Charlotte Harbor Aquatic Preserves' Eleven Year Results of the Seagrass Transect Monitoring Program

1999-2009

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Introduction

Seagrasses are submerged flowering plants important for sustaining the diversity and health of marine environments, particularly shallow estuaries within the Charlotte Harbor Aquatic Preserves. 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. Therefore, 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 seagrass habitats have been an important issue for the past two decades as understanding of the value of these resources gained attention. Despite recognition, there has been documented decline from their historical extent. 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 is one of the most pristine and productive coastal ecosystems in the state. These five interconnected estuaries comprise over 200,000 acres of diverse, complex and fragile estuarine habitats. With growing appreciation for these important estuarine habitats, Florida enacted the Aquatic Preserve Act of 1975 designating 41 Aquatic Preserves across the state. This ensured these exceptional submerged resources could be set aside to be preserved in essentially natural conditions to be enjoyed by future generations.

In southwest Florida, there are six Aquatic Preserves administered by the Florida Department of Environmental Protection (FDEP) through the office of Coastal and Aquatic Managed Areas (CAMA). Five of these are managed out of the Punta Gorda office as the Charlotte Harbor Aquatic Preserves (CHAP) including: *Lemon Bay*; *Gasparilla Sound- Charlotte Harbor*; *Cape Haze*; *Pine Island Sound*; and *Matlacha Pass*. Estero Bay Aquatic Preserve (EBAP) is located just to the south and is managed from an office located in 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

One of the resource management goals of our Aquatic Preserve program is to protect and enhance the health and functioning of seagrass habitats. 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 water quality and seagrass species, abundance, health, and zonation relative to depth. This additional information can be provided by long-term transect monitoring and has become an essential resource management tool.

Preliminary seagrass monitoring in the Charlotte Harbor Aquatic Preserves was conducted in 1998 using established protocols developed by the Southwest Florida Water Management District (SWFWMD) and Sheda Ecological, Inc. Beginning in 1999, all sites throughout the CHAP study area have been monitored annually by CHAP staff with assistance from agency and citizen volunteers. Seagrass monitoring within the Estero Bay Aquatic Preserve began in 2003, but is not summarized in this report.

Program Overview

Throughout the CHAP study area, 50 seagrass monitoring sites have been established. 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 area 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 at the beginning and end of the grass bed is collected on an annual basis.

All CHAP seagrass transects are monitored annually in the late summer, during post-growing season, generally August through November. One site in southern Matlacha Pass and two sites in San Carlos Bay are also monitored quarterly throughout the year by FDEP South District, Environmental Assessment and Restoration (EAR) staff. Seagrass monitoring data may be obtained directly from the CHAP office in Punta Gorda.

Purpose of Summary

Seagrasses have become 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 these analyses relate to defining annual trends in seagrass species distribution, abundance, and maximum depth of growth within the different regions of the study area. This summary is a tool for CHAP resource managers to use 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 seagrass quality and long-term health on an annual basis.

The CHAP seagrass transect monitoring covers the coastal areas throughout the Charlotte Harbor National Estuary Program (CHNEP) study area. CHAP seagrass monitoring methods and data allows CHNEP 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 are used by the CHNEP to set resource-based water quality targets throughout the region.

Methodology

For these analyses, seagrass transect data were 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 a regional border, decisions were also partially based on having a sufficient number of samples within each region. In addition, hydrologic strata used by the Coastal Charlotte Harbor Monitoring Network were used to assist with the delineation of geographic regions in these analyses. See map of CHAP seagrass transects by region 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 waters entering Charlotte Harbor through Boca Grande Pass have the tendency to move toward the eastern shoreline of the harbor and run north, thus impacting transects in the *Lower East Charlotte Harbor* region similarly. In contrast, sites along the western shoreline of the harbor and northwest portion of Punta Gorda are influenced more strongly by waters moving downstream from the Peace and Myakka Rivers, lending to the clustering of these transects into the *Upper West Charlotte Harbor* region.

This report summarizes 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 analyses, quadrats were reviewed to ensure that consistent data sets were available at each transect and limitations were set so that quadrats with at least nine out of the eleven years of data were included. This allowed for the number of quadrats in the analyses to be as standardized as possible, making for stronger interpretation. Quadrats at the beginning and end of grass beds were eliminated (except for the end of bed data for maximum depth of seagrass growth analysis) due to the lack of consistent monitoring from yearly bed shifting.

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 three 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 three most common seagrass species?

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

6) What is the maximum depth of seagrass growth?

7) How dense are the epiphytes on the three most common seagrass species?

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

For each question, a subset of analyses 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 CHAP. These queries were then imported into SPSS, a statistical analysis software package. Graphical representation of the data generally includes bar graphs with a measure of variation (either standard error or deviation depending on sample size) around a mean value.

Questions 3 and 4 relate to seagrass abundance. The standard classification of seagrass coverage is the Braun-Blanquet method which is used in these analyses. This method categorizes seagrass abundance in a quadrat as percent coverage classes. The coverage classes are defined as follows: **0.1** = solitary; **.05** = 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. Beginning in 2005, CHAP staff began monitoring density using a well-defined shoot count method to better characterize the health of seagrass. Quadrats are first assigned a Braun-Blanquet coverage class and 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 vary depending on species. For additional Braun-Blanquet and shoot count information, please contact the CHAP office.

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

In all questions, the seagrass species are graphed by their genus name but refer specifically to: *Halodule wrightii* (Shoal grass), *Thalassia testudinum* (Turtle grass), *Syringodium filiforme* (Manatee grass), *Ruppia maritima* (Widgeon grass) and *Holiphila sp*. including *H. decipiens* (Paddle grass) and *H .engelmannii* (Star grass).

Conclusion

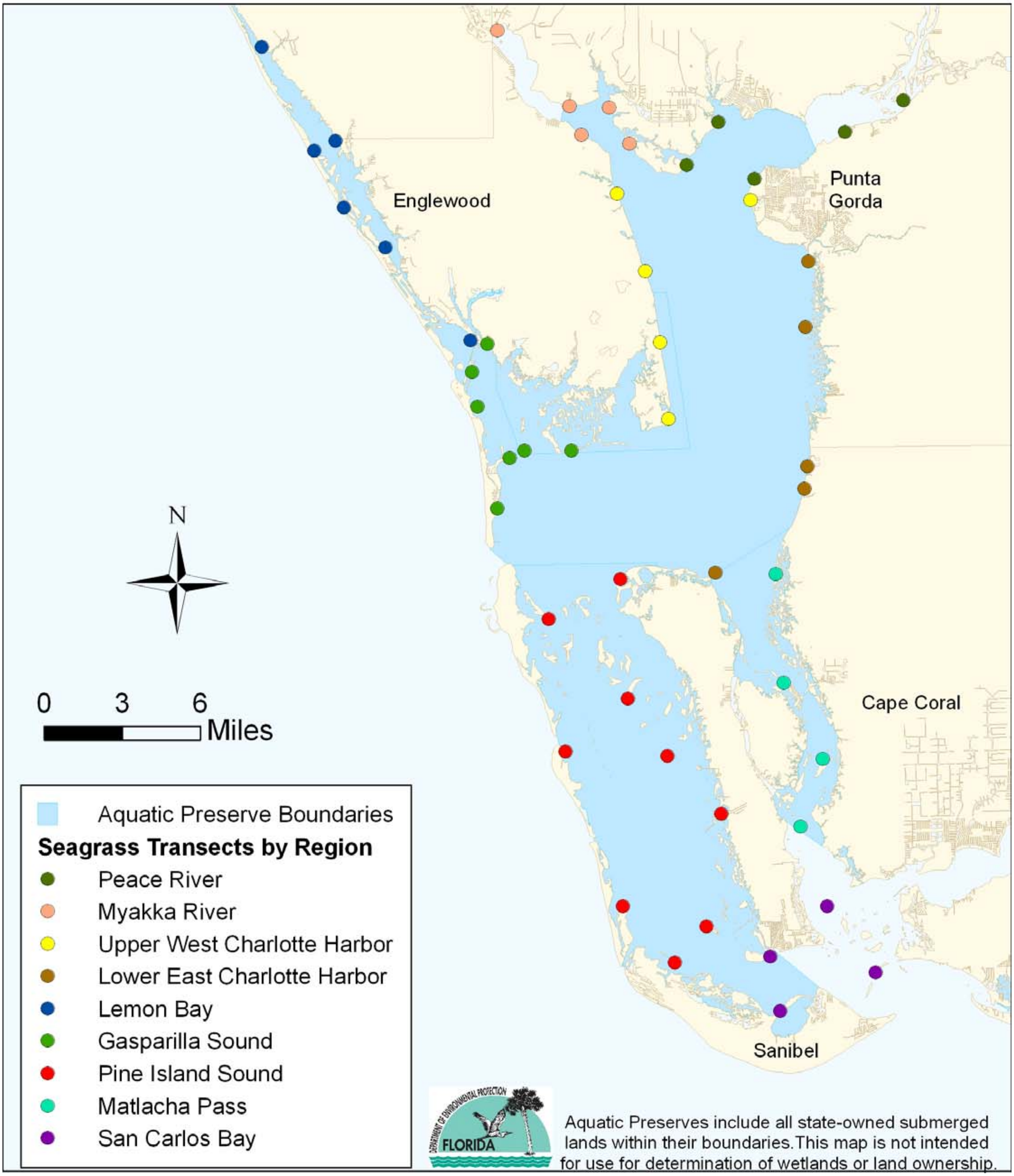
This report on the CHAP Seagrass Transect Monitoring Program is an update to the 1999-2006 summary report and provides an eleven year look at seagrasses within the CHAP study area. This report provides essential information about the health of seagrasses throughout the Charlotte Harbor estuarine complex. 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 interest 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 in these habitats. Comparison of in-season versus off-season, or wet versus dry season, data collected in coordination with FDEP South District EAR staff is also of interest in order to compare seagrass characteristics at selected sites throughout the year.

Acknowledgements

The original 1999-2006 summary was produced with the technical assistance of Jaime Greenawalt-Boswell who provided assistance with the design and implementation of that summary in support of the CHNEP's environmental indicators. A special thank you to all of the current CHAP staff including Heather Stafford, Ray Leary, Mary McMurray, Neil Langenberg and Debbie Horner for their thoughtful review and long days in the field monitoring seagrass and to the FDEP South District EAR staff: Erin Rasnake, Chris Nappi and Jennifer Nelson for their invaluable SCUBA and field assistance. Thanks to previous CHAP staff who contributed to field data collection and program development including: Judy Ott, Katie Laakkonen, Celia Hitchins, Dana Moller and Renee Duffey. Finally, partnership agencies and volunteers are thanked for their hard work in assisting with data collection and the ensured success of this program.

FDEP Charlotte Harbor Aquatic Preserves' Seagrass Monitoring Sites



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

Analysis A: Comparison of Years

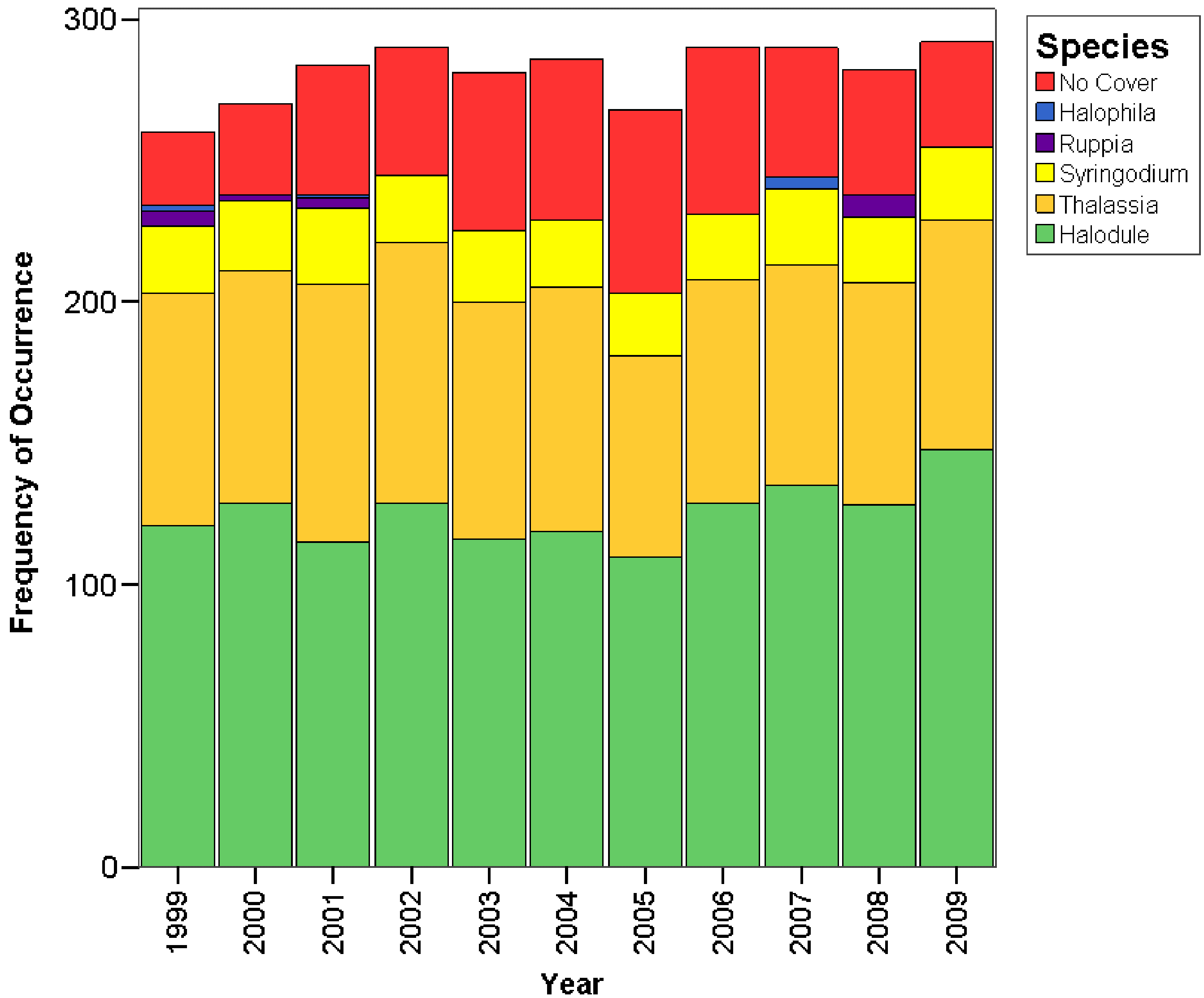


Figure 1.1. Frequency of occurrence of seagrass species and no cover over the period of record (1999-2009) for the CHAP study area.

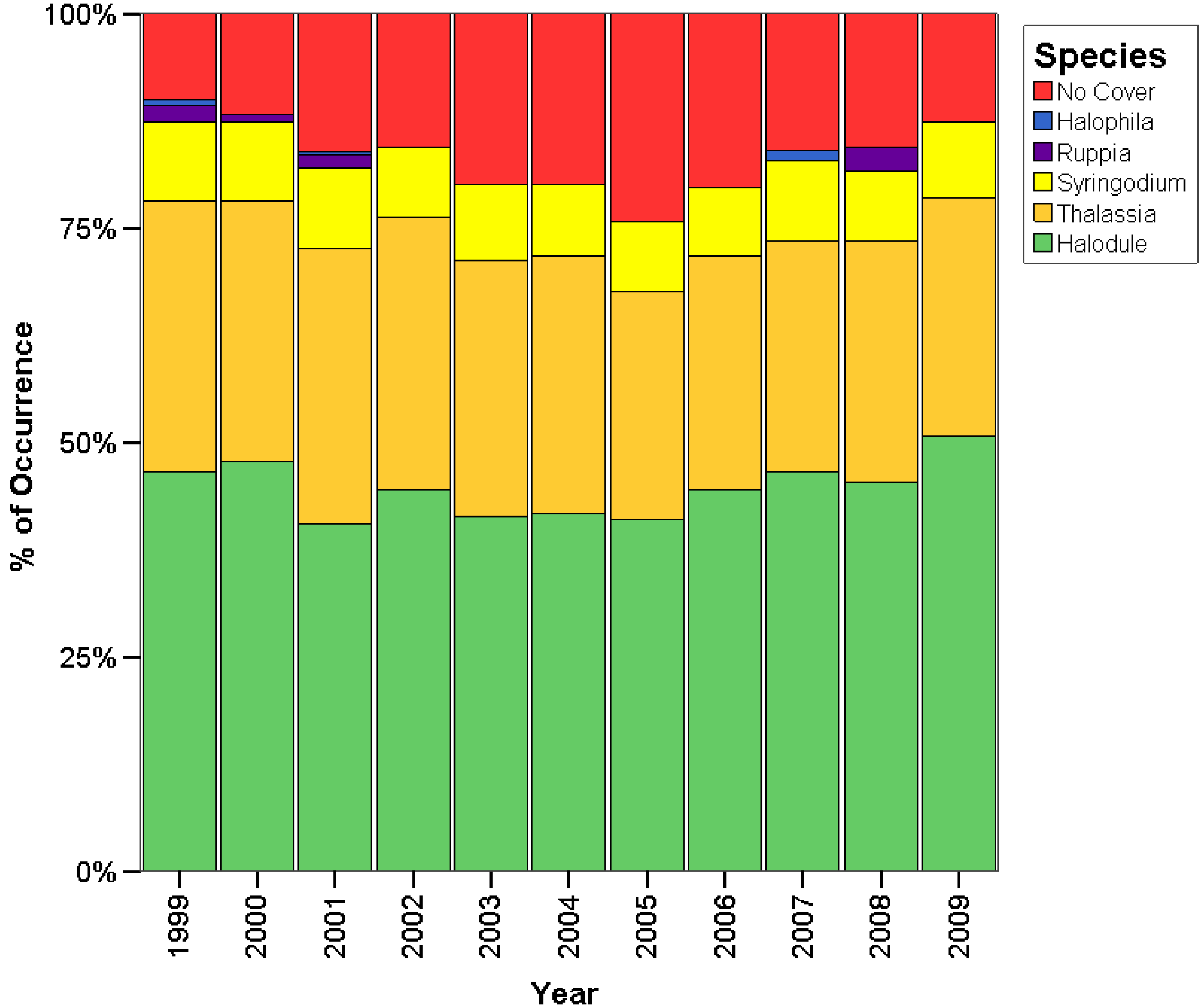


Figure 1.2. Percentage of occurrence of seagrass species and no cover over the period of record (1999-2009) for the CHAP study area.

