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Seagrass monitoring in Old Tampa Bay (Task C)

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DRAFT PENDING RESULTS FROM STATISTICAL ANALYSES

SEAGRASS MONITORING IN OLD TAMPA BAY (TASK C)

A Technical Element of PCEF Project:

IMPLEMENTATION OF THE TAMPA BAY SEAGRASS RESTORATION STRATEGY

Prepared for:

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SEAGRASS MONITORING IN OLD TAMPA BAY (TASK C)

Introduction:

Between 1990 and 1996, increases of seagrass acreage in Tampa Bay occurred at a rate of about 350-500 acres/year, however, a recent estimate by SWFWMD showed a substantial loss of about 2,070 acres between 1996 and 1999. A large portion (about 1,370 acres) of this loss occurred in Old Tampa Bay, primarily along the western shoreline between the Howard Frankland causeway and the Bay-Side bridge.

In 2001, the Tampa Bay Estuary Program, with numerous partners, designed the “Tampa Bay Seagrass Restoration Strategy” to assess potential causes and factors that may hinder successful seagrass restoration primarily in the area defined above. Funding for this project was provided by the Pinellas County Environmental Foundation (PCEF) and the study partners.

A technical element of the seagrass restoration strategy project, called “Task C: Seagrass Intensive Monitoring,” was designed and implemented by the City of Tampa’s Bay Study Group during 2002 and 2003. The purpose of this task was to determine seagrass species distribution and characteristics with water depth in four selected areas in Old Tampa Bay, called quadrants NW, SW, NE and SE (see Figure 1). It should be noted that a substantial and rapid colonization of *Halodule wrightii* occurred in the NW quadrant during 2001 and 2002, prior to the initiation of our study. This new seagrass growth followed the earlier seagrass losses reported for this area (see above). However, much of this newly established seagrass was lost during the course of the seagrass characterization project. Study results from this quadrant therefore reflect, to a large degree, the apparently precarious condition of this short-lived *H. wrightii* coverage.

The seagrass monitoring program coincided with the Old Tampa Bay water quality program, also a technical element of the seagrass restoration strategy project. The primary objective of the seagrass monitoring project was to establish baseline seagrass characteristics in the selected study areas. In addition, the measured seagrass characteristics were to be examined for year-to-year variations, potential relationships with water quality parameters, and also if possible, for relationships with results from other technical elements included in the wide encompassing seagrass restoration strategy project.

Methods:

The seagrass monitoring program consisted of three major activities as listed below.

Seagrass Study Site Monitoring:

Forty-one seagrass study sites were selected in nearshore vegetated areas of the selected Old Tampa Bay study area (13 sites in the NW quadrant, 10 sites in the SW quadrant, and 9 sites each in the SE and NE quadrants, see Figure 1). The study sites in each of the four quadrants included:

- The three seagrass species, *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia* *testudinum*.

- Several seagrass sites selected by FMRI for primary production measurements.
- A wide range in depth distribution of each species.

During September and October of 2002 and October and November of 2003, seagrass characteristics at each study site were assessed within four $1m^{-2}$ placements (MSP; see Figure 2). In each MSP, seagrass abundance as Braun-Blanquet ratings (BB), seagrass density (short-shoots/m^2), and canopy height were determined for each seagrass species encountered. Also in each MSP, attached and drift macroalgae abundance was estimated (BB) and general observations of sediment composition and seagrass epiphyte loads and types were noted. In addition, the elevations expressed as mean tide level, were measured using high resolution kinematic GPS (KGPS) for all seagrass study sites in 2002 and for the NW quadrant only in 2003 (see Johansson 2002 for a description of this technique).

Seagrass Transect Monitoring:

Four seagrass transects in the study area were monitored in early summer (May-June) and fall (September-October) during 2002 and 2003. The monitoring followed the sampling protocols currently employed by the Tampa Bay Interagency Seagrass Monitoring Program, except that water quality measurements were only collected during the fall samplings (see Avery and Johansson 2001). The Hillsborough County Environmental Protection Commission monitored the two transects on the eastern side of the study area in the NE and SE quadrants. The Pinellas County Department of Environmental Management and the City of Tampa each monitored one transect on the western side, the SW and NW quadrants, respectively. Elevation contours of each transect, expressed as mean tide level, were determined by the City of Tampa using KGPS during fall in 2002 and 2003.

Aerial Photography:

The City of Tampa also facilitated a project to obtain professional vertical aerial photography (Gandy Photography, Inc.) of the shallow areas in the Old Tampa Bay study area. Photography was conducted in November 2000, October 2001, and then during both spring and fall of 2002 and 2003. These photos were secured to provide a photographic record of the study areas. A detailed interpretation or discussion of these photos will not be attempted in this report.

Statistical Analyses:

Statistical analyses to test for annual changes in seagrass coverage, and seagrass coverage relationships between water quality and depth distribution were performed by Janicki Environmental, Inc.

Results from these analyses, when completed, will be reported in Appendix A.

Results:

Study Site Seagrass Characteristics:

NW Quadrant (Figure 3):

Fifty-two MSP (13 sites x 4 placements/site) were surveyed for seagrass coverage during October 2002 and November 2003. In 2002, 75 percent of the MSP contained *H. wrightii*. About 15 percent of the MSP contained *S. filiforme* and *T. testudinum* in 2002 and this was relatively unchanged through 2003. However, by 2003, nearly half of the MSP that had contained *H. wrightii* in 2002 had lost all coverage.

The average BB abundance rating decreased for *H. wrightii* and *S. filiforme* between 2002-2003. These ratings are supported by the data for averages of canopy height (CH) and short shoot density (SSD) which also indicate a decrease between 2002-2003.

The decrease seen in *T. testudinum* abundance is minimal and may be considered as inconsequential. A decrease in average CH was seen between 2002-2003, however, the SSD average increased. The trends of decreased CH and increased SSD may offset each other when estimating seagrass abundance.

NE Quadrant (Figure 4):

Nearly 65 percent of the 36 MSP (9 sites x 4 placements/site) surveyed for seagrass coverage during October/ November 2002 contained *H. wrightii*. A slight decrease in *H. wrightii* presence was noted in November 2003, primarily due to displacement by *R. maritima* at one site.

S. filiforme presence within MSP decreased from over 30 percent in October/November 2002 to just under 20 percent in November 2003. This was due to a loss of coverage at study site NE1 (see Figure 1).

T. testudinum was documented in nearly 40 percent of the MSP during October/November 2002. In November 2003, coverage was noted within one MSP that did not contain this species in 2002.

A decrease in average CH combined with a slight increase in average SSD for *H. wrightii* and *T. testudinum* yielded a "no change" in BB abundance ratings between 2002-2003 for these two species. There was, however, a considerable decline in abundance for *S. filiforme* during this time. This decline was a result of a 13cm reduction in the average CH combined with the SSD thinning from ca. $900ssm^{-2}$ in 2002 to $275ssm\text{-}^{2}$ in 2003.

SW Quadrant (Figure 5):

Forty MSP (10 sites x 4 placements/site) were surveyed for seagrass coverage during October 2002 and November/December 2003. During 2002, 28 percent of the MSP contained *H. wrightii*, 47 percent *S. filiforme*, and 19 percent *T. testudinum*. In 2003, sites containing *H. wrightii* dropped slightly to 25 percent. However, *S. filiforme* coverage expanded at four sites and decreased at one site as this species was documented in 67 percent of the MSP. Finally, *T. testudinum* coverage increased at two sites between 2002-2003 resulting in an increase from 19 percent to 22 percent of MSP in which this species was found.

The average BB ratings for *H. wrightii* decreased between 2002-2003 reflecting the decrease in SSD and CH. The BB ratings for *S. filiforme* and *T. testudinum* were essentially unchanged for the time period as increased SSD offset the decrease in CH.

SE Quadrant (Figure 6):

Thirty-six MSP (9 sites x 4 placements/site) were surveyed for seagrass coverage in November 2002 and November/December 2003. In 2002, 39 percent of the MSP contained *H. wrightii*, while *S. filiforme* and *T. testudinum* were documented in 53 and 47 percent, respectively. In 2003, 31 percent of the MSP contained *H. wrightii* due to lost coverage in three MSP. *S. filiforme* was found in 57 percent of the MSP due to new coverage in one placement. The frequency of occurrence for *T. testudinum* did not change between 2002-2003.

Despite a reduction in CH, the average BB ratings for *H. wrightii* increased between 2002-2003 as SSD increased substantially in nearly all meter square placements. BB ratings for *S. filiforme* and *T. testudinum* were similar for 2002-2003 as increased SSD offset the decreased CH.

Transect Seagrass Characteristics:

NW Quadrant (Figure 7):

Data collections along this transect began in May 2001. At that time, the first 700m of the transect had the most abundant *H. wrightii* coverage. Patchy *S. filiforme* was observed along the 1700-2000m section. *T. testudinum* was observed in one area of the transect, however, this coverage did not fall within a pre-selected MSP.

H. wrightii has shown the greatest fluctuation of the three species in terms of abundance and presence/absence. The number of MSP in which this species was found increased through May 2002 and then declined by October 2002. This decline was especially evident between 150-750m. Concurrent with the reduction of *H. wrightii* occurrence, the general abundance also declined. During May 2003, *H. wrightii* appeared to recolonize somewhat although abundance remained low. The occurrence and abundance declined slightly by October 2003.

Generally, *S. filiforme* has been constrained to the 1700-2000m section of the transect. The abundance for this species has fluctuated since 2001, attaining the greatest abundance in May 2003.

Sparse *T. testudinum* has sporadically been seen at 185m since 2001.

NE Quadrant(Figure 8) :

Since data collection began along this transect in 1998, three distinct zones of seagrass coverage have been documented. Generally, *H. wrightii* has been dominant along the 50-225m segment of the transect. Species composition transitions to *T. testudinum* between 225m-400m with some *S. filiforme* contributing to an area of mixed species at the seaward edge of this coverage. Finally, there is a transition from *S. filiforme* to *H. wrightii* beyond the 400m mark.

The shoreward *H. wrightii* has been fairly persistent, however, abundance has increased substantially through October 2003. Conversely, since 1998, the seaward *H. wrightii* edge has receded near 40m and abundance has been reduced.

The *T. testudinum* coverage has been generally stable with some minor interannual variations in abundance. Similarly, *S. filiforme* coverage along the 350-400m section of the transect has been generally stable.

SW Quadrant (Figure 9):

Seagrass coverage along this transect has been dominated by a *H. wrightii* meadow between 150-625m. The typically ephemeral *Ruppia maritima* coverage has waxed and waned along the first 250m of the transect and occasionally mingled with the most inshore *H. wrightii* coverage. *T. testudinum* coverage began near the seaward terminus of the *H. wrightii* meadow and, as the *H. wrightii* coverage ended, became the dominant species out to the crest of the longshore bar. On the seaward face of the longshore bar, *H. wrightii* has been the shallowest species, transitioning *to T. testudinum* at a slightly deeper depth, and finally progressing to *S. filiforme* dominated coverage at the deep edge of the seagrass meadow.

H. wrightii coverage along this transect has been fairly stable since data collection began in May 2001. There have been some interannual fluctuations in coverage and abundance, particularly shoreward of 400m.

S. filiforme coverage has expanded seaward ca. 15m along the seaward face of the longshore bar between May 2001 and October 2003. There have been some interannual fluctuations in abundance at the limited coverage near the 600m site.

T. testudinum shoreward of the longshore bar has been generally stable during the three years of data collection. However, *T. testudinum* coverage on the seaward face of the longshore bar has expanded since May 1991.

SE Quadrant (Figure 10):

Data collected since 1998 indicate that seagrass coverage along this transect has shifted from an area comprised primarily of *T. testudinum* to a meadow co-dominated by *T. testudinum* and *H. wrightii*. Although some *H. wrightii* has recolonized within existing *T. testudinum* beds, much of the new *H. wrightii* has recolonized the previously unvegetated areas between the *T. testudinum* meadows. *S. filiforme* was noted at both ends of the transect.

The increased number of MSP containing *H. wrightii* between May 2002 and October 2003 indicates increased coverage. Also, the abundance increased in most areas.

S. filiforme coverage and abundance fluctuated between 1998 and 2001. However, since 2001, *S. filiforme* along the 350-400m section of the transect (the offshore face of the bar) has increased in both coverage and abundance.

T. testudinum presence increased along the 150-225m section of the transect between 1998-1999, however, only minor interannual variations in coverage and abundance have been noted recently.

