TAMPA BAY INTERAGENCY SEAGRASS MONITORING PROGRAM: SEAGRASS SPECIES DISTRIBUTION AND COVERAGE ALONG FIXED TRANSECTS 1997-2000

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TABLE OF CONTENTS

Executive Summary……………………………………………………………… *iii*

Acknowledgments………………………………………………………………...*v*

Introduction…………………………………………………………………….1

Methods……………………………………………………………………...3

Results………………………………………………………………………… 5

Discussion……………………………………………………………………..10

Literature Cited……………………………………………………………..13

Table……………………………………………………………………………...14

Figures…………………………………………………………………………15

EXECUTIVE SUMMARY

Tampa Bay seagrass meadows have been selected by the Tampa Bay Estuary Program (TBEP) as a biological indicator to help evaluate the progress of the nitrogen reduction strategy implemented for Tampa Bay. The Technical Advisory Committee (TAC) of the TBEP recognized in the early 1990s the need of local resource managers to obtain timely information about trends and conditions of Tampa Bay seagrass meadows in addition to the aerial photography surveys and mapping information produced every other year by the Southwest Florida Water Management District - Surface Water Improvement Management Department (SWIM). In 1994, the TAC outlined a detailed seagrass monitoring program, based on a fixed transect monitoring design.

A consortium of Tampa Bay area agencies have agreed to participate in a fixed seagrass transect monitoring program. These agencies are:

- City of Tampa Bay Study Group
- Florida Fish & Wildlife Conservation Commission - Florida Marine Research Institute
- Hillsborough County Cockroach Bay Aquatic Preserve
- Hillsborough County Environmental Protection Commission
- Manatee County Environmental Management Department
- Pinellas County Department of Environmental Management
- Tampa BayWatch, Inc.

Each agency participating in the Tampa Bay Interagency Seagrass Monitoring Program volunteered the responsibility to annually monitor a set number of transects in assigned subsections of Tampa Bay. The primary components of the program have been to monitor and determine the spatial and temporal seagrass species zonation along the established transects. Transect monitoring began in Hillsborough Bay in 1997, and in the other Tampa Bay subsections in 1998.

The transect monitoring program has provided new and useful insight into the seagrass species composition and abundance in the different subsections of Tampa Bay. No such detailed information about the seagrass distribution in Tampa Bay existed prior to the start of this program. The monitoring program has only existed a few years, however, general statements about bay subsection specific seagrass species abundance and zonation can be made. These statements are summarized below:

1. Seagrass species abundance and zonation along the Old Tampa Bay transects has remained relatively stable over the period of monitoring, 1998 to 2000. There were only minor changes in species abundance and zonation at all transects for the five seagrass species. Generally, *T. testudinum* and *S. filiforme* are more commonly found on the transects located on the eastern side of the bay and *H. wrightii* generally dominates the species composition on the western side. SWIM has reported a

substantial loss of seagrass coverage, specifically for the west-central section of this bay subsection between 1996 and 1999 (Dave Tomasko personal communications). These losses are clearly visible in a comparison of aerial photographs of this area for the two years. Results from the transects located in this area, and monitored between 1998 and 2000, did not indicate any major changes in seagrass abundance primarily because of the geographical location of the transects. As discussed in the report, several transects located in western Old Tampa may not provide a general understanding of the seagrass zonation and abundance in this area.

2. *H. wrightii* is the dominant seagrass found on the transects located in Hillsborough Bay. Prior to 1999, *H. wrightii* was most abundant on the southeastern Hillsborough Bay transects, however, between 1999 and 2000, substantial meadows appeared to be developing along transects located along the Interbay Peninsula in the southwestern portion of the bay.

3. Between 1998 and 2000, *H. wrightii* appeared to decline along the transects located in eastern Middle Tampa Bay. However, there was a slight increase of *T. testudinum* abundance on the four transects located between the Little Manatee River and Piney Point, including Cockroach Bay. Sampling inconsistencies prior to the 2000 survey for most transects located in western Middle Tampa Bay and along the southern Interbay Peninsula precludes a discussion of potential changes in the these areas. Generally, *H. wrightii* is the dominant seagrass species in the northern section of Middle Tampa Bay. *T. testudinum* and *S. filiforme* are more commonly found on the transects located in the middle and southern sections of this bay subsection.

4. Generally, seagrass abundance along the transects located in Lower Tampa Bay remained relatively stable between 1998 and 2000, however, minor thinning was noted for *T. testudinum* along four transects in eastern Lower Tampa Bay. *T. testudinum* is generally the dominant seagrass species found on the transects in the Lower Tampa Bay proper.

5. Generally, only minor changes in seagrass abundance were noted along the transects located in Boca Ciega Bay between 1998 and 2000. *H. wrightii,* dominated seagrass species in the northern section of the bay and *T. testudinum* generally was prevalent in the southern portion.

In summary, results from the Tampa Bay transect monitoring program indicate two major areas with recent and notable changes in seagrass coverage. Seagrass coverage increased along the southeastern Interbay Peninsula as *H. wrightii* meadows developed between 1998 and 2000. In contrast, a loss of *H. wrightii* was noted along eastern Tampa Bay from southeastern Hillsborough Bay to Piney Point between 1999 and 2000.

Finally, the interagency seagrass monitoring program has proven that multiple agencies with a common goal can effectively combine their resources to generate valuable scientific information that will assist in the protection and restoration of Tampa Bay seagrass meadows.

ACKNOWLEDGMENTS

This project has been made possible through the auspices of the Tampa Bay Estuary Program. Special thanks are extended to Holly Greening who has facilitated the coordination and implementation of the seagrass monitoring program. Also, Dave Tomasko (Southwest Florida Water Management District-Surface Water Improvement Management Program), Ray Kurz (Ayres Associates), and Tom Reis (Scheda Ecological Associates, Inc.) provided guidance in the initial design of the monitoring protocols. Field collections were conducted by personnel from Florida Fish & Wildlife Conservation Commission - Florida Marine Research Institute, Hillsborough County Cockroach Bay Aquatic Preserve, Hillsborough County Environmental Protection Commission, Manatee County Environmental Management Department, Pinellas County Department of Environmental Management, Tampa BayWatch, Inc., and City of Tampa Bay Study Group. The generous contributions from these agencies and the hard work by their personnel have ensured the success of this project. Finally, Robin Lewis (Lewis Environmental Services, Inc.) is acknowledged for early on advocating the need to establish permanent seagrass transects in Tampa Bay and for his continued support of this program. The compilation of the collected information into this report was funded by the TBEP and the City of Tampa.