Analysis B: Comparison of Regions

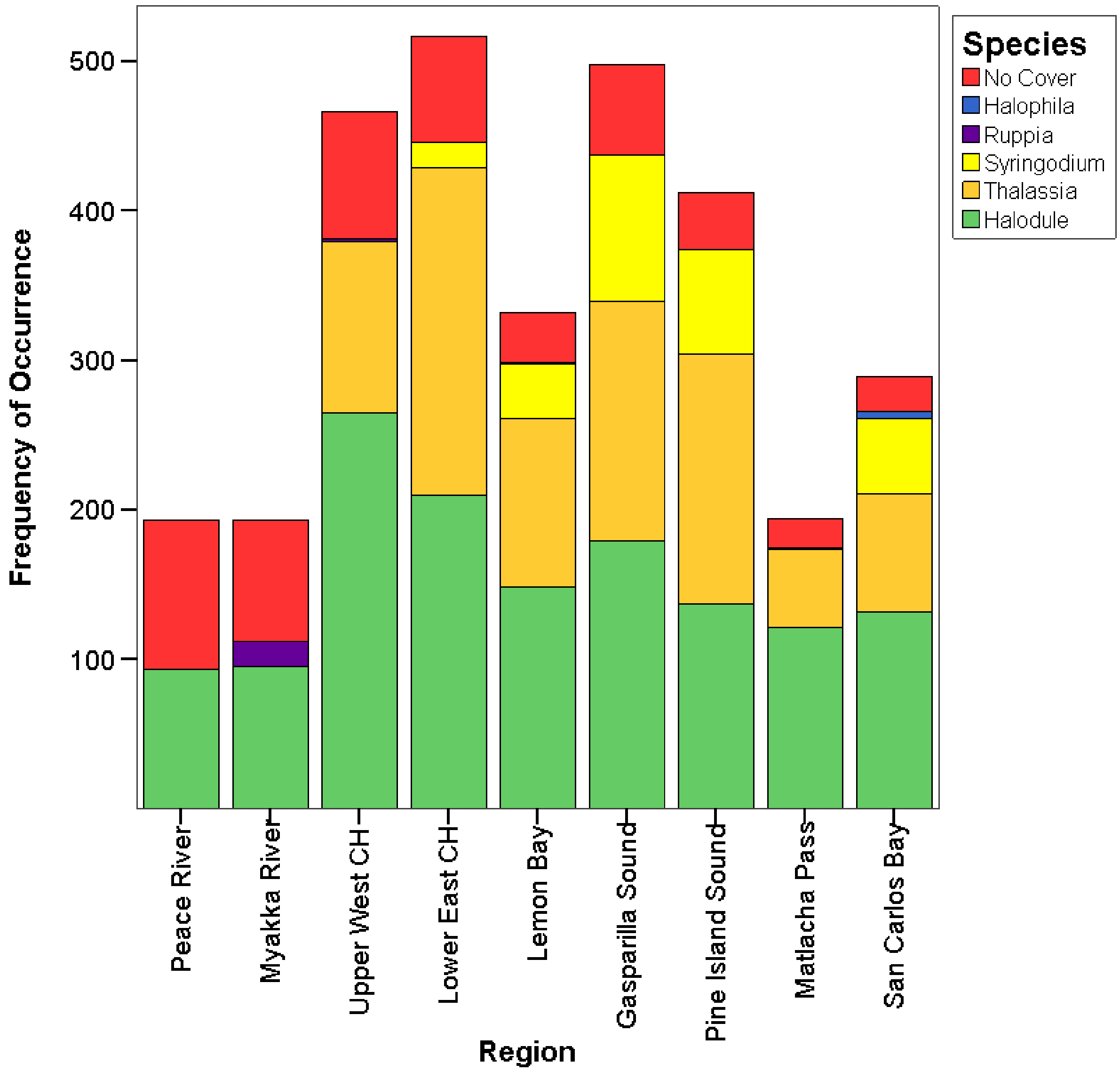


Figure 1.3. Frequency of occurrence of seagrass species and no cover for each region over the period of record (1999-2009) for the CHAP study area.

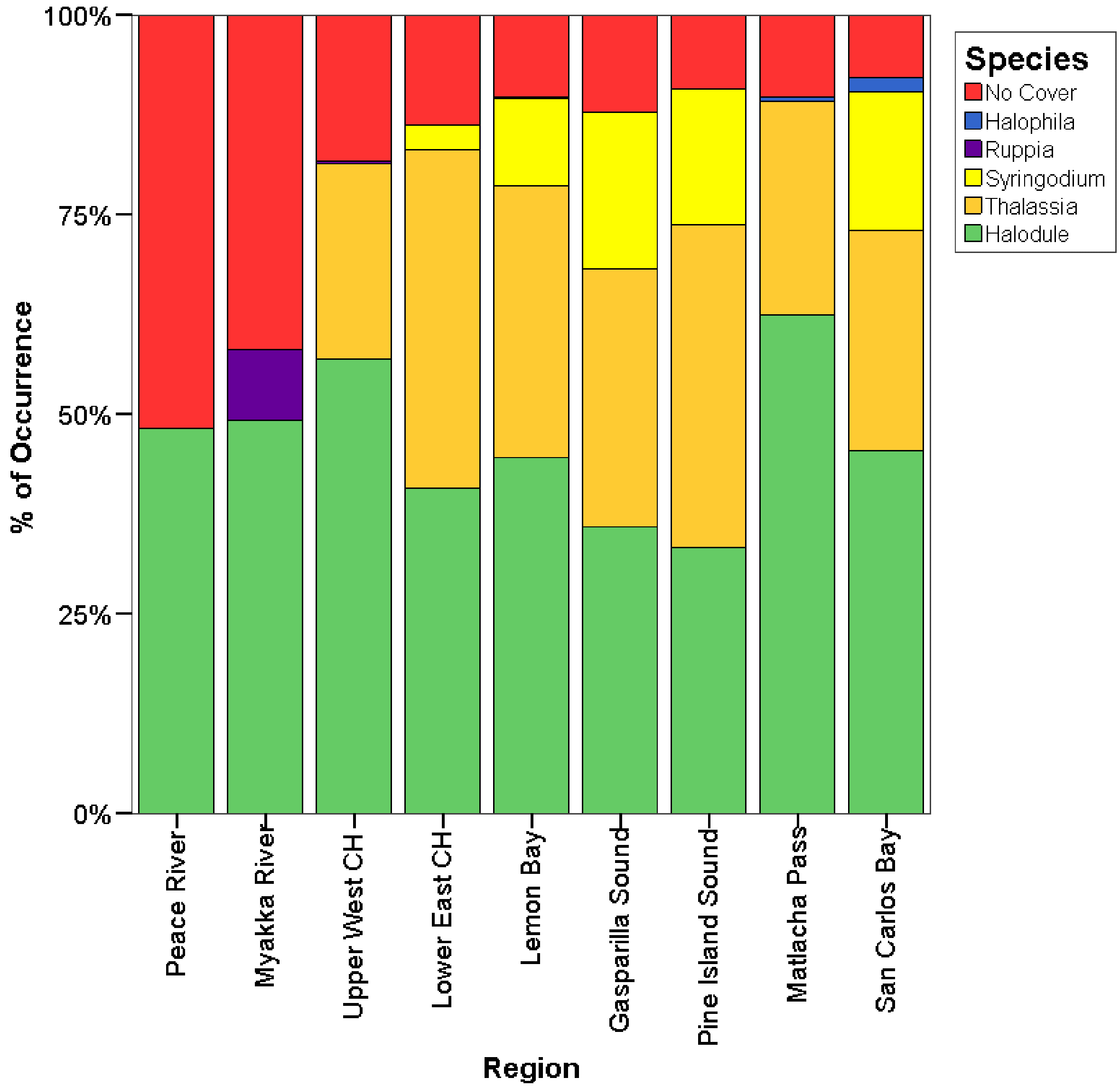


Figure 1.4. Percentage of occurrence of seagrass species and no cover for each region over the period of record (1999-2009) for the CHAP study area.

Analysis C: Comparison of Years by Region

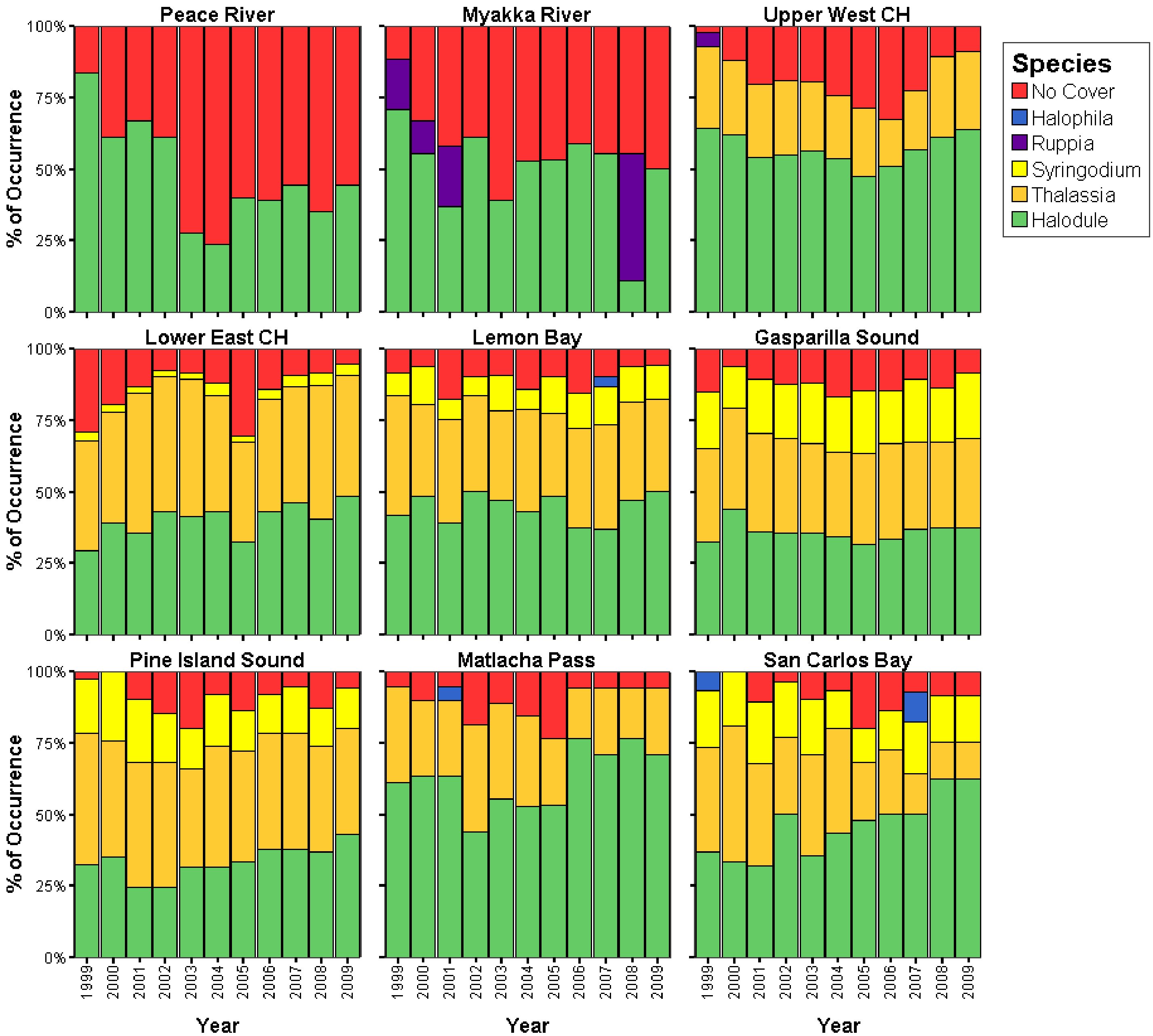


Figure 1.5. Percentage of occurrence of seagrass species and no cover for each region over the period of record (1999-2009) within the CHAP study area.

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

Analysis A: Comparison of Years

CHAP Study Area				
	Total # of Species Occurrence			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
2007	135	78	27	1 : 0.6 : 0.2
2008	128	79	23	1 : 0.6 : 0.2
2009	148	81	26	1 : 0.5 : 0.2
Total	**1379**	**905**	**270**	**1 : 0.7 : 0.2**

Table 2.1. Frequency of occurrence of the three most common seagrass species and their ratios over the period of record (1999-2009) for the CHAP study area.

Analysis B: Comparison of Regions

CHAP Study Area					
	Total # of Species Occurrence				Ratio
Region	Halodule	Thalassia	Syringodium	No Cover	H : T : S : NC
Peace River	93			100	1 : 0.0 : 0.0 : 1.1
Myakka River	95			81	1 : 0.0 : 0.0 : 0.9
Upper West CH	265	114		85	1 : 0.4 : 0.0 : 0.3
Lower East CH	210	219	16	71	1 : 1.0 : 0.08 : 0.3
Lemon Bay	148	113	36	34	1 : 0.8 : 0.2 : 0.2
Gasparilla Sound	179	160	98	61	1 : 0.9 : 0.5 : 0.3
Pine Island Sound	137	167	70	38	1 : 1.2 : 0.5 : 0.3
Matlacha Pass	121	52		20	1 : 0.4 : 0.0 : 0.2
San Carlos Bay	131	80	50	23	1 : 0.6 : 0.4 :0.2
Total	**1379**	**905**	**270**	**513**	**1 : 0.7 : 0.2 : 0.4**

Table 2.2. Frequency of occurrence of the three most common seagrass species and no cover and their ratios for each region over the period of record (1999-2009) for the CHAP study area.

Analysis C: Comparison of Years by Region

A. Peace River			
	Total # of Species Occurrence		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
2007	8	10	1 : 1.3
2008	6	11	1 : 1.8
2009	8	10	1 : 1.3
Total	**93**	**100**	**1 : 1.1**

Table 2.3 (A). 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 (1999-2009) within the Peace River region.

B. Myakka River			
	Total # of Species Occurrence		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
2007	10	8	1 : 0.8
2008	2*	8	1* : 4.0
2009	9	9	1 : 1
Total	**95**	**81**	**1 : 0.9**

Table 2.3 (B and C). 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 (1999-2009) within the Myakka River and Upper West Charlotte Harbor regions.
**Note: In 2008 a majority of Halodule in Myakka River was replaced by Ruppia.*

C. Upper West Charlotte Harbor			
	Total # of Species Occurrence		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
2007	25	9	1 : 0.4
2008	28	13	1 : 0.5
2009	28	12	1: 0.4
Total	**265**	**114**	**1 : 0.4**

D. Lower East Charlotte Harbor				
	Total # of Species Occurrence			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
2007	24	21	2	1 : 0.9 : 0.08
2008	19	22	2	1 : 1.2 : 0.09
2009	26	23	2	1 : 0.9 : 0.08
Total	**210**	**219**	**16**	**1 : 1.0 : 0.08**

Table 2.3 (D and E). Frequency of occurrence of the three most common seagrass species and their ratios for each region over the period of record (1999-2009) within the Lower East Charlotte Harbor and Lemon Bay regions.

E. Lemon Bay				
	Total # of Species Occurrence			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
2007	11	11	4	1 : 1.0 : 0.4
2008	15	11	4	1 : 0.7 : 0.3
2009	17	11	4	1 : 0.6 : 0.2
Total	**148**	**113**	**36**	**1 : 0.8 : 0.2**

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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
2007	17	14	10	1 : 0.8 : 0.6
2008	16	13	8	1 : 0.8 : 0.6
2009	18	15	11	1 : 0.8 : 0.6
Total	**179**	**160**	**98**	**1 : 0.9 : 0.5**

Table 2.3 (F and G). Frequency of occurrence of the three most common seagrass species and their ratios for each region over the period of record (1999-2009) within the Gasparilla Sound and Pine Island Sound regions.

G. Pine Island Sound				
	Total # of Species Occurrence			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
2007	14	15	6	1 : 1.1 : 0.4
2008	14	14	5	1 : 1.0 : 0.4
2009	15	13	5	1 : 0.9 : 0.3
Total	**137**	**167**	**70**	**1 : 1.2 : 0.5**

H. Matlacha Pass			
	Total # of Species Occurrence		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
2007	12	4	1 : 0.3
2008	13	3	1 : 0.2
2009	12	4	1: 0.3
Total	**121**	**52**	**1 : 0.4**

Table 2.3 (H and I). Frequency of occurrence of the three most common seagrass species and their ratios for each region over the period of record (1999-2009) within the Matlacha Pass and San Carlos Bay regions.

I. San Carlos Bay				
	Total # of Species Occurrence			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
2007	14	4	5	1 : 0.3 : 0.4
2008	15	3	4	1 : 0.2 : 0.3
2009	15	3	4	1 : 0.2 : 0.3
Total	**131**	**80**	**50**	**1 : 0.6 : 0.4**

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

Analysis A: Comparison of Years

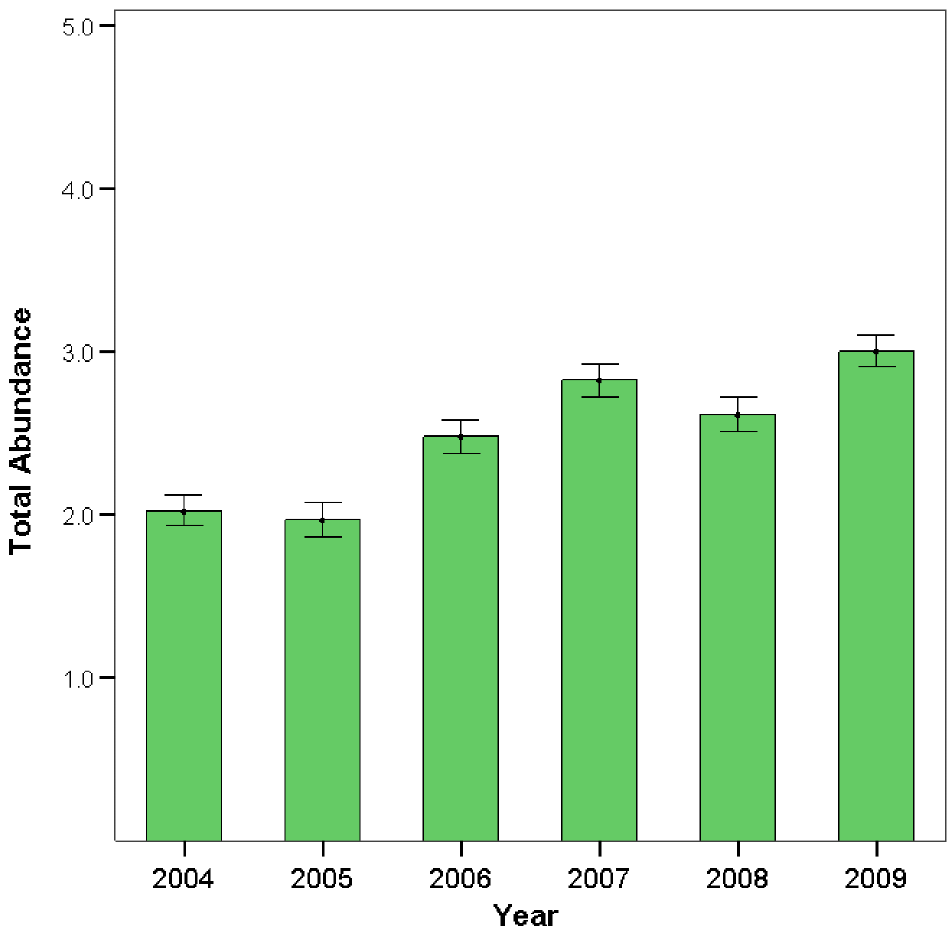


Figure 3.1. Mean Braun-Blanquet total quadrat abundance (+/- SE) over the period of record (2004-2009) for the entire CHAP study area.

