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Tampa Bay Interagency Seagrass Monitoring Program a synopsis of seagrass trends from 1997-2006

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Roger Johansson

Final Draft

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A Synopsis of Seagrass Trends from 1997-2006

Prepared for the Tampa Bay Estuary Program
100 8th Avenue SE
St. Petersburg, FL

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Introduction

In 1996, the Tampa Bay National Estuary Program (now Tampa Bay Estuary Program or TBEP) adopted a resource based management strategy to protect and restore Tampa Bay (Tampa Bay National Estuary Program 1996). Seagrass status and trends were chosen as "biological barometers" to gauge improvements in water quality as point and non-point source nitrogen loading targets were adopted.

Initially, seagrass coverage change was determined through examination of biennial photography of Tampa Bay seagrass meadows. However, it became apparent that further data were needed to detect spatial and temporal changes within specific seagrass zones and species composition over depth gradients. Subsequently, the City of Tampa, Bay Study Group (BSG) initiated a fixed transect seagrass monitoring program in Hillsborough Bay which embraced several levels of monitoring recommended by the TBEP Technical Advisory Committee (Squires et al., 1993). This transect program provided a template for the TBEP to expand transect monitoring into other Tampa Bay subsections in 1998. Currently, 62 transects (Figure 1) are monitored by the Tampa Bay Interagency Seagrass Monitoring Program or TBISP (Avery and Johansson, 2001). Seven local agencies participate in the annual monitoring effort.

In 2006, the Environmental Protection Commission of Hillsborough County drafted a seagrass management plan for Hillsborough County (Environmental Protection Commission of Hillsborough County, 2006). During 2007, the TBEP expanded this concept to include thirty management areas within Tampa Bay (Figure 1). Seagrass transect data are currently collected within twenty-eight of the management areas.

This paper presents trends in percent frequency of occurrence (PFOC) of submerged aquatic vegetation (SAV). PFOC is defined as the number of times a seagrass or attached alga species is found within a specific data set of meter square placements divided by the total number of meter square placements within that data set. The data sets comprised of all meter square placements grouped either by management area (MA), bay subsection, or Tampa Bay as a whole. Ancillary data of SAV species annual PFOC, abundance, short shoot density (SSDm^{-2}), and canopy height (cm) are presented in the appendix.

Transect Monitoring Methods

At most sites, the fixed transects start at the shoreline and traverse the study area on a line most often perpendicular to the shoreline. Most transects end at a water depth greater than the depth needed to attain the seagrass coverage target for the shallow water estuarine shelf (Janicki, 1996) for that particular bay subsection. Transect depth maximums range from approximate depths of -1.0m to -3.5m Local Mean Tide Level (LMTL). Transect lengths range from 40m to 2700m. PVC poles mark the starting point, each 100m mark (where applicable), and the terminus of each transect (Figure 3). Both differentially corrected and uncorrected GPS positions have been used to record the location of the 100m poles.

SAV composition and abundance, if present, were determined within a 1x1m PVC frame placed by a diver on the bottom. In Old Tampa Bay, Hillsborough Bay, and Middle Tampa Bay, information was collected at a minimum of 25m intervals and at a minimum of 50m intervals in Boca Ciega Bay and Lower Tampa Bay (Figure 3). The abundance of each SAV species observed within the frame was estimated using the Braun Blanquet coverage class rating system (Braun Blanquet 1965). In addition, short shoot density and canopy height were determined within subsets (generally $100cm^2$ to $625cm^2$) of selected 1x1m PVC frame placements. These placement sites were selected by TBISP field personnel assigned to the transect using one or more applicable criteria:

1. In meadows less than 100m in width: at a minimum, placements were selected in mid bed and edge bed; the edge bed is defined as the last seagrass short shoot on the transect.
2. In meadows greater than 100m in width: at a minimum, placements were selected at 100m intervals and edge bed; here, the edge bed is defined as the most seaward seagrass short shoot on a transect.
3. Deepest site that a species is found; this may be in addition to 1 and 2.
4. Sites of new species development along a transect; this may be in addition to 1 and 2.

SAV assessments along eleven Hillsborough Bay fixed seagrass transects and two Middle Tampa Bay fixed seagrass transects began in 1997. Forty-eight fixed seagrass transects were initiated in 1998 to provide seagrass information from the remainder of Tampa Bay. However, since 1998, several transects have been added while others were deleted. In addition, issues have arisen to preclude data collection at several sites for one to two years. Avery and Johansson (2003) present a detailed discussion of the transect selection process and related issues.

Sediment elevation contours of several permanent seagrass transects located in Hillsborough Bay, Middle Tampa Bay, and Old Tampa Bay have been determined from near-shore to approximately 2m(LMTL) depth using high resolution kinematic GPS (KGPS). See Johansson 2002 for a detailed description of this technique.

Data Analysis Methods

The purpose of this paper is to describe overall seagrass trends within each of the 28 MAs. Accordingly, in management areas that have more than one transect, the transect information has been grouped into a single data set. This approach may mask specific local trends that could be evident in examination of individual transects. Further, inconsistencies in data collection along some transects due to large fluctuations in 1x1m PVC frame placements on the shallow estuarine shelf may generate misleading trends. This may have happened due to inaccurate methodology assumptions by the assigned TBISP team. Documents presenting transect data from 1997-2005 can be obtained through the TBEP.

Nonlinear regression analysis of trends were performed for PFOC, abundance, short shoot density, and canopy height for each of the 28 MAs using Systat®v.12 and plotted with Systat SigmaPlot® v.10. Data were grouped by:

- Each MA and SAV species averaged for all years
- Each MA and total SAV by year
- Each MA SAV species by year
- Each bay segment and SAV species averaged for all years
- Each bay segment and total SAV by year
- Each bay segment SAV species by year
- Tampa Bay and SAV species averaged for all years
- Tampa Bay and total SAV by year
- Tampa Bay SAV species by year

Results

The PFOC for SAV absence and presence, averaged over the monitoring period, and annual seagrass PFOC are presented for the following groups: 1) by MA for each Tampa Bay subsection, 2) Tampa Bay subsections: Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, Lower Tampa Bay and Boca Ciega Bay, and 3) Tampa Bay. Further, seagrass depth ranges are discussed for Old Tampa Bay, Hillsborough Bay, and Middle Tampa Bay.

Data concerning SAV PFOC by year and SAV abundance, short shoot density, and canopy height for each MA, bay subsection, and Tampa Bay are found in the Appendix.

Seagrass Management Areas: *Trends in Submerged Aquatic Vegetation*

<u>Old Tampa Bay</u>

MA19 SAV has consisted of the seagrass *H. wrightii*, *S. filiforme*, *T. testudinum*, and the alga *Caulerpa prolifera*. *H. wrightii* has been the dominant seagrass in this area, although *S. filiforme* and *T. testudinum* were major constituents (Figure 4). In addition, *C. prolifera* has been a major SAV constituent. Overall, seagrass PFOC increased between 1998 and 2002, but has since leveled (Figure 5).

MA20 SAV has consisted of the seagrass *H. wrightii*, *Ruppia maritima*, *S. filiforme*, *T. testudinum*, and *C. prolifera*. *H. wrightii* has been the dominant seagrass in this area, although *R. maritima, S. filiforme* and *T. testudinum* were major constituents (Figure 4). In addition, *C. prolifera* has been present. Seagrass PFOC increased slightly between 2001 and 2003 but has since leveled (Figure 5).

MA21 SAV has consisted of *H. wrightii*, *R. maritima*, *S. filiforme*, and *C. prolifera*. In this area of sparse seagrass coverage, *H. wrightii* has been the dominant species (Figure 4). *R. maritima* and *S. filiforme* were minor seagrass constituents as was the alga *C.*

prolifera. Seagrass PFOC was fairly stable between 2001-2004 but increased in 2005 (Figure 5).

MA22 SAV has consisted of *H. wrightii*, *R. maritima*, and *S. filiforme*. *H. wrightii* has been the dominant seagrass in this area (Figure 4). In addition, *R. maritima* and *S. filiforme* were minor seagrass constituents. Seagrass PFOC decreased between 2001-2003 but has since increased (Figure 5).

MA23 SAV has consisted of *H. wrightii*, *Halophila engelmanni*, *S. filiforme*, *T. testudinum*, and *C. prolifera*. *H. wrightii* has been the dominant seagrass in this area though *H. engelmanni* and *C. prolifera* have occasionally been major contributors (Figure 4). Seagrass PFOC increased between 1999-2001, however, PFOC decreased in 2002 and has since been stable (Figure 5).

MA24 SAV has consisted of *H. wrightii*, *Halophila engelmanni*, and *T. testudinum*. *H. wrightii* has been the primary seagrass species along this generally barren flat (Figure 6). Although seagrass PFOC indicates an upward trend (Figure 7), coverage has remained sparse.

MA25 SAV has consisted of *C. prolifera*, *R. maritima*, *H. wrightii*, *S. filiforme*, and *T. testudinum*. *H. wrightii* and *T. testudinum* have been the codominant species in this area (Figure 6). Further, *R. maritima* and *S. filiforme* were important constituents. *C. prolifera* was rarely documented. Seagrass PFOC in this area has remained consistently high (Figure 7).

MA26 SAV has consisted of *H. wrightii*, *S. filiforme*, *T. testudinum* and *C. prolifera*. *H. wrightii* has been the dominant species in this area, although *S. filiforme* and *T. testudinum* were major constituents (Figure 6). Seagrass PFOC increased slightly following 2003 (Figure 7).

MA28 SAV has consisted of *H. wrightii*, *S. filiforme*, *T. testudinum* and *C. prolifera*. *S. filiforme* has been the dominant SAV species, though *T. testudinum* and *C. prolifera* were major constituents (Figure 6). Seagrass PFOC decreased following 1999 but then increased from 2003-2006 (Figure 7).

Hillsborough Bay

MA1 SAV has consisted of *R. maritima* (Figure 8). Seagrass PFOC has been very low (Figure 9).

MA2 SAV has consisted of *H. wrightii* (Figure 8). The seagrass PFOC by this species has been stable (Figure 9), however, the majority of the flats have lacked seagrass coverage.

MA3 SAV has consisted of *H. wrightii* and *R. maritima*. *H. wrightii* has been the dominant SAV constituent (Figure 8). Seagrass PFOC has been consistently low (Figure 9) as the majority of the flats have lacked seagrass coverage.

MA4 SAV has consisted of *H. wrightii*, *R. maritima*, and *C. prolifera*. *H. wrightii* has been the dominant SAV constituent (Figure 8). *R. maritima* and *C. prolifera* were noted infrequently. Seagrass PFOC reached a maximum during 1999-2000 and then declined through 2005 (Figure 9).

MA5 SAV has consisted of *H. wrightii* and *R. maritima*. *H. wrightii* has been the dominant SAV constituent (Figure 8). This Hillsborough Bay MA has generally had the highest seagrass PFOC (Figure 9). Further, the recent increase in seagrass FOC can be attributed to increased *H. wrightii* coverage on the transect located near Bullfrog Creek (Avery and Johansson, 2006).

Middle Tampa Bay

MA6 SAV has consisted of *H. wrightii, R. maritima, T. testudinum, and C. prolifera*. *H. wrightii* has been the major SAV constituent (Figure 10). *R. maritima* and *T. testudinum* have been minor constituents. Overall, seagrass coverage trends in this MA have been stable (Figure 11).

MA7 SAV has consisted of *H. wrightii*, *S. filiforme* and *T. testudinum*. *H. wrightii* has been the dominant species, though *S. filiforme* and *T. testudinum* have been major constituents (Figure 10). Seagrass PFOC in this area has been stable (Figure 11).

MA17 SAV has consisted of *H. wrightii, R. maritima*, *S. filiforme*, *T. testudinum*, and *C. prolifera*. *S. filiforme* has been the dominant species, though *C. prolifera*, *H. wrightii*, and *T. testudinum* have been major constituents (Figure 10). *R. maritima* was not frequently present. Seagrass PFOC in this MA has been stable (Figure 11).

MA18 SAV has consisted of *H. wrightii, S. filiforme, T. testudinum*, and *C. prolifera*. *S. filiforme* has been the dominant species, though *H. wrightii*, and *T. testudinum* have been major constituents (Figure 10). *C. prolifera* has been a minor SAV component in this area. Overall, seagrass PFOC in this area has not appreciably changed during the course of the study (Figure 11).

MA27 SAV has consisted of *H. wrightii, R. maritima*, *S. filiforme*, *T. testudinum*, and *C. prolifera*. *H. wrightii* has been the dominant SAV species in this area followed by *C. prolifera* (Figure 10). *S. filiforme* and *T. testudinum* have been minor constituents. Seagrass PFOC has been generally stable in this MA (Figure 11).

Lower Tampa Bay

MA8 SAV has consisted of *H. wrightii*, *S. filiforme, and T. testudinum. T. testudinum* has been the dominant seagrass, though *H. wrightii*, and *S. filiforme* have been major constituents (Figure 12). Seagrass PFOC declined from 1998-2003 and then increased through 2006 (Figure 13).

MA9 SAV has consisted of *H. engelmanni*, *H. wrightii*, *R. maritima*, *S. filiforme*, and *T. testudinum*. *H. wrightii* has been the dominant species, though *T. testudinum* has been a major constituent (Figure 12). This area has had the greatest fluctuation of seagrass PFOC in Lower Tampa Bay (Figure 13).

MA10 SAV has consisted of *H. wrightii*, *S. filiforme, and T. testudinum*. *T. testudinum* has been the dominant species, though *H. wrightii* has also been prevalent (Figure 12). *S. filiforme* was a minor constituent in this MA. Seagrass PFOC in this area has been the least variable of the Lower Tampa Bay MAs (Figure 13).

MA11 SAV has consisted of *H. wrightii*, *S. filiforme*, and *T. testudinum*, and *C. prolifera*. *T. testudinum* has been the dominant species, although *S. filiforme* and *H. wrightii* have been major constituents (Figure 12). *C. prolifera* has been a minor constituent. The seagrass PFOC is not presented due to inconsistent placement of the 1x1 meter PVC frames during several sampling occasions.

Boca Ciega Bay

MA12 SAV has consisted of *H. wrightii*, *S. filiforme*, and *T. testudinum*. *T. testudinum* has been the major SAV constituent (Figure 14). *H. wrightii* has also been commonly present with *S. filiforme* generally a minor component in this area. Seagrass PFOC has been consistent (Figure 15).

MA13 SAV has consisted of *H. wrightii* and *T. testudinum*. *H. wrightii* has been the dominant species (Figure 14). Overall, seagrass PFOC increased though 2005, but decreased in 2006 (Figure 15).

MA14 SAV has consisted of *H. wrightii* and *T. testudinum*. *H. wrightii* has been the dominant species (Figure 14). Seagrass PFOC has increased slightly since 2000 (Figure 15).

MA15 SAV has consisted of *H. wrightii* (Figure 14). The PFOC has increased since 2000 (Figure 15).

MA16 SAV has consisted of *H. wrightii*, *S. filiforme*, *T. testudinum* and *C. prolifera*. *S. filiforme* and *T. testudinum* have codominated this area, although *H. wrightii* has been a major constituent (Figure 14). *C. prolifera* has been seen infrequently. The seagrass PFOC has been stable (Figure 15).

Tampa Bay Subsections: *Trends in Submerged Aquatic Vegetation*

Old Tampa Bay

Five seagrass species, *H. wrightii*, *H. engelmanni*, *R. maritima*, *S. filiforme*, and *T. testudinum*, and the alga, *C. prolifera*, have been documented within Old Tampa Bay (Figure 16). *H. wrightii* has been the most common species, found in over 40 percent of

1x1 meter PVC frame placements (Figure 16). The seagrass PFOC in this bay subsection has increased from near 60 percent in 1998 to ca 75 percent in 2006 (Figure 17).

Hillsborough Bay

Hillsborough Bay SAV has consisted of *H. wrightii*, *R. maritima*, and *C. prolifera*. *H. wrightii* has been the most common species with *R. maritima* and *C. prolifera* seen intermittently (Figure 16). However, only 10 to 20 percent of the 1x1 meter PVC frame placements contained any seagrass coverage (Figure 17).

Middle Tampa Bay

Middle Tampa Bay SAV has consisted of *H. wrightii*, *R. maritima*, *S. filiforme*, *T. testudinum*, and *C. prolifera*. *H. wrightii* has been the dominant seagrass in Middle Tampa Bay, found at nearly twice the frequency of *S. filiforme* and *T. testudinum* (Figure 16). Seagrass PFOC has increased slightly since 1998 (Figure 17).

Lower Tampa Bay

Lower Tampa Bay SAV has consisted of *H. engelmanni*, *H. wrightii*, *R. maritima*, *S. filiforme*, *T. testudinum*, and *C. prolifera*. *T. testudinum* has been the most common species in this subsection's seagrass meadows (Figure 16). *H. wrightii* was also frequently seen. Seagrass PFOC in this Tampa Bay subsection was reduced by ca 20 percent between 1998 and 2000 (Figure 17), but has since remained somewhat stable.

Boca Ciega Bay

Boca Ciega Bay SAV has consisted of *H. wrightii*, *S. filiforme*, *T. testudinum*, and *C. prolifera*. *H. wrightii* and *T. testudinum* codominate the seagrass coverage in this bay subsection (Figure 16). Seagrass PFOC has increased slightly since 1998 (Figure 17).

Tampa Bay: *Trends in Submerged Aquatic Vegetation*

Tampa Bay SAV has consisted of the seagrasses *H. engelmanni*, *H. wrightii*, *R. maritima*, *S. filiforme*, *T. testudinum*, and the attached alga, *C. prolifera*. *H. wrightii* has been the dominant SAV component in Tampa Bay (Figure 18), found at nearly twice the frequency of *T. testudinum*. Overall, seagrass PFOC changed little from 1998-2006, hovering near 50 percent (Figure 19).

Seagrass Depth Ranges

Old Tampa Bay

Depth contours have been developed in MA20, MA21, MA25, MA26, and MA27. Within this data set, *H. wrightii* and *S. filiforme* had a similar depth range of 0m to -1.9mLMTL and -0.1m to -1.9mLMTL, respectively (Figure 20). *R. maritima* was restricted to a shallower depth range of -0.1m to -0.8mLMTL. *T. testudinum* was found between -0.4m to -1.6mLMTL.

Hillsborough Bay

Depth contours have been developed for all Hillsborough seagrass transects. *H. wrightii* occurred at a depth range of 0m to -1.4mLMTL (Figure 21). *R. maritima* occupied a narrower depth range of 0m to -0.5mLMTL.

Middle Tampa Bay

Depth contours have been developed for one transect in MA6 and all transects in MA18 and MA27. Within this data set, *H. wrightii* occurred at -0.1m to -2.0mLMTL (Figure 22) which is similar to that found in Old Tampa Bay. *R. maritima* was found at a shallower depth range of 0.2m to -0.5mLMTL. *S. filiforme* was found at -0.2m to -1.9mLMTL, while *T. testudinum* had a slightly narrower range of -0.3m to -1.8mLMTL.

Discussion

SAV trends within each Tampa Bay subsection and Tampa Bay as a whole are examined below. Further, ancillary data which drive major changes within MA seagrass are presented. Also, the depth limits for seagrass species are compared within the upper Tampa Bay subsections. Finally, longshore sandbar features found in Old Tampa Bay and Middle Tampa are discussed.

Seagrass Trends in Tampa Bay Subsections

Old Tampa Bay

Seagrass PFOC in Old Tampa Bay has shown the greatest increase of any Tampa Bay subsection (Figure 17), primarily due to increased *H. wrightii* and *S. filiforme* coverage (Appendix OTB1). In 2006, the seagrass PFOC was near 75 percent which was the highest of any Tampa Bay subsection. However, a large shallow subtidal flat in MA21 has been largely barren of SAV. *H. wrightii* has been the most common species in this area though coverage has been erratic (Appendix OTB1). A suite of intensive studies conducted during 2003-2006 found that the combined water quality constituents of chlorophyll-*a*, color, and turbidity may reach levels to preclude sustained seagrass recolonization in this area (Greening 2004; Cross 2007).

C. prolifera has been a common SAV component in MA19 and MA28 (Appendix OTB1). However, this alga was absent within these two areas in 2006. Conversely, dense *C. prolifera* coverage developed during 2006 in western MA23.

Hillsborough Bay

H. wrightii has dominated the seagrass PFOC in Hillsborough Bay (Appendix HB1). *R. maritima* has been common in MA1 and MA3. In spite of the varying *H. wrightii* coverage noted between 1997 and 2006, seagrass PFOC has remained between 10-20 percent (Figure 17). Over 80 percent of the shallow subtidal flats were barren of seagrass coverage through 2006.

During the 1980s and 1990s, there were several episodes of *C. prolifera* rapidly vegetating several large areas followed by loss of coverage (City of Tampa 2003). A similar "boom and bust" episode occurred in MA4 and eastern MA27 (Figure 1) along southeastern Interbay Peninsula (Figure 2) during 2002-2006.

Middle Tampa Bay

Middle Tampa Bay seagrass PFOC has remained near 40 percent over the period of study (Figure 17). However, a degree of variability was seen among *H. wrightii* and *S. filiforme*. For example, in the western section of Middle Tampa Bay, increased *S. filiforme* PFOC in MA18 offset decreases in *H. wrightii* PFOC (Appendix MTB1). Similarly, increased *H. wrightii* coverage in the northern area of MA6 offset the loss of most *H. wrightii* at the mouth of the Little Manatee River (Avery and Johansson, 2006). *T. testudinum* PFOC was relatively stable for all the MAs.

C. prolifera has been a variable SAV component in Middle Tampa Bay. Prior to the October 2006 SAV assessment period, *C. prolifera* was a prominent feature along southeastern Interbay Peninsula (MA27). However, between June and August 2006, the coverage of this alga was greatly reduced. During the same time period, *C. prolifera* disappeared in MA17 (Dr. Susan Bell, personal communication). It is interesting to note that during the period of *C. prolifera* loss in MA27, a large number of a green sacoglossans (nudibranch) tentatively identified as *Elysia sp.* were noted in the SAV of this area. Although it has been postulated that *Elysia sp.* may act as a biological control of *Caulerpa sp*. (Thibaut et al. 2001), the cause for this coverage loss is not clear.

Lower Tampa Bay

The reduction of Lower Tampa Bay seagrass PFOC from ca 90 percent in 1998 to ca 50 percent during 2002 (Figure 17) was primarily due to offshore *T. testudinum* loss in MA8, MA9, and MA11 (Appendix LTB1). *S. filiforme* has been seen in ca 15 percent of 1x1 meter PVC frame placements and was predominately found in Terra Ceia Bay with intermittent coverage located near the mouth of the Manatee River. Seagrass coverage upstream in the Manatee River has been variable, consisting of mixed *H. engelmanni*, *H. wrightii*, and *R. maritima* coverage.

Boca Ciega Bay

Seagrass composition transitions from a *H. wrightii* dominated community at the north end of Boca Ciega Bay to a *T. testudinum* dominated community at the south end (Avery and Johansson, 2006*)*. Boca Ciega Bay seagrass PFOC has remained consistent during the study period (Figure 17). *H. wrightii* has been most stable in MA12 (Appendix BCB1). *T. testudinum* PFOC has been stable in each MA where present except MA16. Within this MA, a large reduction in *T. testudinum* occurred between 1998 and 2001 as species composition transitioned to a *S. filiforme* dominated meadow.

Tampa Bay Seagrass Trends

Tampa Bay seagrass PFOC has remained stable during the study period (Figure 22). *T. testudinum* PFOC declined slightly between 1998 and 2002, but since, has changed little (Appendix TB1). The *S. filiforme* PFOC has been consistent at nearly twenty percent. Also, *C. prolifera* has been a major SAV constituent and has been predominately found in upper Tampa Bay. No SAV was seen in nearly half of the meter square placements during 1998-2006 (Figure 22) indicating that a large portion of Tampa Bay's shallow shelf is available for seagrass recolonization. Much of this available area is located in Hillsborough Bay and in several areas of Middle Tampa Bay and Old Tampa Bay. Seagrass recolonization in these areas would substantially increase the total Tampa Bay seagrass coverage.