Seagrass Study Site and Transect Elevation Measurements:

Examples of results from seagrass study site elevation measurements in 2002 and 2003 in the NW quadrant are shown in Figures 11 and 12. This was the only quadrant where study site elevations were measured both in 2002 and 2003. The elevation differences seen between the two years are generally not greater than the error of the method used. Therefore, no significant loss or accumulation of sediment could be detected between the two sampling periods. To note, this finding encompasses study sites with seagrass cover that changed little between the two years to sites that changed from dense seagrass cover in 2002 to bare sand in 2003 (see below). An example of the former is site NW1 (Figure 11), and an example of the latter is site NW8B (Figure 12). All study site locations and 2002 depth measurements are shown in Table 1.

Elevation contours of the four transects, one located in each transect (see Figure 1), were determined during the fall in 2002 and 2003. The bathymetric profiles recorded for the transects located in the SE (Figure 13) and SW (Figure 14) quadrants suggest little change between the two years of surveys. The contours generated for the transect located in the NE (Figure 15) quadrant, may suggest that an approximately 20m narrowing of the longshore bar occurred between the two sampling periods. However, additional measurements are needed to confirm these findings. The apparent elevation differences recorded between the two years for the near-shore shallow portion of this transect were probably due to methodology problems caused by poor GPS satellite coverage. Elevation differences between the two years for the transect in the NW quadrant (Figure 16) are generally within the error of the method used. Still, it is interesting to note that relatively large variations occurred in the 1300 to 1700m portion of the transect, an area with substantial seagrass loss between the two years. Nevertheless, to determine if this portion of the transect is subject to significant sediment shifts, additional measurements are needed.

Discussion and Conclusion:

Seagrass Characteristics:

Seagrass observations from both transects and study sites indicate, in general, that there were no large losses of seagrass in the NE, SE, and SW quadrants during the period of study. However, there were shifts in seagrass species composition within specific areas and these changes are discussed below. In contrast, species composition changed little in the NW quadrant except for the marked reduction of *H. wrightii* presence.

The transect data from the NE quadrant indicate that seagrass coverage (independent of species composition) was relatively consistent out to 450m. However, there was a species shift during 2002-2003 from a *H. wrightii* dominated community along the 50-200m section of the transect to a community co-dominated by *H. wrightii* and *R. maritima*. Further, the seaward seagrass edge of the transect has receded ca. 40m since 1998, potentially exposing the longshore bar to erosion. Finally, although the transect data indicate a fairly stable *S. filiforme* presence shoreward of the longshore bar, study site data show a decline in *S. filiforme* at two “edge of bed” study sites. This difference may be a result of the transect *S. filiforme* receiving less wave energy exposure due to the protection of the longshore bar. The study site *S. filiforme* lack the protection from such a feature.

In the SE quadrant, transect and study site data indicate that both *S. filiforme* and *T. testudinum* are stable species. In contrast, transect data indicate an expansion of *H. wrightii* coverage during 2002-2003 while the study site data show a loss of *H. wrightii* within meter square placements. Both data sets, however, appear to agree that *H. wrightii* abundance has increased.

In the SW quadrant, transect and study site data show no major variations in *H. wrightii*, *S. filiforme*, and *T. testudinum* coverage. Transect data indicate expansion of the offshore *S. filiforme* since 2001. Similarly, expansion of *S. filiforme* was noted at three study sites between 2002-2003. Further, there were species shifts within specific sites. For example, a mixed *H. wrightii*/*T. testudinum* site transitioned into a predominately *T. testudinum* site in the southern region of the quadrant between 2002-2003.

A substantial seagrass loss has been reported for the NW quadrant between 1996 and 1999 (see above). However, no information exists describing which species contributed to this loss. Following this period, there was considerable *H. wrightii* recolonization in the NW quadrant. *H. wrightii* recolonization was noted on the transect from May 2001 (initial data collection) through May 2002, near the time for implementation of the "Tampa Bay Seagrass Restoration Strategy" project. Therefore, the data collection in this quadrant appears to have been initiated during a period of *H. wrightii* recolonization and expansion.

Following the short period of *H. wrightii* recolonization in the NW quadrant, a decline was noted in October 2002 and the subsequent data indicate that the loss of *H. wrightii* continued through 2003. Antithetically, *S. filiforme* and *T. testudinum* coverage in the NW quadrant have been fairly stable, although it appears that the *S. filiforme* abundance has been more variable than *T. testudinum*.

Macroalgae appears to be persistent in the NW, NE, and SW quadrants. Although the macroalgae abundance has been rated through the BB class coverage system, seasonal fluctuations in biomass and species composition were not assessed. Sufficient macroalgae biomass combined with an extended residence time may have a negative impact on seagrass coverage due to extended light reduction, the effect of a macroalgae mat on local water chemistry, and the abrasive effect of macroalgae on seagrass.

Seagrass Depth Distribution:

The depth distribution of the three seagrass species in each quadrant, was determined from both study site and transect elevation measurements (Figure 17). *H. wrightii* was the shallowest occurring seagrass in all four quadrants. This species was found as shallow as –0.24mMTL in the NE quadrant. Shallow located *S. filiforme* and *T. testudinum* were generally found at deeper depths. Quadrants NE and NW had relatively narrow depth ranges for the three seagrass species. Specifically, *S. filiforme* and *T. testudinum* in the NW quadrant had very narrow depth ranges, resulting from the relatively limited distribution of these species in this quadrant. In contrast, quadrants SE and SW had seagrass growth over wide depth ranges as a result of well developed seagrass meadows (*S. filiforme* and *T. testudinum*, and *H. wrightii* and *S. filiforme*, respectively) offshore from the shallow longshore sand bar at the deep edge of the near shore flats. The deepest grass located during the study was *T. testudinum*, in the SE quadrant at approximately –1.50mMTL. Both *H. wrightii* and *S. filiforme* reached about –1.40mMTL in the SW quadrant.

Recommendations for Future Studies:

It is recommended that a study aimed to answer the following question be considered as a future task: “Is the maintenance of a stable longshore bar dependent on healthy seagrass coverage on the offshore slope of the bar?” This question has broad seagrass management implications for Tampa Bay. Several Tampa Bay seagrass researchers have postulated that prominent longshore bars serve an important function in the protection of seagrass meadows on the shallow flats inshore of the bars (Lewis et al. 1985; Lewis 2002). With a loss or reduction of the bar, it can be expected that substantial seagrass losses will occur on the shallow shelf.

Observations during the Old Tampa Bay study, and other studies as well, suggest that prominent shallow sandbars at the offshore edge of the near-shore flats only appear to be present where relatively dense seagrass coverage exists on the offshore slope of the bar. Examples of such areas include, North Shore Park and Coquina Key in St. Petersburg, and the SW quadrant in Old Tampa Bay. In areas currently lacking seagrass coverage on the offshore slope, examinations of historical and recent aerial photography indicate that bars, that were present historically, have been subject to substantial erosion following the apparent loss of seagrass on the offshore slope. Examples of such areas include, Wolf Branch and the Kitchen in Hillsborough county.

The Fish Creek area in the NE quadrant of Old Tampa Bay currently has a relatively well developed longshore bar. However as discussed above, elevation contours of the transect in this area, determined during the fall of 2002 and 2003, may suggest that an approximately 20m narrowing of the bar occurred between the two sampling periods (see Figure 15). In addition, seagrass surveys of the transect conducted since 1998 clearly show that the seaward edge of the seagrass on the offshore slope has retreated towards shore by approximately 40m. Currently, the seaward edge of the grass nearly coincides with the crest of the longshore bar.

Thus, the longshore bar at Fish Creek may be threatened by erosion due to receding offshore seagrass cover, and would, therefore, present an excellent study opportunity to evaluate the theory that the maintenance of a stable longshore bar is dependent on healthy seagrass coverage on the offshore slope.

In addition to the longshore bar studies at Fish Creek, and appropriate control sites, it is also recommended that the monitoring of the seagrass transects in the four quadrants be continued on, at least, on an annual basis and that annual aerial photography of the four quadrants be conducted during the fall.

Additional recommendations may be proposed when the statistical analyses performed by Janicki Environmental Inc. have been completed.

References:

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LOCATION OF SEAGRASS SURVEY SITES AND MEASURED DEPTH IN 2002			
STUDY SITE	LAT	LON	AVERAGE DEPTH (mMTL)
NE1	27.9476	-82.5454	-0.60
NE2	27.9543	-82.5499	-0.55
NE3	27.9581	-82.5493	-0.45
NE4	27.9543	-82.5488	-0.60
NE5	27.9595	-82.5636	-1.05
NEP1	27.9411	-82.5511	-0.75
NEP2	27.9622	-82.5635	-0.70
NEP3	27.9653	-82.5586	-0.60
NEP4	27.9612	-82.5531	-0.35
NW1	27.9167	-82.6713	-0.80
NW10	27.9185	-82.6504	-0.75
NW11	27.9245	-82.6524	-1.10
NW2	27.9214	-82.6536	-0.90
NW3	27.9176	-82.6630	-0.85
NW4	27.9092	-82.6466	-0.80
NW5	27.9178	-82.6530	-0.90
NW6	27.9095	-82.6520	-0.80
NW7	27.9112	-82.6392	-0.90
NW8B	27.9191	-82.6518	-0.75
NW9	27.9144	-82.6467	-0.80
NWP1	27.9087	-82.6409	-0.50
NWP3	27.9141	-82.6465	-0.80
SE1	27.8972	-82.5370	-0.75
SE2	27.9060	-82.5356	-0.50
SE3	27.9148	-82.5363	-1.05
SE4	27.9359	-82.5457	-1.40
SE5	27.9362	-82.5451	-1.25
SEP1	27.9388	-82.5544	-0.80
SEP2	27.9391	-82.5385	-0.60
SEP3	27.9107	-82.5368	-0.55
SEP4	27.8967	-82.5345	-0.60
SW1	27.9011	-82.6248	-1.10
SW2	27.8851	-82.6148	-0.80
SW3B	27.8883	-82.6145	-1.40
SW4	27.8812	-82.6071	-1.40
SW5	27.8897	-82.6209	-0.95
SW6	27.8939	-82.6165	-1.15
SWP1	27.8887	-82.6266	-0.50
SWP2	27.8801	-82.6119	-0.65
SWP3	27.8780	-82.6100	-0.70
SWP4	27.8796	-82.6057	-0.95

Table 1. Location of seagrass survey sites and measured depth in 2002.

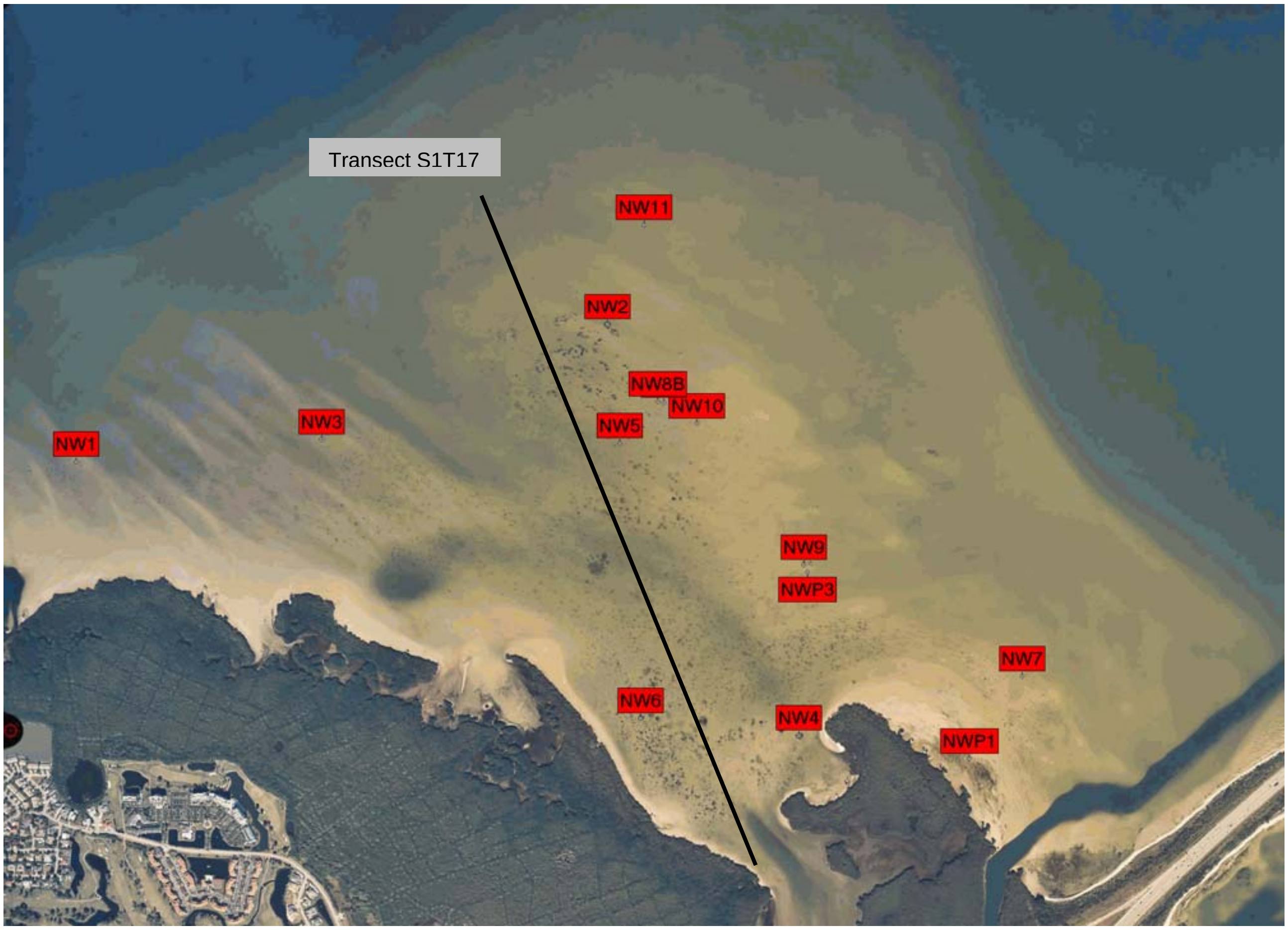

Figure 1A. Location of seagrass study sites and transect in the NW quadrant of Old Tampa Bay.