Analysis B: Comparison of Regions

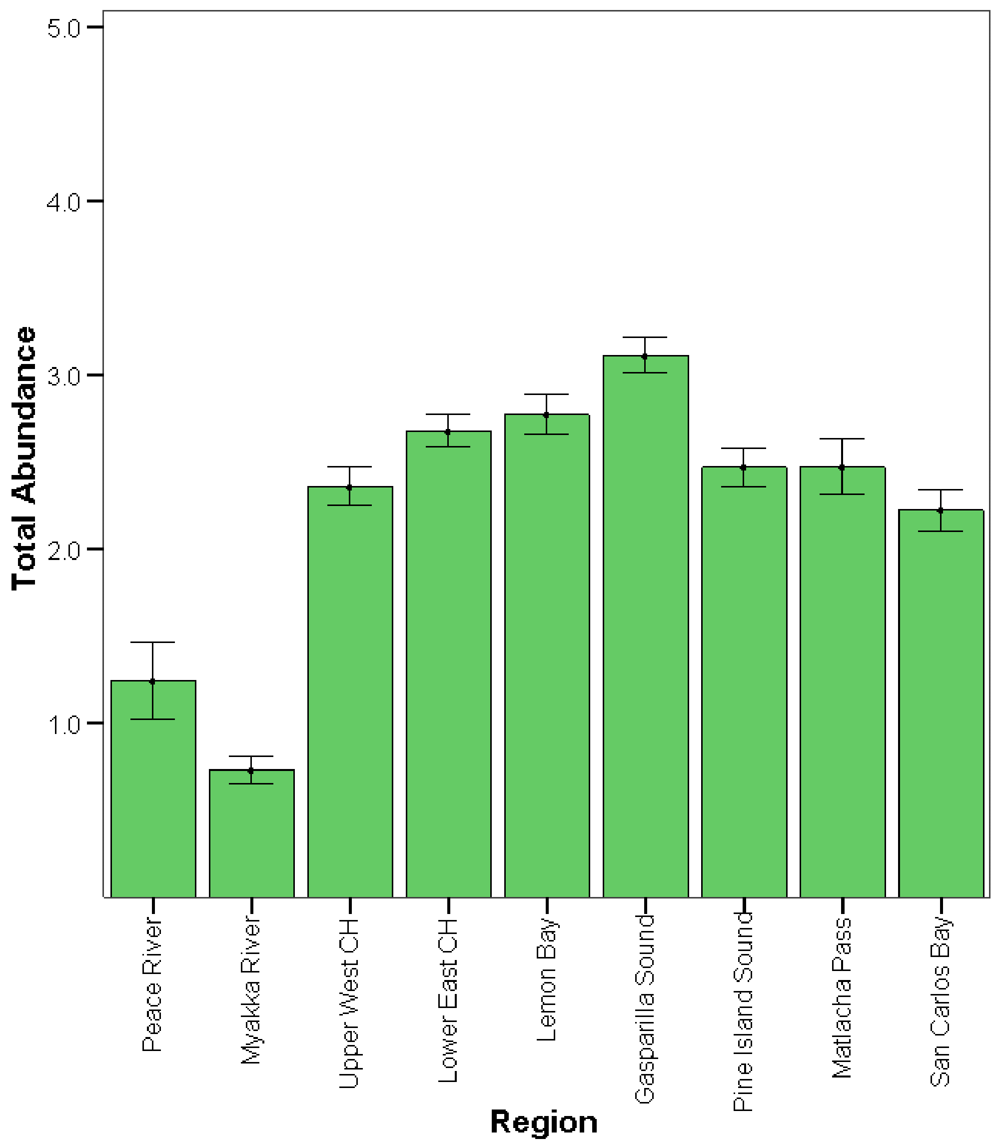


Figure 3.2. Mean Braun-Blanquet total quadrat abundance (+/- SE) for each region over the period of record (2004-2009) for the CHAP study area.

Analysis C: Comparison of Years by Region

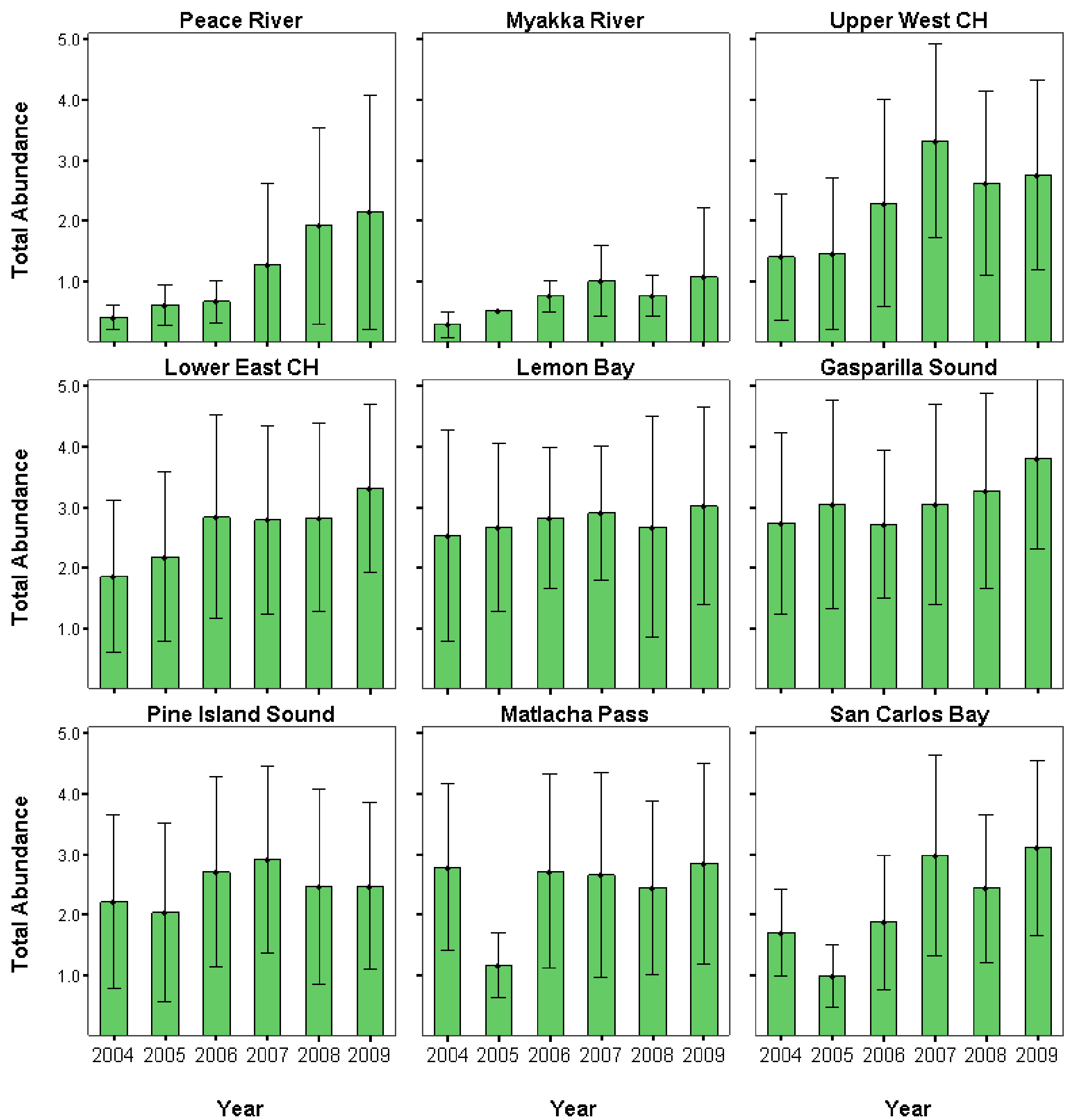


Figure 3.3. Mean Braun-Blanquet total quadrat abundance (+/- SD) for each region over the period of record (2004-2009) within the CHAP study area

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

Analysis A: Comparison of Years

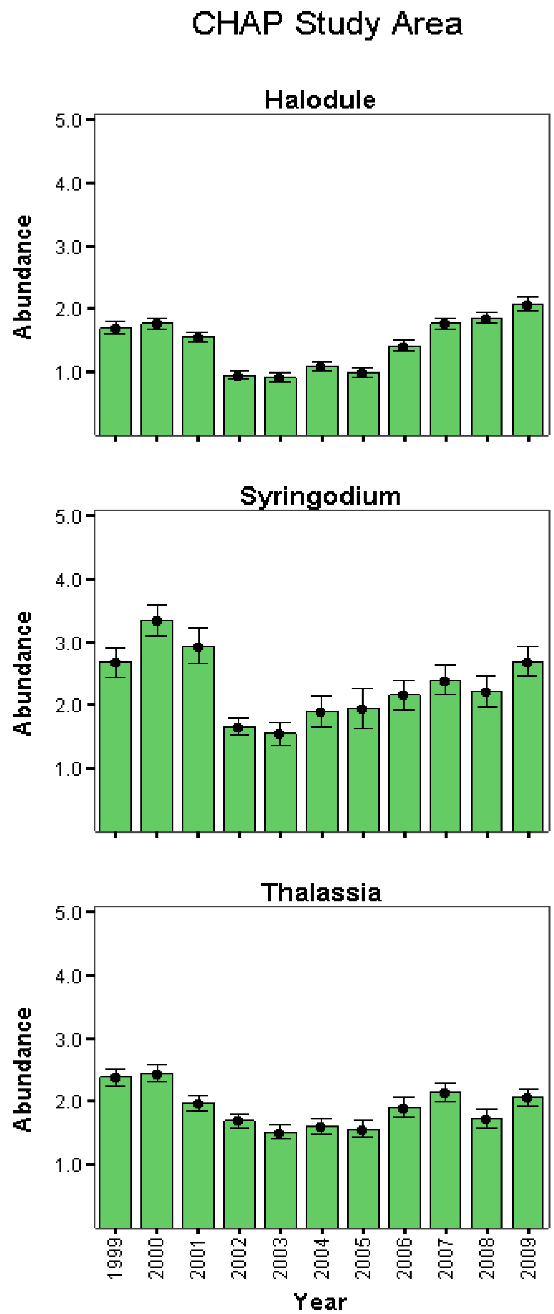


Figure 4.1. Mean Braun-Blanquet abundance (+/- SE) by species over the period of record (1999-2009) for the CHAP study area.

Analysis B: Comparison of Regions

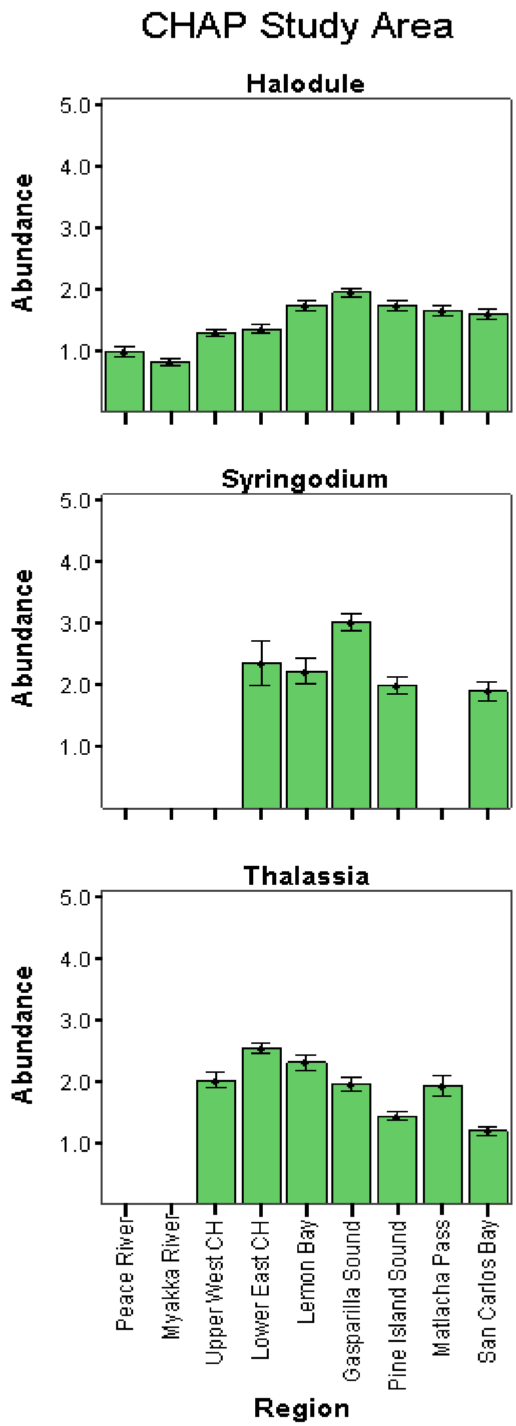


Figure 4.2. Mean Braun-Blanquet abundance (+/- SE) by species for each region over the period of record (1999-2009) for the CHAP study area.

Analysis C: Comparison of Years by Region

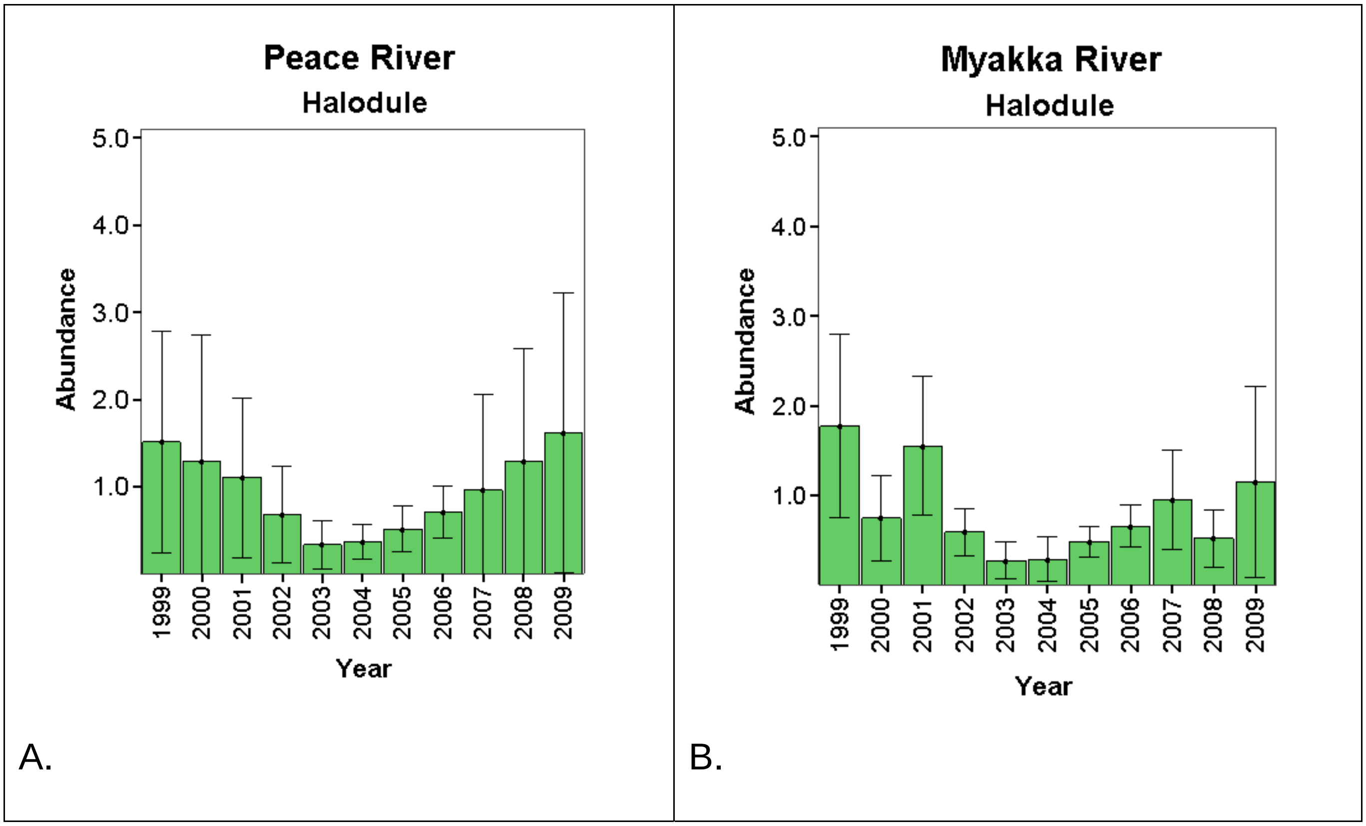


Figure 4.3 (A-B). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2009) within the Peace River and Myakka River regions.