Seagrass Depth Ranges

Middle Tampa Bay *H. wrightii* had the greatest depth range (0m to -2.0mLMTL, Figure 20) within the MAs assessed for bathymetry. A similar, but slightly narrower range was found in Old Tampa Bay for this species (Figure 18) with yet a more limited range found in Hillsborough Bay (Figure 19). Although there were interannual differences, *S. filiforme* in Old Tampa Bay (Figure 18) and Middle Tampa Bay (Figure 20) were found at similar depths (0m to -1.9mLMTL and -0.1m to -1.9mLMTL, respectively). *T. testudinum* was found at a wider depth range in Middle Tampa Bay (-0.4m to -1.8mLMTL, Figure 20) than in Old Tampa Bay (-0.4m to -1.6mLMTL, Figure 18). *R. maritima* was found at a much narrower depth range in all three of the upper Tampa Bay subsections (Figures 18, 19, and 20) rarely exceeding -0.5mLMTL.

Seagrass Species Zonation and Longshore Bars

Several MAs in Old Tampa Bay and Middle Tampa Bay have longshore sandbars features described by Lewis et. al. (1985). It is hypothesized that these features protect existing seagrass from wave or current energy (Lewis 2002).

Stable seagrass meadows consisting of *H. wrightii*, *S. filiforme* and *T. testudinum* have persisted in Old Tampa Bay MA19, MA20, MA25, and MA26. These meadows follow the seagrass zonation described by Lewis et. al. (1985) with inshore *H. wrightii* coverage predominating and then transitioning to *T. testudinum*/*S. filiforme* coverage seaward. Longshore sandbars were present near the seaward edge of seagrass coverage in MA19, MA20, MA25, and MA27.

Longshore sandbars, similar to those seen in Old Tampa Bay, have been present in western Middle Tampa Bay (MA17 and MA18). Examinations of the TBISP transect data show that *S. filiforme* has been a common SAV component along the seaward face of these features (Avery and Johansson 2006). However the zonation of seagrass species has not consistently followed the *H. wrightii*/*T. testudinum*/*S. filiforme* spatial pattern commonly seen in Old Tampa Bay. For example, along the southern transect in MA18, seagrass composition inshore of the longshore bar has been predominately *S. filiforme*. In contrast, inshore seagrass composition along the northern transect within this MA has consisted of a mix of patchy *H. wrightii*, *S. filiforme*, and *T. testudinum*.

Longshore sandbar features, as those described above, were apparently present historically in eastern Middle Tampa Bay (Lewis 2002). Further, historical photographs suggest that similar structures may have been present south of Interbay Peninsula. Lewis (2002) hypothesized that these features were degraded following losses of the seaward seagrass coverage due to increased eutrophication during the 1950s and 1960s. In 2006, *S. filiforme* was planted south of the Interbay Peninsula along a depth gradient from -0.6m to -0.9mLMTL to investigate the ability of the planted seagrass to stabilize and/or accrete sediments to promote the potential development of a longshore bar feature. This project is ongoing through July 2008.

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Finally, the help of Kerry Hennenfent and John Pacowta with project management, data collection and compilation, and manuscript review is greatly appreciated.

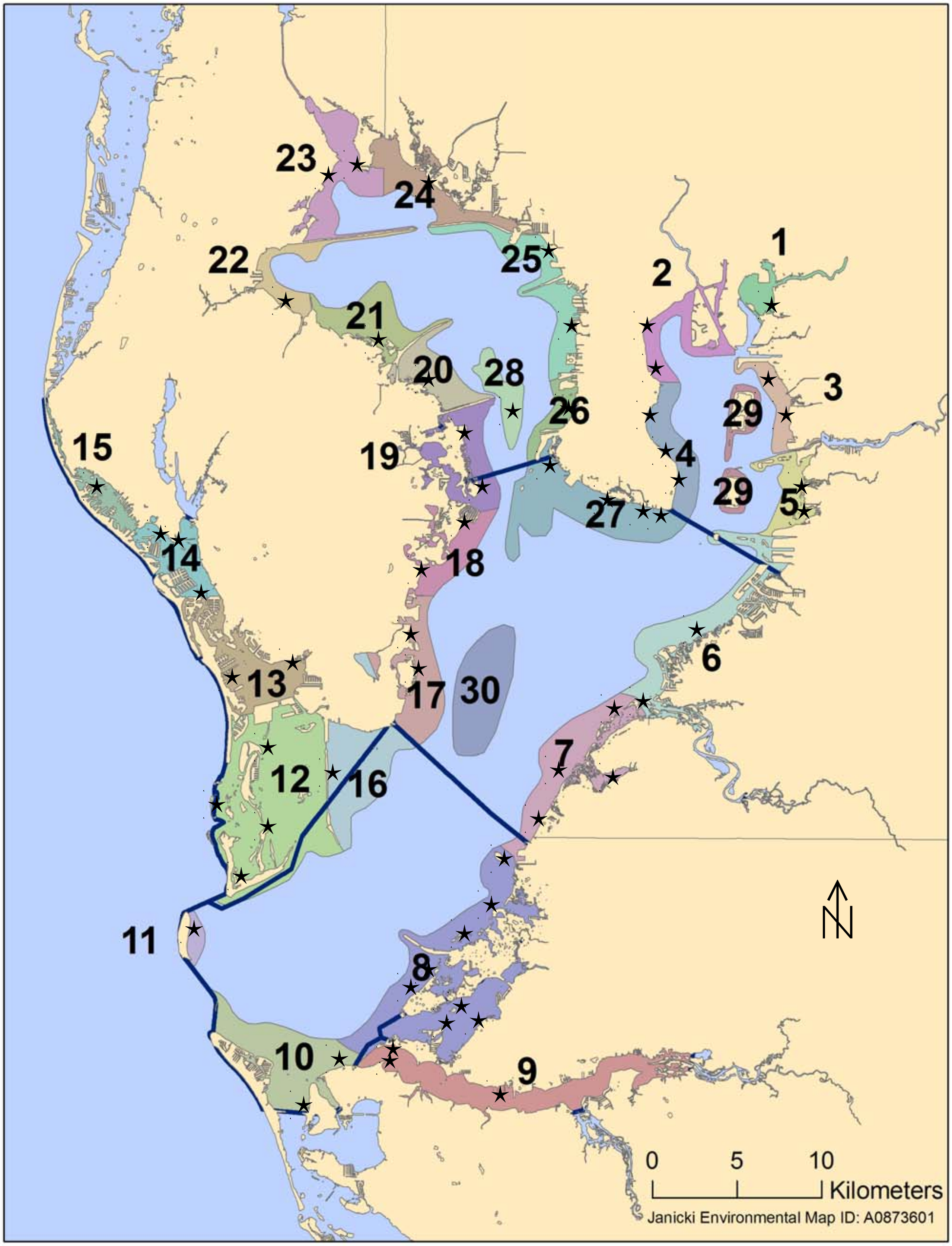


Figure 1. Location of the 30 Management Areas and 62 fixed seagrass transects (★) in Tampa Bay. Map courtesy of Janicki Environmental, Inc.

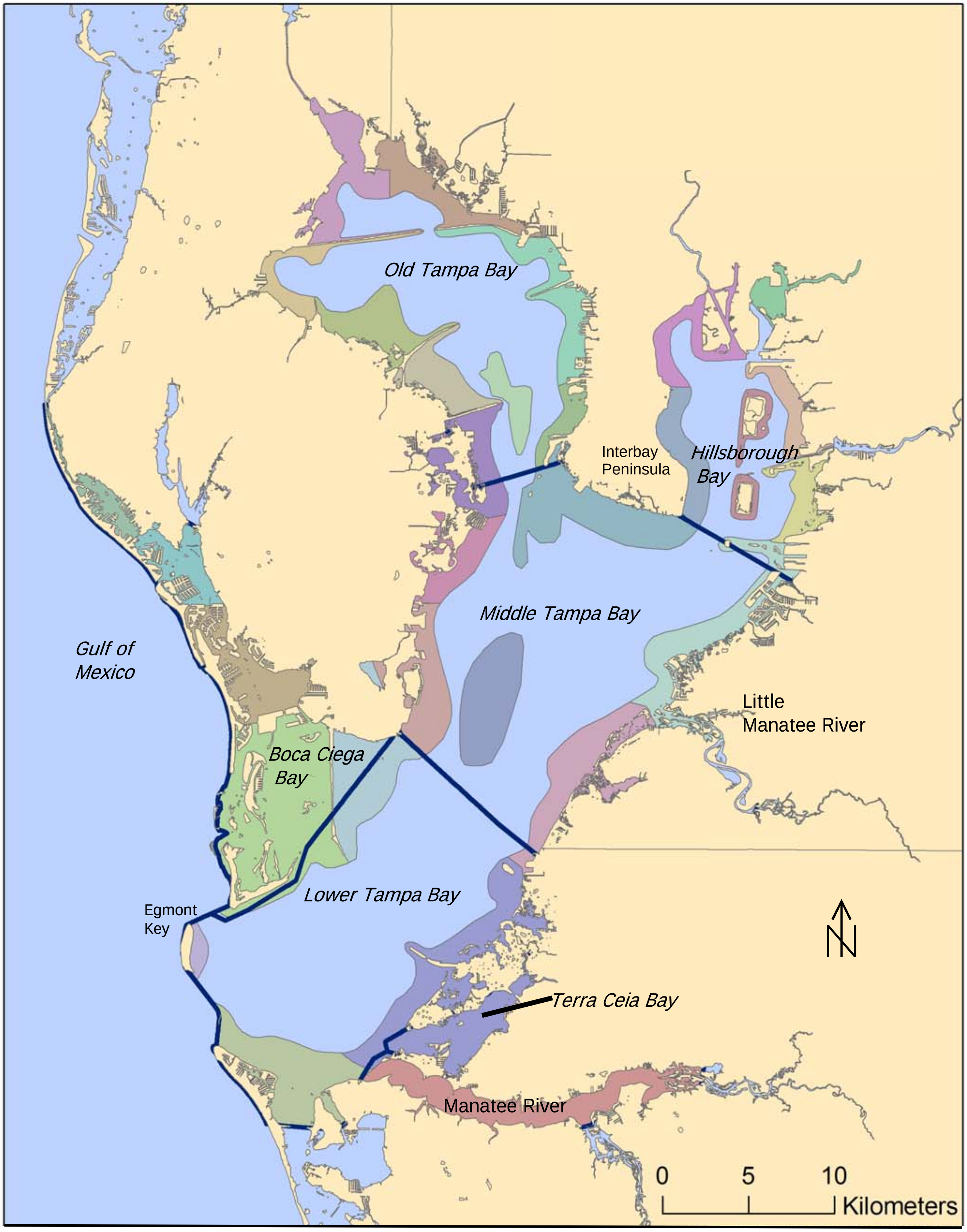
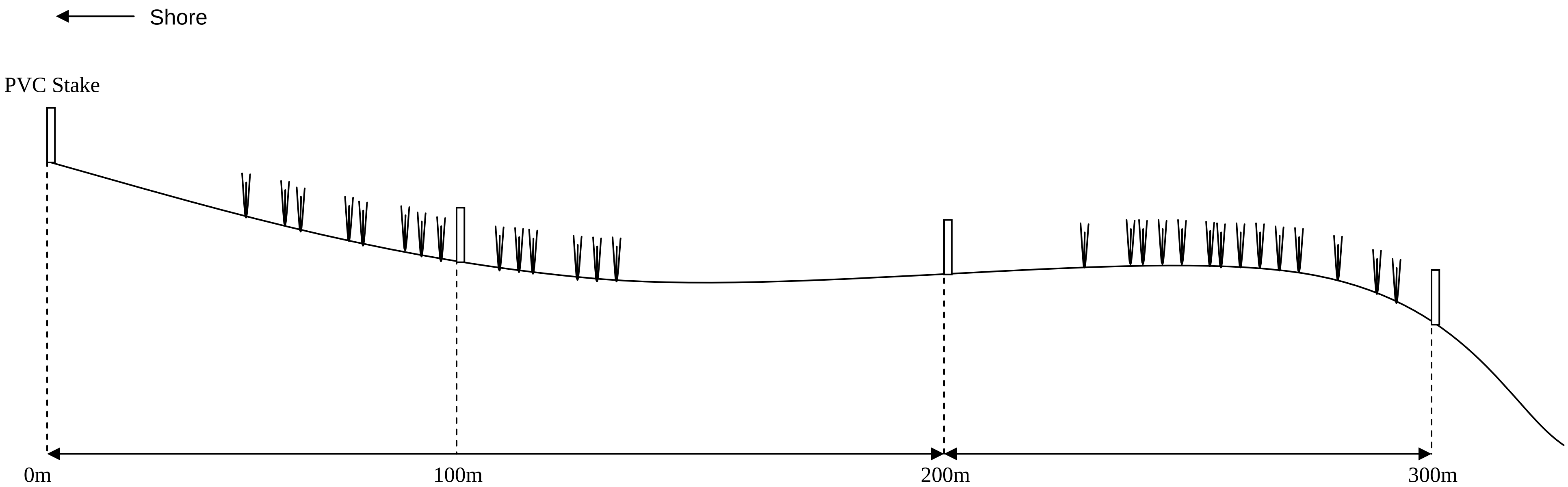


Figure 2. Tampa Bay. Map courtesy of Janicki Environmental, Inc.



For SAV assessments, a 1x1m PVC frame is placed at 25m intervals in Old Tampa Bay, Hillsborough Bay, and Middle Tampa Bay. Placements increase to 50m intervals in Lower Tampa Bay and Boca Ciega Bay. A PVC stake marks each 100m interval.

1x1m PVC frame placements increase to 10m intervals over the seaward 100m quadrant containing seagrass (all Tampa Bay subsections).

Figure 3. Schematic indicating minimum placement intervals of a 1x1m PVC frame for the Tampa Bay Interagency Seagrass Monitoring Program's SAV assessment along a typical fixed transect.

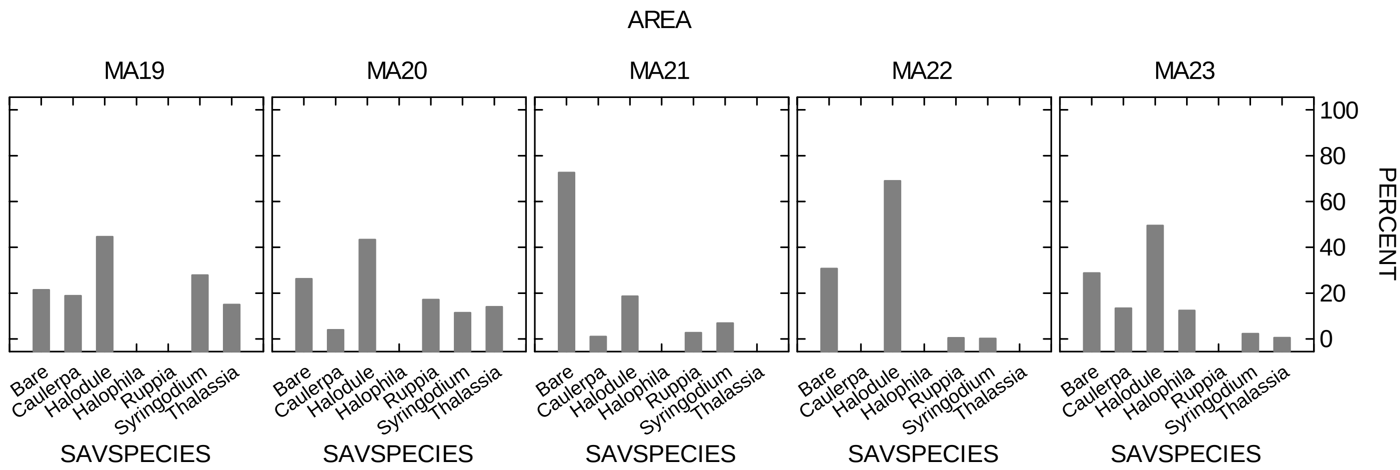


Figure 4. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within western Old Tampa Bay management areas.

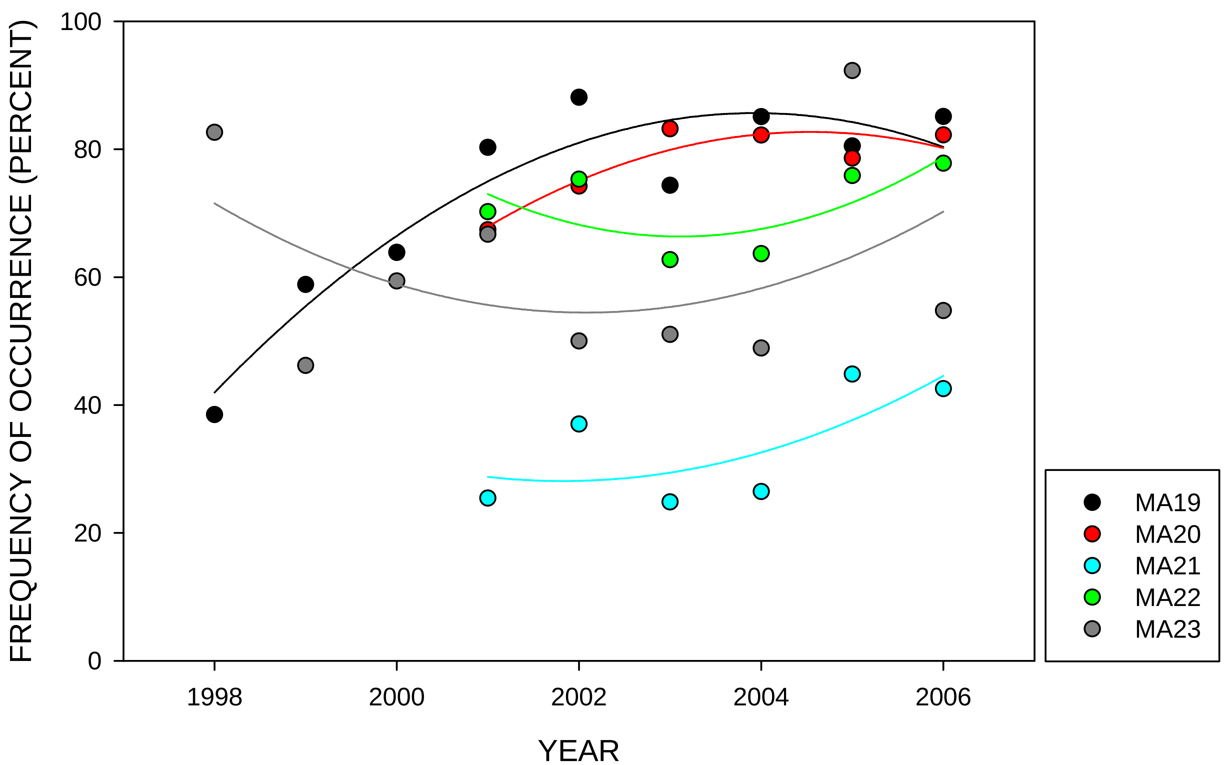


Figure 5. Percent frequency of occurrence of seagrass coverage within western Old Tampa Bay management areas from 1998-2006.

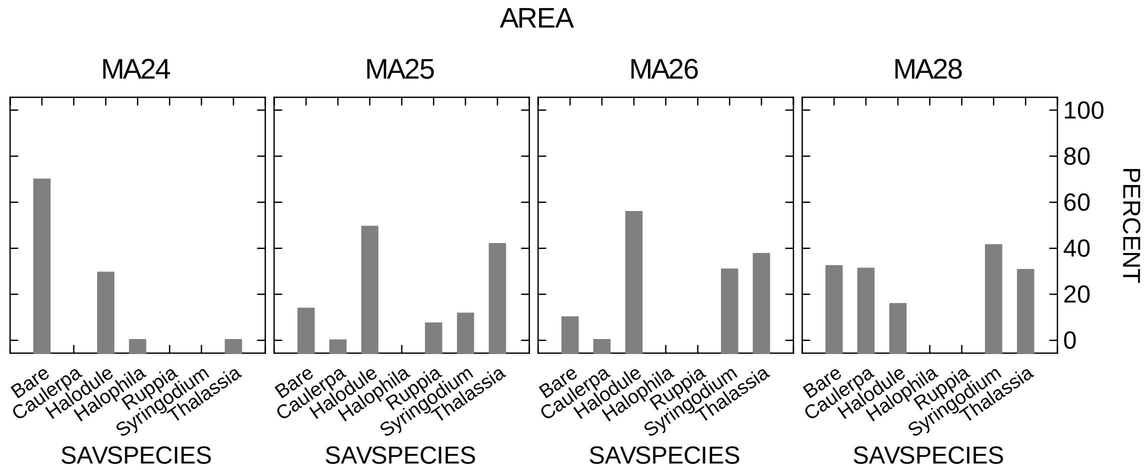


Figure 6. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas, within eastern Old Tampa Bay management areas.

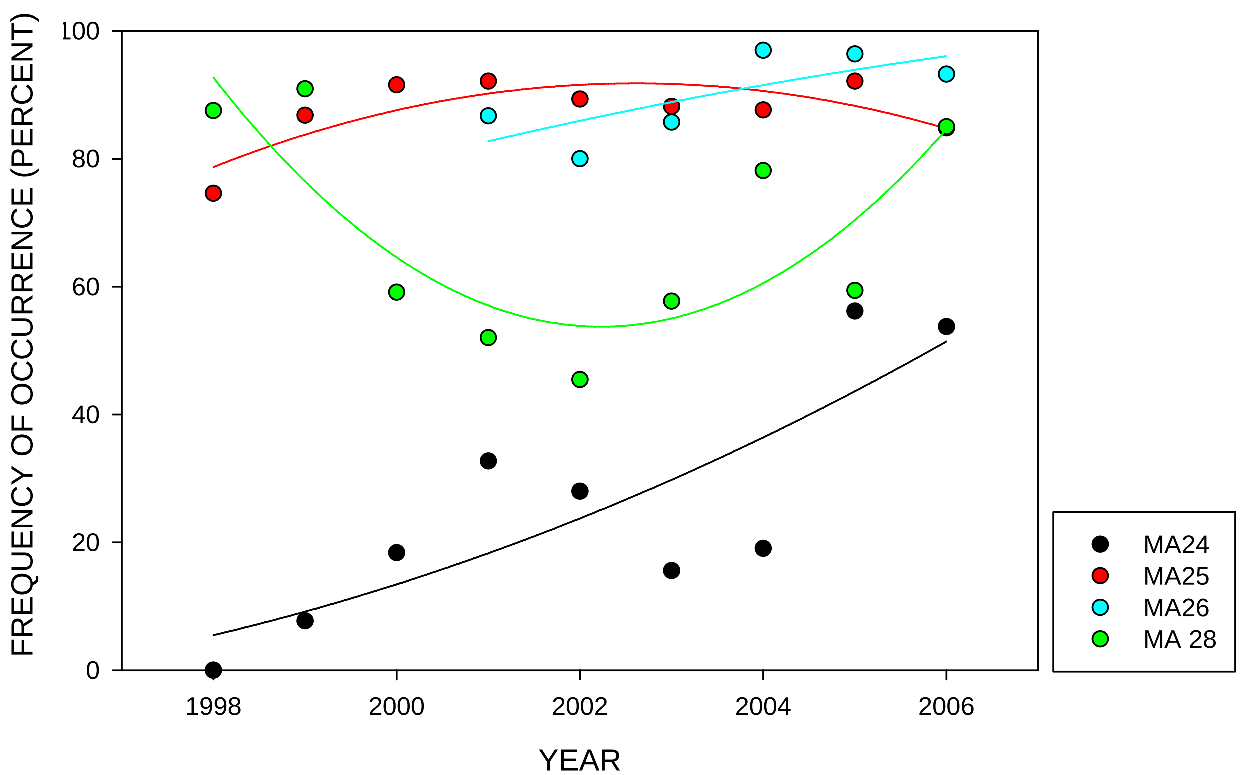


Figure 7. Percent frequency of occurrence of seagrass coverage within eastern Old Tampa Bay management areas from 1998-2006.

