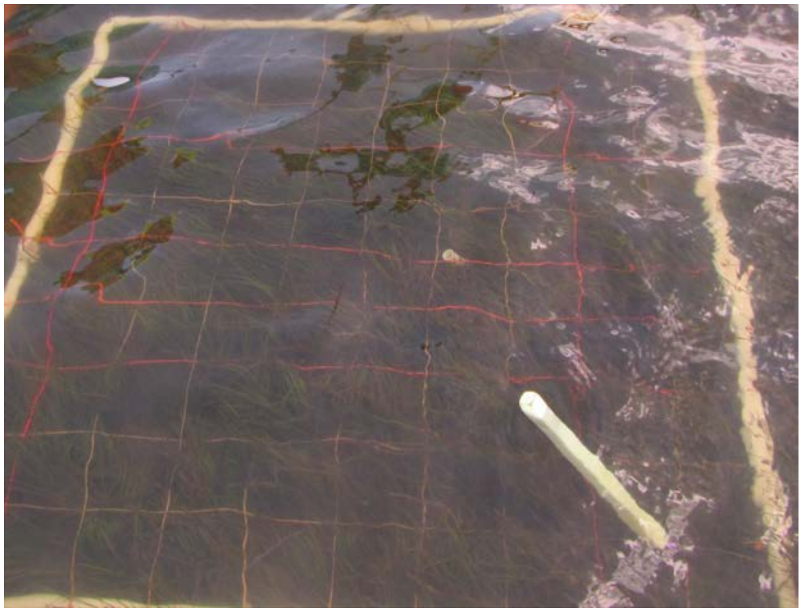
Charlotte Harbor Aquatic Preserves: 18-Year Results of the Seagrass Transect Monitoring Program 1999-2016



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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, shelter, and spawning and nursery habitat to a great diversity of aquatic organisms. They also reduce turbidity, facilitate sediment stabilization, and aid in nutrient and carbon cycling.

Seagrass distribution and health are primarily determined by salinity and the amount of light penetrating through the water column. Therefore, seagrass growth is 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 what seagrass species grow where, to what depths, and at what abundances.

The state of Charlotte Harbor seagrass habitats has been an important issue for many decades as understanding of the value of these resources gained attention. This summary is a tool in providing critical information to resource managers in assessing 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. The five interconnected estuaries include more than 177,000 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 ensures these exceptional submerged resources are 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 (DEP) through the Office of Resilience and Coastal Protection (RCP). 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 is located just to the south and is managed from an office in Fort Myers Beach.

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

Program Background

One of the resource management goals of the 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 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.

Program Overview

Throughout the CHAP study area, 50 seagrass monitoring sites have been established. These sites are 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 natural bathymetry and water clarity. At regular intervals along each transect (every 10 m or 50 m, depending on transect length), 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 annually.

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 also are monitored quarterly throughout the year by DEP’s Division of Environmental Assessment and Restoration (DEAR) 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 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 in fulfilling our goal of protecting and enhancing the health and functioning of seagrass habitats. It allows us to capture an overall view annually of seagrass quality and long-term health.

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 allow CHNEP to assess progress toward achieving quantifiable objective FW-1 to "Protect, enhance and restore native habitats where physically feasible and within natural variability, including submerged aquatic vegetation." In addition, the seagrass data are used by CHNEP to set resource-based water quality targets in 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 also were 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, leading 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 and to ensure these quadrats are measured every year as a repeat quadrat. Summarizing data at these repeat quadrats allows the analyses to be as standardized as possible and makes for stronger interpretation. The number of repeat quadrats at each transect was reviewed in 2007, and additional repeat quadrats were added at certain transects to consistently capture the bed more accurately. For analyses purposes in this 1999-2016 report, these additional quadrats were included as they now have 10 years of data. 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) because they are not consistently monitored as a repeat quadrat, due to yearly shifts in beginning and end of the seagrass beds.

Report Summary

Seven specific questions are addressed in this summary, including:

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 that CHAP manages. 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; 0**.05** = few; **1** = <5%; **2** = 5 to 25%; **3** = 26 to 50%; **4** = 51 to 75%; and **5** = 76 to 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 or reference the CHAP Seagrass Monitoring SOPs.

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 *Halophila sp*., including *H. decipiens* (Paddle grass) and *H. engelmannii* (Star grass).

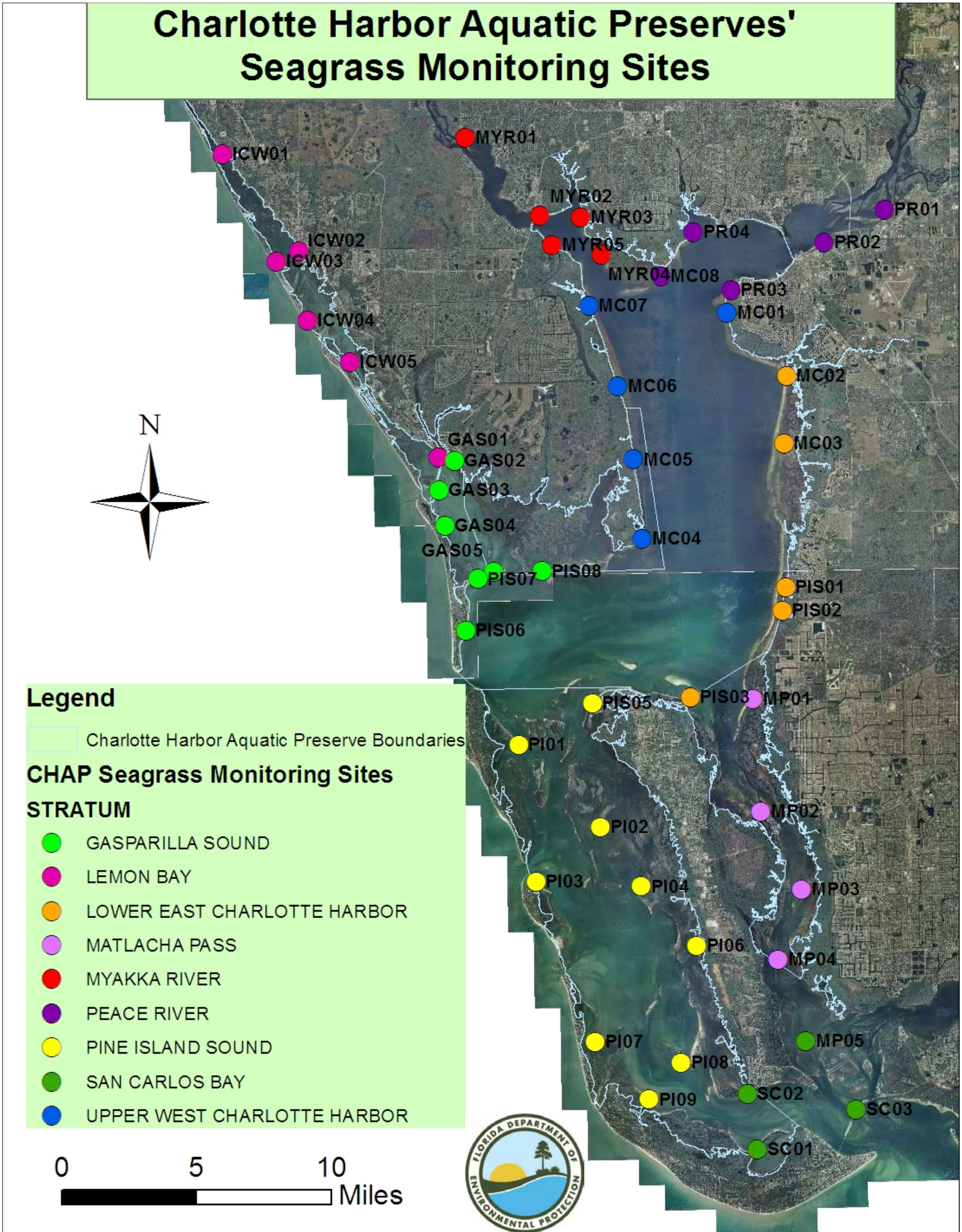
Conclusion

This report on the CHAP Seagrass Transect Monitoring Program is an update to the 1999-2009 summary report and provides an 18-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, scientists and other stakeholders in creating strategies for the long-term viability of this critical habitat. By observing yearly changes and reporting them, an up-to-date status of this resource is captured.

In addition to the summary reports, this dataset also has been analyzed and published in the *Florida Scientist* (Brown et. al, 2013) and a NOAA report (Leary, 2012) and has been presented at numerous conferences. The program also was highlighted in the Fall 2013 *Guy Harvey* magazine. Long-term goals include updating this summary annually after the completion of every monitoring season. There also is an expressed interest in linking this information with specific water quality parameters. This will broaden the scope to gain insight about the strong relationship water quality can play in these habitats.

Acknowledgements

A special thank you to all the CHAP staff, including Heather Stafford, Mary McMurray, Arielle Taylor-Manges, Allyson Genson and Dave Hersl, for their long days in the field monitoring seagrass and in the office entering and QA'ing data, and to DEP DEAR's Kirby Wolfe and his staff for their 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, Renee Duffey, Ray Leary, Rebecca Jenkins, Neil Langenberg and Debbie Horner. The original 1999-2006 summary was produced with the technical assistance of Jaime Greenawalt-Boswell, who provided guidance with the design and implementation of that summary in support of CHNEP's environmental indicators. Finally, partnership agencies and volunteers are thanked for their hard work in assisting with data collection and the ensured success of this program.



Charlotte Harbor Aquatic Preserves' Seagrass Monitoring Sites
MYR01
ICW01
MYR02
MYR03
PR01
PR04
ICW02
ICW03
MYR05
PR02
MYR04
MC08
PR03
MC07
MC01
ICW04
ICW05
MC02
MC06
N
GAS01
MC03
GAS02
MC05
GAS03
GAS04
MC04
GAS05
PIS08
PIS07
PIS01
PIS02
PIS06
Legend
PIS03
MP01
PIS05
Charlotte Harbor Aquatic Preserve Boundaries
PI01
CHAP Seagrass Monitoring Sites
STRATUM
MP02
PI02
GASPARILLA SOUND
LEMON BAY
PI03
PI04
MP03
LOWER EAST CHARLOTTE HARBOR
MATLACHA PASS
PI06
MP04
MYAKKA RIVER
PEACE RIVER
PINE ISLAND SOUND
PI07
MP05
PI08
SAN CARLOS BAY
SC02
PI09
SC03
UPPER WEST CHARLOTTE HARBOR
SC01
0
5
10
Miles
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

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

Analysis A: Comparison of Years

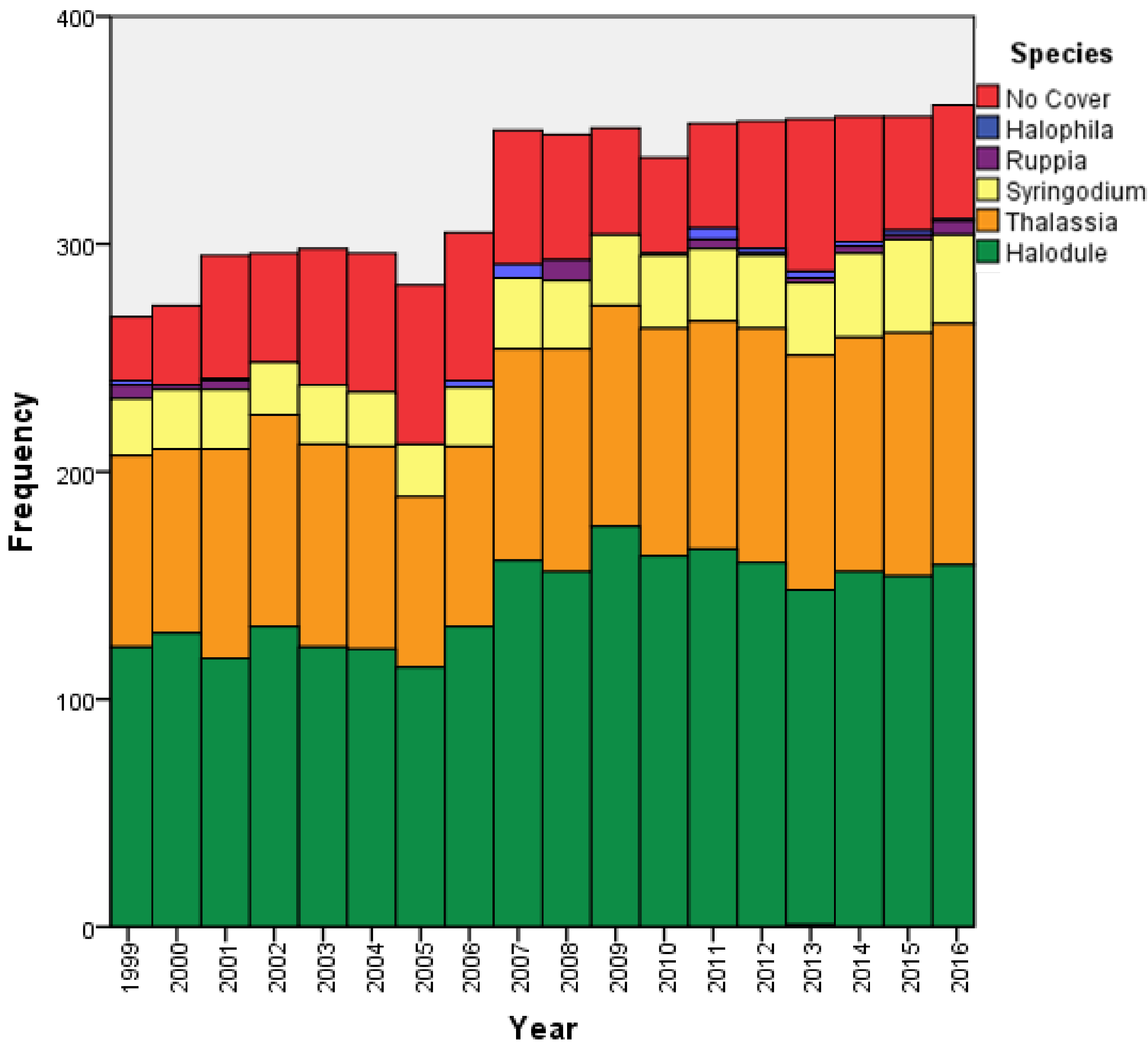


Figure 1.1. Frequency of occurrence of seagrass species and no cover over the period of record (1999-2016) for the CHAP study area.

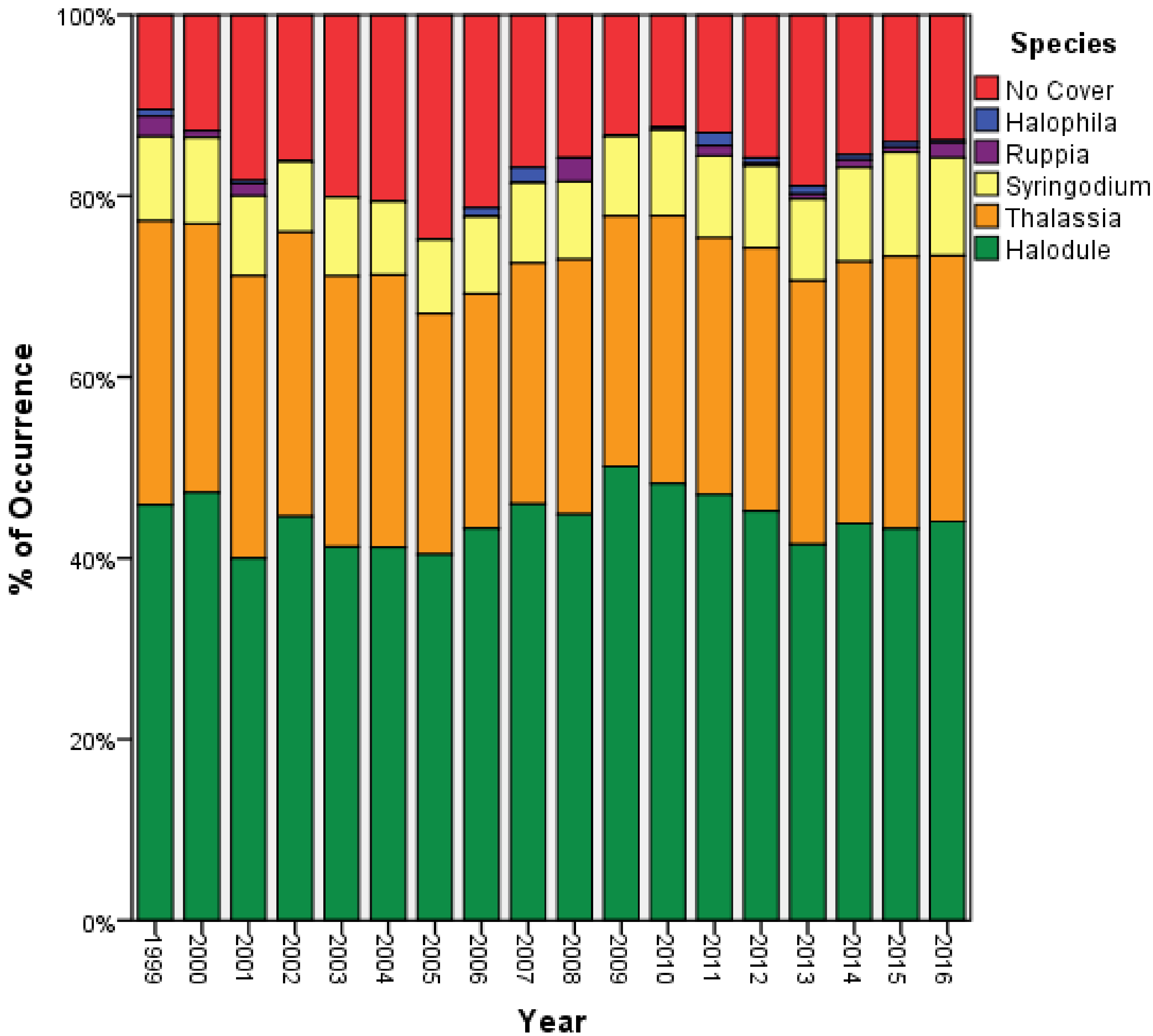


Figure 1.2. Percentage of occurrence of seagrass species and no cover over the period of record (1999-2016) for the CHAP study area.