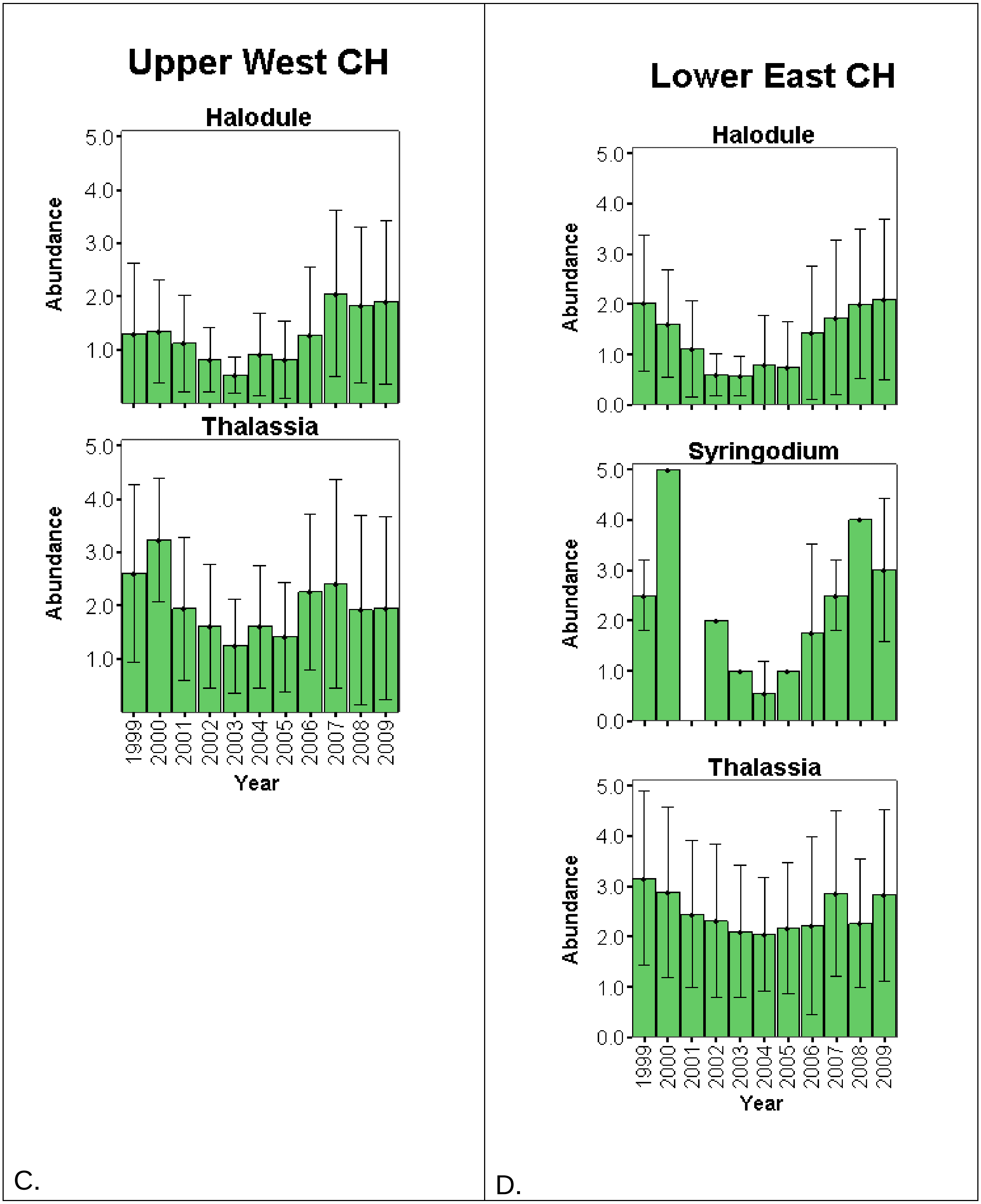


Figure 4.3 (C-D). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2009) within the Upper West and Lower East Charlotte Harbor regions.

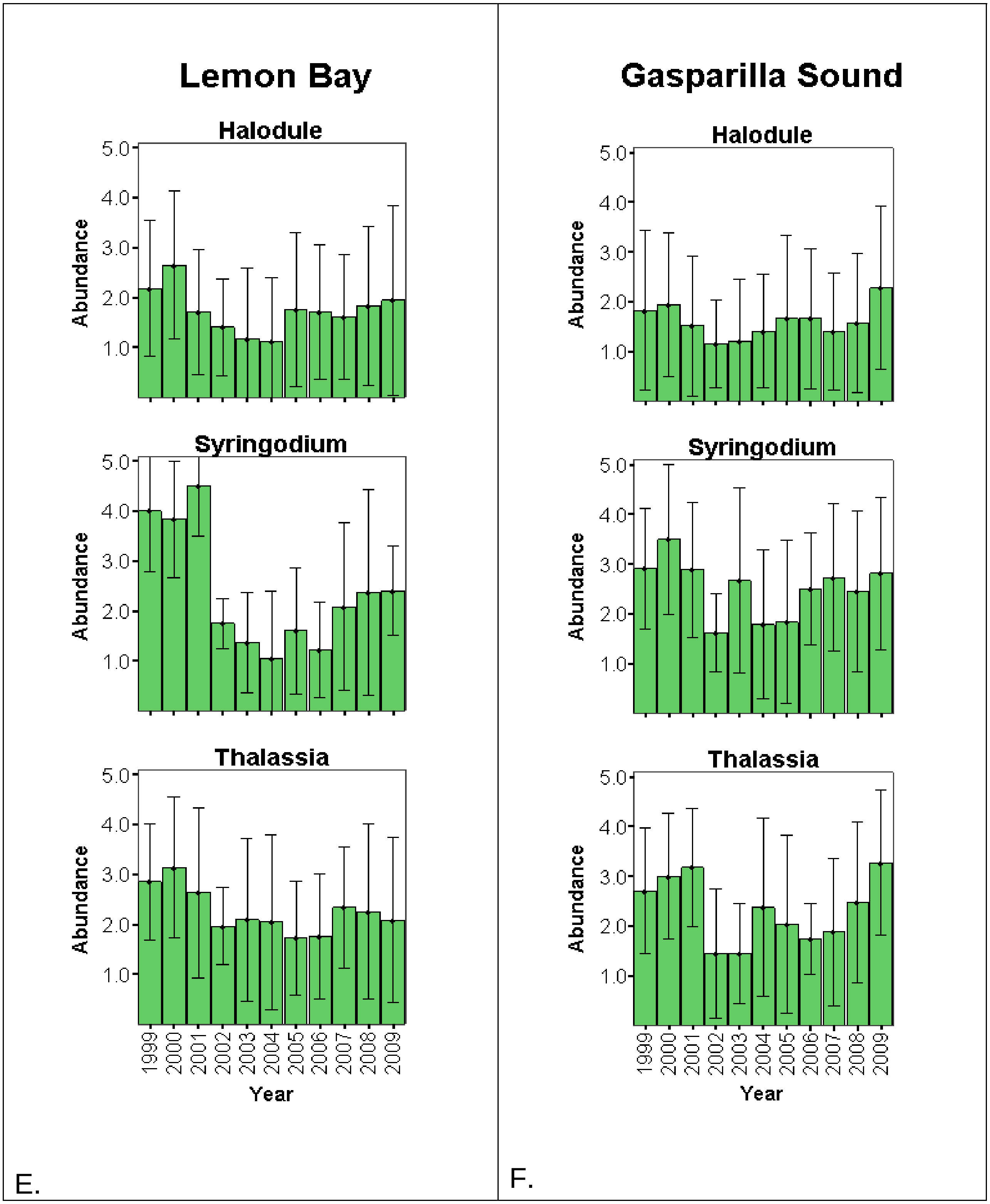
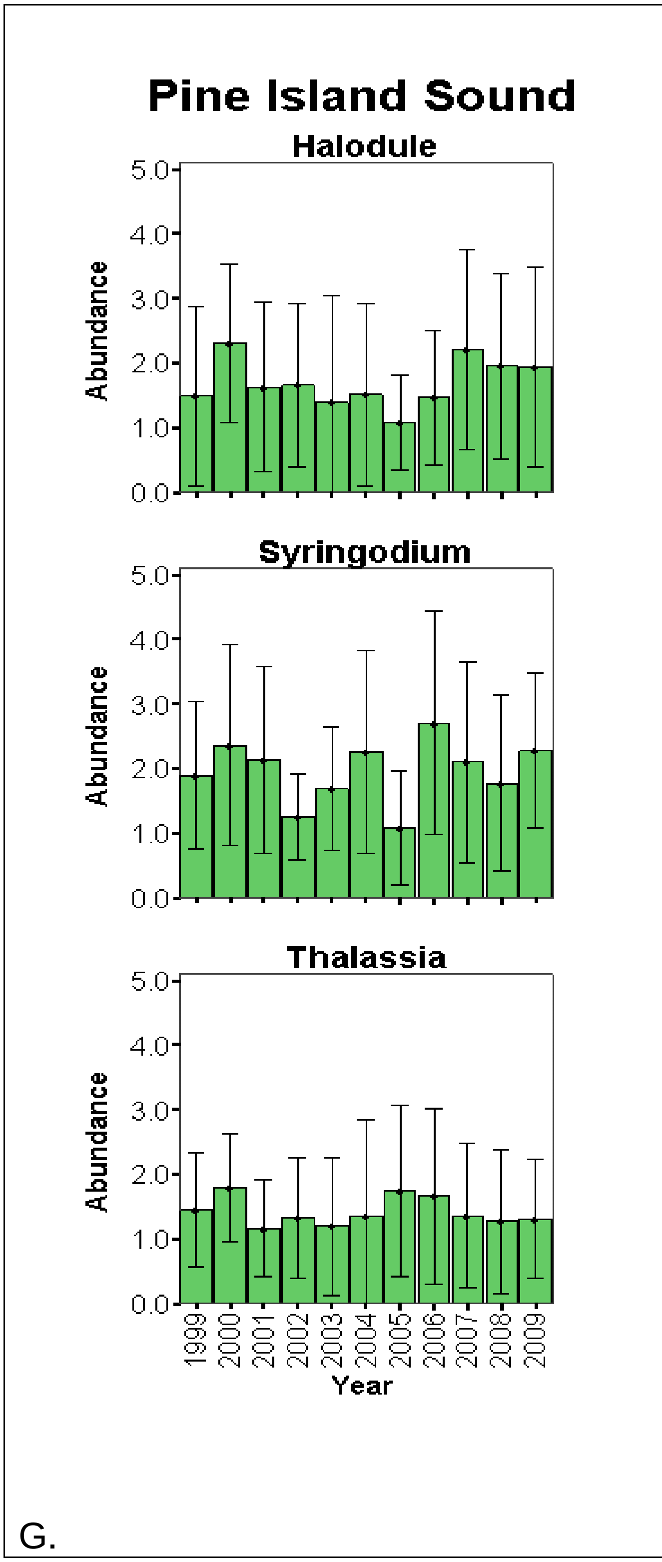


Figure 4.3 (E-F). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2009) within the Lemon Bay and Gasparilla Sound regions.



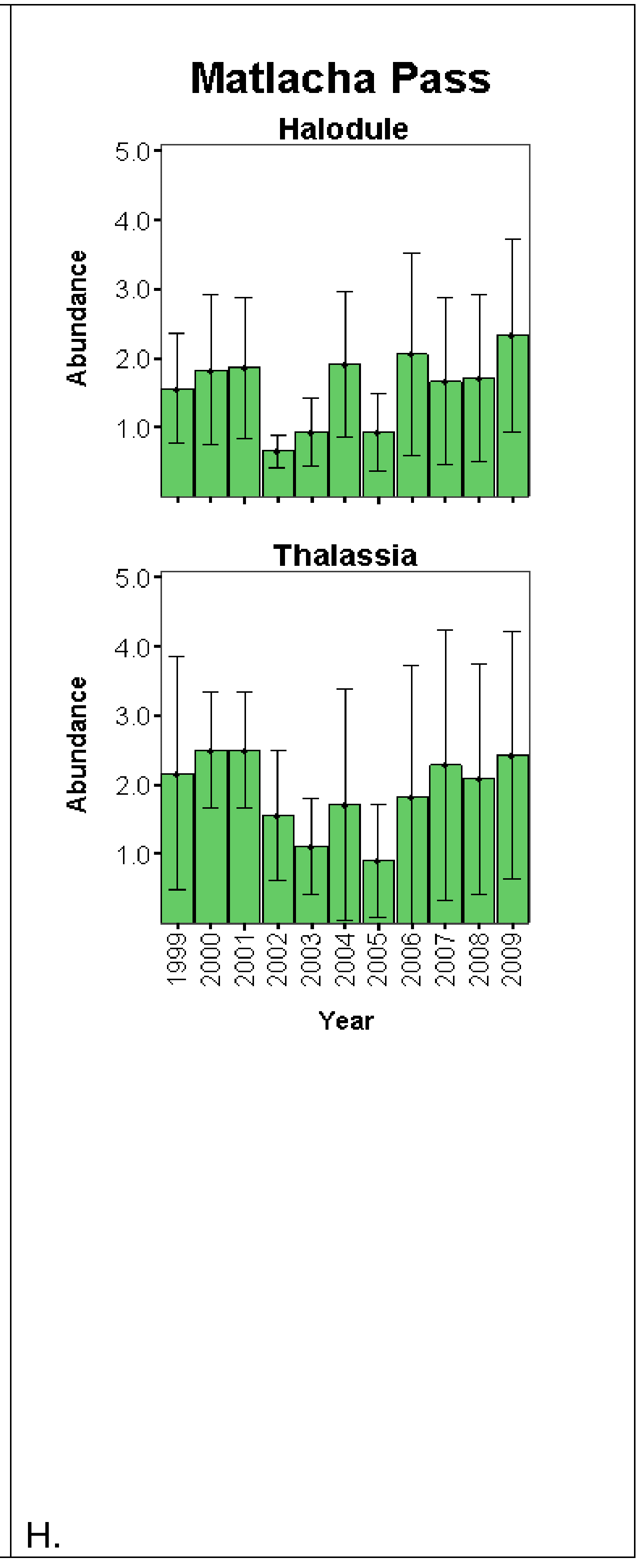


Figure 4.3 (G-H). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2009) within the Pine Island Sound and Matlacha Pass regions.

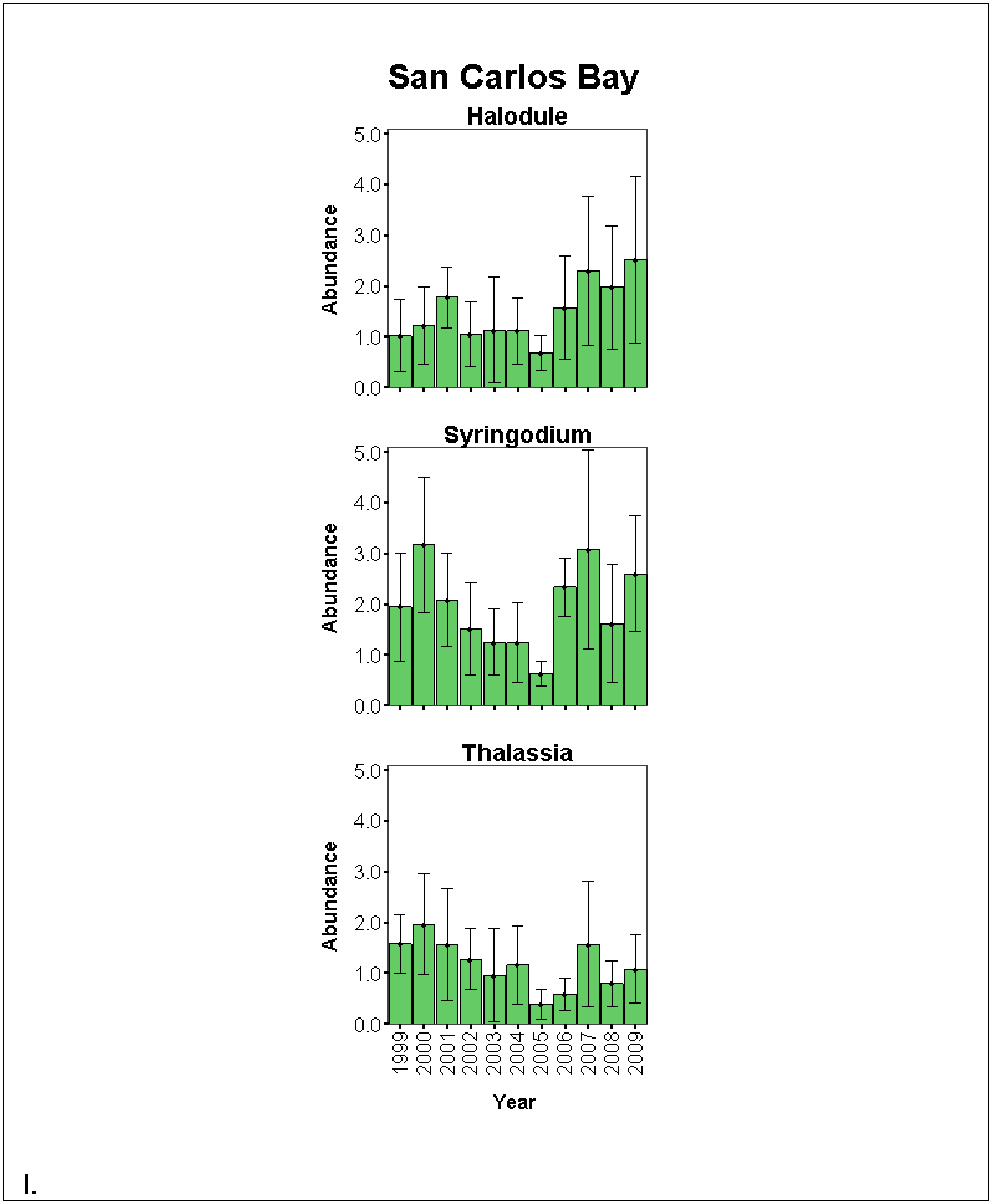


Figure 4.3 (I). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2009) within the San Carlos Bay region.

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

Analysis A: Comparison of Years (for Halodule)

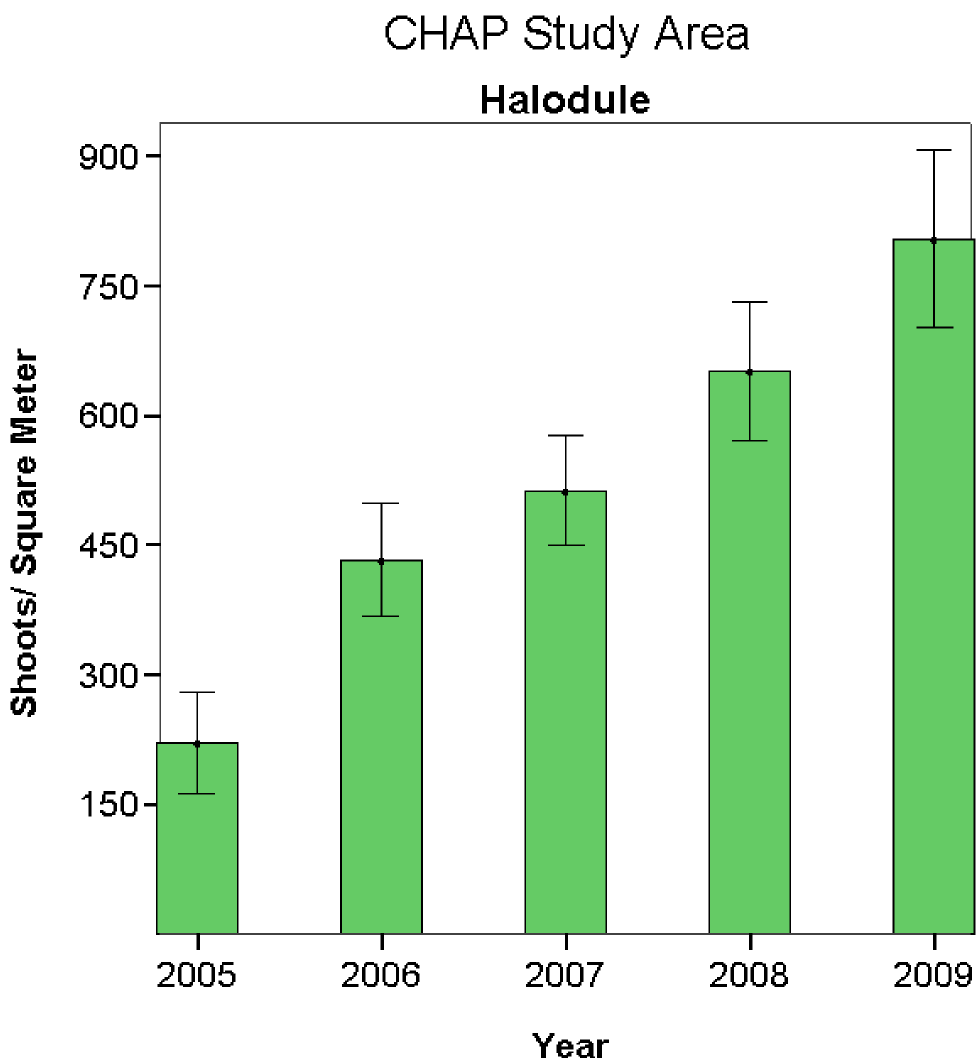


Figure 5.1. Mean shoot density (+/- SE) of *Halodule wrightii* over the period of record (2005-2009) for the entire CHAP study area.

