Seagrass Annual Data Summary
From the
Charlotte Harbor & Estero Bay
Aquatic Preserves
Seagrass Transect Monitoring Program

1999-2006

Prepared September 2007
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Introduction

Seagrasses are submerged flowering plants important for sustaining the diversity and health of marine environments, particularly shallow estuaries such as Charlotte Harbor and Estero Bay. Seagrasses provide primary food sources as well as shelter, spawning and nursery habitat to a great diversity of aquatic organisms. They also reduce turbidity, facilitate sediment stabilization and aid in nutrient cycling.

Seagrass distribution and health are primarily determined by salinity and the amount of light penetrating through the water column. Seagrass growth is thus affected by water quality variables such as color and suspended matter, including turbidity and chlorophyll from algae. Epiphytic growth on seagrass blades also reduces light available for growth. Together, these factors largely regulate which seagrass species grow where, to what depths, and at what abundances.

The state of Charlotte Harbor and Estero Bay seagrass habitats have become an important issue within the past two decades as understanding of the value of these resources has risen. Despite recognition, there has been documented decline in their abundance. This summary aims to become a tool in providing critical information to resource managers to assess the status of this resource.

Aquatic Preserves

The Charlotte Harbor estuarine complex make up one of the most pristine and productive coastal ecosystems in the state. These seven interconnected estuaries comprise over 170,000 acres of diverse, complex and fragile estuarine habitats. With growing appreciation for these areas, Florida enacted the Aquatic Preserve Act of 1975. This ensured these exceptional submerged resources could be set aside to be preserved in essentially natural condition to be enjoyed by future generations.

Regionally, there are six Aquatic Preserves administered by the Florida Department of Environmental Protection. Five of these are managed out of Punta Gorda as the Charlotte Harbor Aquatic Preserves (CHAPs) including: *Lemon Bay*; *Gasparilla Sound – Charlotte Harbor*; *Cape Haze*; *Pine Island Sound*; and *Matlacha Pass*. Estero Bay Aquatic Preserve (EBAP) is managed from an office located on Fort Myers Beach.

Aquatic Preserves are submerged lands with exceptional biological, aesthetic and scientific values managed to sustain their natural resources for the public's continued enjoyment. This goal is accomplished through resource management, resource protection, research, and education.

Background to Program

Historically, aerial surveys have been the most widely used tool for mapping seagrasses. They are valuable for estimating seagrass locations, acres, and broad changes over time. However, additional information is needed to determine localized changes over time including seagrass

species, abundance, health, and zonation relative to depth and water quality. This information will ensure effective management of these resources.

One of the resource management goals of our Aquatic Preserve program is to protect and enhance the health and functioning of seagrass habitats. Identifying additional seagrass species information provided by long-term transect monitoring is an essential resource management tool towards this goal. Another major focus of the transect monitoring is to explain the link between water quality and seagrass health. By defining this link, resource managers are more able to predict the response of seagrass to changes in water quality. This information provides sound criteria for resource management practices and conservation of our Aquatic Preserves and their watersheds.

Program Overview

Preliminary seagrass monitoring was conducted in 1998 for the Charlotte Harbor Aquatic Preserves using established protocols from SWFWMD and Sheda Ecological, Inc. Beginning in 1999, all sites throughout the CHAPs have been monitored annually by field staff with assistance from agency and citizen volunteers. Seagrass monitoring in the Estero Bay Aquatic Preserve began in 2003.

Throughout the Charlotte Harbor Aquatic Preserves study area, 50 seagrass monitoring sites have been established. Estero Bay Aquatic Preserve study area manages five monitoring sites. These sites were chosen to be widely distributed, representative of seagrass conditions in specific locations, and of adequate length for field personnel to monitor. See site map on page 7 for locations.

At each site, a "transect" is established along a fixed line from the shallow, shoreward edge of the seagrasses to the deep, waterward edge. Transect lengths vary from approximately 10 to 600 meters throughout the study areas depending on bathymetry and water clarity. At regular intervals along each transect, detailed information such as seagrass species, abundance, and density is collected using a one square meter "quadrat". In addition to these regular intervals, data on the beginning and end of the grass bed is collected on an annual basis.

All CHAPs seagrass transects are monitored annually in the fall during post-growing season, generally September through November. All EBAP sites are monitored biannually, in the dormant (February) and growing season (August). Information collected by this monitoring program may be obtained directly from the Charlotte Harbor Aquatic Preserves office in Punta Gorda.

Purpose of Summary

Seagrass has become a critical indicator species for the health of our estuary. This summary provides an outlet for the annual observation of the health and functioning of this vital resource. The questions to be answered by this analysis relate to defining baseline and annual trends in seagrass species distribution, abundance, and maximum depth of growth within the different regions of the study areas.

This summary is a tool for CHAPs and EBAP resource managers to be used to help fulfill our goal of protecting and enhancing the health and functioning of seagrass habitats. It allows us to capture an overall view of the quality and long-term health on an annual basis.

The CHAPs and EBAP seagrass transect monitoring covers the coastal areas throughout the Charlotte Harbor National Estuary Program (CHNEP) study area. The monitoring methods used to collect the seagrass data also make it valuable to the CHNEP as an environmental indicator. It allows them to assess progress toward achieving quantifiable objective FW-1a to "maintain the extent and quality of native submerged aquatic vegetation". In addition, the seagrass data is used by the CHNEP to set resource-based water quality targets throughout the region, in lieu of regulatory-based criteria.

Methodology

For this analysis, seagrass transect data was grouped into geographic regions. These estuary regions are defined as having similar hydrologic conditions, particularly in relation to salinity and water clarity because of their strong relationship with the spatial characteristics of seagrass. In regions where transects were on the border, decisions were also partially based on having a good number of samples in each region. In addition, hydrologic strata used by the Coastal Charlotte Harbor Water Quality Monitoring Network were used to assist with the delineation of seagrass regions in this analysis. See map of seagrass regions on page 7.

In particular, the *Upper West Charlotte Harbor* and *Lower East Charlotte Harbor* regions need additional clarification. These regions were largely based on their relationship to tidal and riverine influences. Gulf water entering Charlotte Harbor through the Boca Grande Pass has the tendency to move toward the east wall of the Harbor and run north, thus impacting transects in the *Lower East Charlotte Harbor* region similarly. In contrast, sites along the west wall of the Harbor and tip of Punta Gorda are influenced more strongly by waters moving down from the Peace and Myakka Rivers lending to the clustering of these transects into the *Upper West Charlotte Harbor* region.

There are two study areas in this summary: the Charlotte Harbor Aquatic Preserves and the Estero Bay Aquatic Preserve study areas. These study areas are managed by the same agency but from different offices as previously noted. For management purposes, data from the two study areas were analyzed separately. Nevertheless, they are both included in this summary as they use the same monitoring methods and were established for the same purpose.

This summary defines data relative to those fixed intervals or "quadrats" located along individual transects. Over the duration of the program, effort has been made to capture as much information as possible at these quadrats. For purposes of analysis, quadrats were reviewed to ensure that consistent data sets were available at each of these points. For the CHAPs quadrats, limitations were set so that only points with at least six out of the eight years of data were included. For EBAP sites, each quadrat had to have at least three out of the four years of data to be included in the analysis. This allowed for the number of quadrats in the analysis to be as standardized as possible, making for stronger interpretation. Quadrats at the beginning and end

of grass beds were also eliminated from the analysis due to their lack of consistent monitoring due to bed shift from year to year.

Report Summary

Seven specific questions are addressed by this summary. They include:

1) How frequently does each seagrass species occur (including no cover*)?

2) How are the 3 most common seagrass species distributed (including no cover*)?

3) What is the TOTAL abundance of all seagrass species combined?

4) What is the abundance of the 3 most common seagrass species?

5) How dense are the 3 most common seagrass species?

6) What is the maximum depth of seagrass growth?

7) How heavy are the epiphytes on the 3 most common seagrass species?

*Note: Quadrats defined as *no cover* are locations where the seafloor is unvegetated.

For each question, a subset of analysis was addressed that includes:

Analysis A: Comparison of Years

Analysis B: Comparison of Regions

Analysis C: Comparison of Years by Region

Data for these questions were generated through queries from an Access database managed by the CHAPs. These queries were then imported into SPSS, a statistical analysis software. Graphical representation of the data generally includes bar graphs with a variation (either standard error or deviation depending on sample size) around a mean value.

In Analysis A, CHAPs and EBAP study areas were split for graphing purposes as a result of the difference in time periods (CHAPs 1999-2006; EBAP 2003-2006) to allow for more valuable interpretation. In addition, only the growing season (August) subset of EBAP data was analyzed to correspond more closely with CHAPs monitoring season, allowing for more robust analysis.

Questions 3 and 4 relate to seagrass abundance. The standard classification of seagrass coverage is the Braun-Blanquet method which is used in this analysis. This method categorizes seagrass abundance in a quadrat as percent cover classes. The coverage classes are defined as follows: **r** = solitary; **+** = few; **1** = <5%; **2** = 5 - 25%; **3** = 26 -50%; **4** = 51 - 75%; and **5** = 76 - 100%. You will notice that the graphs for these questions are scaled from 0.0 through 5.0 which relate back to these coverage classes.

Question 5 relates to density for each seagrass species. The CHAPs began monitoring for density using a well-defined shoot count method in 2005 to better characterize the health of

seagrass. Quadrats are first assigned a Braun-Blanquet coverage class and then based on that number, a pre-determined pattern of shoots are counted. This number is then mathematically computed and given as the average density of the quadrat. Please note that the scales used for this analysis are species-specific. For additional Braun-Blanquet and shoot count information, please contact the Charlotte Harbor Aquatic Preserves office.

Question 7 relates to epiphytic growth on seagrass blades. This growth plays a significant role in the health of seagrasses. Seagrass provides a substrate for a myriad of marine organisms including snails, barnacles and algae. In highly eutrophic environments, this growth can explode and significantly block seagrass blades from receiving light. For our analysis, epiphytes are classified in relation to their density as clean, light, moderate, or heavy growth.

In all questions, the three most dominant seagrass species of concern are *Halodule wrightii* (Shoal grass), *Thalassia testudinum* (Turtle grass), and *Syringodium filiforme* (Manatee grass).

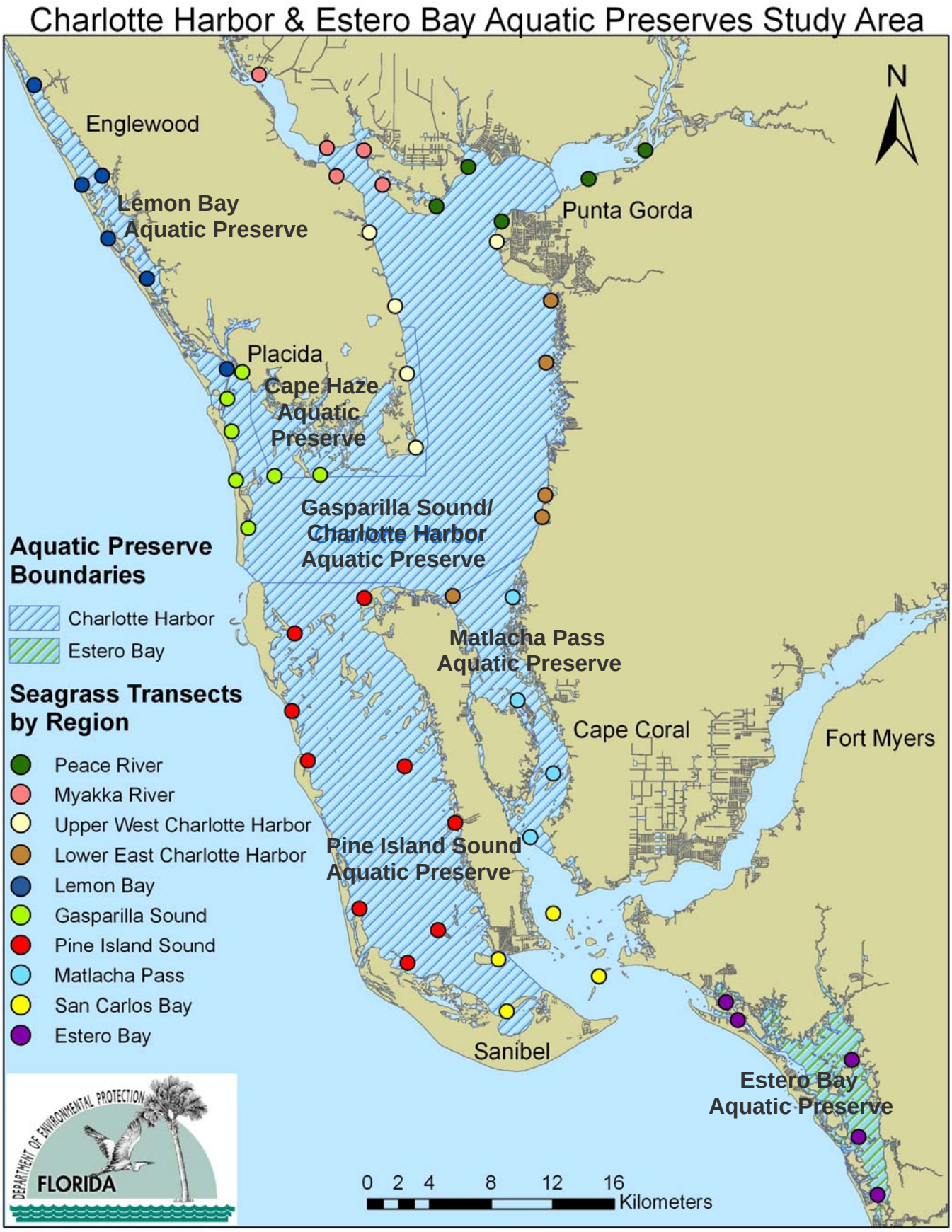
Conclusion

This 1999-2006 CHAPs and EBAP Seagrass Annual Data Summary is an important step towards providing essential information about the health of seagrasses throughout the Charlotte Harbor estuarine complex. It is intended to provide a tool for resource managers in creating strategies for the long-term viability of this critical habitat. By observing yearly changes and reporting them, we are able to capture an up-to-date status of this resource.

Long-term goals include updating this summary annually after the completion of every monitoring season. There is also an expressed interested in linking this information with water quality data. This will broaden the scope in order to gain insight about the strong relationship water quality can play on these habitats.

Acknowledgements

This summary was produced with the technical assistance from the Charlotte Harbor National Estuary Program. Special thanks go to Jaime Greenawalt-Boswell for providing assistance with the design and implementation of this summary in support of the CHNEP's environmental indicators. Thanks to all of the Charlotte Harbor Aquatic Preserves staff including Judy Ott, Mindy Schneider, Ray Leary and Heather Stafford for their thoughtful review and support. Thanks to Stephanie Erickson from the Estero Bay Aquatic Preserve for providing and entering monitoring data. Thanks to Renee Duffey from the Charlotte Harbor Environmental Center for her technical support with statistical analyses. Finally, generous contribution from partnership agencies and volunteers for their hard work in assisting with data collection are thanked for their invaluable assistance and ensured success of this program.


Charlotte Harbor & Estero Bay Aquatic Preserves Study Area
N
Englewood
Lemon Bay
Aquatic Preserve
Punta Gorda
Placida
Cape Haze
Aquatic
Preserve
Gasparilla Sound/
Charlotte Harbor
Aquatic Preserve
Aquatic Preserve
Boundaries
Charlotte Harbor
Estero Bay
Seagrass Transects
by Region
Peace River
Myakka River
Upper West Charlotte Harbor
Lower East Charlotte Harbor
Lemon Bay
Gasparilla Sound
Pine Island Sound
Matlacha Pass
San Carlos Bay
Estero Bay
Matlacha Pass
Aquatic Preserve
Cape Coral
Fort Myers
Pine Island Sound
Aquatic Preserve
Sanibel
Estero Bay
Aquatic Preserve
DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Question 1: How frequently does each seagrass species occur (including no cover)?

Analysis A: Comparison of Years

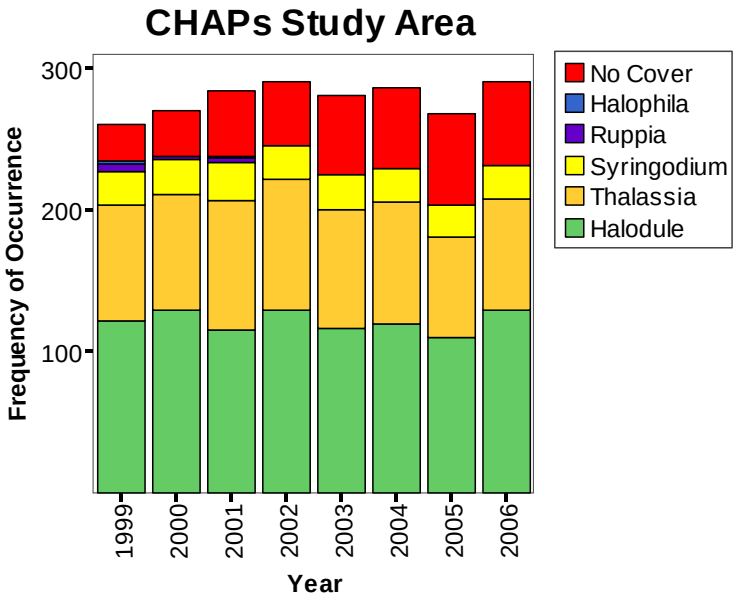


Figure 1.1. Frequency of occurrence of seagrass species and no cover over the period of record (1999-2006) for the entire Charlotte Harbor Aquatic Preserves study area.

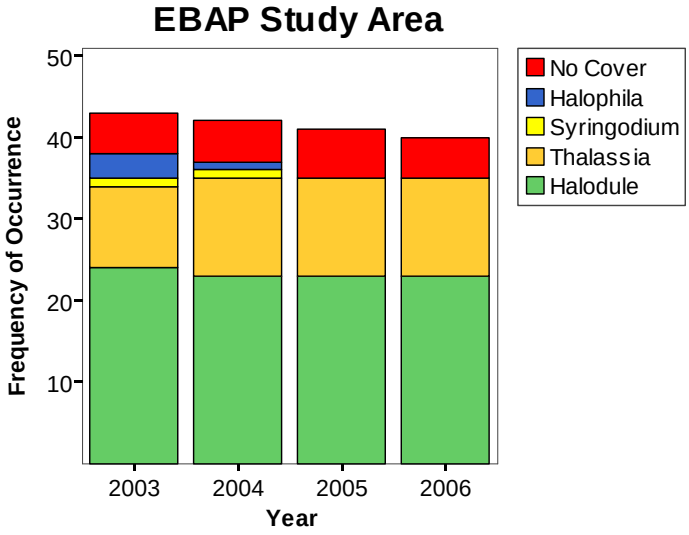


Figure 1.2. Frequency of occurrence of seagrass species and no cover over the period of record (2003-2006) for the Estero Bay Aquatic Preserve study area.