Analysis B: Comparison of Regions

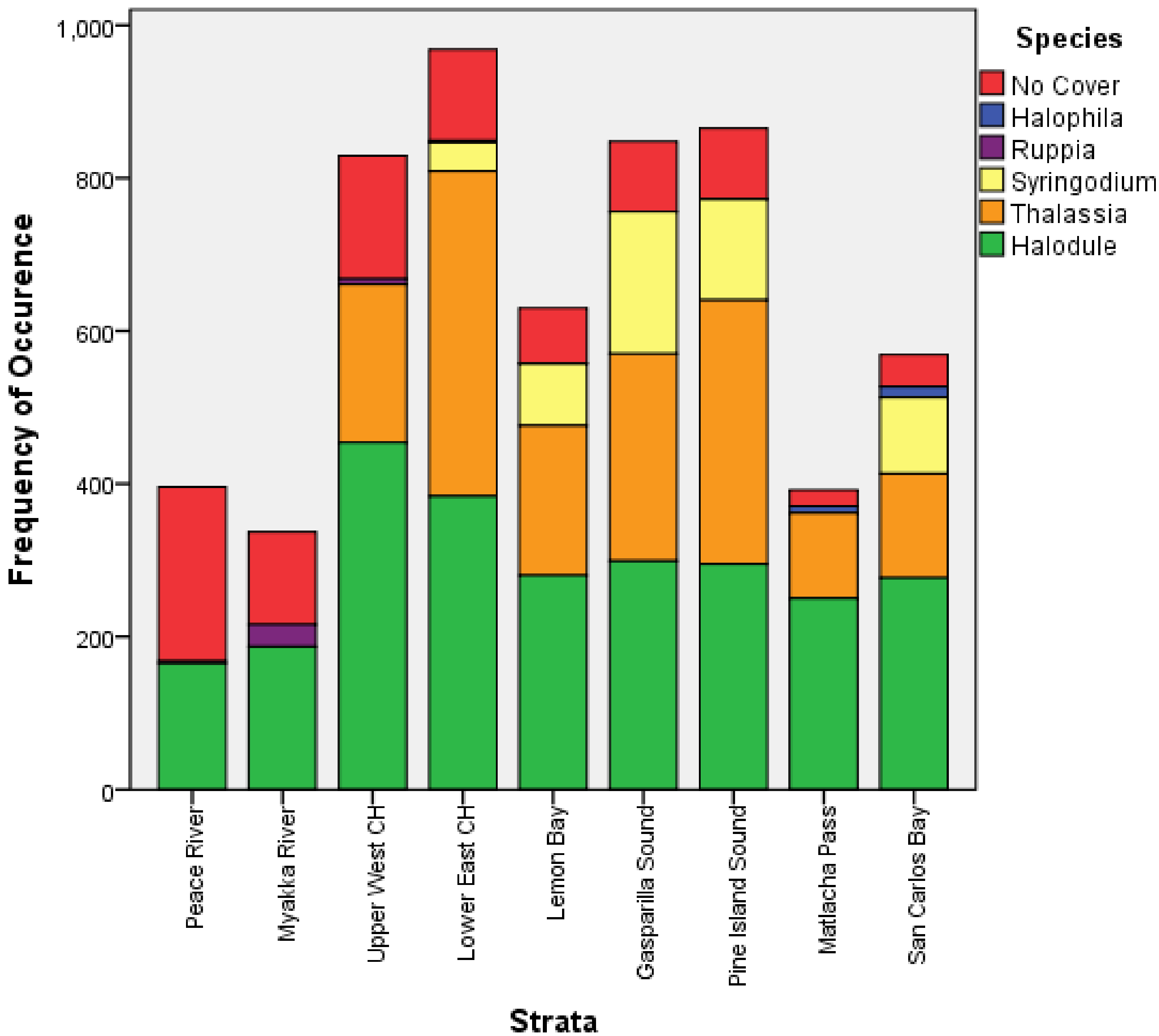


Figure 1.3. Frequency of occurrence of seagrass species and no cover for each region over the period of record (1999-2016) for the CHAP study area.

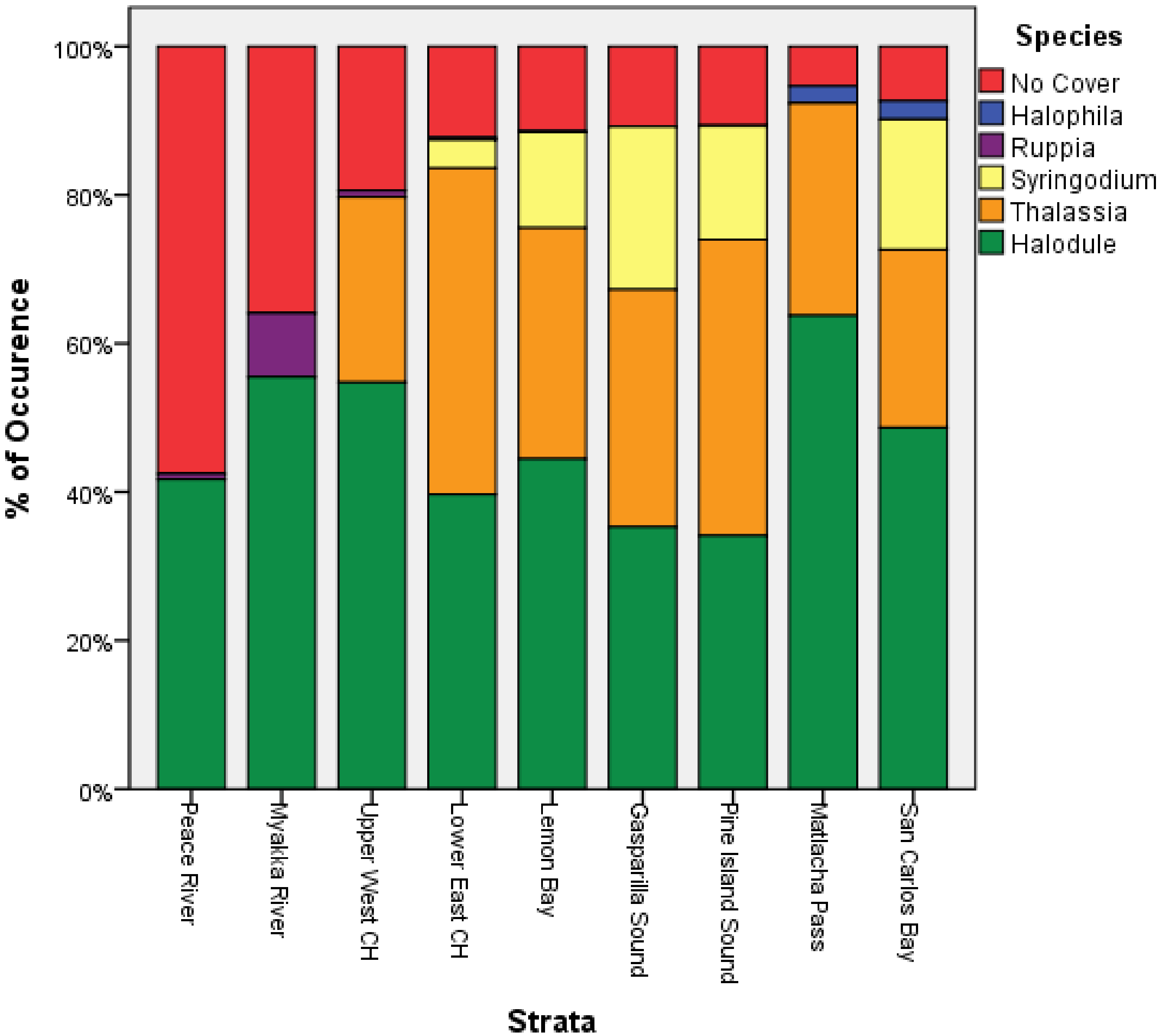


Figure 1.4. Percentage of occurrence of seagrass species and no cover for each region over the period of record (1999-2016) for the CHAP study area.

Analysis C: Comparison of Years by Region

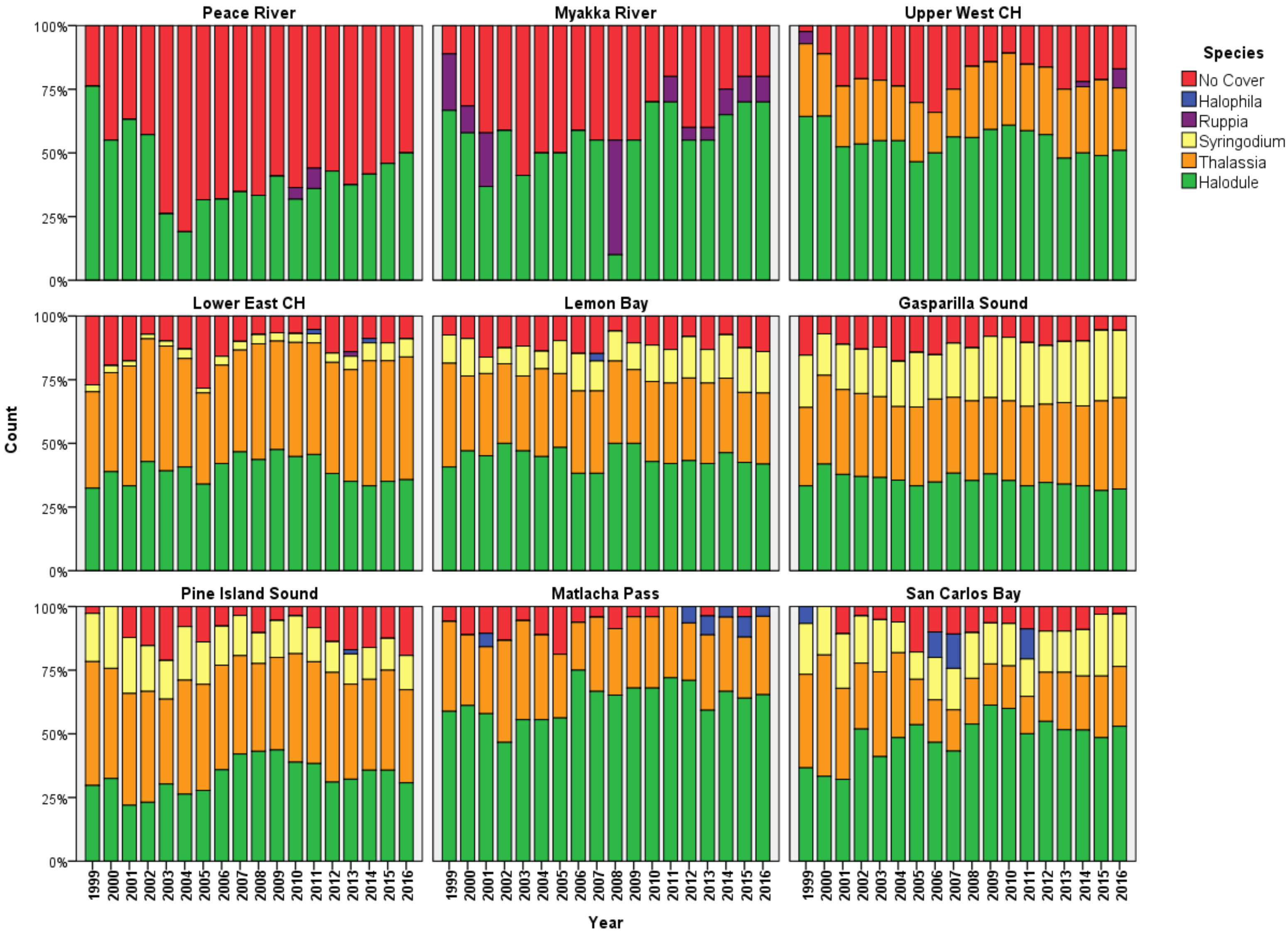


Figure 1.5. Percentage of occurrence of seagrass species and no cover for each region over the period of record (1999-2016) within the CHAP study area.

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

Analysis A: Comparison of Years

CHAP Study Area				
	# 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
2007	161	90	28	1 : 0.6 : 0.2
2008	154	96	28	1 : 0.6 : 0.2
2009	176	97	31	1 : 0.6 : 0.2
2010	163	100	32	1 : 0.6 : 0.2
2011	166	100	32	1 : 0.6 : 0.2
2012	160	103	32	1 : 0.6 : 0.2
2013	147	103	32	1 : 0.7 : 0.2
2014	156	103	37	1 : 0.7 : 0.2
2015	154	107	41	1 : 0.7 : 0.3
2016	159	106	39	1 : 0.7 : 0.2
Total	**2564**	**1672**	**526**	**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 (1999-2016) for the CHAP study area.

Analysis B: Comparison of Regions

CHAP Study Area					
	Total # of Species				Ratio
Region	Halodule	Thalassia	Syringodium	No Cover	H : T : S : NC
Peace River	165			228	1 : 0.0 : 0.0 : 1.4
Myakka River	187			121	1 : 0.0 : 0.0 : 0.7
Upper West CH	454	207		161	1 : 0.5 : 0.0 : 0.4
Lower East CH	384	425	37	119	1 : 1.1 : 0.1 : 0.3
Lemon Bay	280	196	81	72	1 : 0.7 : 0.3 : 0.3
Gasparilla Sound	299	271	186	92	1 : 0.9 : 0.6 : 0.3
Pine Island Sound	295	345	132	92	1 : 1.2 : 0.5 : 0.3
Matlacha Pass	250	112		21	1 : 0.5 : 0.0 : 0.08
San Carlos Bay	271	128	88	42	1 : 0.5 : 0.4 :0.2
Total	**2585**	**1684**	**524**	**948**	**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 (1999-2016) for the CHAP study area.

Analysis C: Comparison of Years by Region

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
2007	8	15	1 ; 1.9
2008	7	14	1 ; 2.0
2009	9	13	1 ; 1.4
2010	7	14	1 ; 2.0
2011	9	14	1 ; 1.6
2012	9	12	1 ; 1.3
2013	9	15	1 ; 1.7
2014	10	14	1 ; 1.4
2015	11	13	1 ; 1.2
2016	12	12	1 ; 1.0
Total	**162**	**205**	**1 ; 1.3**

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 the Peace River region over the period of record (1999-2016).

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
2007	11	9	1 ; 0.8
2008	2	9	1 ; 4.5
2009	11	9	1 ; 0.8
2010	14	6	1 ; 0.4
2011	14	4	1 ; 0.3
2012	11	8	1 ; 0.7
2013	11	8	1 ; 0.7
2014	13	5	1 ; 0.4
2015	14	4	1 ; 0.8
2016	14	4	1 ; 0.8
Total	**189**	**122**	**1 ; 0.6**

Table 2.3 (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 (1999-2016) within the Myakka River region.
**Note: In 2008 a majority of Halodule in Myakka River was replaced by Ruppia.*

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
2007	27	9	1 ; 0.3
2008	28	14	1 ; 0.5
2009	29	13	1; 0.4
2010	28	13	1; 0.5
2011	27	12	1; 0.4
2012	28	13	1; 0.5
2013	23	13	1; 0.6
2014	25	13	1; 0.5
2015	23	14	1; 0.6
2016	27	13	1; 0.5
Total	**449**	**207**	**1 ; 0.5**

Table 2.3 (C). Frequency of occurrence of the three most common seagrass species and their ratios for the Upper West Charlotte Harbor region over the period of record (1999-2016).

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
2007	28	24	2	1 : 0.9 : 0.07
2008	24	25	2	1 : 1.0 : 0.08
2009	29	26	2	1 : 0.9 : 0.07
2010	26	26	2	1 : 1.0 : 0.08
2011	26	25	2	1 : 1.0 : 0.08
2012	21	24	2	1 : 1.1 : 0.10
2013	20	25	3	1 : 1.3 : 0.15
2014	19	28	4	1 : 1.5 : 0.21
2015	20	27	4	1 : 1.4 : 0.20
2016	20	27	4	1 : 1.4 : 0.20
Total	**374**	**410**	**37**	**1 : 1.1 : 0.10**

Table 2.3 (D). Frequency of occurrence of the three most common seagrass species and their ratios within the Lower East Charlotte Harbor region over the period of record (1999-2016).

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
2007	13	11	4	1 : 0.8 : 0.3
2008	17	11	4	1 : 0.6 : 0.2
2009	19	11	4	1 : 0.6 : 0.2
2010	15	11	5	1 : 0.7 : 0.3
2011	16	12	5	1 : 0.8 : 0.3
2012	16	12	6	1 : 0.8 : 0.4
2013	16	12	5	1 : 0.8 : 0.3
2014	19	12	7	1 : 0.6 : 0.4
2015	17	11	7	1 : 0.6 : 0.4
2016	18	12	7	1 : 0.7 : 0.4
Total	**271**	**195**	**78**	**1 : 0.7 : 0.3**

Table 2.3 (E). Frequency of occurrence of the three most common seagrass species and their ratios for the Lemon Bay region over the period of record (1999-2016).

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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	18	14	10	1 : 0.8 : 0.6
2008	17	15	10	1 : 0.9 : 0.6
2009	19	15	12	1 : 0.8 : 0.6
2010	17	15	12	1 : 0.9 : 0.7
2011	16	15	12	1 : 0.9 : 0.8
2012	18	16	12	1 : 0.9 : 0.7
2013	17	16	12	1 : 0.9 : 0.7
2014	17	16	13	1 : 0.9 : 0.8
2015	17	19	15	1 : 1.1 : 0.9
2016	17	19	14	1 : 1.1 : 0.8
Total	**301**	**278**	**191**	**1 : 0.9 : 0.6**

Table 2.3 (F). Frequency of occurrence of the three most common seagrass species and their ratios for the Gasparilla Sound region over the period of record (1999-2016).

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
2007	24	22	9	1 : 0.9 : 0.4
2008	25	20	7	1 : 0.8 : 0.3
2009	24	20	8	1 : 0.8 : 0.3
2010	21	23	8	1 : 1.1 : 0.4
2011	23	24	8	1 : 1.0 : 0.3
2012	18	25	7	1 : 1.4 : 0.4
2013	19	22	7	1 : 1.2 : 0.4
2014	20	20	7	1 : 1.0 : 0.4
2015	20	22	7	1 : 1.1 : 0.4
2016	16	19	7	1 : 1.2 : 0.4
Total	**304**	**342**	**129**	**1 : 1.1 : 0.4**

Table 2.3 (G). Frequency of occurrence of the three most common seagrass species and their ratios for the Pine Island Sound region over the period of record (1999-2016).

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
2007	16	7	1 ; 0.4
2008	15	6	1 ; 0.4
2009	17	7	1; 0.4
2010	17	7	1; 0.4
2011	18	7	1; 0.4
2012	22	7	1; 0.3
2013	16	8	1; 0.5
2014	16	7	1; 0.4
2015	16	6	1; 0.4
2016	17	8	1; 0.5
Total	**254**	**111**	**1 ; 0.4**

Table 2.3 (H). Frequency of occurrence of the three most common seagrass species and their ratios for the Matlacha Pass region over the period of record (1999-2016).

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
2007	16	3	3	1 : 0.2 : 0.2
2008	19	5	5	1 : 0.3 : 0.3
2009	19	5	5	1 : 0.3 : 0.3
2010	18	5	5	1 : 0.3 : 0.3
2011	17	5	5	1 : 0.3 : 0.3
2012	17	6	5	1 : 0.3 : 0.3
2013	16	7	5	1 : 0.4 : 0.3
2014	17	7	6	1 : 0.4 : 0.4
2015	16	8	8	1 : 0.5 : 0.5
2016	18	8	7	1 : 0.4 : 0.4
Total	**260**	**129**	**91**	**1 : 0.5 : 0.4**

Table 2.3 (I). Frequency of occurrence of the three most common seagrass species and their ratios for the San Carlos Bay region over the period of record (1999-2016).

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

Analysis A: Comparison of Years

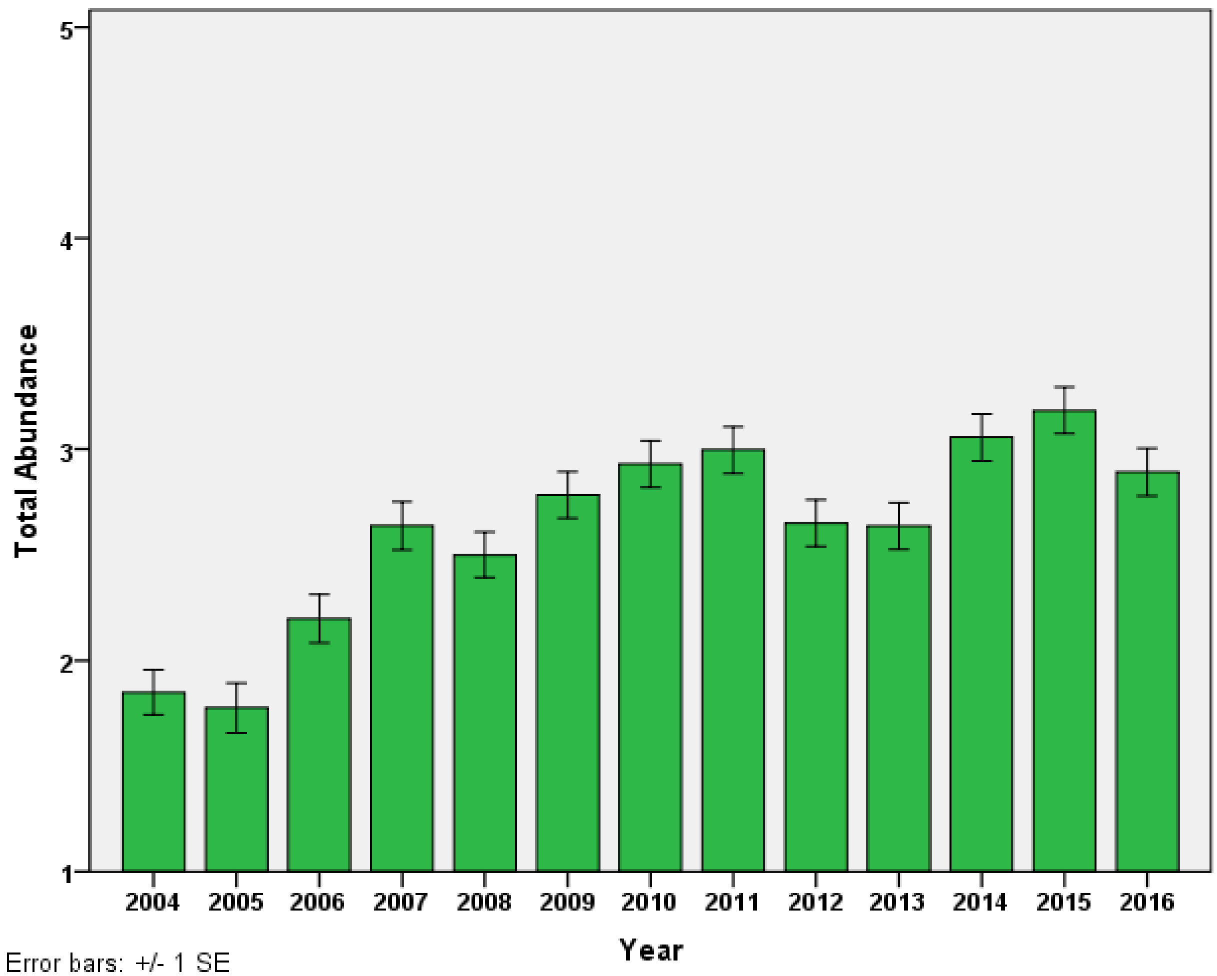

Figure 3.1. Mean Braun-Blanquet total quadrat abundance (+/- SE) over the period of record (2004-2016) for the entire CHAP study area.