INTRODUCTION

Tampa Bay seagrass meadows have been selected by the Tampa Bay Estuary Program (TBEP) as a biological indicator to help evaluate the progress of the nitrogen reduction strategy implemented for Tampa Bay (TBNEP, 1996). The Technical Advisory Committee (TAC) of the TBEP recognized in the early 1990s the need of local resource managers to obtain timely information about trends and conditions of Tampa Bay seagrass meadows in addition to the aerial photography surveys and mapping information produced every other year by the Southwest Florida Water Management District - Surface Water Improvement Management Department (SWIM).

The TAC outlined a detailed seagrass monitoring program in 1994 in a report entitled "Monitoring Program to Assess Environmental Changes to Tampa Bay, Florida" (Coastal Environmental, Inc., 1994). The described monitoring program was based on a fixed transect monitoring design. The TAC stated that the primary objective of the monitoring program should address cost-effective and technically feasible measurements of:

1. Areal extent of seagrass in each bay subsection.
2. Seagrass zonation with depth.
3. Changes in seagrass zonation, patterns of zonation, and seagrass distribution over time.

A secondary objective of the transect monitoring program should address the health of the seagrass.

To meet the primary and secondary objectives, the TAC recommended four levels of monitoring. These monitoring levels were:

1. Map and groundtruth all submerged aquatic vegetation (SAV).
2. Describe SAV coverage, seagrass short shoot density, and collect hydrographic data.
3. Measure photosynthetic active radiation (PAR), seagrass leaf production, collect SAV for biomass determinations of seagrass, macroalgae, and epiphytes.
4. Implement each level at a greater frequency.

In 1997, the City of Tampa, Bay Study Group (BSG), incorporated fixed transect monitoring into its Hillsborough Bay seagrass monitoring program that was partially based on the outline recommended by the TAC in 1994 (Avery, in press). In addition, the BSG transect monitoring program included features used by Dr. Robert Virnstein in the Indian River Lagoon (Virnstein and Morris, 1996).

In 1997, the TBEP requested the BSG to describe its fixed transect monitoring program in a presentation to a consortium of Tampa Bay area agencies including:

- Florida Fish & Wildlife Conservation Commission - Florida Marine Research Institute (FMRI)
- Hillsborough County Environmental Protection Commission (HCEPC)
- Hillsborough County Cockroach Bay Aquatic Preserve (CB)
- Manatee County Environmental Management Department (MC)
- Pinellas County Department of Environmental Management (PC)
- Southwest Florida Water Management District-Surface Water Improvement Management Program (SWIM)

The consortium endorsed the fixed transect monitoring concept and agreed to participate in a seagrass monitoring program that met several of the objectives identified by the TAC in 1994. The primary components of the program would initially be to monitor and determine the spatial and temporal seagrass species zonation along the established transects. Each agency participating in the program, from here on called the Tampa Bay Interagency Seagrass Monitoring Program, volunteered the responsibility to annually monitor a set number of transects in assigned subsections of Tampa Bay. In 2000, Tampa BayWatch, Inc. (TBI) also requested to become a partner in the program and was subsequently assigned several transects. This report primarily discusses the information describing the spatial and temporal seagrass species distribution these agencies have collected from their assigned transects, starting in 1997 or thereafter. The information collected to date by the transect monitoring program does not lend itself to extensive numerical analysis. Therefore, in this initial report, the findings from the program are generally presented in descriptive and graphical formats.

A second primary objective of the seagrass monitoring program outlined by the TAC in 1994 was to determine seagrass species distribution with water column depth. The depth of the seagrass encountered along the transects could then be compared to the adopted TBEP seagrass depth targets, expressed as depth below mean tidal level (MTL), for the respective bay subsection. This comparison would assist in evaluating the progress of the Tampa Bay seagrass restoration effort. During the monitoring conducted for the period presented in this report, the different agencies have recorded general water depths at sampling points along each transect. However, these depth measurements are not related to a fixed datum and are influenced by tidal stage and other factors affecting water depth. Therefore, the seagrass depth distribution along the transects can not be determined accurately, and should not be discussed, until fixed datum depth measurements have been collected along the transects.

An exception to the statement above of not discussing the distribution of seagrass with depth can be made for a transect in the Kitchen area of Hillsborough Bay. Here the BSG has tested a GPS based method (Johansson, 2000; Johansson in press) that determined accurate elevations (+/- 5cm or better, referenced to a fixed datum) for approximately every meter along the 1300m long transect. The discussion of the Kitchen transect is provided as an example to illustrate the importance of accurate depth measurements. Similar depth measurements should be performed at regular intervals (perhaps every 3 to 5 years) at all transects to obtain meaningful seagrass depth distribution information that can be related to the TBEP seagrass restoration goal.

In 1994, the TAC also recommended that water quality measurements, including subsurface light (PAR) data, be included in the seagrass monitoring program. These measurements have been performed by the participants of the program at selected locations along the seagrass transects. The purpose of these measurements, in addition to providing a once per year "snap shot" of water quality conditions, was to compare "inshore" water quality collected along the transects to water quality conditions measured on a regular basis by various agencies at "deep" water quality stations. It was recommended that several years of comparable water quality information be collected before this comparison was done. The comparison has not been attempted in this initial report.

METHODS

In 1997, 30 fixed seagrass monitoring transects were selected from randomly selected Tampa Bay transects that had previously been used by SWIM to groundtruth the every other year aerial photographic surveys. An additional 27 fixed transects were placed in a nonrandom manner in other areas of interest within Tampa Bay. In 2000, two transects in Middle Tampa Bay and three transects in Lower Tampa Bay were added. Also, in 2000, one transect in Lower Tampa Bay was not monitored due to the impending expansion at Port Manatee. In total there were 62 seagrass transects monitored in Tampa Bay during 2000 (Figure 1) The agency responsible for monitoring each transect and the initial monitoring year for that transect is presented in Table 1.

The transect monitoring is conducted during the fall of each year (primarily October and November) to coincide with the period of expected maximum seagrass biomass. In addition, the every other year SWIM aerial photographic surveys are most often flown during this time period.

