RESULTS OF THE FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION, CHARLOTTE HARBOR AQUATIC PRESERVES' SEAGRASS MONITORING PROGRAM FROM 1999–2009

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Abstract: *Seagrass monitoring is conducted annually throughout the Charlotte Harbor estuarine complex by the Florida Department of Environmental Protection, Charlotte Harbor Aquatic Preserves office. This program provides baseline, status and trends data of seagrass parameters for assessing estuarine health. Results from 1999–2009 show the three most common seagrass species throughout the Charlotte Harbor area are Halodule wrightii, Thalassia testudinum and Syringodium filiforme. Seagrass appears relatively stable across the study area with minor declines associated with considerable wet years and hurricane events. Since 2004, the total abundance of all seagrass species, as well as the density of H. wrightii, increased significantly. In 2009, H. wrightii and S. filiforme had the highest mean shoot count in Gasparilla Sound and Lemon Bay. The tidal Peace and Myakka river systems have the lowest occurrence, abundance and densities of seagrass. The maximum depth of seagrass growth has increased since 1999 with San Carlos Bay having the deepest growing seagrass. San Carlos Bay experienced declines in seagrass abundance during high flow events from the Caloosahatchee River. Continued monitoring will be important to track changes, understand potential causes of trends, and to aid in estuarine management so the aquatic preserves can be maintained in an essentially natural condition.*

Key Words: Seagrass, Monitoring, Charlotte Harbor Aquatic Preserves, *Halodule wrightii*, *Thalassia testudinum*, *Syringodium filiforme*

The Florida Department of Environmental Protection (FDEP) Charlotte Harbor Aquatic Preserves (CHAP) office, through the Office of Coastal and Aquatic Managed Areas (CAMA), has been monitoring seagrasses since 1999 at fifty fixed transects throughout the Lemon Bay, Gasparilla Sound-Charlotte Harbor, Cape Haze, Pine Island Sound and Matlacha Pass Aquatic Preserves (Fig. 1). Aquatic preserves are exceptional sovereign submerged lands set aside by the Florida Legislature to be preserved in an essentially natural condition for future generations to enjoy (Chapter 18-20.001(2) F.A.C.). To properly manage these aquatic preserves, CHAP staff monitor water quality and seagrass conditions to obtain baseline conditions, assess status and trends, and identify areas of concern. Long term quantitative monitoring of seagrass beds at repeatable intervals along fixed transects provides valuable information to resource managers such as seagrass species distribution, density, abundance, and the deep edge of the meadows. The data from this program has been provided to other agencies for statewide seagrass

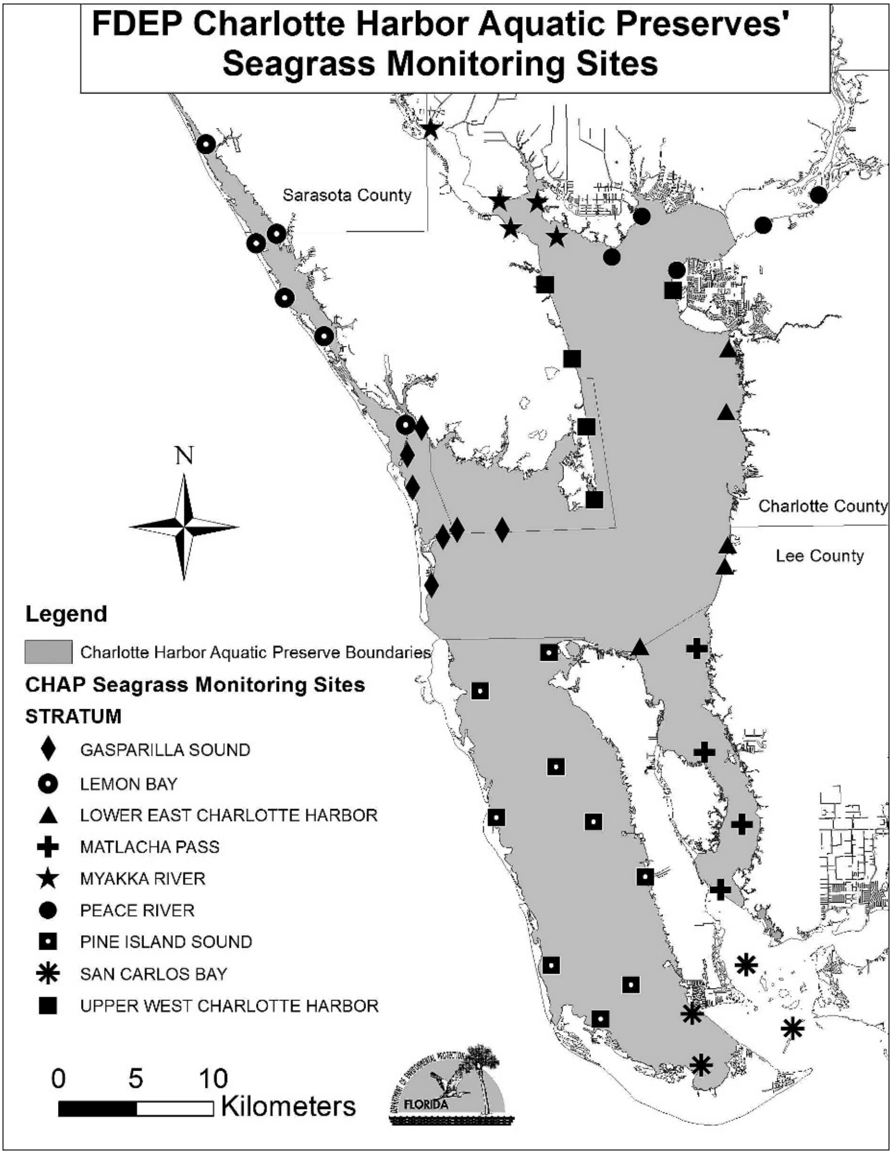

FIG. 1. Florida Department of Environmental Protection (FDEP), Charlotte Harbor Aquatic Preserve's (CHAP) seagrass monitoring sites by region.

reports, establishing water clarity targets based on the seagrass deep edge depth data, and has provided information for regulatory review of activities proposed in the aquatic preserves.