Analysis B: Comparison of Regions

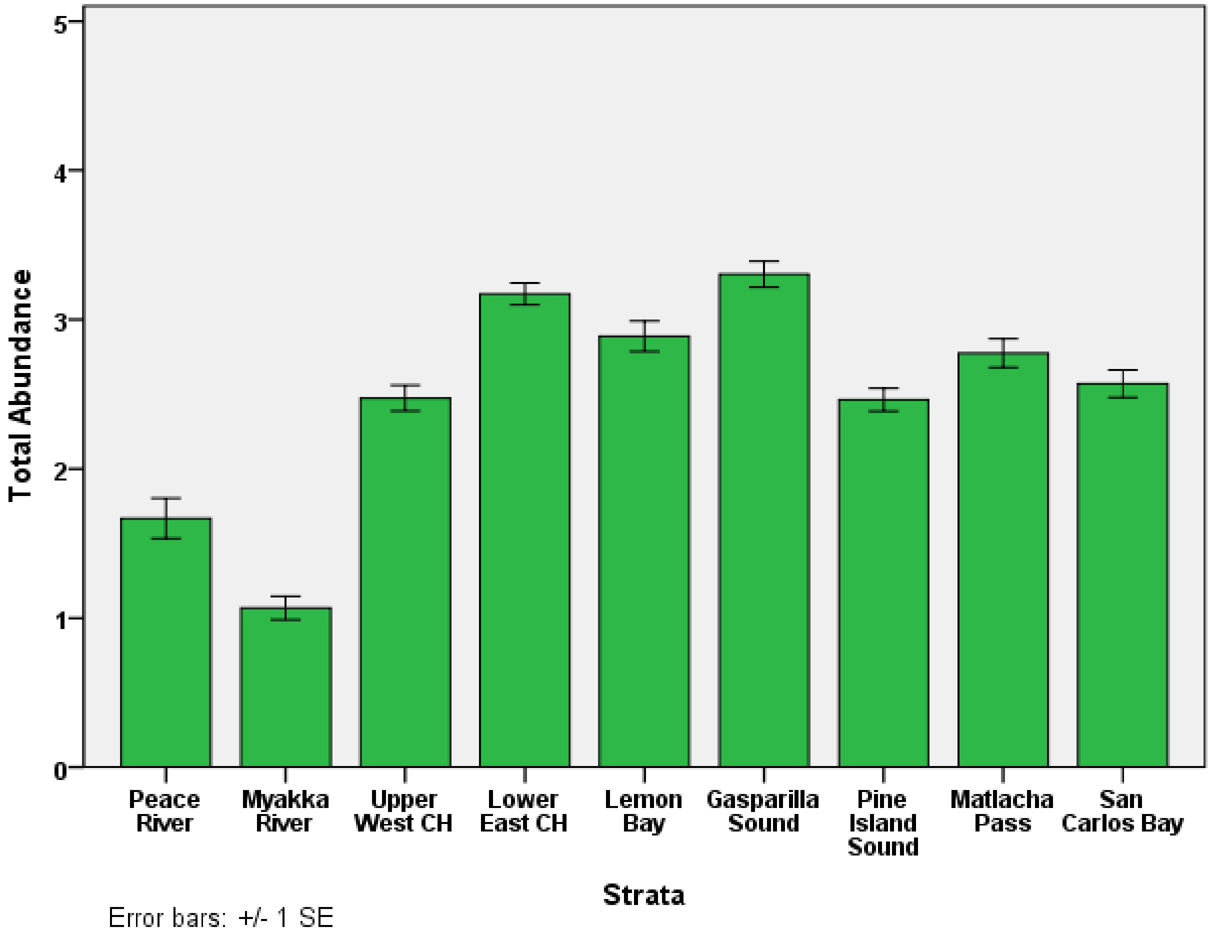

Figure 3.2. Mean Braun-Blanquet total quadrat abundance (+/- SE) for each region over the period of record (2004-2016) for the CHAP study area.

Analysis C: Comparison of Years by Region

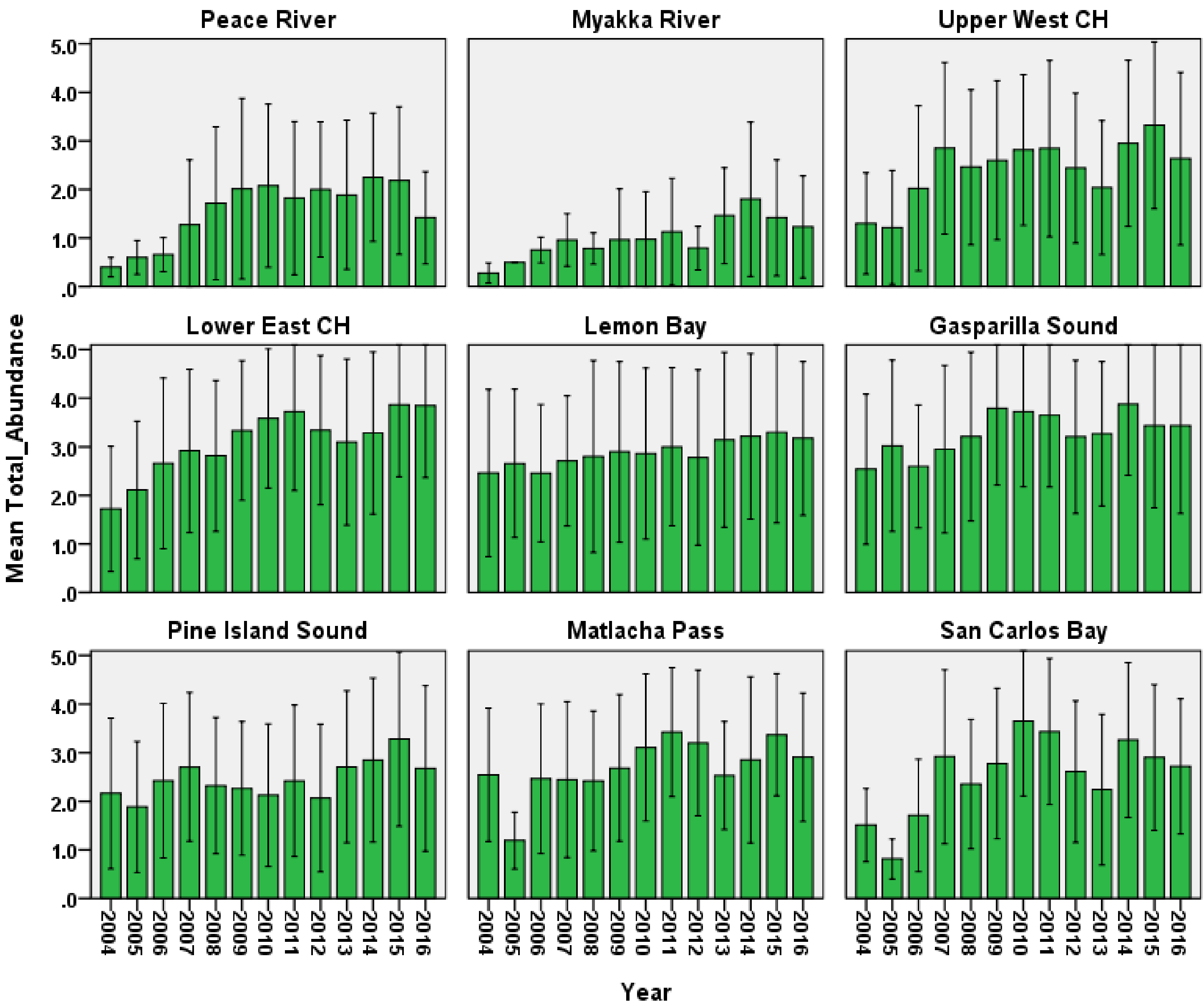

Figure 3.3. Mean Braun-Blanquet total quadrat abundance (+/- SD) for each region over the period of record (2004-2016) within the CHAP study area

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

Analysis A: Comparison of Years

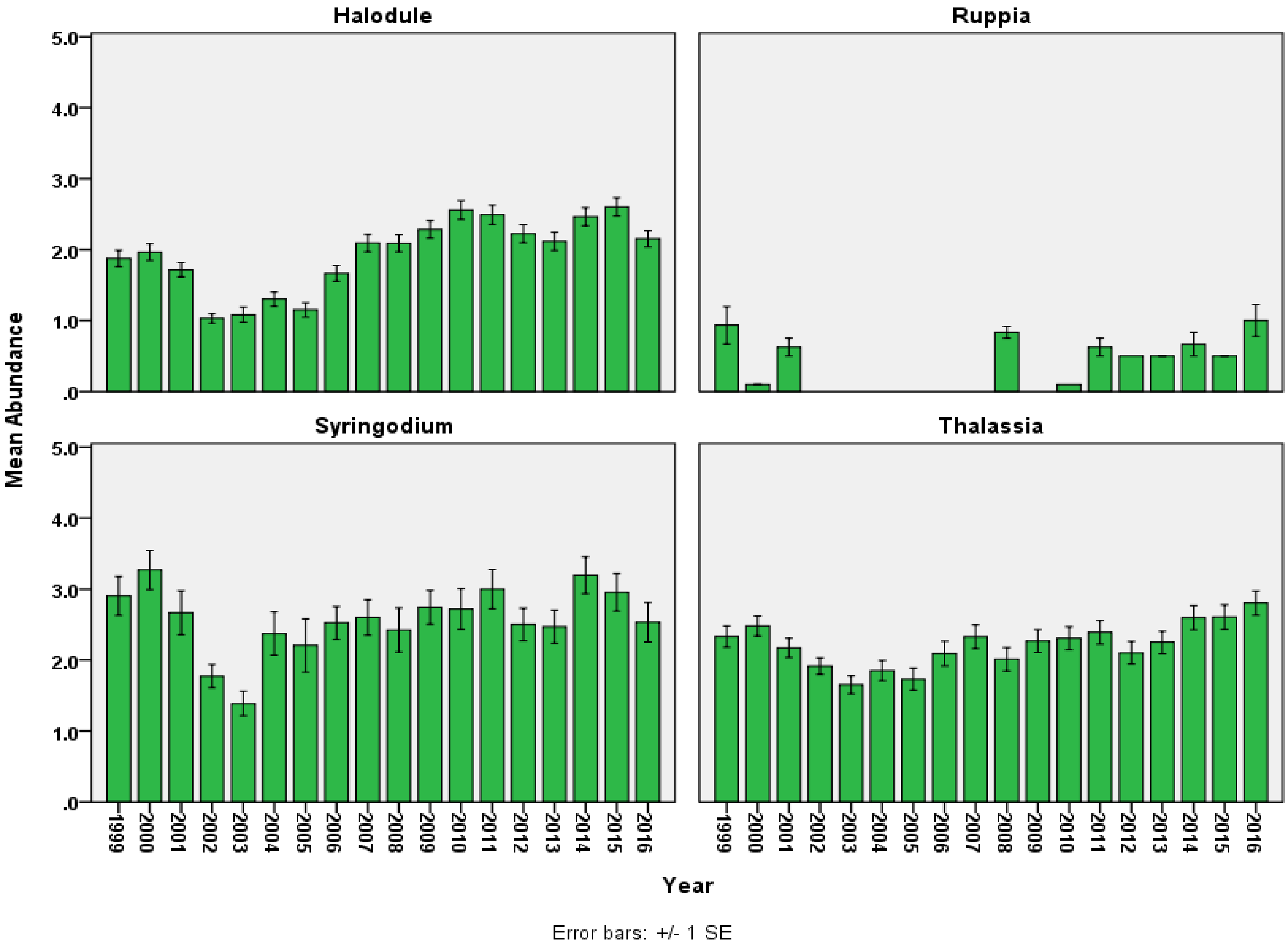

Figure 4.1. Mean Braun-Blanquet abundance (+/- SE) by species over the period of record (1999-2016) for the CHAP study area.

Analysis B: Comparison of Regions

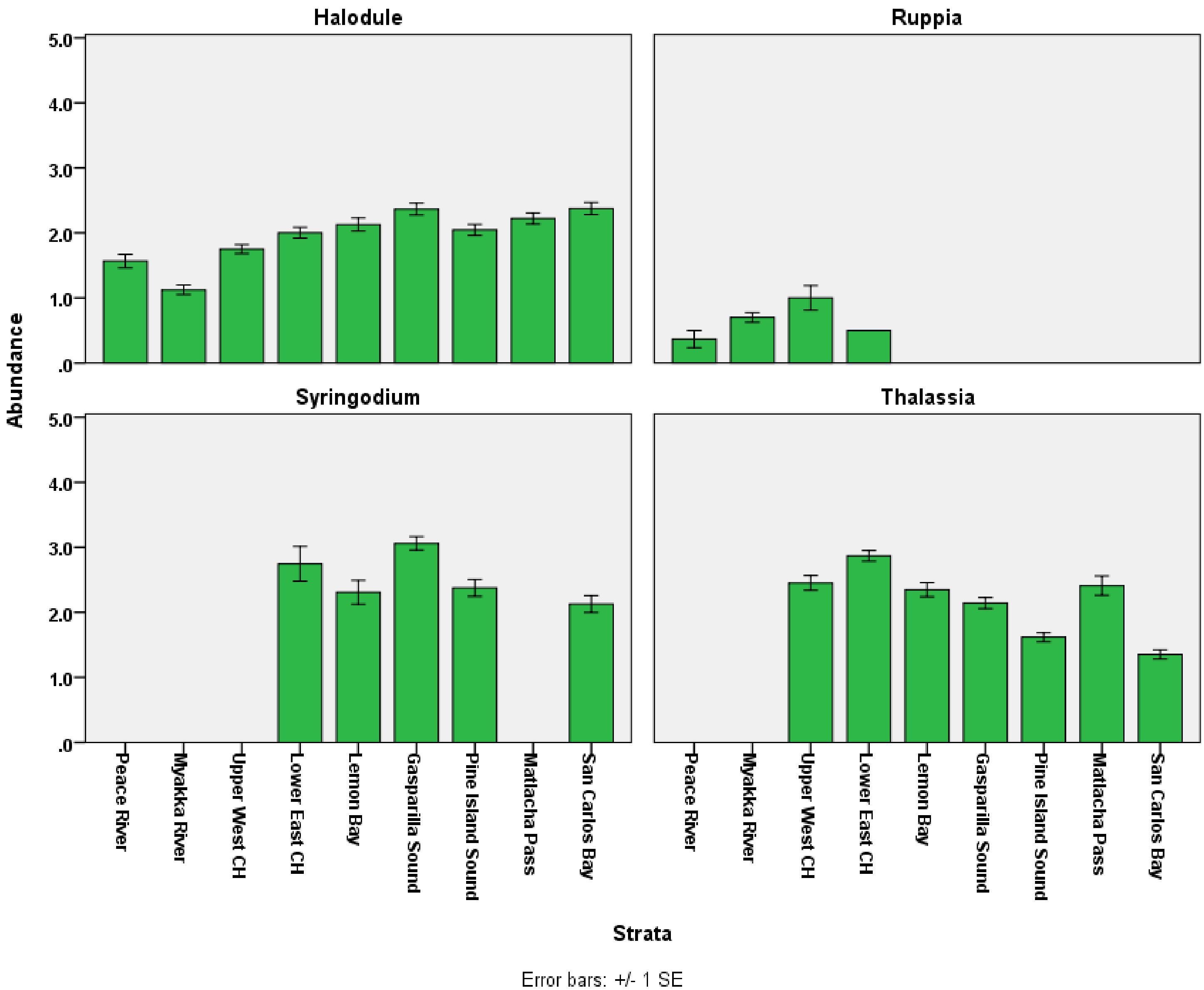

Figure 4.2. Mean Braun-Blanquet abundance (+/- SE) by species for each region over the period of record (1999-2016) for the CHAP study area.

Analysis C: Comparison of Years by Region

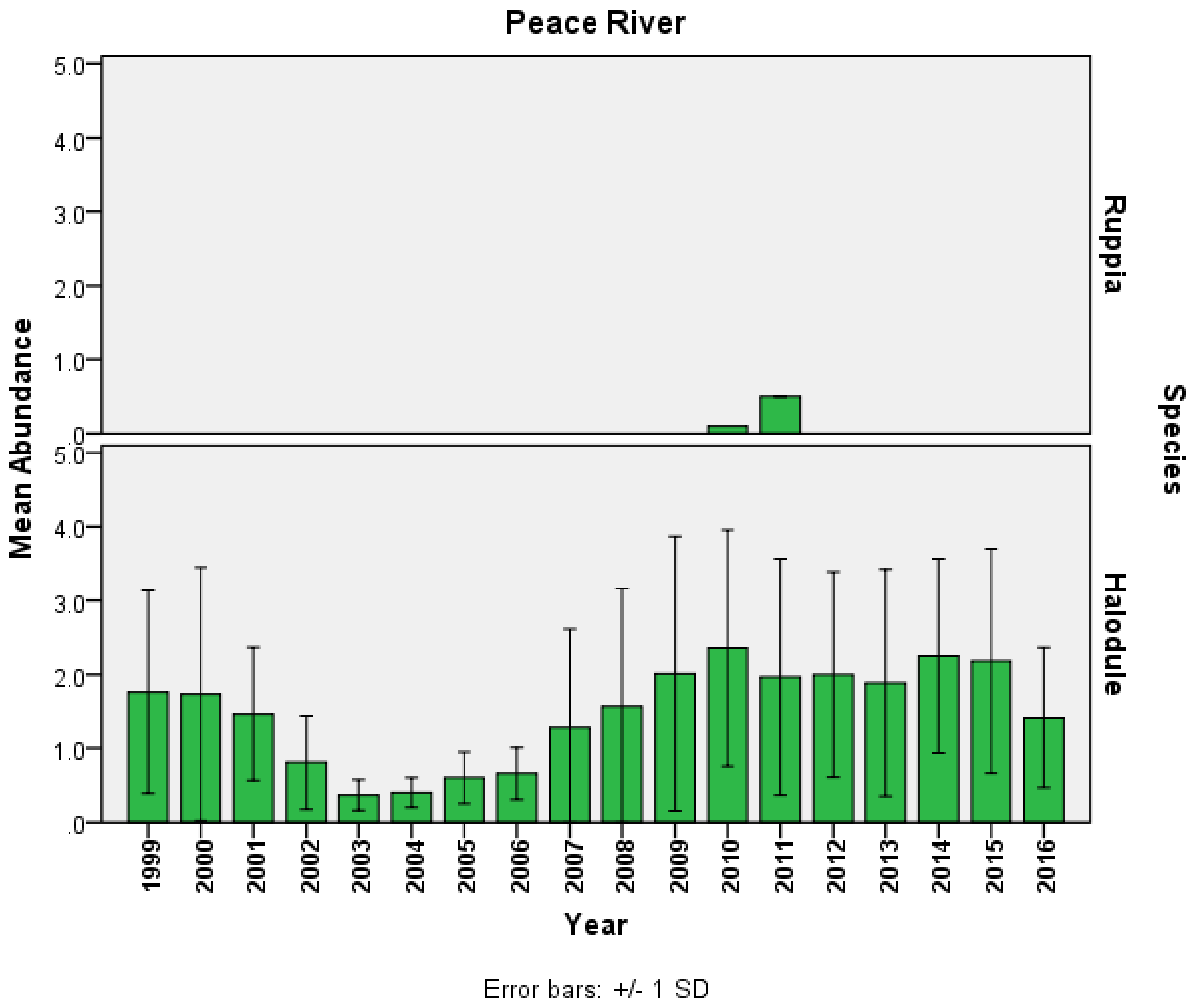

Figure 4.3 (A). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Peace River region.