Generally, 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 that approximates the adopted TBEP seagrass target depth for the respective bay subsection. The target depths range from 1.0m to 2.5m. The length of the transects range from 40m to 1360m. PVC poles mark the starting point, each 100m mark (where applicable), and the terminus of each transect.

Seagrass species composition and abundance are determined within a meter square frame placed on the bottom by a diver along the transect line at every 25m in Old Tampa Bay, Hillsborough Bay, and Middle Tampa Bay, and at every 50m in Boca Ciega Bay and Lower

Tampa Bay (including Terra Ceia Bay). The abundance of each seagrass species within the frame is estimated using the Braun-Blanquet rating system (Braun-Blanquet, 1965). Seagrass abundance is rated as follows:

- 0 = no coverage
- 0.1 = solitary short shoot
- 0.5 = sparse or <1% coverage
- 1 = 1% - 5% coverage
- 2 = 6% - 25% coverage
- 3 = 26% - 50% coverage
- 4 = 51% - 75% coverage
- 5 = 76% - 100% coverage
- 6 = coverage of interest outside the meter square placements

The category 6 rating is used to note seagrass coverage and shifts in seagrass species composition in areas along the transect located between the meter square placement locations.

Other data collected at each meter square placement include:

1. Time
2. Water depth (not corrected for tidal stage nor related to a fixed elevation datum)
3. A general rating of sediment composition (oyster bar, shell, sand, muddy sand, mud)
4. A general rating of seagrass epiphyte load (clean, light, moderate, heavy)
5. A general rating of seagrass appearance (excellent, good, fair, poor)
6. A general rating of attached and drift macro-algae abundance

The abundance of macro-algae is rated using the Braun-Blanquet rating system, however, the depth of the algal mat is not measured. Further, the level of identification of the macro-algae present is dependant on the expertise within each monitoring agency.

Seagrass short shoot density and canopy height measurements are taken along the transect for each species found at the middle of the meadow and at the deep edge of the meadow. Three replicate counts of short shoot density are made within either a 10cmx10cm or a 25cmx25cm square frame. The larger frame is most often used when the short shoot density is low. Five canopy height measurements to the nearest centimeter are also made at these locations using a ruler.

Hydrographic and PAR measurements are also recorded at the middle of the meadow, at the deep edge of the meadow and, at the two meter water column depth. The hydrographic measurements are only taken at the middle and at the edge of the seagrass bed, if the seagrass coverage extends beyond the two meter depth. Further, the hydrographic data are only collected at mid depth when the water depth is less than two meters. Samples are taken from the surface to the bottom at one meter increments, if the water depth is greater than or equal to two meters. Triplicate PAR light measurements are taken at mid depth using two Li-Cor® 192SA 2Π sensors which are separated vertically by 50cm. Measurements are only taken if the water column depth is 75cm or greater. This depth allows at least 25cm of water above the top sensor.

Water samples are collected from mid depth at the time of hydrographic and PAR measurements. The samples are stored in 125ml opaque Nalgene® containers and placed on ice until analysis of chlorophyll-*a* and turbidity can be performed in the laboratory. Secchi disk depth is also measured at the two meter depth or at the deep edge of the seagrass meadow.

Training of Participating Agency Personnel:

During the initial development of the seagrass transect monitoring program, concerns were raised about the need to collect comparable data between the participating agencies. To address this concern, a training class was scheduled several weeks prior to the start of the annual monitoring to train personnel in field sampling procedures and protocols. The class required that field personnel of each participating agency determined seagrass species composition and Braun-Blanquet abundance within several meter square placements in a selected seagrass meadow. Each meter square placement remained fixed until all agencies had performed counts. In addition, short shoot density and canopy height for each seagrass species were measured at each meter square placement. Also, subjective ratings of sediment type, epiphyte load and types, and general seagrass condition were evaluated. These training sessions have been repeated prior to each successive annual sampling.

Following the completion of the annual field transect monitoring, the agency field personnel reconvene to discuss and attempt to resolve potential problems and difficulties encountered during the transect sampling.

RESULTS

The evaluation of changes in seagrass species abundance, distribution, and zonation over time along several of the monitoring transects for the data collected to this date is limited. Since the start of the monitoring program, despite the annual training sessions described above, inconsistencies and changes in field data collection procedures have occurred that make interannual data comparisons of several transects difficult. The most serious inconsistencies include the placement of meter square frames at incorrect intervals and failures to survey the entire transect length. In addition, several transects have been relocated away from oyster or mud dominated sites to locations deemed more suitable for potential seagrass colonization. However, data generated from the majority of the transects during the 1998-2000 surveys are adequate for the interannual comparisons. In this report, general trends of seagrass species abundance, distribution, and zonation over time will be discussed for the 1997-2000 period for Hillsborough Bay and the 1998-2000 period for Old Tampa Bay, Middle Tampa Bay, Lower Tampa Bay (including Terra Ceia Bay), and Boca Ciega Bay.

Five species of seagrass have been documented in Tampa Bay during the course of the seagrass transect monitoring program. These are: *Halodule wrightii* (Shoal grass), *Halophila engelmanni* (Star grass*), Ruppia maritima* (Widgeon grass), *Syringodium filiforme* (Manatee grass), and *Thalassia testudinum* (Turtle grass). Findings of the attached alga *Caulerpa prolifera* are also recorded, because it has been suggested that *C. prolifera* may be a pioneer species for seagrass establishment (Clinton Dawes, personal communication).

<u>Seagrass Species Abundance and Zonation in Old Tampa Bay:</u>

Twelve transects have been monitored in Old Tampa Bay (Figure 2). See Table 1 for starting years of each transect. All five seagrass species and the alga *C. prolifera* have been found in this bay subsection. Results for transects are presented in Figures 3 through 14. A summary of seagrass species frequency of occurrence and other transect information for 2000 for the Old Tampa Bay transects are shown in Figure 69.

Generally, the four transects north of the Courtney Campbell Causeway had sparse *H. wrightii* abundance. Scattered *H. engelmanni* and *C. prolifera* were also noted near Safety Harbor. Also, very sparse *S. filiforme* was found along S1T1 (Figure 3) in 1999, however, it was not reported in 2000.