Analysis B: Comparison of Regions (for Halodule)

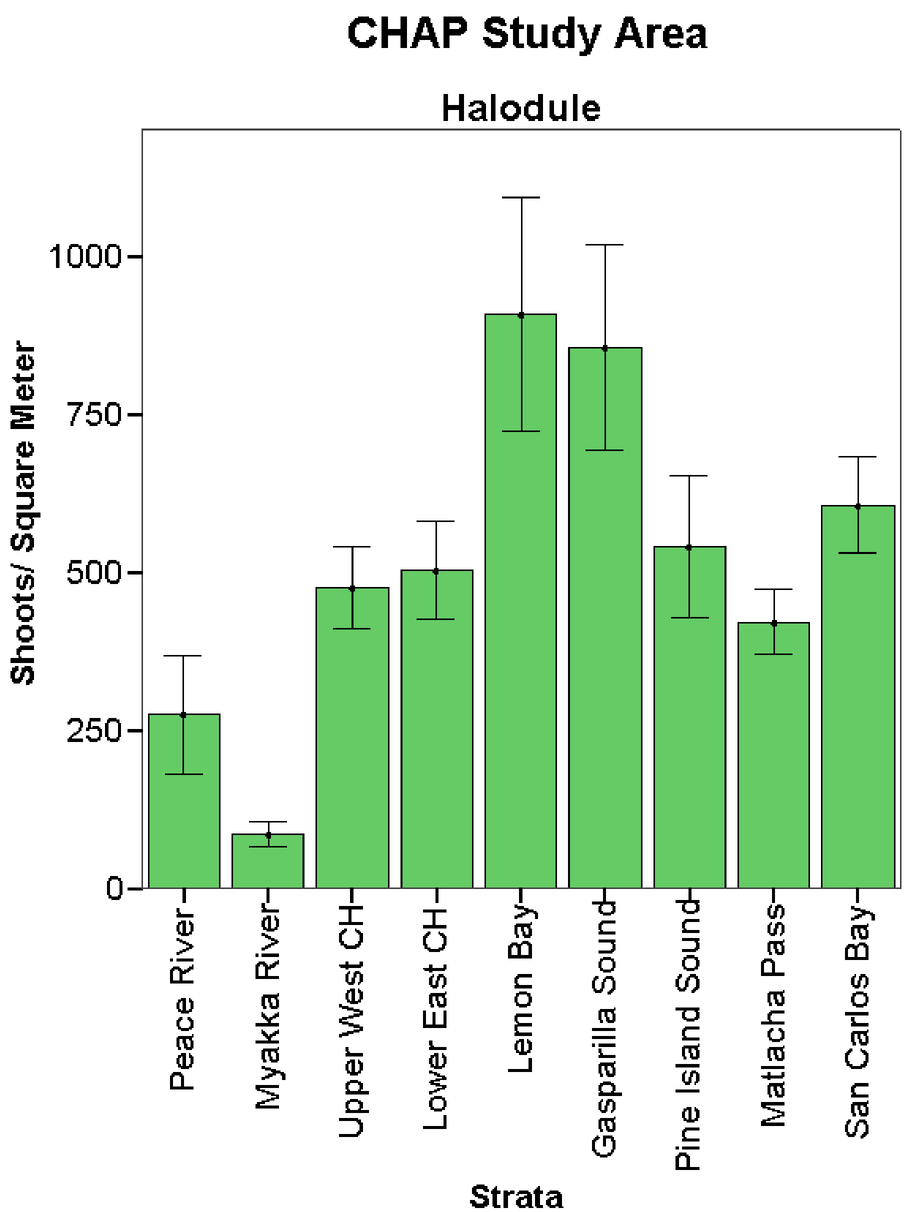


Figure 5.2. Mean shoot density (+/- SE) of *Halodule wrightii* for each region over the period of record (2005-2009) for the CHAP study area.

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

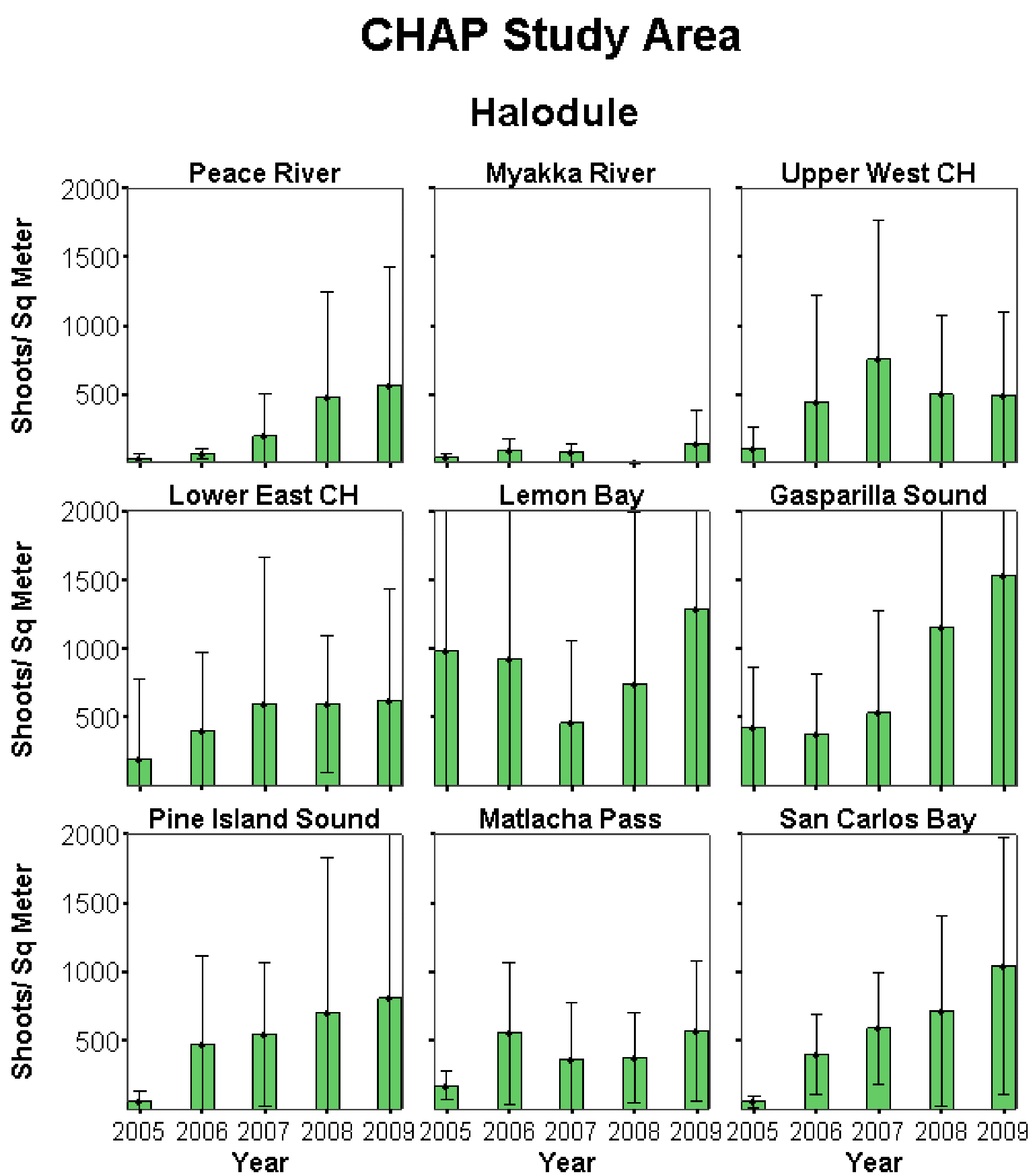


Figure 5.3. Mean shoot density (+/- SD) of *Halodule wrightii* for each region over the period of record (2005-2009) within the CHAP study area.

Analysis A: Comparison of Years (for Thalassia)

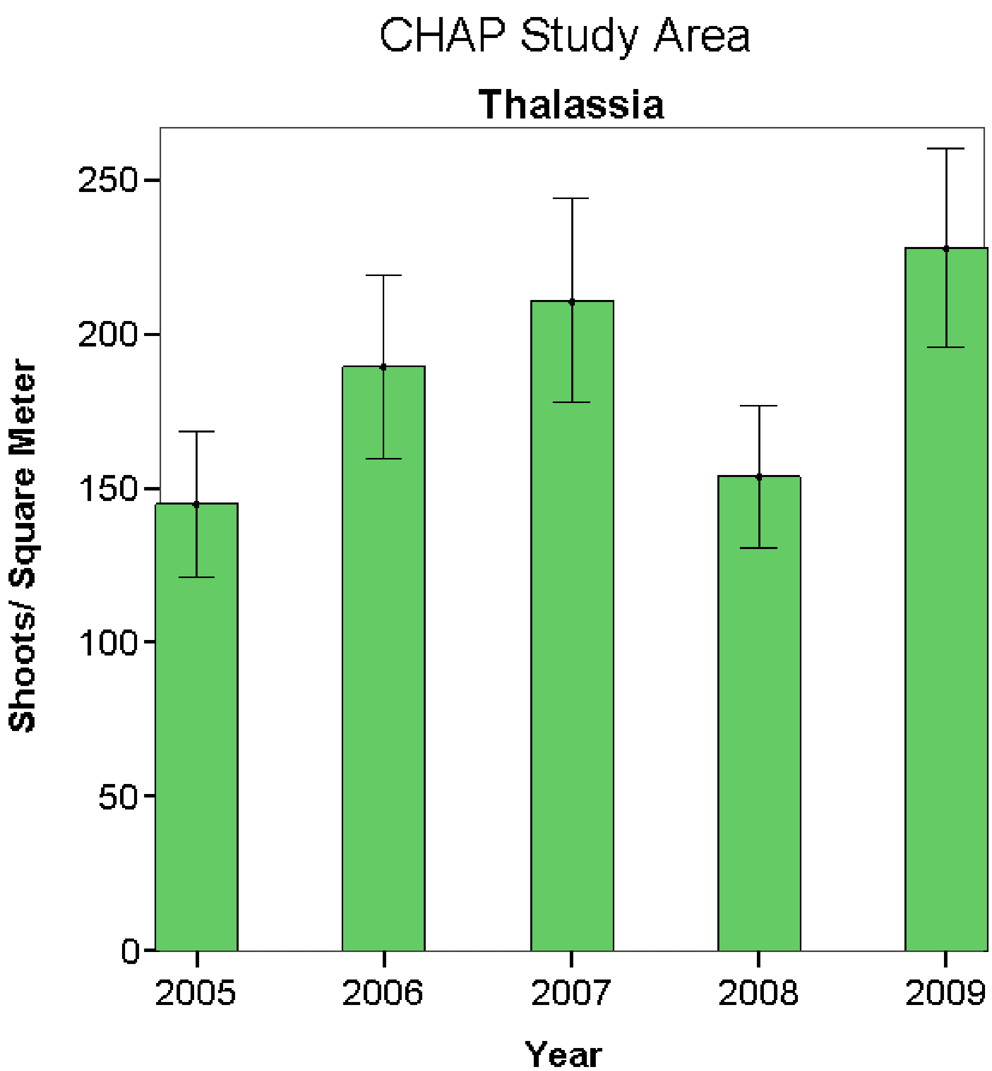


Figure 5.4. Mean shoot density (+/- SE) of *Thalassia testudinum* over the period of record (2005-2009) for the entire CHAP study area.

Analysis B: Comparison of Regions (for Thalassia)

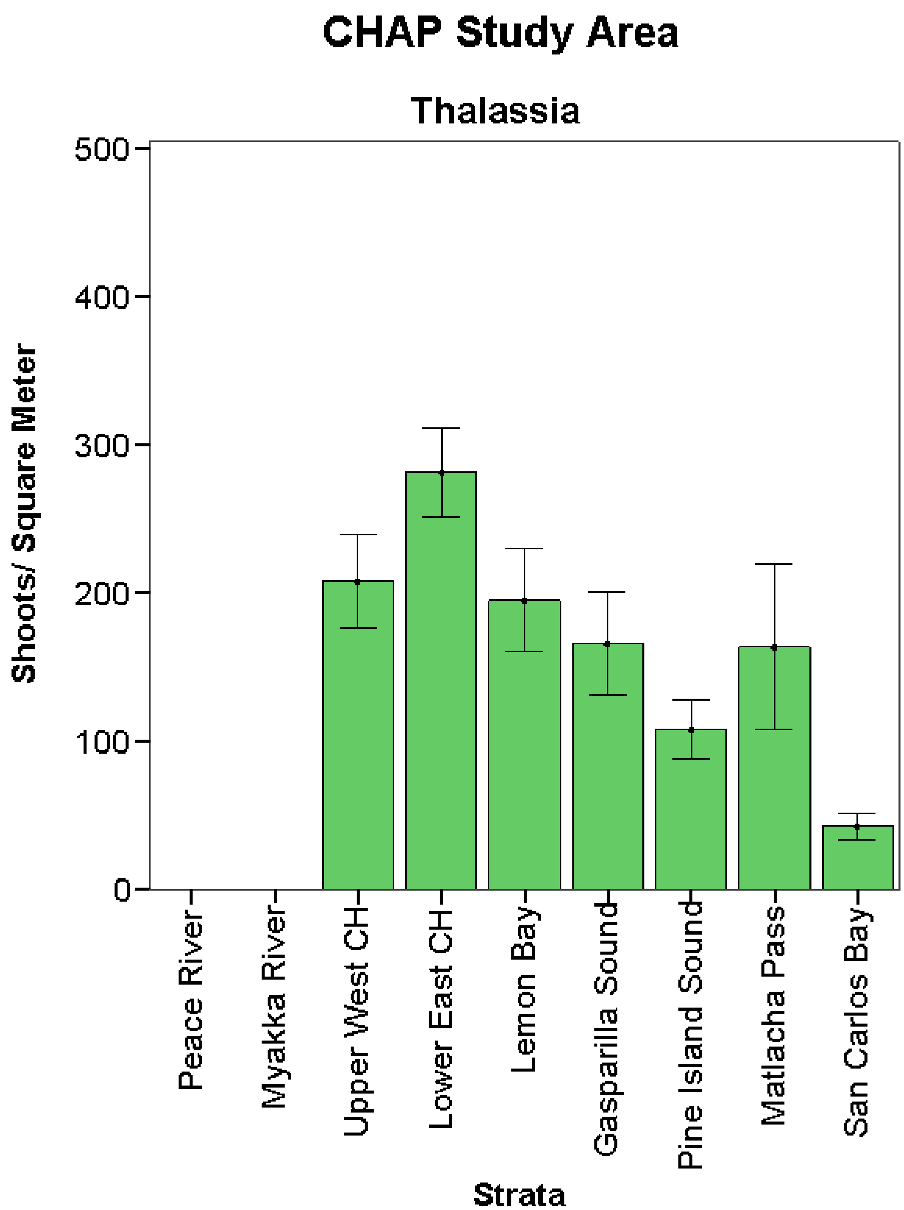


Figure 5.5. Mean shoot density (+/- SE) of *Thalassia testudinum* for each region over the period of record (2005-2009) for the CHAP study area.

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

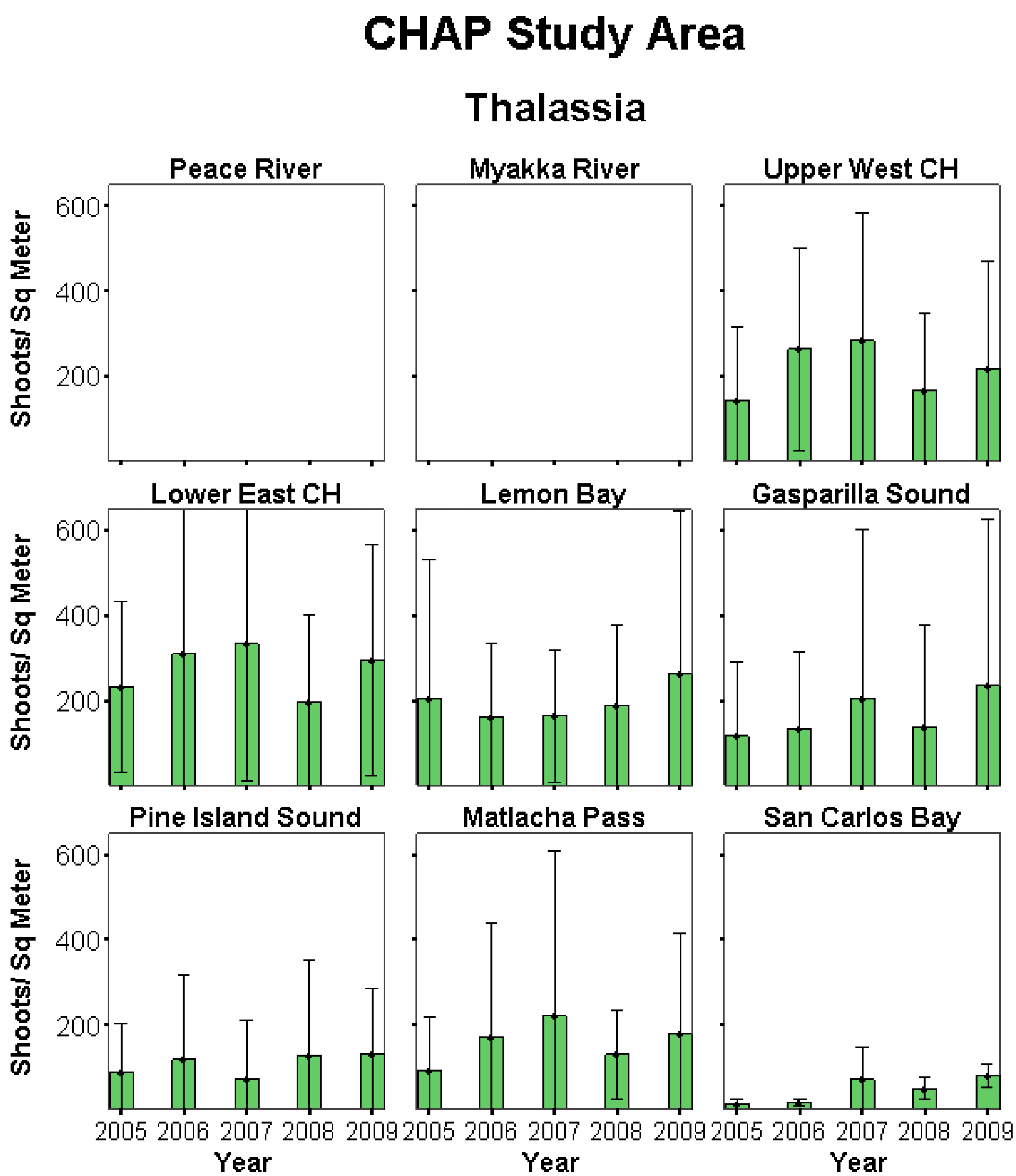


Figure 5.6. Mean shoot density (+/- SD) of *Thalassia testudinum* for each region over the period of record (2005-2009) within the CHAP study area.