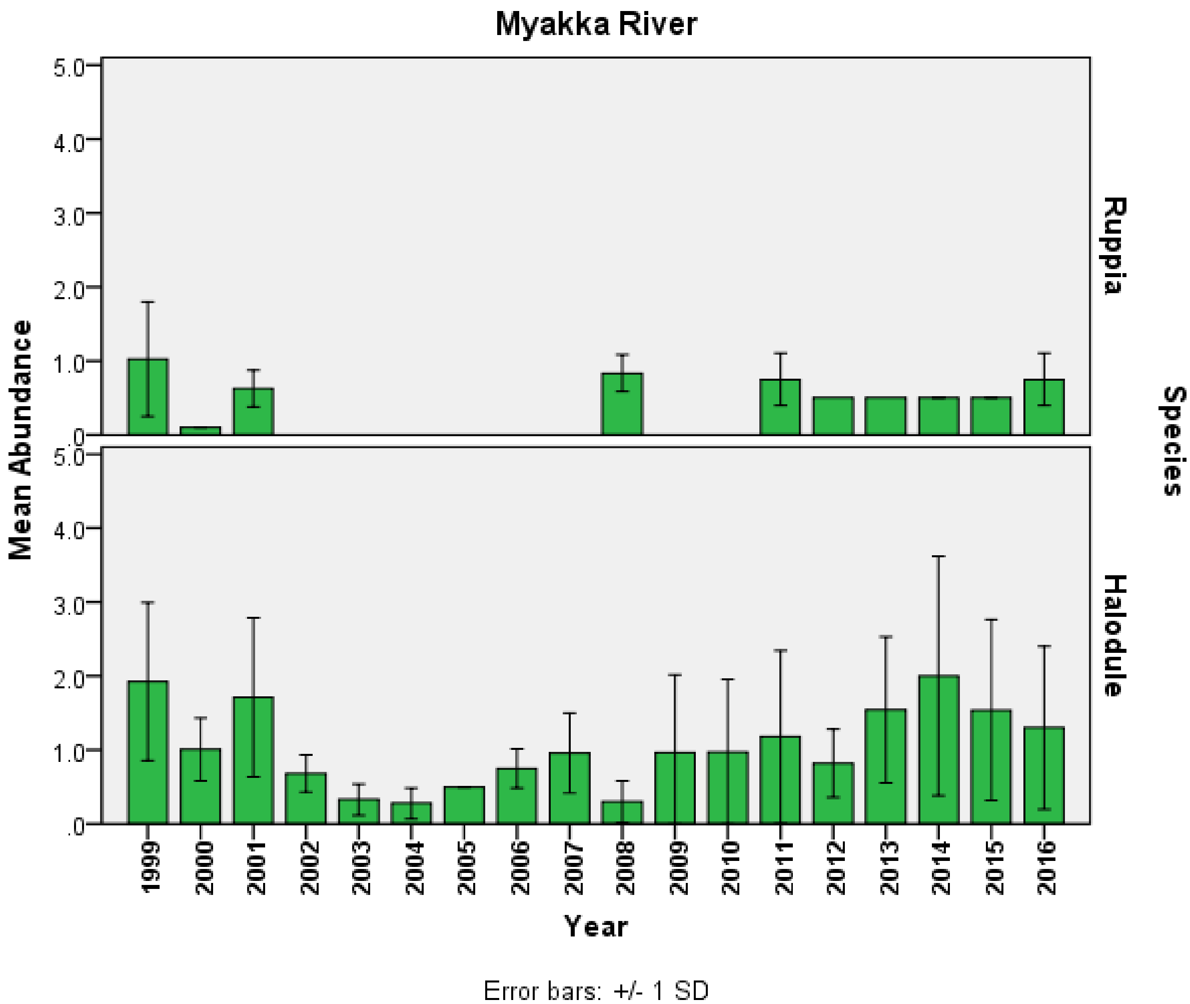

Figure 4.3 (B). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Myakka River region.

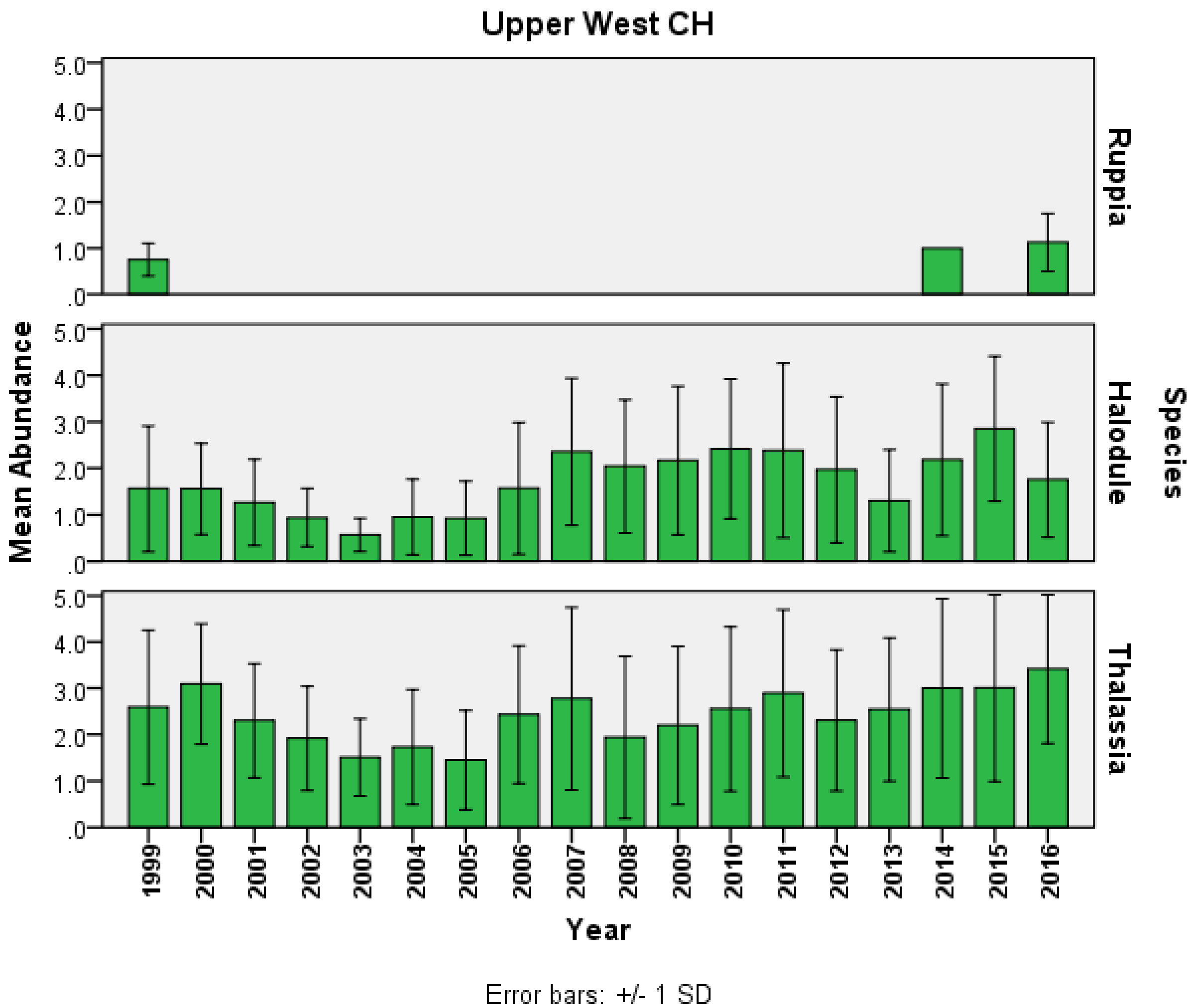

Figure 4.3 (C). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Upper West Charlotte Harbor region.

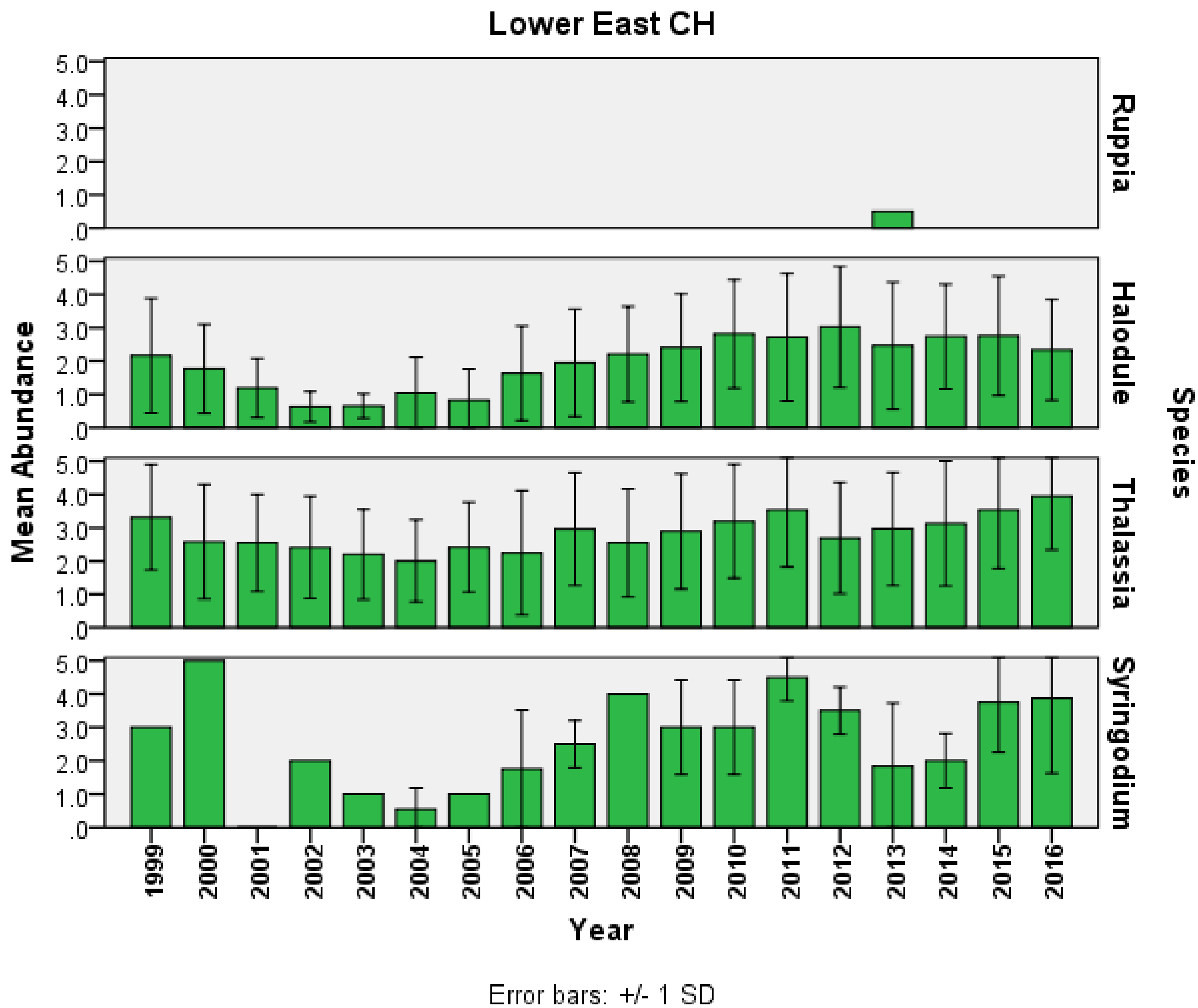

Figure 4.3 (D). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Lower East Charlotte Harbor region.

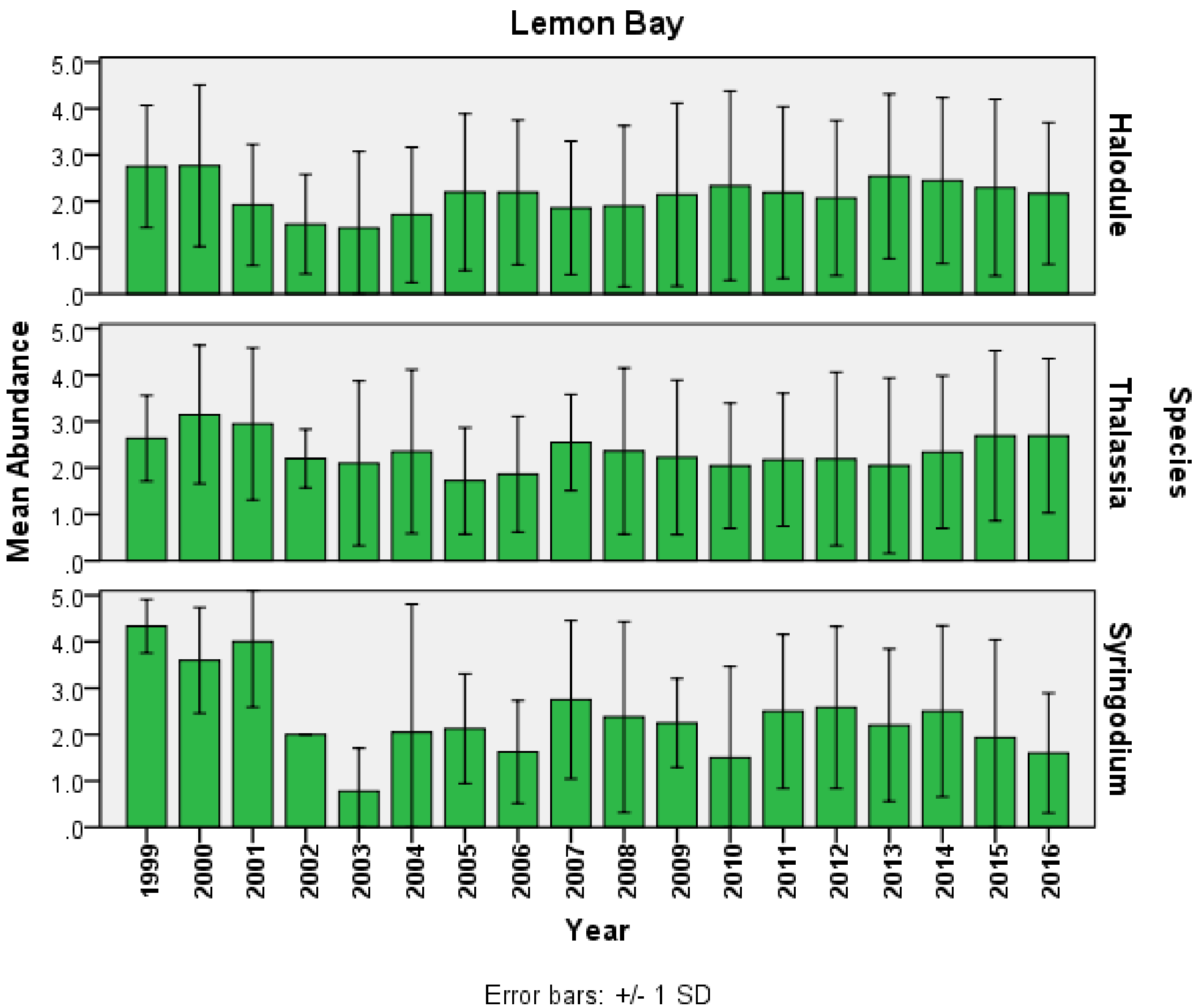

Figure 4.3 (E). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Lemon Bay region.

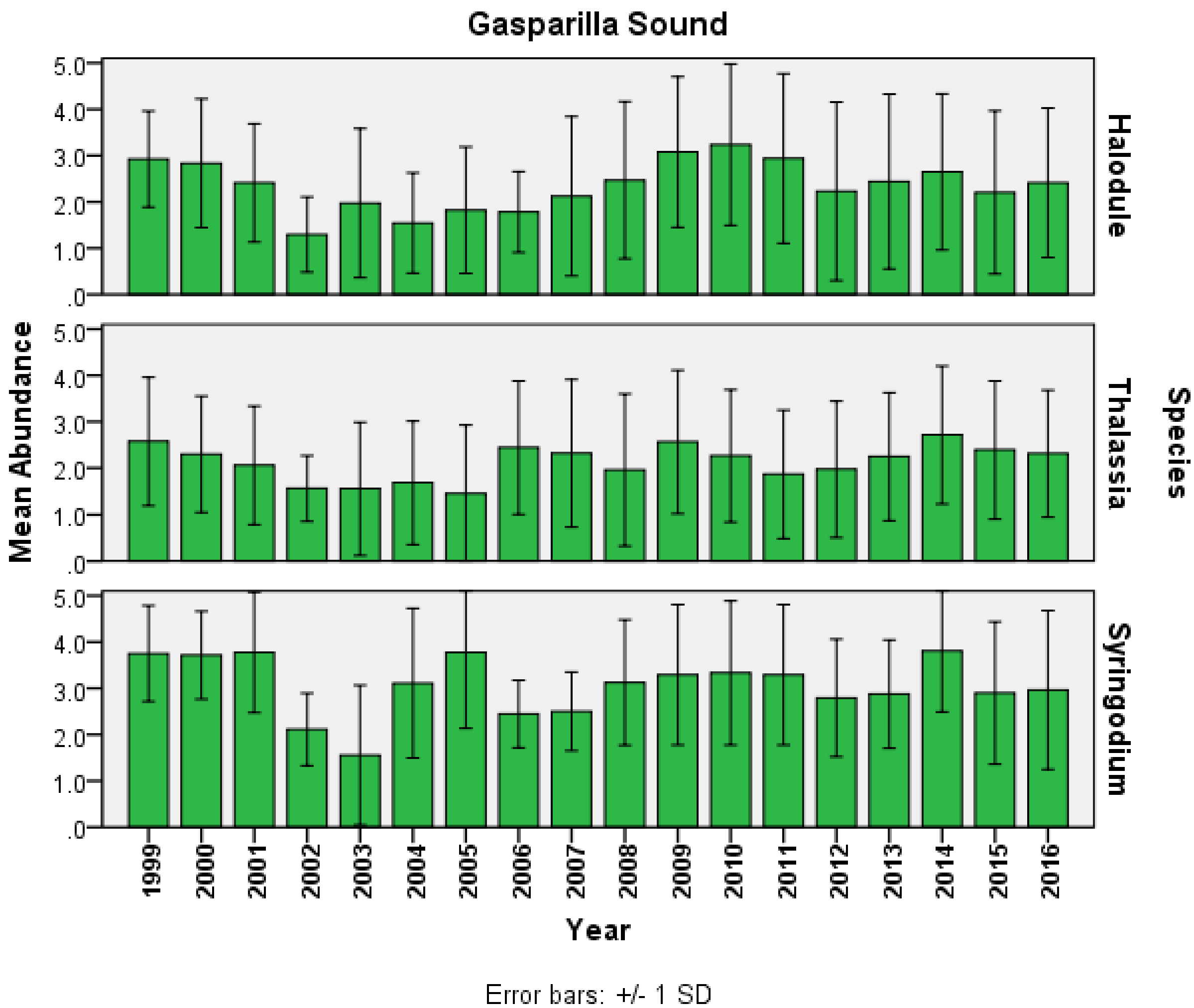

Figure 4.3 (F). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Gasparilla Sound region.