Seagrass meadows are considered to be one of the most productive ecosystems (Larkum et al., 2010), playing an integral role in the estuarine environment by improving water quality, stabilizing sediment, removing

TABLE 1. Braun Blanquet abundance categories for seagrass coverage in a square meter and corresponding code (as seen in graphs).

Code	Braun-Blanquet Abundance %
0	no cover
1	<5
2	5–25
3	26–50
4	51–75
5	76–100

suspended materials from the water column, aiding in nutrient cycling and providing shelter and food for many juvenile estuarine and marine species (Hemminga et al., 2000). Several seagrass characteristics can help determine the ecosystem health and quality of an estuary, including the presence or absence of seagrass, abundance, density, species type, epiphytic growth (plant and animal), blade lengths and the water depth at which they are found. Each year these key parameters are monitored along fixed transects that are representative of a defined waterbody and watershed within the CHAP.

The CHAP will continue to monitor this important submerged resource to track yearly changes in various seagrass characteristics and create summary reports. The FDEP CHAP Seagrass Report (Brown, 2011) is a graphical summary of seagrass species, occurrence, abundance and density between regions and by year from 1999–2009. This paper includes a statistical analysis of the FDEP CHAP's 2011 report, highlighting significant trends and discussion of the results.

MATERIALS AND METHODS—*Field methods*—The CHAP seagrass monitoring program occurs annually throughout late summer and fall (August to November) in order to capture seagrass at its prime abundance. The program includes fifty sites covering an extensive geographic area; from the southern end of Sarasota County in Lemon Bay throughout Charlotte and Lee Counties including five aquatic preserves, San Carlos Bay and the Peace and Myakka River systems. The transect locations (FIG. 1) are influenced by various watersheds and have been grouped accordingly. Each transect starts perpendicular to shore at the beginning of the seagrass bed and ends waterward at the deep edge (the last shoot) of the seagrass bed. Every year, the transects are monitored at fixed repeatable intervals or stations, which are physically marked with PVC stakes and geo-referenced using a sub-meter accuracy Trimble© GPS unit. Transects range from 10m to over 600m long and stations are typically set every 50m, except for transects <50m in length, where stations are set every 10m. At each station, ten parameters are measured within a one square meter quadrat (divided into 100 cm^2 squares) including depth of the water, sediment type, total abundance (using Braun-Blanquet (BB) abundance ranges, Fourqurean et al., 1999; TABLE 1), species type and species abundance, shoot density per species, five blade lengths per species, epiphyte type and epiphyte density, and relative location of the station (i.e. beginning, middle or end of bed). Shoot density is measured for each species at each station using a pre-determined pattern relative to the BB abundance. A BB abundance of 5 would require the shoots counted in only 5 squares (every other square along a diagonal pattern within the quadrat), while every shoot would be counted in a quadrat with a BB of 1. The shoot count measurements are then calculated appropriately in the database as the density of the entire quadrat (i.e. the shoot count number is multiplied by a factor, relative to the BB abundance, to represent a total of 100 squares). Epiphyte densities are recorded as either clean (1), light (2), moderate (3) or heavy (4). All parameters have been measured since 1999, except for total abundance which began in 2004 and density/shoot counts which began in 2005. Detailed monitoring procedures are outlined in the FDEP CHAP protocols (Stearns, 2007).

Analyses methods—The field monitoring data is entered into an Access© database each year following the field survey. Water depths (cm) measured in the field are converted to mean water depths in Excel© using the beginning and ending tide stage for the transect, the closest NOAA benchmark tidal datum and the time recorded at each station. Status and trends by year, hydrological region and species were developed using SPSS© statistical software.

For analyses of BB abundance, the number code associated with the abundance category was used. A BB of 0, or no cover, was included in the analysis of total abundance but not for species abundance, as this relates only to the abundance of a particular species by region and year. The 50 transects were grouped and summarized according to nine hydrological regions: Peace River, Myakka River, Upper West Charlotte Harbor (UWCH), Lower East Charlotte Harbor (LECH), Lemon Bay, Gasparilla Sound, Pine Island Sound, Matlacha Pass and San Carlos Bay (Fig. 1). Individual transect analyses were not examined, as transects were grouped by hydrological region to search for trends. Only the repeatable stations (monitored nine out of the eleven years) along each transect were analyzed for consistency. Beginning and end of bed data were not used for the determination of abundance and density, as the seagrass beds typically vary from year to year in extent. However, deep edge data were used to determine maximum seagrass growth depths.