Analysis A: Comparison of Years (for Syringodium)

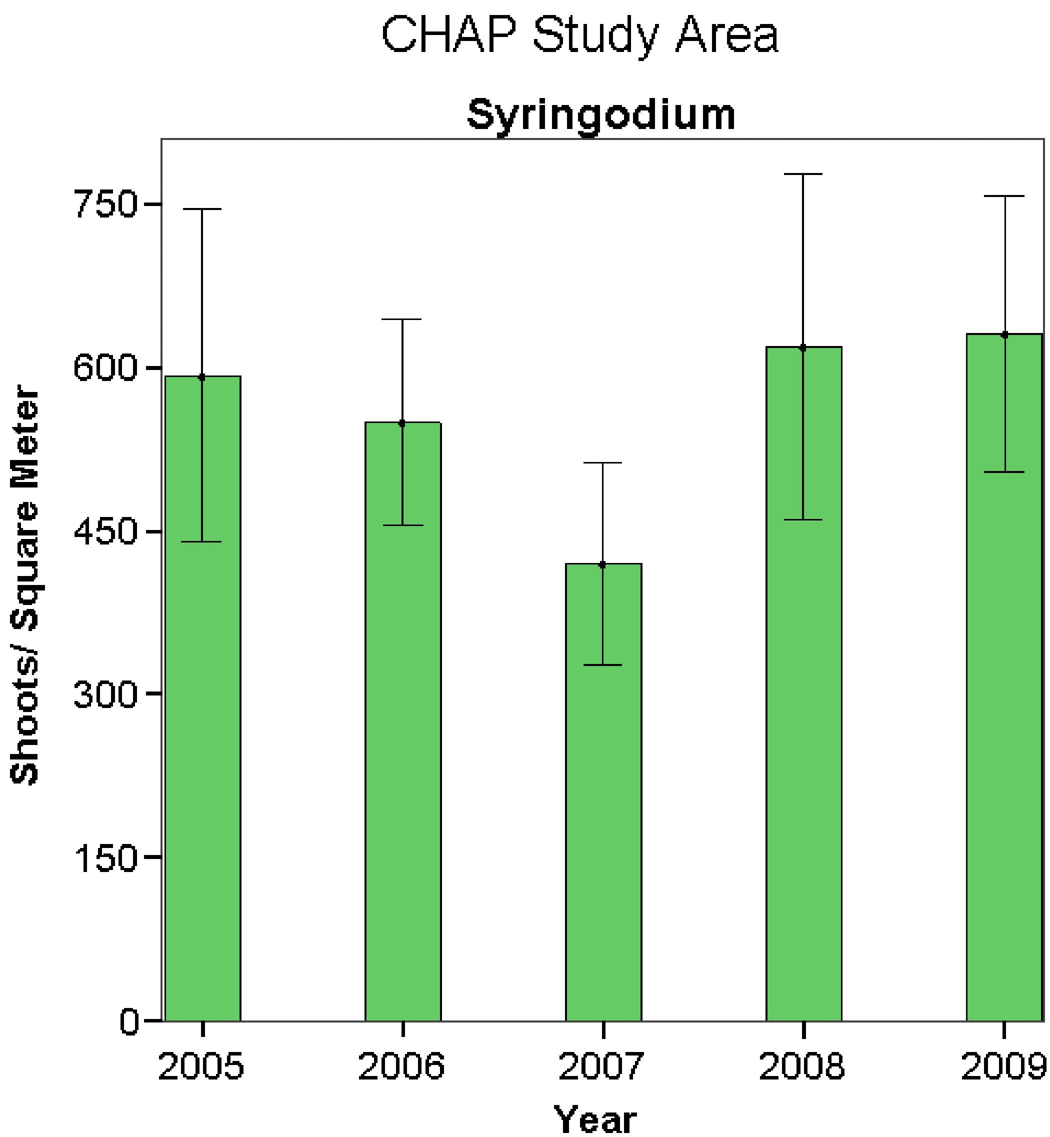


Figure 5.7. Mean shoot density (+/- SE) of *Syringodium filiforme* over the period of record (2005-2009) for the entire CHAP study area.

Analysis B: Comparison of Regions (for Syringodium)

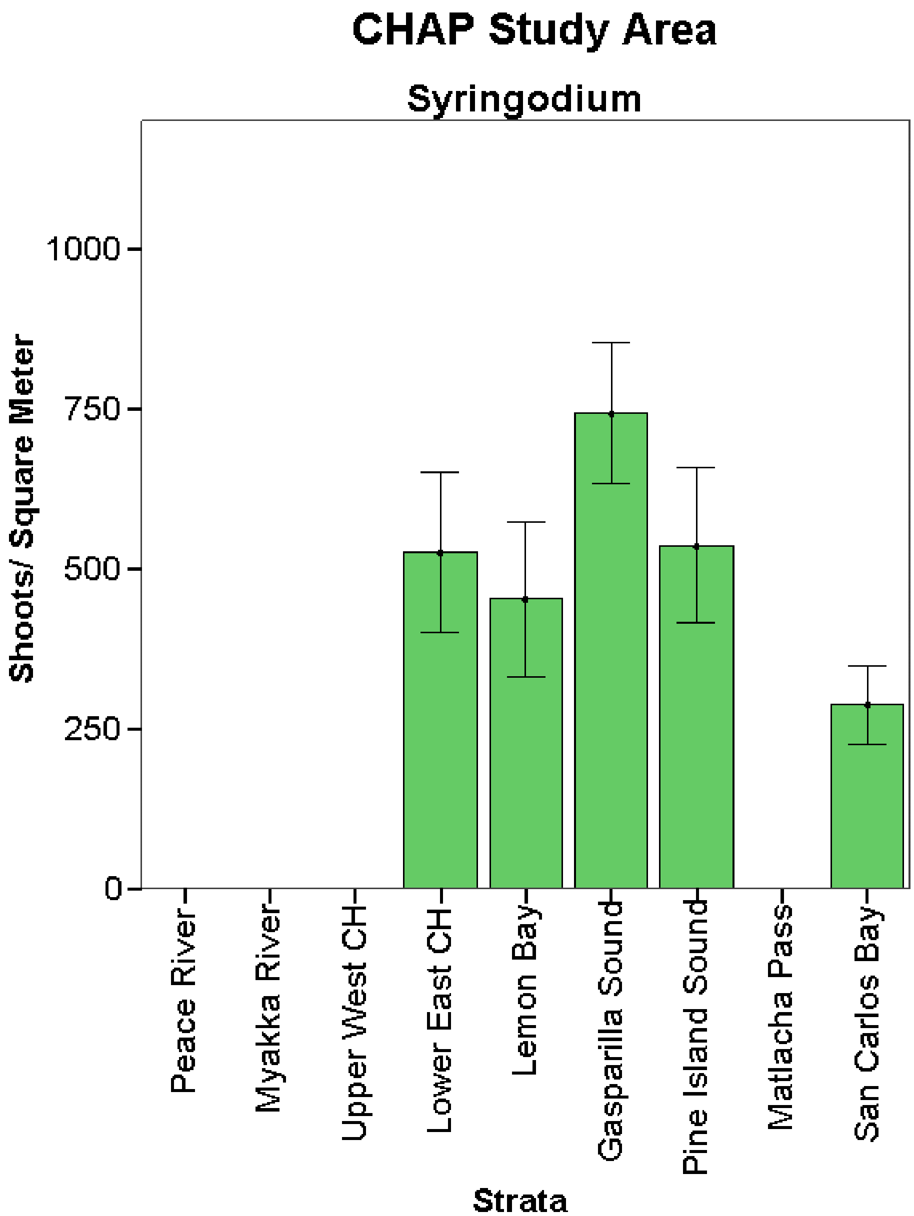


Figure 5.8. Mean shoot density (+/- SE) of *Syringodium filiforme* for each region over the period of record (2005-2009) for the CHAP study area.

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

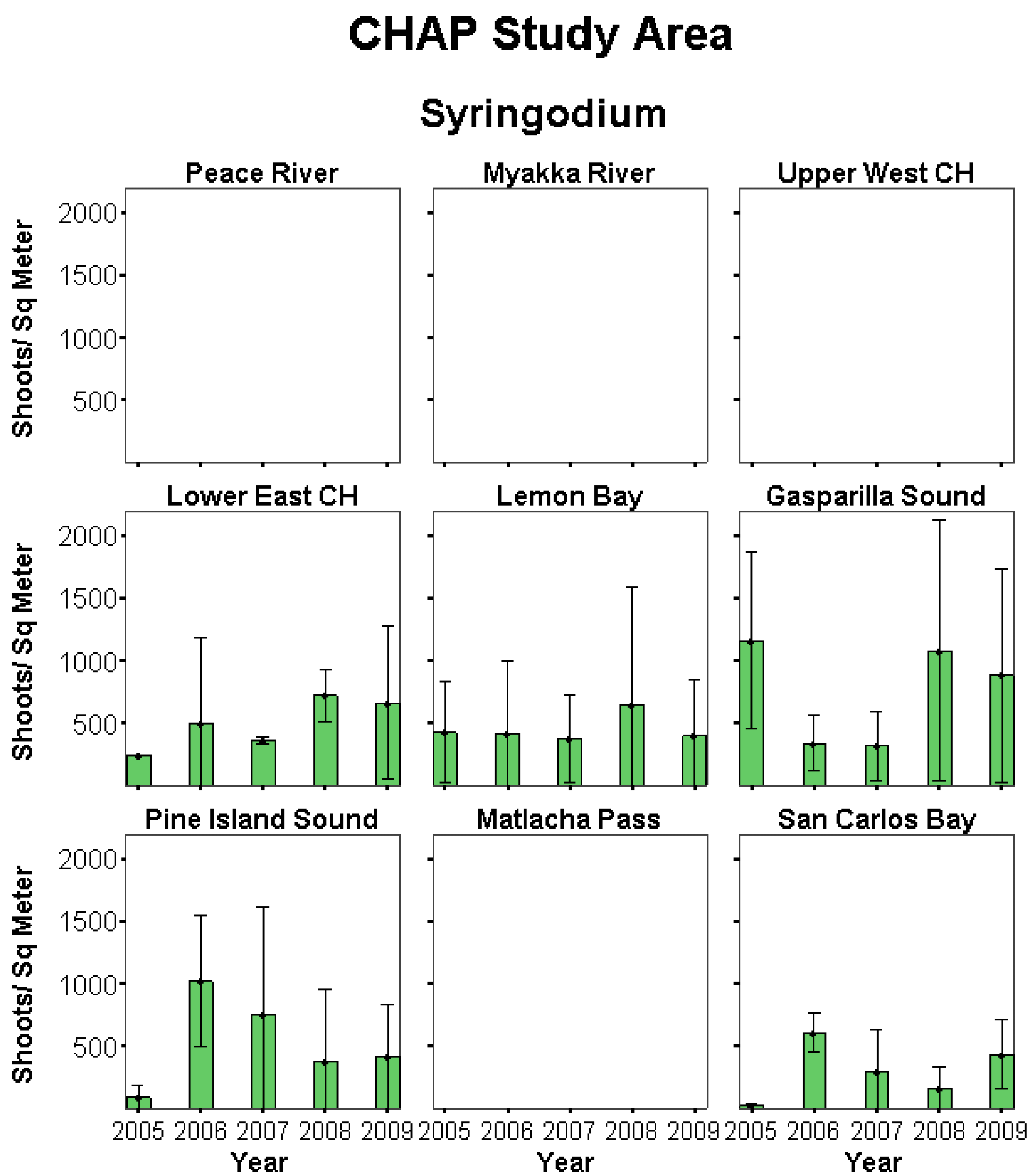


Figure 5.9. Mean shoot density (+/- SD) of *Syringodium filiforme* for each region over the period of record (2005-2009) within the CHAP study area.

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

Analysis A: Comparison of Years

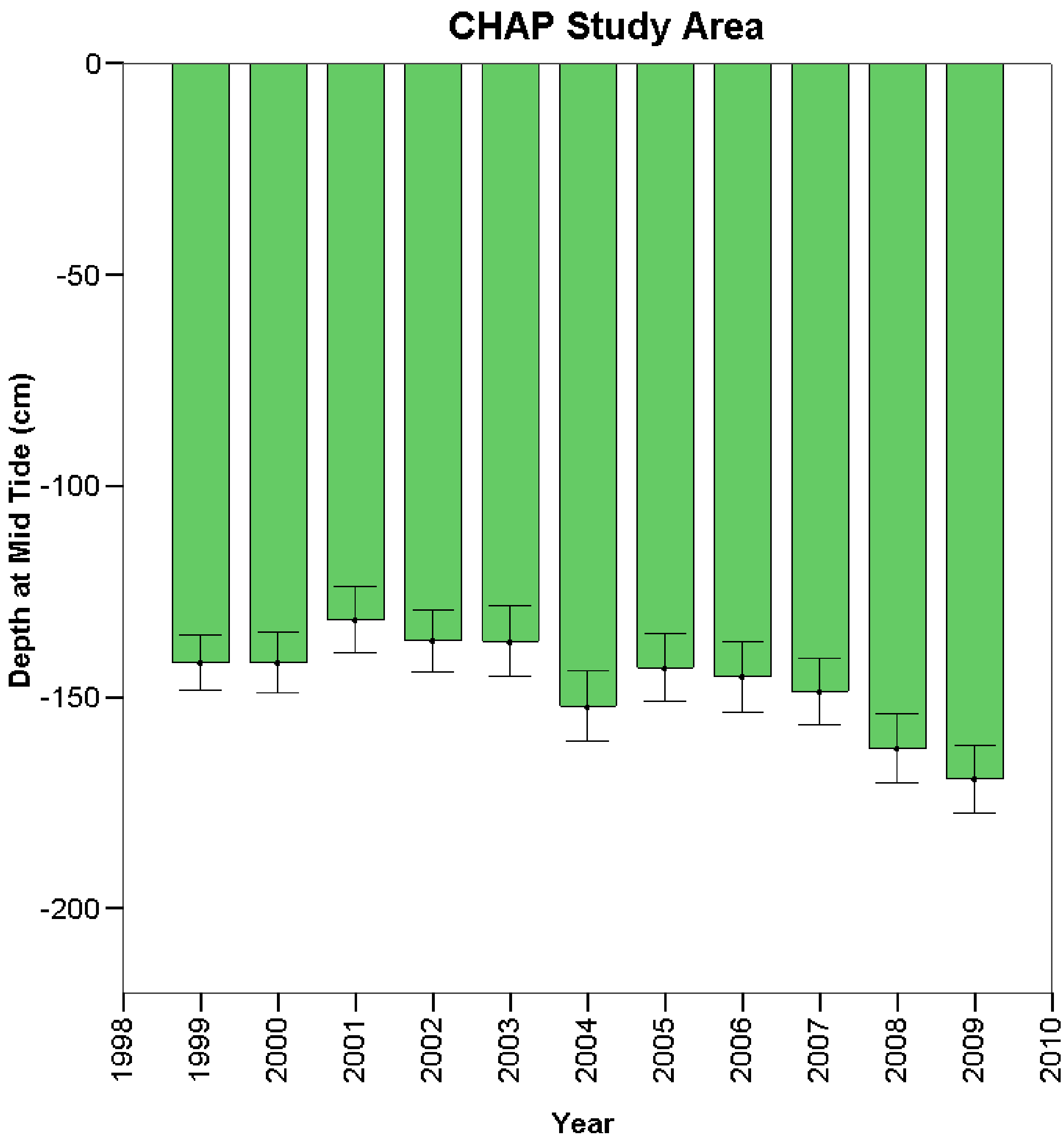


Figure 6.1. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) over the period of record (1999-2009) for the entire CHAP study area.