South of the Courtney Campbell Causeway on the west side of Old Tampa Bay, scattered *H. wrightii* was the prevalent species along the four transects. Sparse to patchy *S. filiforme* was present along transects S1T9 (Figure 11) and S1T10 (Figure 12). Some patchy *C. prolifera* and *T. testudinum* was noted at transect S1T9 just south of Weedon Island. In contrast, *T. testudinum* has been a major component of the seagrass meadows along S1T5 (Figure 7) and S1T6 (Figure 8) in eastern Old Tampa Bay. *S. filiforme* was present on all transects along the eastern part of the bay, including the mid bay shoal transect S1T8 (Figure 10).

Seagrass coverage along the Old Tampa Bay transects did not change appreciably over the period of monitoring. There were only minor changes in species abundance and zonation at all transects for the five seagrass species.

<u>Seagrass Species Abundance and Zonation in Hillsborough Bay</u>:

Eleven transects have been monitored in Hillsborough Bay between 1997 and 2000 (Figure 15). Two species of seagrass, *H. wrightii* and *R. maritima,* have been found in Hillsborough Bay. Results for transects are presented in Figures 16 through 26. A summary of seagrass species frequency of occurrence and other transect information for 2000 for the Hillsborough Bay transects are shown in Figure 70.

R. maritima has been observed along five transects, however, only transect S2T5 (Figure 19) has had persistent coverage. This ephemeral species is generally found close to shore and often its coverage transitions to *H. wrightii* further offshore.

H. wrightii coverage has been found on all eleven transects in Hillsborough Bay except S2T4 (Figure 18) and S2T6 (Figure 20). Generally, *H. wrightii* coverage was unchanged or increased along the remaining nine transects over the period of study.

The most substantial increase in seagrass coverage in Hillsborough Bay has occurred in western Hillsborough Bay along the Interbay Peninsula from Catfish Point to west of Gadsden Point (transects S2T112 [Figure 25] and S2T12 [Figure 26]). Between 1999 and 2000, *H. wrightii* colonized much of this shallow shelf. Other changes of *H. wrightii* coverage were seen along transect S2T2 (Figure 16) in the Kitchen area of southeastern Hillsborough Bay. Transect S2T2 has had relatively stable *H. wrightii* coverage between 200m and 600m for the period between 1997 and 2000. In 1999, sparse *H. wrightii* was also found in the area between 600m and 900m, however, this coverage was not present in 2000.

H. wrightii is the dominant seagrass in Hillsborough Bay. Prior to 1999, a large percentage of *H. wrightii* coverage was located in southeastern Hillsborough Bay, however, between 1999 and 2000, substantial meadows began to develop along the Interbay Peninsula in the southwestern portion of the bay.

R. maritima is mainly found in northeastern Hillsborough Bay, south of Pendola Point. However, this species is a minor constituent of the seagrass coverage in Hillsborough Bay.

<u>Seagrass Species Abundance and Zonation in Middle Tampa Bay:</u>

Thirteen transects have been monitored in Middle Tampa (Figure 27). See Table 1 for starting years of each transect. Four species of seagrass, *H. wrightii*, *R. maritima*, *S. filiforme*, and *T. testudinum*, and the alga *C. prolifera* have been in this bay subsection. Results for transects are presented in Figures 28 through 40. A summary of seagrass species frequency of occurrence and other transect information for 2000 for Middle Tampa Bay transects are shown in Figure 71.

H. wrightii was the dominant species along the two northern transects S3T13 (Wolf Branch; Figure 40) and S3T9 (Little Manatee River; Figure 36) in northeastern Middle Tampa Bay. *H. wrightii* coverage at the Wolf Branch site had thinned in the 100m to 375m area between the 1997 and 2000 surveys. Sparse to patchy *H. wrightii* was found between 900m and 1100m in the period 1997 to 1999, but was absent in 2000. Sparse *H. wrightii* has waxed and waned near this outer portion of the Wolf Branch sandbar since 1986 (BSG observations). At

S3T9 (Figure 36)*,* *H. wrightii* coverage was stable between 1998-1999, however, it had thinned considerably by 2000.

H. wrightii, S. filiforme, and *T. testudinum* were found along the four transects located between the Little Manatee River and Piney Point (including S3T4 in Cockroach Bay). *T. testudinum* abundance at the Cockroach Bay site (Figure 31) increased between 1998 and 2000. The remaining three transects S3T3, S3T5, and S3T6 (Figures 30, 32, and 33) had minor increases of *T. testudinum* coverage, but had lost *H. wrightii* coverage. The 2000 data for transect S3T5, just south of Cockroach Bay, may be suspect because the CB monitoring group did not find any PVC markers delineating the transect.

The three transects located on the south end of the Interbay Peninsula have been dominated by *H. wrightii*. Data from S3T12 (Figure 39) near Broad Creek indicate increasing *H. wrightii* coverage between 1997 and 2000. This trend is similar to coverage found at the Hillsborough Bay transects S2T112 and S2T12. Results from S3T2 (Figure 29) between 1998 and 2000 are inconclusive because of incorrect placement of meter squares and inadequate transect length. These methodology problems were corrected in 2000. Transect S3T10 (Figure 37), located near Picnic Island Creek, was established in 2000. This transect was dominated by *H. wrightii.*

Results from S3T1, S3T6, and S3T7 (Figures 28, 33, and 34) are inconclusive between 1998 and 2000 because an incorrect sampling technique was used. However, there was sufficient information from transect S3T1 to suggest that a fairly stable *H. wrightii* and *S. filiforme* mixed bed existed between 650m and 700m in 1999. It appears that the bed had expanded somewhat in 2000.

Transect S3T11 located at Coffeepot Bayou (Figure 38) was established in 2000. This transect was dominated by *S. filiforme.*

The major change in seagrass coverage in Middle Tampa Bay between 1998 and 2000 appeared to be a decline in *H. wrightii* along eastern Middle Tampa Bay. However, there was a slight increase in *T. testudinum* coverage on the four transects between the Little Manatee River and Piney Point, including Cockroach Bay. The 2000 results for the transects in western Middle Tampa Bay and along southern Interbay Peninsula (except for S3T12) should be viewed as baseline information because of inconsistent sampling during previous surveys. Generally, *H. wrightii* is the dominant seagrass species in the northern section of Middle Tampa Bay. *T. testudinum* and *S. filiforme* are more commonly found on the transects located in the middle and south sections of this bay subsection

<u>Seagrass Species Abundance and Zonation in Lower Tampa Bay, including Terra Ceia Bay and the Manatee River:</u>

Fifteen transects have been established in Lower Tampa Bay (Figure 41), including Terra Ceia Bay and the Manatee River to U.S. Highway 41. See Table 1 for starting years of each transect. All five Tampa Bay seagrass species have been found in this section of Tampa Bay. Results from each transect are presented in Figures 42 through 56. A summary of seagrass species frequency of occurrence and other transect information for 2000 for the Lower Tampa Bay area transects are shown in Figure 72.