Assumptions of normality were tested using: 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. Assumptions of linearity were examined using plots of observed versus predicted values and residuals versus predicted values. In addition, assumptions of independence were assessed using autocorrelation function (ACF) and the Durbin-Watson d test. Where the assumptions were violated, data were either transformed or robust nonparametric regressions (Theil-Kendall regression) were used for detection of trends. However, if assumptions were met or the data was transformed, linear regression was used. These statistical methods for trend analyses are those employed by Leary, 2011.

Analyses of flow versus abundance for San Carlos Bay were conducted using the mean annual discharge from the S-79 Franklin Locks and Dam against the average annual abundances of all species combined, *H. wrightii*, *S. filiforme*, and *T. testudinum*. Average abundances were regressed against flow, and included both Pearson's correlation and ANOVA tables. Likewise, paired t-tests were run on flow versus average abundances. In addition, ANOVA with the Brown-Forsythe F test (a modified ANOVA which is robust against heteroscedastic data) and Dunnett's T^3 *post hoc* (a robust *post hoc* test when data are heteroscedastic) comparisons were run for abundances against the years (used as a proxy for mean flow since there was only one value per year) to determine which flow-years were significantly different. Pearson correlation were run correlating Matlacha Pass average annual seagrass (all species combined) and mean annual rainfall in Ft. Myers. A significance value of $p<0.05$ was used to determine if the trends were significant or not.

Results—As a whole, the seagrass parameters measured were stable throughout the region from 1999–2009. There were some decreases in abundance and density in 2004 and 2005, the two years characterized by higher than average rainfall and hurricanes. However, since that period, seagrasses have rebounded with some of the highest recorded abundances and densities in the CHAP monitoring program, and were found at the deepest depths in 2009. Variations in species abundance, occurrence and densities by year and hydrological region were observed over the study period within the

TABLE 2. Percentage of occurrence of seagrass species (including no cover) by year within the CHAP. (H. Species refers to the genus *Halophila.*).

Year	No Cover	H. wrightii	T. testudinum	S. filiforme	R. maritima	H. Sp.
1999	10	46.5	31.5	9.2	1.9	0.8
2000	11.9	47.8	30.4	9.3	0.7	0
2001	16.2	40.5	32	9.5	1.4	0.4
2002	15.5	44.5	31.7	8.3	0	0
2003	19.9	41.3	29.9	8.9	0	0
2004	19.9	41.6	30.1	8.4	0	0
2005	24.3	41	26.5	8.2	0	0
2006	20.3	44.5	27.2	7.9	0	0
2007	15.8	47.4	26.8	9.3	0	0.7
2008	16	47	25.4	8.7	2.8	0
2009	12.5	51.2	27.5	8.8	0	0
Mean	16.6	44.8	29.0	8.8	0.6	0.2

estuary primarily due to the influence of the hydrologic regions' watershed and annual variations in climatic conditions.

Seagrass species occurrence—The three most frequently occurring seagrass species throughout the Charlotte Harbor area are *Halodule wrightii*, *Thalassia testudinum*, and *Syringodium filiforme* occurring approximately 45%, 29% and 9% of the time respectively (TABLE 2). Seagrass absence (i.e. no cover) was observed approximately 17% of the time along consistently sampled transect stations. *Ruppia maritima, Halophila engelmannii* and *Halophila decipiens* are also found in the study area but with no major occurrence or abundance, and were not used for these analyses or for finding the deep edge of bed. *H. wrightii* occurs in all estuary regions, while *T. testudinum* and *S. filiforme* are found in most regions with the exception of the Peace and Myakka Rivers. *S. filiforme* is absent in Matlacha Pass as well. For all regions, Leary (2011) found *H. wrightii* frequency, based on density not occurrence, was significantly increasing over the years ($p=0.030$).

Total abundance—Since the initiation of monitoring total abundance of all seagrass species combined (2004), total abundance has increased significantly ($p<0.001$) from an average BB of 1 to 2 (FIG. 2). Gasparilla Sound has the most abundant seagrass (BB of 2) over the 2004–2009 time period, while Myakka and Peace Rivers have the lowest average total abundances (BB of 0.5 and 0.4 respectively). Six of the nine regions showed significant increasing coverage trends from 2004–2009 (Peace River $p=0.004$, Myakka River $p=0.025$, UWCH $p<0.001$, LECH $p<0.001$, Gasparilla Sound $p=0.002$ and San Carlos Bay $p<0.001$; Leary, 2011). The three remaining stratum show increasing, but non- significant trends in total BB abundance.

Species abundance—Throughout the study area from 1999–2009, *H. wrightii* was the only species to have a significant increasing trend in