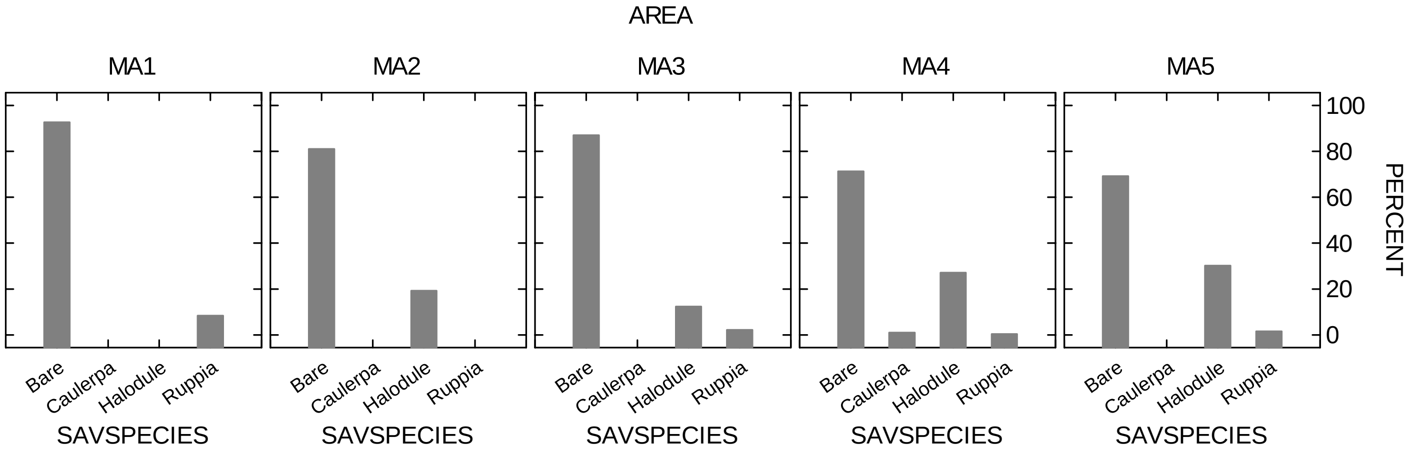


Figure 8. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Hillsborough Bay.

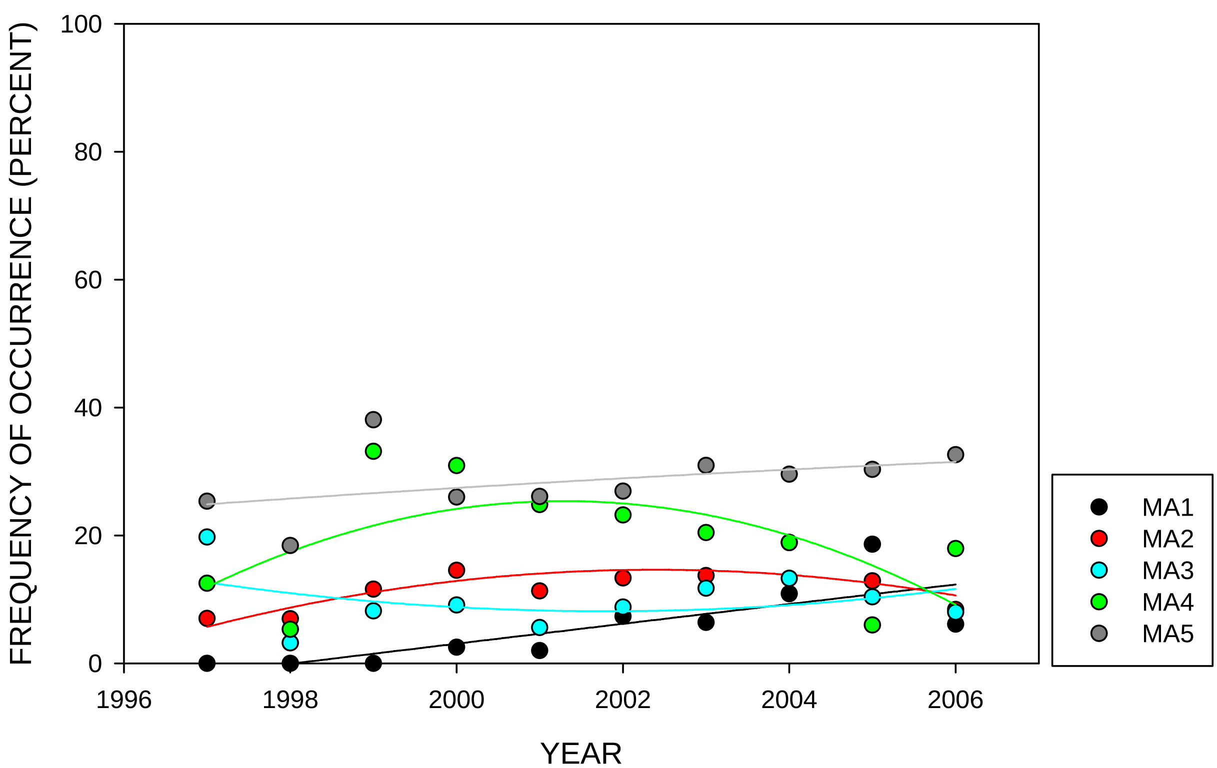


Figure 9. Percent frequency of occurrence of seagrass coverage within Hillsborough Bay management areas from 1997-2006.

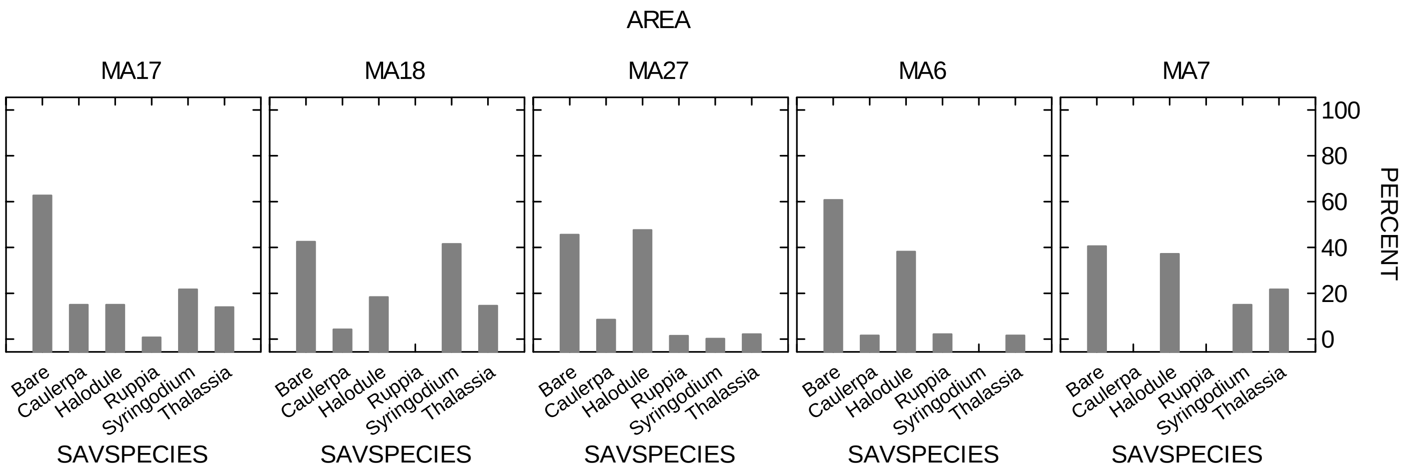


Figure 10. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Middle Tampa Bay.

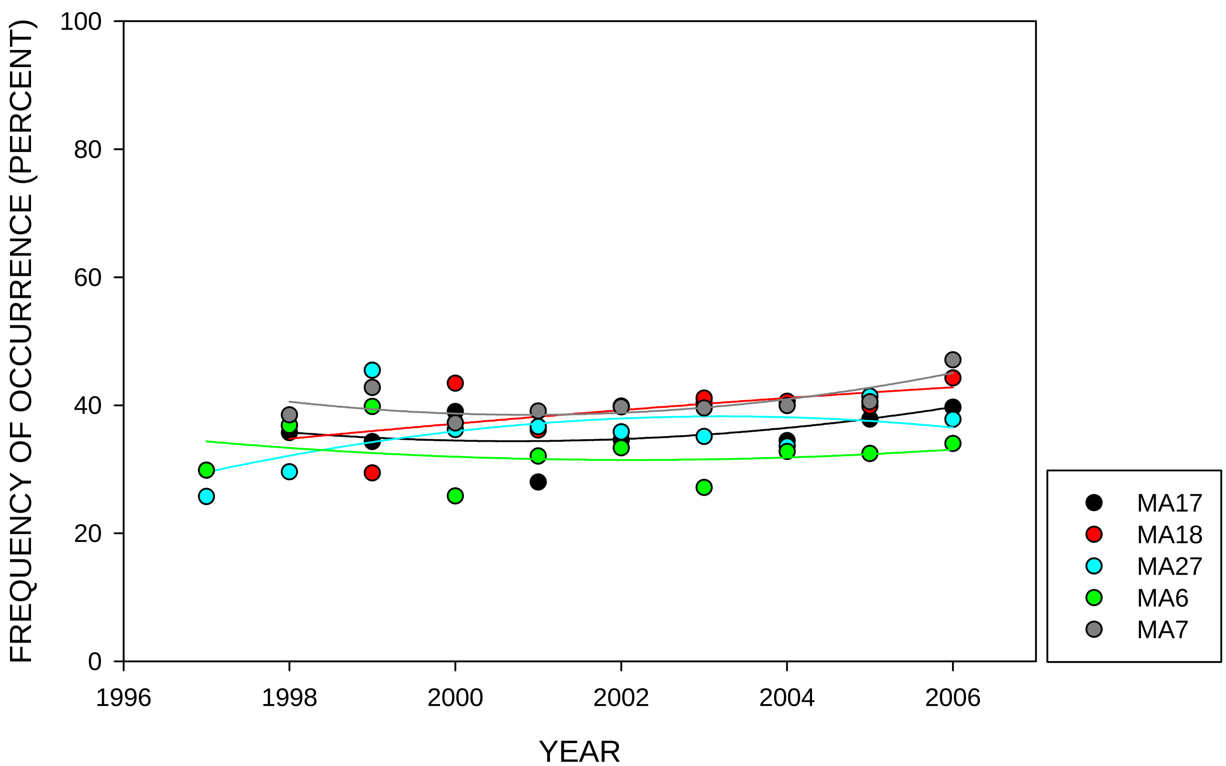


Figure 11. Percent frequency of occurrence of seagrass coverage within Middle Tampa Bay management areas from 1997-2006.

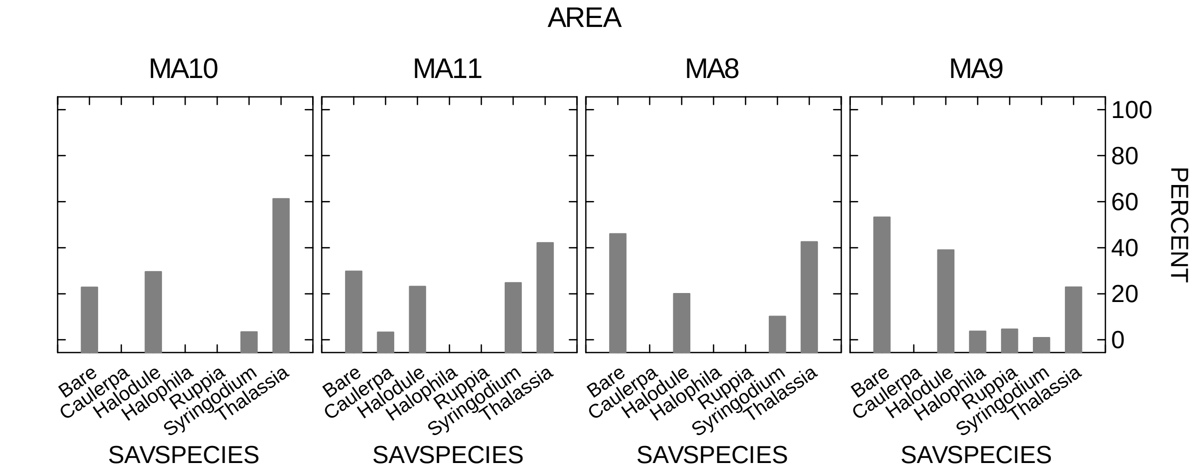


Figure 12. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Lower Tampa Bay.

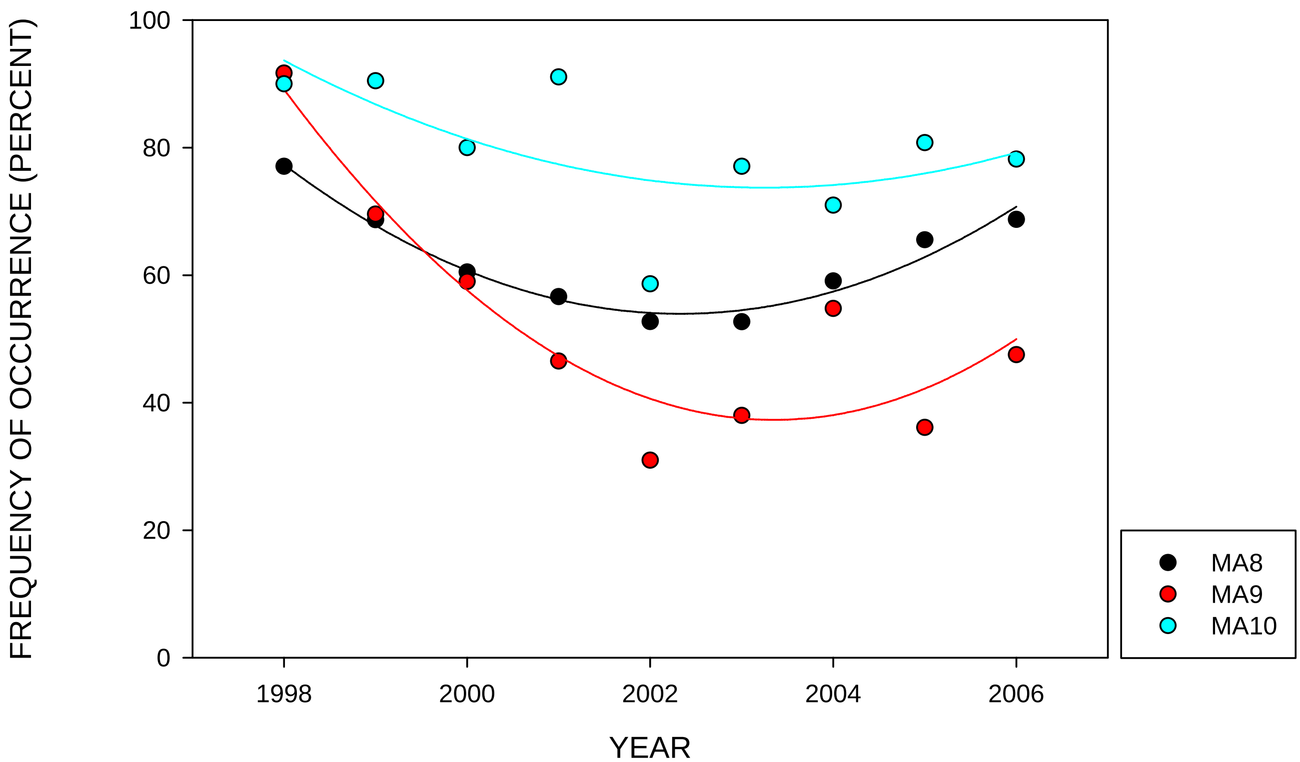


Figure 13. Percent frequency of occurrence of seagrass coverage within Lower Tampa Bay management areas from 1998-2006.

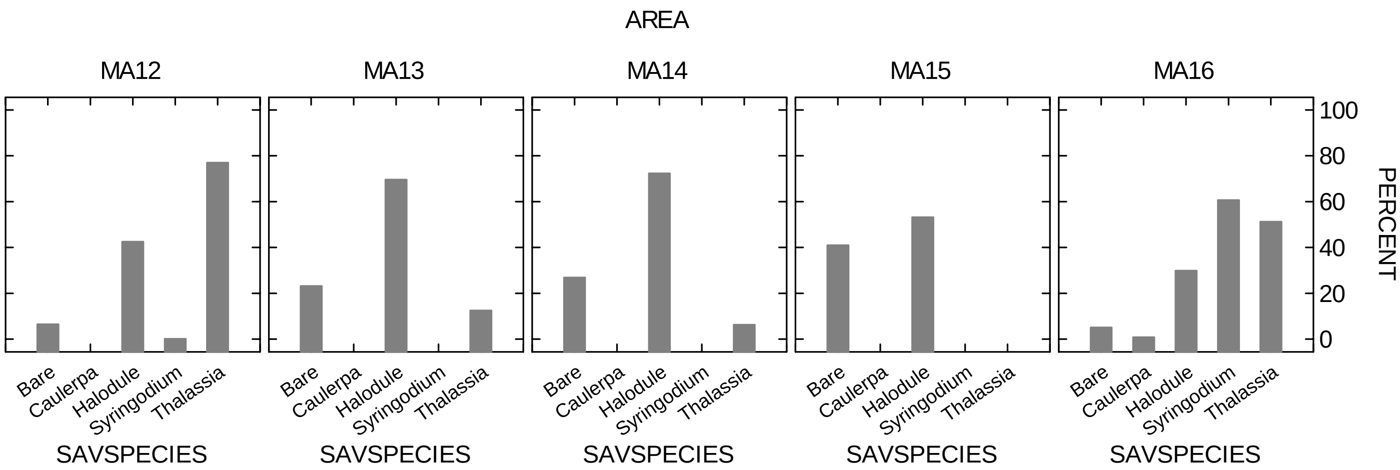


Figure 14. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Boca Ciega Bay.

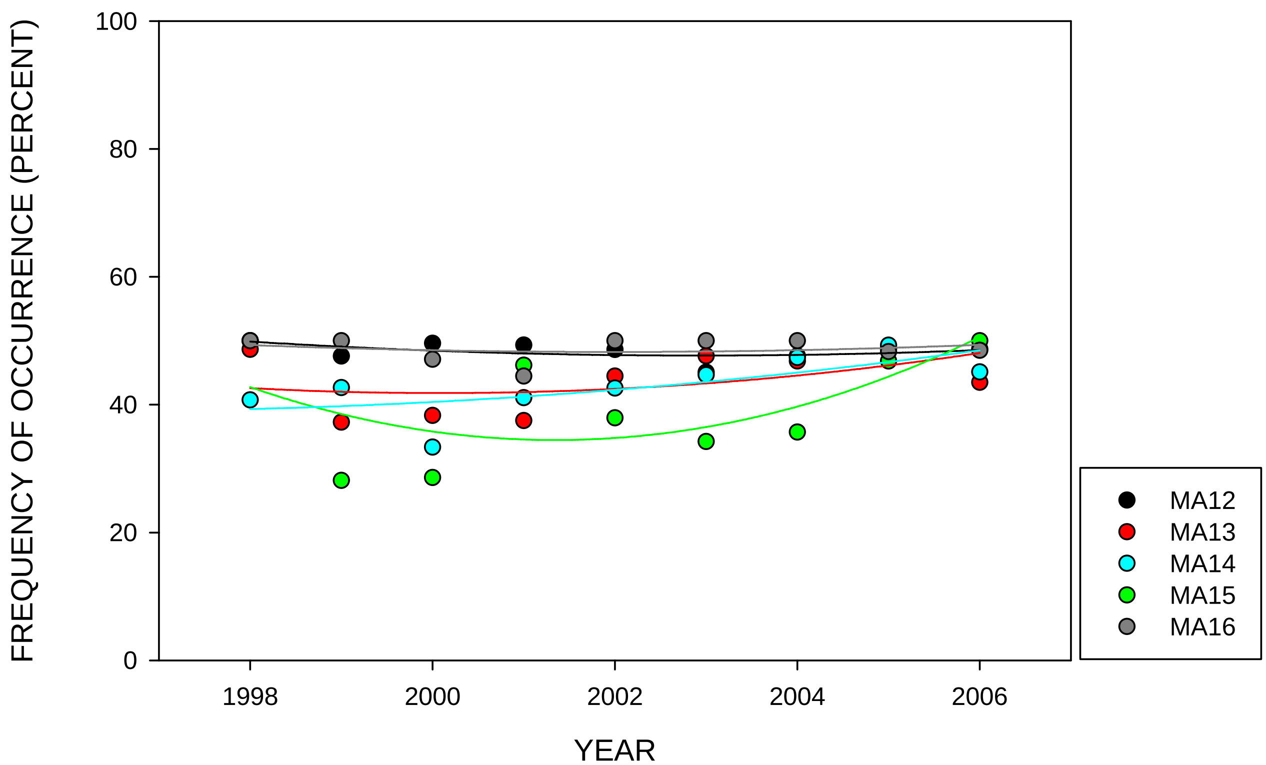


Figure 15. Percent frequency of occurrence of seagrass coverage within Boca Ciega Bay management areas from 1998-2006.

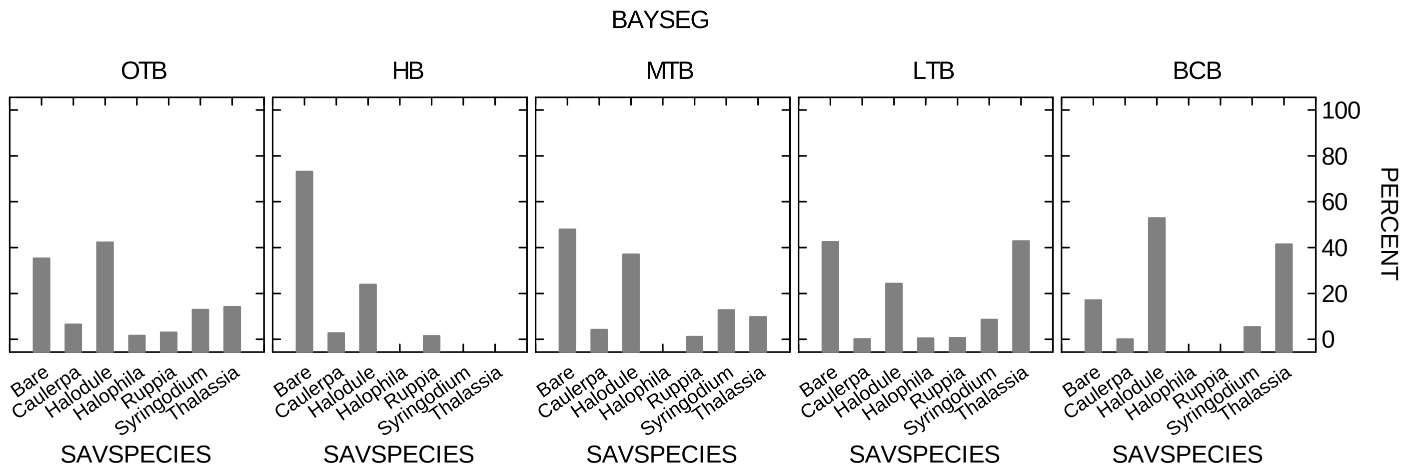


Figure 16. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Tampa Bay subsections: Old Tampa Bay (OTB), Hillsborough Bay (HB), Middle Tampa Bay (MTB), Lower Tampa Bay (LTB), and Boca Ciega Bay (BCB).
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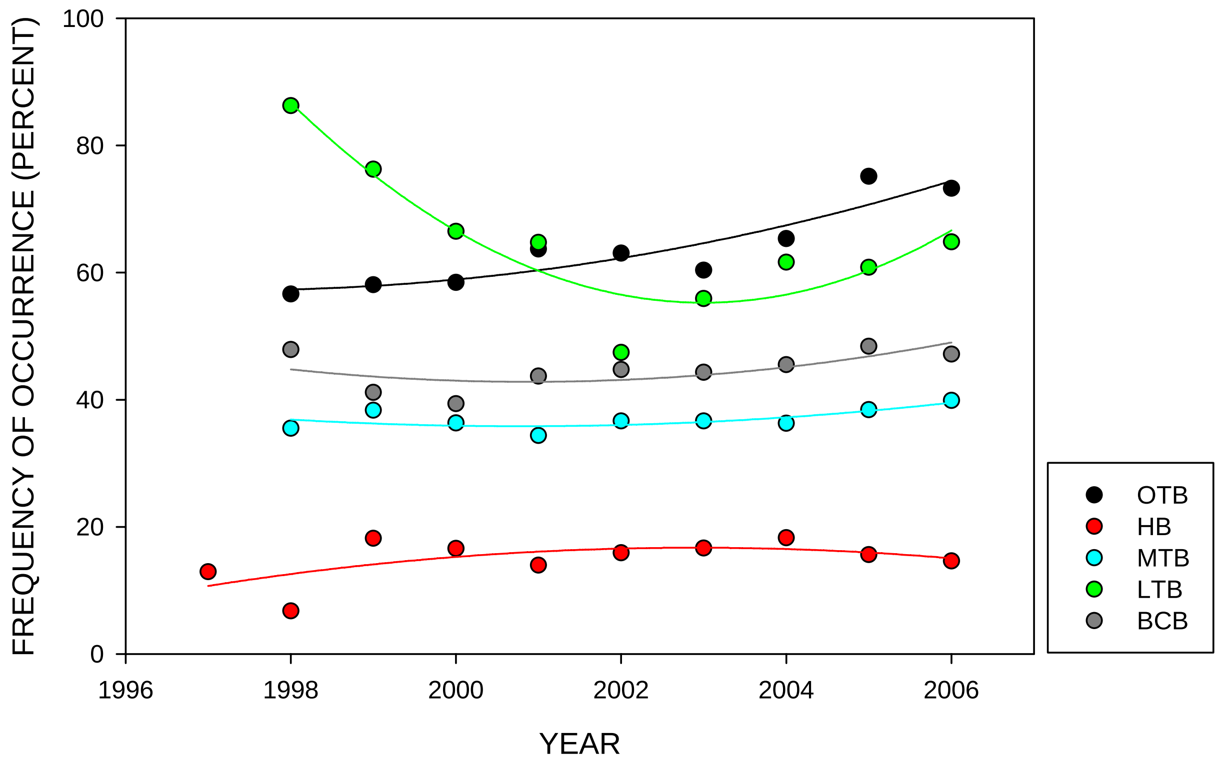


Figure 17. Percent frequency of occurrence of seagrass coverage within Tampa Bay subsections from 1997-2006.