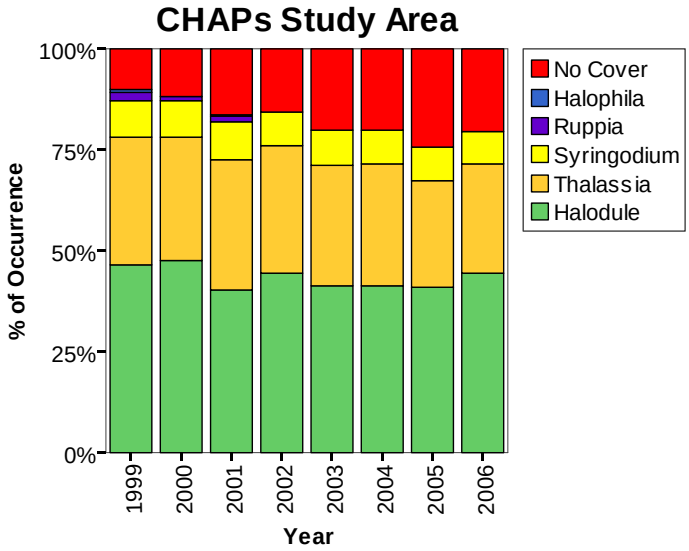


Figure 1.3. Percentage of occurrence of seagrass species and no cover over the period of record (1999-2006) for the entire Charlotte Harbor Aquatic Preserves study area.

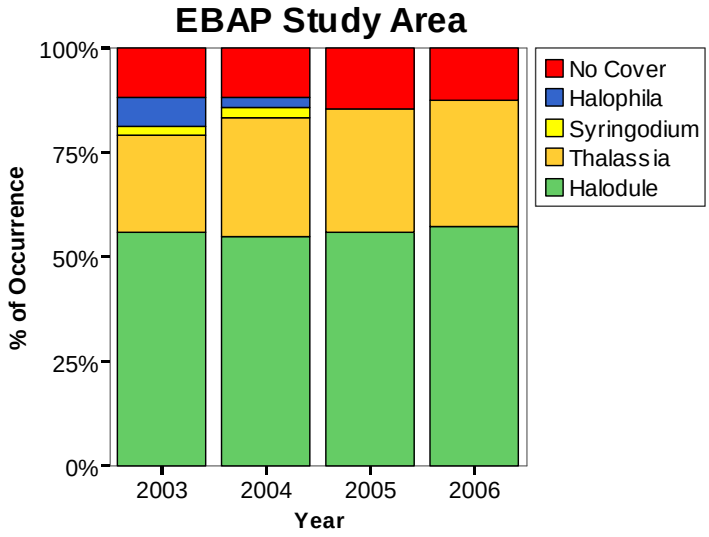


Figure 1.4. Percentage of occurrence of seagrass species and no cover over the period of record (2003-2006) for the Estero Bay Aquatic Preserve study area.

Analysis B: Comparison of Regions

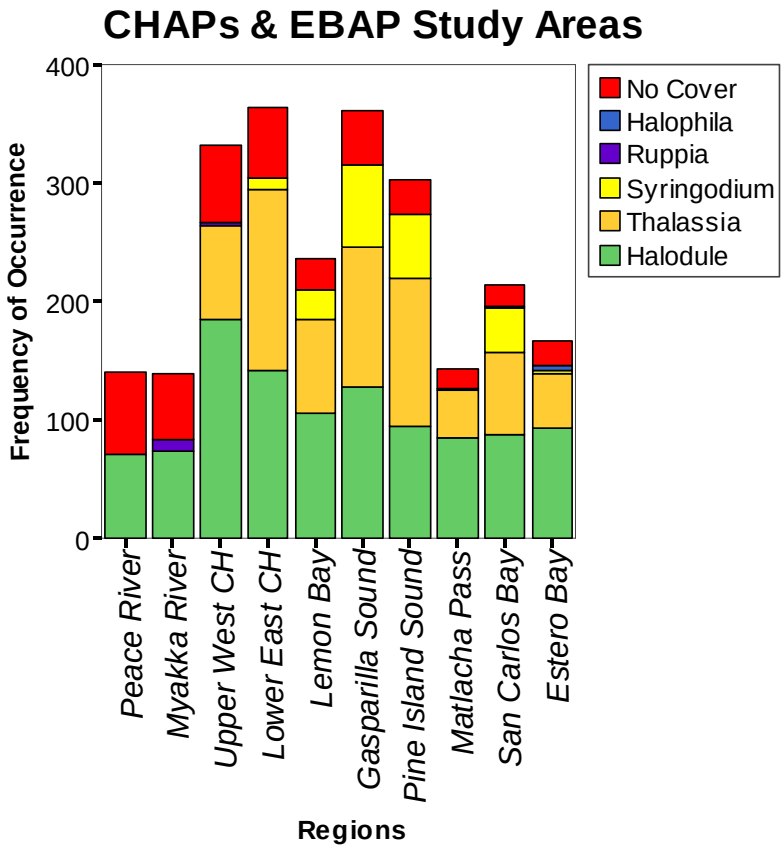


Figure 1.5. Frequency of occurrence of seagrass species and no cover for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

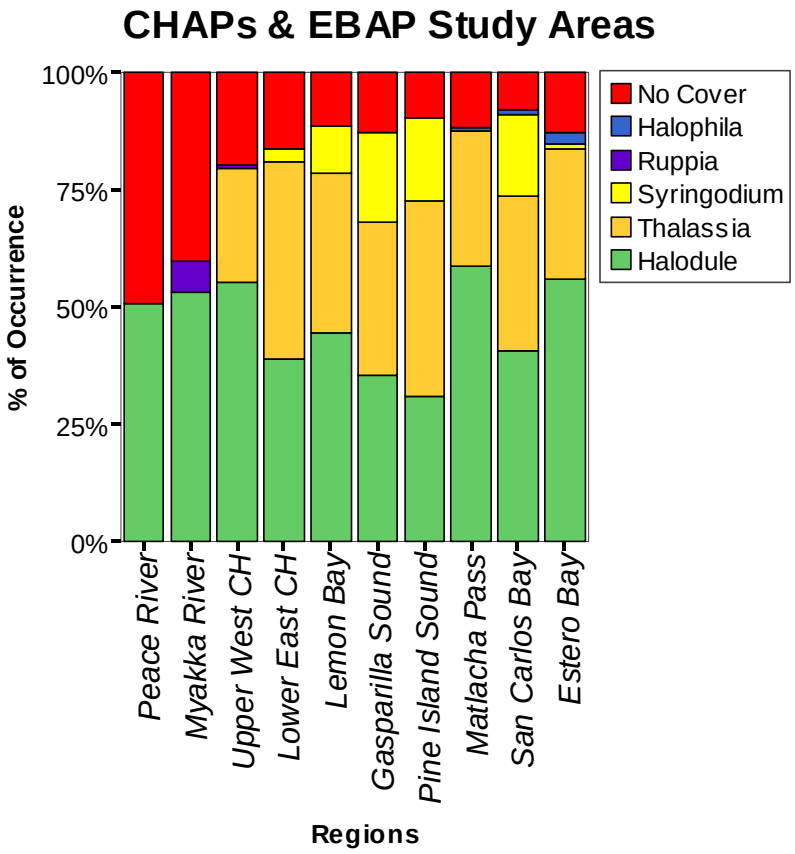


Figure 1.6. Percentage of occurrence of seagrass species and no cover for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

Analysis C: Comparison of Years by Region

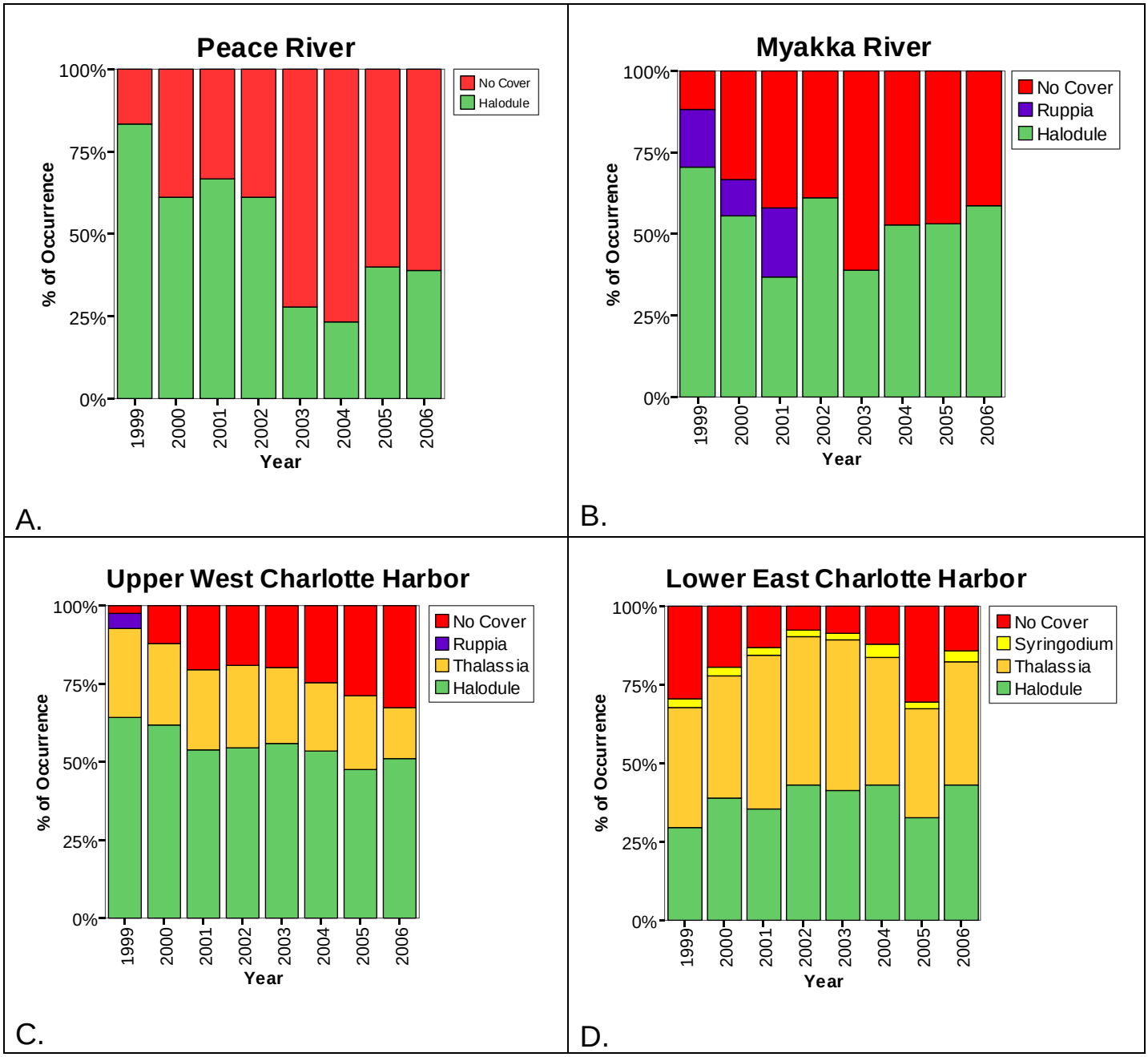


Figure 1.7 (A-D). Percentage of occurrence of seagrass species and no cover for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

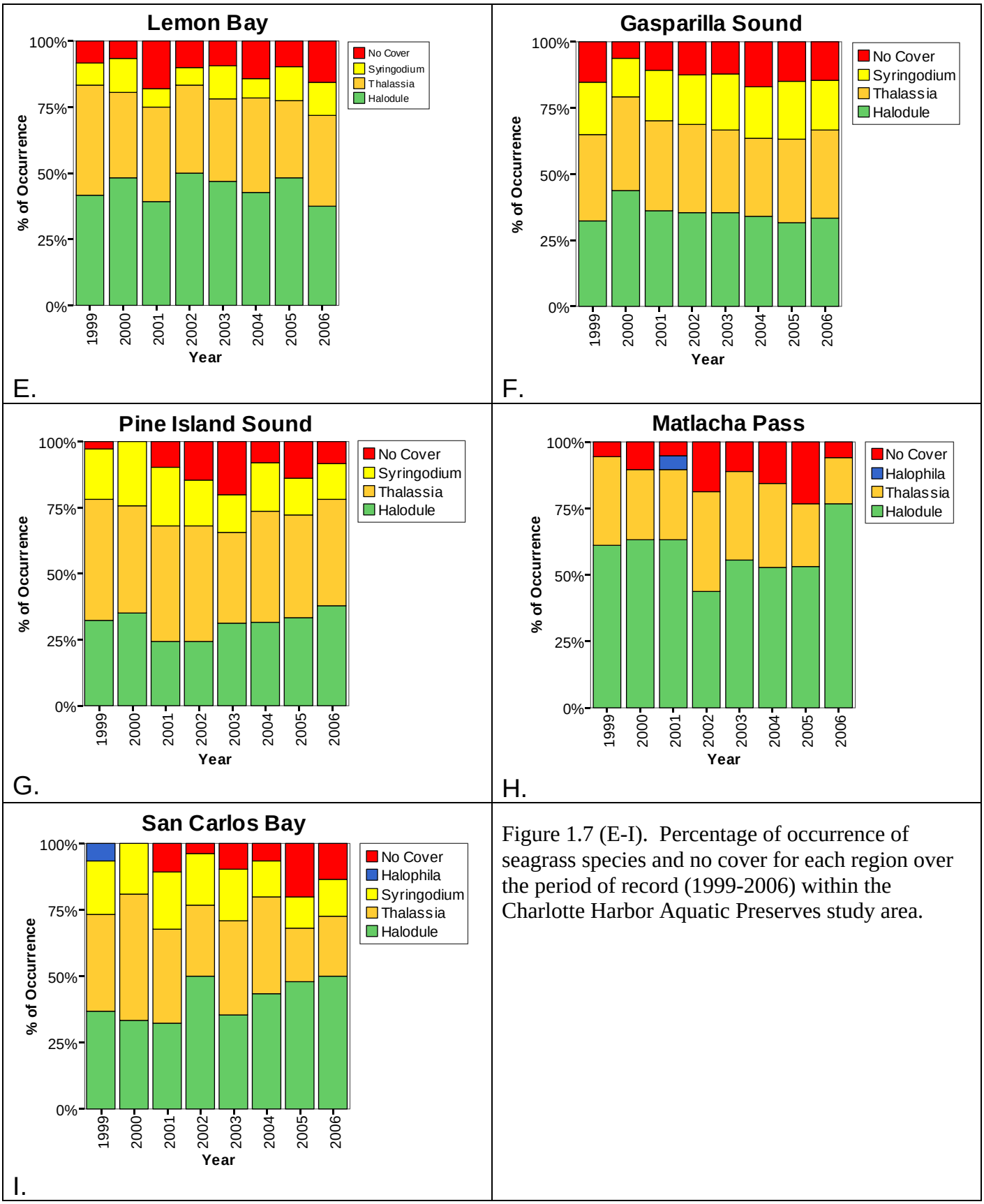


Figure 1.7 (E-I). Percentage of occurrence of seagrass species and no cover for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

Question 2: How are the 3 most common seagrass species distributed (including no cover)?

Analysis A: Comparison of Years

Table 2.1. Frequency of occurrence of the three most common seagrass species and their ratios over the period of record (1999-2006) for the entire Charlotte Harbor Aquatic Preserves study area.

CHAPs Study Area				
	# of Species			Ratio
Year	Halodule	Thalassia	Syringodium	H : T : S
1999	121	82	24	1 : 0.7 : 0.2
2000	129	82	25	1 : 0.6 : 0.2
2001	115	91	27	1 : 0.8 : 0.2
2002	129	92	24	1 : 0.7 : 0.2
2003	116	84	25	1 : 0.7 : 0.2
2004	119	86	24	1 : 0.7 : 0.2
2005	110	71	22	1 : 0.6 : 0.2
2006	129	79	23	1 : 0.6 : 0.2
Total	**968**	**667**	**194**	**1 : 0.7 : 0.2**

Table 2.2. Frequency of occurrence of the three most common seagrass species and their ratios over the period of record (2003-2006) for the Estero Bay Aquatic Preserve study area.