Figure 1B. Location of seagrass study sites and transect in the SW quadrant of Old Tampa Bay.

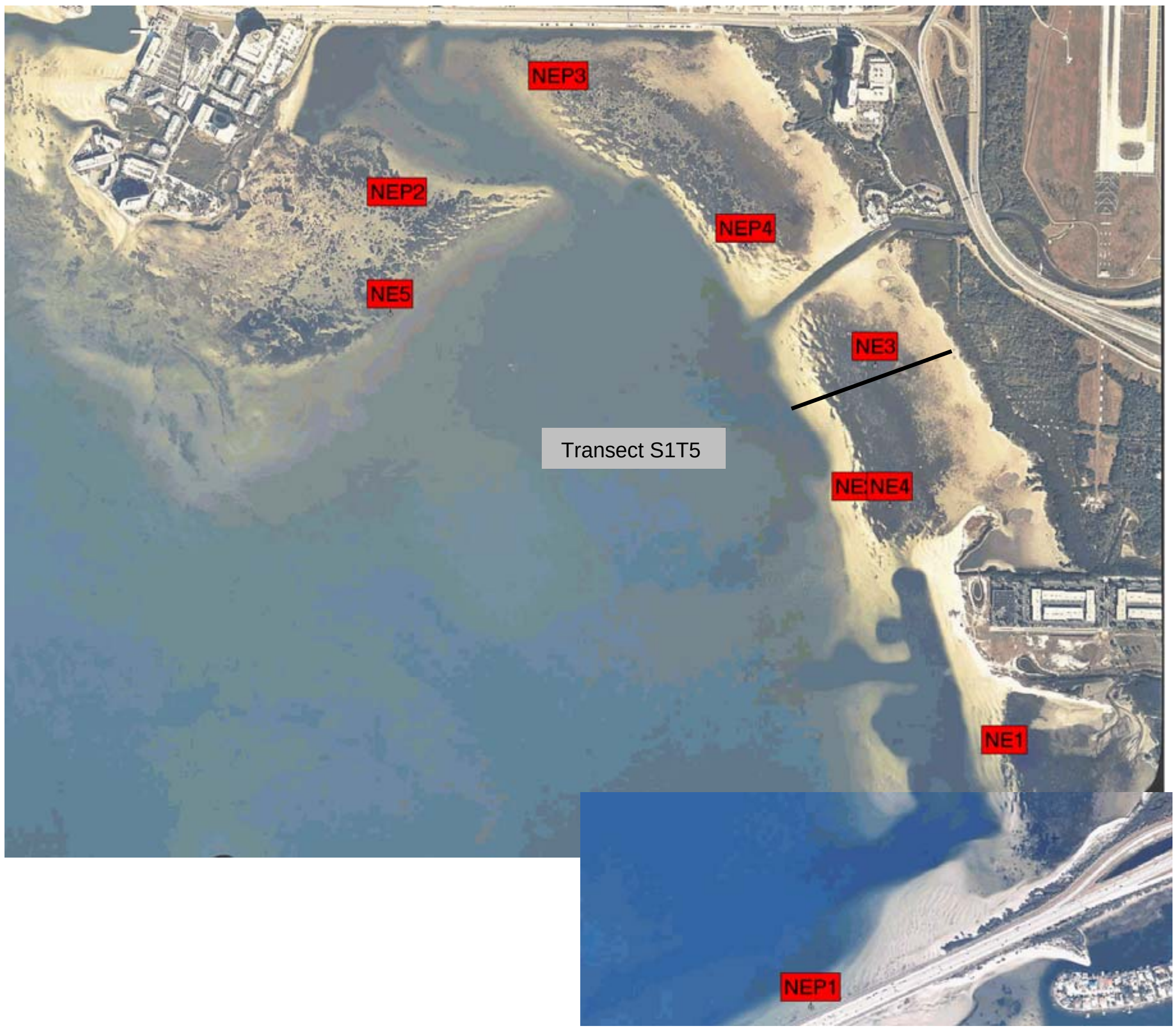

Figure 1C. Location of seagrass study sites and transect in the NE quadrant of Old Tampa Bay.

Figure 1D. Location of seagrass study sites and transect in the SE quadrant of Old Tampa Bay.

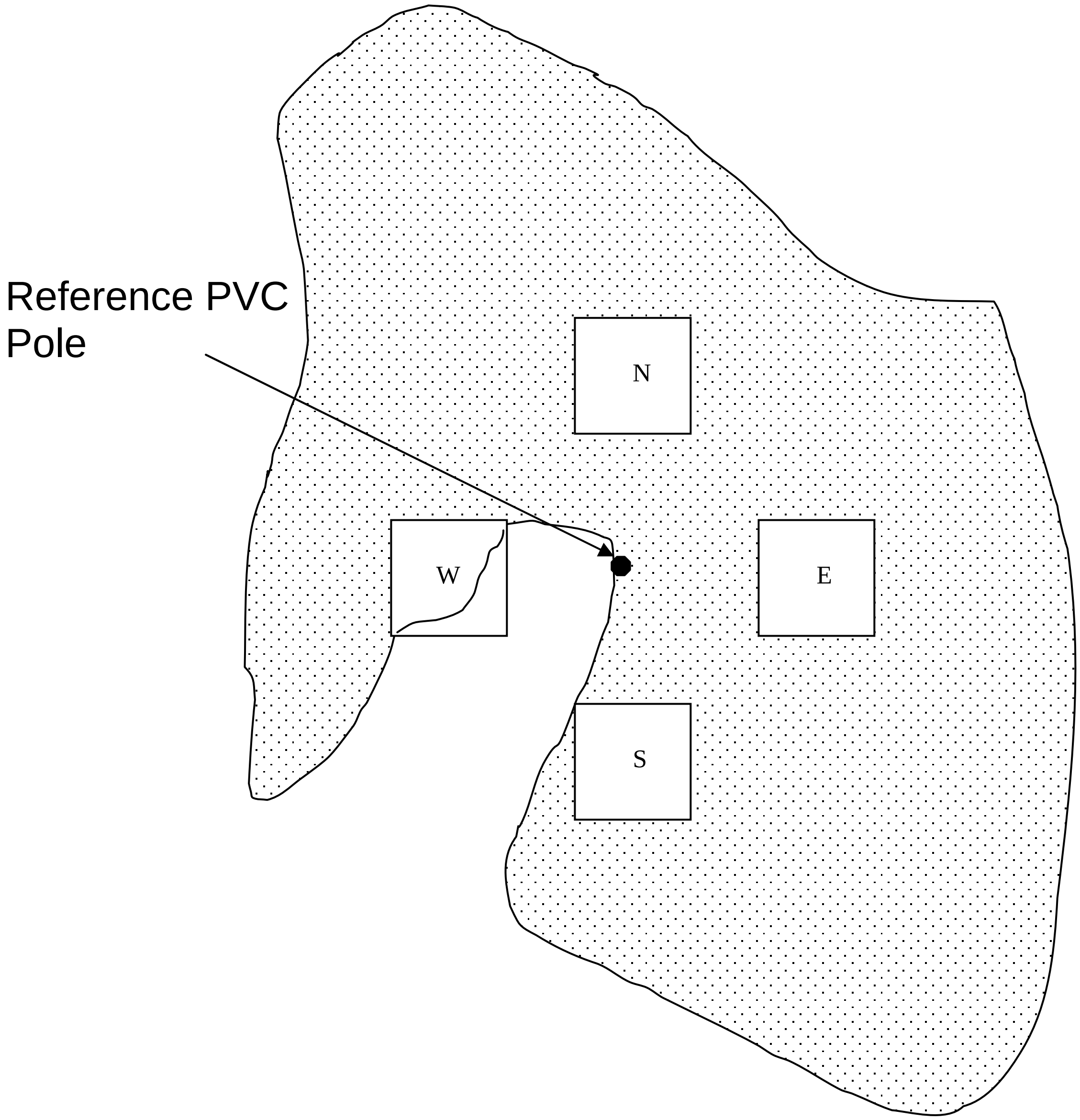

Figure 2. Placement of $1m^{-2}$ grids within seagrass coverage in relation to PVC reference pole.

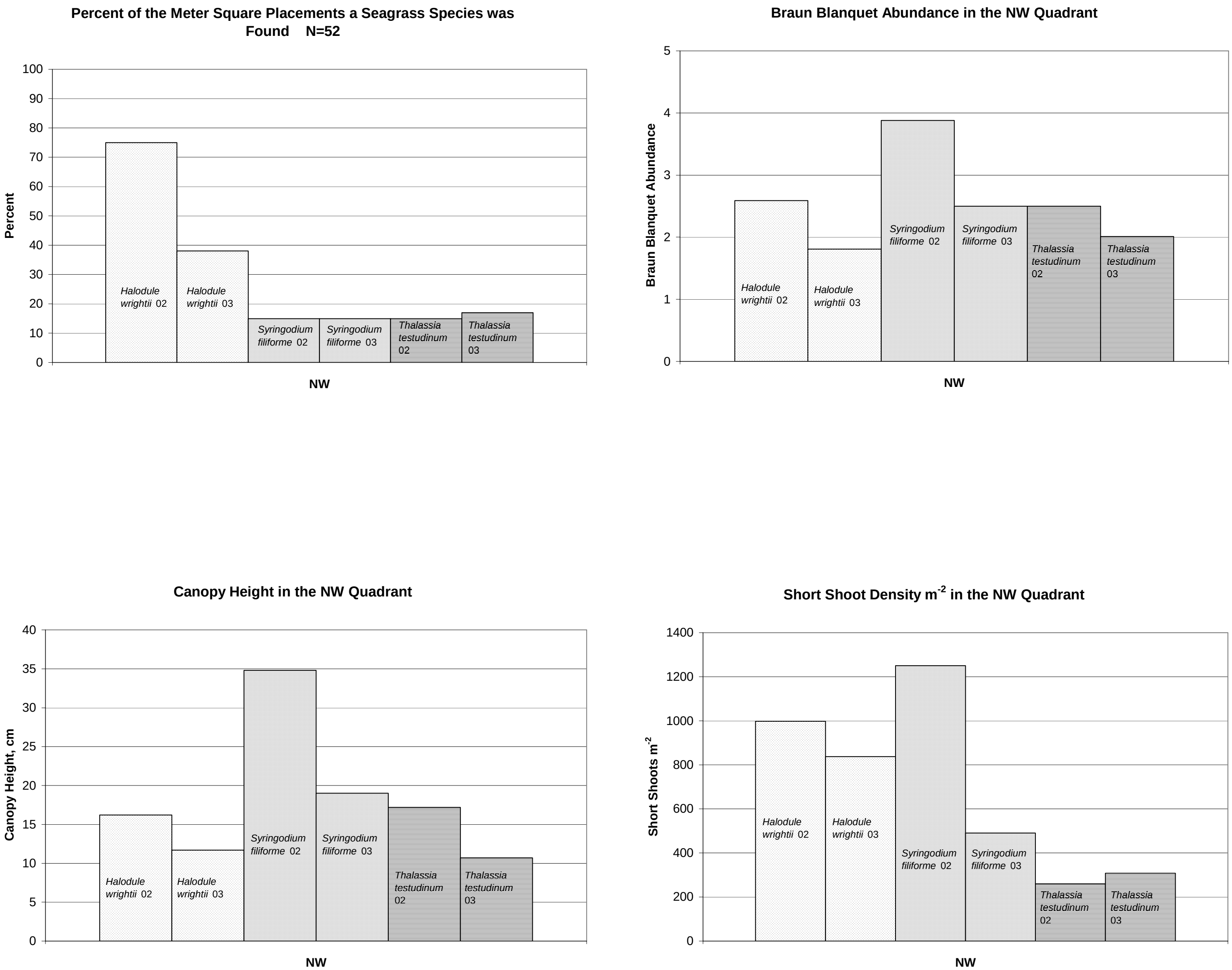

Figure 3. Percent Occurrence, Braun Blanquet Abundance, Canopy Height, and Short Shoot Density of *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum* in the NW Quadrant in 2002 and 2003.