Transects S4T1, S4T2, and S4T3 (Figures 42, 43, and 44) are located between Port Manatee and the Sunshine Skyway bridge. Monitoring for S4T1 was discontinued in 2000 due to the impending port expansion. Between 1998 and 2000, a fairly stable meadow of *T. testudinum* was documented along transects S4T2 and S4T3. Sporadic occurrences of *H. wrightii* and *S. filiforme* were recorded on both transects.

T. testudinum was also the dominant species found on transects S4T4 (Figure 45) and S4T6 (Figure 47) located between the Sunshine Skyway bridge and the mouth of the Manatee River. *T. testudinum* coverage thinned along both transects between 1998 and 2000. *H. wrightii* and *S. filiforme* were minor constituents of the seagrass composition on these two transects. A third transect in this area, S4T15 (Figure 56), was established in 2000. Along this transect, *H. wrightii* dominated inshore and transitioned to a *T. testudinum* meadow at 100m.

Three transects are monitored in Terra Ceia Bay. Transect S4T5 (Figure 46) had a stable mixed bed of *S. filiforme* and *T. testudinum* between 1998 and 2000. Sporadic *H. wrightii* was also reported. Transects S4T13 (Figure 54) and S4T14 (Figure 55), established in 2000, were dominated by *S. filiforme* with patchy *H. wrightii* and *T. testudinum*.

Three transects are located within the Manatee River. Transect S4T7 (Figure 48) located at the mouth of the river had a mixed bed of *H. wrightii* and *T. testudinum*. *H. wrightii* coverage has remained relatively stable since 1998, but the *T. testudinum* thinned considerably between 1999 and 2000. Transect S4T9 (Figure 50) had a mixed bed of *H. wrightii* and *T. testudinum* that did not change appreciably between 1998 and 2000. Transect S4T8 (Figure 49) contained a mixed bed of sparse to patchy *H. engelmanni* and *H. wrightii* in 1999. In 2000, the *H. engelmanni* was replaced by sparse to patchy *R. maritima*.

Transect S4T10 (Figure 51), just south of the Manatee River, was a mixed bed composed of *H. wrightii*, *S. filiforme*, and *T. testudinum* in 1998. Between 1998 and 2000, the *S. filiforme* disappeared, the inshore *H. wrightii* bed expanded somewhat, and the *T. testudinum* coverage thinned.

Transects S4T11 (Figure 52), located near the mouth of Anna Maria Sound, and S4T12 (Figure 53) on the east side of Egmont Key are *T. testudinum* dominated transects. Both transects had a relatively stable meadow with some expansion noted between 1999 and 2000.

Generally, changes in seagrass coverage and abundance in Lower Tampa Bay was negligible between 1998 and 2000, except for some minor *T. testudinum* thinning along four transects in eastern Lower Tampa Bay.

Seagrass Species Abundance and Zonation in Boca Ciega Bay:

Eleven transects have been established in Boca Ciega Bay (Figure 57). See Table 1 for starting years of each transect. *H. wrightii*, *S. filiforme*, and *T. testudinum* were found in Boca Ciega Bay during the course of the monitoring. Results from each transect monitored between 1998 and 2000 are presented in Figures 58 through 68. A summary of seagrass species frequency of occurrence and other transect information for 2000 for Boca Ciega Bay transects are shown in Figure 73.

Transects S5T1, S5T2, S5T3, S5T4, S5T5, and S5T6 (Figures 58 through 63) in the northern half of Boca Ciega Bay were dominated by *H. wrightii*. The *H. wrightii* coverage was relatively stable at S5T1, S5T2, S5T4 and S5T5 over the period of monitoring. A decrease in abundance was noted at S3T3 between 1998 and 1999 and at S5T6 between 1999 and 2000. A small amount of *T. testudinum* was also found at S5T2 and S5T6. The *T. testudinum* coverage increased between 1999 and 2000 at S5T2, however, it decreased at S5T6

During 1998, in southern Boca Ciega Bay, *T. testudinum* was the dominant species along transects S5T7, S5T8, S5T9, and S5T10 (Figures 64 through 67). *H. wrightii* was the only seagrass species found at transect S5T11 (Figure 68). There were only minor changes in seagrass coverage along transects S5T7, S5T9, and S5T11 between 1998 and 2000. Loss of *T. testudinum* on S5T8 shifted species dominance on this transect to *S. filiforme* in 2000. *T. testudinum* abundance along S5T10 decreased between 1998 and 1999, however, in 2000 it had increased.

Only minor changes in seagrass coverage were noted in Boca Ciega between 1998 and 2000, with the exception of the shift in dominant species on transect S5T8, discussed above. Generally, seagrass composition is dominated by *H. wrightii* in the northern section of the bay and transitions to *T. testudinum* in the southern portion.

DISCUSSION

The annual fixed transect monitoring program provides local resource managers timely information on Tampa Bay seagrass meadows in addition to the aerial photography surveys and mapping information produced every other year by SWIM. The transect monitoring supplies an “on the ground” based detailed temporal and spatial description of seagrass species composition and abundance in the different subsections of Tampa Bay. Further, the detailed transect information may assist and complement the SWIM photographic and mapping effort in the interpretation of the aerial photographs and the production of seagrass coverage maps by providing extensive ground based information on Tampa Bay seagrass meadows.

The transect monitoring program is a large undertaking that would not have been possible without the participation and cooperation of the agencies involved. These agencies employ varying degrees of seagrass monitoring expertise and, as expected, inconsistencies in the data collection have been encountered during the first years of the program. However, the problems have recently become less prevalent as a result of the annual interagency training sessions. The training is expected to continue on annual schedule to enhance monitoring skills, to train new personnel, and to help introduce potential changes to the monitoring protocol.
The geographical location of several transects have limited the usefulness of the collected information. These transects were selected from the randomly placed transects previously used by SWIM for ground-truthing of the aerial photographs. Several of these transects are located in western Old Tampa Bay. These transects do not provide a general understanding of the seagrass zonation and abundance in this area. Currently, two additional transects are planned in western Old Tampa Bay to enhance the monitoring information.