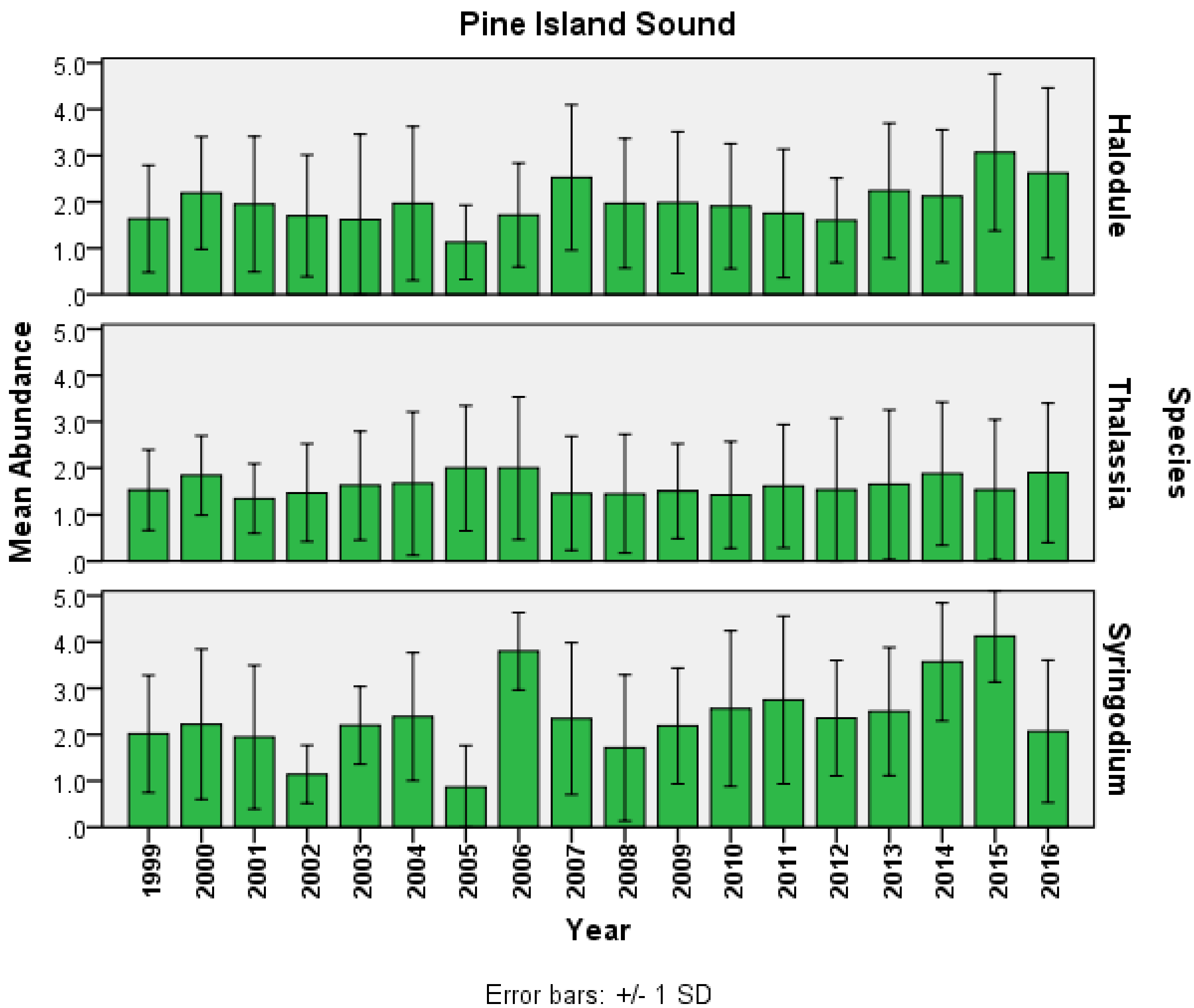

Figure 4.3 (G). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Pine Island Sound region.

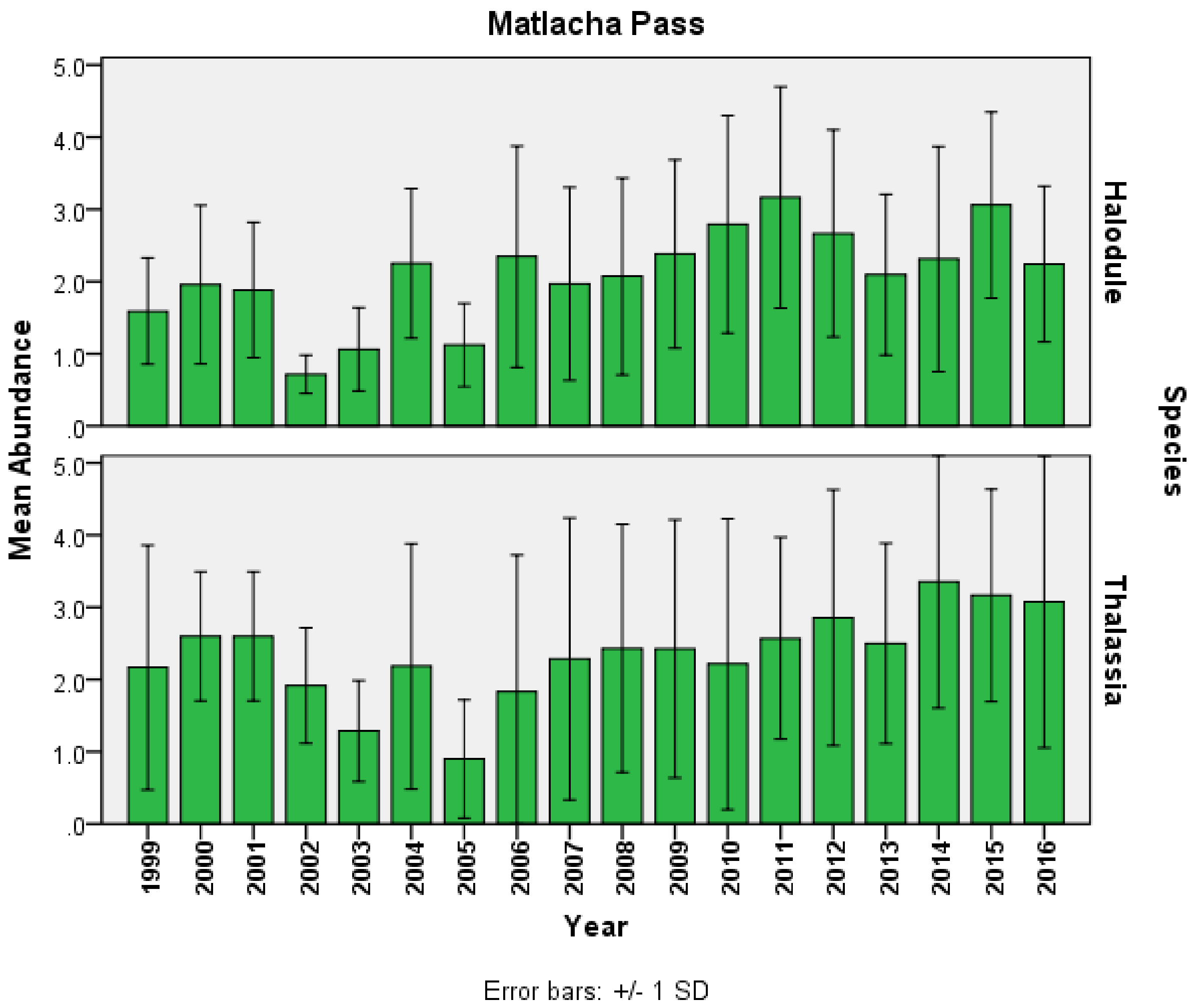

Figure 4.3 (H). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the Matlacha Pass region.

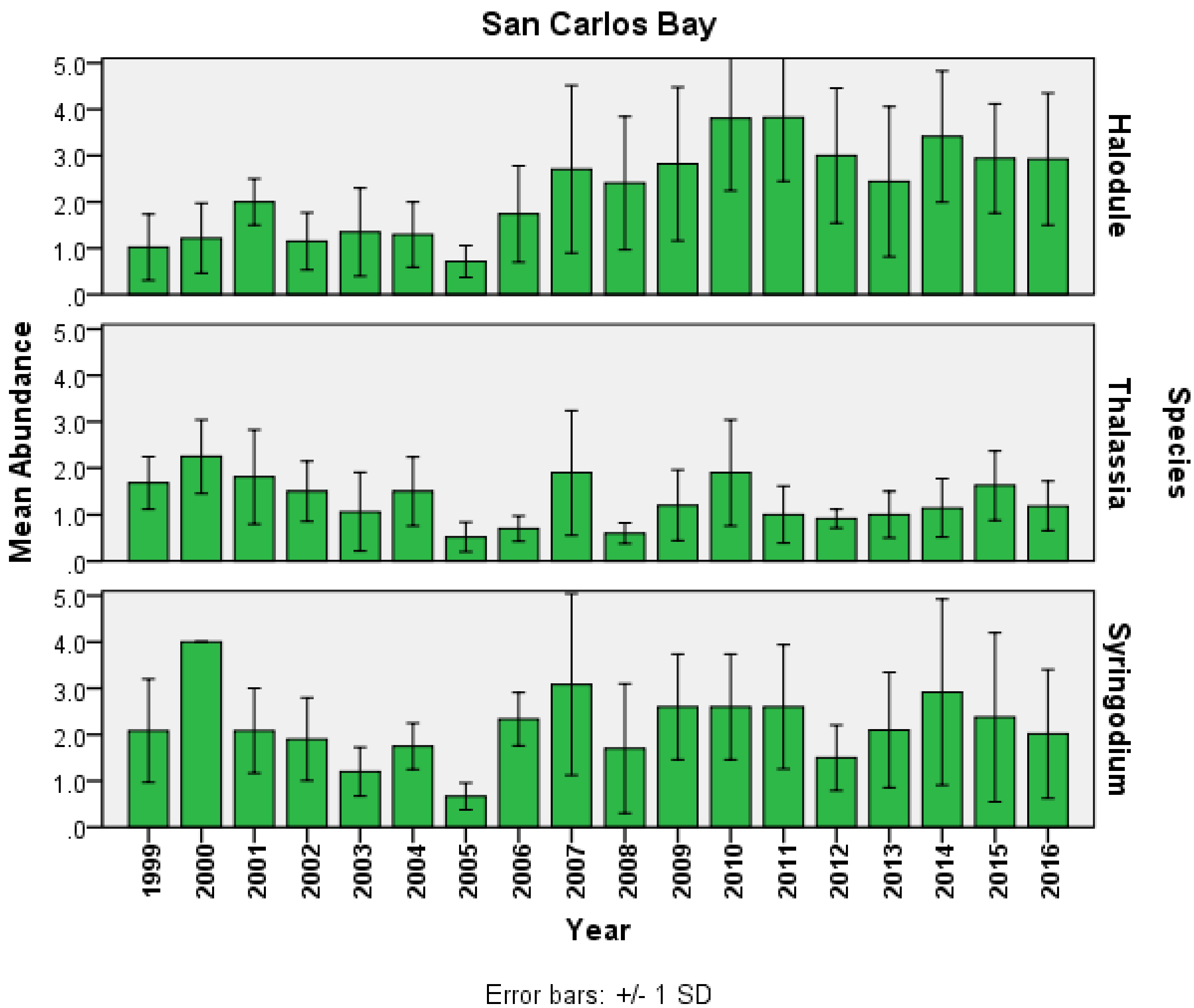

Figure 4.3 (I). Mean Braun-Blanquet abundance (+/- SD) by species for each region over the period of record (1999-2016) within the San Carlos Bay region.

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

Analysis A: Comparison of Years (for Halodule)

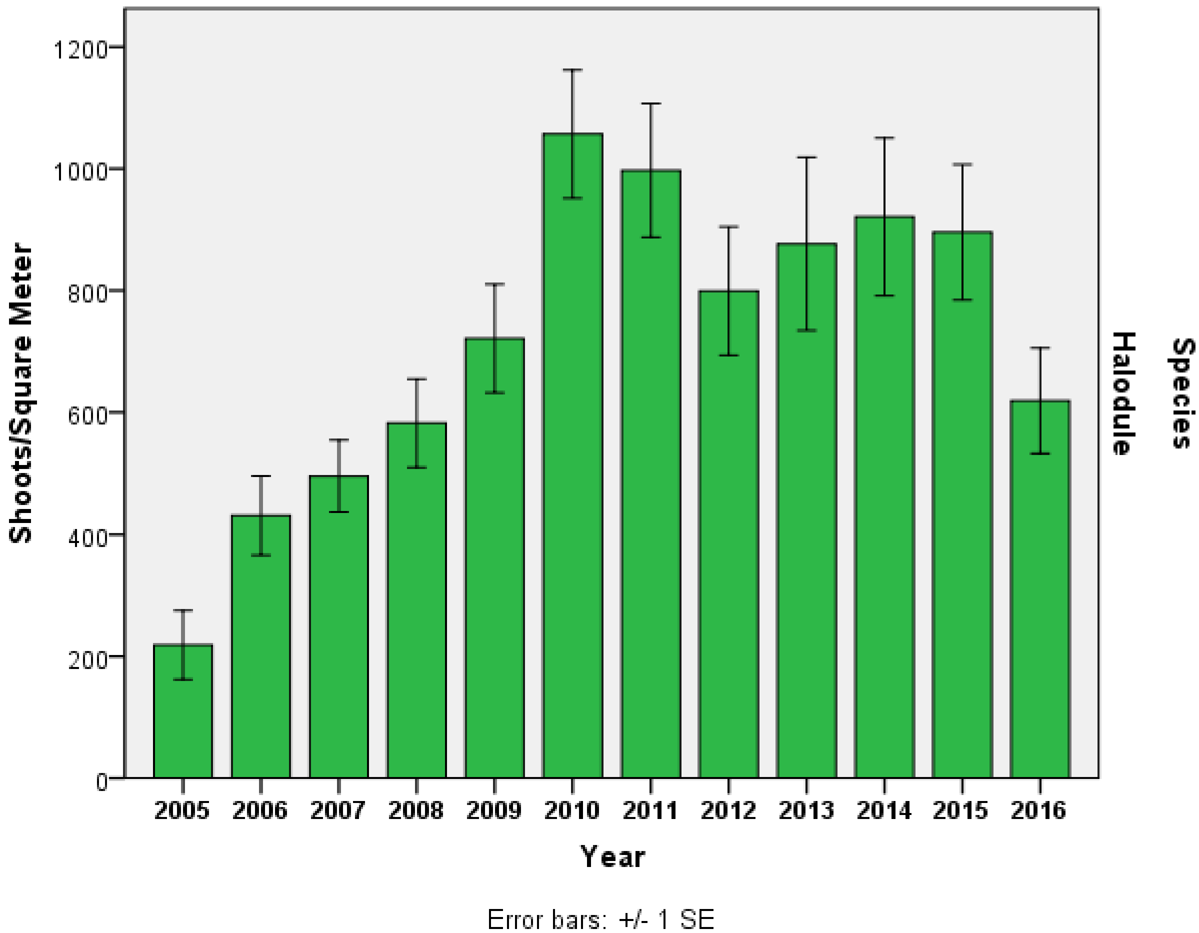

Figure 5.1. Mean shoot density (+/- SE) of *Halodule wrightii* over the period of record (2005-2016) for the entire CHAP study area.

Analysis B: Comparison of Regions (for Halodule)

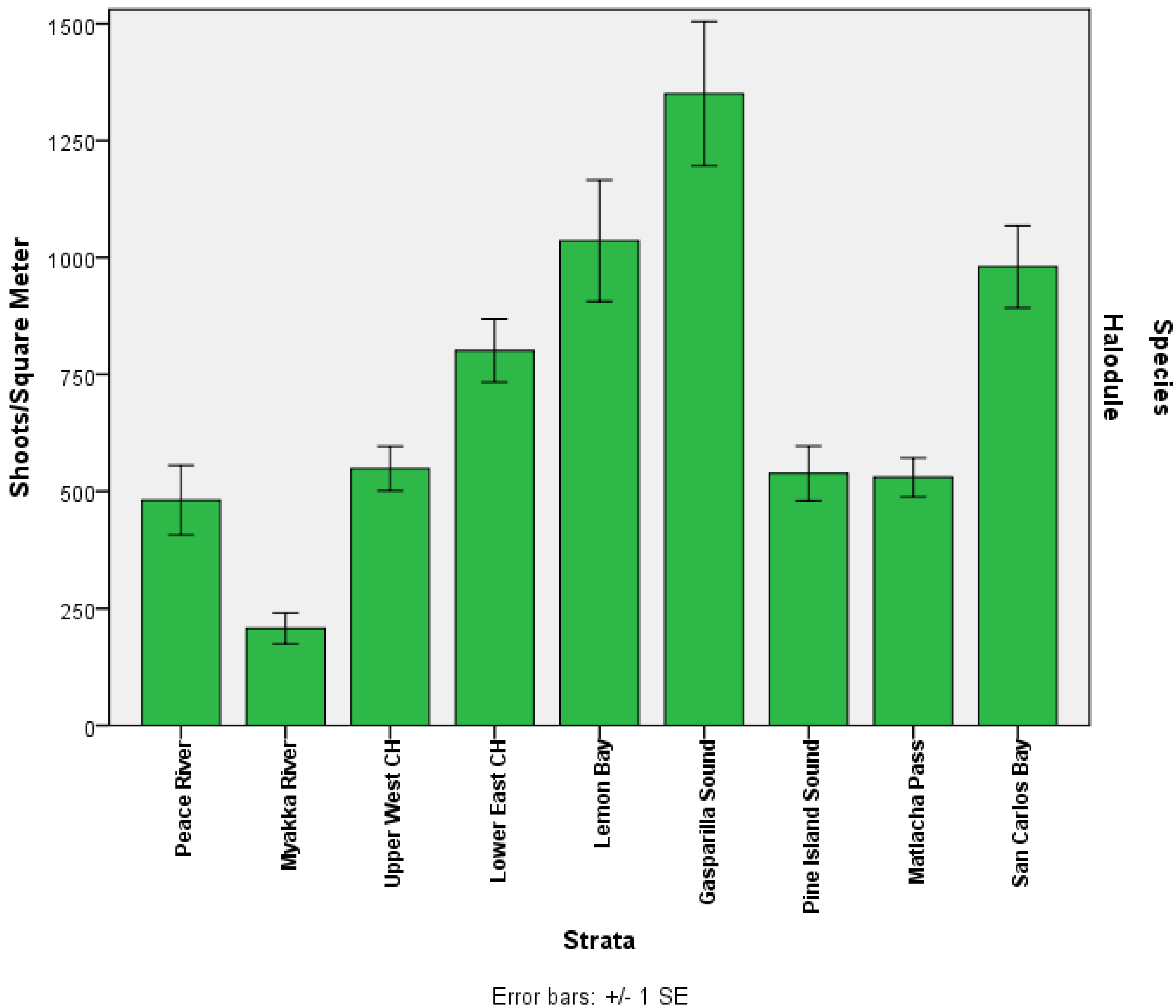

Figure 5.2. Mean shoot density (+/- SE) of *Halodule wrightii* for each region over the period of record (2005-2016) for the CHAP study area.