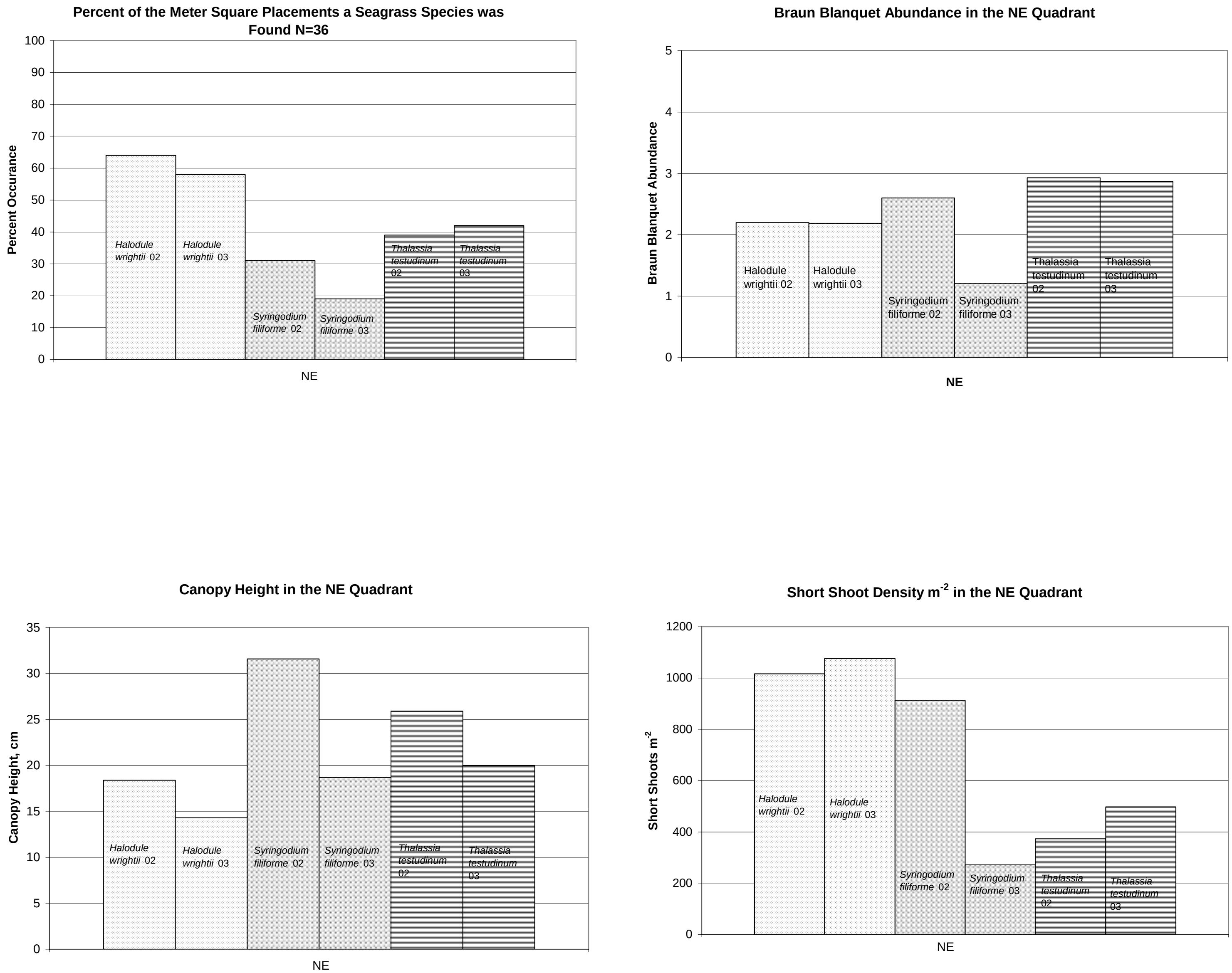

Figure 4. Percent Occurrence, Braun Blanquet Abundance, Canopy Height, and Short Shoot Density of *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum* in the NE Quadrant in 2002 and 2003.

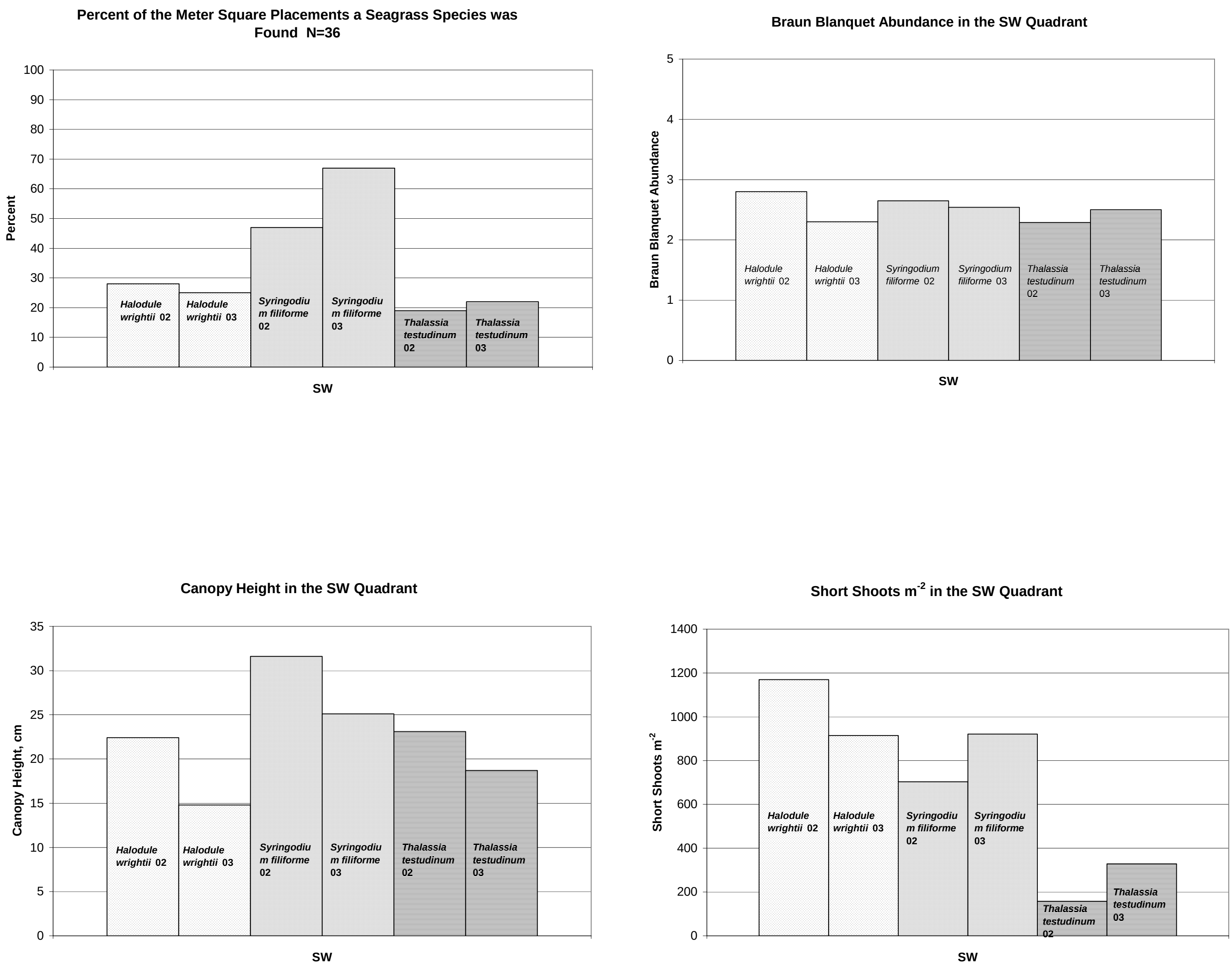

Figure 5. Percent Occurrence, Braun Blanquet Abundance, Canopy Height, and Short Shoot Density of *Halodule wrightii*, *Syringodium filiforme,* and *Thalassia testudinum* in the SW Quadrant in 2002 and 2003.

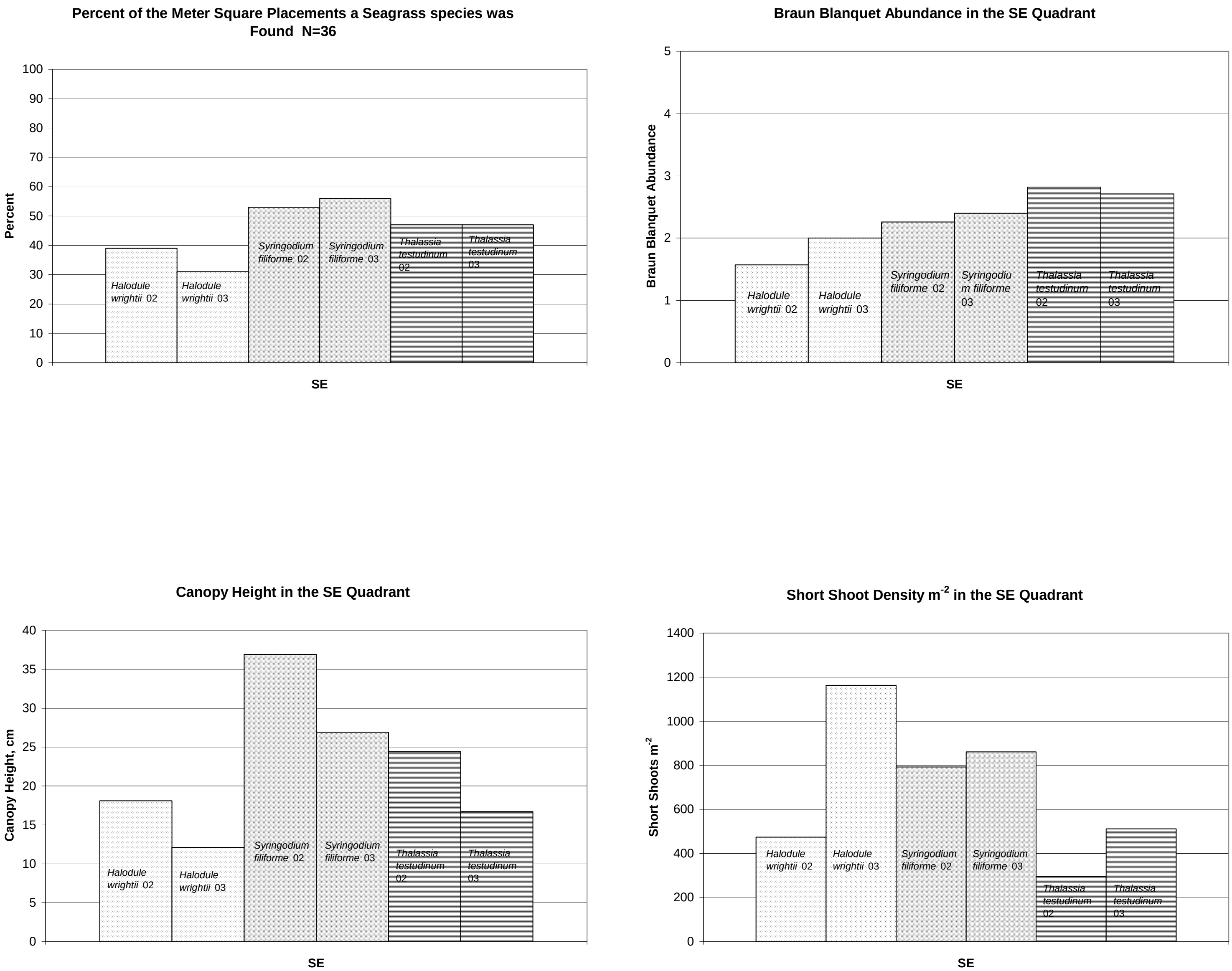

Figure 6. Percent Occurrence, Braun Blanquet Abundance, Canopy Height, and Short Shoot Density of *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum* in the SE Quadrant in 2002 and 2003.

