p=0.024 and p=0.043, respectively). However, it should be noted that FDEP South District only sampled MP04, and did so at a different intervals. Further post hoc analyses showed that removing the CHAP MP04 training data improved the strength of the regression of end of bed (p=0.024) and for bed length (p=0.023).



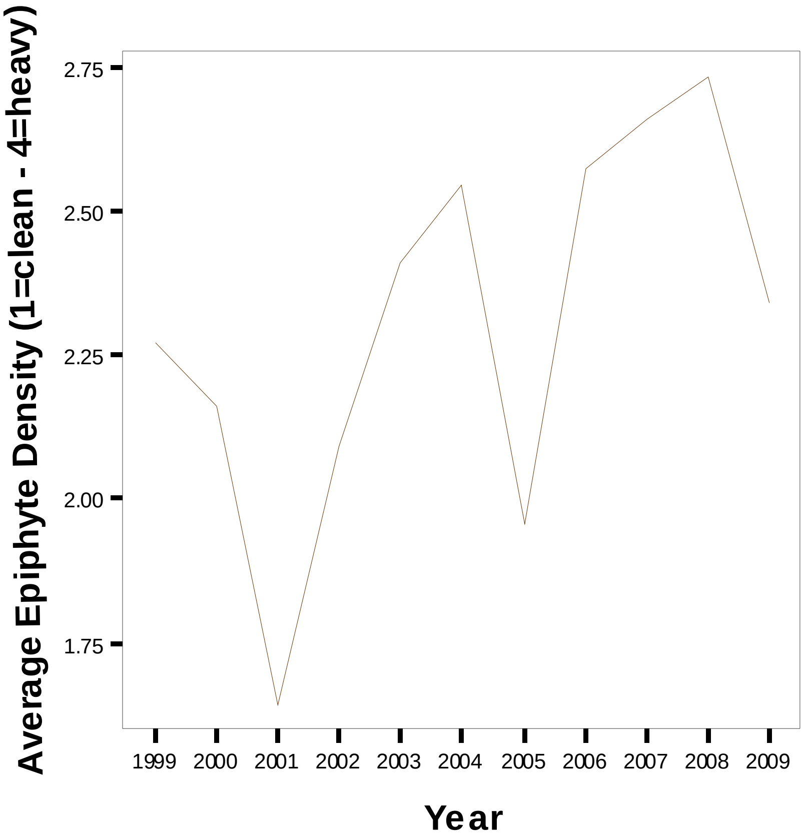
Blade Lengths:

The average blade length for all species combined and for the entire region was increasing, but was not significant (p=0.447). The same was true for *H. wrightii* (p=0.772); whereas *T. testudinum* increased significantly at a rate of .690 cm per year (p=0.010). There were insufficient data for *Halophila spp.* and *R. maritima*. Data for MP04 were found to be non-normal and heteroscedastic, numerous transformations and 20% trimming were attempted but could not resolve these issues; therefore Theil-Kendall regression was used. All species combined increased significantly at MP01 (p<0.001), and decreased at MP02 (p=0.050) and at MP04 (p=0.011). Both MP01 and MP03 had significant increases in blade lengths for *H. wrightii* (p=0.007 and p=0.021, respectively), and MP01 had significant increases in *T. testudinum* blade lengths (p=0.001). There were no other significant trends for blade lengths.



Epiphyte Density:

For the entire region, irrespective of seagrass specie, epiphyte densities increased significantly (R^2=0.039; $F(1,320)$=12.815; $p<0.001$). Increases in epiphyte densities for the region were also observed for *H. wrightii* (R^2=0.106; $F(1,249)$=29.674; $p<0.001$), whereas epiphyte densities declined for *T. testudinum* (p=0.229), but were not significant. There were insufficient data for *Halophila spp.* and *R. maritima*. Epiphyte densities overall increased at MP02 (p=0.003) and MP04 (p=0.001), and for *H. wrightii* at MP02 ($p<0.001$), MP03 (p=0.006), and MP04 (p=0.001). Epiphyte densities declined at MP01 on *T. testudinum*, but were not significant (p=0.242). There were insufficient data to run regressions on *T. testudinum* at the other sites. There were no significant trends for all species combined at MP01 (p=0.792) or MP03 (p=0.194).



Discussion:

Matlacha Pass Aquatic Preserve:

Within the Matlacha Pass Aquatic Preserve, *H. wrightii* was the most frequently encountered seagrass species. This is not surprising, as this has been documented for the entire Charlotte Harbor estuary, similar surrounding estuaries (e.g.: Sarasota Bay, Tampa Bay, etc.), and in previous findings for Matlacha Pass (e.g.: Avery and Johansson, 2001; Corbett and Hale, 2006; Tomasko et al, 2011). Overall total abundance of seagrasses was increasing, and *H. wrightii* was found to be the primary specie driving this increase. This is most likely due to fact that *H. wrightii* is more tolerant of variations in salinity than *T. testudinum* (the next most frequent seagrass specie in the aquatic preserve, and essentially the only other specie present in the study area during the study period). Although total abundance increased significantly, shoot densities did not nor did average blade lengths. At first glance, this may seem improbable, but this may indicate that the ramets are producing a greater number of leaves per shoot and/or the leaves are wider. Unfortunately, estimated epiphyte loads increased significantly for all species combined and for *H. wrightii*. This may be indicative of eutrophication (e.g.: Fourqurean and Rutten, 2003). The deep edge of beds trended significantly deeper, however it is not certain at this moment if this is due to increased effort in locating the true end of the seagrass bed or if they are in fact progressing deeper. The beginning of beds within the aquatic preserve was statistically significantly advancing shoreward, whereas there was no significant increase in the end of bed or the overall bed lengths unless corrected for sampling frequency. These trends, as a whole, suggest that overall seagrass heath is improving. However, it should be noted that during 2004 and 2005 there was a sharp decline in seagrasses most likely due to increases in freshwater inputs, both natural (numerous tropical storms and hurricanes hit the area, and increased rainfall) and anthropogenic (numerous large-scale releases from Lake Okeechobee; Brown et al, 2011). Although not discussed in this paper, drift algae abundance was analyzed for the entire aquatic preserve, but not for individual sites, and was found to be increasing at a significant rate (p=0.024).