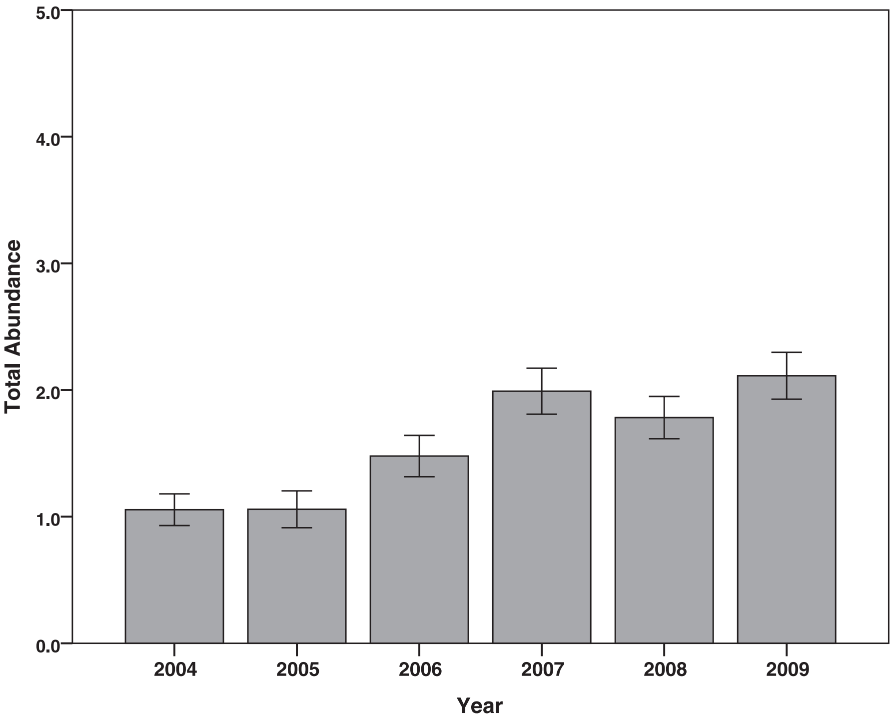

FIG. 2. Mean annual Braun-Blanquet (BB) total quadrat abundance (+/− SE) for the three major seagrass species, including no cover, over the period of record (2004–2009) for the CHAP study area.

abundance ($p<0.001$). By region, *H. wrightii* abundance increased significantly in San Carlos Bay ($p<0.001$), Myakka River ($p=0.019$), UWCH ($p< 0.001$), LECH ($p<0.001$) and Matlacha Pass ($p<0.001$). Lemon Bay and San Carlos Bay had significant declines in *T. testudinum* abundances ($p=0.025$ and $p<0.001$ respectively), and *S. filiforme* decreased significantly in Lemon Bay ($p=0.025$). With all years combined, Gasparilla Sound had the highest average abundances of *H. wrightii* (BB of 2) and *S. filiforme* (BB of 3), while the LECH region had the highest average abundance of *T. testudinum.* The Peace and Myakka Rivers had the lowest average *H. wrightii* abundance (BB of 1); while the lowest average abundances of *T. testudinum* and *S. filiforme* (BB of 2) occur in San Carlos Bay.

Region wide, all three seagrass species displayed a decline in species abundance during the years 2002–2005. Species abundance then increased with the abundances from 2007–2009 similar to 1999–2001 coverages. San Carlos Bay and Matlacha Pass were the only two regions with decreases in seagrass coverage in 2005 for all species present (FIG. 3). San Carlos Bay mean annual seagrass abundance (all species combined) significantly declined in 2005 ($p<0.001$), which was significantly different from all other years (p ranges from

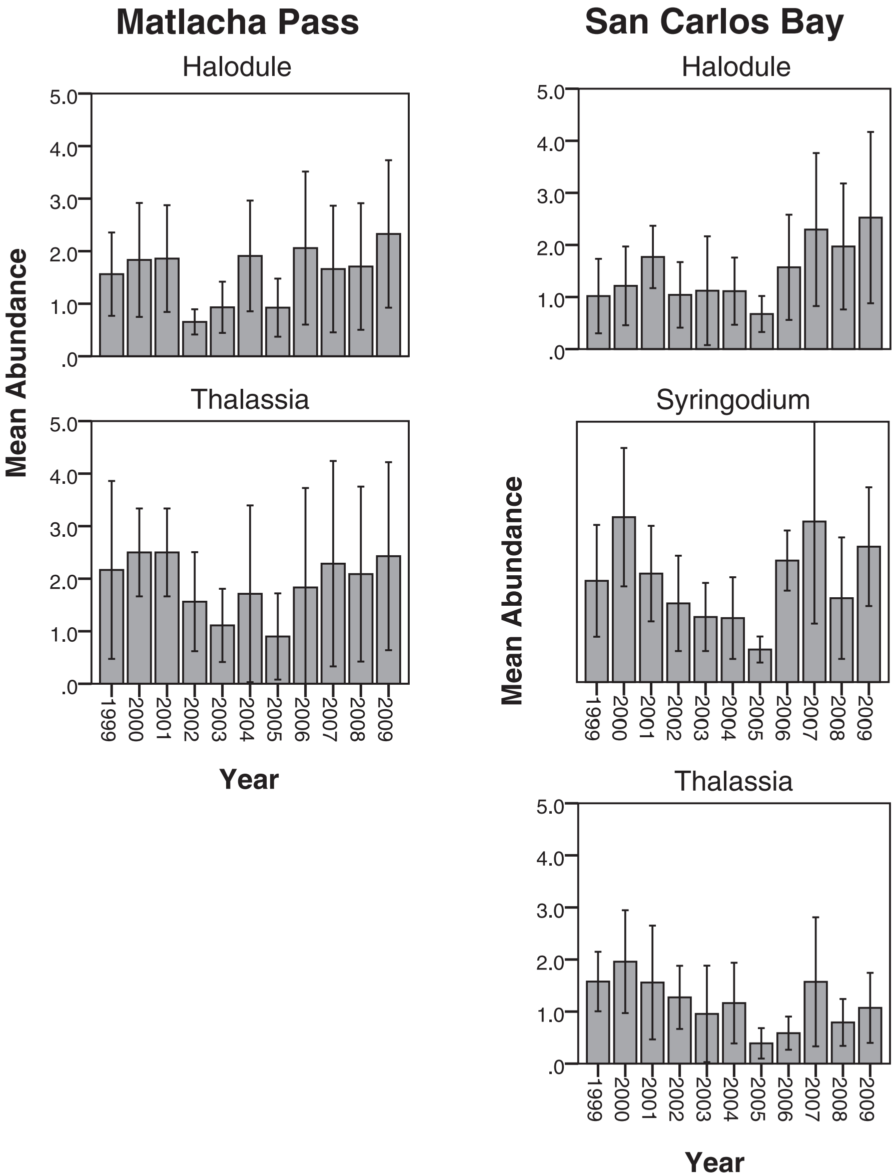

FIG. 3. Mean BB abundance (+/− SD) by species and year for Matlacha Pass and San Carlos Bay over the study period (1999–2009).