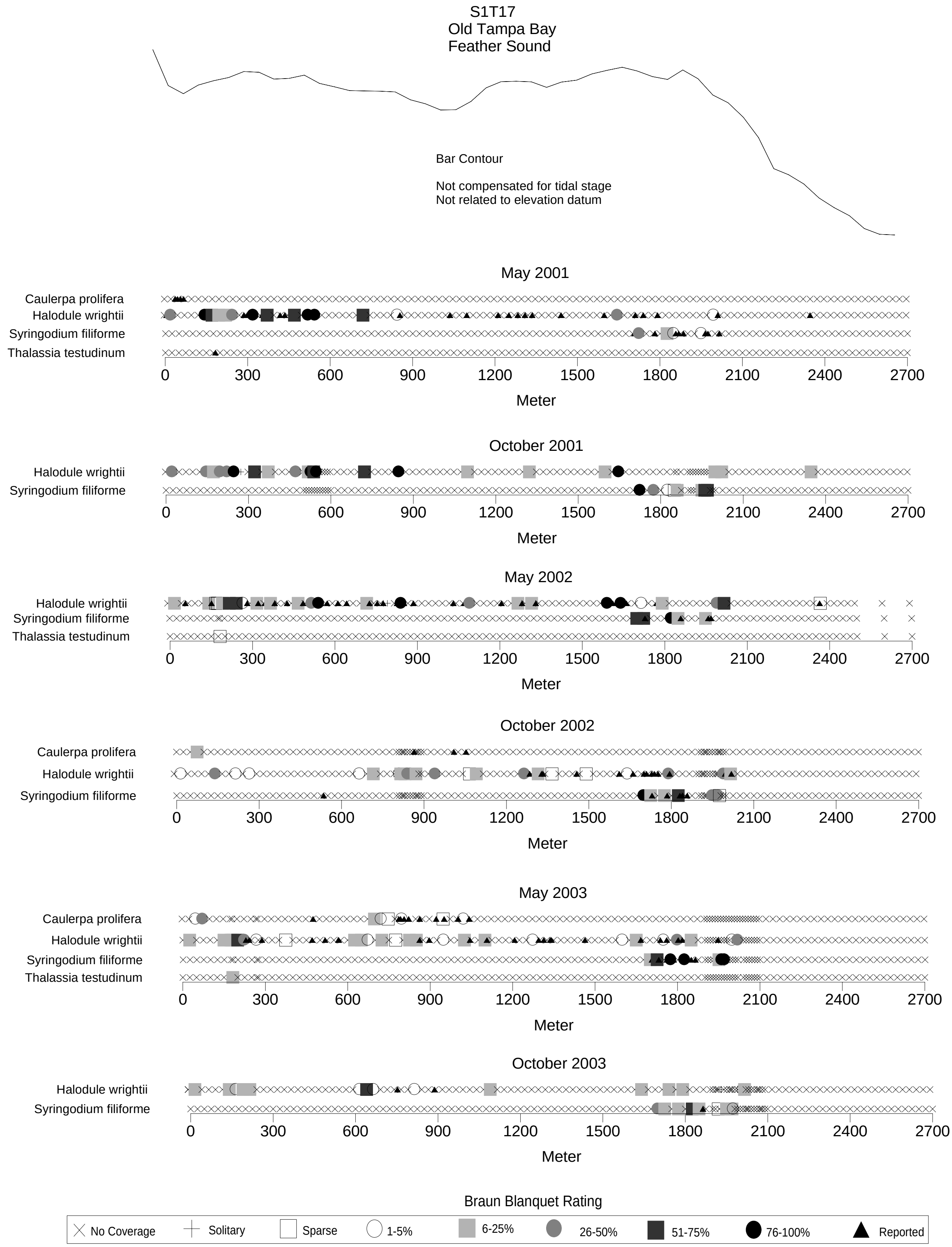

Figure 7. Distribution and abundance of *Halodule wrightii*, *Syringodium filiforme*, *Thalassia testudinum*, and the attached alga, *Caulerpa prolifera*, along Transect S1T17 (NW Quadrant) from May 2001-October 2003.

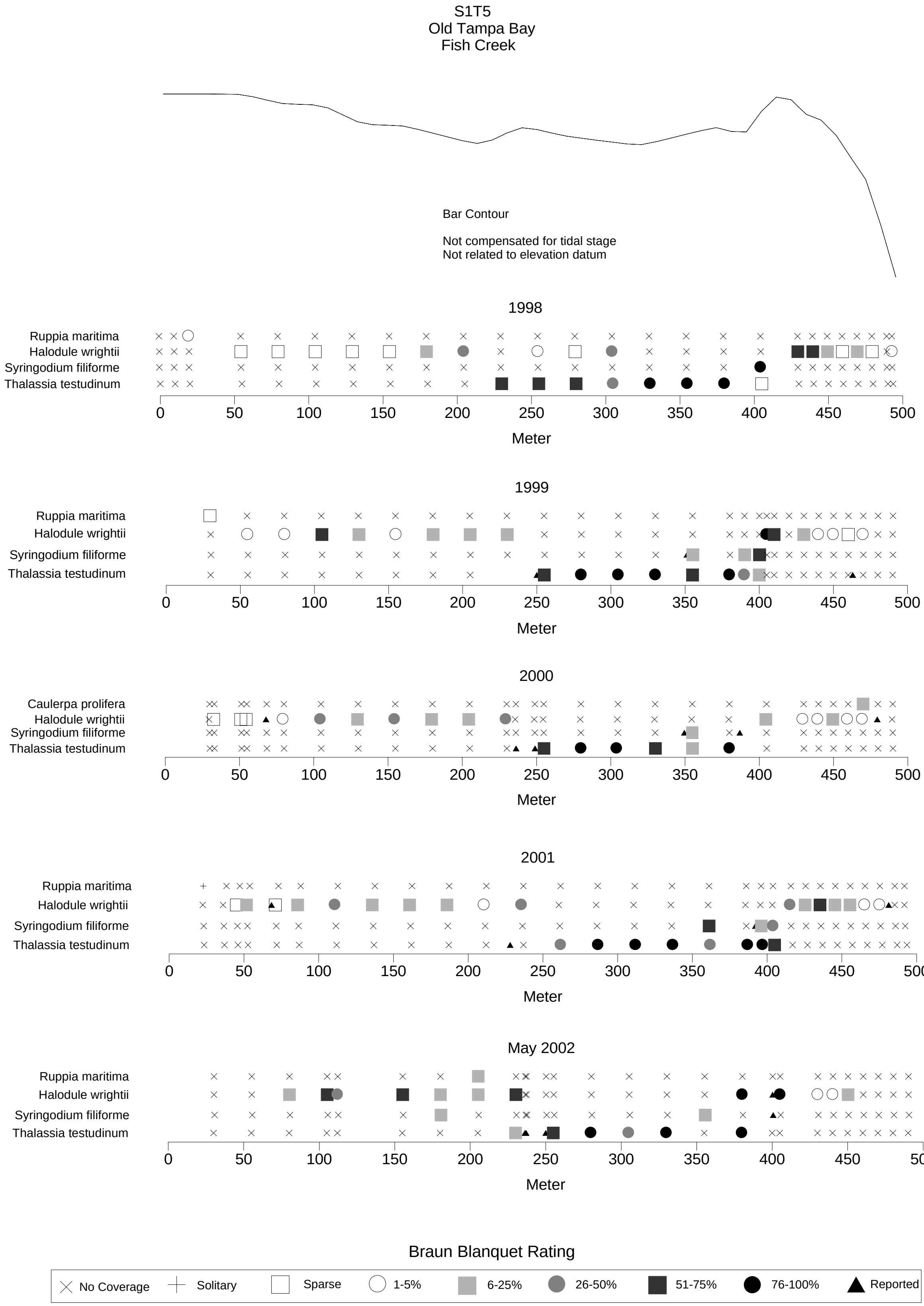

Figure 8. Distribution and abundance of *Ruppia maritima*, *Halodule wrightii*, *Syringodium filiforme*, *Thalassia testudinum*, and the attached alga, *Caulerpa prolifera*, along Transect S1T5 (NE Quadrant) from October 1998-October 2003 (continued next page).

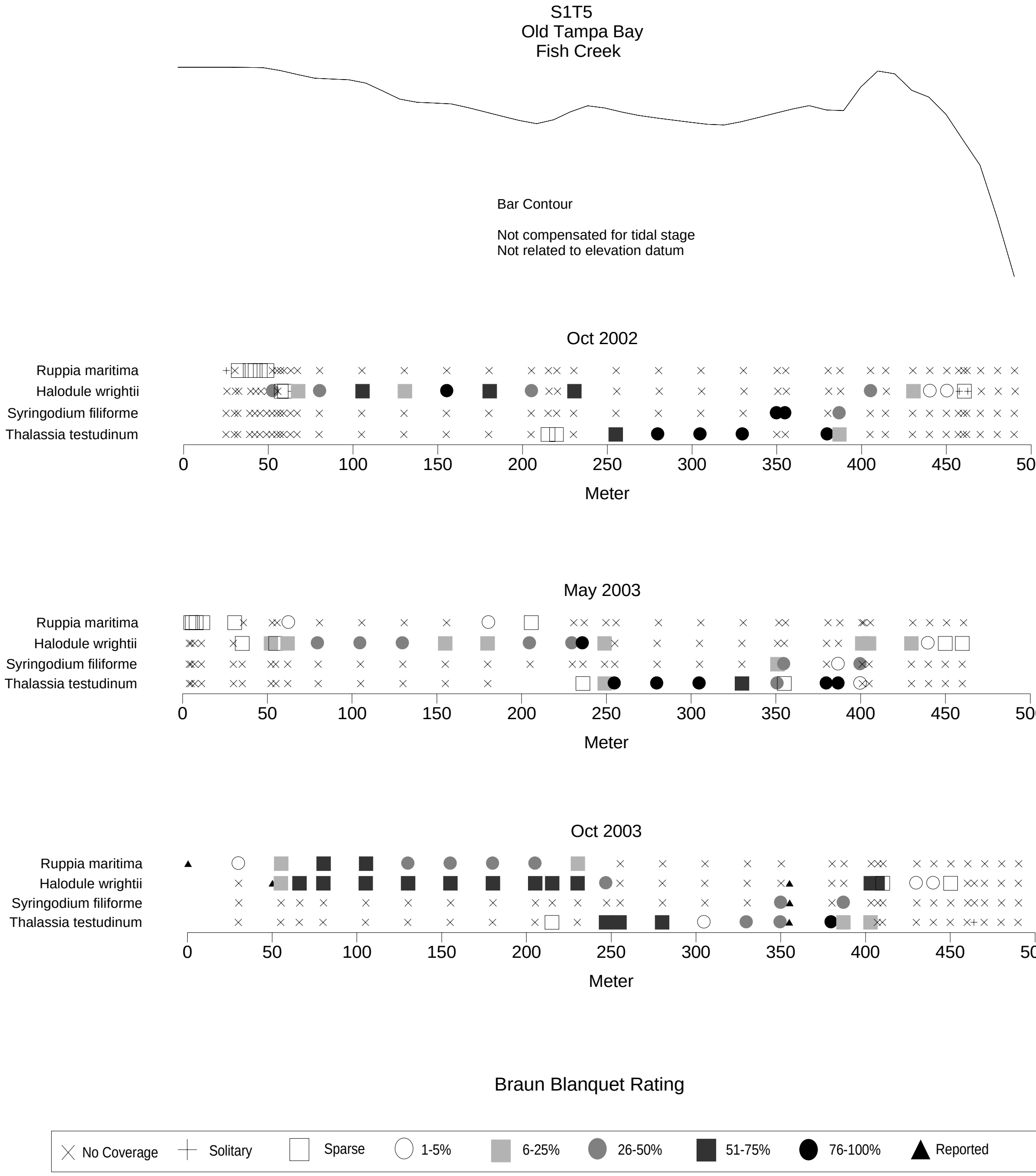

Figure 8 (Continued). Distribution and abundance of *Ruppia maritima*, *Halodule wrightii*, *Syringodium filiforme*, *Thalassia testudinum*, and the attached alga, *Caulerpa prolifera*, along Transect S1T5 (NE Quadrant) from October 1998-October 2003.