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

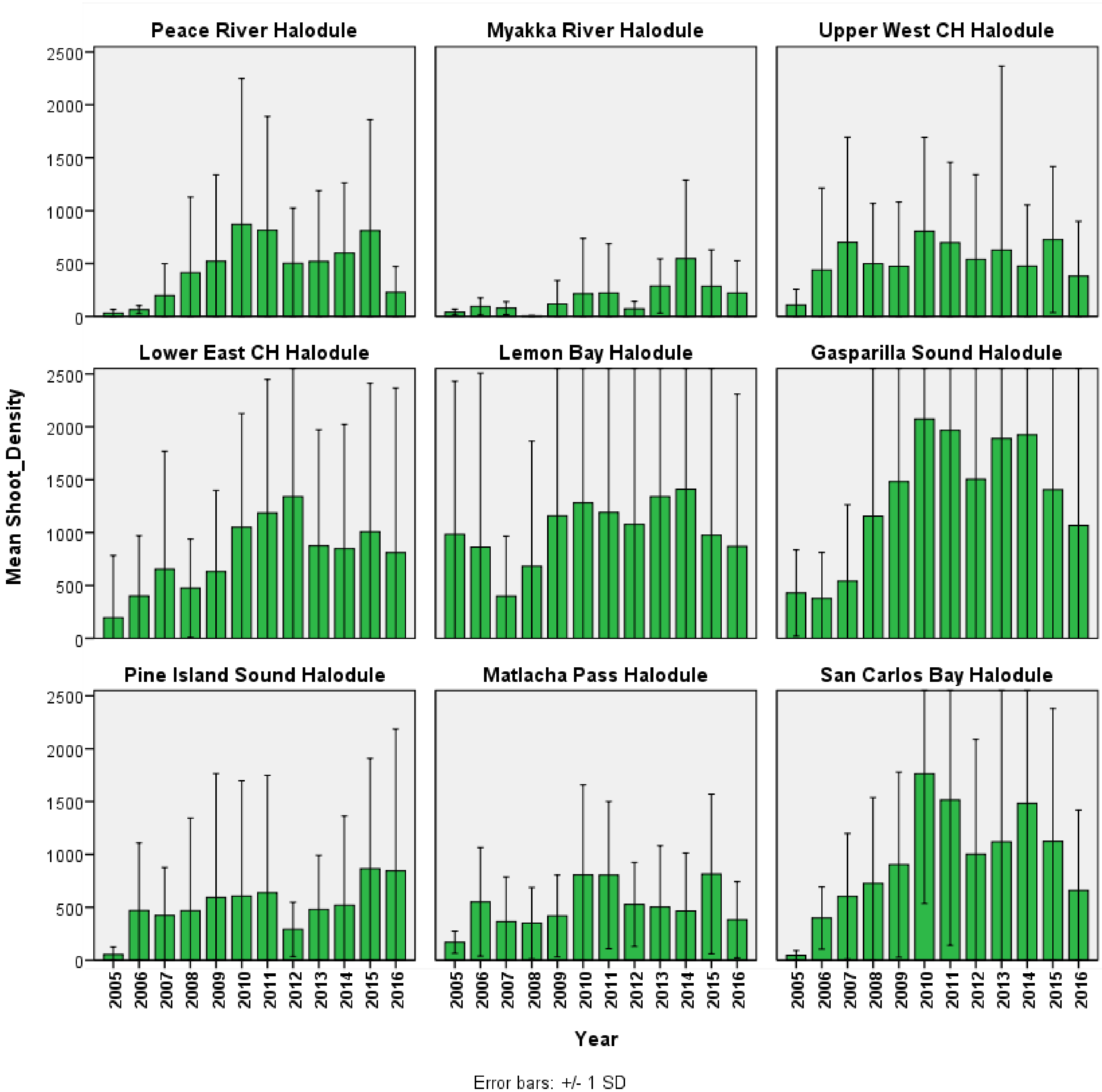

Figure 5.3. Mean shoot density (+/- SD) of *Halodule wrightii* for each region over the period of record (2005-2016) within the CHAP study area.

Analysis A: Comparison of Years (for Thalassia)

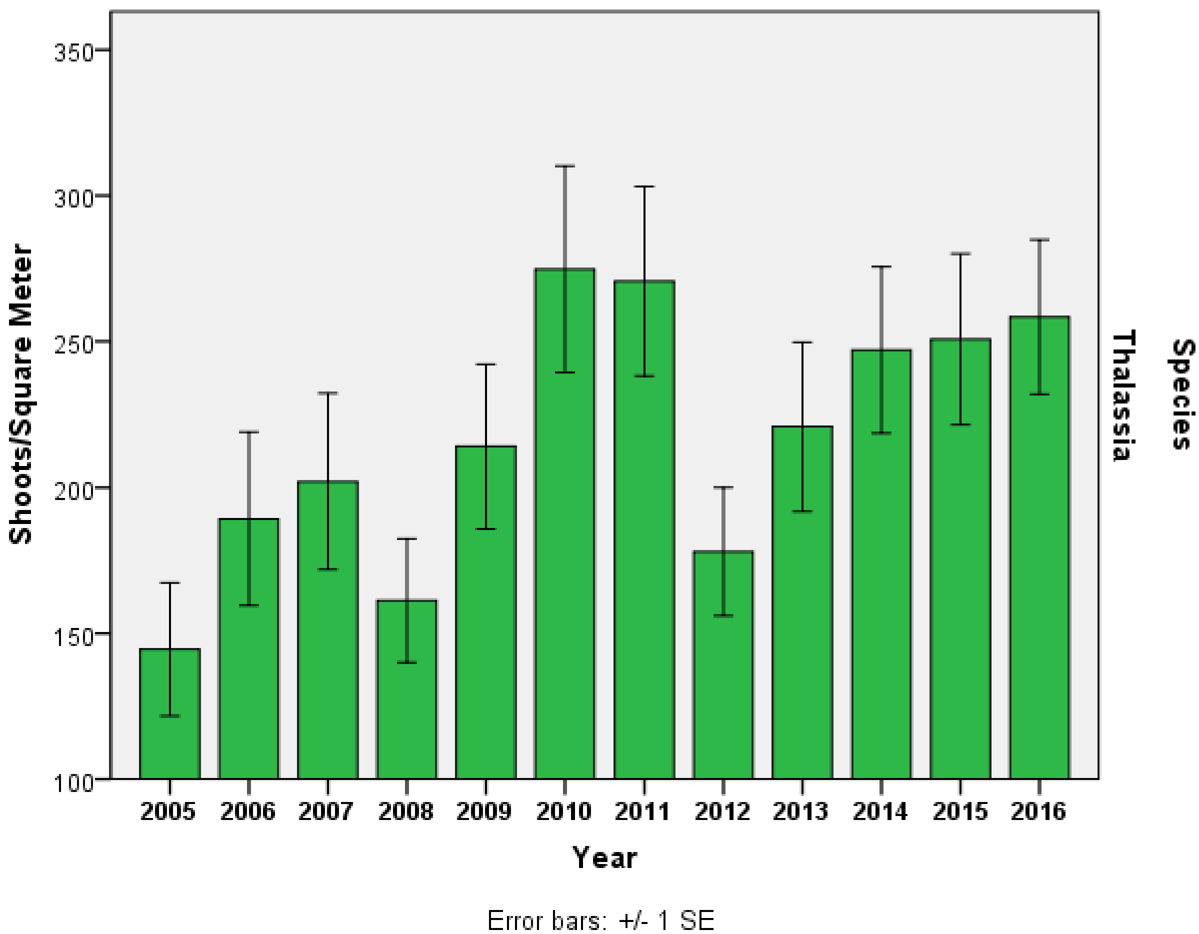

Figure 5.4. Mean shoot density (+/- SE) of *Thalassia testudinum* over the period of record (2005-2016) for the entire CHAP study area.

Analysis B: Comparison of Regions (for Thalassia)

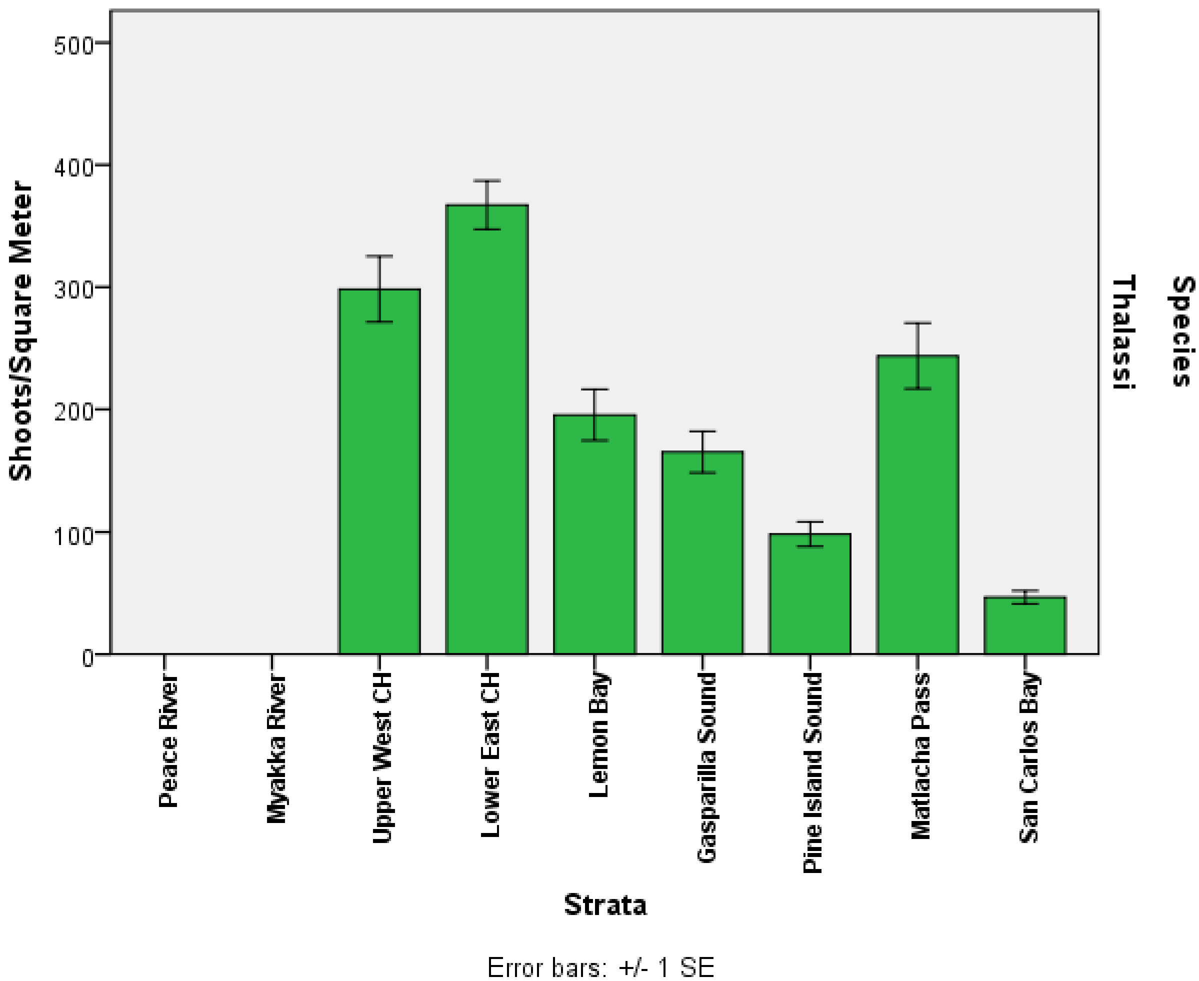

Figure 5.5. Mean shoot density (+/- SE) of *Thalassia testudinum* for each region over the period of record (2005-2016) for the CHAP study area.

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

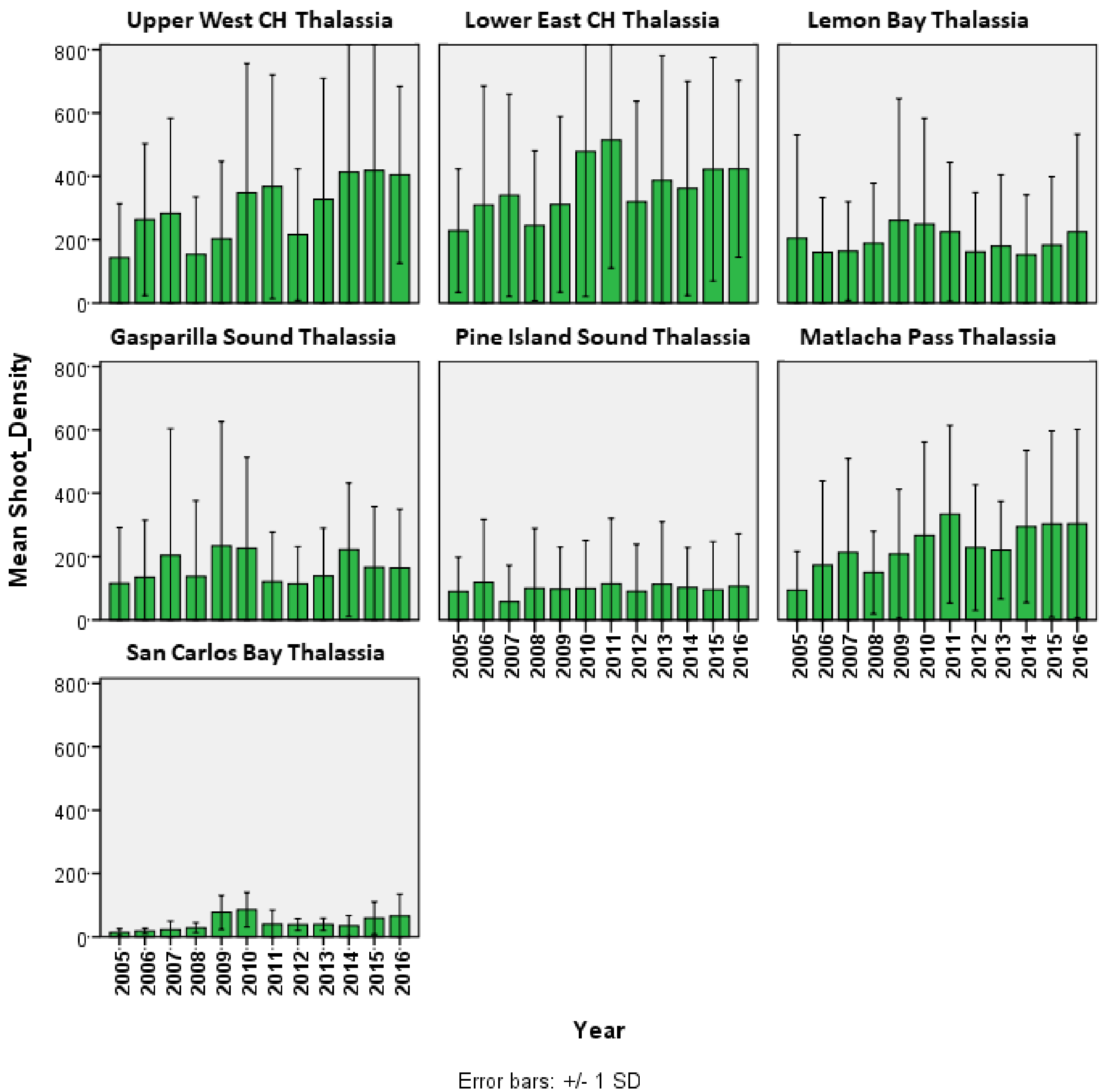

Figure 5.6. Mean shoot density (+/- SD) of *Thalassia testudinum* for each region over the period of record (2005-2016) within the CHAP study area.

Analysis A: Comparison of Years (for Syringodium)

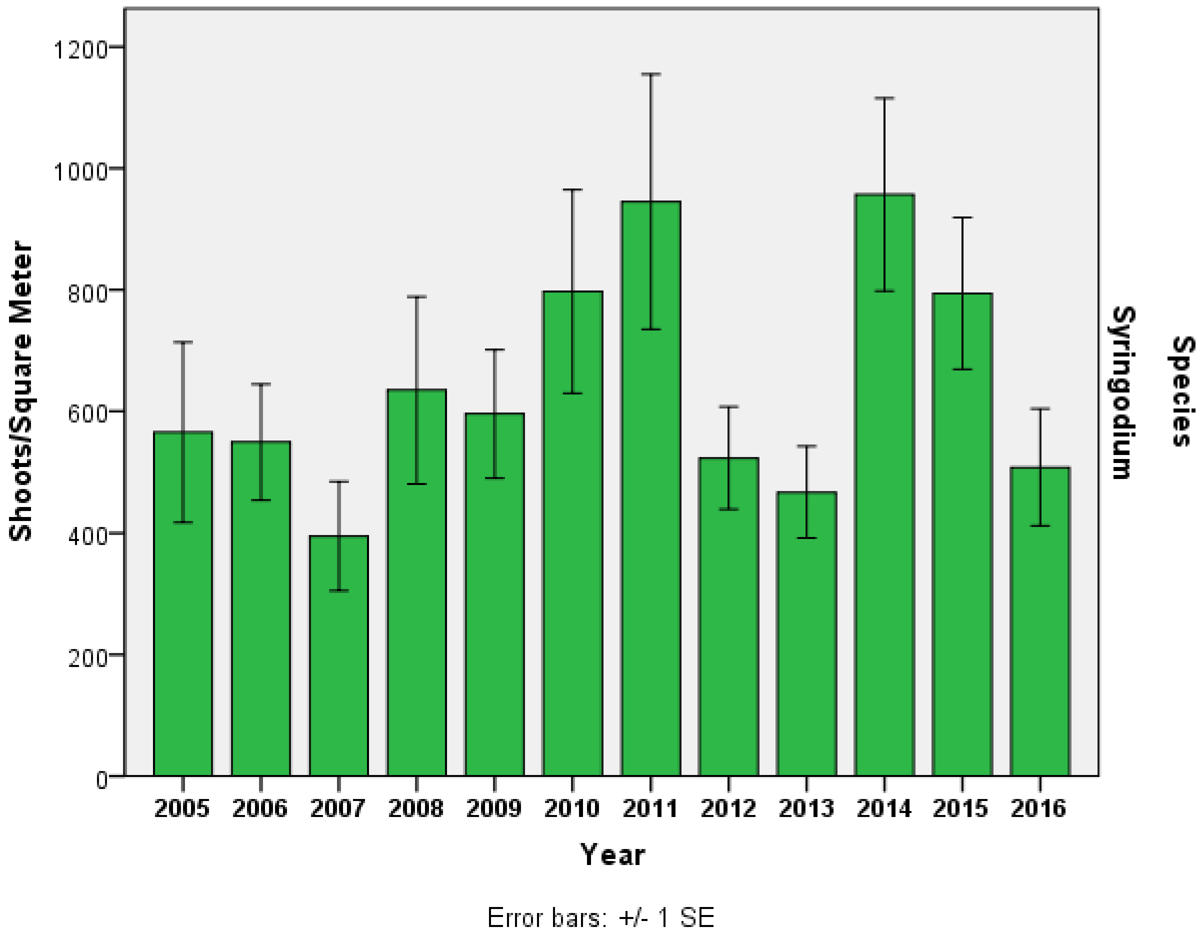

Figure 5.7. Mean shoot density (+/- SE) of *Syringodium filiforme* over the period of record (2005-2016) for the entire CHAP study area.