EBAP Study Area				
	# of Species			Ratio
Year	Halodule	Thalassia	Syringodium	H : T : S
2003	24	10	1	1 : 0.4 : 0.04
2004	23	12	1	1 : 0.5 : 0.04
2005	23	12	0	1 : 0.5 : 0.00
2006	23	12	0	1 : 0.5 : 0.00
Total	**93**	**46**	**2**	**1 : 0.5 : 0.02**

Analysis B: Comparison of Regions

Table 2.3. Frequency of occurrence of the three most common seagrass species and their ratios for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

CHAPs & EBAP Study Areas					
	Total # of Species				***Ratio***
Region	***Halodule***	***Thalassia***	***Syringodium***	***No Cover***	***H : T : S : NC***
Peace River	71			69	1 : 0.0 : 0.0 : 1.0
Myakka River	74			56	1 : 0.0 : 0.0 : 0.8
Upper West CH	184	80		66	1 : 0.4 : 0.0 : 0.4
Lower East CH	141	153	10	59	1 : 1.1 : 0.08 : 0.4
Lemon Bay	105	80	24	27	1 : 0.8 : 0.2 : 0.3
Gasparilla Sound	128	118	69	46	1 : 0.9 : 0.5 : 0.4
Pine Island Sound	94	125	54	29	1 : 1.3 : 0.6 : 0.3
Matlacha Pass	84	41		17	1 : 0.5 : 0.0 : 0.2
San Carlos Bay	87	70	37	17	1 : 0.8 : 0.4 :0.2
Estero Bay	93	46	2	21	1 : 0.5 : 0.02 : 0.2
Total	**1061**	**713**	**196**	**407**	**1 : 0.7 : 0.20 : 0.4**

Analysis C: Comparison of Years by Region

Table 2.4 (A-B). Frequency of occurrence of the three most common seagrass species (and no cover in regions with only one species) and their ratios for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

A. Peace River			
	# of Species		***Ratio***
Year	***Halodule***	***No Cover***	***H : NC***
1999	15	3	1 : 0.2
2000	11	7	1 : 0.6
2001	12	6	1 : 0.5
2002	11	7	1 : 0.6
2003	5	13	1 : 2.6
2004	4	13	1 : 3.3
2005	6	9	1 : 1.5
2006	7	11	1 : 1.6
Total	**71**	**69**	**1 : 1.0**

B. Myakka River			
	# of Species		***Ratio***
Year	***Halodule***	***No Cover***	***H : NC***
1999	12	2	1 : 0.2
2000	10	6	1 : 0.6
2001	7	8	1 : 1.1
2002	11	7	1 : 0.6
2003	7	11	1 : 1.6
2004	9	8	1 : 0.9
2005	8	7	1 : 0.9
2006	10	7	1 : 0.7
Total	**74**	**56**	**1 : 0.8**

Table 2.4 (C-D). Frequency of occurrence of the three most common seagrass species (and no cover in regions with only one species) and their ratios for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

C. Upper West Charlotte Harbor			
	# of Species		Ratio
Year	Halodule	Thalassia	H : T
1999	27	12	1 : 0.4
2000	26	11	1 : 0.4
2001	21	10	1 : 0.5
2002	23	11	1 : 0.5
2003	23	10	1 : 0.4
2004	22	9	1 : 0.4
2005	20	10	1 : 0.5
2006	22	7	1 : 0.3
Total	**184**	**80**	**1 : 0.4**

D. Lower East Charlotte Harbor				
	# of Species			Ratio
Year	Halodule	Thalassia	Syringodium	H : T : S
1999	10	13	1	1 : 1.3 : 0.10
2000	14	14	1	1 : 1.0 : 0.07
2001	16	22	1	1 : 1.4 : 0.06
2002	22	24	1	1 : 1.1 : 0.05
2003	19	22	1	1 : 1.2 : 0.06
2004	21	20	2	1 : 0.9 : 0.10
2005	15	16	1	1 : 1.1 : 0.07
2006	24	22	2	1 : 0.9 : 0.08
Total	**141**	**153**	**10**	**1 : 1.1 : 0.07**

Table 2.4 (E-F). Frequency of occurrence of the three most common seagrass species (and no cover in regions with only one species) and their ratios for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

E. Lemon Bay				
	# of Species			Ratio
Year	Halodule	Thalassia	Syringodium	H : T : S
1999	10	10	2	1 : 1.0 : 0.2
2000	15	10	4	1 : 0.7 : 0.3
2001	11	10	2	1 : 0.9 : 0.2
2002	15	10	2	1 : 0.7 : 0.1
2003	15	10	4	1 : 0.7 : 0.3
2004	12	10	2	1 : 0.8 : 0.2
2005	15	9	4	1 : 0.6 : 0.3
2006	12	11	4	1 : 0.9 : 0.3
Total	**105**	**80**	**24**	**1 : 0.8 : 0.2**

F. Gasparilla Sound				
	# of Species			Ratio
Year	Halodule	Thalassia	Syringodium	H : T : S
1999	13	13	8	1 : 1.0 : 0.6
2000	21	17	7	1 : 0.8 : 0.3
2001	17	16	9	1 : 0.9 : 0.5
2002	17	16	9	1 : 0.9 : 0.5
2003	15	13	9	1 : 0.9 : 0.6
2004	16	14	9	1 : 0.9 : 0.6
2005	13	13	9	1 : 1.0 : 0.6
2006	16	16	9	1 : 1.0 : 0.6
Total	**128**	**118**	**69**	**1 : 0.9 : 0.5**

Table 2.4 (G-H). Frequency of occurrence of the three most common seagrass species (and no cover in regions with only one species) and their ratios for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

G. Pine Island Sound				
	# of Species			Ratio
Year	Halodule	Thalassia	Syringodium	H : T : S
1999	12	17	7	1 : 1.4 : 0.6
2000	13	15	9	1 : 1.2 : 0.7
2001	10	18	9	1 : 1.8 : 0.9
2002	10	18	7	1 : 1.8 : 0.7
2003	11	12	5	1 : 1.1 : 0.5
2004	12	16	7	1 : 1.3 : 0.6
2005	12	14	5	1 : 1.2 : 0.4
2006	14	15	5	1 : 1.1 : 0.4
Total	**94**	**125**	**54**	**1 : 1.3 : 0.6**

H. Matlacha Pass			
	# of Species		Ratio
Year	Halodule	Thalassia	H : T
1999	11	6	1 : 0.6
2000	12	5	1 : 0.4
2001	12	5	1 : 0.4
2002	7	6	1 : 0.9
2003	10	6	1 : 0.6
2004	10	6	1 : 0.6
2005	9	4	1 : 0.4
2006	13	3	1 : 0.2
Total	**84**	**41**	**1 : 0.5**

Table 2.4 (I). Frequency of occurrence of the three most common seagrass species (and no cover in regions with only one species) and their ratios for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

I. San Carlos Bay				
	# of Species			Ratio
Year	Halodule	Thalassia	Syringodium	H : T : S
1999	11	11	6	1 : 1.0 : 0.6
2000	7	10	4	1 : 1.4 : 0.6
2001	9	10	6	1 : 1.1 : 0.7
2002	13	7	5	1 : 0.5 : 0.4
2003	11	11	6	1 : 1.0 : 0.6
2004	13	11	4	1 : 0.9 : 0.3
2005	12	5	3	1 : 0.4 : 0.3
2006	11	5	3	1 : 0.5 : 0.3
Total	**87**	**70**	**37**	**1 : 0.8 : 0.4**

Question 3: What is the TOTAL abundance of all seagrass species combined?

Analysis A: Comparison of Years

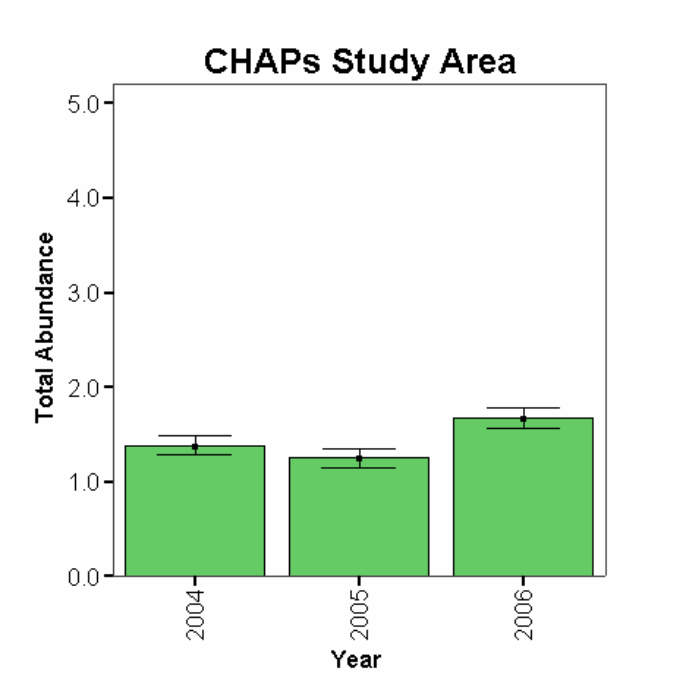


Figure 3.1. Mean Braun-Blanquet total quadrat abundance (+/- SE) over the period of record (2003-2006) for the entire Charlotte Harbor Aquatic Preserves study area.

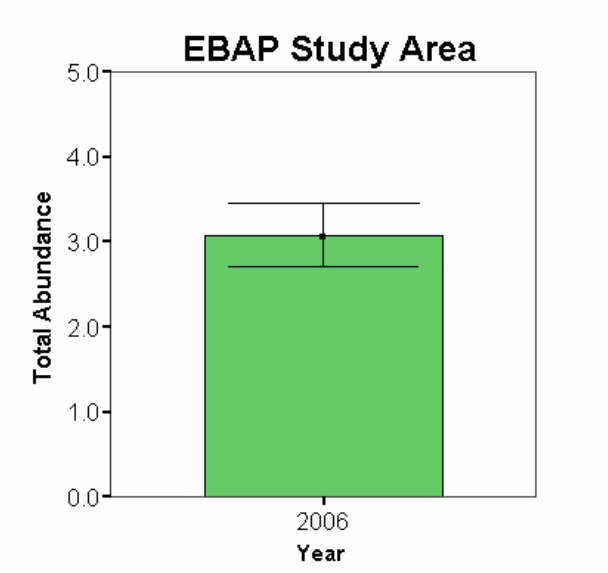


Figure 3.2. Mean Braun-Blanquet total quadrat abundance (+/- SE) over the period of record (2006) for the Estero Bay Aquatic Preserve study area.

Analysis B: Comparison of Regions

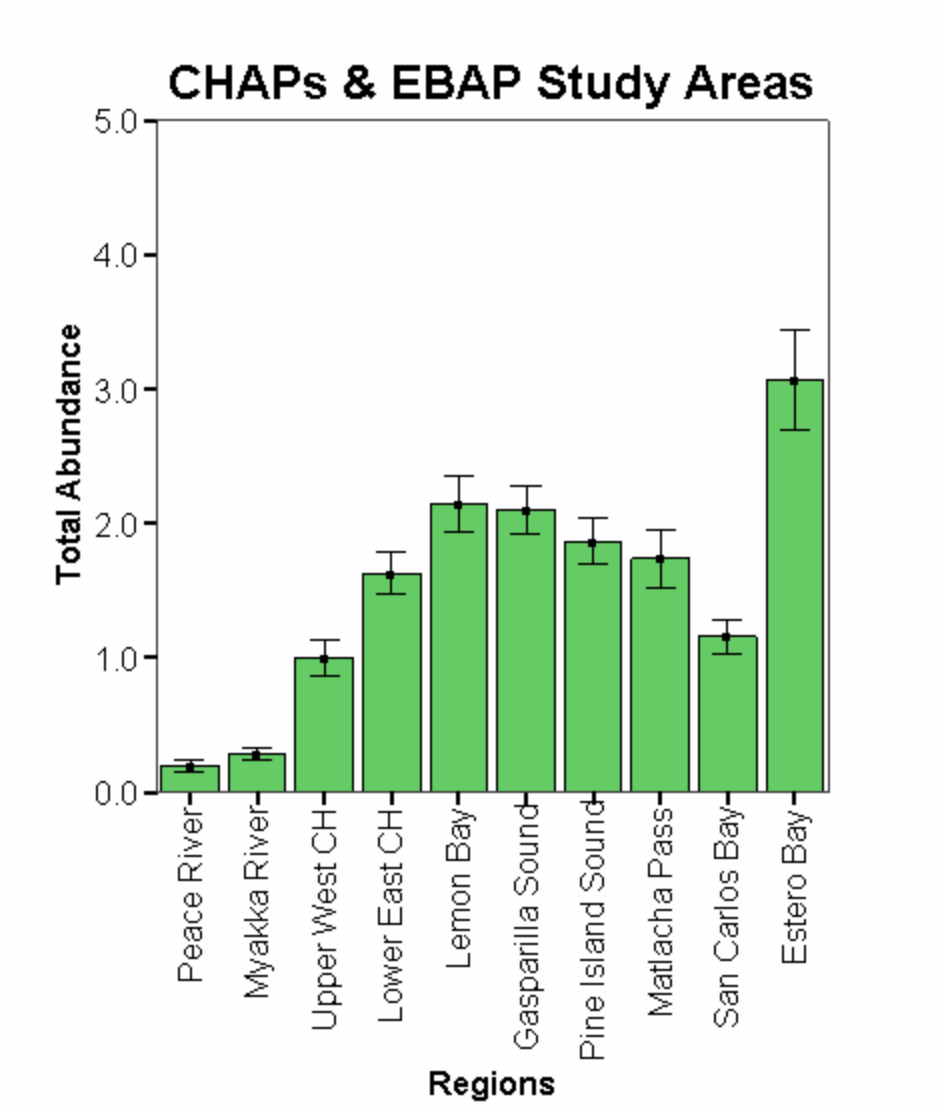


Figure 3.3. Mean Braun-Blanquet total quadrat abundance (+/- SE) for each region over the period of record for the Charlotte Harbor (2003-2006) and Estero Bay (2006) Aquatic Preserve study areas.

Analysis C: Comparison of Years by Region

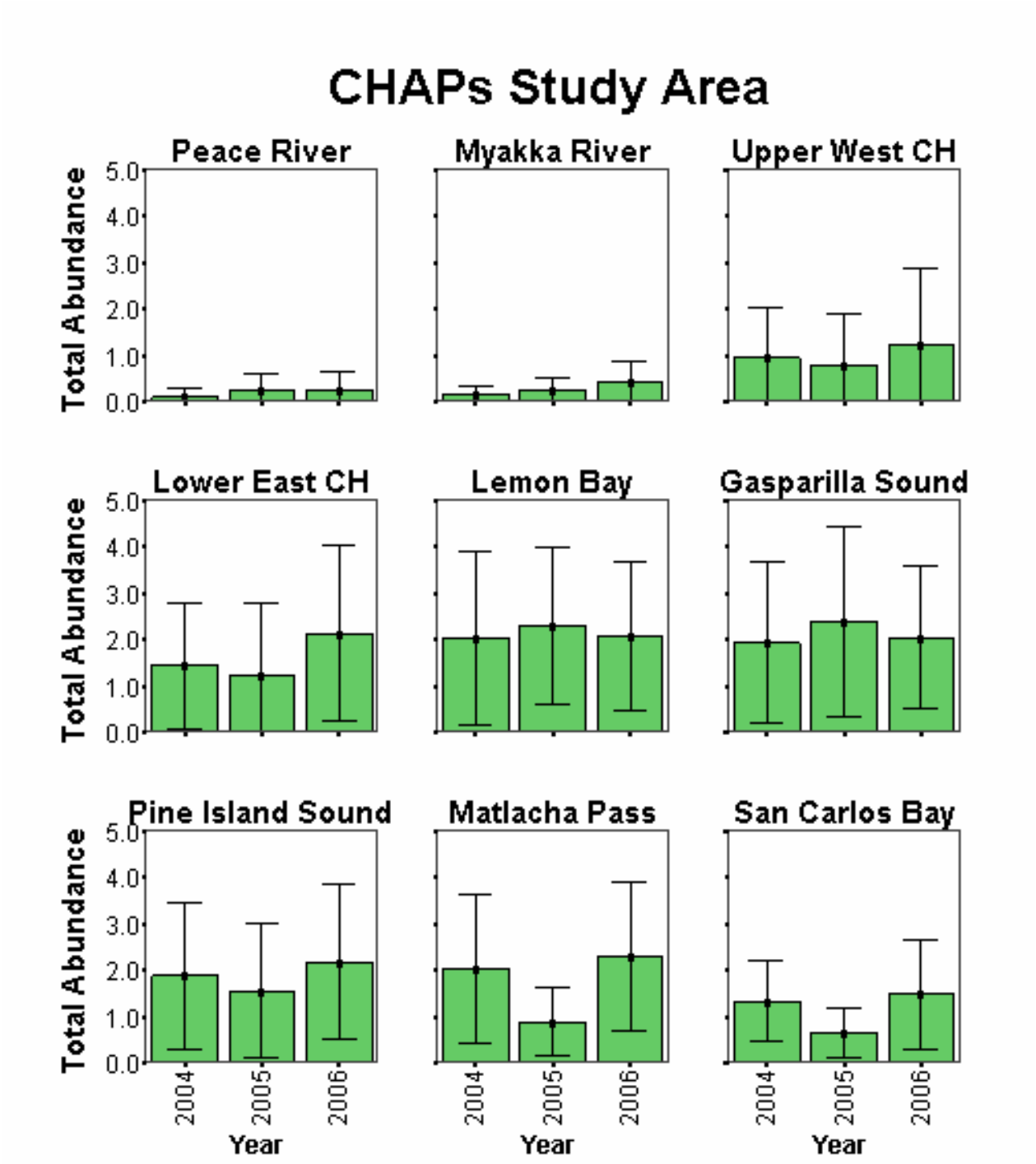


Figure 3.4. Mean Braun-Blanquet total quadrat abundance (+/- SD) for each region over the period of record (2003-2006) within the Charlotte Harbor Aquatic Preserves study area.

Question 4: What is the abundance of the 3 most common seagrass species?