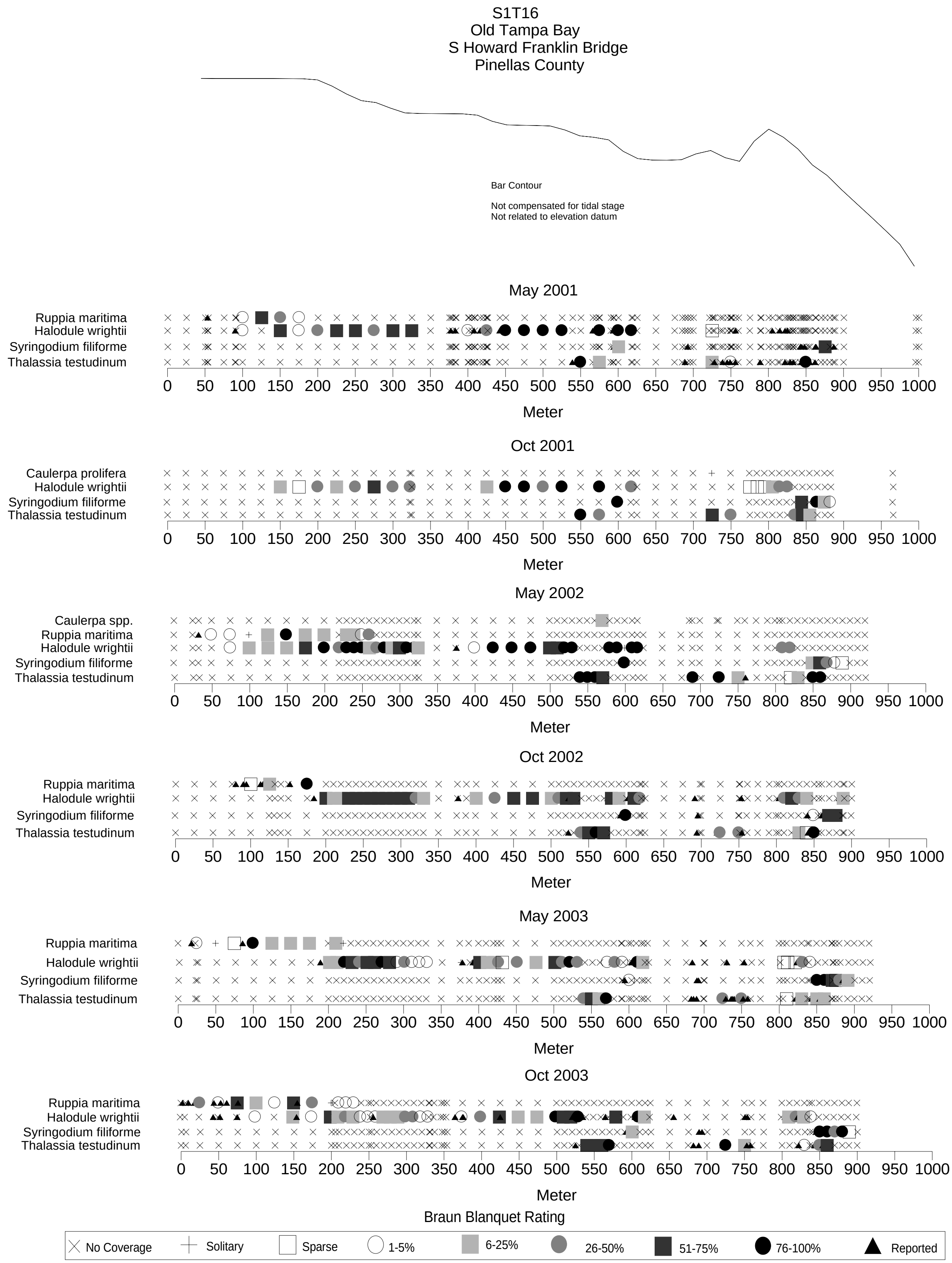

Figure 9. Distribution and abundance of *Ruppia maritima*, *Halodule wrightii*, *Syringodium filiforme*, *Thalassia testudinum*, and the attached alga, *Caulerpa prolifera*, along Transect S1T16 (SW Quadrant) from May 2001-October 2003.

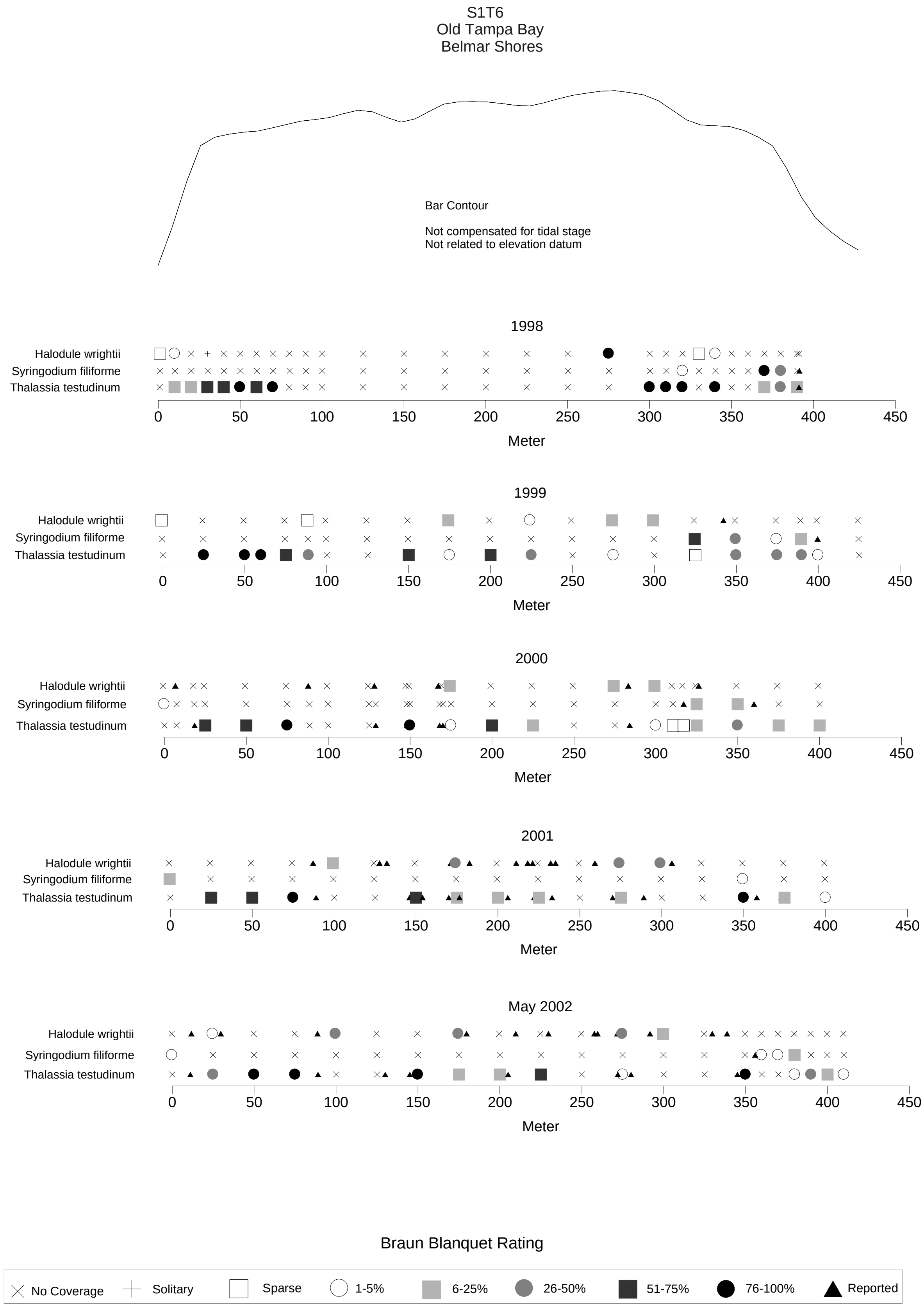

Figure 10. Distribution and abundance of *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum* along Transect S1T6 (SE Quadrant) from October 1998-October 2003 (continued next page).

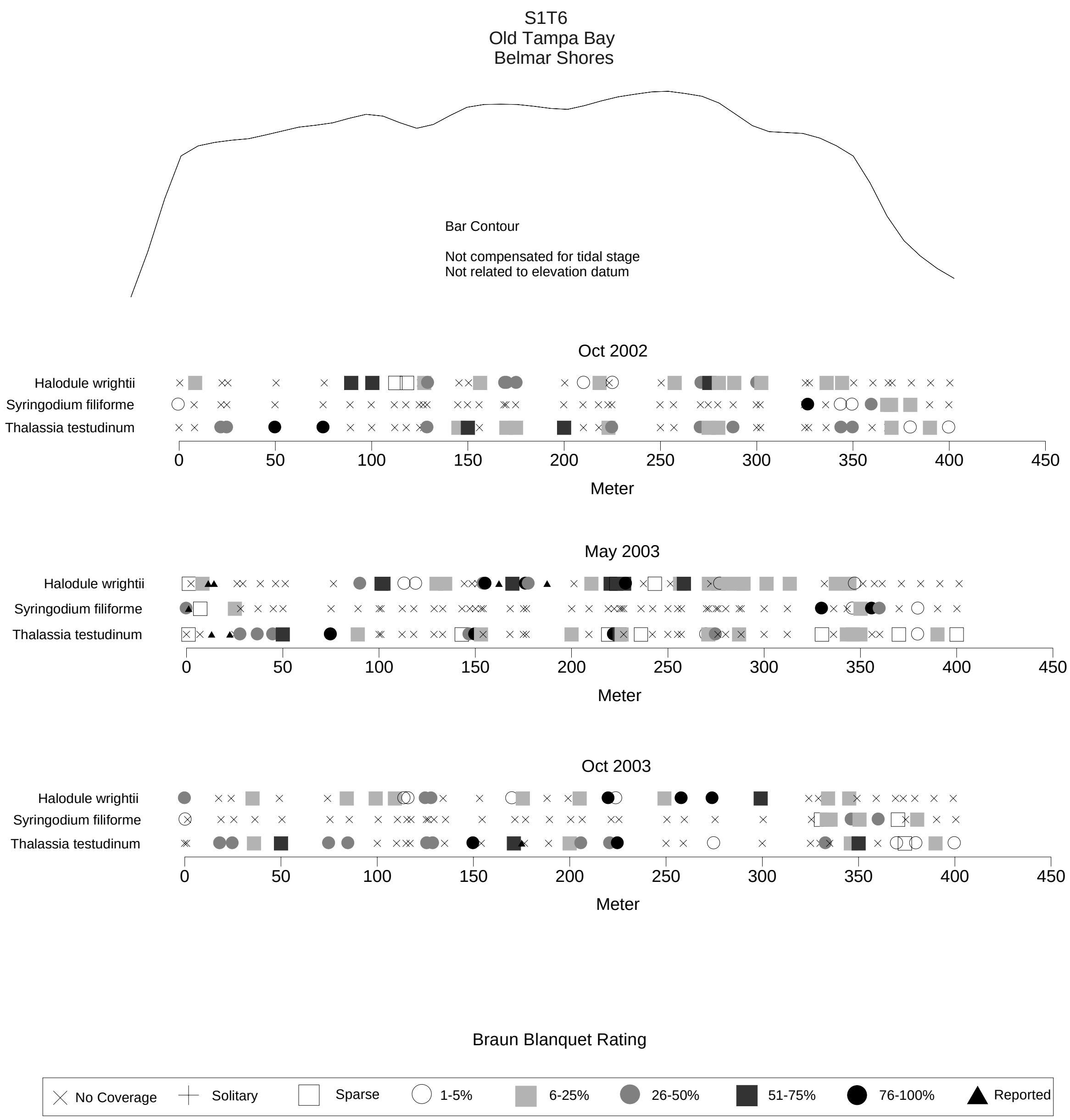

Figure 10 (Continued). Distribution and abundance of *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum* along Transect S1T6 (SE Quadrant) from October 1998-October 2003.