Analysis B: Comparison of Regions

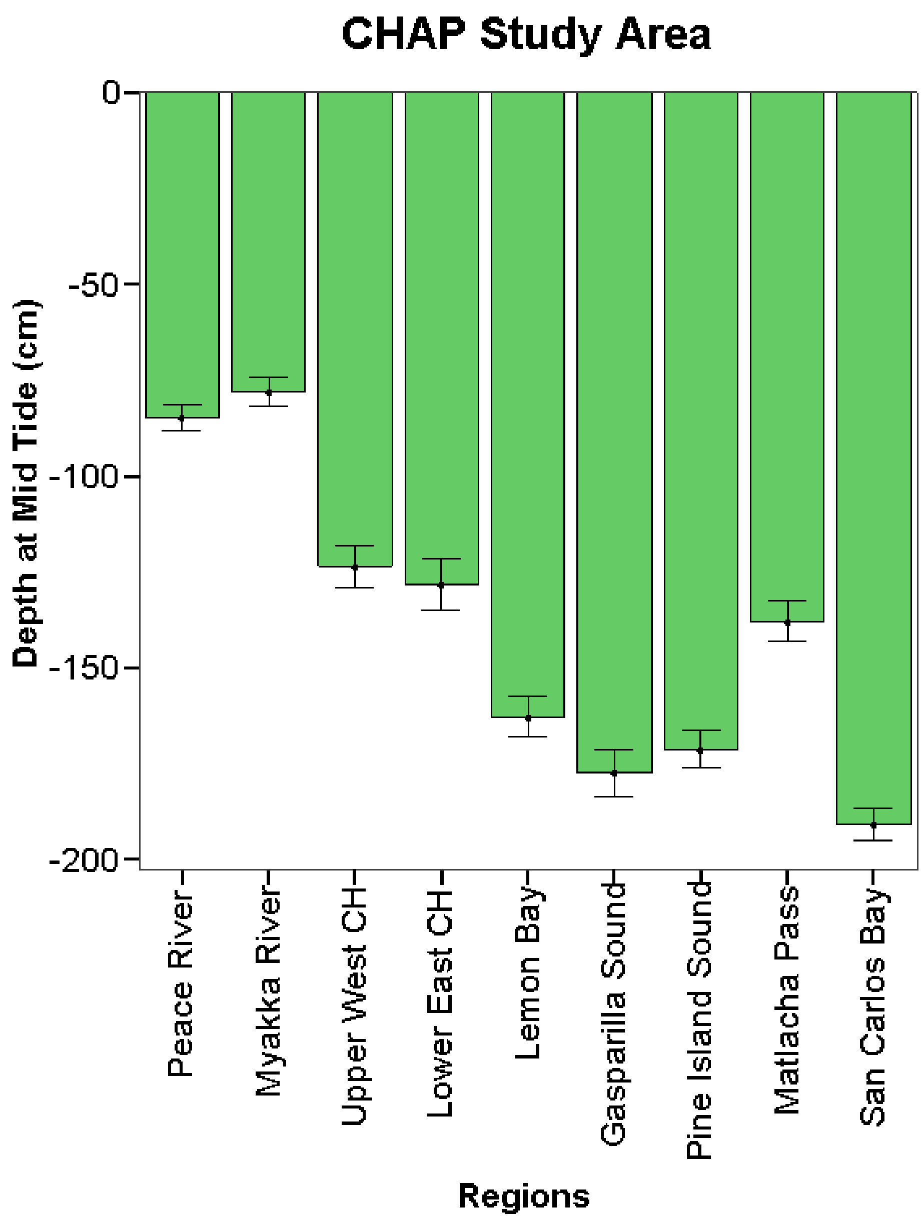


Figure 6.2. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) for each region over the period of record (1999-2009) for the CHAP study area.

Analysis C: Comparison of Years by Region

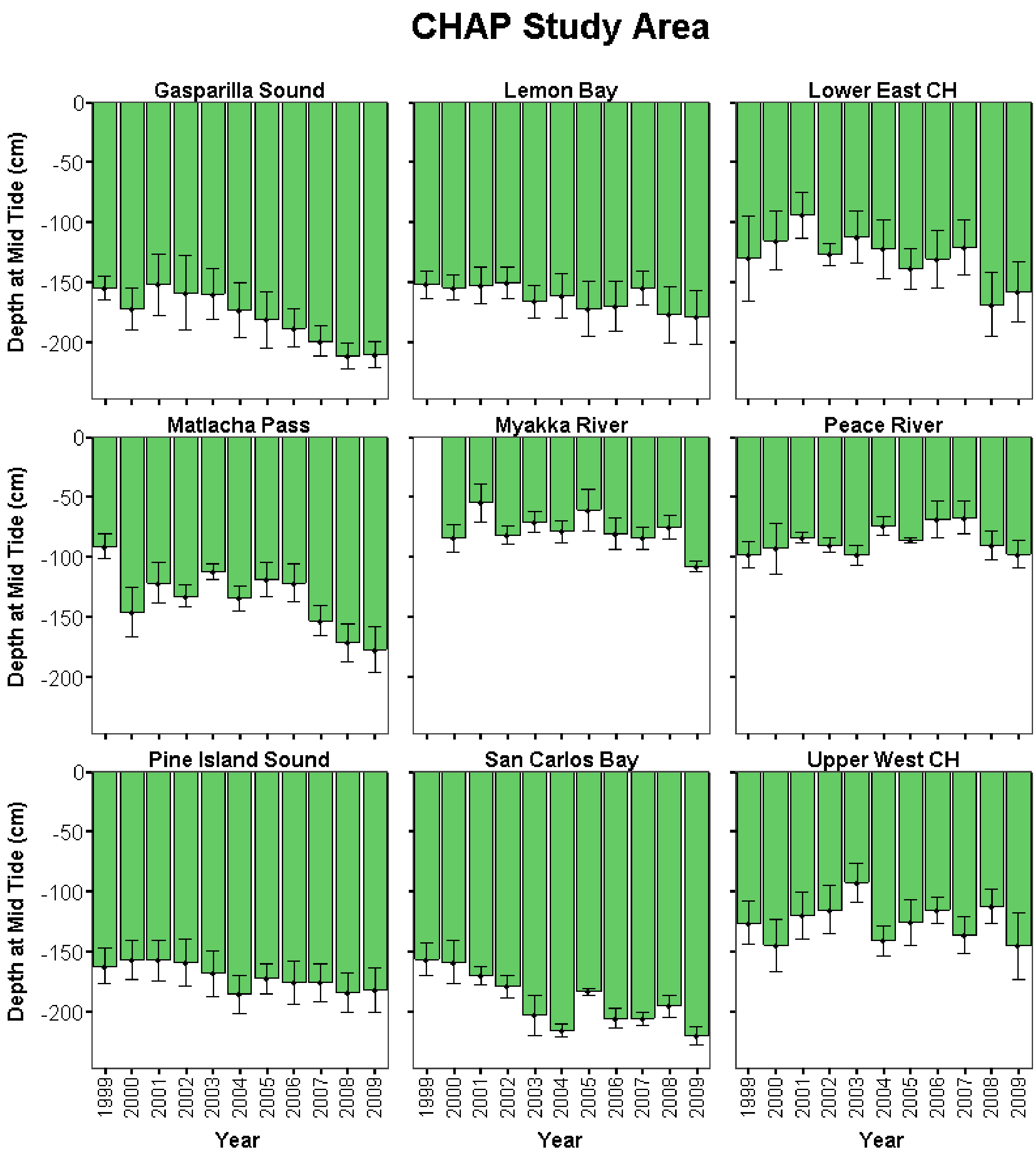


Figure 6.3. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) for each region over the period of record (1999-2009) within the CHAP study area.

Question 7: How dense are the epiphytes on the three most common seagrass species?

Analysis A: Comparison of Years

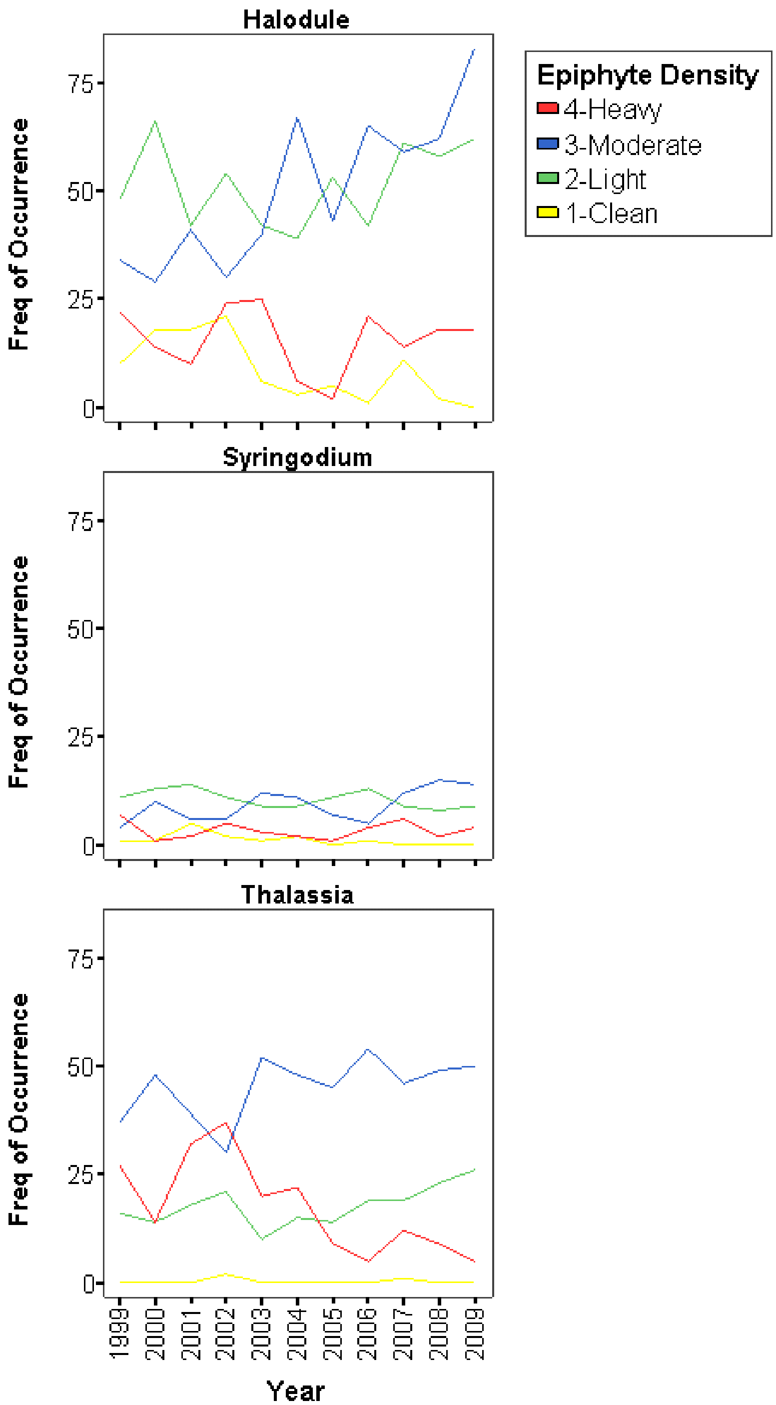


Figure 7.1. Frequency of occurrence of epiphyte density by species over the period of record (1999-2009) for the entire CHAP study area.

Analysis B: Comparison of Regions

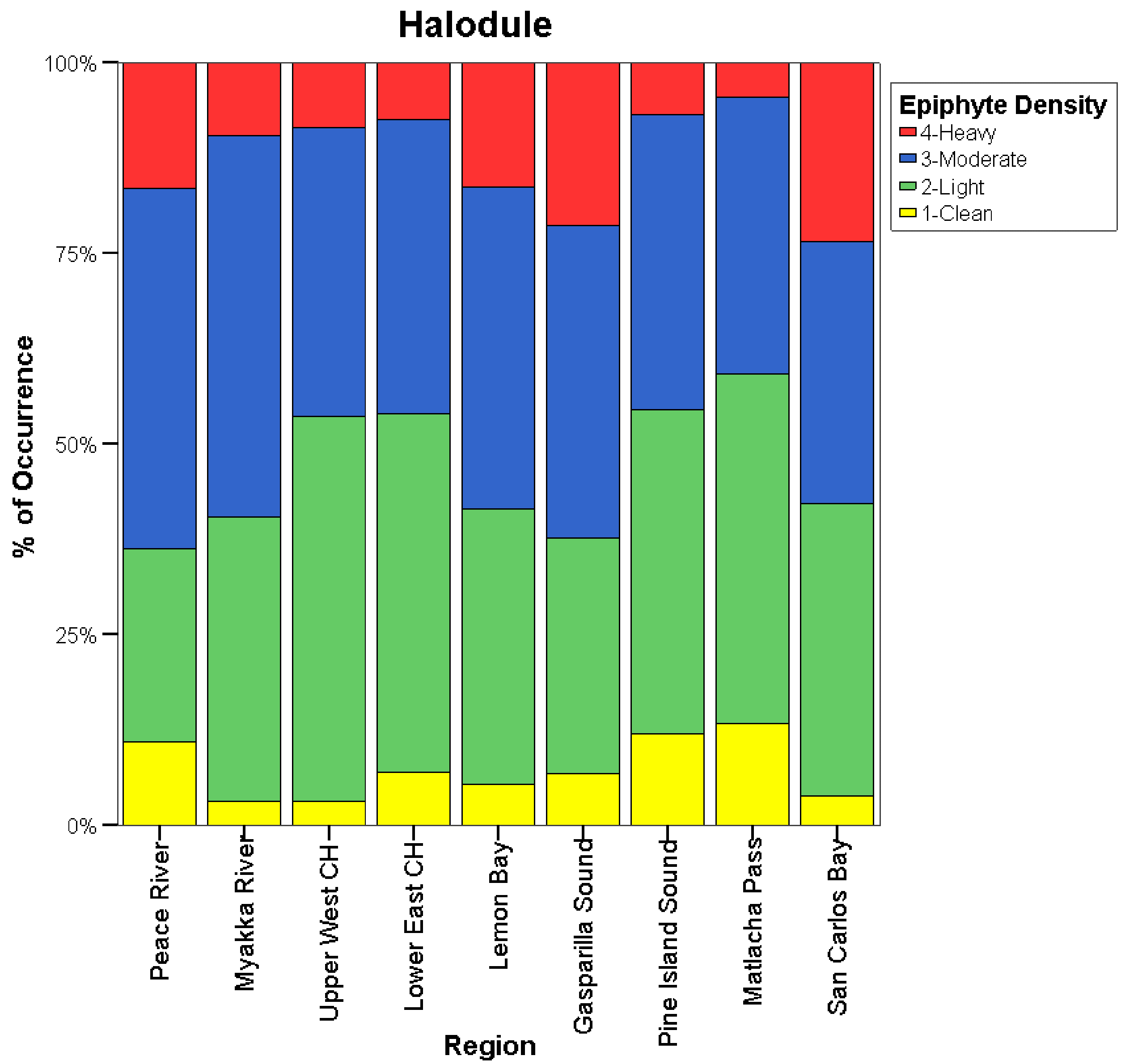


Figure 7.2. Percentage of occurrence of epiphyte density for *Halodule wrightii* for each region over the period of record (1999-2009) within the CHAP study area.

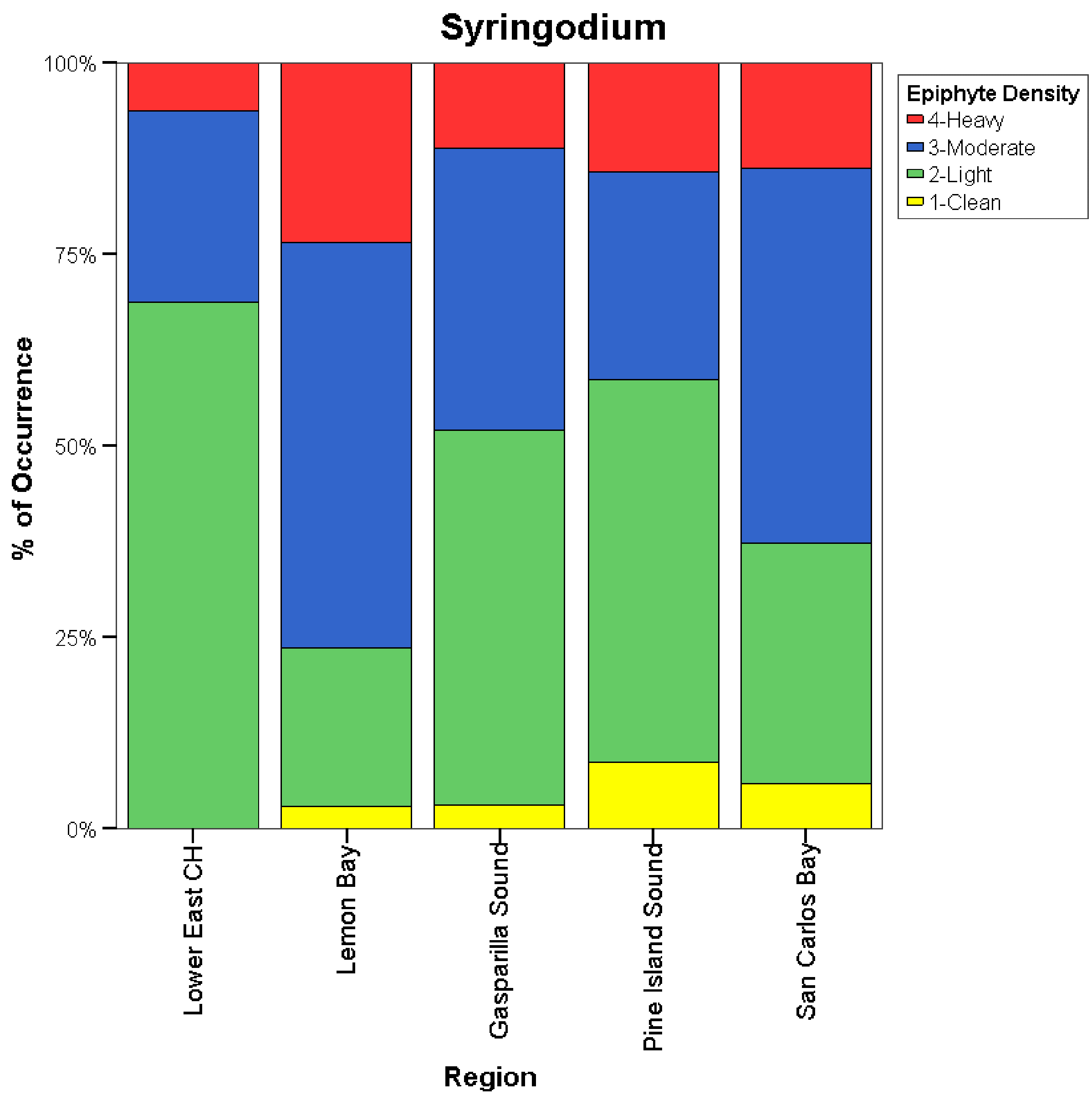


Figure 7.3. Percentage of occurrence of epiphyte density for *Syringodium filiforme* for each region over the period of record (1999-2009) within the CHAP study area.