Analysis A: Comparison of Years

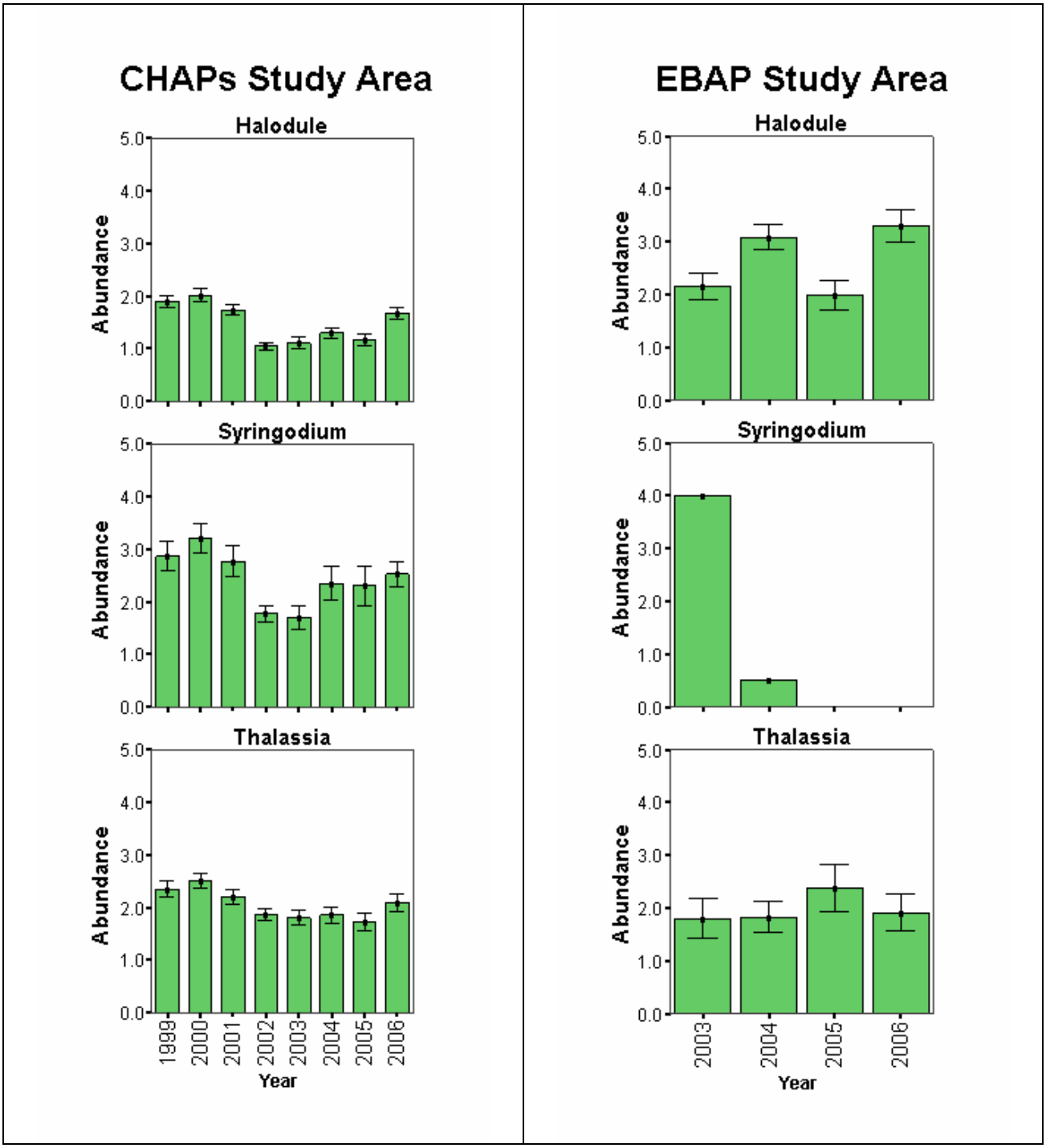


Figure 4.1. Mean Braun-Blanquet abundance (+/- SE) by species over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

Analysis B: Comparison of Regions

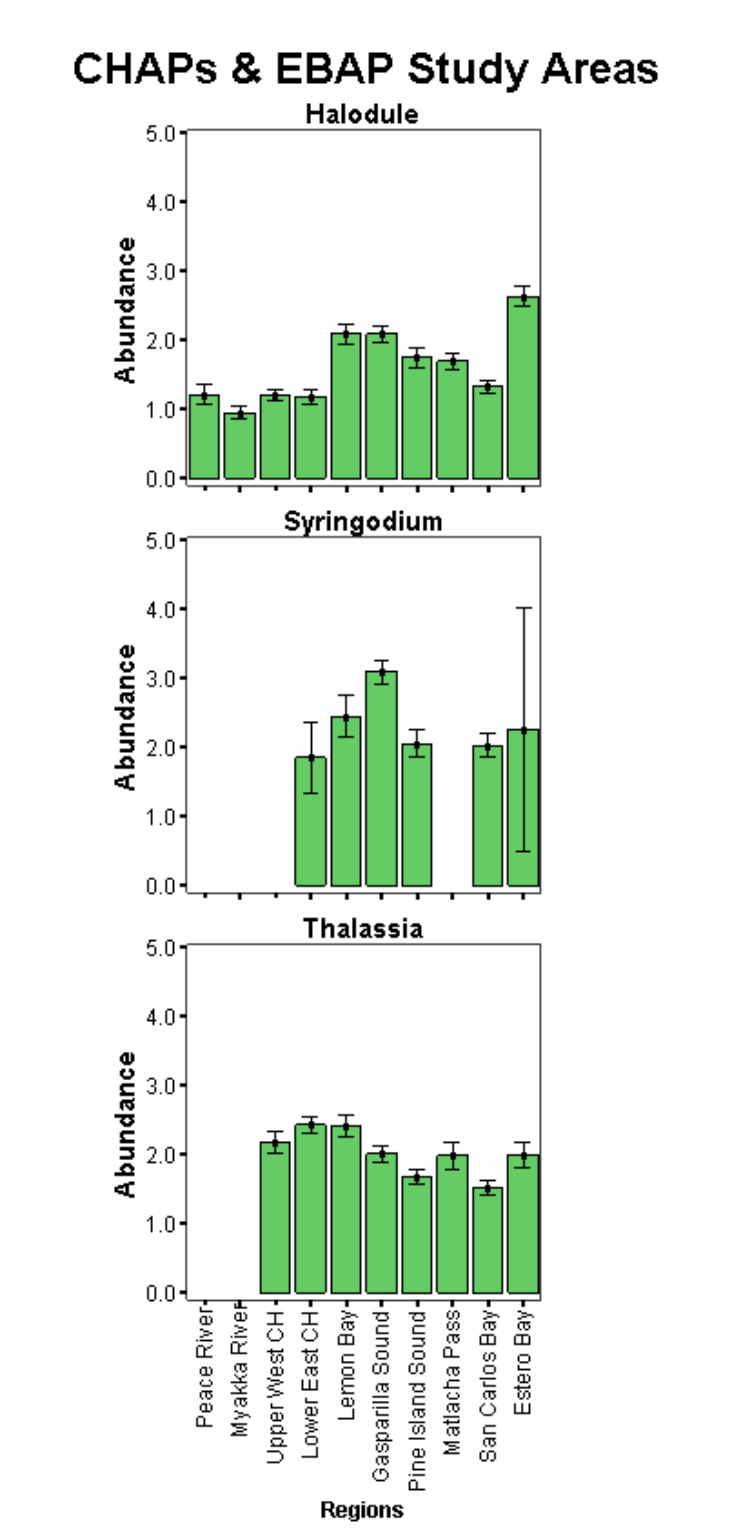


Figure 4.2. Mean Braun-Blanquet abundance (+/- SE) by species for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