0.020 for 2003 and 2006 to <0.001 for all other years) and was negatively influenced by the Caloosahatchee River flow (p=0.001). Matlacha Pass seagrass abundance was negatively correlated to annual rainfall (−0.774, p=0.005), not flow.

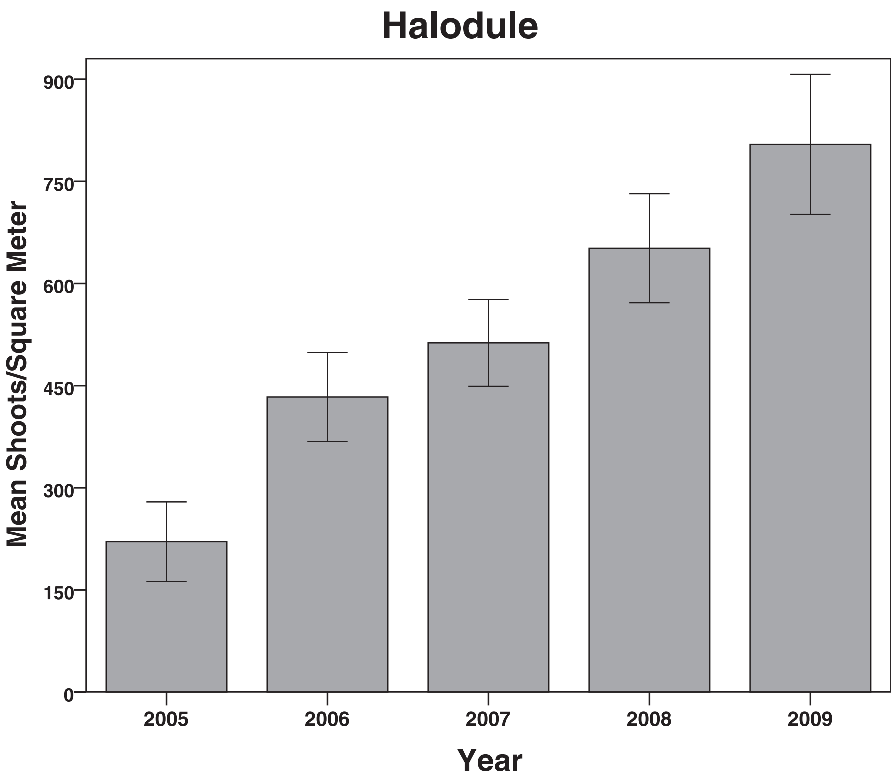

FIG. 4. *Halodule wrightii* mean annual shoots per square meter (+/− SE) over the CHAP study area from 2005–2009. (Note: shoot counts were not conducted before 2005).

Shoot density—Recording shoot counts, or density, per species within each quadrat began in 2005. The highest densities of *H. wrightii, T. testudinum* and *S. filiforme* occurred in 2009. Across the study area, mean *H. wrightii* shoot counts significantly increased from 2005 to 2009 ($p<0.001$); from 221 to 841 shoots/m^2 (FIG. 4). Myakka and Peace Rivers, Gasparilla Sound and San Carlos Bay all had significantly increasing trends in densities for *H. wrightii* ($p=0.007$, $p=0.013$, $p=0.002$ and $p<0.001$ respectively) and for all seagrass species combined ($p=0.017$, $p=0.014$, $p=0.002$ and $p<0.001$ respectively). UWCH and LECH had significant increasing trends for all species combined ($p=0.023$ and $p=0.004$ respectively), while Pine Island Sound had an increasing trend in *H. wrightii* density ($p=0.028$).

Over the five years that density was measured, Lemon Bay and Gasparilla Sound regions had the highest mean *H. wrightii* densities at 907 and 856 shoots /m^2 respectively. The average density of *S. filiforme* was 562 shoots/m^2, throughout all the regions, with the highest occurring in 2009 (631 shoots/m^2). Gasparilla Sound had the highest average density of *S. filiforme* (744 shoots/ m^2) with all years combined. *T. testudinum* densities were highest in 2009