As noted earlier, a primary objective of the seagrass monitoring program outlined by the TAC in 1994 was to determine seagrass species distribution with water column depth. To this date, however, the seagrass depth distribution along the transects has not been determined accurately relative to a fixed datum, except for the transect located in the Kitchen area of Hillsborough Bay. Figure 74 illustrates the depth profile (measured as mMTL) and the geographical location (LAT/LON) of transect S2T2 from shore to approximately 1350m offshore. Noted in the figure is the section of the transect, between approximately 200m and 620m, that contains the main *H. wrightii* meadow (see Figure 16). It is evident that the majority of the seagrass found on this transect is located between –0.25 mMTL and –0.50mMTL. The elevation of the deep edge of the meadow (-0.50mMTL) agrees with earlier elevation studies of this meadow (Johansson 2000). This depth is substantially shallower than the TBEP adopted –1.0mMTL depth target for Hillsborough Bay.

The discussion of the Kitchen transect has been provided as an example to illustrate how accurate depth measurements of the Tampa Bay seagrass meadows can be related to the TBEP seagrass restoration goal. Further, accurate seagrass species depth distribution in combination with local water quality information can be to used to determine the amount of light available to the seagrass meadows and potentially also the light requirements of the Tampa Bay seagrass species. It is recommended that accurate depth measurements related to a fixed datum be performed at regular intervals (perhaps every 3 to 5 years) for all transects in Tampa Bay.

Further, current water quality sampling is generally conducted at locations deeper and further offshore than areas with seagrass cover, or areas expected to be colonized by seagrass. There is mounting evidence that near shore water quality may be substantially different than that found in “deep water” locations. An extensive water quality monitoring program of both shallow and deep areas, that addresses this question, is currently being developed by participants in the TBEP.

The transect monitoring program has provided new and useful insight into the seagrass species composition and abundance in the different subsections of Tampa Bay, despite the program shortcomings discussed above. No such detailed information about the seagrass distribution in Tampa Bay existed prior to the start of this program. The monitoring program has only existed a few years, however, general statements about bay subsection specific seagrass species abundance and zonation can be made. These statements are summarized below:

1.
Seagrass species abundance and zonation along the Old Tampa Bay transects has remained relatively stable over the period of monitoring, 1998 to 2000. There were only minor changes in species abundance and zonation at all transects for the five seagrass species. Generally, *T. testudinum* and *S. filiforme* are more commonly found on the transects located on the eastern side of the bay and *H. wrightii* generally dominates the species composition on the western side. SWIM has reported a substantial loss of seagrass coverage, specifically for the west-central section of this bay subsection between 1996 and 1999 (Dave Tomasko personal communications). These losses are clearly visible in a comparison of aerial photographs of this area for the two years. Results from the transects located in this area, and monitored between 1998 and 2000, did not indicate any major changes in seagrass abundance primarily because of the geographical location of the transects. As discussed earlier, several transects located in western Old Tampa may not provide a general understanding of the seagrass zonation and abundance in this area.

2. *H. wrightii* is the dominant seagrass found on the transects located in Hillsborough Bay. Prior to 1999, *H. wrightii* was most abundant on the southeastern Hillsborough Bay transects, however, between 1999 and 2000, substantial meadows appeared to be developing along transects located along the Interbay Peninsula in the southwestern portion of the bay.

3. Between 1998 and 2000, *H. wrightii* appeared to decline along the transects located in eastern Middle Tampa Bay. However, there was a slight increase of *T. testudinum* abundance on the four transects located between the Little Manatee River and Piney Point, including Cockroach Bay. Sampling inconsistencies prior to the 2000 survey for most transects located in western Middle Tampa Bay and along the southern Interbay Peninsula precludes a discussion of potential changes in the these areas. Generally, *H. wrightii* is the dominant seagrass species in the northern section of Middle Tampa Bay. *T. testudinum* and *S. filiforme* are more commonly found on the transects located in the middle and south sections of this bay subsection.

4. Generally, seagrass abundance along the transects located in Lower Tampa Bay remained relatively stable between 1998 and 2000, however, minor thinning was noted for *T. testudinum* along four transects in eastern Lower Tampa Bay. *T. testudinum* is generally the dominant seagrass species found on the transects in the Lower Tampa Bay proper.

5. Generally, only minor changes in seagrass abundance were noted along the transects located in Boca Ciega Bay between 1998 and 2000. *H. wrightii,* dominated seagrass species in the northern section of the bay and *T. testudinum* generally was prevalent in the southern portion.

In summary, results from the Tampa Bay transect monitoring program indicate two major areas with recent and notable changes in seagrass coverage (Figure 75). Seagrass coverage increased along the southeastern Interbay Peninsula as *H. wrightii* meadows developed between 1998 and 2000. In contrast, a loss of *H. wrightii* was noted along eastern Tampa Bay from southeastern Hillsborough Bay to Piney Point between 1999 and 2000.

Finally, the interagency seagrass monitoring program has proven that multiple agencies with a common goal can effectively combine their resources to generate valuable scientific information that will assist in the protection and restoration of Tampa Bay seagrass meadows.

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Table 1. Transect monitoring in Tampa Bay by agency and initial monitoring date.

Region	Transect	HCEPC	BSG	PC	CB	FMRI	MC	TBI
Old Tampa Bay	S1T1	1999						
	S1T2	1998						
	S1T3	1998						
	S1T4	1999						
	S1T5	1998						
	S1T6	1998						
	S1T7	1998						
	S1T8	1998						
	S1T9	1998						
	S1T10	1999						
	S1T11	1999						
	S1T12	1998						
Hillsborough Bay	S2T2		1997					
	S2T3		1997					
	S2T4		1997					
	S2T5		1997					
	S2T6		1997					
	S2T8		1997					
	S2T9		1997					
	S2T10		1997					
	S2T111		1997					
	S2T112		1997					
	S2T12		1997					
Middle Tampa Bay	S3T1					1998		
	S3T2					1998		
	S3T3				1998			
	S3T4				1998			
	S3T5				1998			
	S3T6				1998			
	S3T7					1998		
	S3T8					1998		
	S3T9				1998			
	S3T10							2000
	S3T11							2000
	S3T12		1997					
	S3T13		1997					
Lower Tampa Bay	S4T1						1999	
	S4T2						1998	
	S4T3						1999	
	S4T4						1998	
	S4T5						1998	
	S4T6						1998	
	S4T7						1998	
	S4T8						1999	
	S4T9						1999	
	S4T10						1998	
	S4T11						1998	
	S4T12		1998					
	S4T13							2000
	S4T14							2000
	S4T15							2000
Boca Ciega Bay	S5T1			1998				
	S5T2			1999				
	S5T3			1998				
	S5T4			1998				
	S5T5			1998				
	S5T6			1998				
	S5T7			1998				
	S5T8			1998				
	S5T9			1998				
	S5T10			1998				
	S5T11			1998				