Analysis C: Comparison of Years by Region

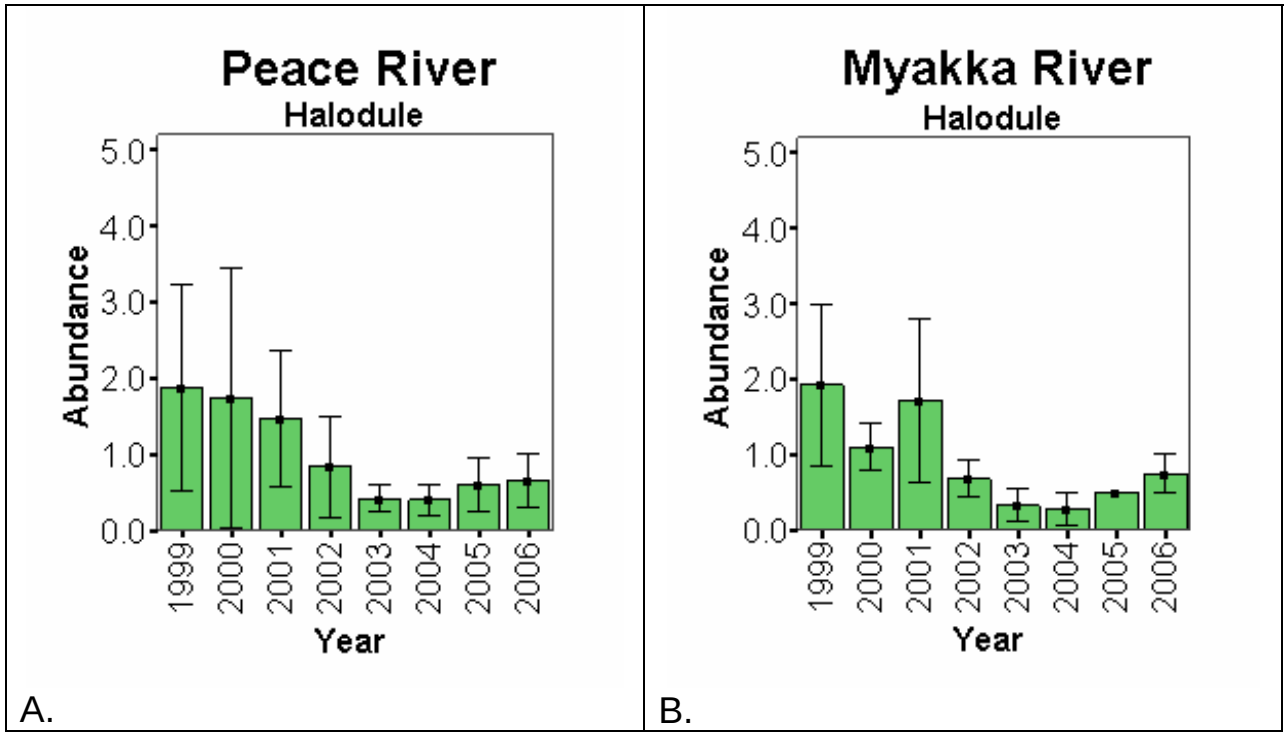


Figure 4.3 (A-B). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

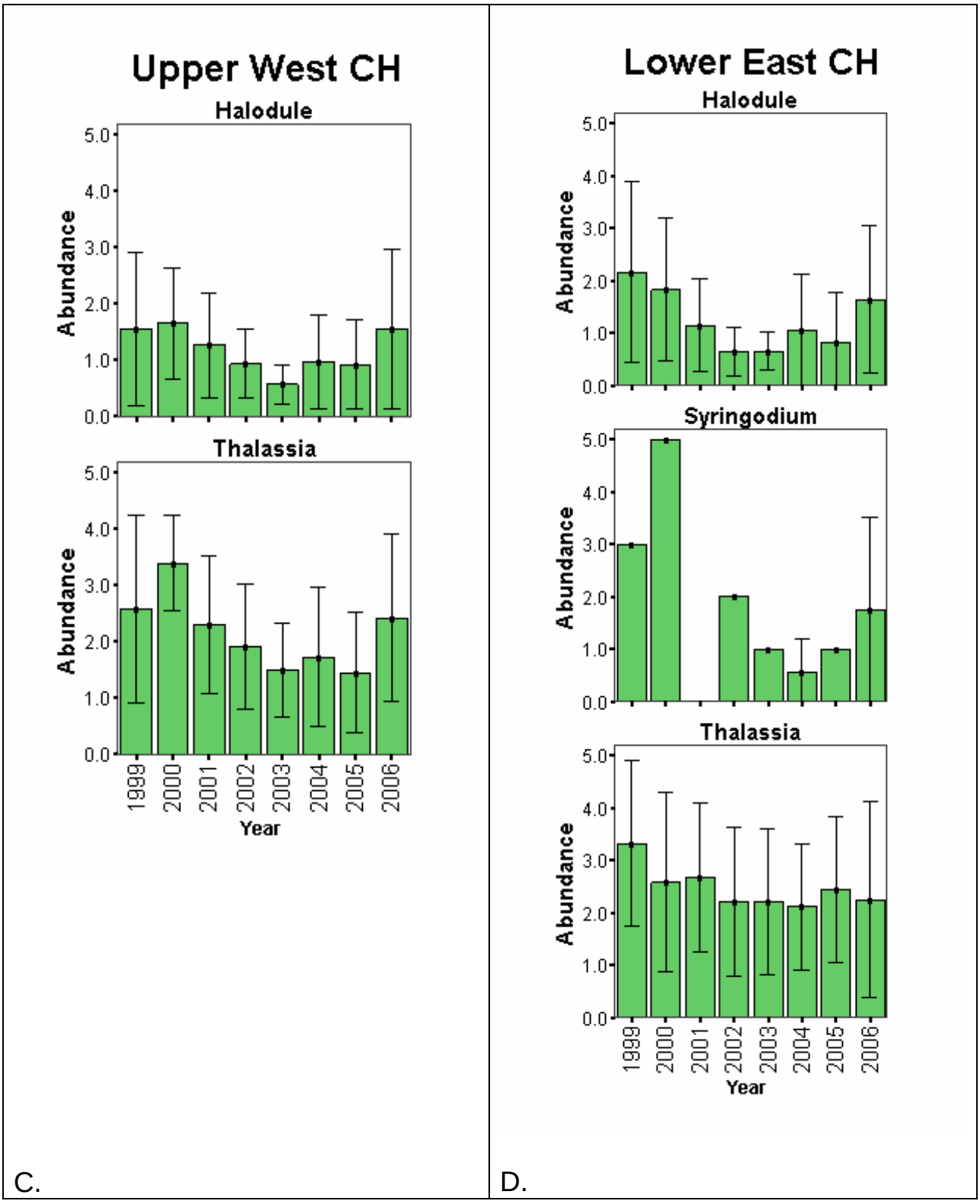


Figure 4.3 (C-D). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

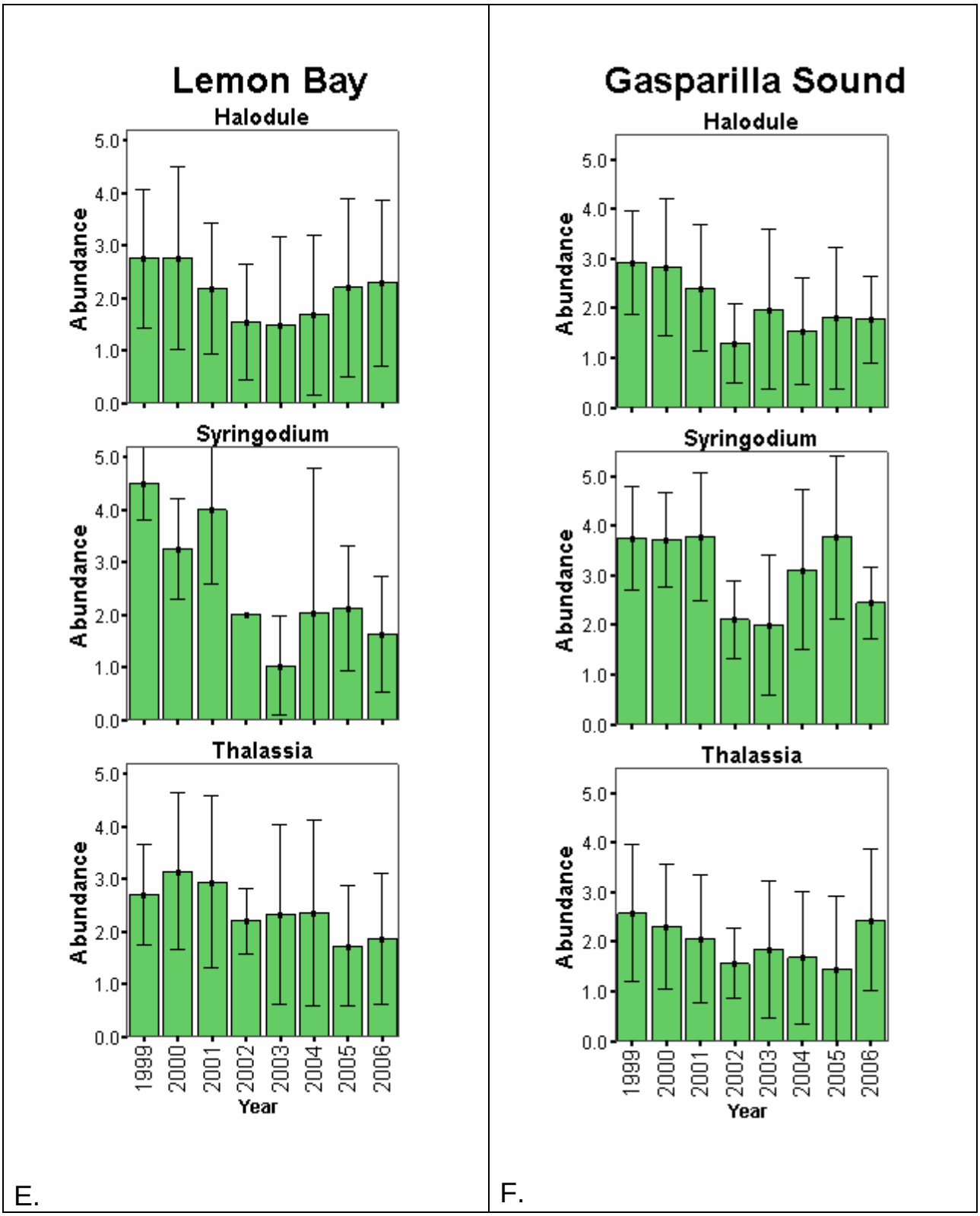


Figure 4.3 (E-F). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

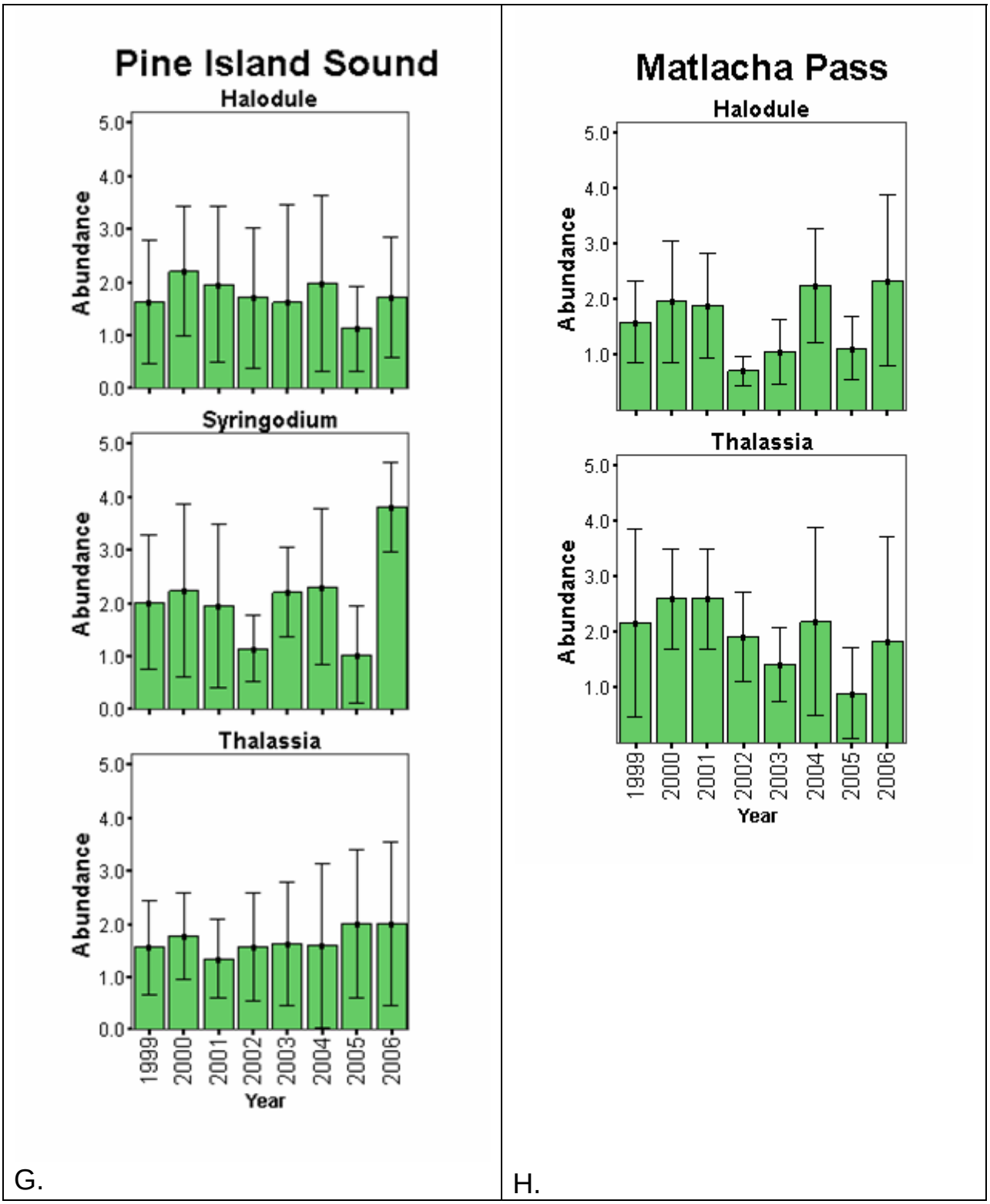
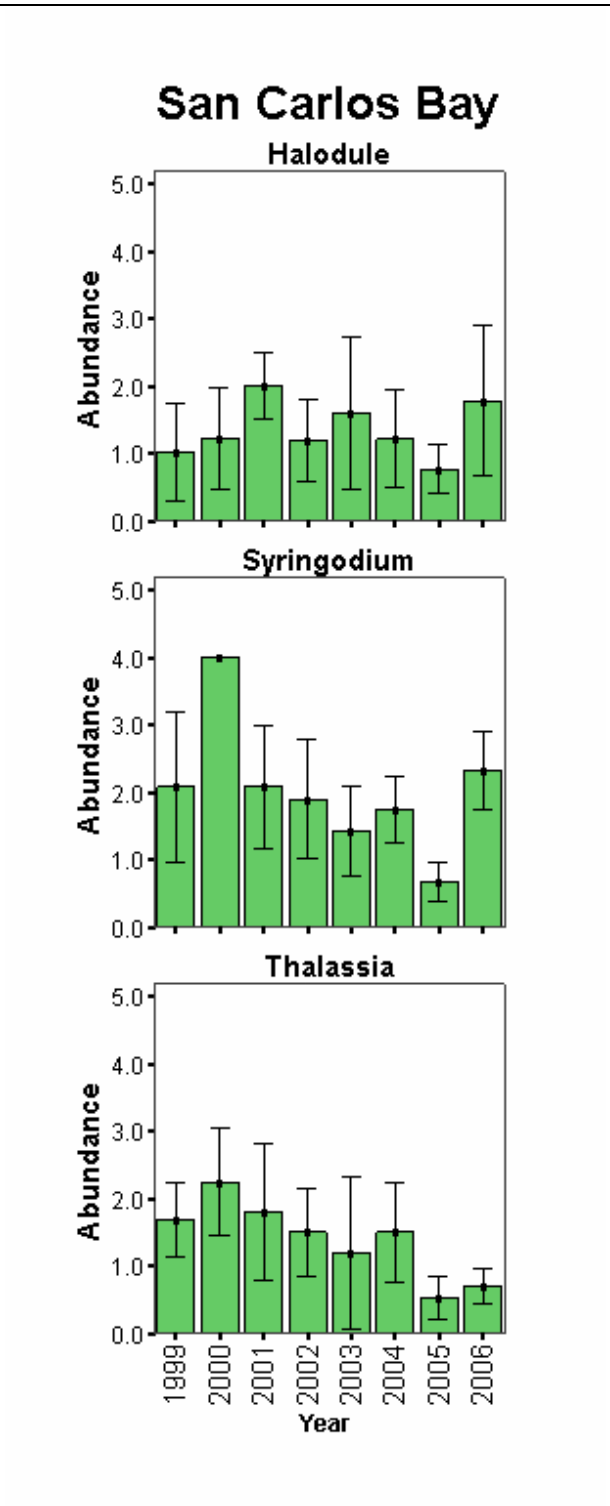


Figure 4.3 (G-H). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.



I.

Figure 4.3 (I). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

Question 5: How dense are the 3 most common seagrass species?

Analysis A: Comparison of Years (for Halodule)

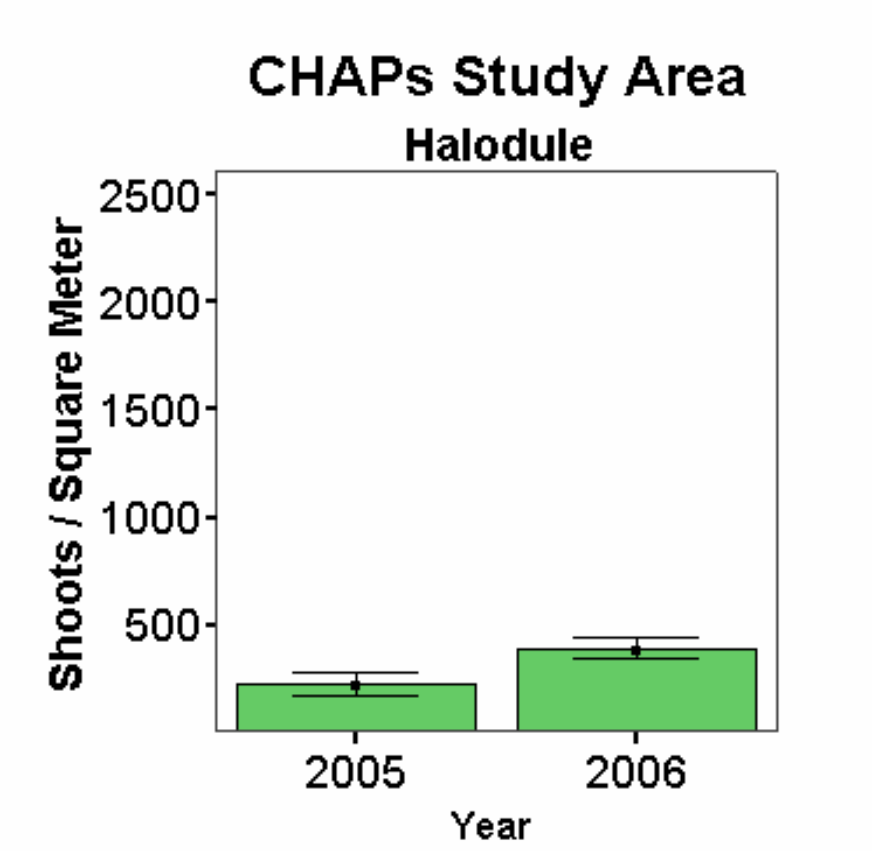


Figure 5.1. Mean shoot density (+/- SE) of *Halodule wrightii* over the period of record (2005-2005) for the entire Charlotte Harbor Aquatic Preserves study area.

Analysis B: Comparison of Regions (for Halodule)

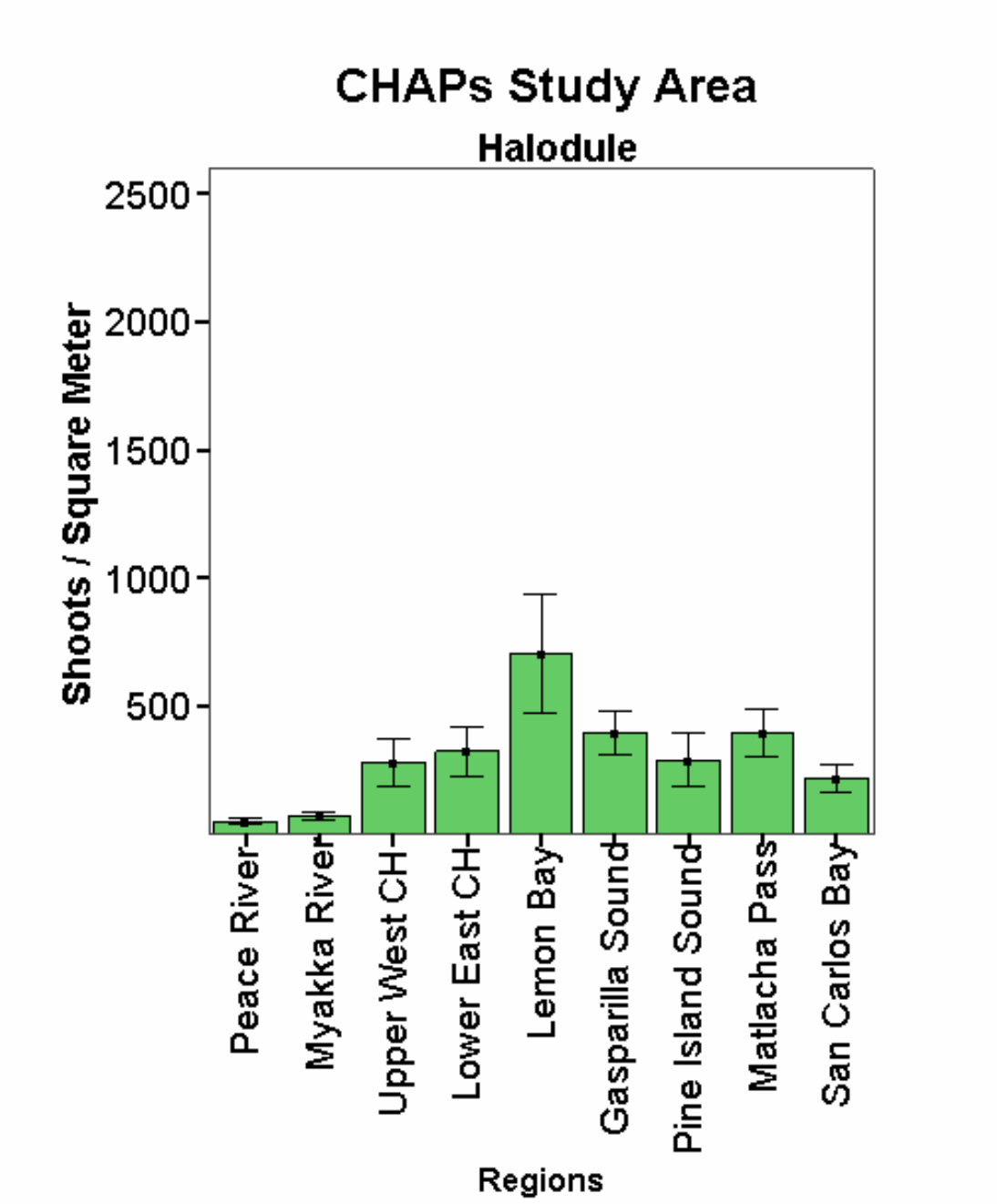


Figure 5.2. Mean shoot density (+/- SE) of *Halodule wrightii* for each region over the period of record (2005-2006) for the Charlotte Harbor Aquatic Preserves study area.

Analysis C: Comparison of Years by Region (for Halodule)

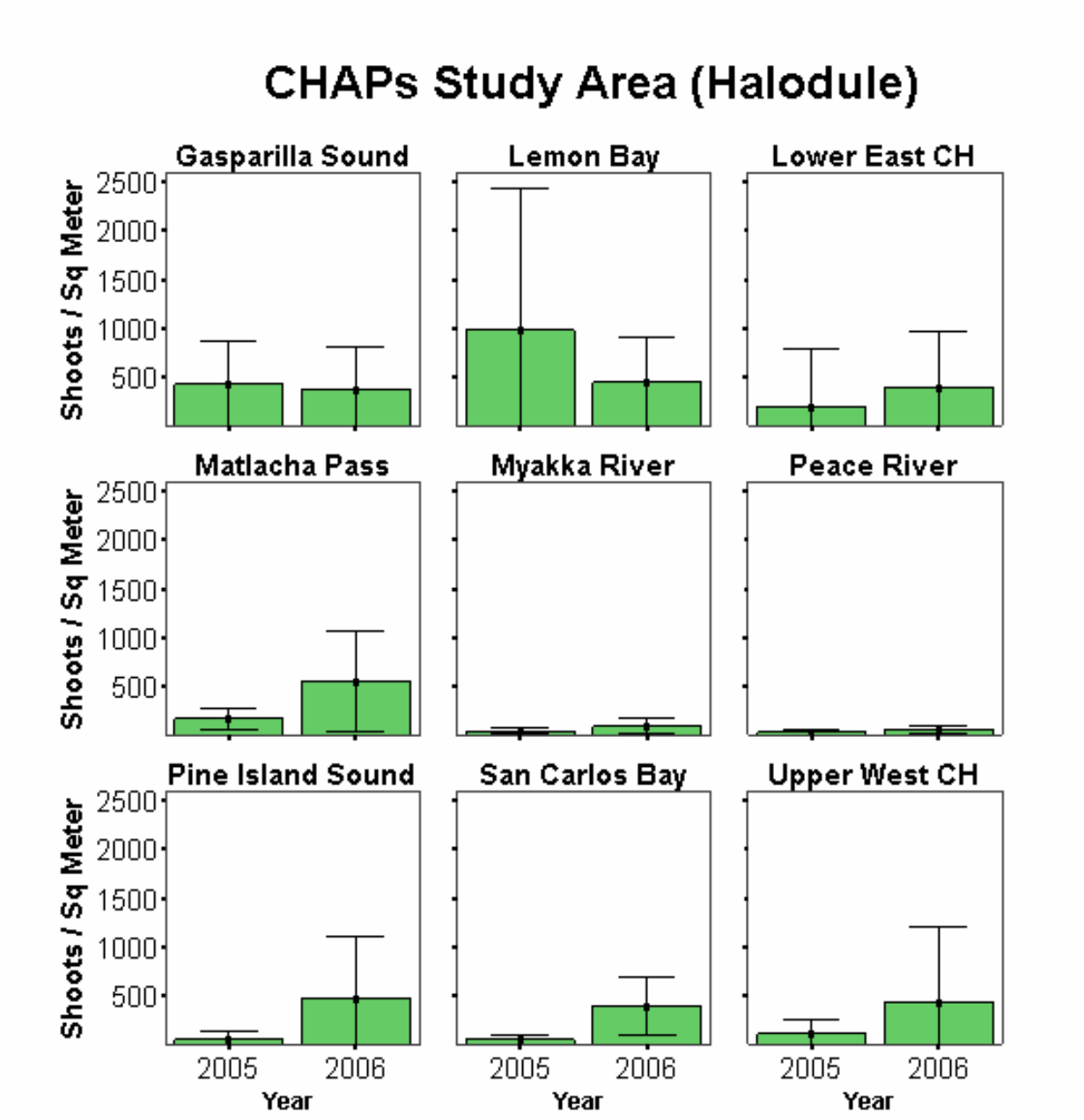


Figure 5.3. Mean shoot density (+/- SD) of *Halodule wrightii* for each region over the period of record (2005-2006) within the Charlotte Harbor Aquatic Preserves study area.
**Note: an extreme outlier for the Halodule shoot count data recorded in Lemon Bay in 2006 was removed and thought to be erroneous.*

Analysis A: Comparison of Years (for Thalassia)

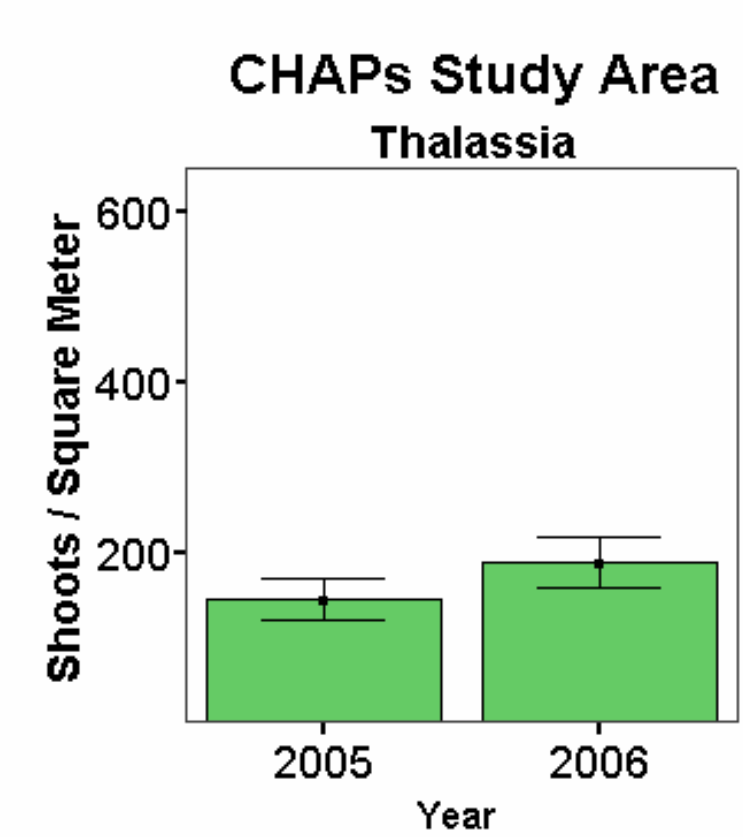


Figure 5.4. Mean shoot density (+/- SE) of *Thalassia testudinum* over the period of record (2005-2005) for the entire Charlotte Harbor Aquatic Preserves study area.