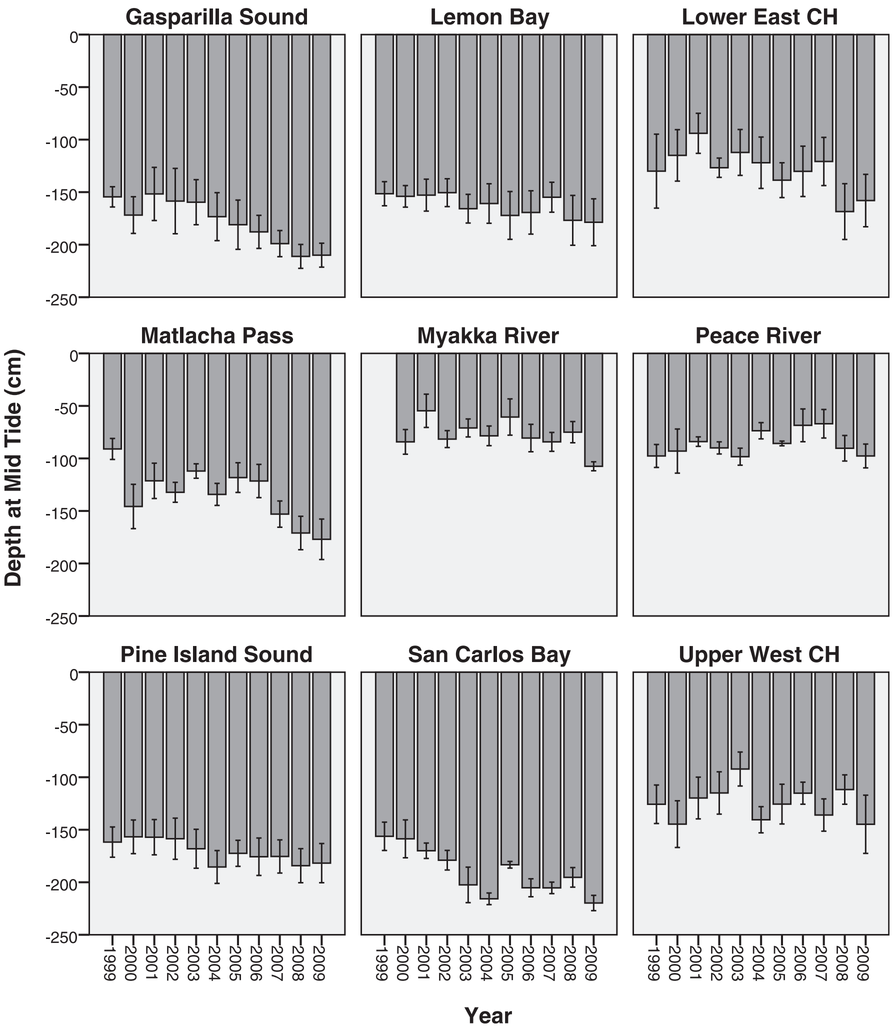

FIG. 5. Deep edge seagrass mean depth (+/− SE) by region over the study period.

throughout all the regions, with LECH having the greatest densities (281 shoots/m^2) and San Carlos Bay having the least (43 shoots/m^2).

Deep edge—On average, across the study area, the maximum depth of seagrass growth (deep edge) increased significantly from 1999 (−1.42 m) to 2009 (−1.69 m; $p=0.006$). San Carlos Bay has, on average, the deepest growing seagrass growing (−1.91 m), followed by Gasparilla Sound (−1.77 m), Pine Island Sound (−1.71 m) and Lemon Bay (−1.63 m; FIG. 5). From 1999 to 2009, deep edge measurements trended significantly deeper only in the San Carlos Bay ($p=0.001$), Matlacha Pass ($p=0.001$), Gasparilla Sound ($p<0.001$), and LECH ($p=0.017$) regions.

Epiphytes—From 1999–2009, epiphyte densities have increased significantly ($p<0.001$) over the study area. Regionally across all seagrass species, epiphyte density significantly increased in Pine Island Sound ($p=0.014$), Matlacha Pass ($p<0.001$) and San Carlos Bay ($p<0.001$), while there were significant decreasing trends in UWCH ($p=0.040$) and Gasparilla Sound ($p=0.017$). *T. testudinum* epiphyte densities decreased significantly in Lemon Bay ($p<0.001$), UWCH ($p<0.001$), LECH ($p=0.005$), and Gasparilla Sound ($p<0.001$) while epiphyte densities for *H. wrightii* increased in LECH ($p=0.031$), Pine Island Sound ($p<0.001$), Matlacha Pass ($p<0.001$) and San Carlos Bay ($p<0.001$) over the study period. The majority of epiphyte densities were characterized as light or moderate, with *T. testudinum* exhibiting more moderate to heavy loading than the other two species. *H. wrightii's* heaviest loading occurred in San Carlos Bay, while the heaviest loading on *T. testudinum* and *S. filiforme* occurred in UWCH and Lemon Bay, respectively.

Discussion—The overall trends in seagrass abundance and density over the study area and period correspond well with one another. The trends are influenced by several interacting variables, but a primary driver for the overall trends appears to be related to the amount of freshwater the watershed and estuary received. Freshwater influence from seasonal rainfall as well as natural and anthropogenic flow, can lead to a decline in salinity and water quality (i.e. increases in nutrients, chlorophyll a, color, turbidity, etc.) in the receiving estuary (McPherson and Miller, 1987). Color, chlorophyll and other suspended matter, such as turbidity, are primary factors causing reduced water clarity and light penetration to the seagrass beds (McPherson and Miller, 1987; Corbett et al., 2005; Greenawalt-Boswell et al., 2006). Water clarity increases with increased salinity levels, therefore reduced water clarity as a result of freshwater flow can cause adverse conditions for optimum seagrass growth from decreased light penetration (Johansson, 2000; Tomasko et al., 2001; Doering et al., 2002; Corbett et al., 2005; Greenawalt-Boswell et al., 2006). Losses of seagrass coverage in Tampa Bay, Sarasota Bay and Upper Charlotte Harbor have been linked to reduced water clarity from increased freshwater inflow and stormwater runoff (Tomasko et al., 2005). Seagrass in the CHAP region is highly influenced by freshwater flows from the Caloosahatchee, Peace and Myakka Rivers.