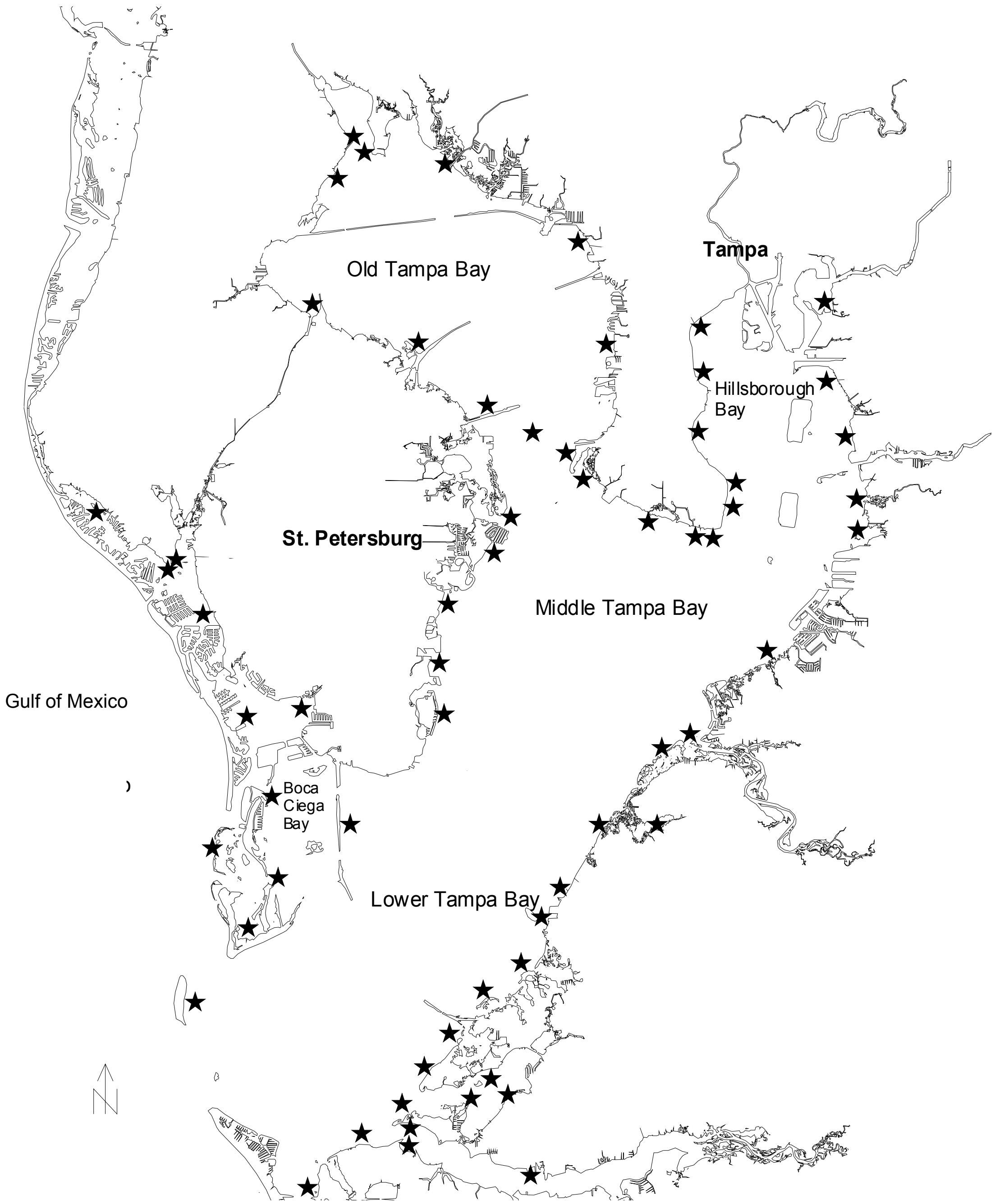

Figure 1. Location of the 62 seagrass monitoring transects in Tampa Bay.