Analysis B: Comparison of Regions (for Thalassia)

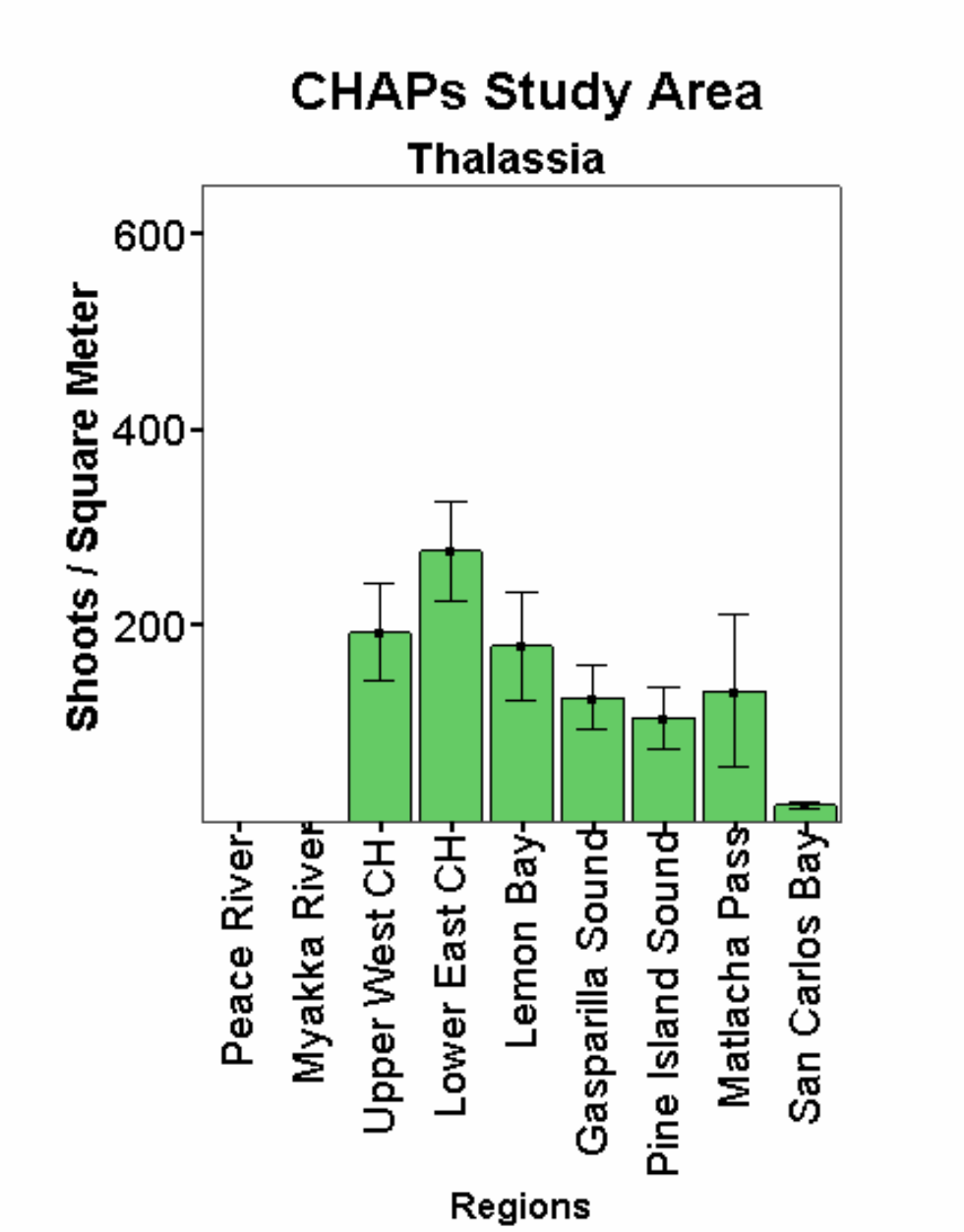


Figure 5.5. Mean shoot density (+/- SE) of *Thalassia testudinum* for each region over the period of record (2005-2006) for the Charlotte Harbor Aquatic Preserves study area.

Analysis C: Comparison of Years by Region (for Thalassia)

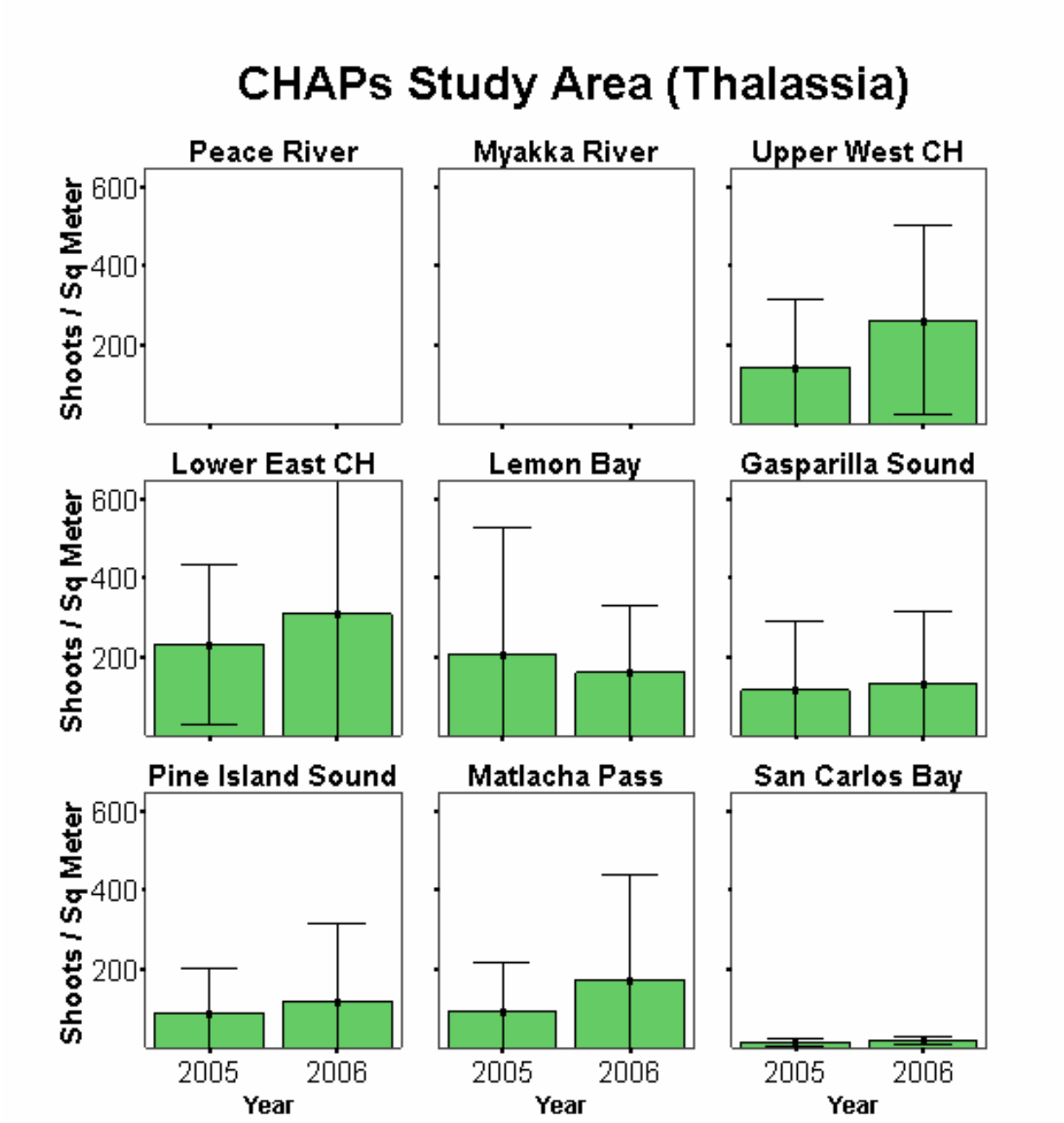


Figure 5.6. Mean shoot density (+/- SD) of *Thalassia testudinum* for each region over the period of record (2005-2006) within the Charlotte Harbor Aquatic Preserves study area.

Analysis A: Comparison of Years (for Syringodium)

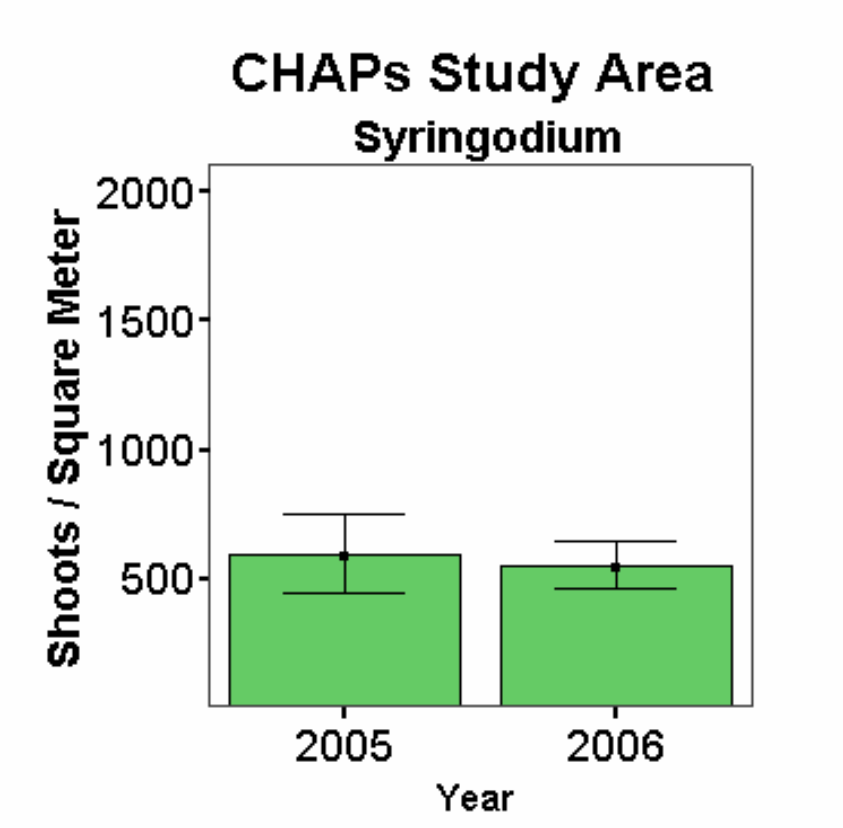


Figure 5.7. Mean shoot density (+/- SE) of *Syringodium filiforme* over the period of record (2005-2005) for the entire Charlotte Harbor Aquatic Preserves study area.

Analysis B: Comparison of Regions (for Syringodium)

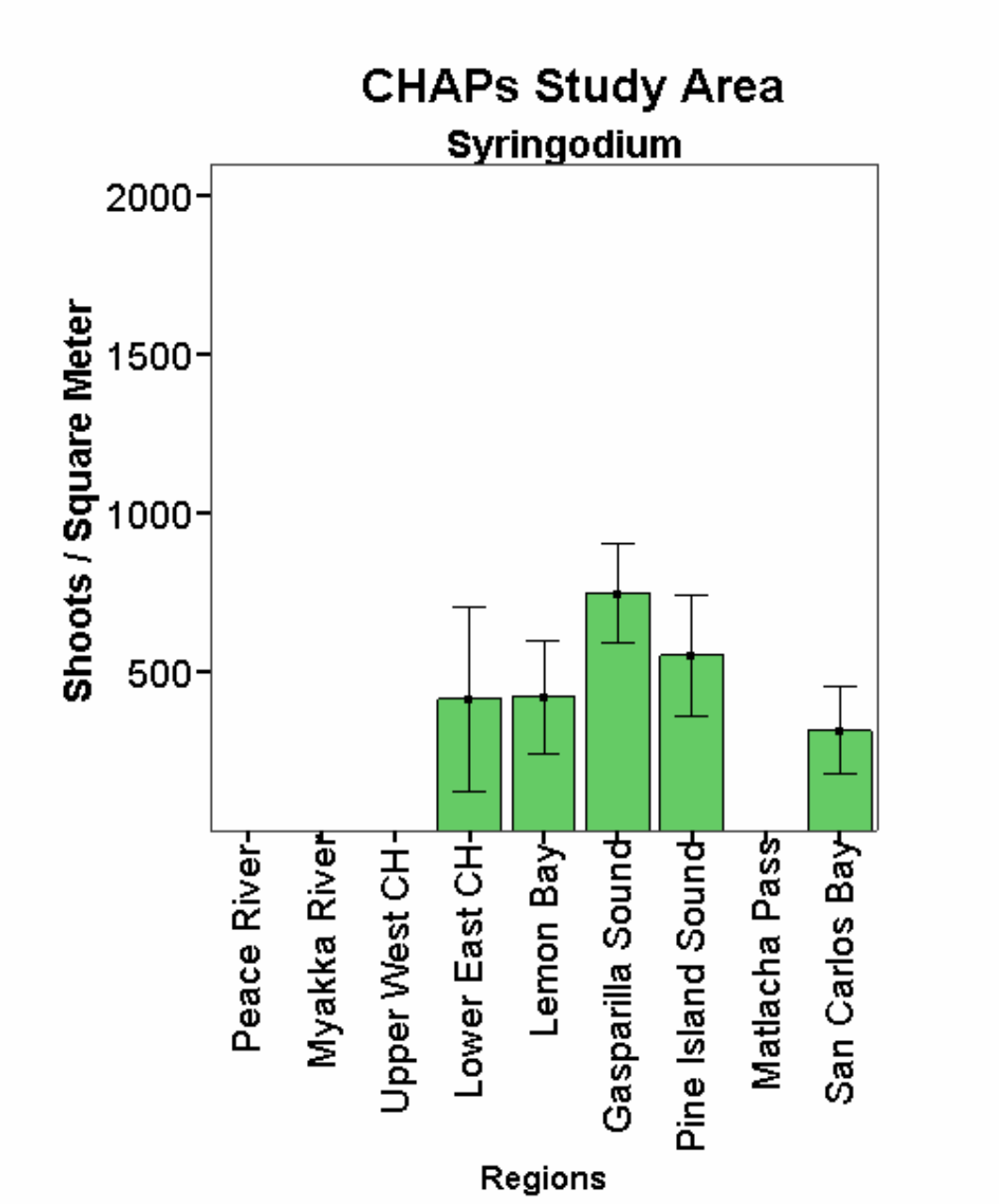


Figure 5.8. Mean shoot density (+/- SE) of *Syringodium filiforme* for each region over the period of record (2005-2006) for the Charlotte Harbor Aquatic Preserves study area.

Analysis C: Comparison of Years by Region (for Syringodium)

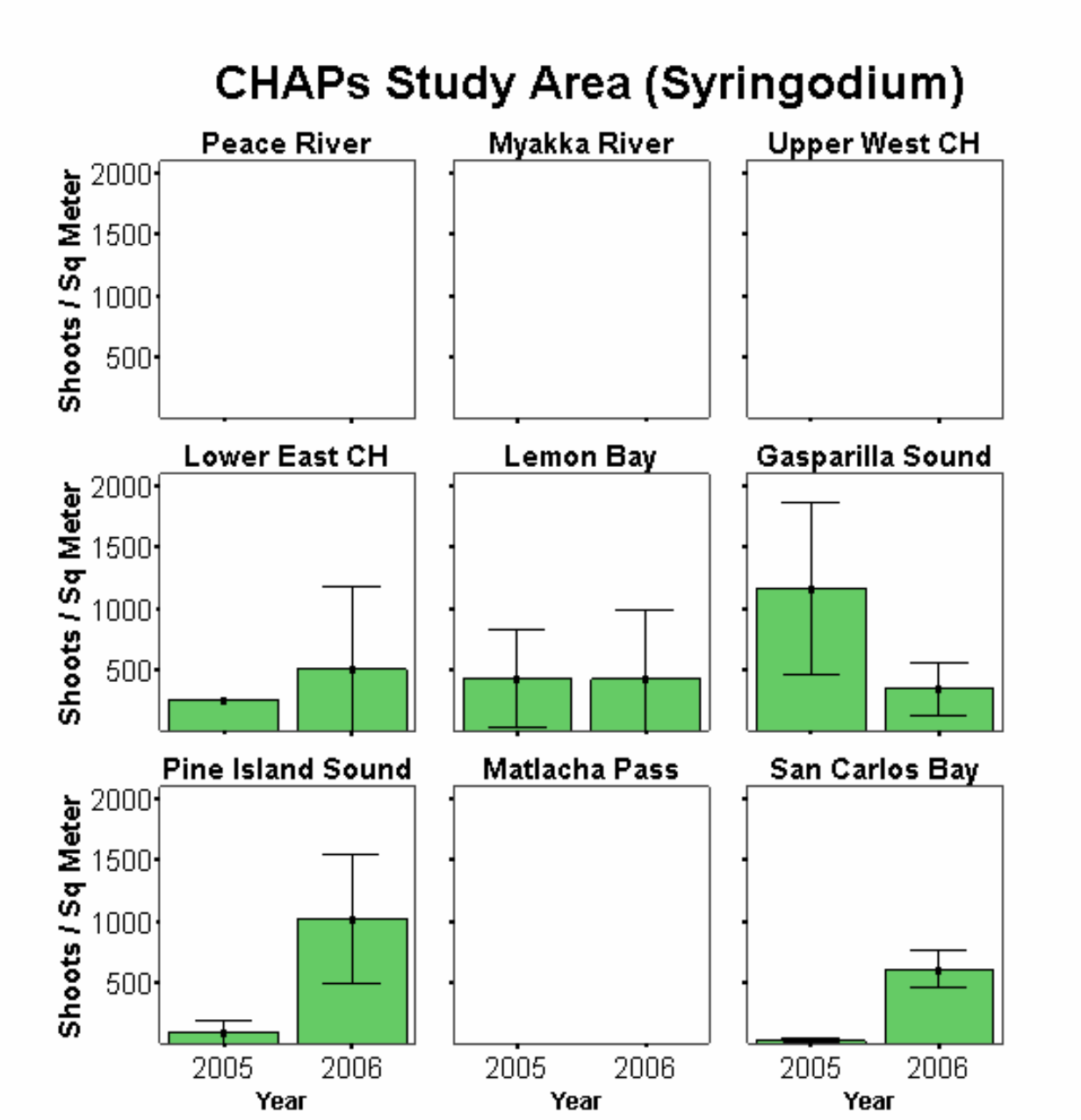


Figure 5.9. Mean shoot density (+/- SD) of *Syringodium filiforme* for each region over the period of record (2005-2006) within the Charlotte Harbor Aquatic Preserves study area.

Question 6: What is the maximum depth of seagrass growth?

Analysis A: Comparison of Years

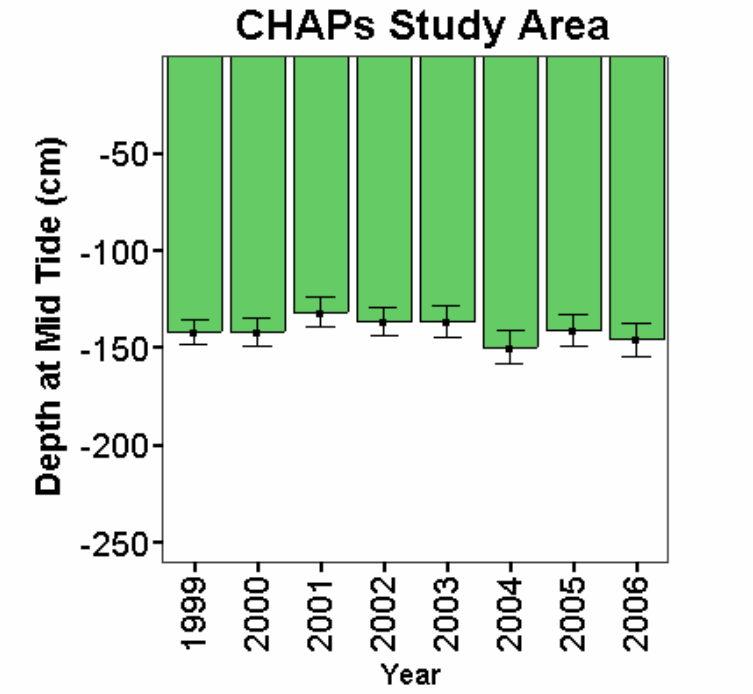


Figure 6.1. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) over the period of record (1999-2006) for the entire Charlotte Harbor Aquatic Preserves study area.