Analysis B: Comparison of Regions (for Syringodium)

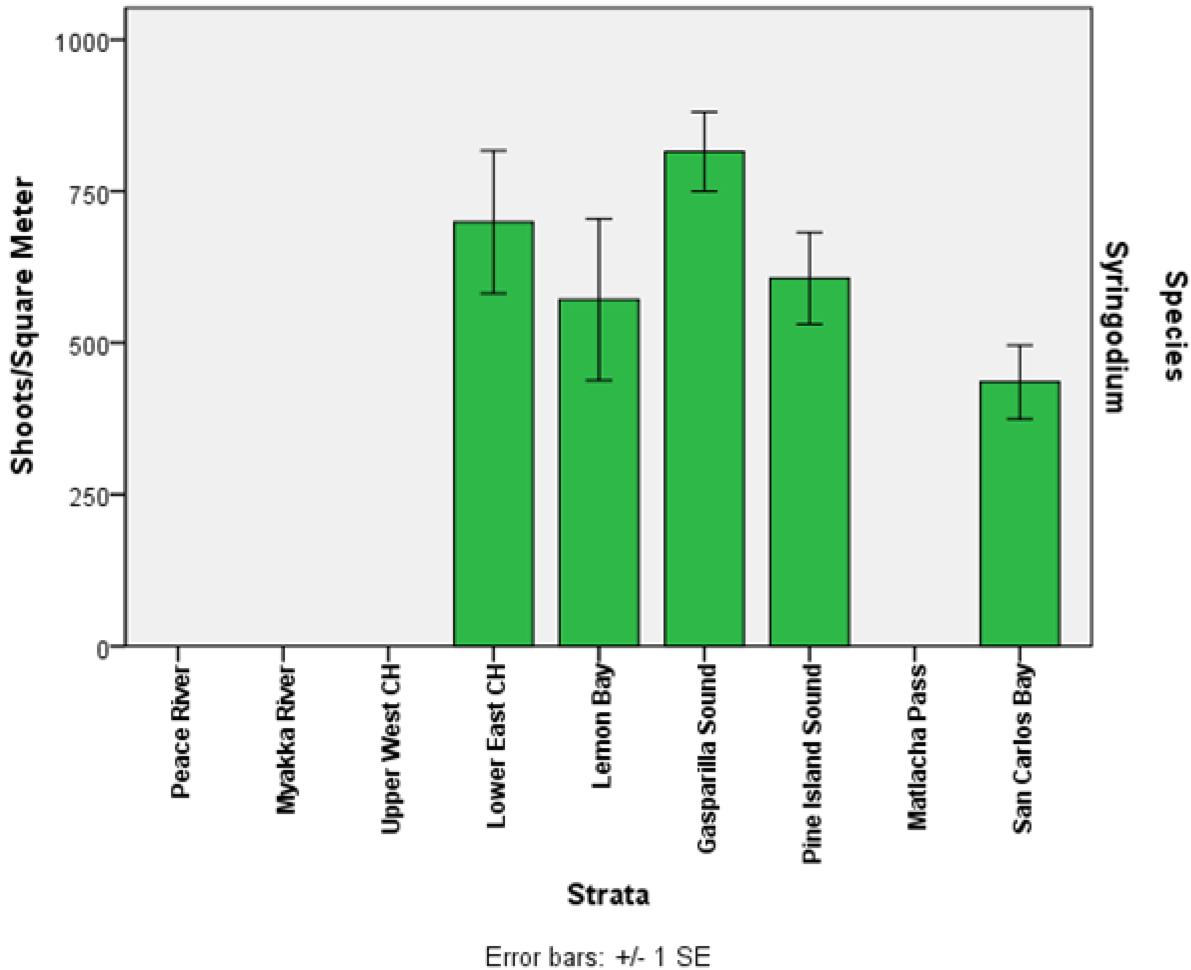

Figure 5.8. Mean shoot density (+/- SE) of *Syringodium filiforme* for each region over the period of record (2005-2016) for the CHAP study area.

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

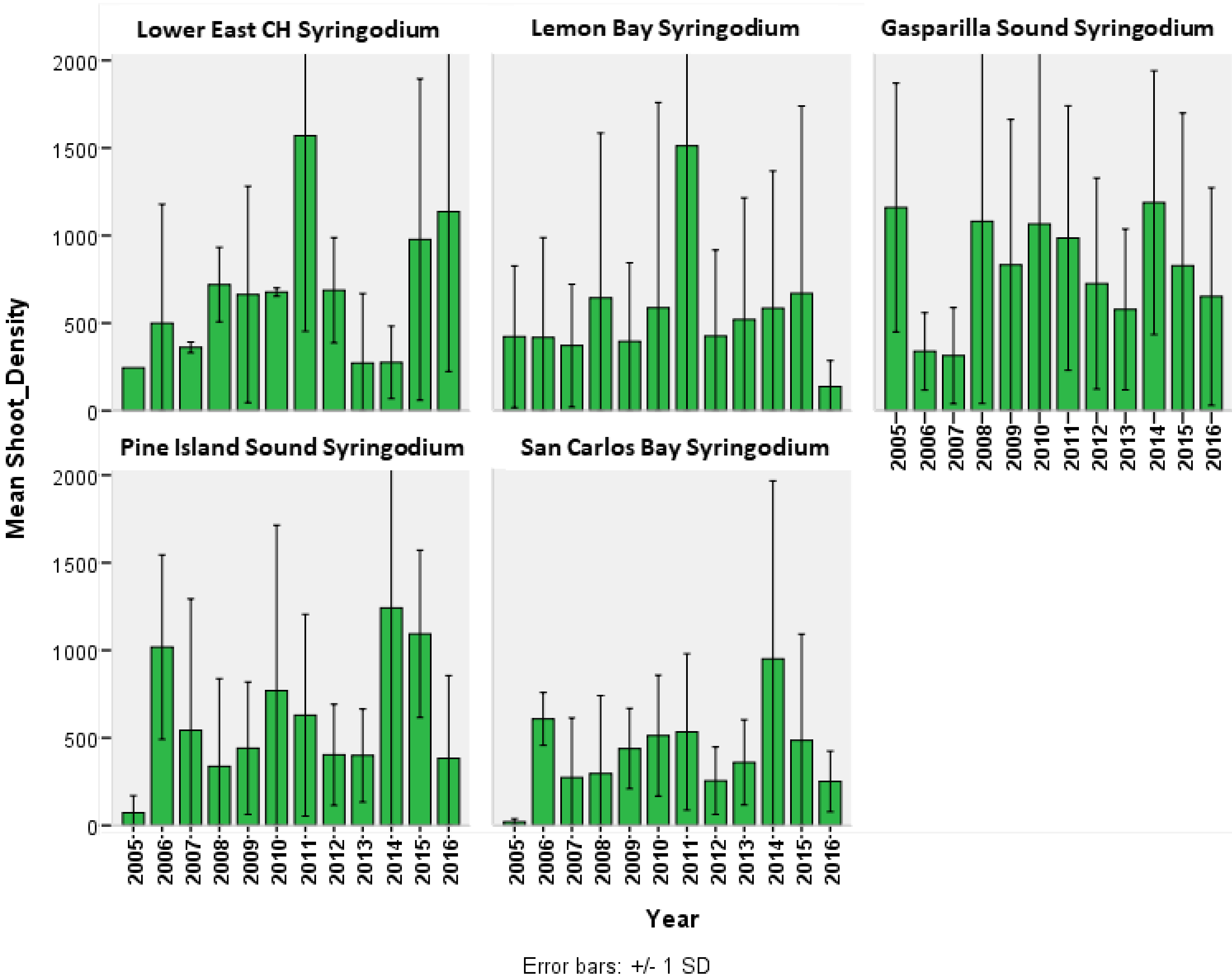

Figure 5.9. Mean shoot density (+/- SD) of *Syringodium filiforme* for each region over the period of record (2005-2016) within the CHAP study area.

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

Analysis A: Comparison of Years

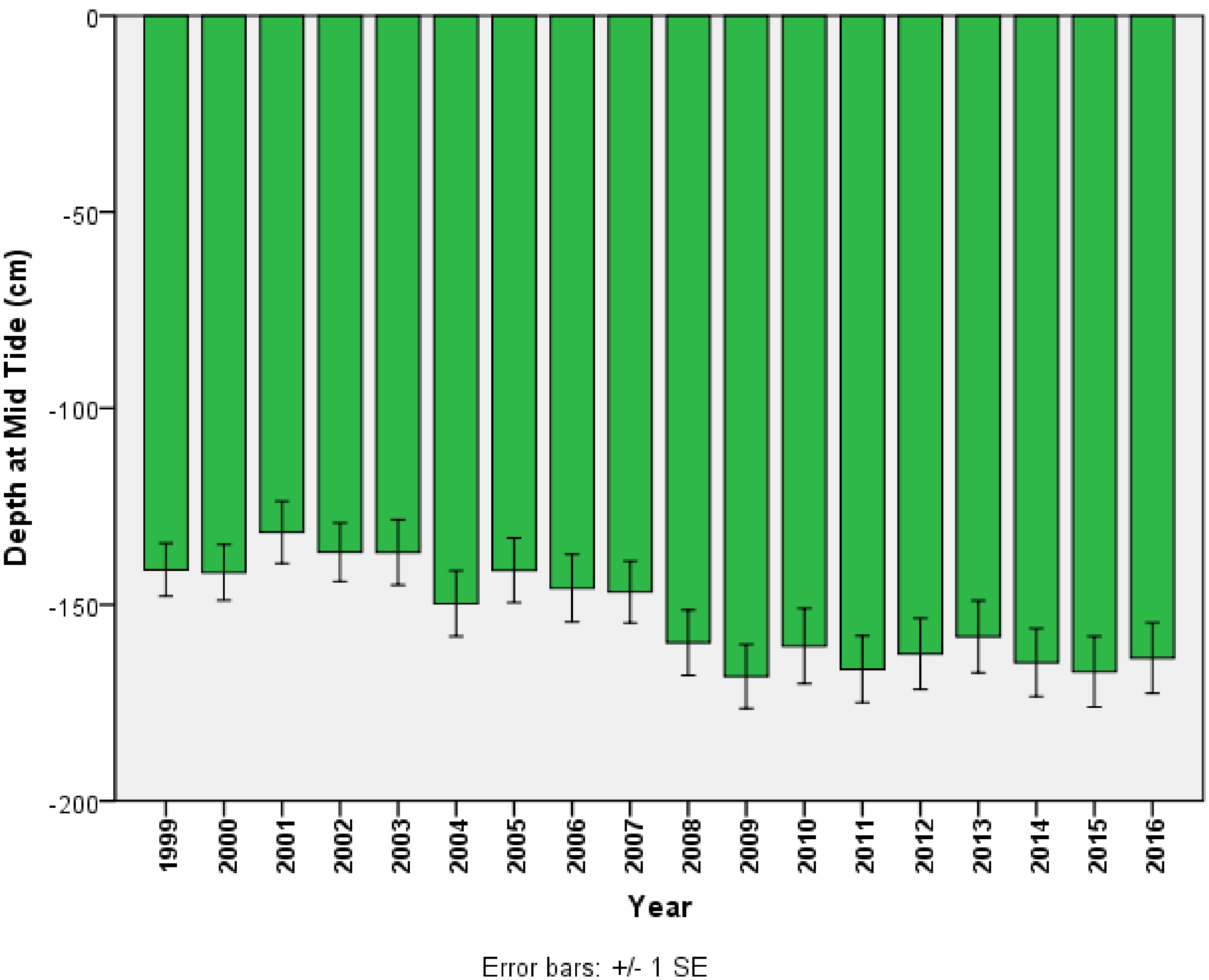

Figure 6.1. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) over the period of record (1999-2016) for the entire CHAP study area.

Analysis B: Comparison of Regions

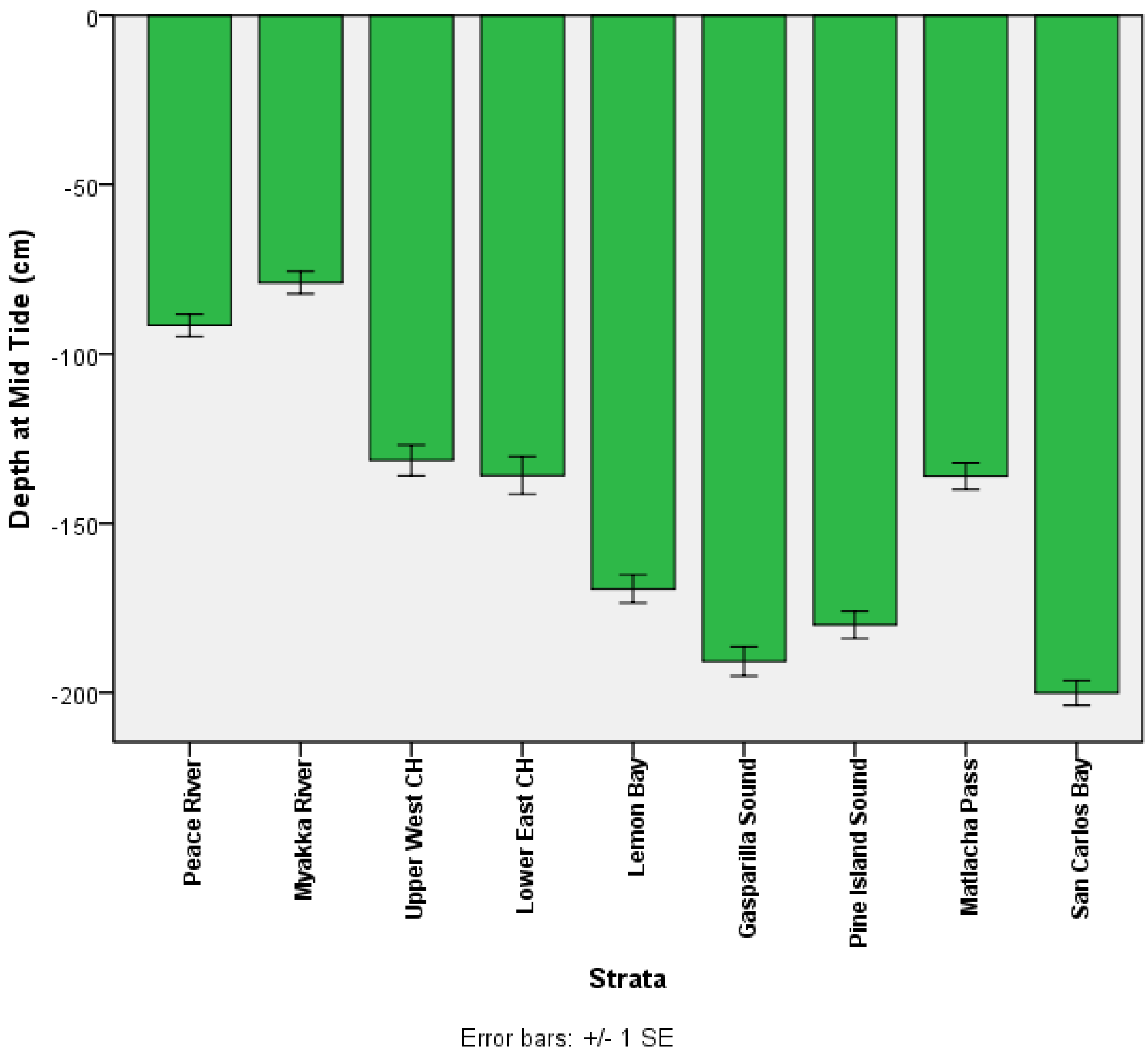

Figure 6.2. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) for each region over the period of record (1999-2016) for the CHAP study area.

Analysis C: Comparison of Years by Region

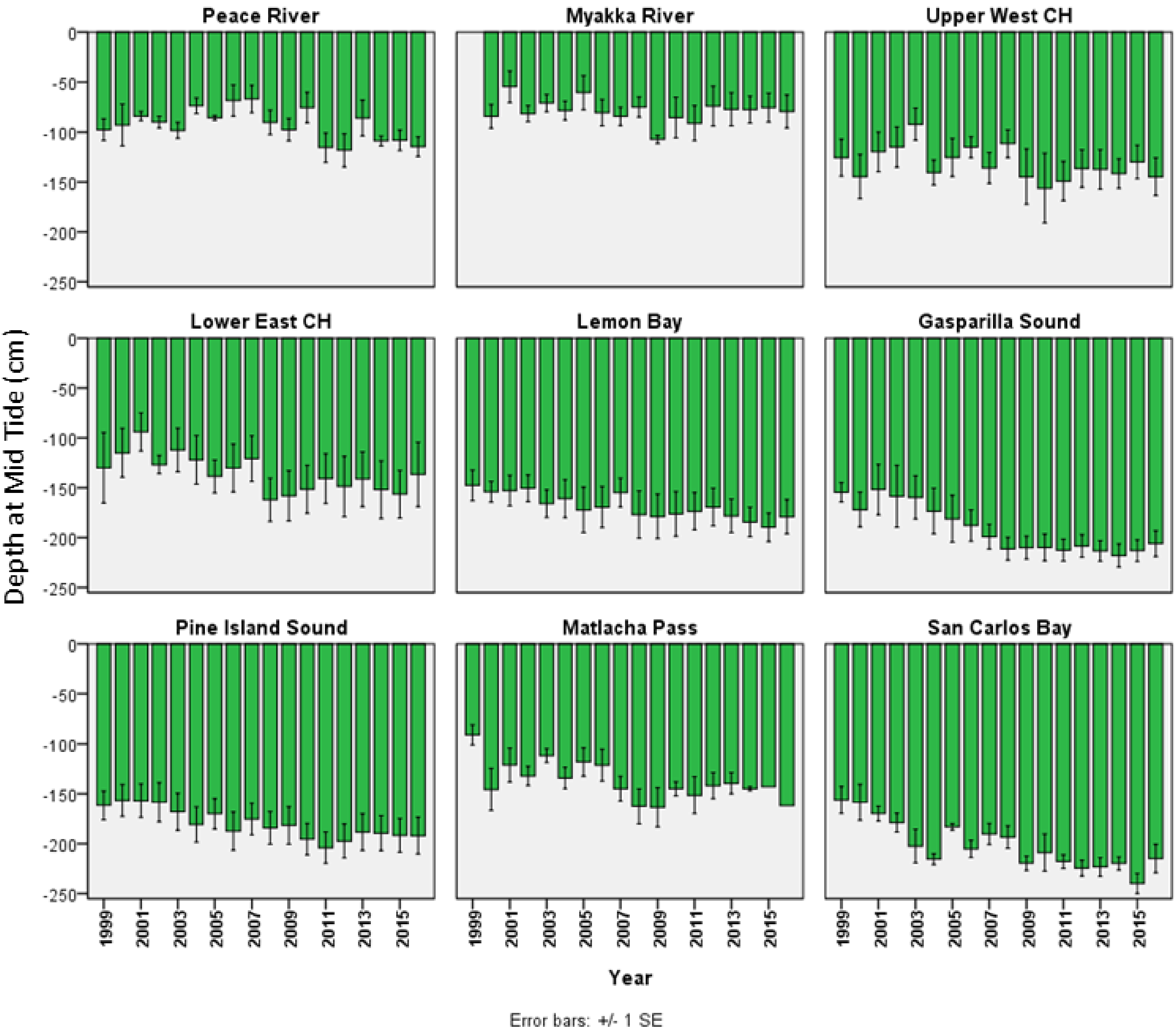

Figure 6.3. Mean depth (+/- SE) of maximum seagrass growth (corrected to mid tide) for each region over the period of record (1999-2016) within the CHAP study area.

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

Analysis A: Comparison of Years

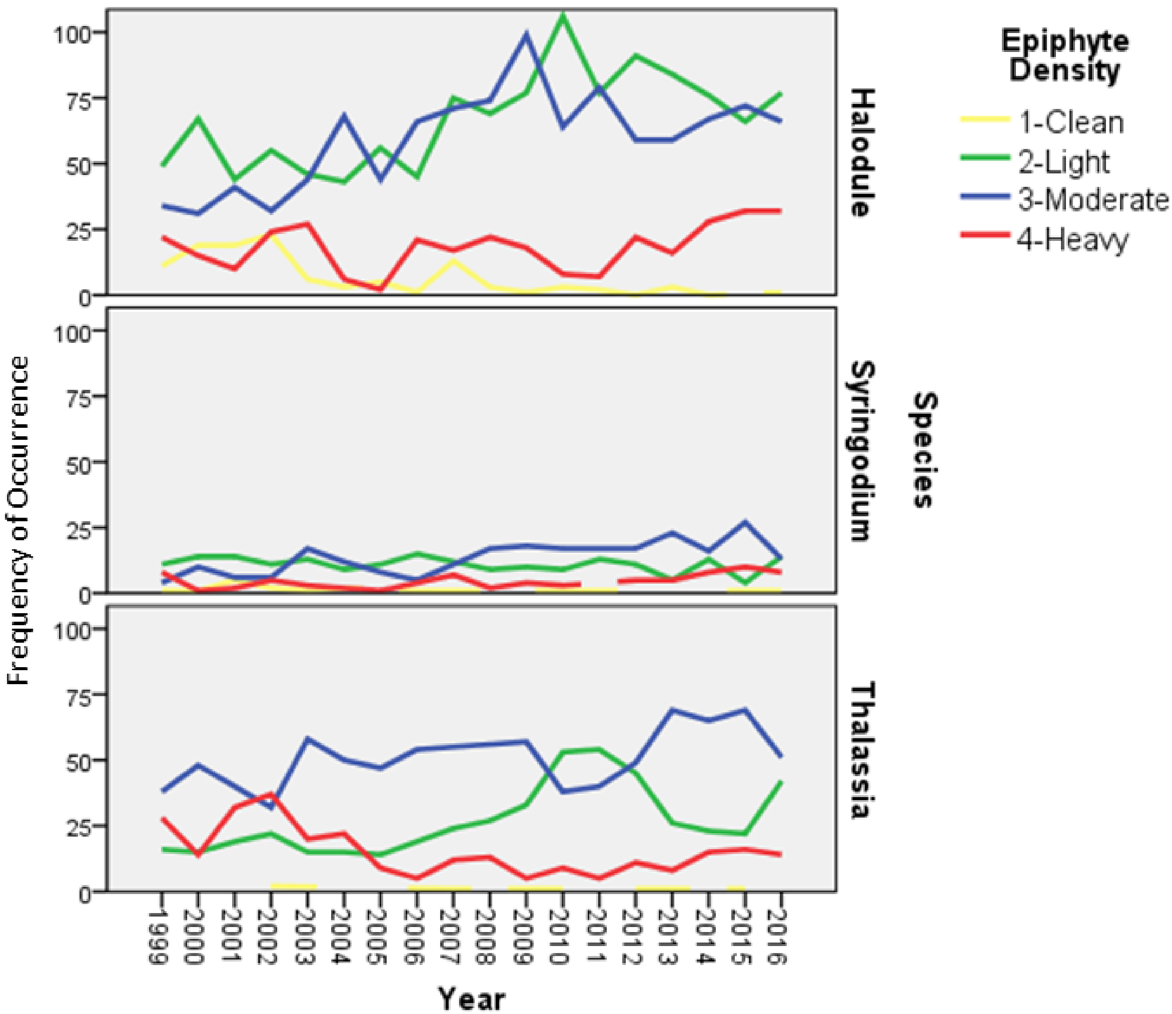

Figure 7.1. Frequency of occurrence of epiphyte density by species over the period of record (1999-2016) for the entire CHAP study area.