MP01:

The northernmost site in Matlacha Pass Aquatic Preserve, MP01, had the highest frequency of *T. testudinum* of all the sites. In fact as a percentage of abundance, *T. testudinum* was the most abundant specie at this site. However, as a percentage of density, *H. wrightii* was most abundant. In addition, the abundance of *H. wrightii* increased significantly during the study period as did total abundance, and there were no significant trends in density. This would seem to suggest a shift in dominant specie for this site. MP01 was the only site to show a significant increase in the deep edge of the bed, this is the only bed with a conclusively determined end of bed, and therefore the seagrasses are growing at greater depths along this transect. This was the only site to have grasses at the beginning of the bed receding from shore, however this was not significant. The end of bed advanced waterward and the overall bed length increased. This was the only site to show a significant increase in average blade lengths. These increases were not only for all species combined at this site, but also for both *H. wrightii* and *T. testudinum*. In addition, MP01 was the only site to show a decrease in epiphyte densities, however this was not significant. This site is the shortest within the Matlacha Pass Aquatic Preserve (average length = 52.75m), and appears to be improving more than the other sites.

MP02:

The most frequent specie along MP02 is *H. wrightii*; this is as both a percentage of abundance and of density. Between 2004 and 2005, *T. testudinum* was lost along the transect, indicating a shift in community structure. This may have been due in part to increased rainfall during these years, or due to hurricane damage. This was the only site to have significant decreases in total abundance and the abundance of *H. wrightii*, declining from an average of 1.8 in 1999 to 0.67 in 2009. The end of bed and overall bed length increased significantly, however this may be because it appears as if the seagrasses continue to the other shore in a patchy manor making it difficult to identify the end of bed. Along with MP04, MP02 had significant decreases in blade lengths and significant increases in epiphyte densities. At MP02, this may be due to freshwater inputs from the Spreader Waterway to the east of the site. This site is also the closest to a developed area. Of the four sites in Matlacha Pass Aquatic Preserve, MP02 appears to be in the worst condition.

MP03:

The most frequently encountered seagrass specie at this site is *H. wrightii*. There were no significant increases in total abundance, species abundance or shoot density. There were also no significant trends for blade length or overall epiphyte density at this site. There was, however, a significant increase in epiphyte densities upon *H. wrightii*. As with the other sites in the aquatic preserve, the end of bed advanced waterward. The beginning of bed advanced shoreward, as well, and the overall bed length increased. However, it should be noted that the end of bed has not been conclusively identified, as this bed appears to continue indefinitely in a patchy manor. This site is also the longest within the Matlacha Pass Aquatic Preserve (average length 354.10m). Of the four sites, MP03 had the fewest significant trends. This may indicate that it is the most stable of the sites within the aquatic preserve.

MP04:

Of the seagrass species encountered along MP04, *H. wrightii* is the most frequent, and represents nearly 100% of the species along the transect. This is the only site in the aquatic preserve to encounter both *R. maritima* and *Halophila spp*. Total abundance and the abundance of *H. wrightii* increased significantly at MP04. However, like MP02, this site had increases in epiphyte densities, and decreases in blade lengths. Both the beginning and end of bed increased significantly, as did the overall bed length. However, as noted before, this site does not have a conclusive end of bed and continues into the channel. This site on the whole, appears to be improving.

Conclusions:

Overall, the seagrass meadows within the Matlacha Pass Aquatic Preserve appear to be improving; with the exception of MP02. At all sites the beds were expanding, as well as for the aquatic preserve as a whole. The deep edge of growth has been extending deeper at all sites individually, but was only significant for MP01 and the aquatic preserve. With the exception of MP02, the total abundance was increasing; as was the abundance of *H. wrightii*. However, there were no significant increases in density, this may be due to the limited amount of time it has been collected and should be reanalyzed with a larger dataset over a greater period of time. In addition, there were increases in blade lengths at individual sites and for *T. testudinum* as a whole. The increasing trend in epiphyte densities is something that needs to be looked into more closely; as this can harm the seagrasses due to shading. MP02 should be further examined in order to determine the causes of the declines along this transect, and to seek a remedy to its decline.

These improvements to the seagrass meadows within the Matlacha Pass Aquatic Preserve are most likely due to multiple factors. The establishment of Outstanding Florida Waters and of Aquatic Preserves has most likely contributed to protecting this submerged resource, as well as other legislation at all levels. Increased public awareness of the value of seagrasses has added to its protection and improvement; in particular its value to commercial and recreational fisheries as a nursery for important shellfish and finfish, as well as habitat and a food source. And, the amount, timing, and quality of freshwater being delivered to the region, both naturally and anthropogenic, has also played a part in the quantity and quality of the seagrasses within the Matlacha Pass Aquatic Preserve. With further research, and continued protection, the seagrass meadows of Matlacha Pass Aquatic Preserve can continue to improve water quality, enhance the esthetic value of the region, and bolster important fisheries for future generations.

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