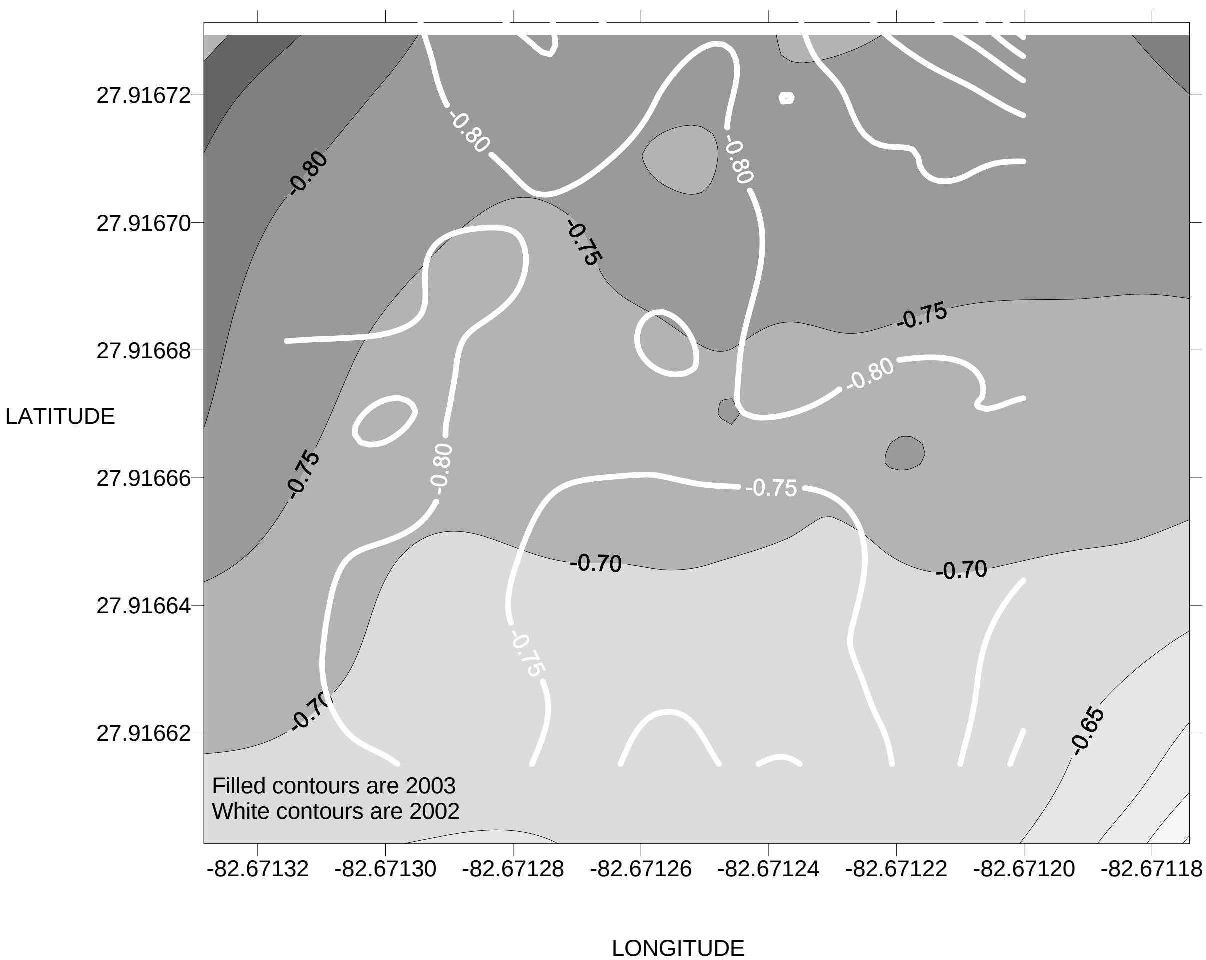

Figure 11. Sediment surface elevations (mMTL) measured in October 2002 and November 2003 at seagrass study site NW1 in Old Tampa Bay.

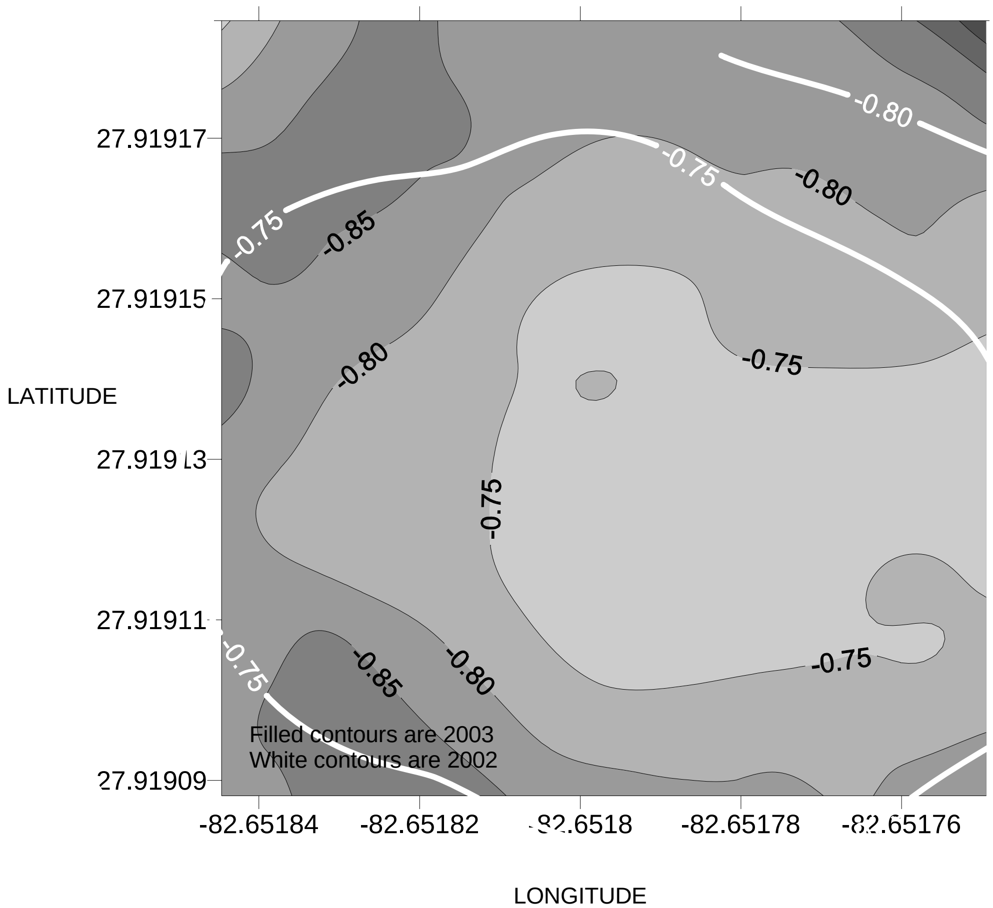

Figure 12. Sediment surface elevations (mMTL) measured in October 2002 and November 2003 at seagrass study site NW8B in Old Tampa Bay.

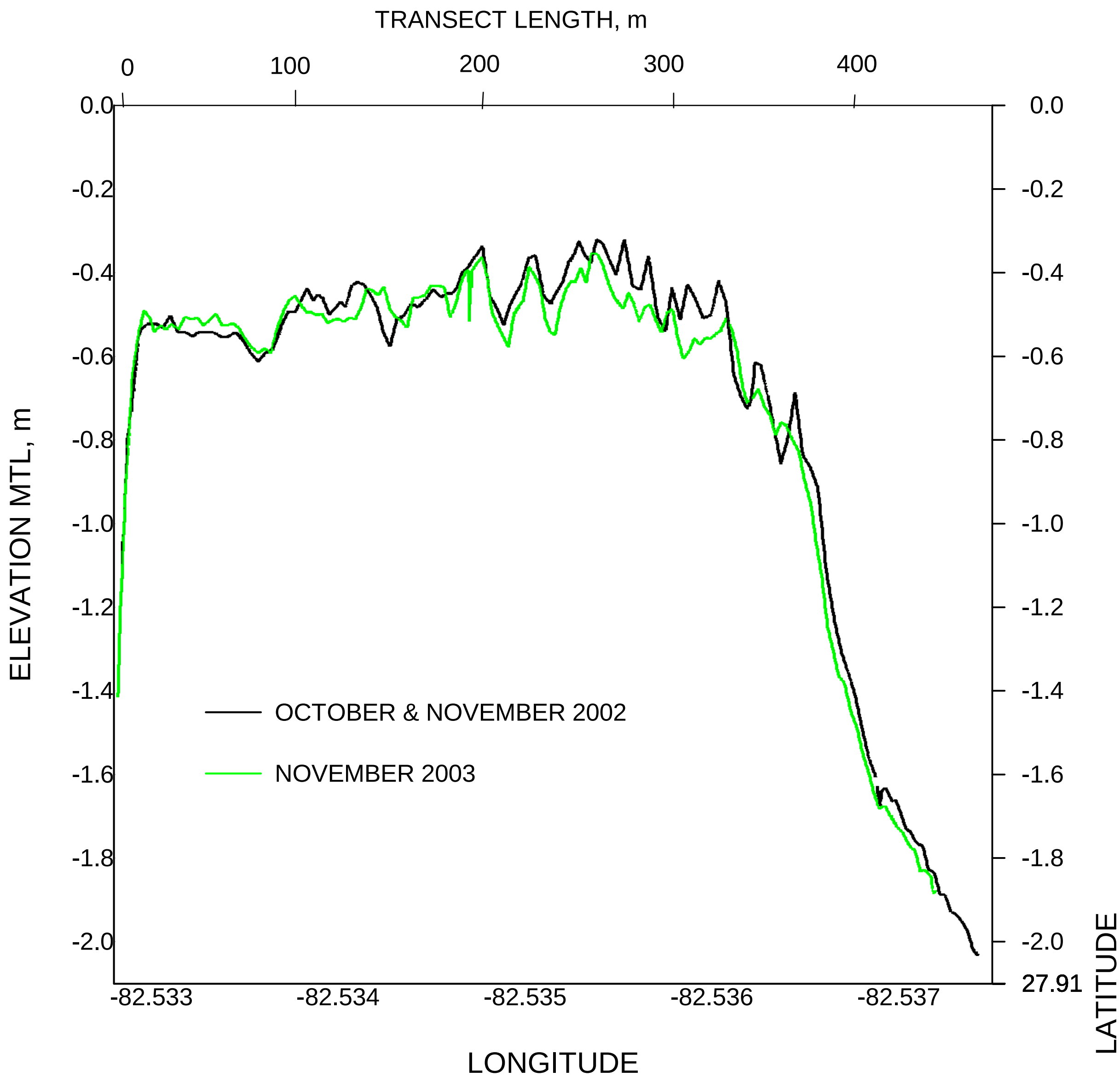

Figure 13. Sediment surface elevations (mMTL) measured in October and November 2002, and November 2003 at seagrass transect S1T6 (SE quadrant) in Old Tampa Bay.

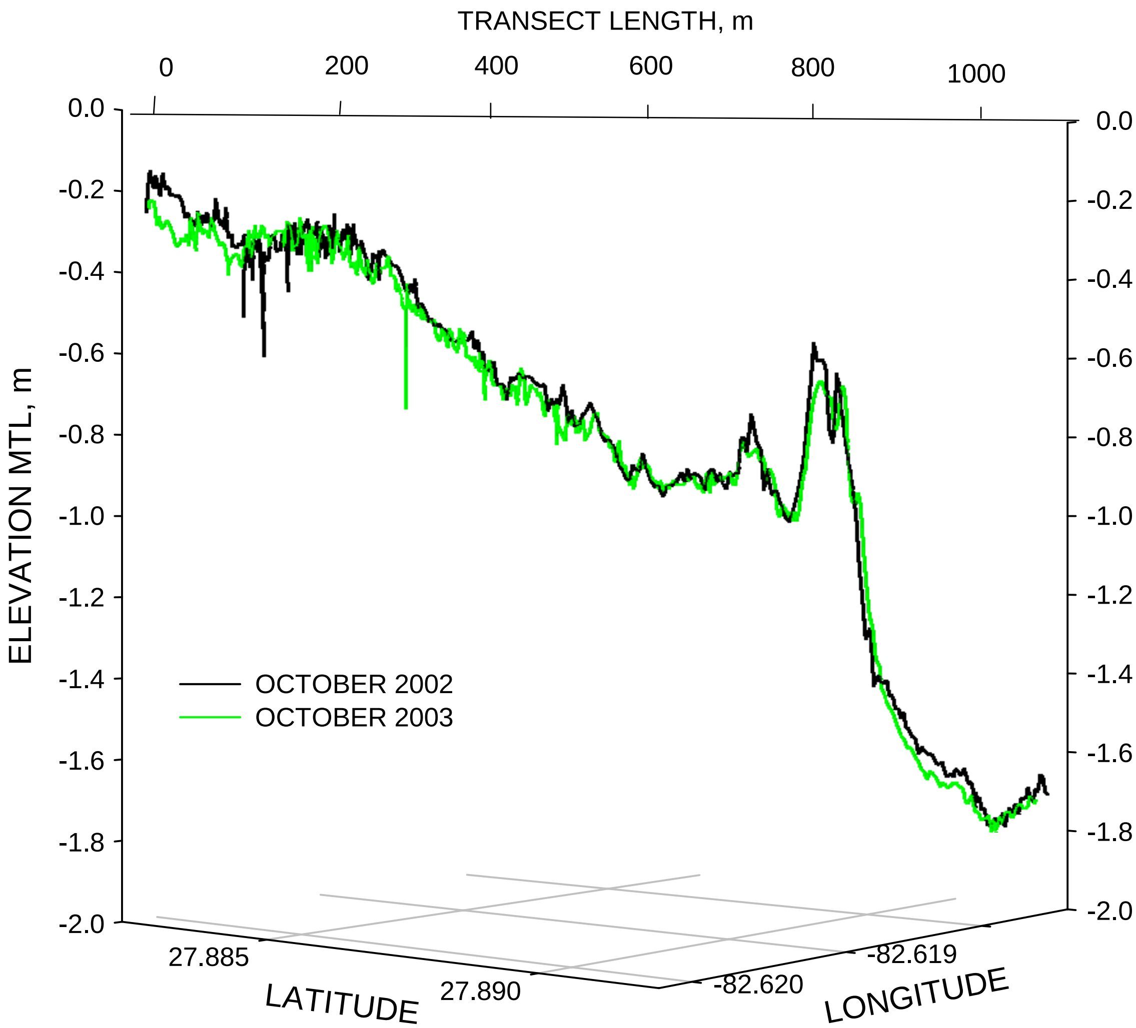

Figure 14. Sediment surface elevations (mMTL) measured in October 2002 and October 2003 at seagrass transect S1T16 (SW quadrant) in Old Tampa Bay.