Analysis B: Comparison of Regions

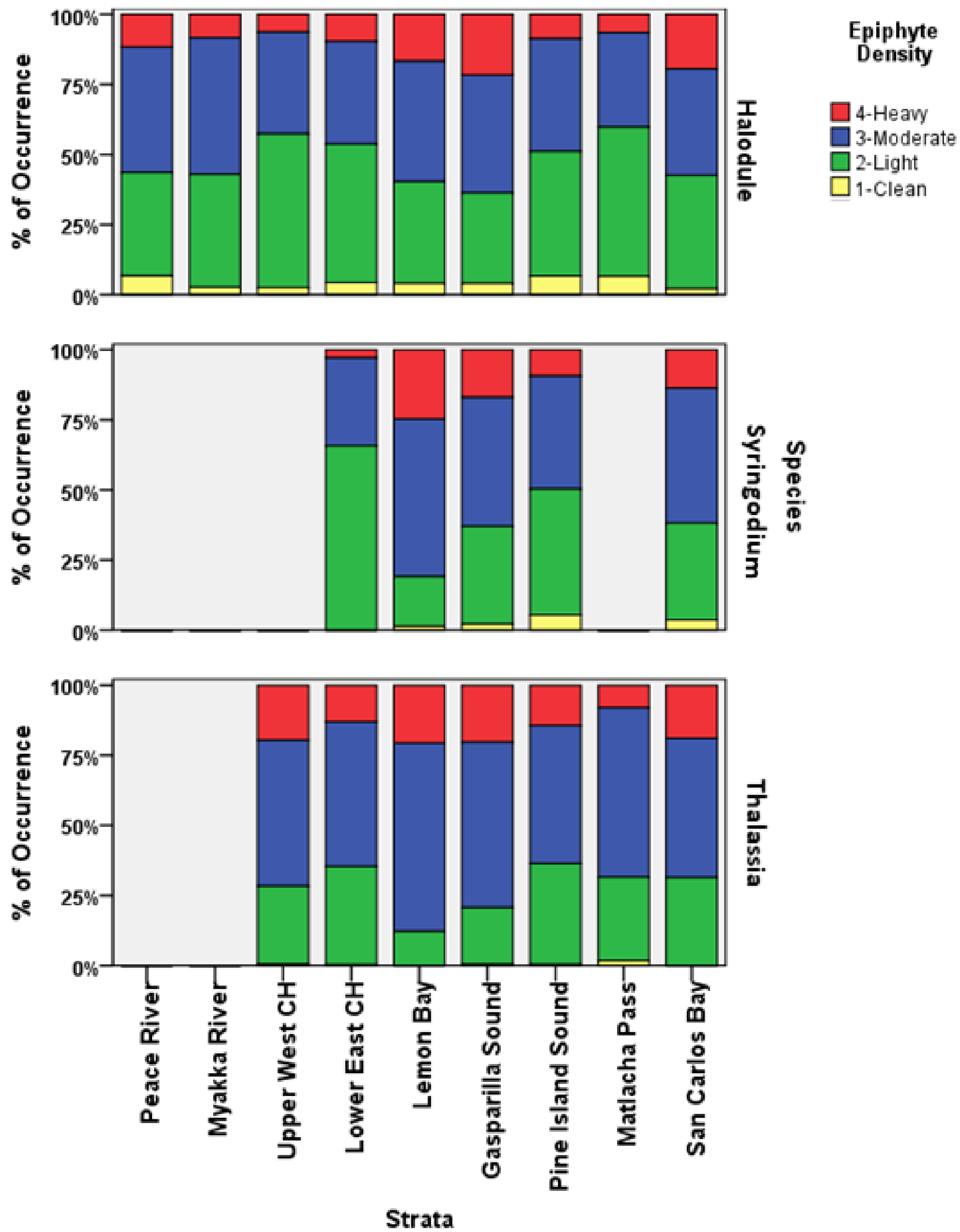

Figure 7.2. Percentage of occurrence of epiphyte density for *Halodule wrightii, Thalassia testudinum, and Syringodium filiforme* for each region over the period of record (1999-2016) within the CHAP study area.

Analysis C: Comparison of Years by Region

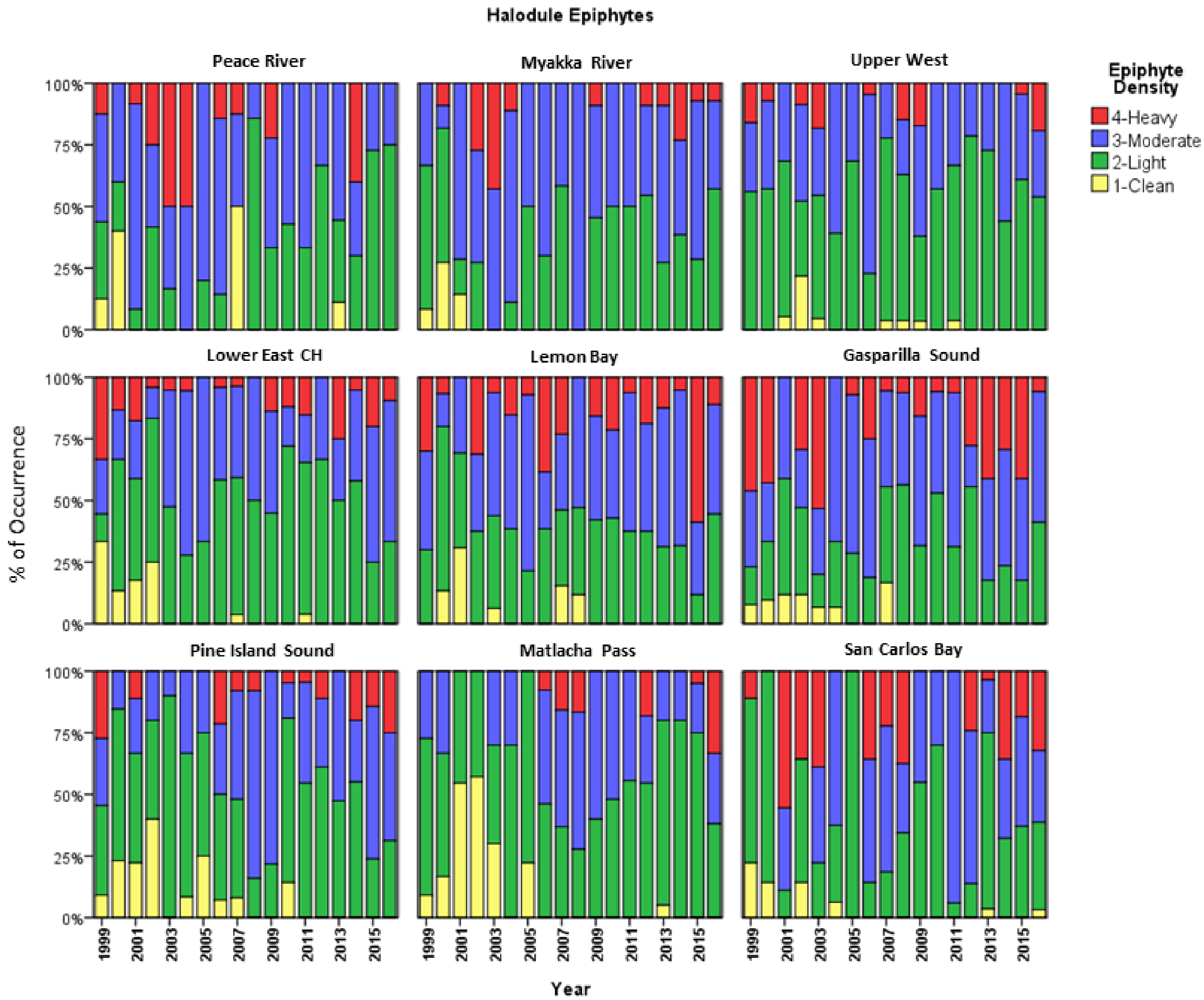

Figure 7.5. Percentage of occurrence of epiphyte density for *Halodule wrightii* for each region over the period of record (1999-2016) within the CHAP study area.

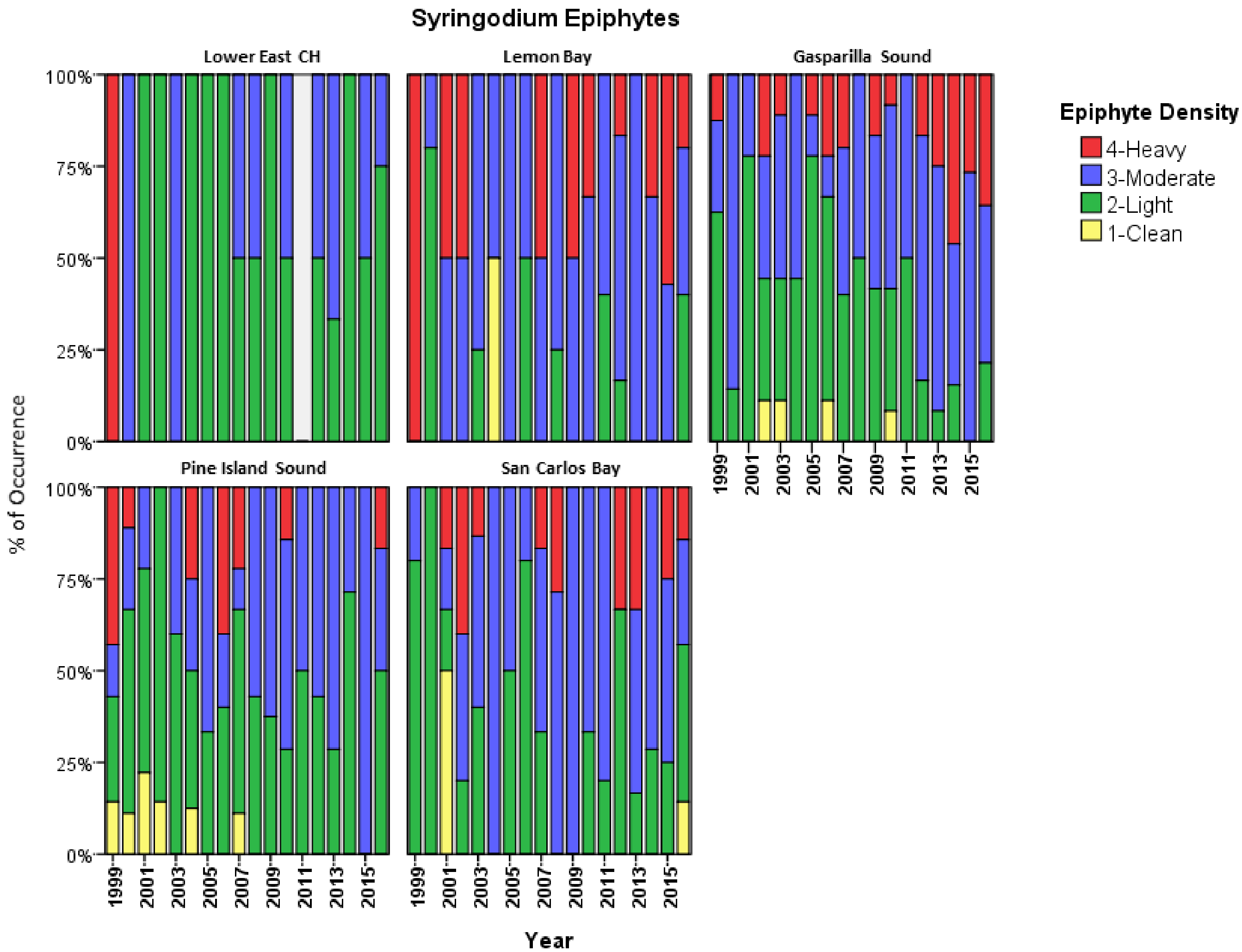

Figure 7.6. Percentage of occurrence of epiphyte density for *Syringodium filiforme* for each region over the period of record (1999-2016) within the CHAP study area.

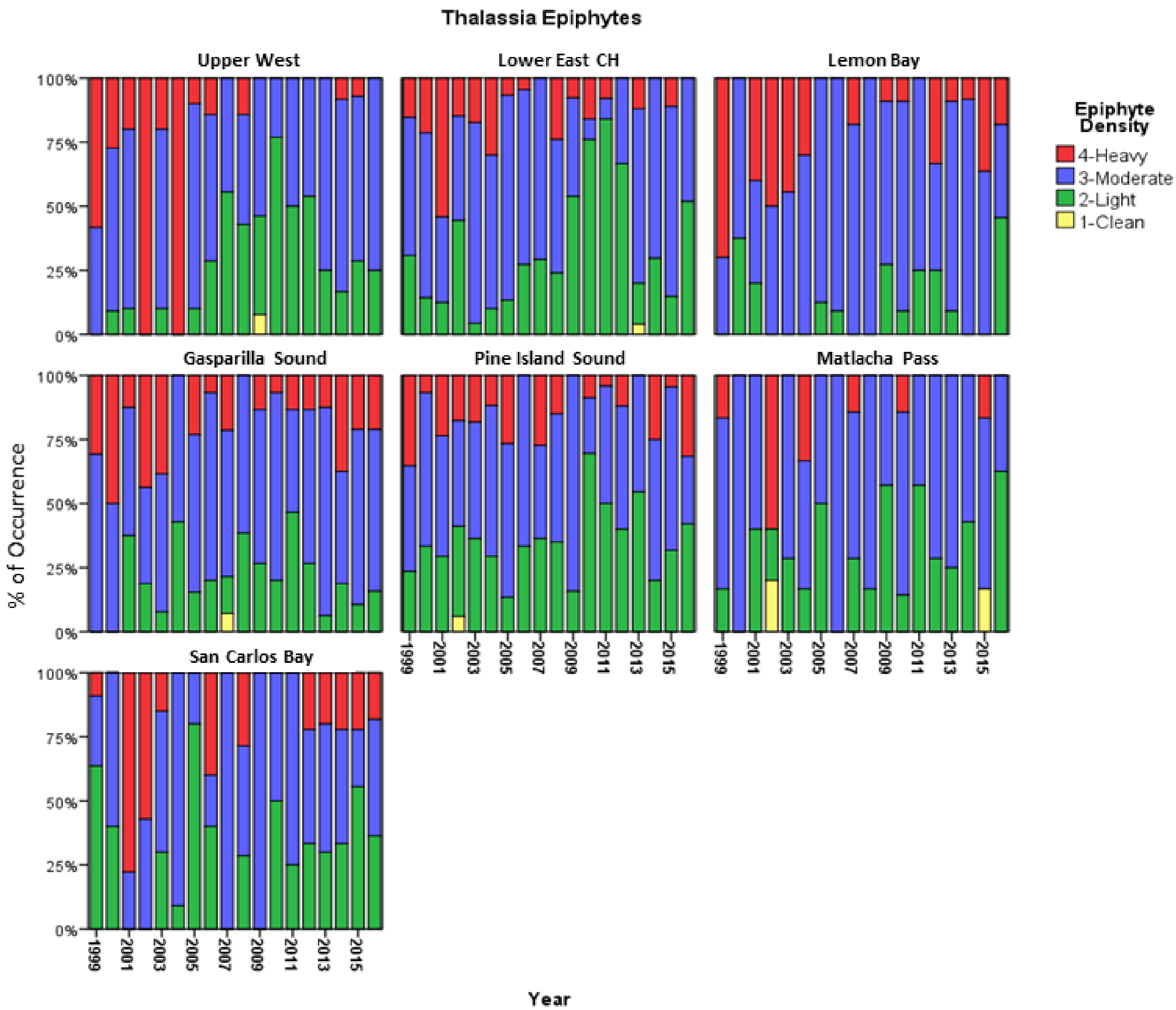

Figure 7.7. Percentage of occurrence of epiphyte density for *Thalassia testudinum* for each region over the period of record (1999-2016) within the CHAP study area.

Additional Analysis: Comparison of Species

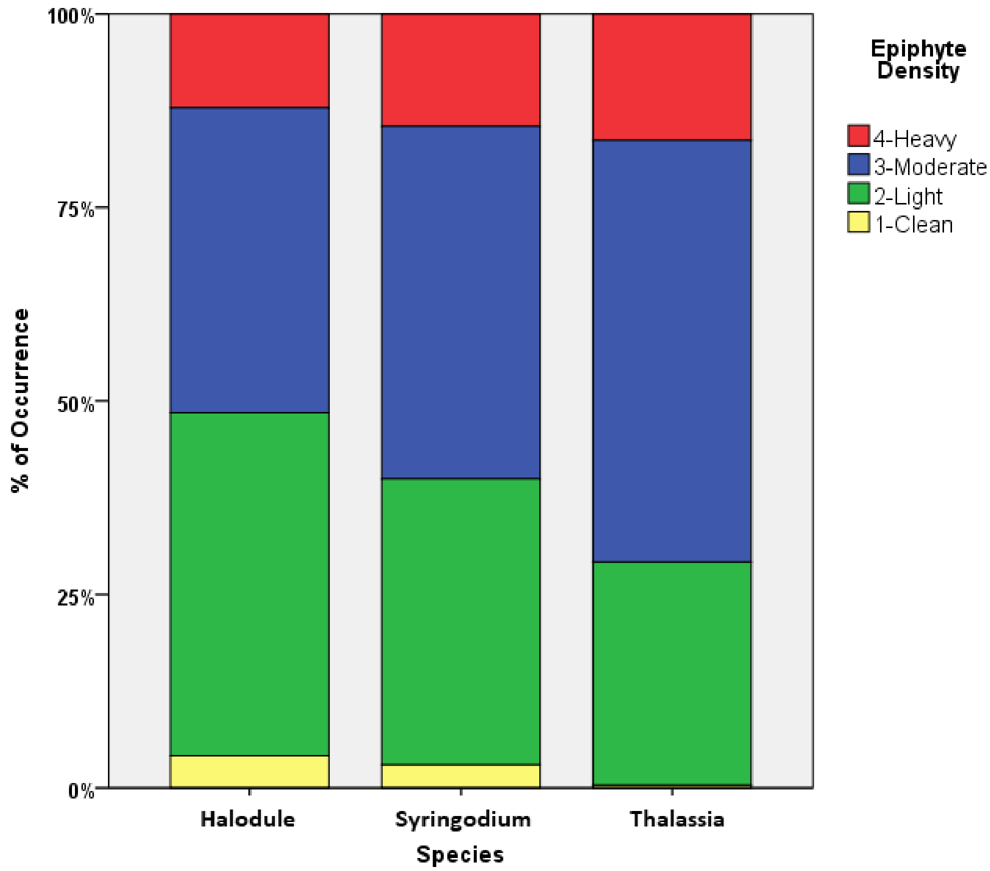

Figure 7.8. Percentage of occurrence of epiphyte density for each species over the period of record (1999-2016) for the entire CHAP study area.