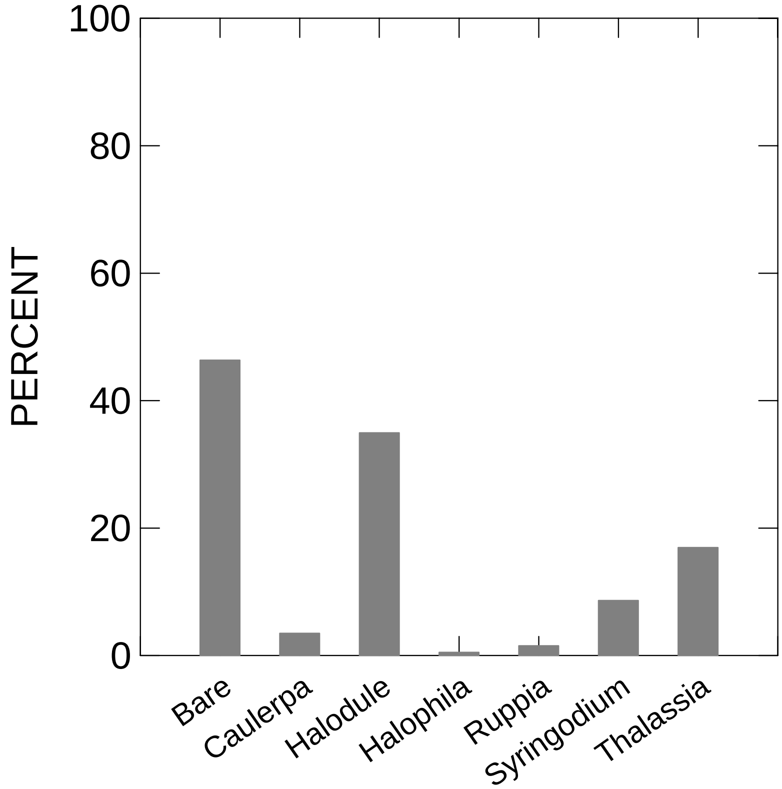


Figure 18. Average percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas in Tampa Bay.

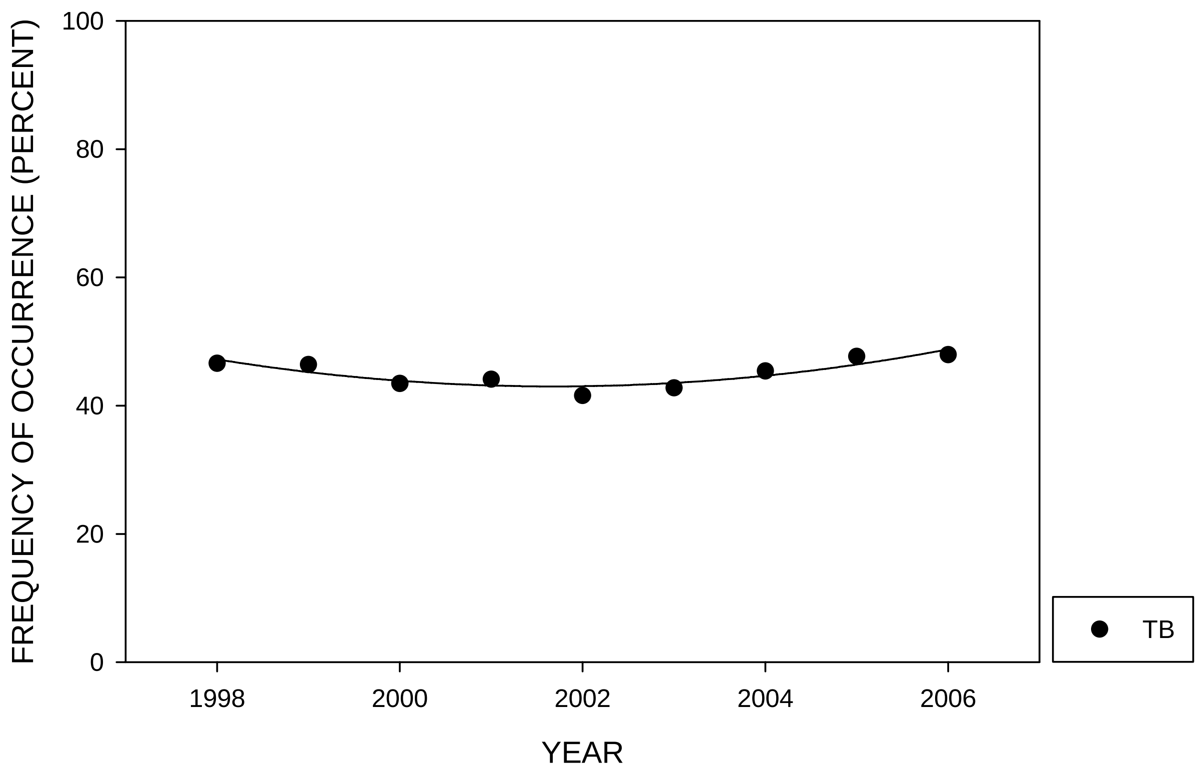


Figure 19. Percent frequency of occurrence of seagrass coverage in Tampa Bay from 1998-2006.

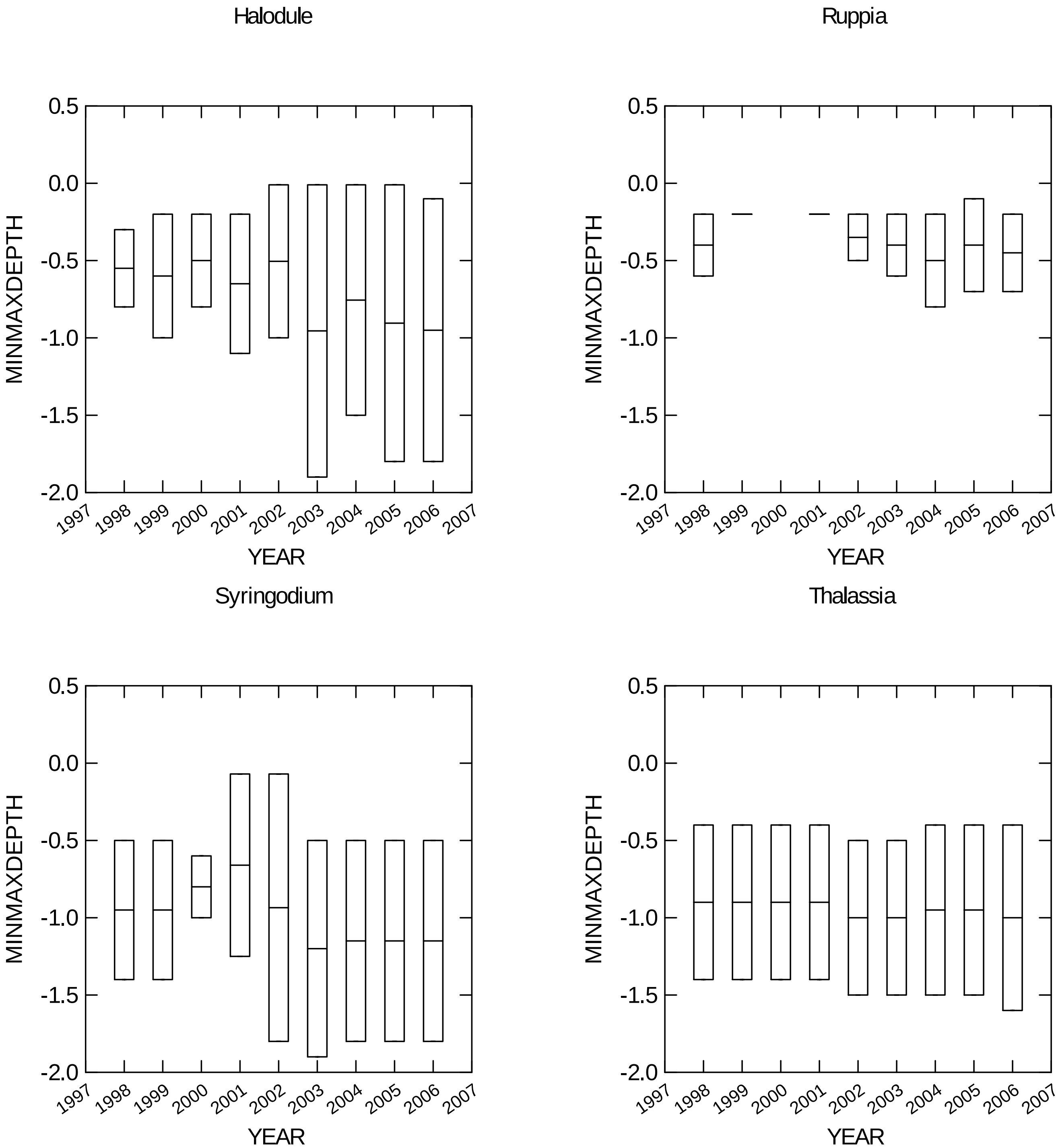


Figure 20. Depth ranges (meters, local mean tide level) of *H. wrightii, R. maritima, S. filiforme,* and *T. testudinum* from contours developed for Old Tampa Bay management areas: MA20, MA21, MA25, MA26, and MA27.

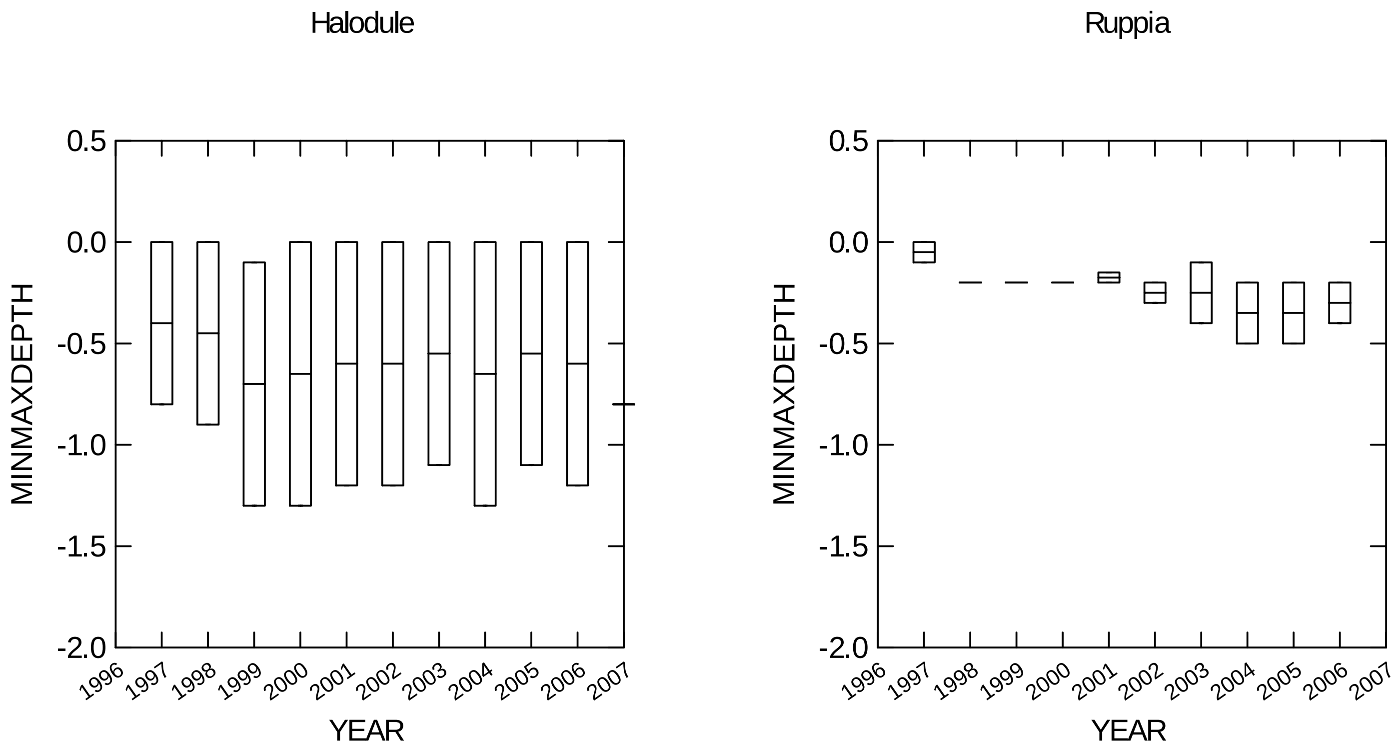


Figure 21. Depth ranges (meters, local mean tide level) of *H. wrightii* and *R. maritima* from contours developed for Hillsborough Bay management areas: MA1, MA2, MA3, MA4, and MA5.

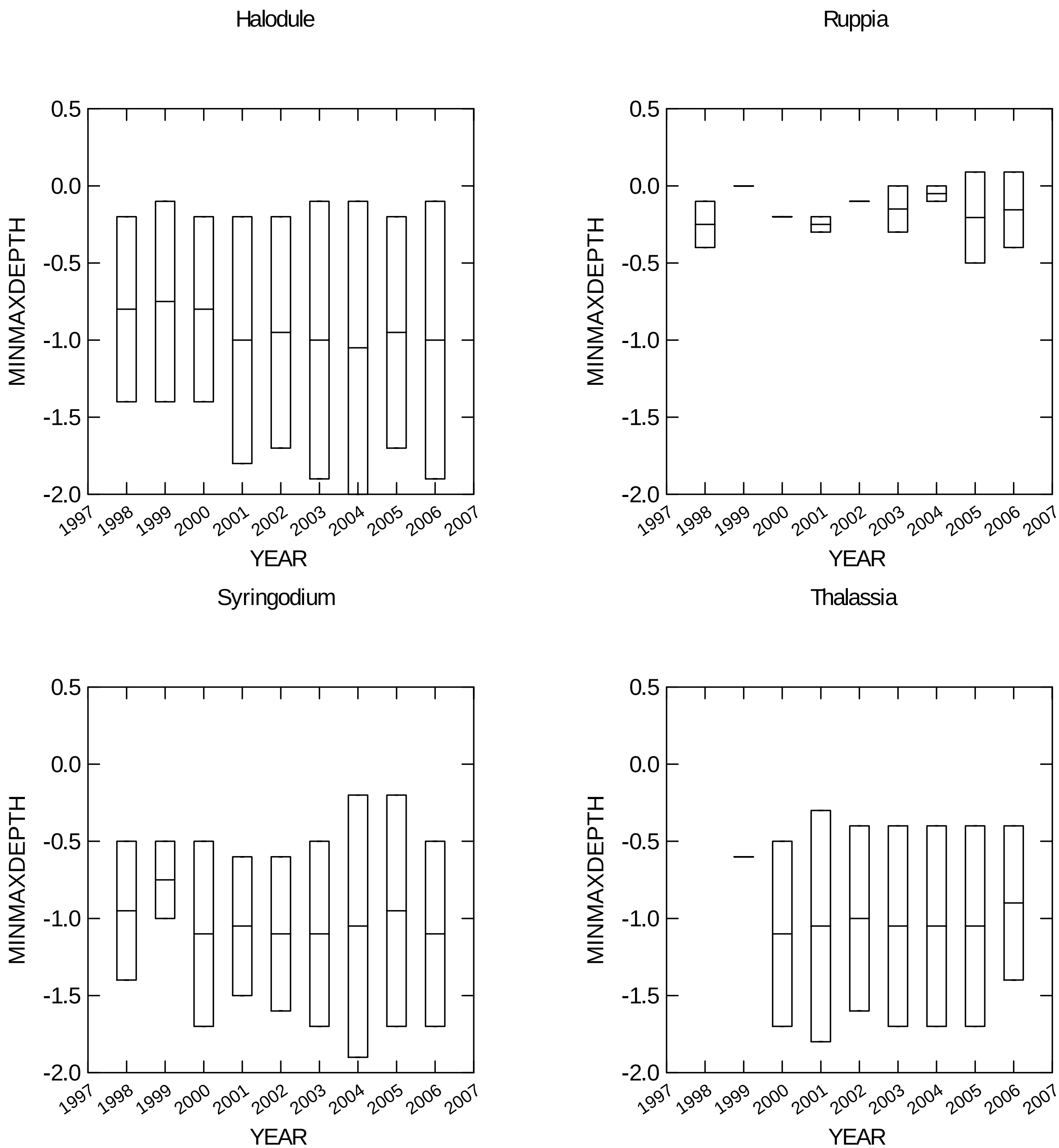
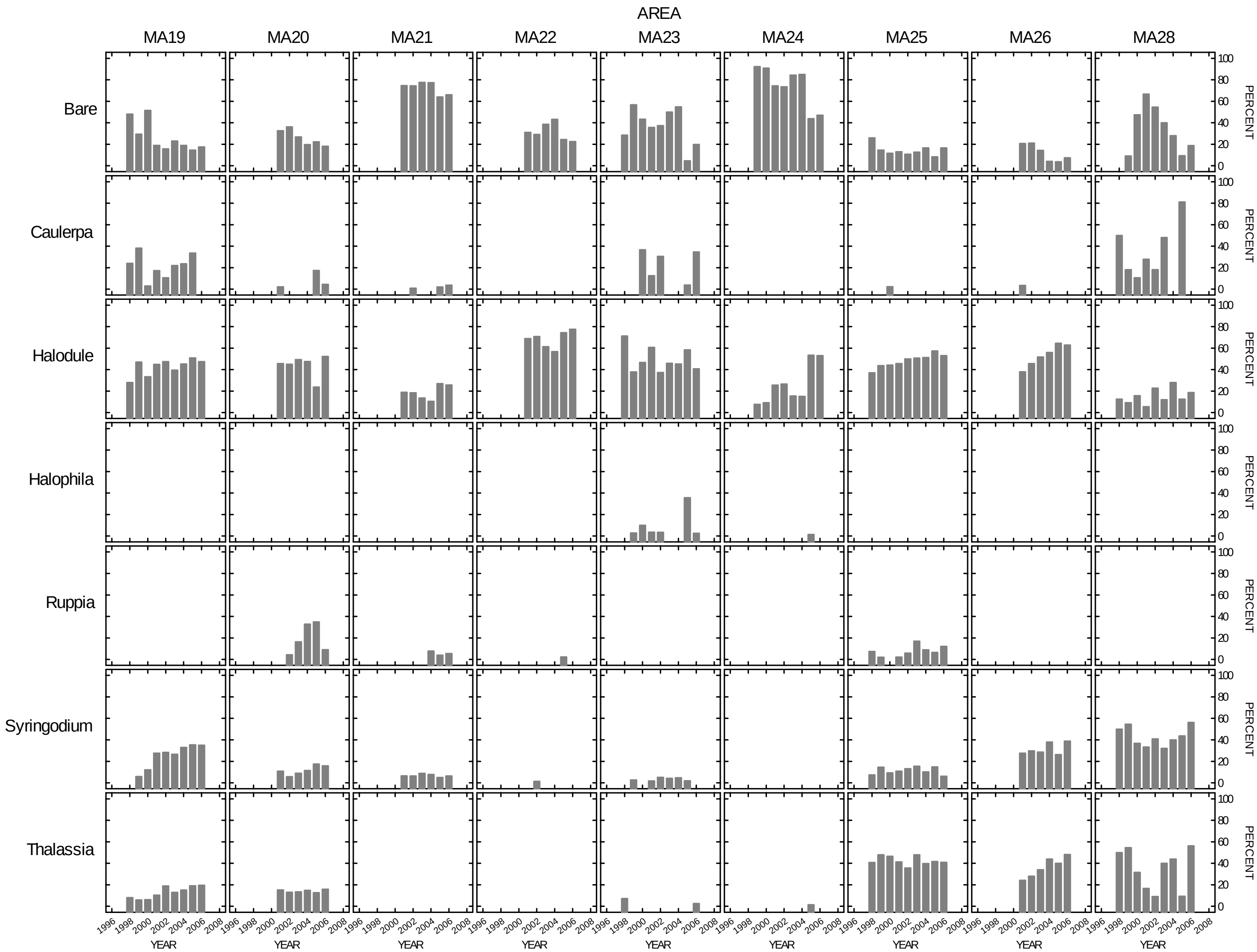
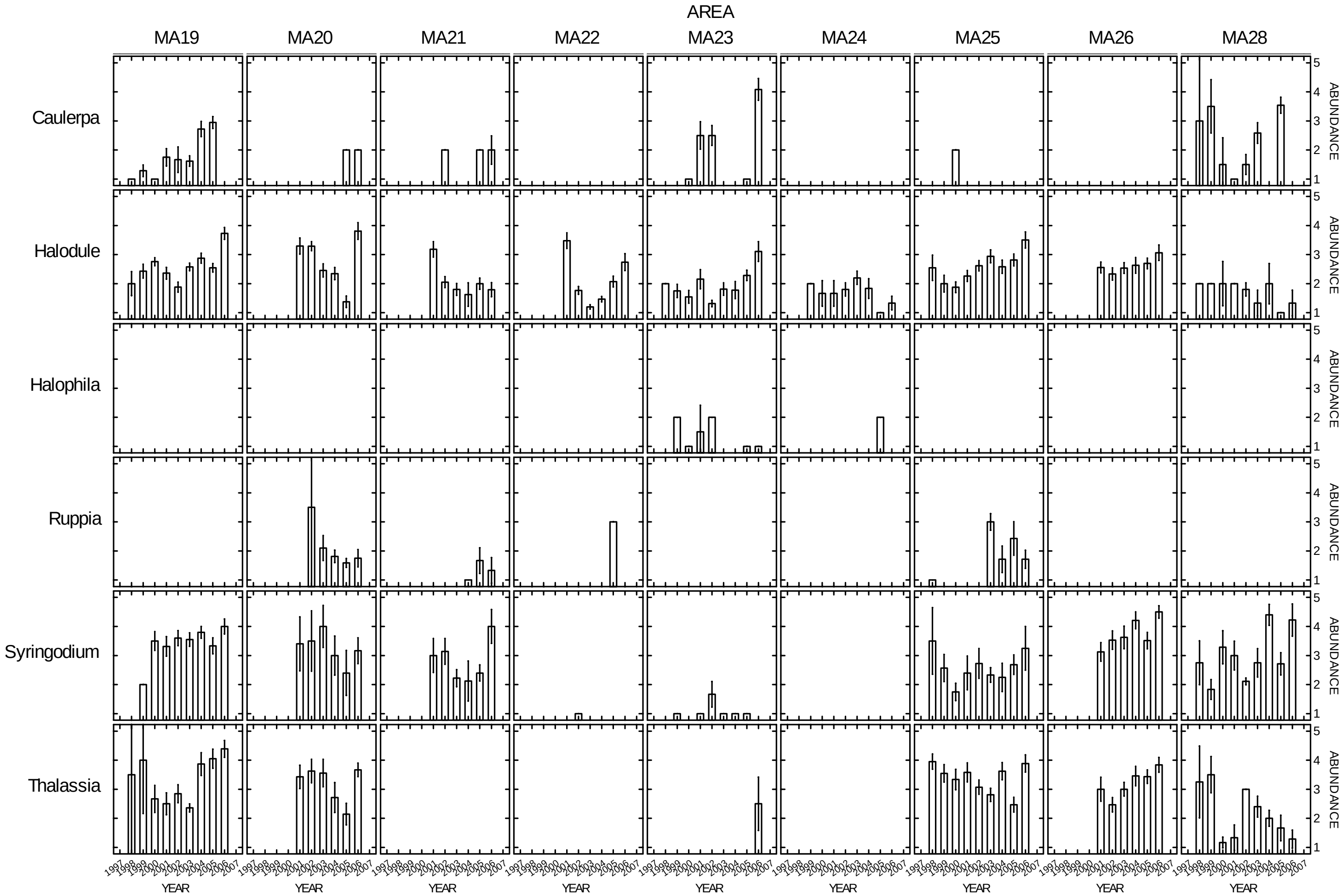


Figure 22. Depth ranges (meters, local mean tide level) of *H. wrightii*, *R. maritima*, *S. filiforme*, and *T. testudinum* from contours developed for Middle Tampa Bay management areas: MA6, MA18, and MA27.