Species occurrence is dependent on salinity, and areas that are subject to freshwater flow and high variations in salinity, such as the Peace and Myakka Rivers, cannot support stable seagrass populations (Greenawalt-Boswell et al., 2006). The Peace and Myakka Rivers do in fact have the lowest occurrence, abundance and densities of seagrass, as well some of the lowest salinities and water clarity in the Charlotte Harbor complex (Duffey et al., 2007). Seagrass beds near the Caloosahatchee River are also influenced by changes in salinity, and the quantity and timing of freshwater flows are especially important in this region as it can be controlled through the gate and lock system upstream (McPherson and Miller, 1987; Doering et al., 2002; Corbett et al., 2005).

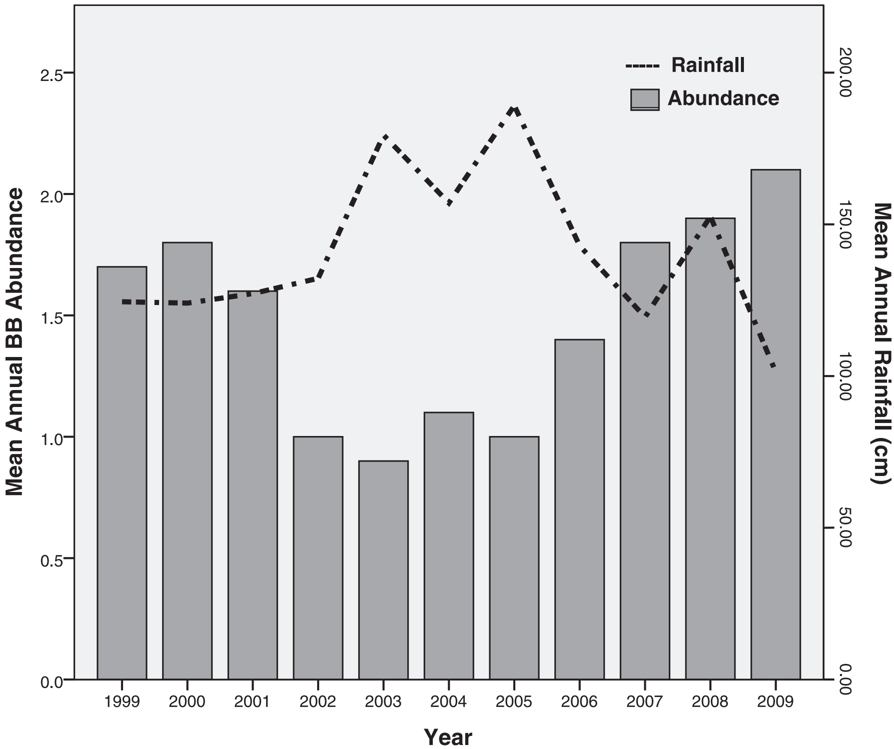

FIG. 6. Mean *H. wrightii* BB abundance for the CHAP study area over the study period in relation to mean annual rainfall in Ft. Myers, FL.

According to Florida State University's Florida State Climate Center (2010), Ft. Myers' lowest average annual rainfalls over the study period occurred in 1999, 2000, 2007 and 2009, with 2009 having the lowest average annual rainfall (101.3 cm). In response to the low rainfall, it appears that seagrasses such as *H. wrightii,* flourished, having the highest abundances and densities during the dry years (FIG. 6). Corbett (2006) also documented increases in aerial seagrass coverage during the drought conditions of 1999 to 2002. The years 2003, 2004, 2005 and 2008 mark some of the wettest years of the study period, with the numerous tropical storms and hurricanes that inundated southwest FL in 2004 (Hurricane Charley) and 2005 (Hurricane Wilma). In 2005, the region experienced 189.1 cm of rain (FSU, 2010), the highest recorded during the study period which likely contributed to a decline in species' abundance (FIG. 6) and the lowest densities in the study period. In Matlacha Pass, annual rainfall was negatively correlated to species abundance. Dawes and Avery (2010) found that *H. wrightii* coverage in Hillsborough Bay (Tampa, FL) decreased as well during the wet hurricane years of 2003–2005.

The frequency of freshwater releases through the gate and lock system on the Caloosahatchee River also increased in response to high rainfall conditions.