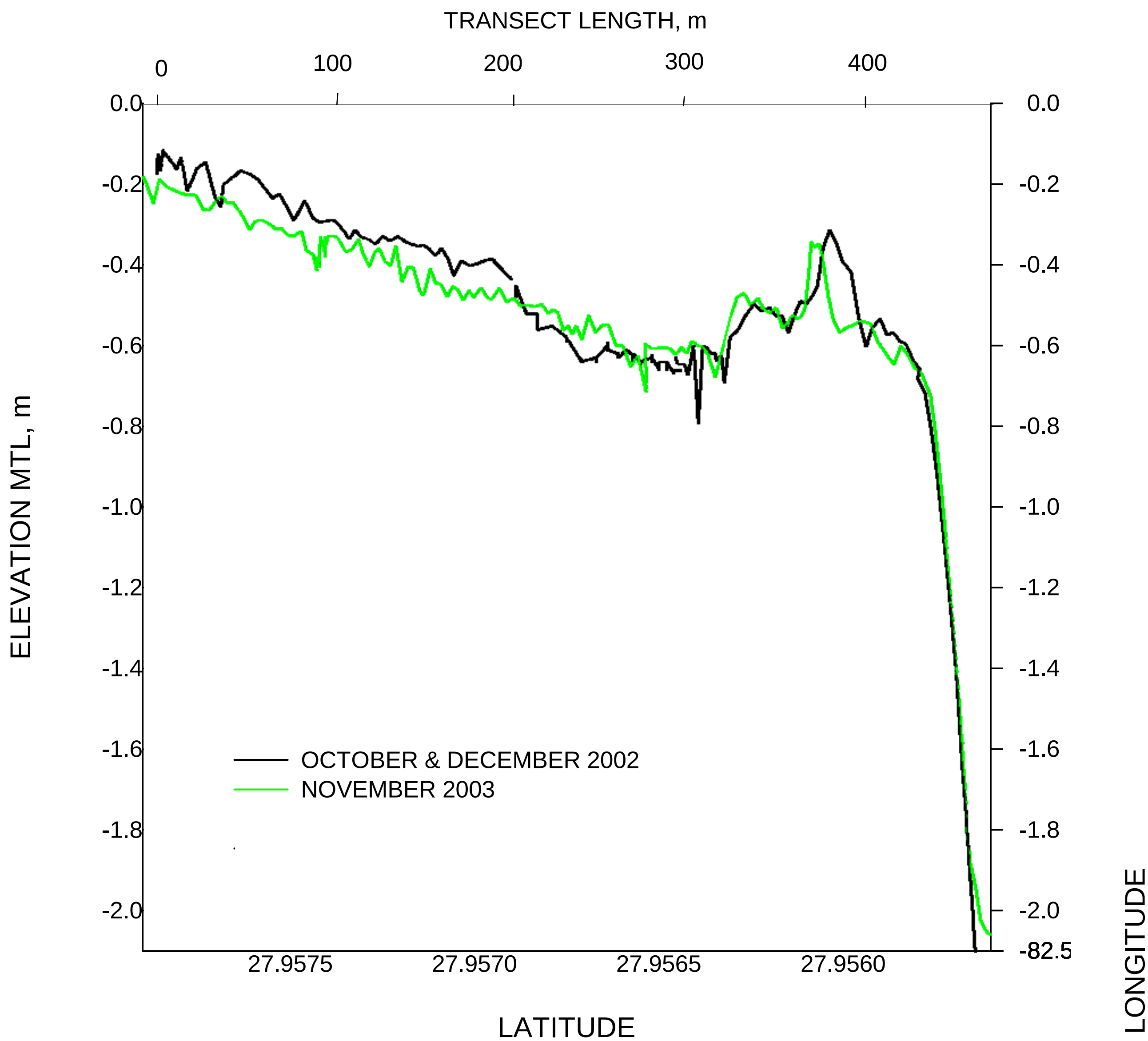

Figure 15. Sediment surface elevations (mMTL) measured in October and December 2002, and November 2003 at seagrass transect S1T5 (NE quadrant) in Old Tampa Bay.

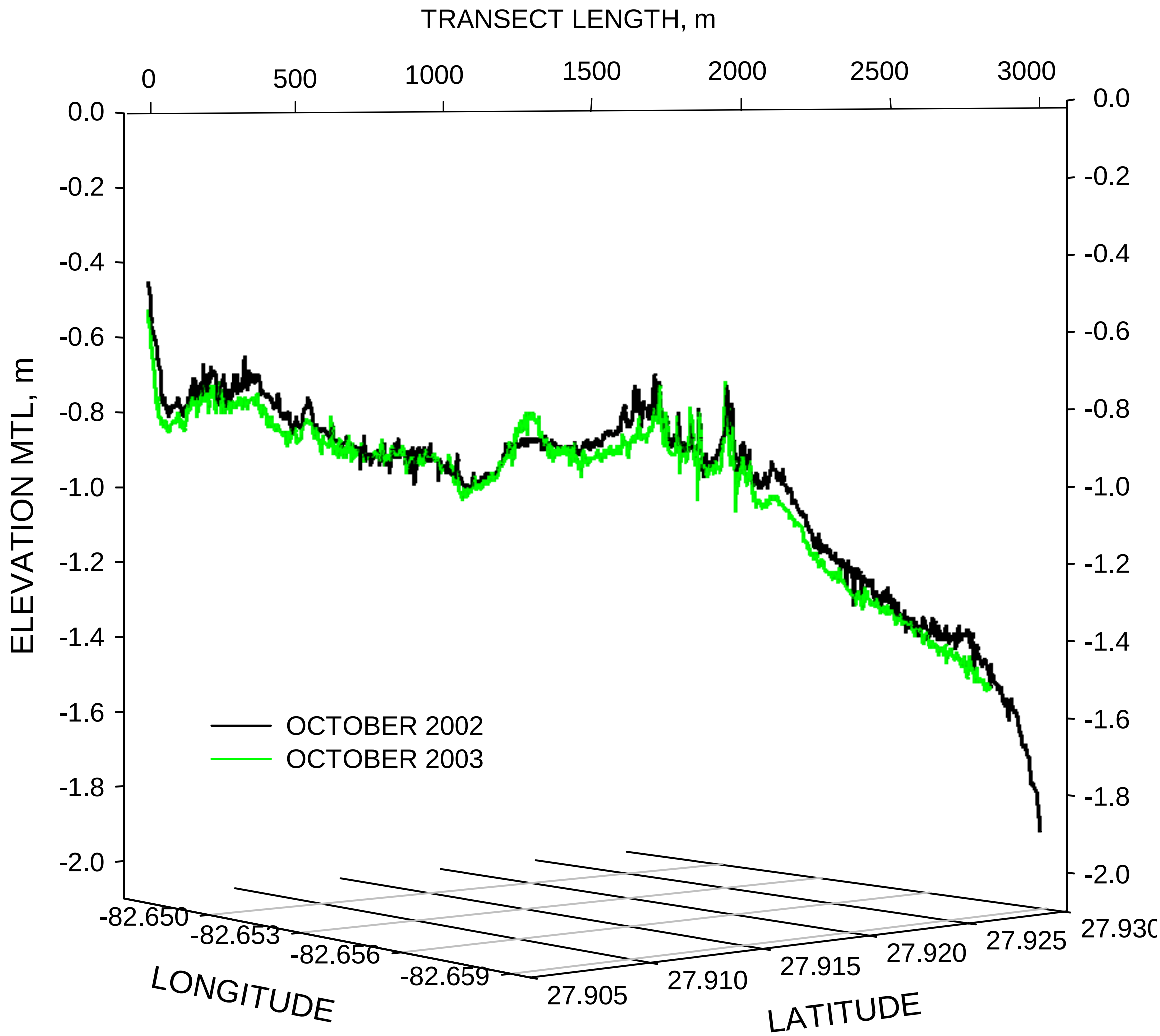

Figure 16. Sediment surface elevations (mMTL) measured in October 2002 and October 2003 at seagrass transect S1T17 (NW quadrant) in Old Tampa Bay.

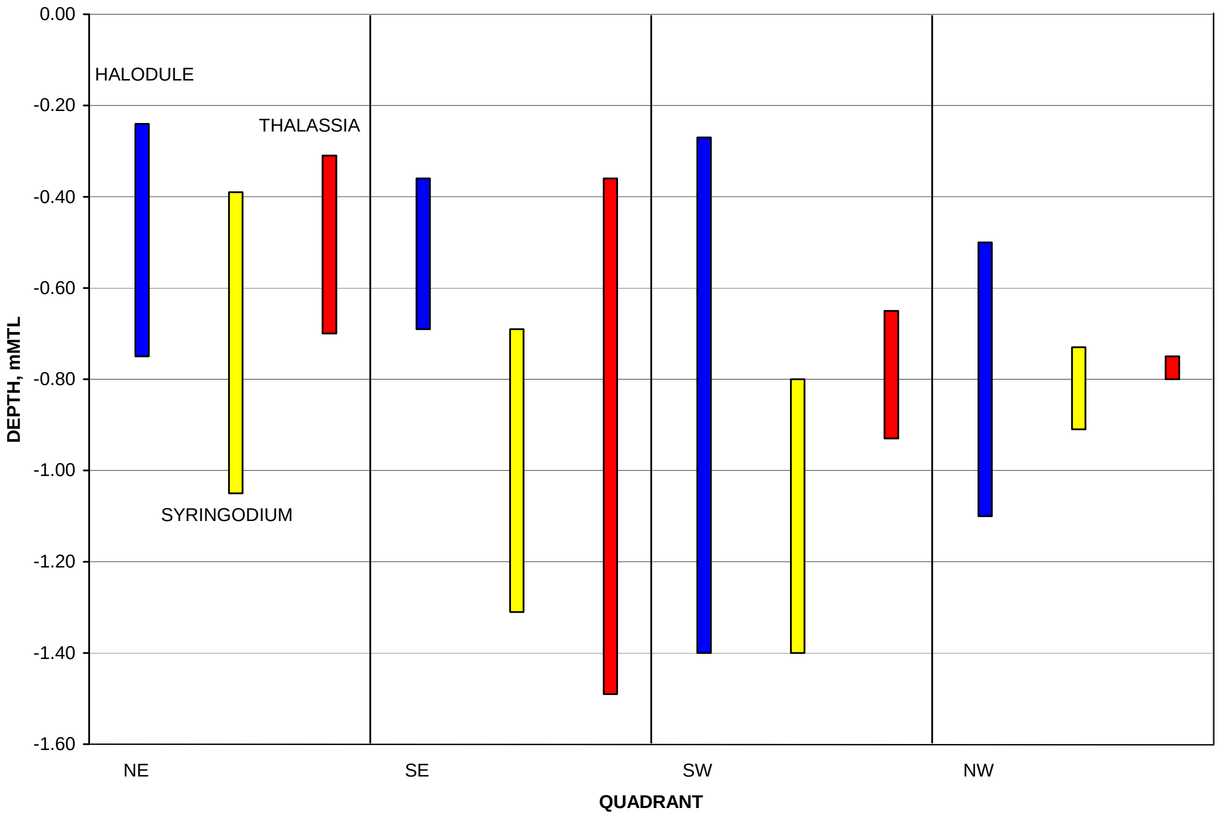

Figure 17. Depth distribution (mMTL) of seagrass species, *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum* in the four Old Tampa Bay quadrants for seagrass study sites and transects. Braun-Blanquet abundance ratings of 2 through 5 were used.