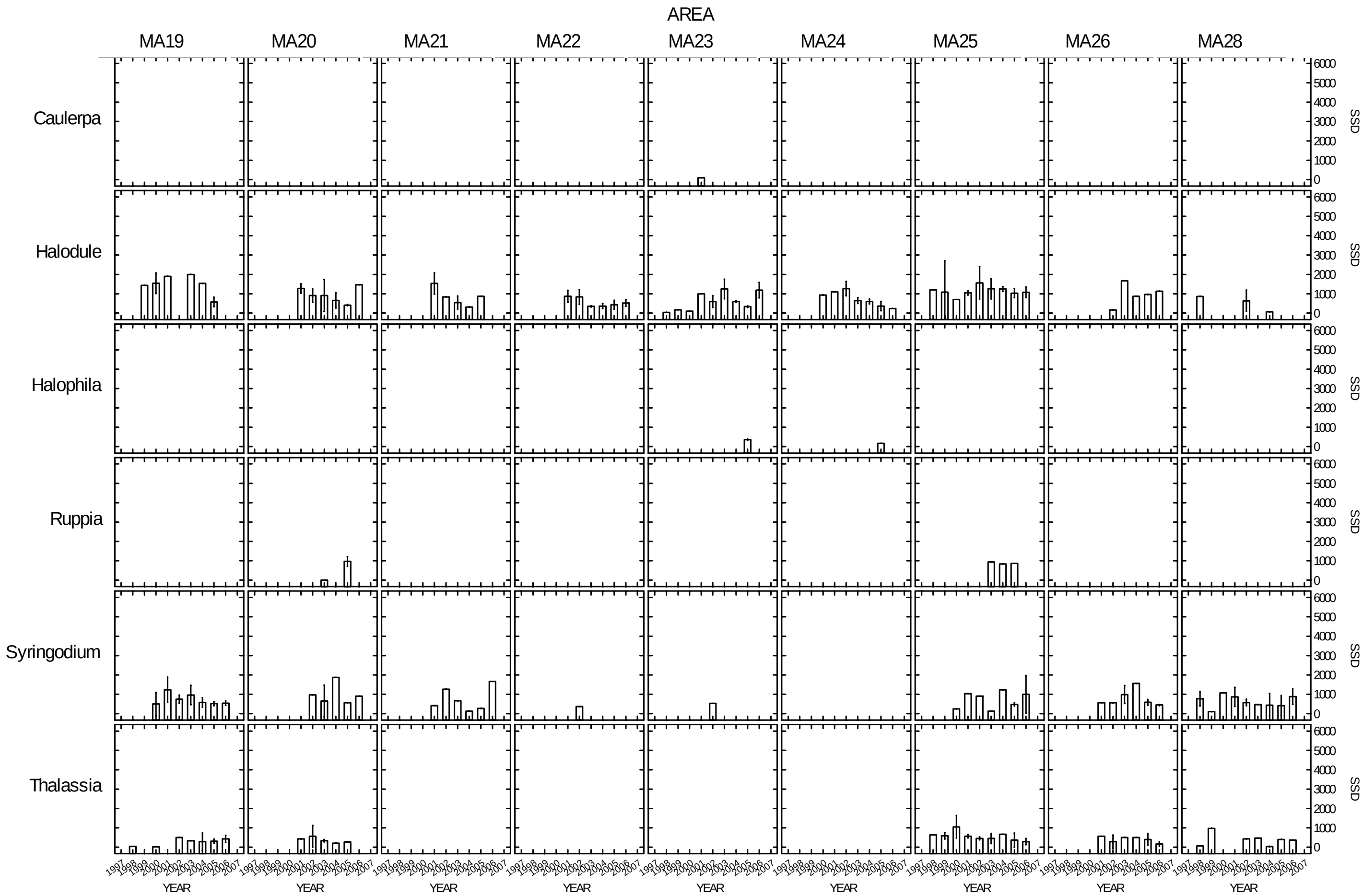
Appendix



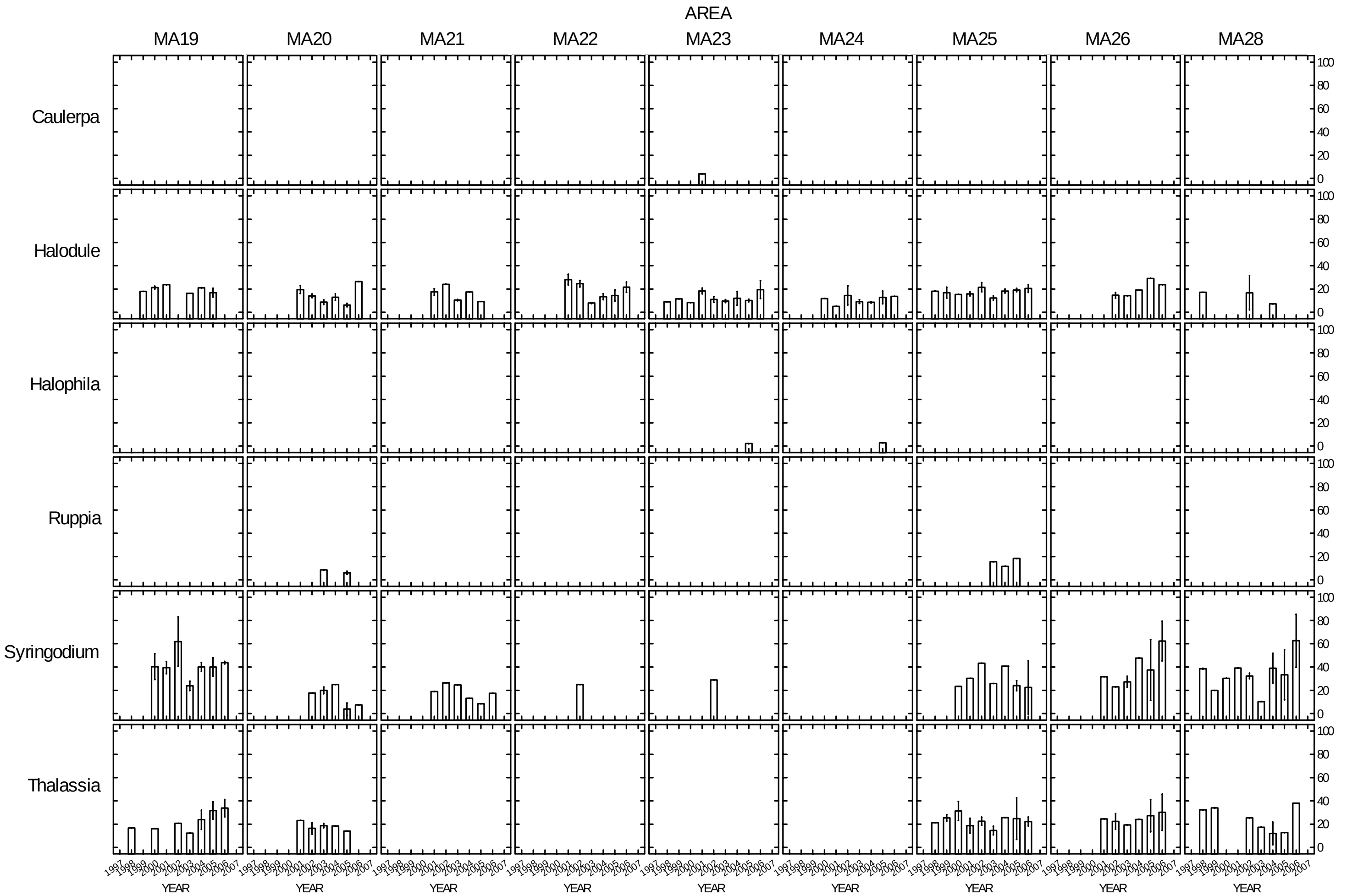
Appendix-OTB1. Percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas SAV coverage within Old Tampa Bay Management Areas from 1998-2006.



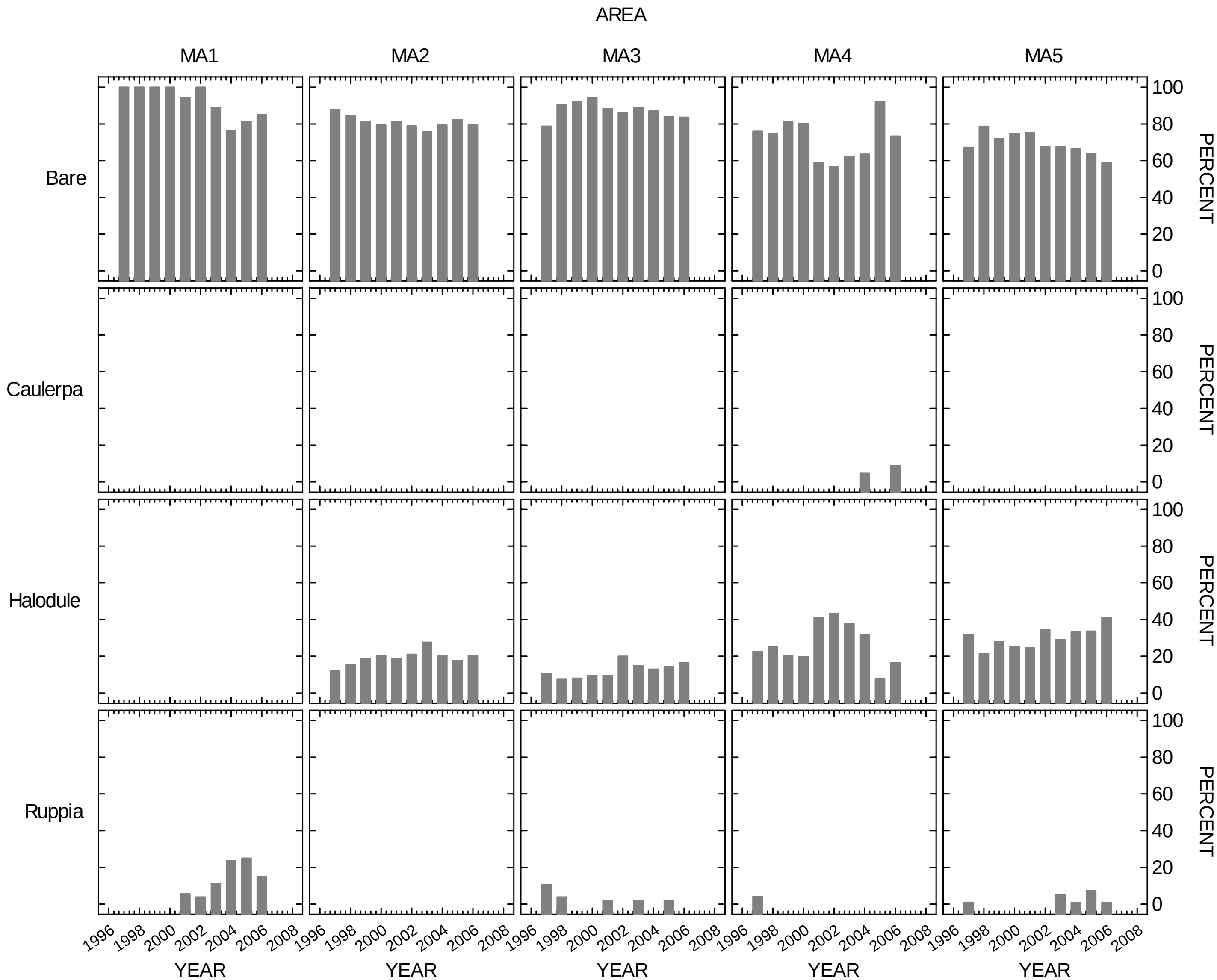
Appendix-OTB2. Abundance (Braun Blanquet class coverage) of SAV coverage within Old Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



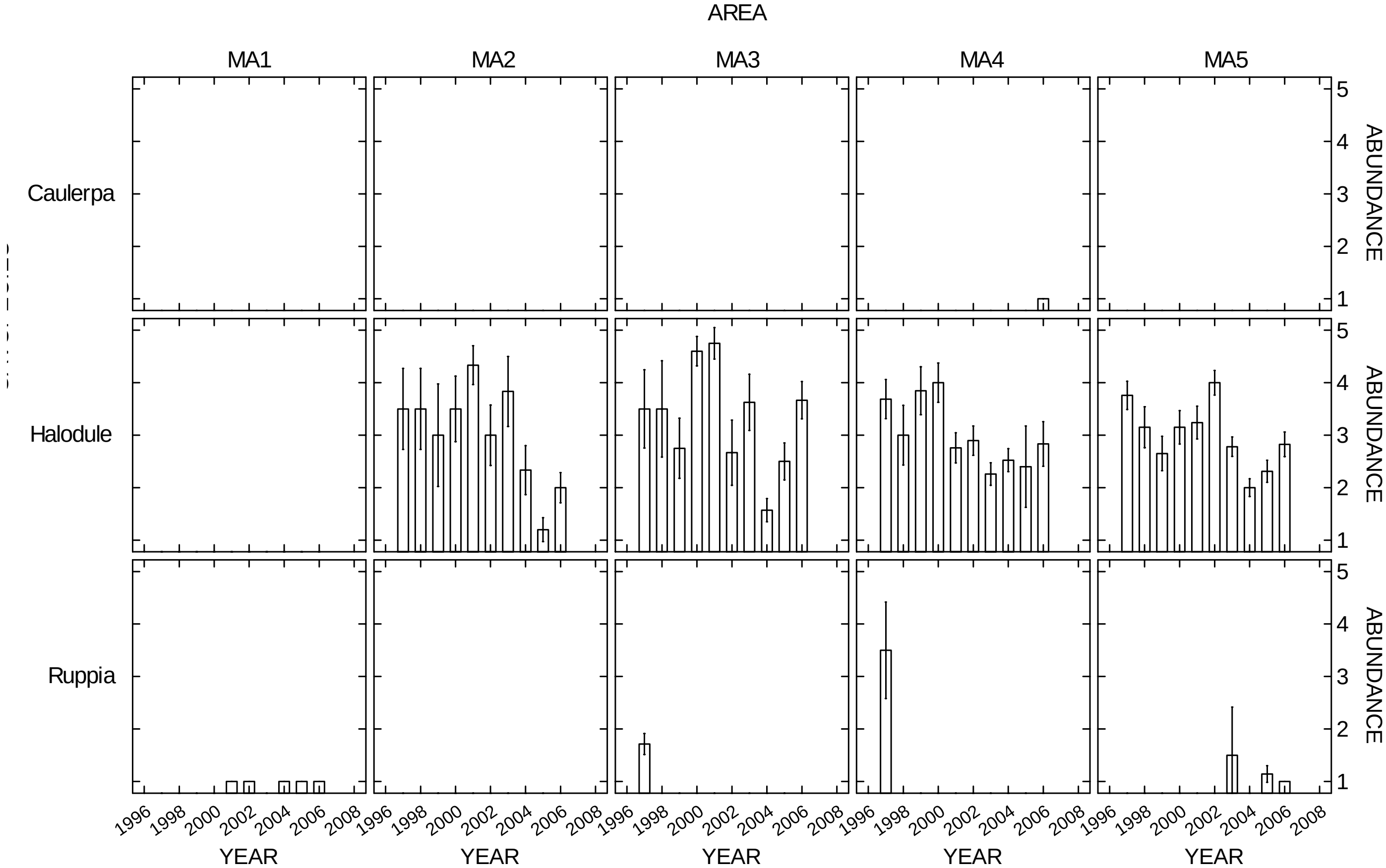
Appendix-OTB3. Short shoot density ($SSDm^{-2}$) of SAV species within the Old Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



Appendix-OTB4. Canopy height (cm) of SAV species within the Old Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



Appendix- HB1. Percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Hillsborough Bay Management Areas from 1997-2006.



Appendix-HB2. Abundance (Braun Blanquet class coverage) of SAV coverage within Hillsborough Bay Management Areas from 1997-2006. Error bars equal 1SE.

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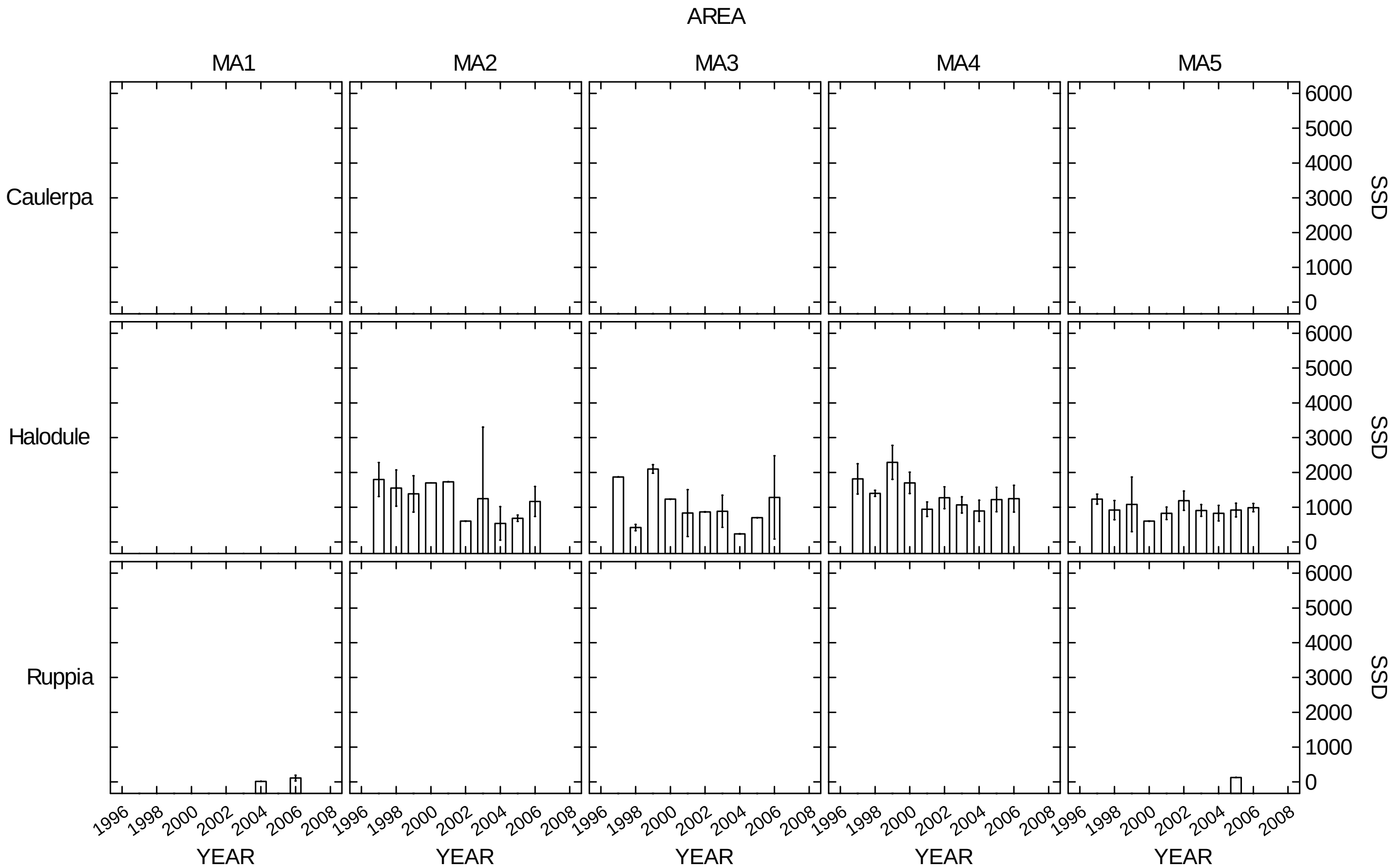
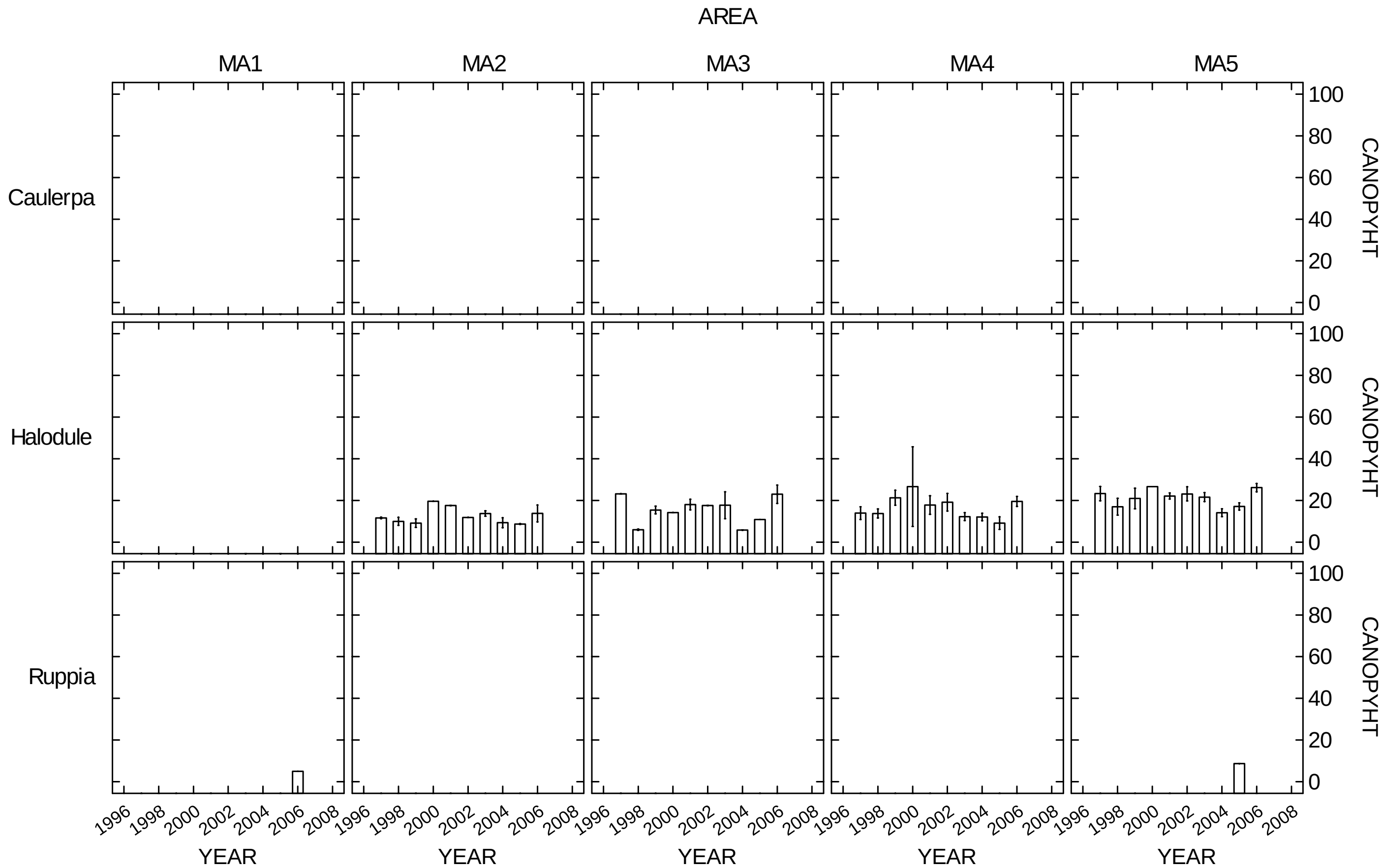
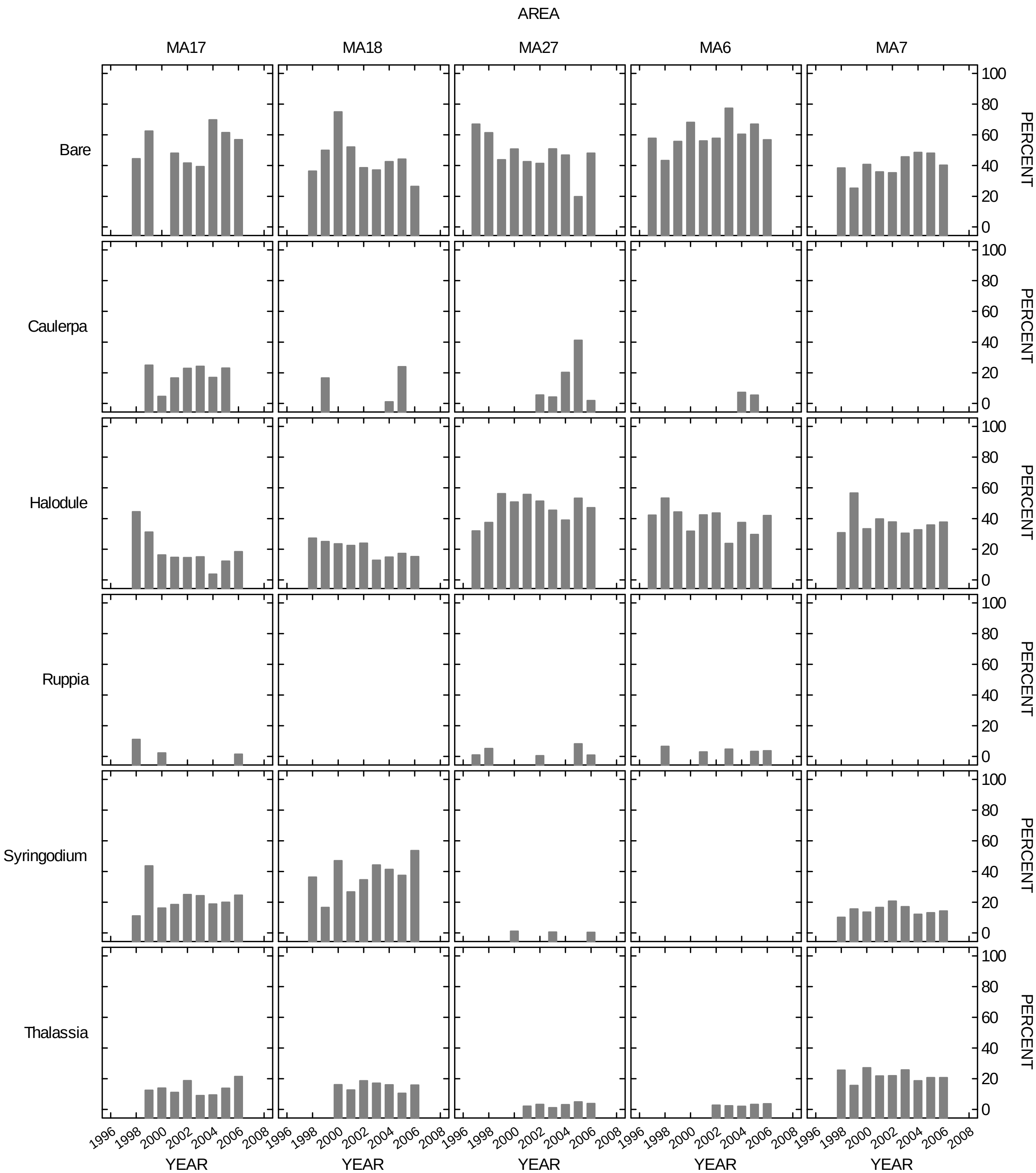