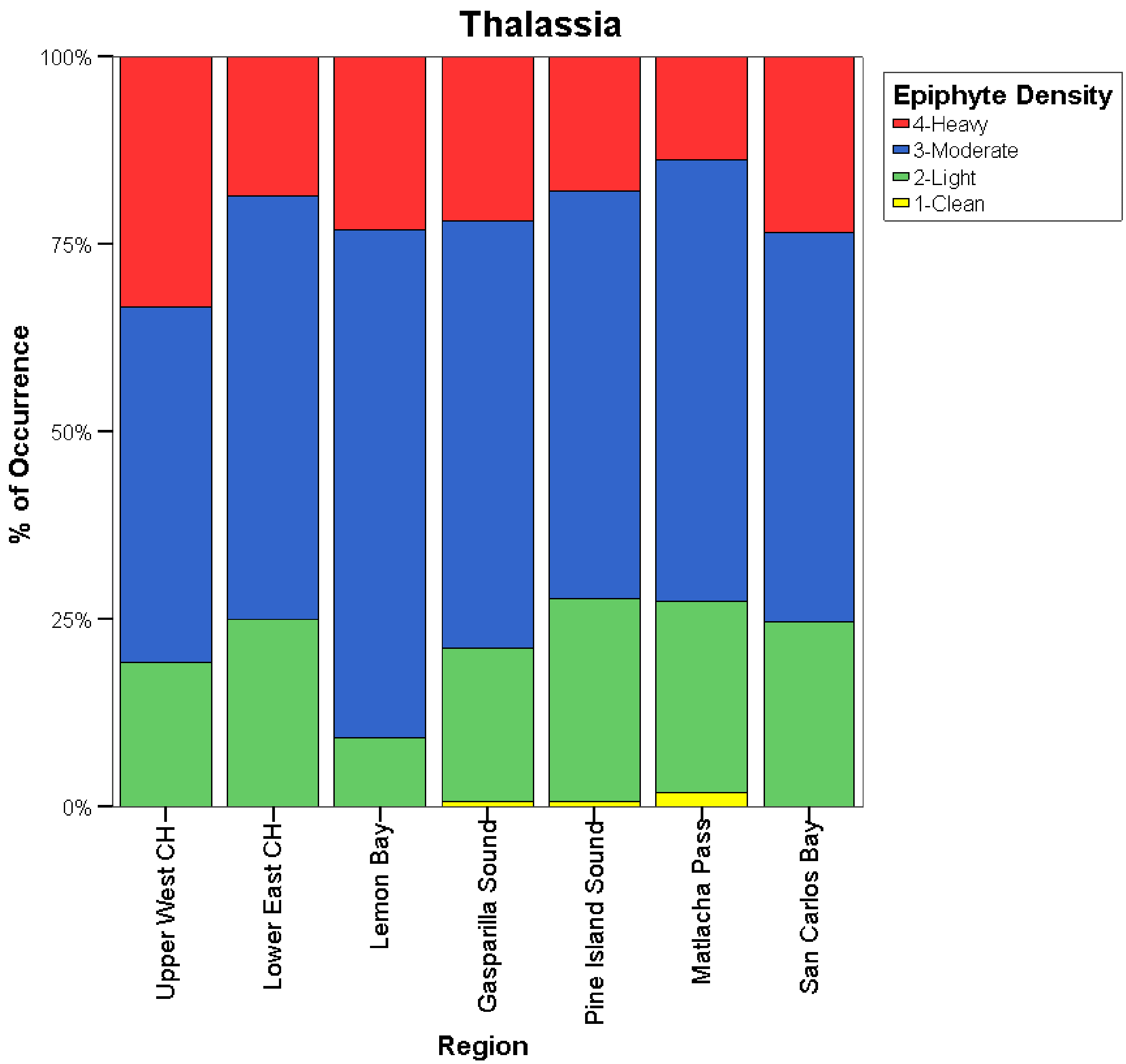


Figure 7.4. Percentage of occurrence of epiphyte density for *Thalassia testudinum* for each region over the period of record (1999-2009) within the CHAP study area.

Analysis C: Comparison of Years by Region

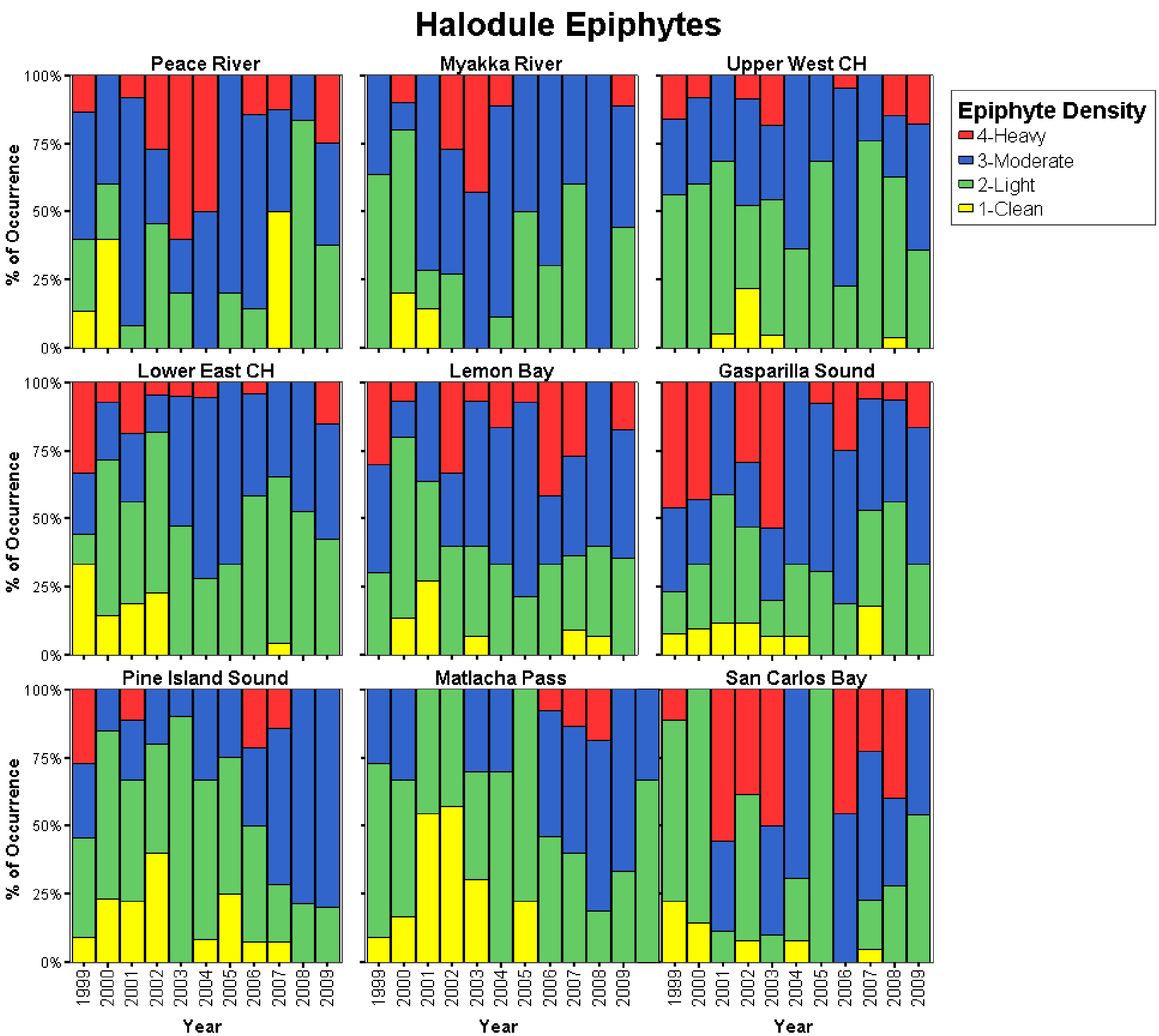


Figure 7.5. Percentage of occurrence of epiphyte density for *Halodule wrightii* for each region over the period of record (1999-2009) within the CHAP study area.

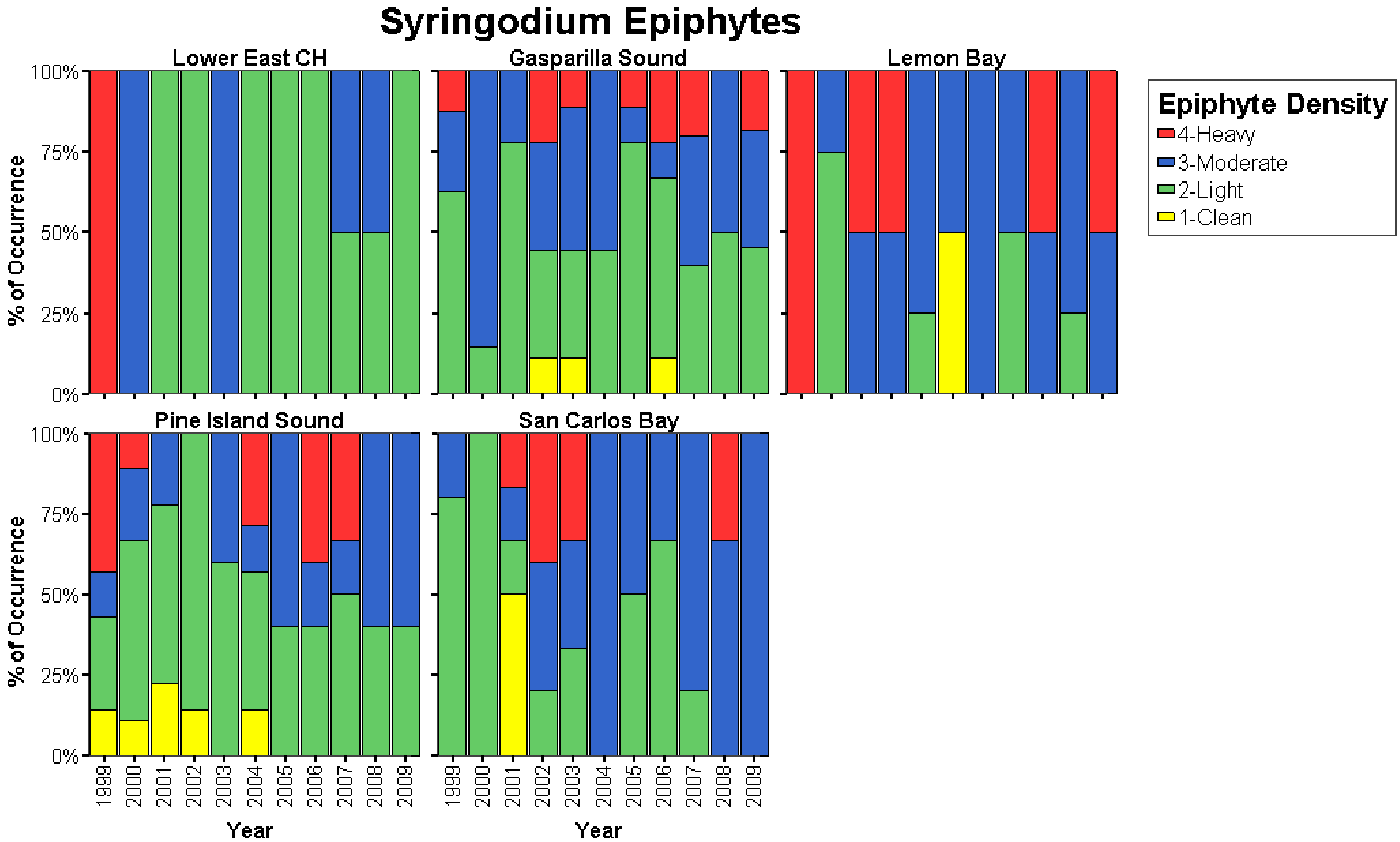


Figure 7.6. Percentage of occurrence of epiphyte density for *Syringodium filiforme* for each region over the period of record (1999-2009) within the CHAP study area.

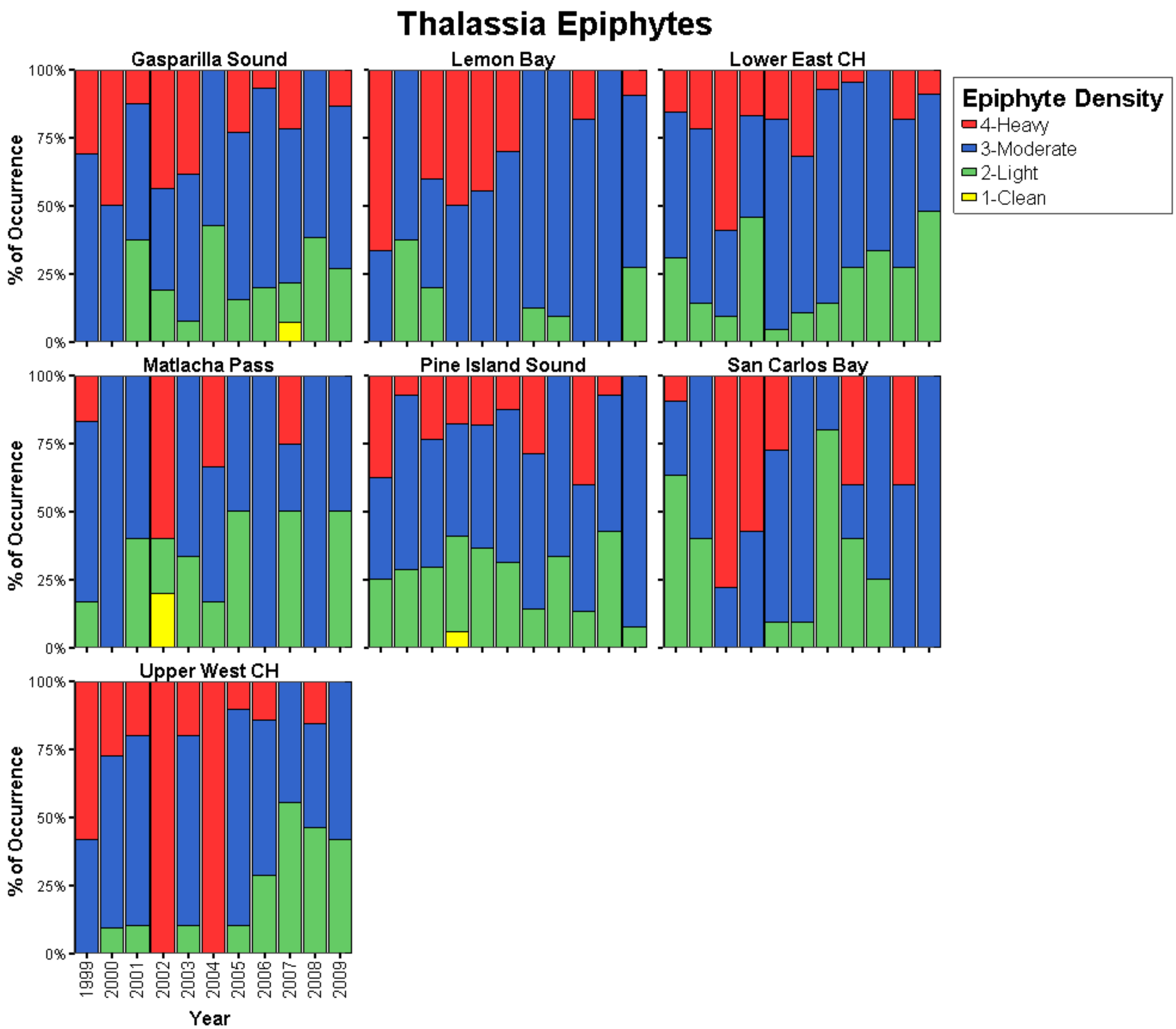


Figure 7.7. Percentage of occurrence of epiphyte density for *Thalassia testudinum* for each region over the period of record (1999-2009) within the CHAP study area.

Additional Analysis: Comparison of Species

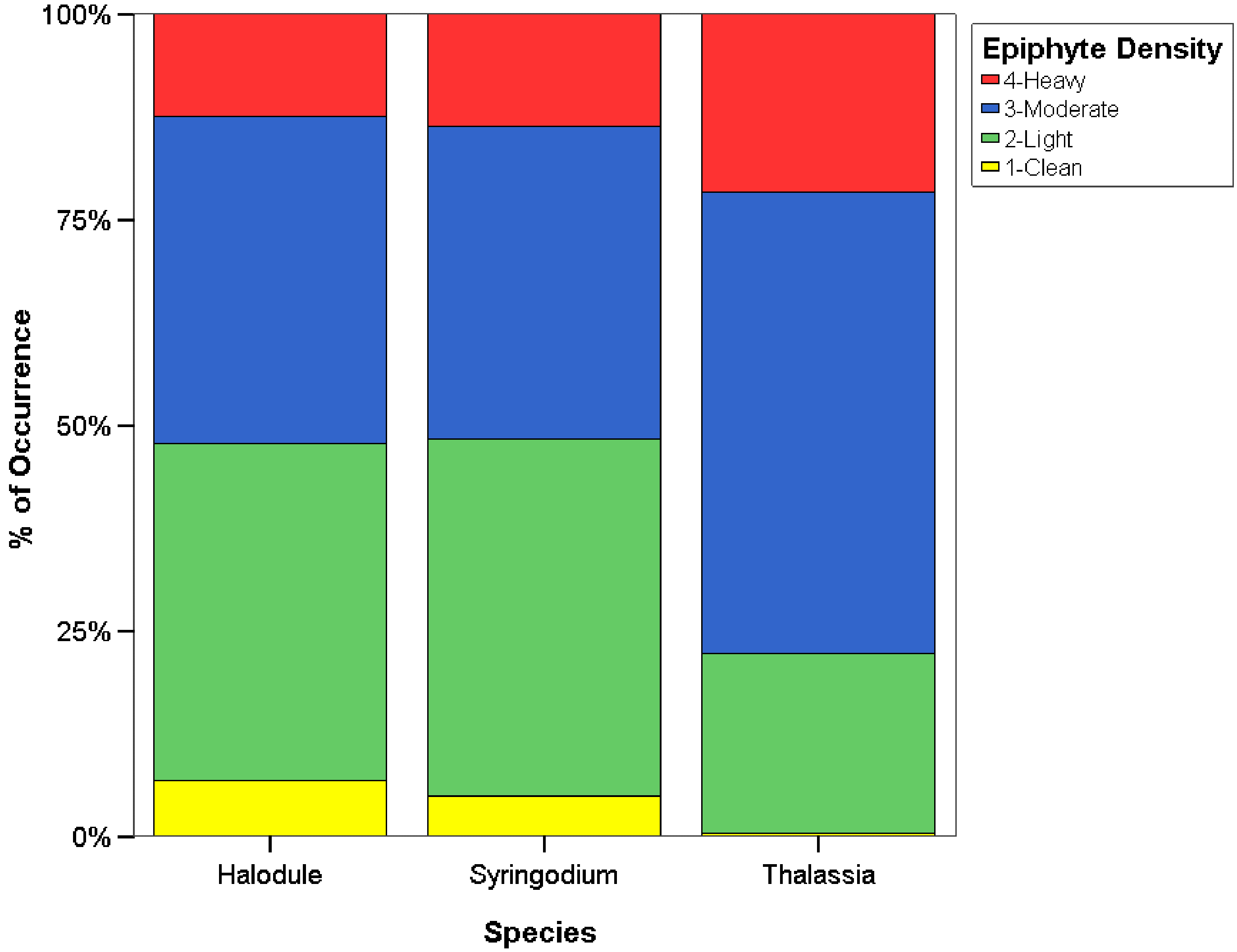


Figure 7.8. Percentage of occurrence of epiphyte density for each species over the period of record (1999-2009) for the entire CHAP study area.

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