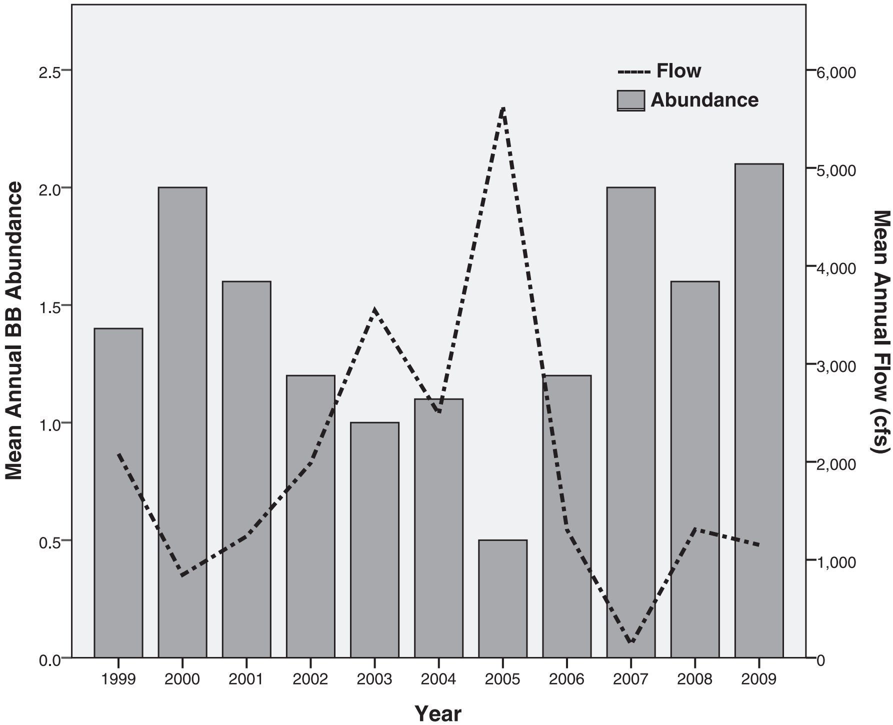

FIG. 7. Mean BB abundance of seagrasses in San Carlos Bay by year in relation to mean annual flow at the S-79 lock on the Caloosahatchee River.

Freshwater discharges from this highly managed system enter into southern Matlacha Pass and San Carlos Bay. During the study period, measured flows at the western most lock (S-79) were the highest in July 2005 (reaching 22,156 cfs), according to the SFWMD (2010). Hurricane Wilma also passed through the study area Oct. 24, 2005, generating high rainfall and flow events. As a result, southern Matlacha Pass and San Carlos Bay experienced a low fluctuating salinity environment which has been shown to be a significant factor in causing a decline in seagrass abundance (Corbett et al., 2005; Greenawalt-Boswell et al., 2006). The high flows through the S-79 lock negatively impacted seagrass abundance in San Carlos Bay (FIG. 7), as this region experienced a significant decline in abundance in 2005. Compared to other years, 2005 seagrass abundance in San Carlos Bay was found to be significantly different. Corbett et al. (2005) also related high discharge years to lower seagrass coverage due to low salinity and/or lower light availability. One particular transect in San Carlos Bay, closest to the mouth of the Caloosahatchee River, lost *T. testudinum* (a species that prefers high salinity waters) at all stations after the high flow event and the low salinity environment caused by Hurricane Wilma. Flows averaged 11,450 cfs within the 16 days after Wilma and salinity at the nearby CHAP continuous water quality station averaged 7.2 ppt ten days prior to monitoring the seagrass transect on Nov. 9, 2005 and reached as low as 3.5 ppt on Nov.4th. Doering and Chamberlain (2000) noted that *T. testudinum* is negatively impacted between salinity values of 6–12 ppt, and mortality of *H. wrightii* shoots begin below 6 ppt (Doering et al., 2002). The quantity and duration of the Caloosahatchee high freshwater flows created a low and variable salinity environment resulting in the disappearance of *T. testudinum* at this transect from 2005–2009, as well as the decrease in all San Carlos Bay's seagrass species abundance in 2005 and *T. testudinum* abundance over the study period.

Hurricane related freshwater discharges have affected seagrasses on the southeast coast of Florida (Loxahatchee River Estuary) as well. *S. filiforme* declined one month after hurricanes Frances and Jeanne in 2004 due to the high daily salinity fluctuations that resulted from the freshwater discharges (Ridler et al., 2006).

Even though San Carlos Bay has been subjected to high flow events from the Caloosahatchee River, this region has on average, from 1999–2009, the deepest growing seagrasses for all species combined (−1.91 m, FIG. 5). This may be due to the fact San Carlos Bay is a deeper waterbody compared to the other shallow estuaries of the study area, but Duffey et al. (2007) noted San Carlos Bay to have above average water clarity and found a significant increase in secchi depth (clarity) from 1998–2005.

Several environmental and anthropogenic factors negatively influence seagrass health within the CHAP other than salinity fluctuations. Nutrient over-enrichment in the water column can lead to harmful algal and epiphytic growth while frequent activities such as boating, trawling, and coastal land development (including dredging and filling) can cause an increase in turbidity (Burkholder et al., 2007; McGlathery, 2001). Together, turbidity and excess nutrients can cause a reduction in water clarity therefore leading to seagrass decline (Burkholder et al., 2007; Tomasko, 2005). Burkholder et al. (2007) and Orth (2006) explain that "other human-related changes such as increased temperatures from global warming, exotic species introductions, and trophic imbalances that lead to overgrazing may also interact with nutrient enrichment and other stressors to cause seagrass declines."

While some of the detrimental factors to seagrass are not directly manageable, such as reduced salinity due to high rainfall and storm events, others could be more effectively managed. For example, impacts from boat propeller scarring and harmful artificial releases of freshwater could be managed in an effort to support healthy and diverse seagrass beds within the CHAP.

The results from this monitoring program highlight the variability of seagrass beds found within CHAP over the study period. Specific trends in seagrass density and total abundance were dependent upon on when the parameter was first collected. In order to properly characterize long term trends, the CHAP seagrass monitoring program will continue providing a critical tool to capture annual abundance, densities, species composition, and deep edge of bed trends. These monitoring data play an integral role in assessing seagrass and estuarine health. Linking additional water quality parameters and future clarity trends to the CHAP seagrass monitoring program data will be critical to the management of the Charlotte Harbor estuarine system.

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