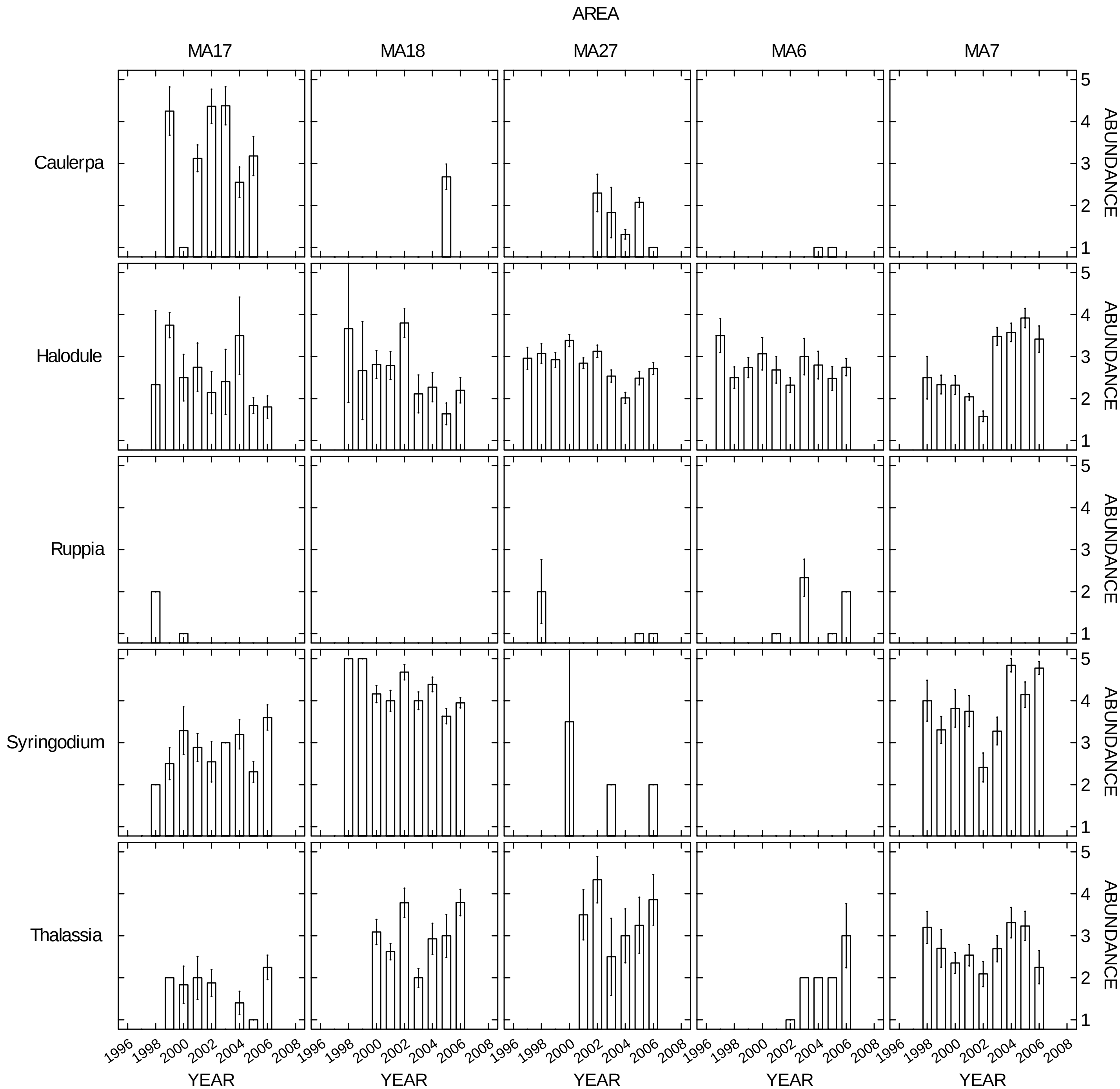
Appendix-HB3. Short shoot density ($SSDm^{-2}$) of SAV species within the Hillsborough Bay Management Areas from 1997-2006. Error bars equal 1SE.



Appendix-HB4. Canopy height (cm) of SAV species within the Hillsborough Bay Management Areas from 1997-2006. Error bars equal 1SE.



Appendix-MTB1. Percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Middle Tampa Bay Management Areas from 1998-2006.



Appendix-MTB2. Abundance (Braun Blanquet class coverage) of SAV coverage within Middle Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.

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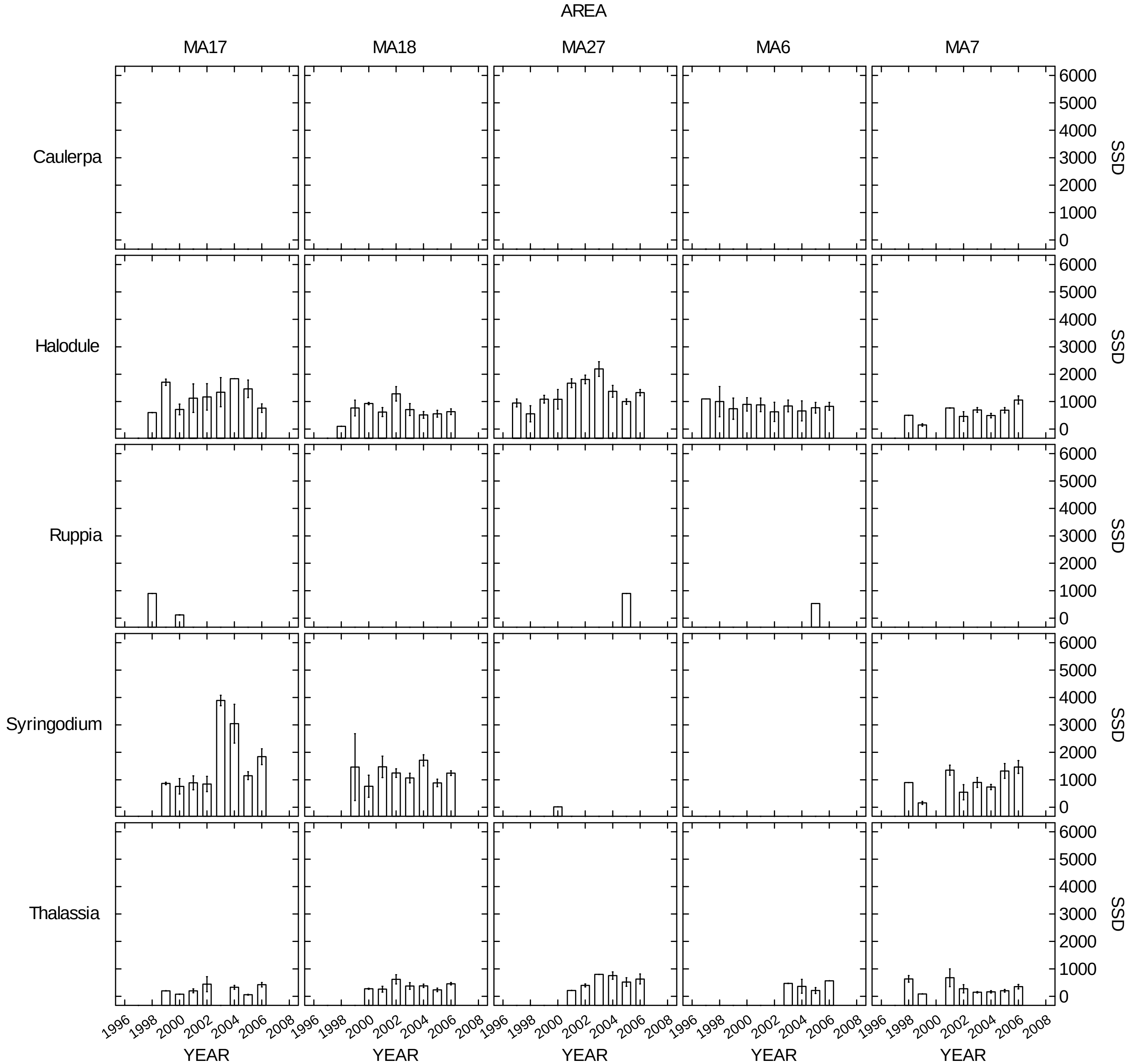
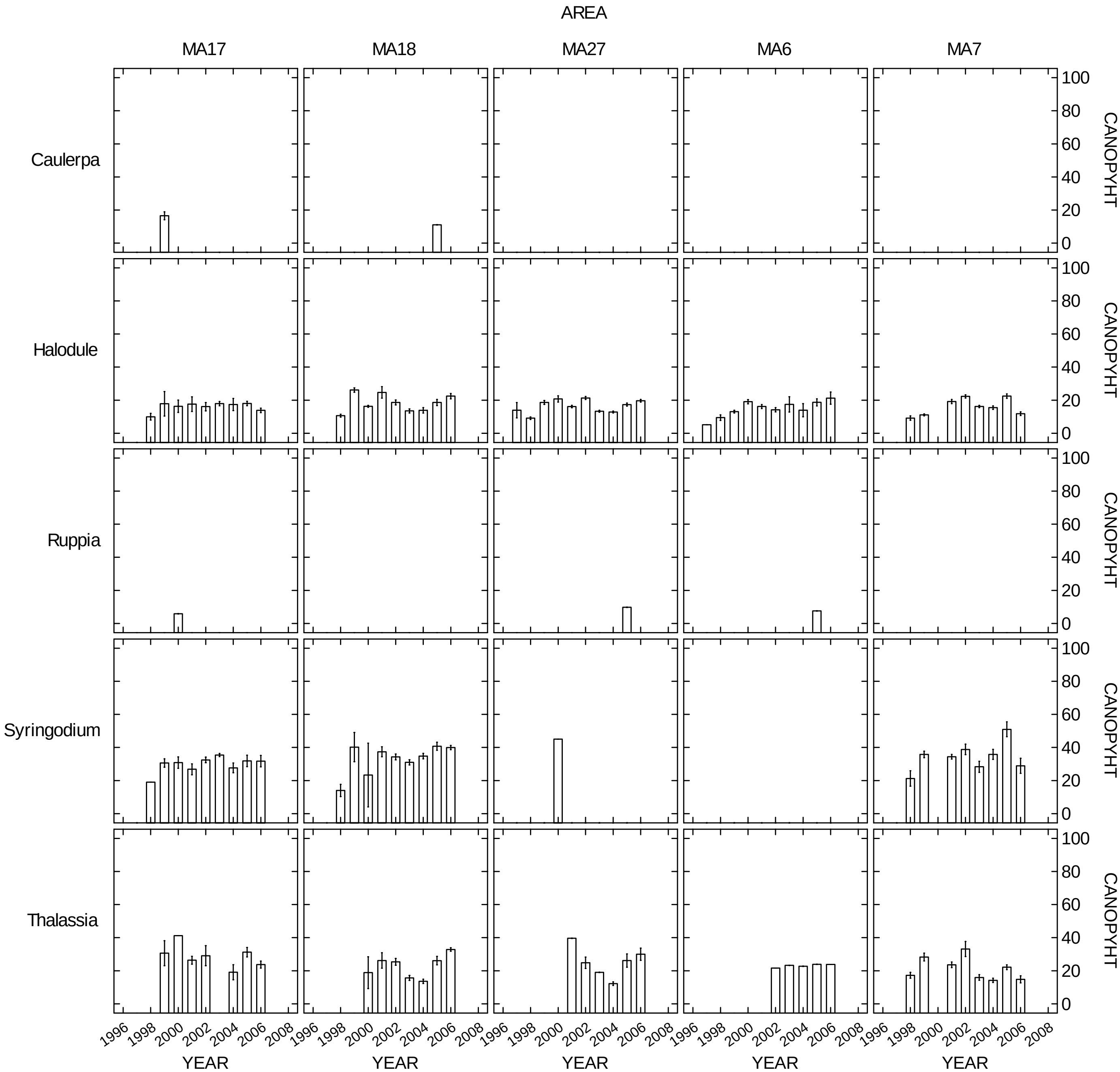
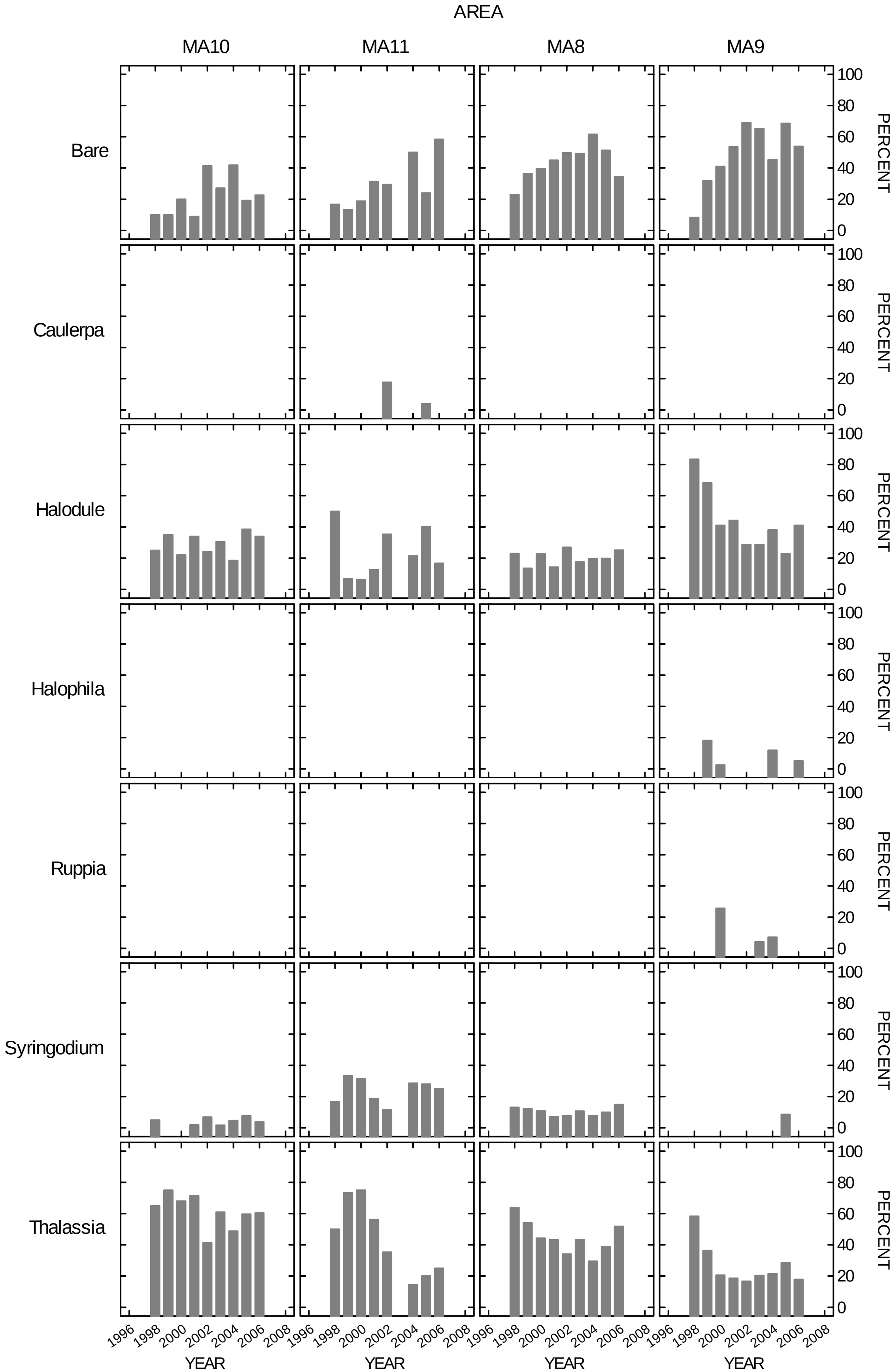


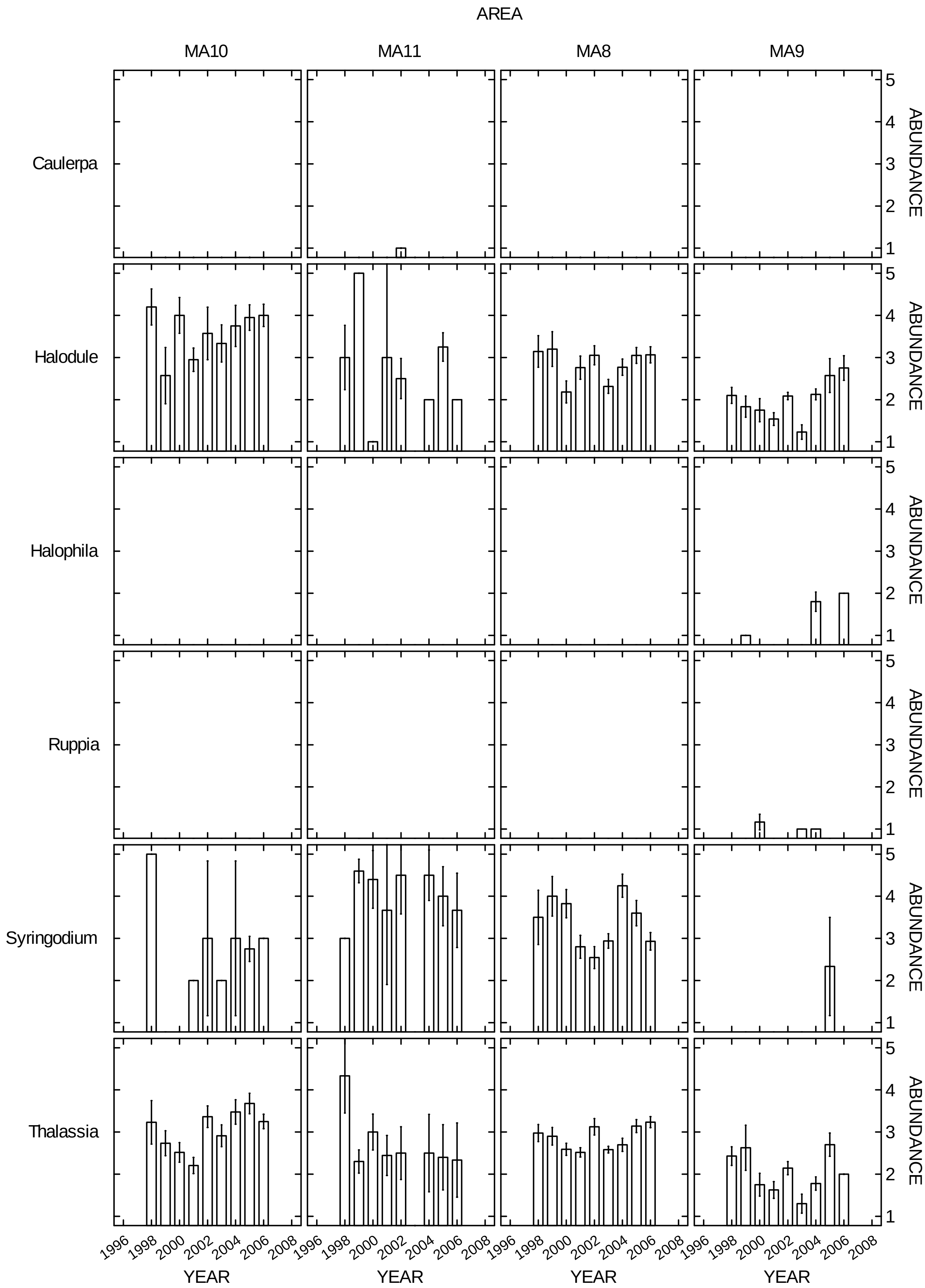
Appendix-MTB3. Short shoot density (SSDm^{-2}) of SAV species within the Middle Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