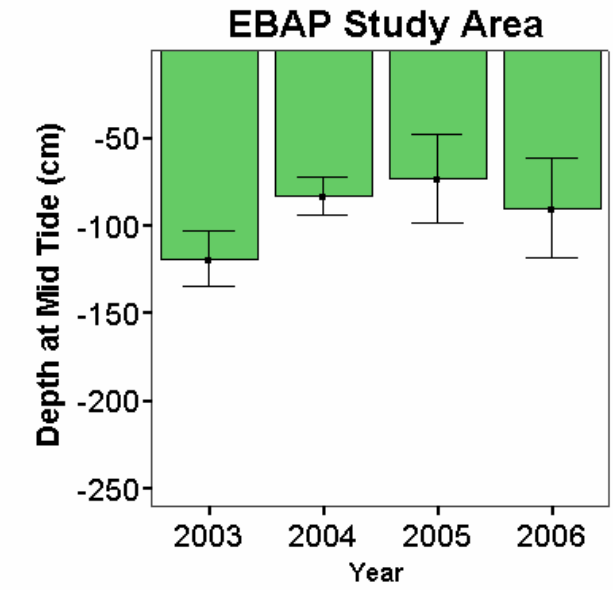


Figure 6.2. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) over the period of record (2003-2006) for the Estero Bay Aquatic Preserve study area.

Analysis B: Comparison of Regions

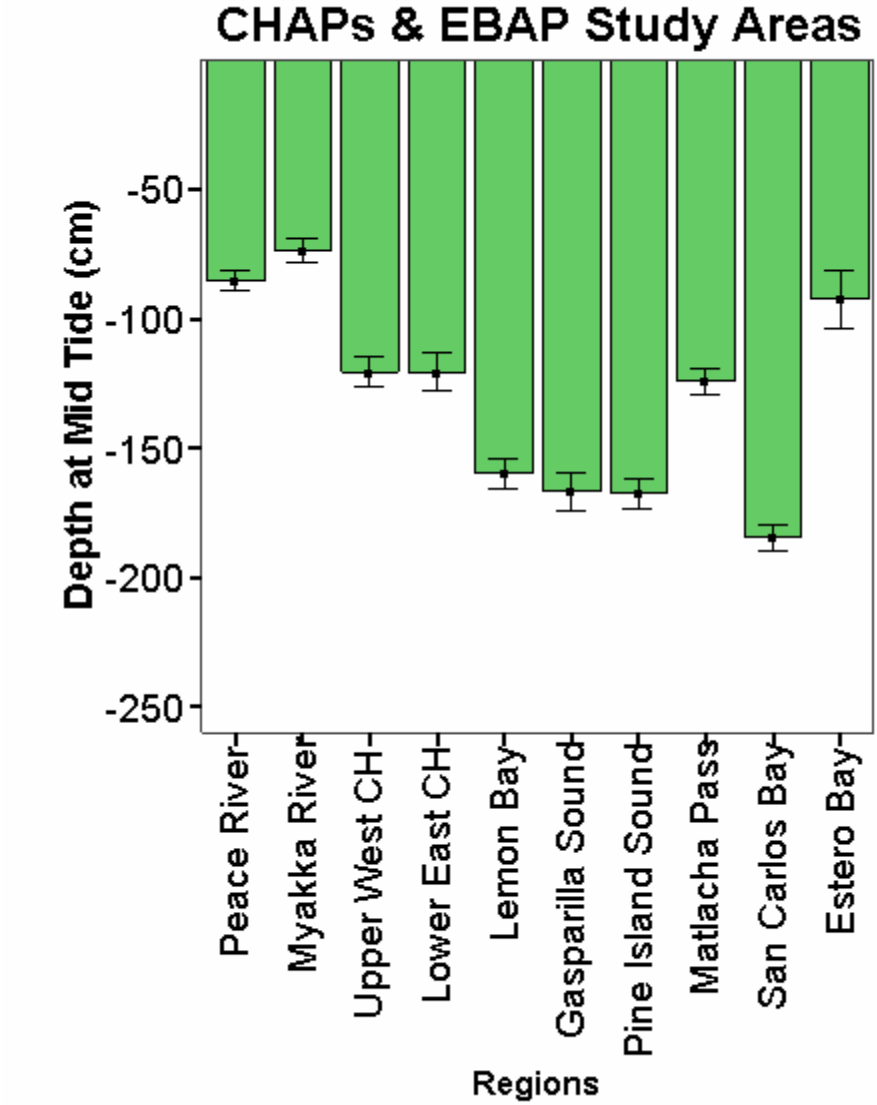


Figure 6.3. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

Analysis C: Comparison of Years by Region

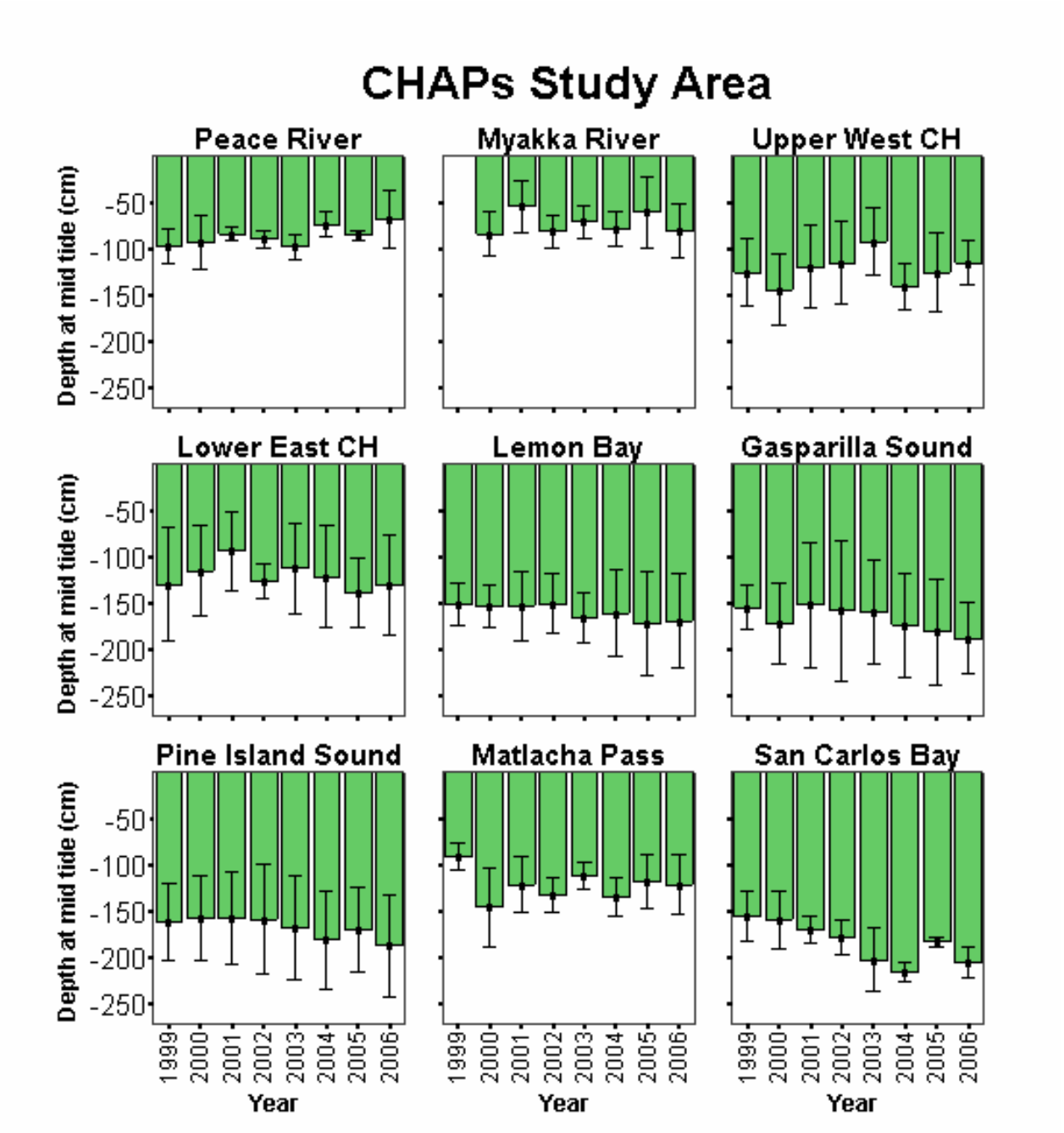


Figure 6.4. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

Question 7: How heavy are the epiphytes on the 3 most common seagrass species?

Analysis A: Comparison of Years

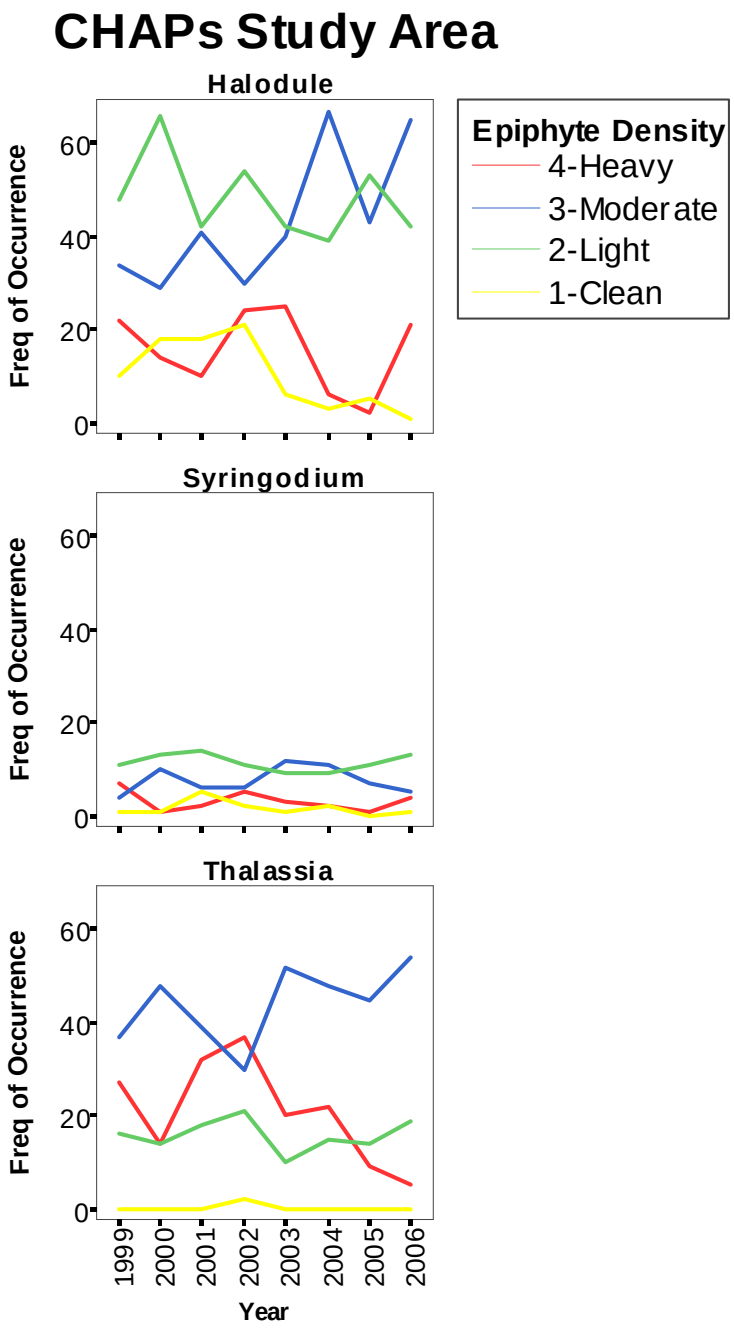


Figure 7.1. Frequency of occurrence of epiphyte load rankings by species over the period of record (1999-2006) for the entire Charlotte Harbor Aquatic Preserves study area.

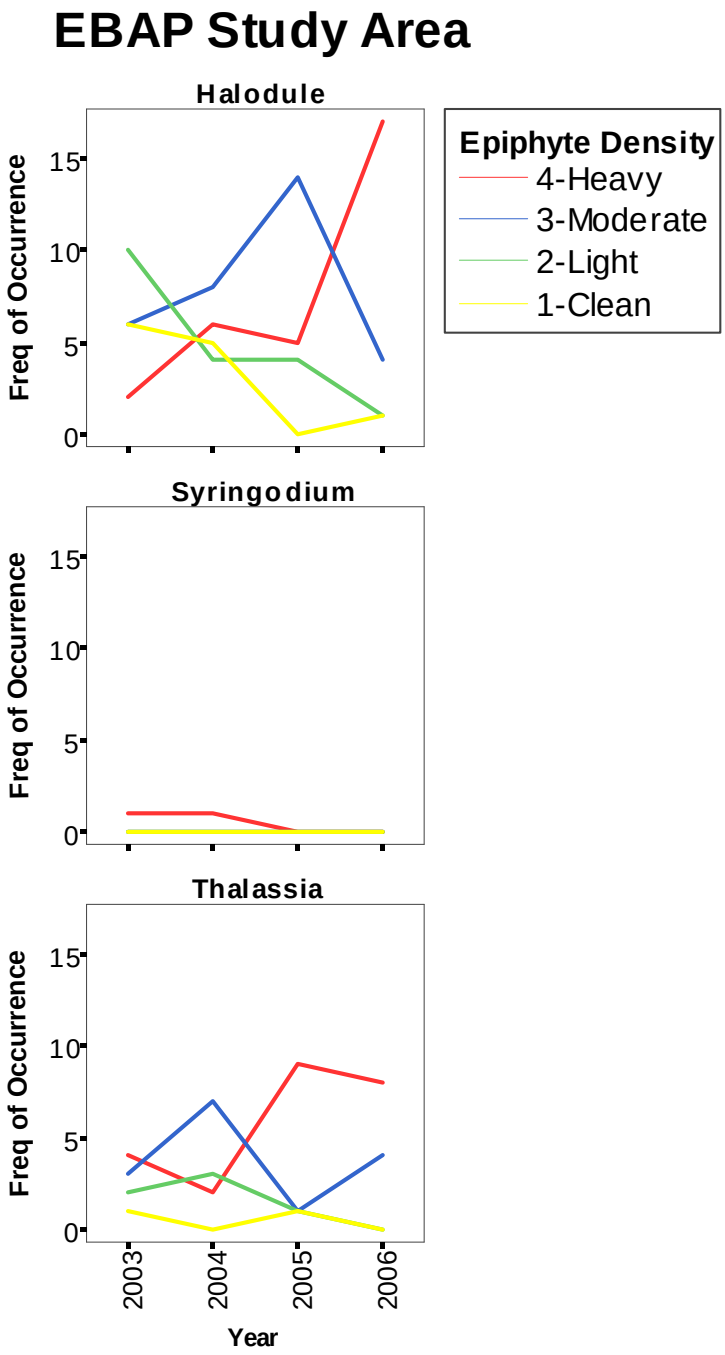


Figure 7.2. Frequency of occurrence of epiphyte load rankings by species over the period of record (2003-2006) for the Estero Bay Aquatic Preserve study area.

Analysis B: Comparison of Regions

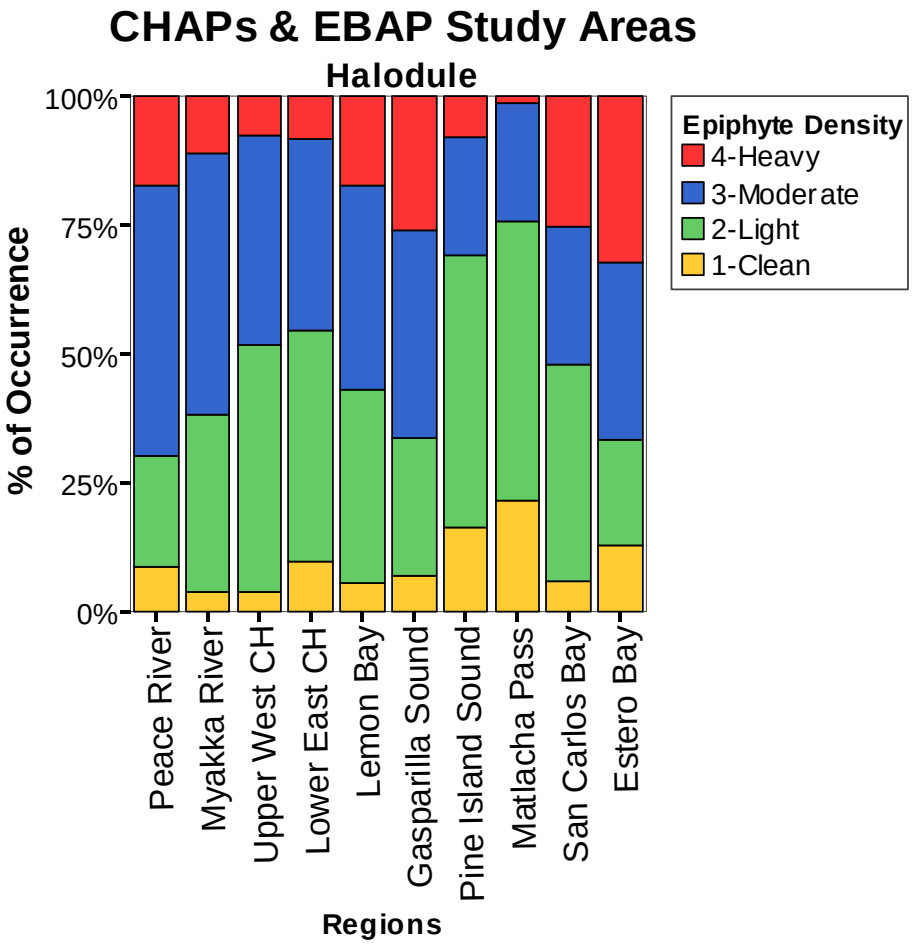


Figure 7.3. Percentage of occurrence of epiphyte load rankings for *Halodule wrightii* for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