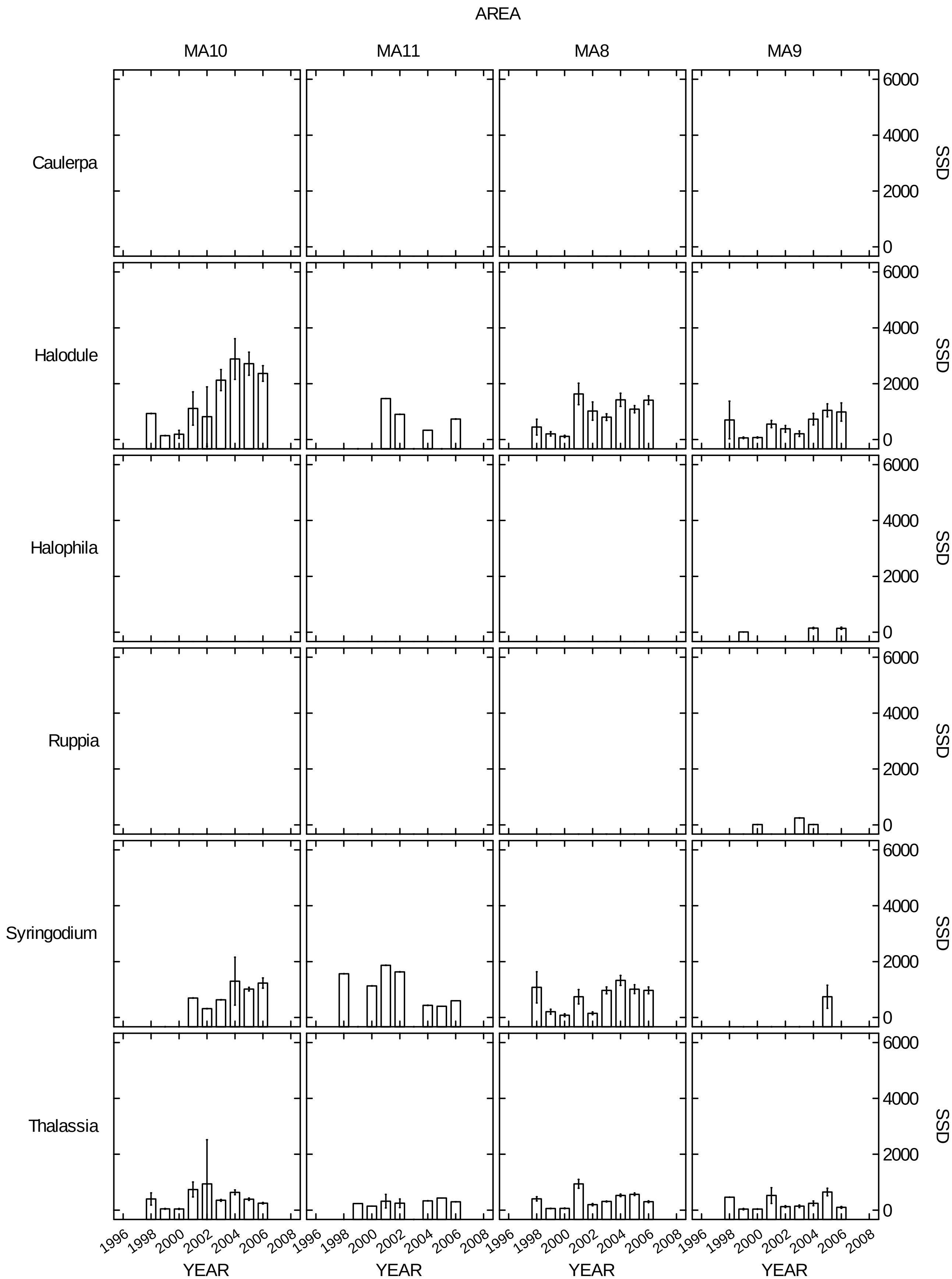
Appendix-MTB4. Canopy height (cm) of SAV species within the Middle Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



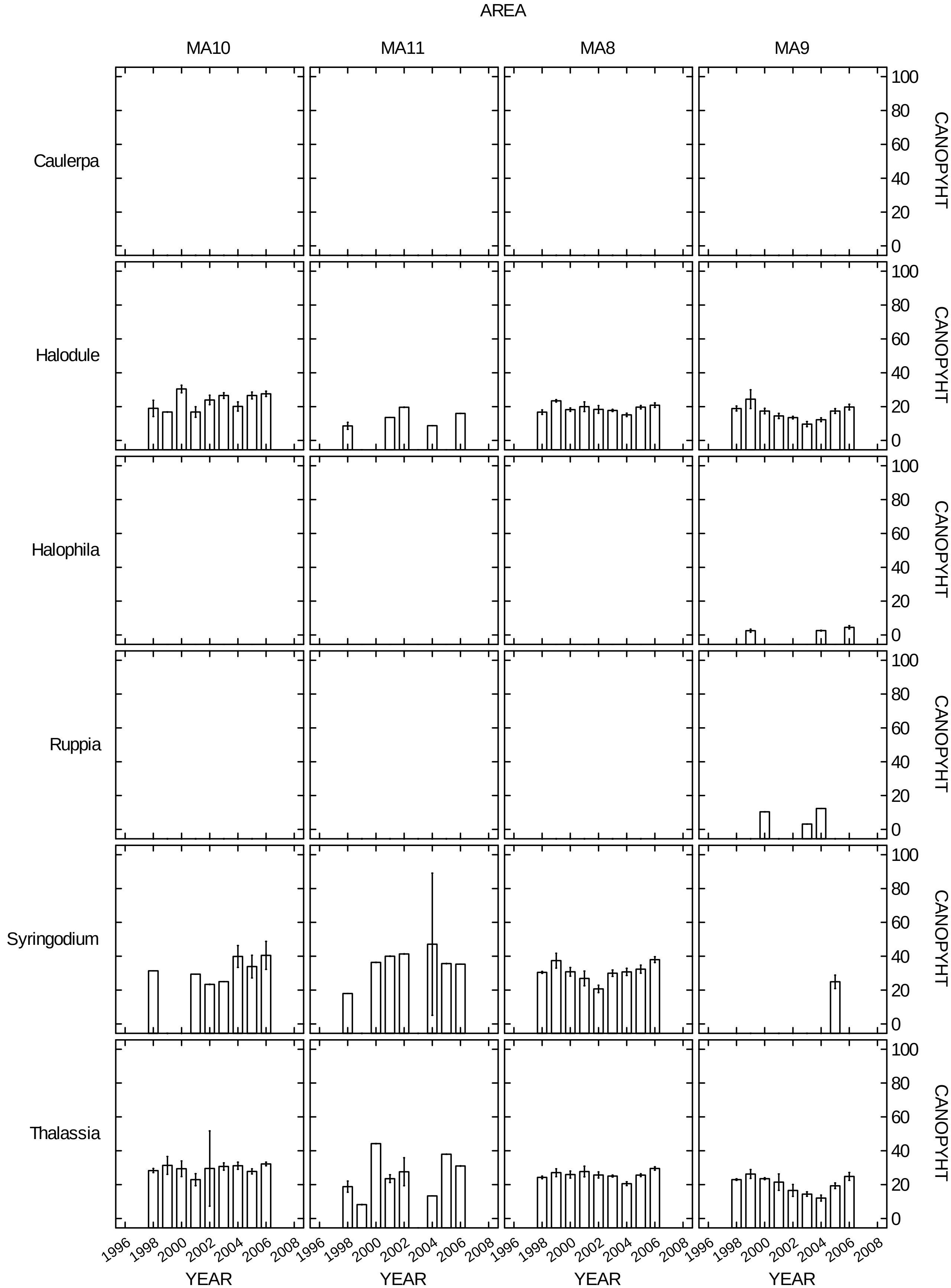
Appendix-LTB1. Percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Lower Tampa Bay Management Areas from 1998-2006.



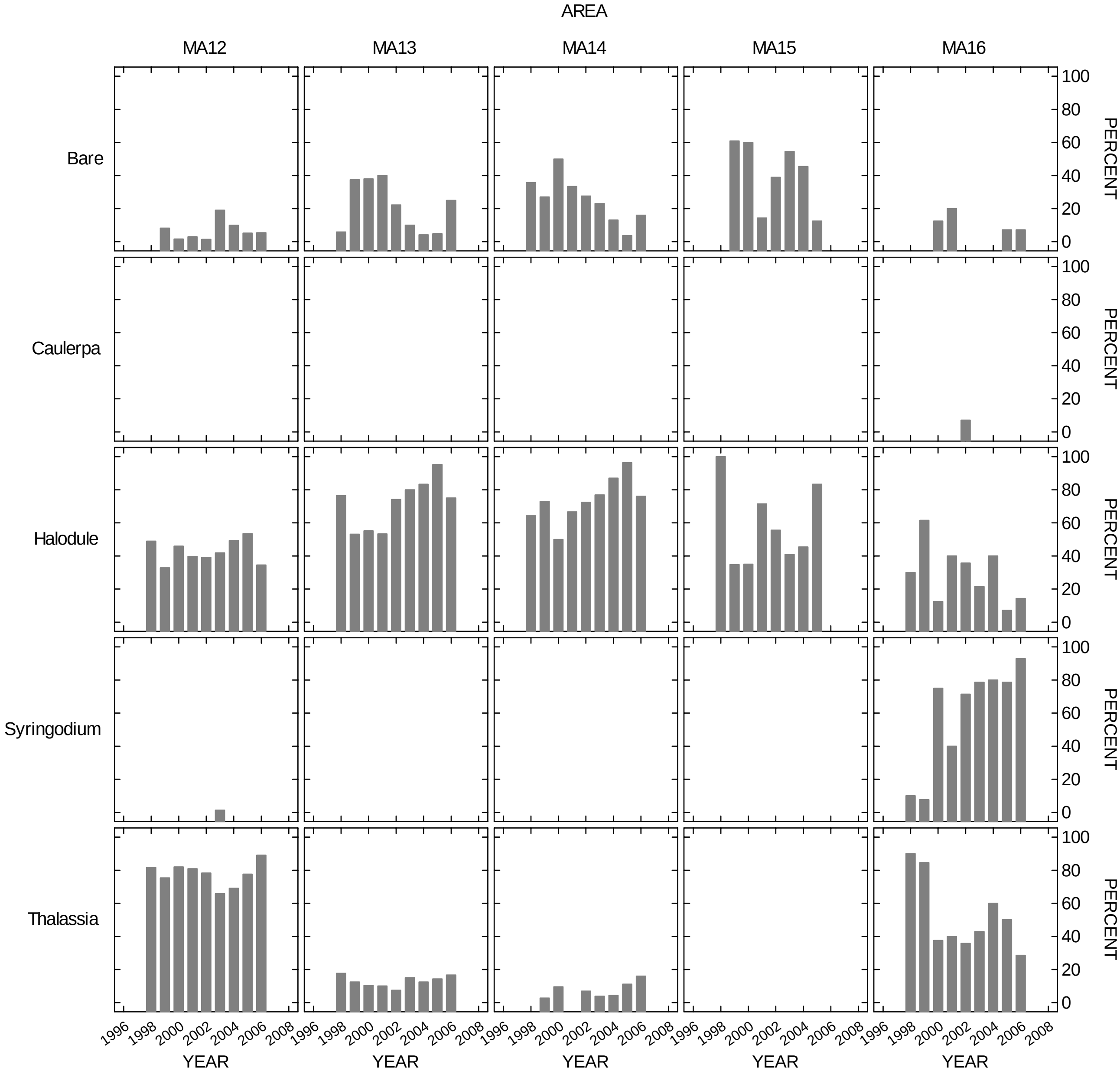
Appendix-LTB2. The abundance (Braun Blanquet class coverage) of SAV coverage within Lower Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



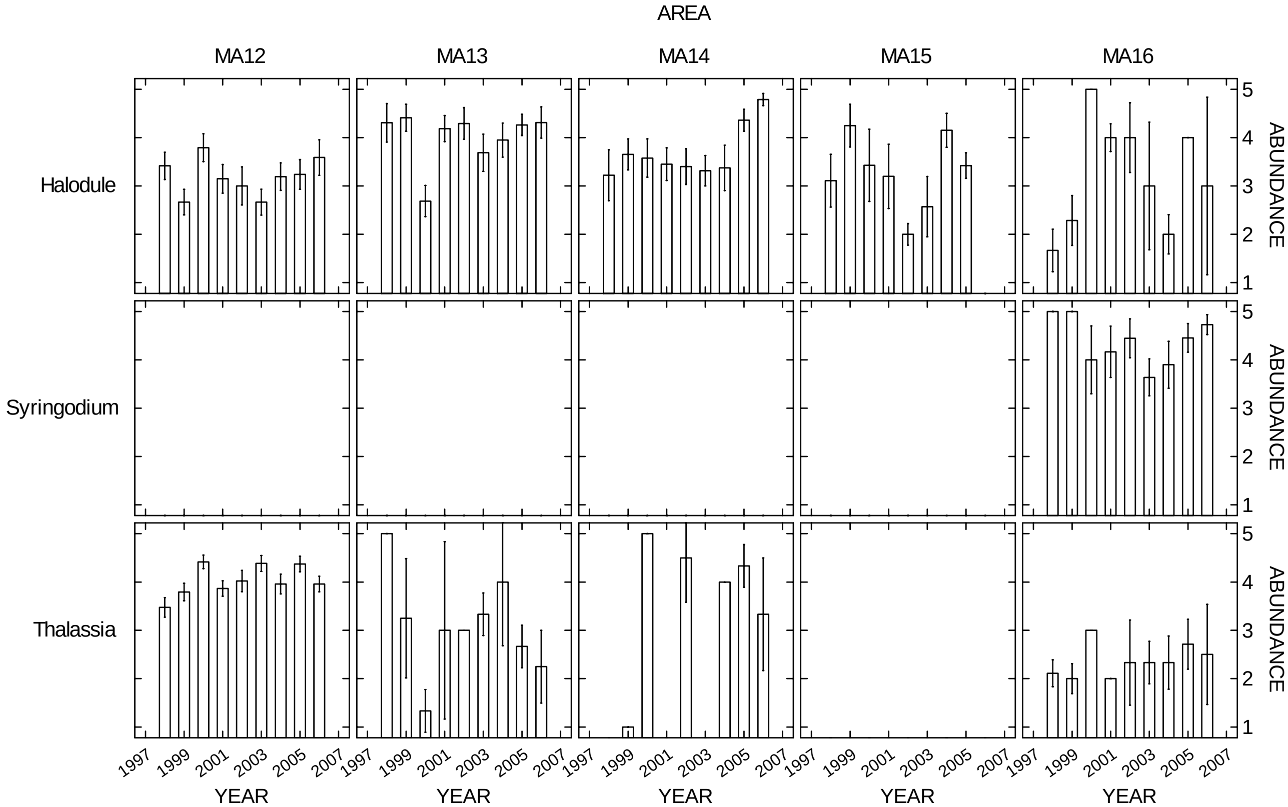
Appendix-LTB3. Short shoot density (SSDm^{-2}) of SAV species within the Lower Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



Appendix-LTB4. Canopy height (cm) of SAV species within the Lower Tampa Bay Management Areas from 1998-2006. Error bars equal 1SE.



Appendix-BCB1. Percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Boca Ciega Bay Management Areas from 1998-2006.



Appendix-BCB2. The abundance (Braun Blanquet class coverage) of SAV coverage within Boca Ciega Bay Management Areas from 1998-2006. Error bars equal 1SE.

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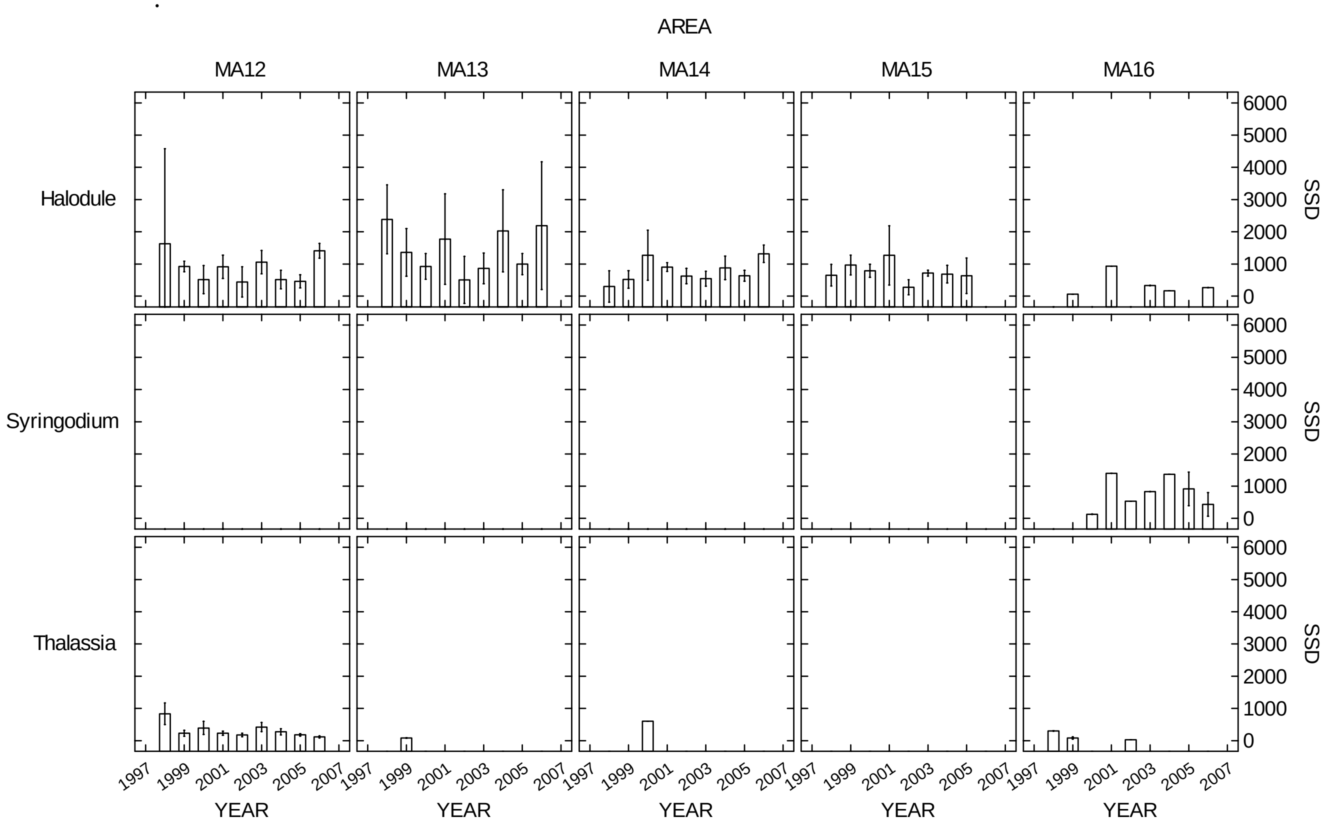
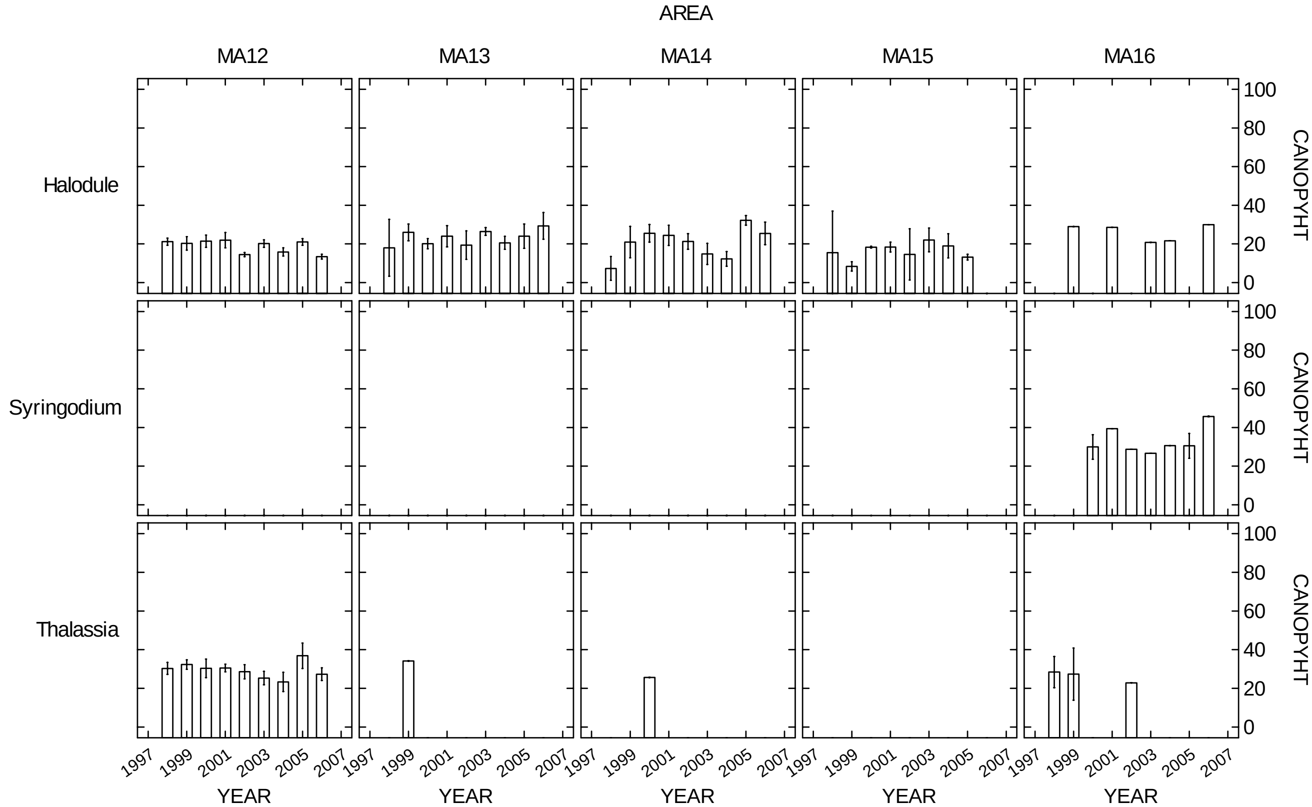
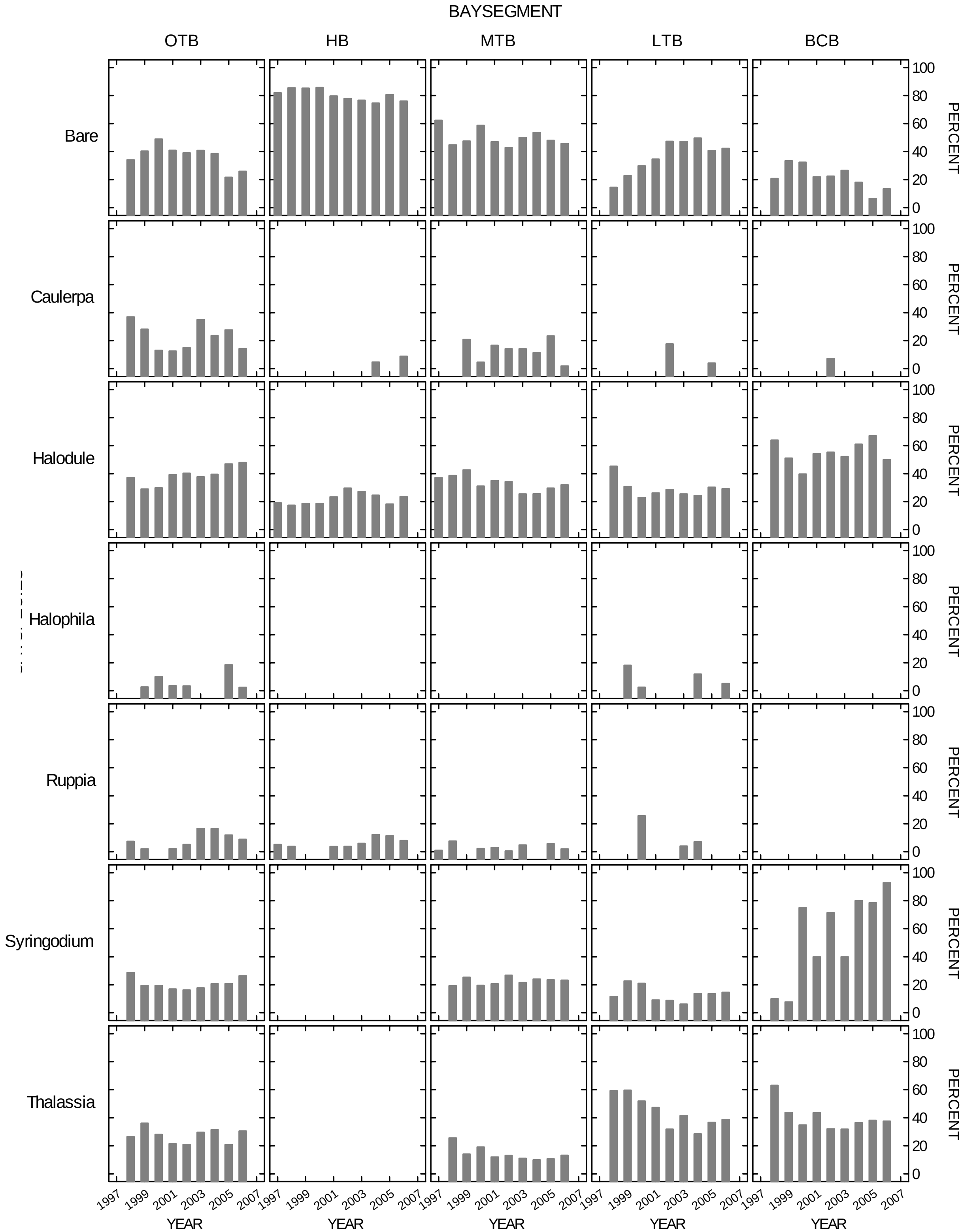


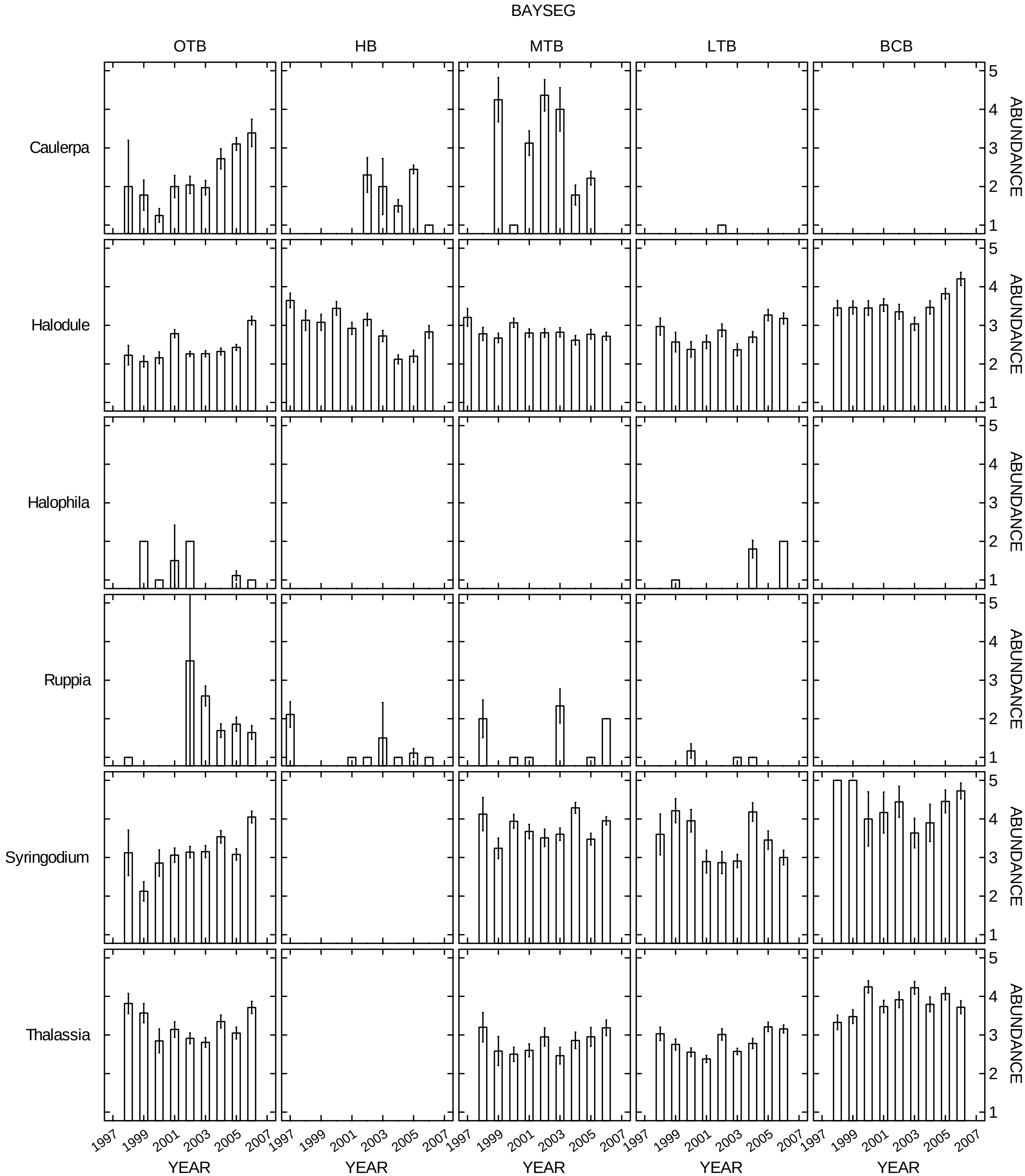
Appendix-BCB3. Short shoot density ($SSDm^{-2}$) of SAV species within the Boca Ciega Bay Management Areas from 1998-2006. Error bars equal 1SE.



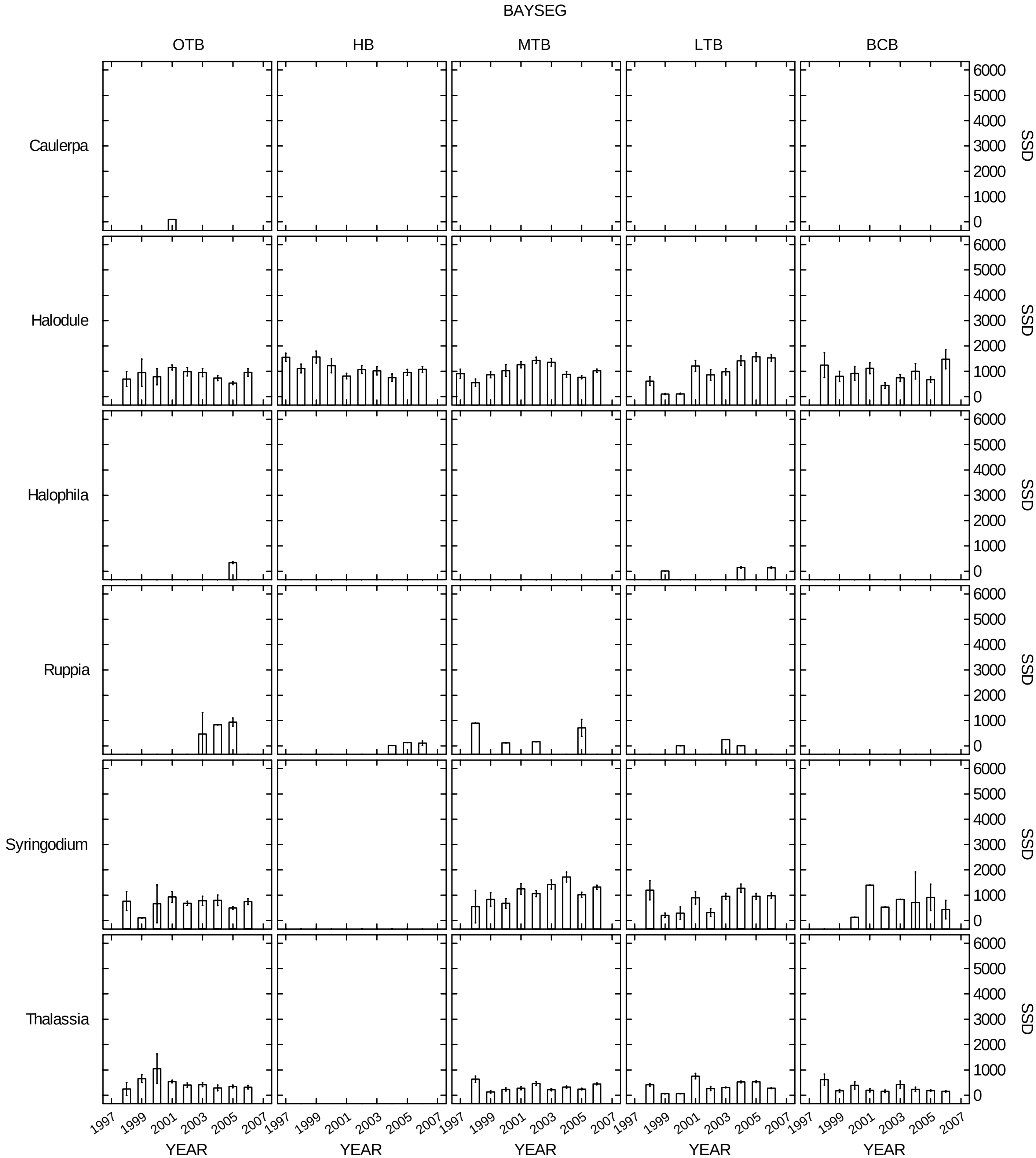
Appendix-BCB4. Canopy height (cm) of SAV species within the Boca Ciega Bay Management Areas from 1998-2006. Error bars equal 1SE.



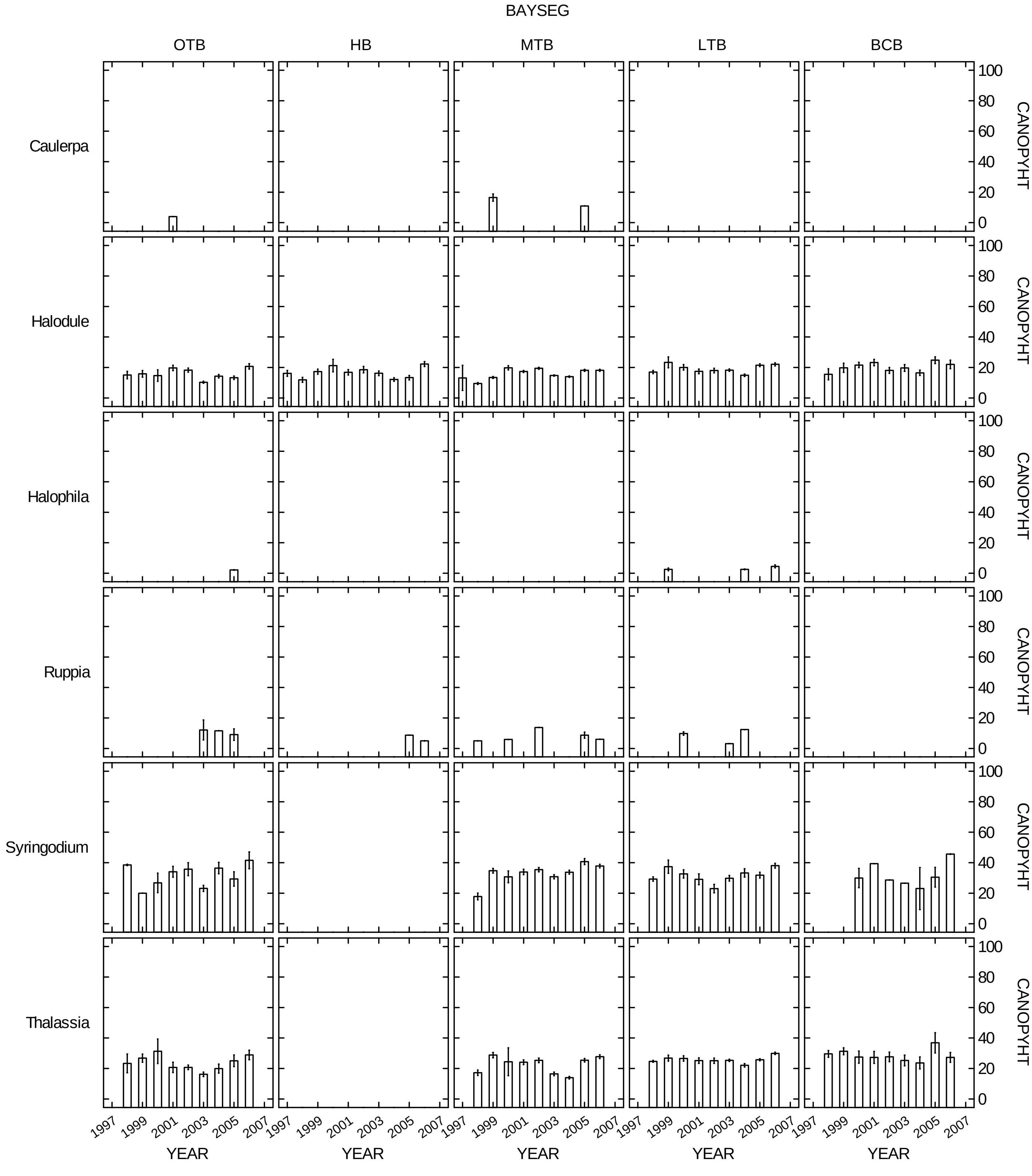
Appendix-TBS1. Percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within the major Tampa Bay subsections from 1997-2006.



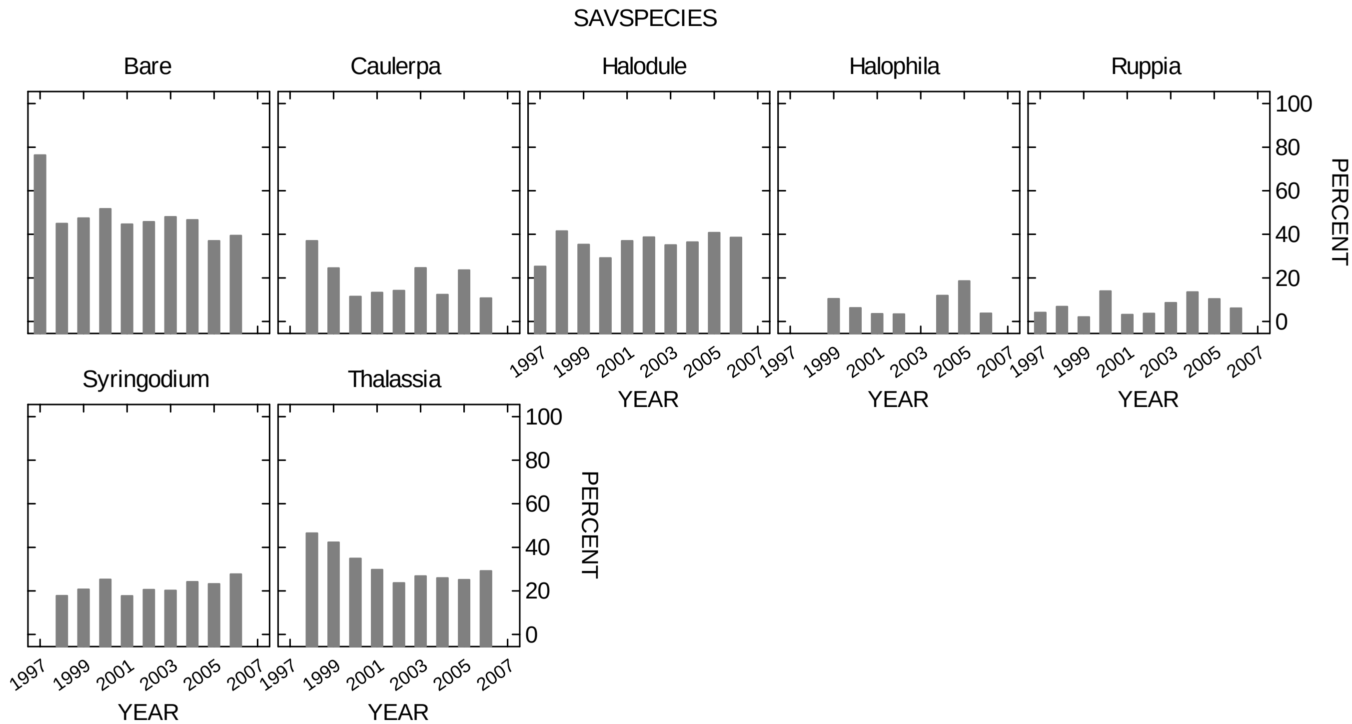
Appendix-TBS2. Abundance of SAV species within the major Tampa Bay subsections from 1997-2006. Error bars equal 1SE.



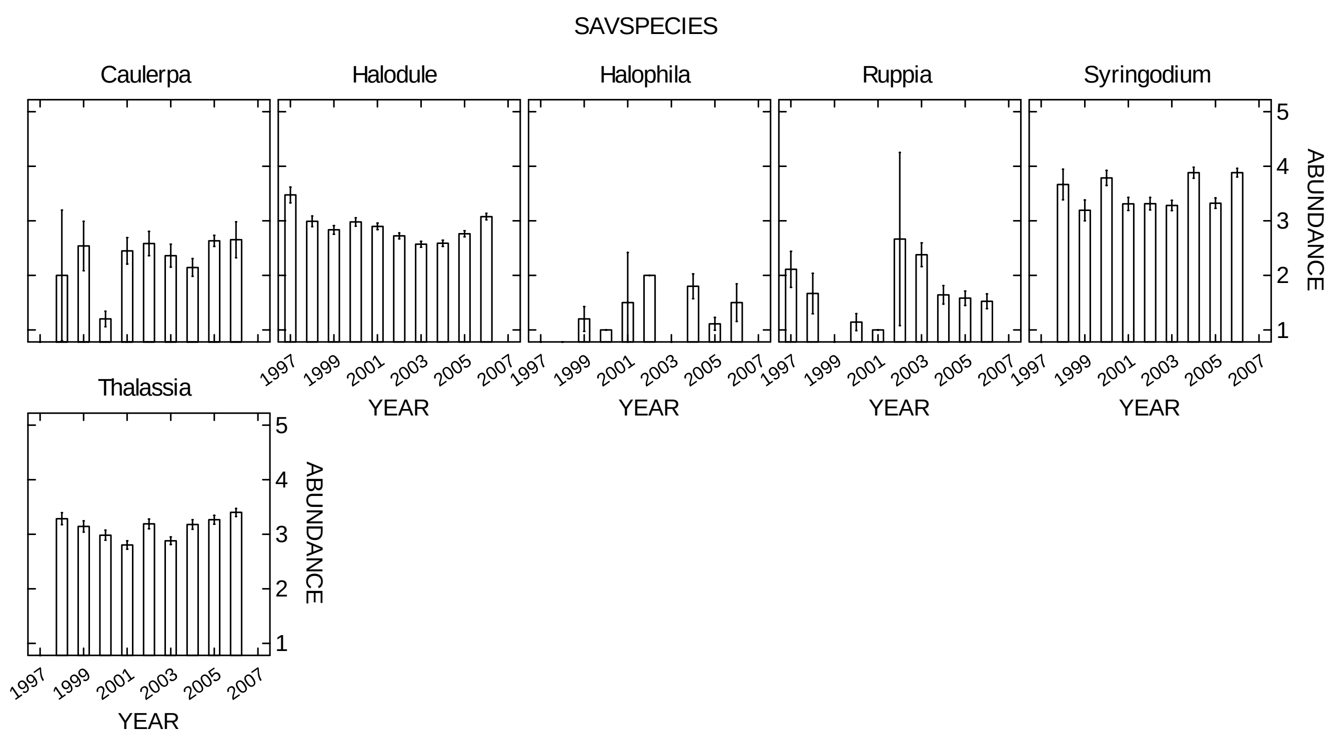
Appendix-TBS3. Short shoot density (SSDm^{-2}) for SAV species within the major Tampa Bay subsections from 1997-2006. Error bars equal 1SE.



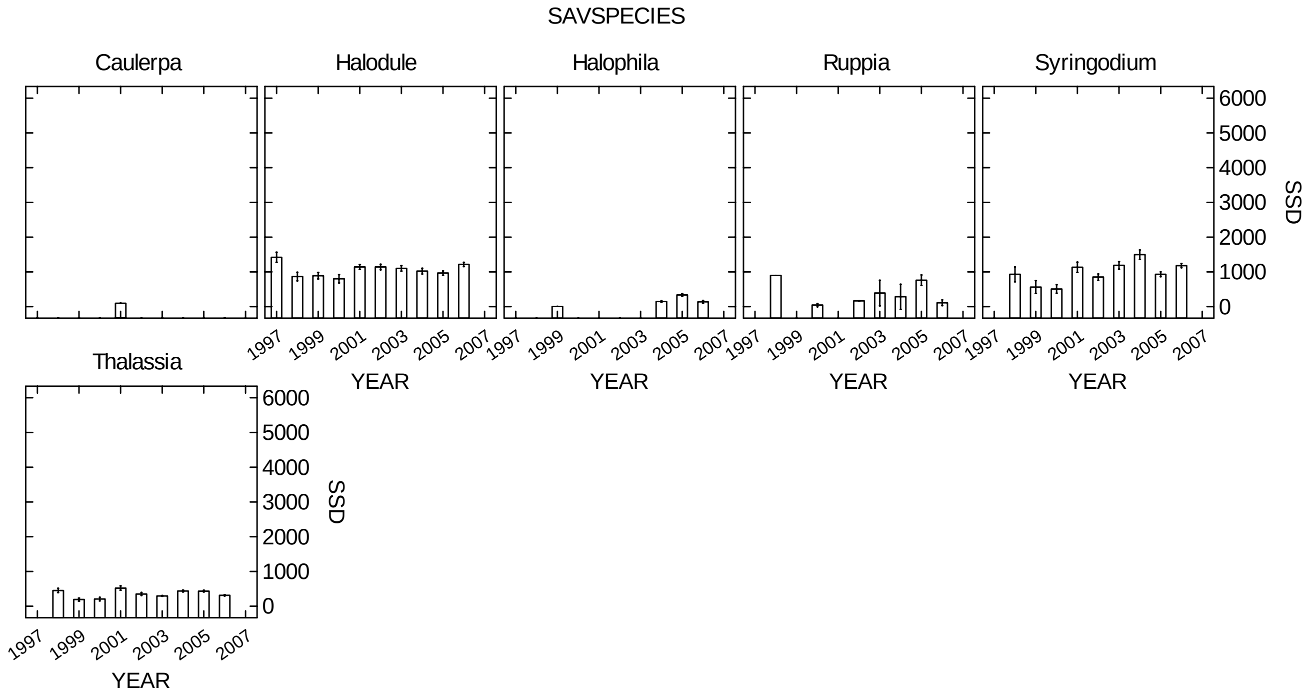
Appendix-TBS4. Canopy height (cm) for SAV species within the major Tampa Bay subsections from 1997-2006. Error bars equal 1SE.



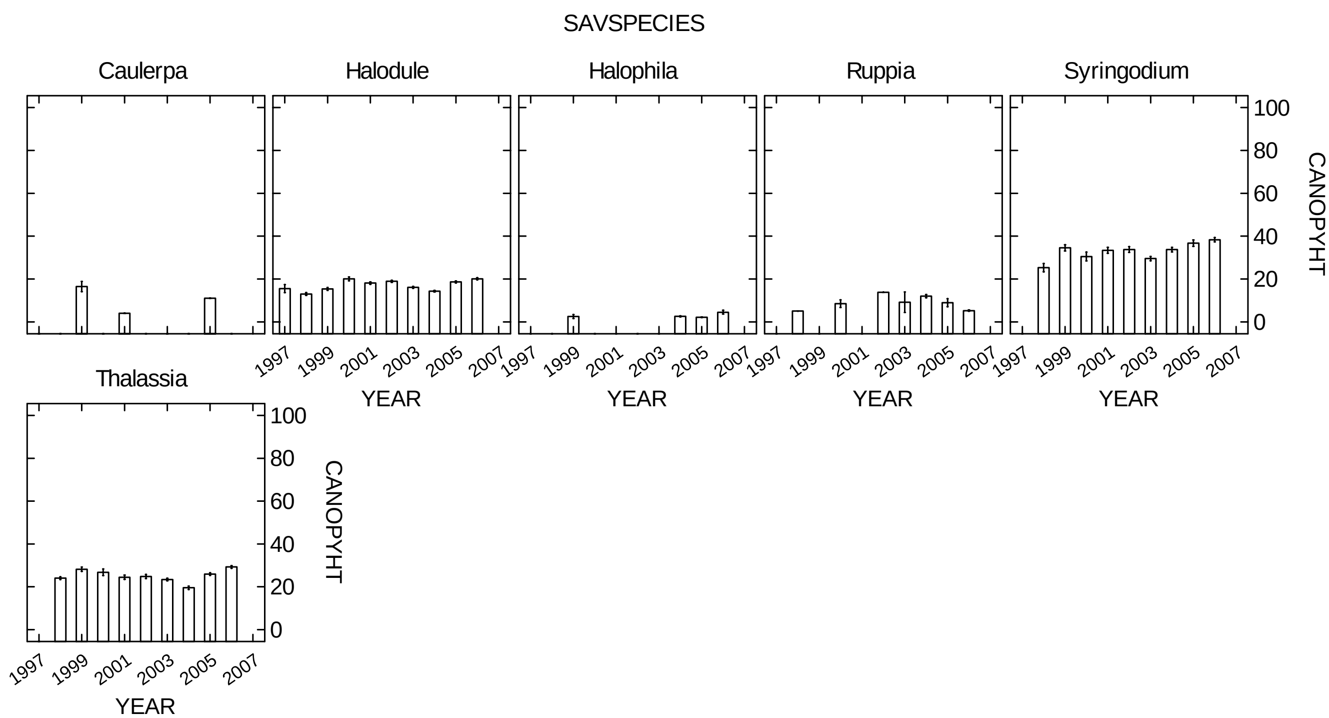
Appendix-TB1. Percent frequency of occurrence of seagrass coverage, *Caulerpa prolifera* coverage, and bare areas within Tampa Bay from 1997-2006.



Appendix-TB2. The abundance (Braun Blanquet class coverage) of SAV coverage within Tampa Bay from 1997-2006. Error bars equal 1SE.



Appendix-TB3. Short shoot density ($SSDm^{-2}$) of SAV coverage within Tampa Bay from 1997-2006. Error bars equal 1SE.



Appendix-TB4. Canopy height (cm) of SAV coverage within Tampa Bay from 1997-2006. Error bars equal 1SE.