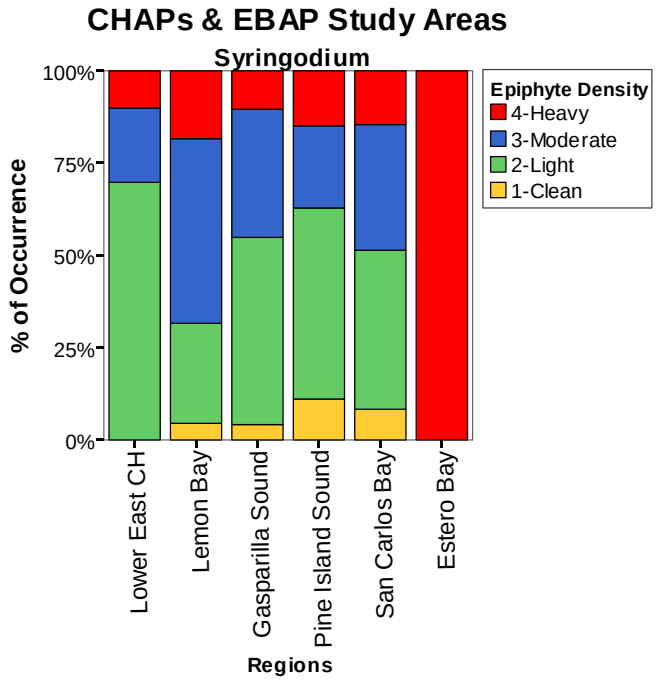


Figure 7.4. Percentage of occurrence of epiphyte load rankings for *Syringodium filiforme* for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

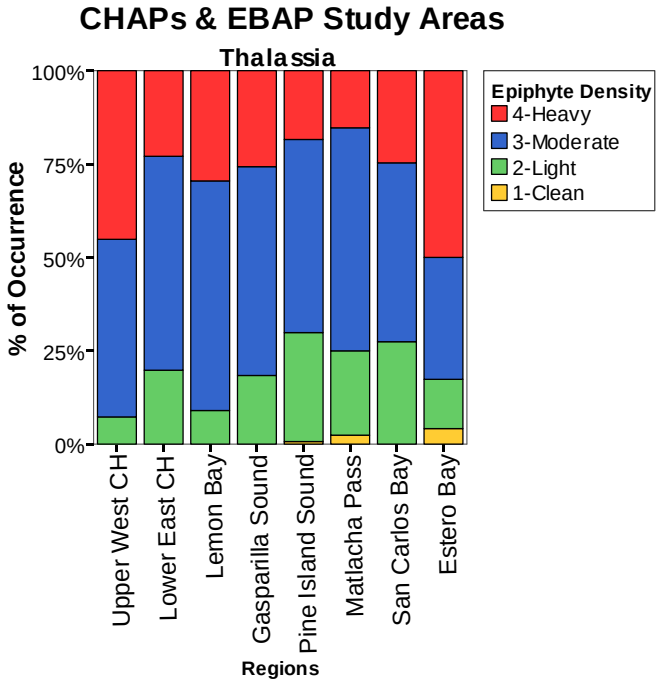


Figure 7.5. Percentage of occurrence of epiphyte load rankings for *Thalassia testudinum* for each region over the period of record for the Charlotte Harbor (1999-2006) and Estero Bay (2003-2006) Aquatic Preserve study areas.

Analysis C: Comparison of Years by Region

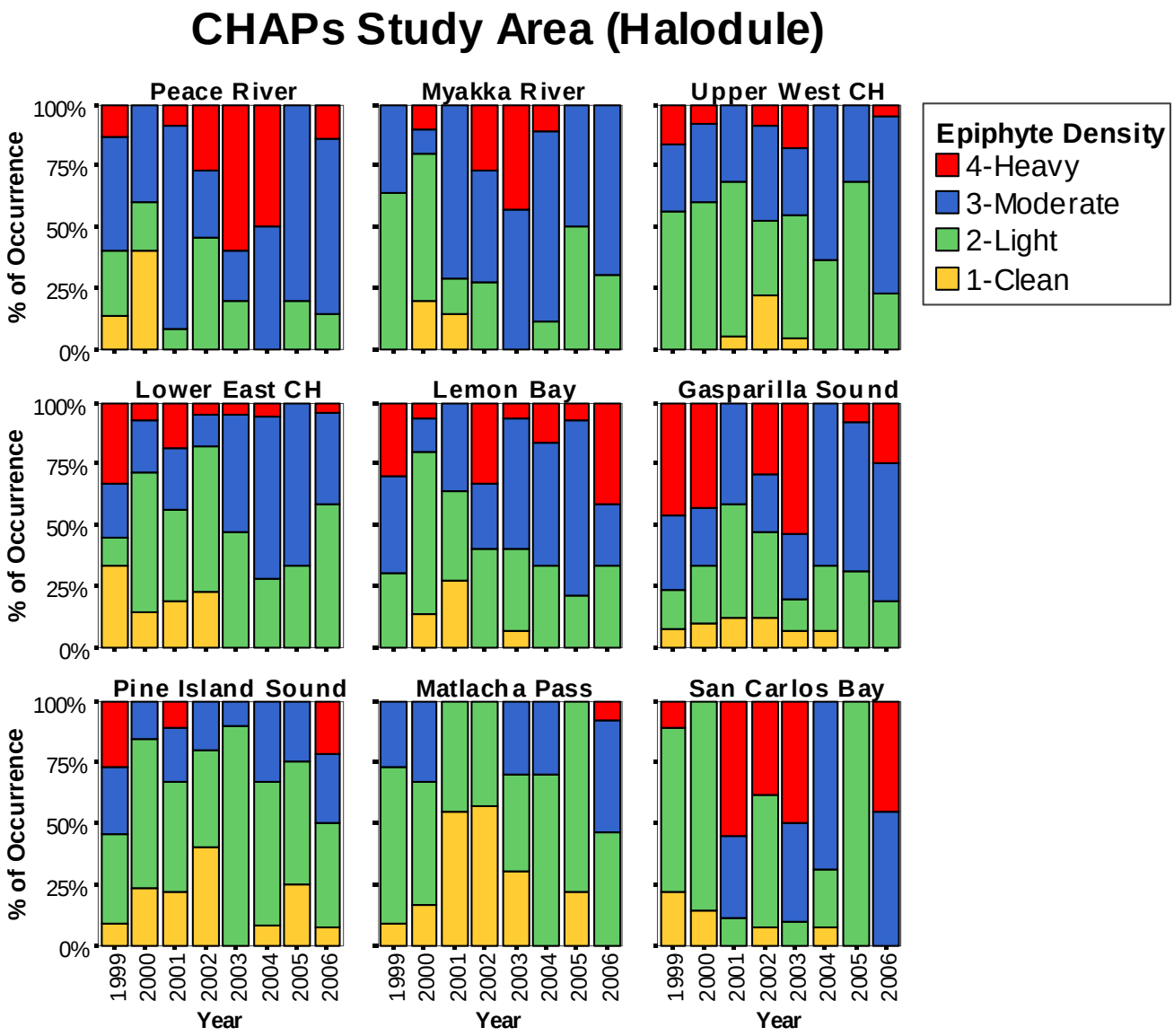


Figure 7.6. Percentage of occurrence of epiphyte load rankings for *Halodule wrightii* for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

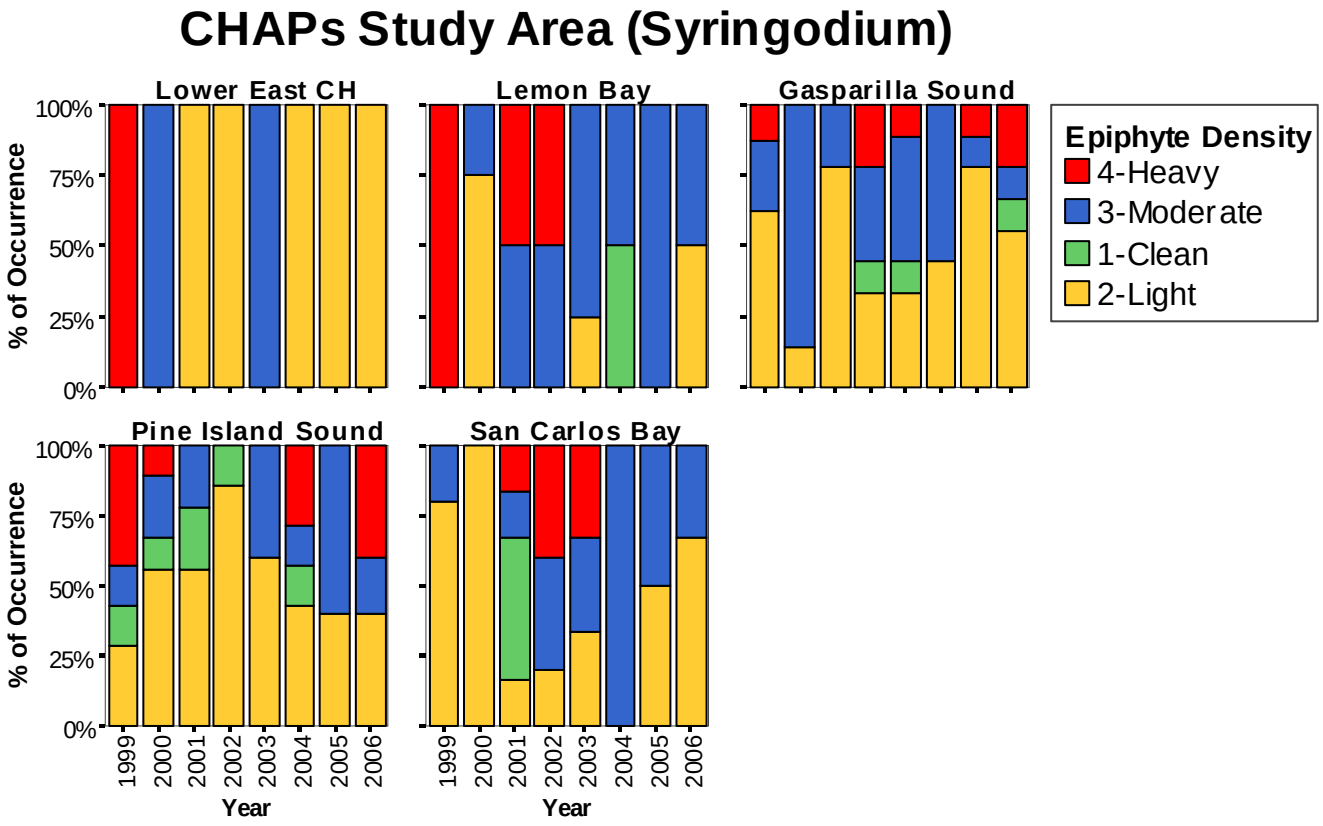


Figure 7.7. Percentage of occurrence of epiphyte load rankings for *Syringodium filiforme* for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

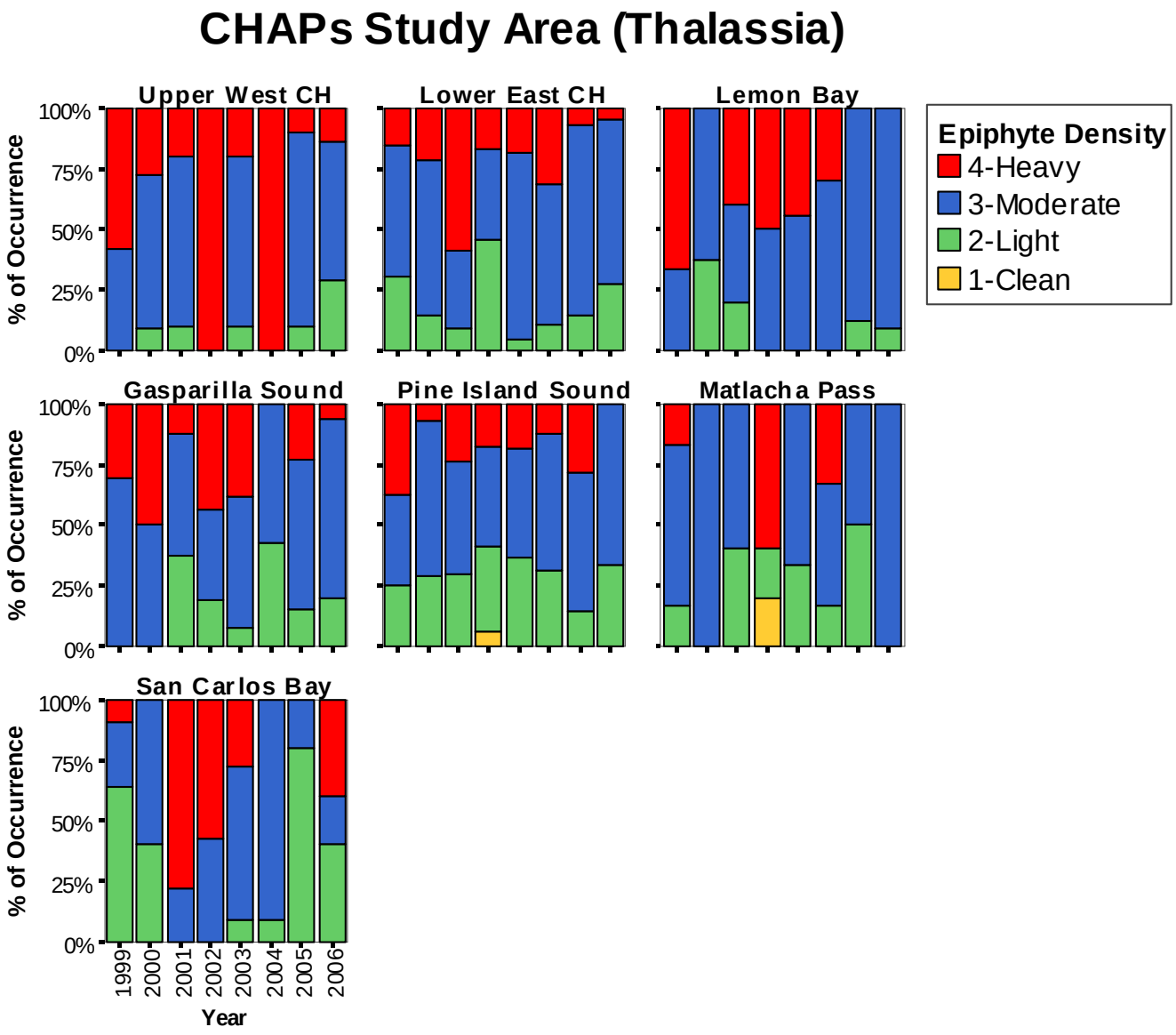


Figure 7.8. Percentage of occurrence of epiphyte load rankings for *Thalassia testudinum* for each region over the period of record (1999-2006) within the Charlotte Harbor Aquatic Preserves study area.

Additional Analysis: Comparison of Species by Study Area

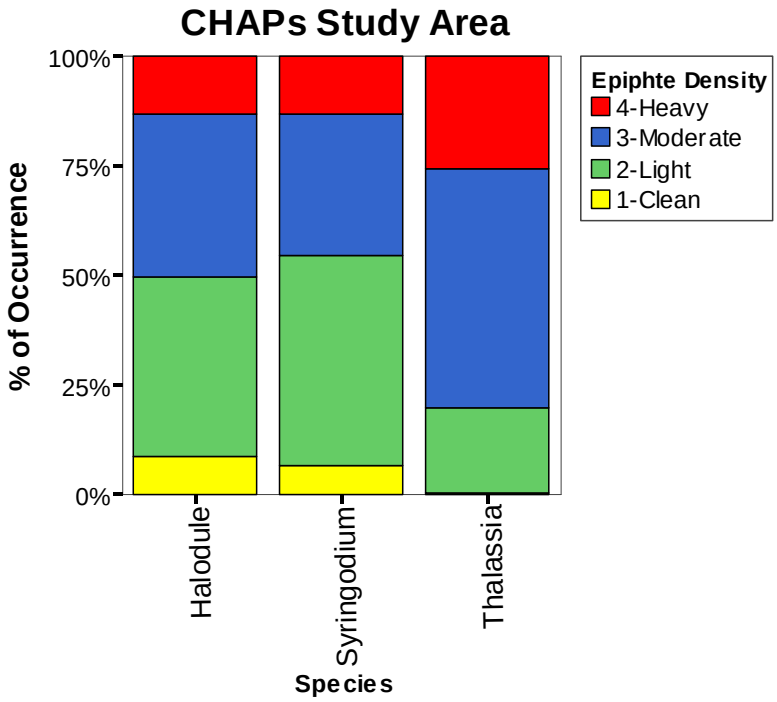


Figure 7.9. Percentage of occurrence of epiphyte load rankings for each species over the period of record (1999-2006) for the entire Charlotte Harbor Aquatic Preserves study area.

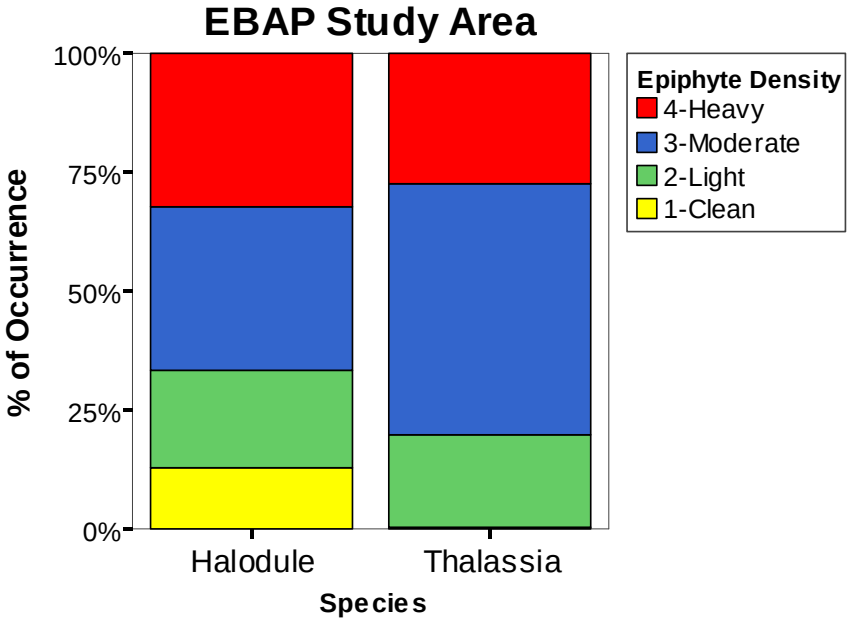


Figure 7.10. Percentage of occurrence of epiphyte load rankings for each species over the period of record (2003-2006) for the Estero Bay Aquatic Preserve study area.