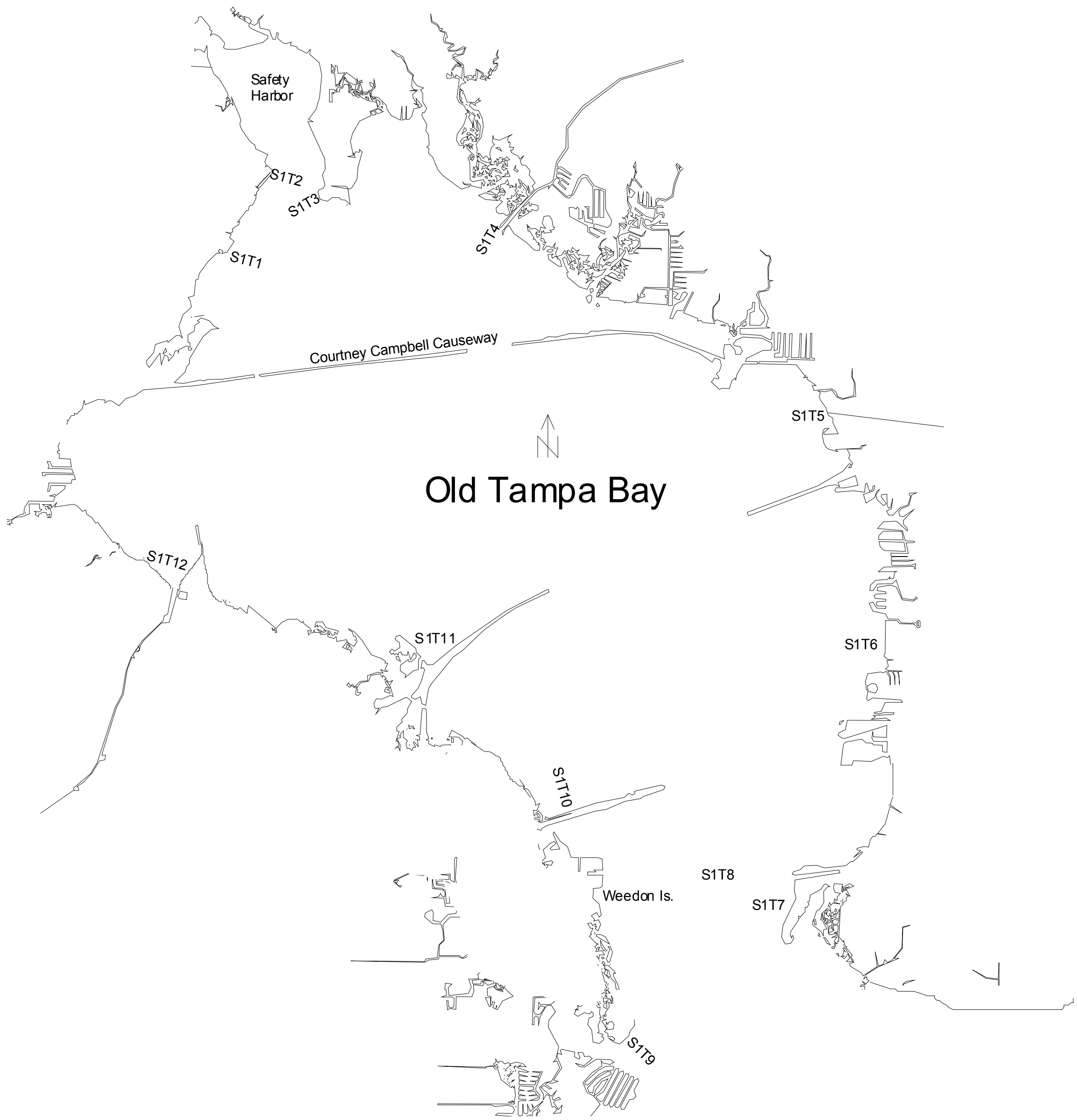

Figure 2. Location of the 12 seagrass monitoring transects in Old Tampa Bay.

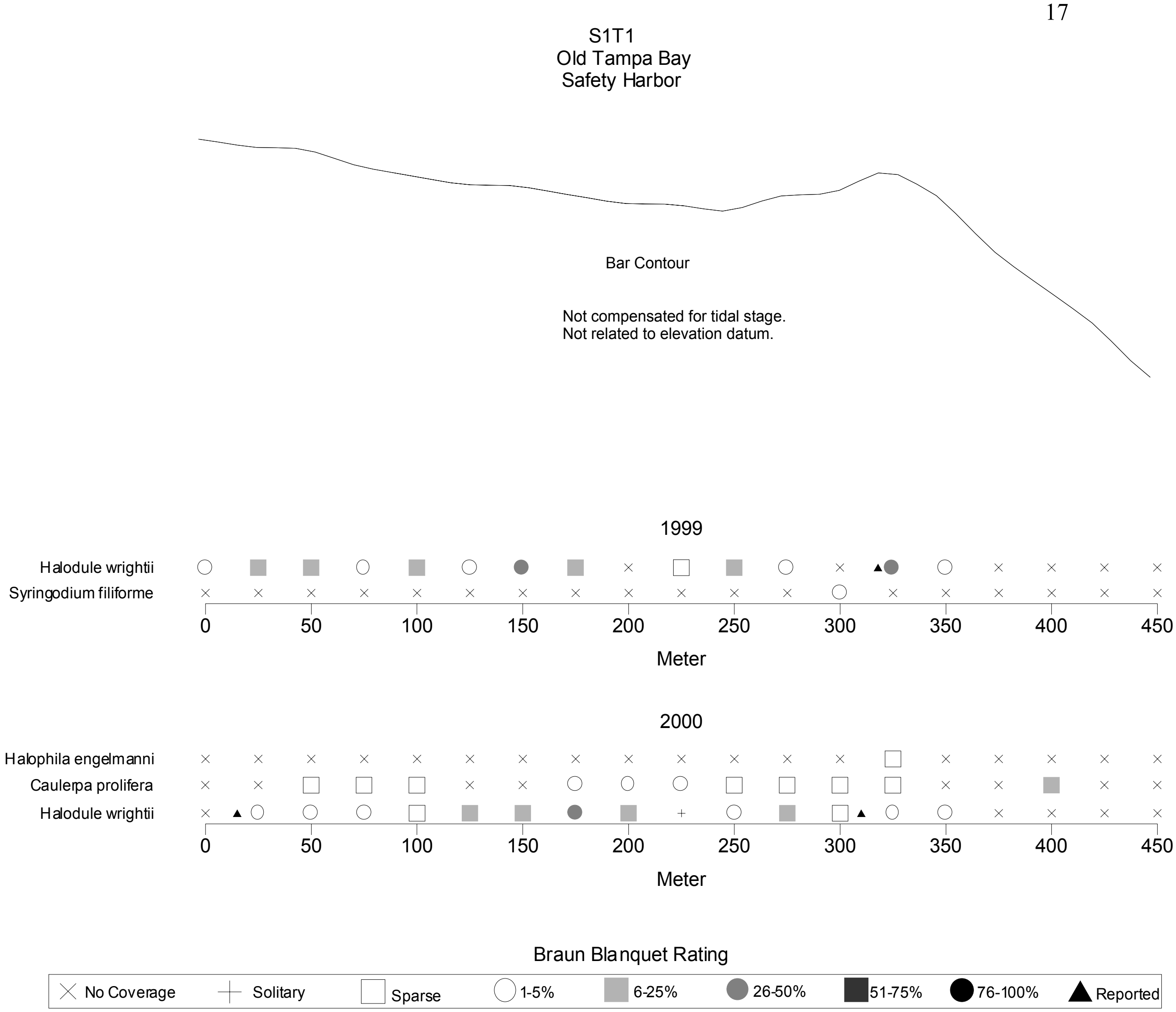

Figure 3. Seagrass species, abundance and zonation at S1T1 from 1999-2000.

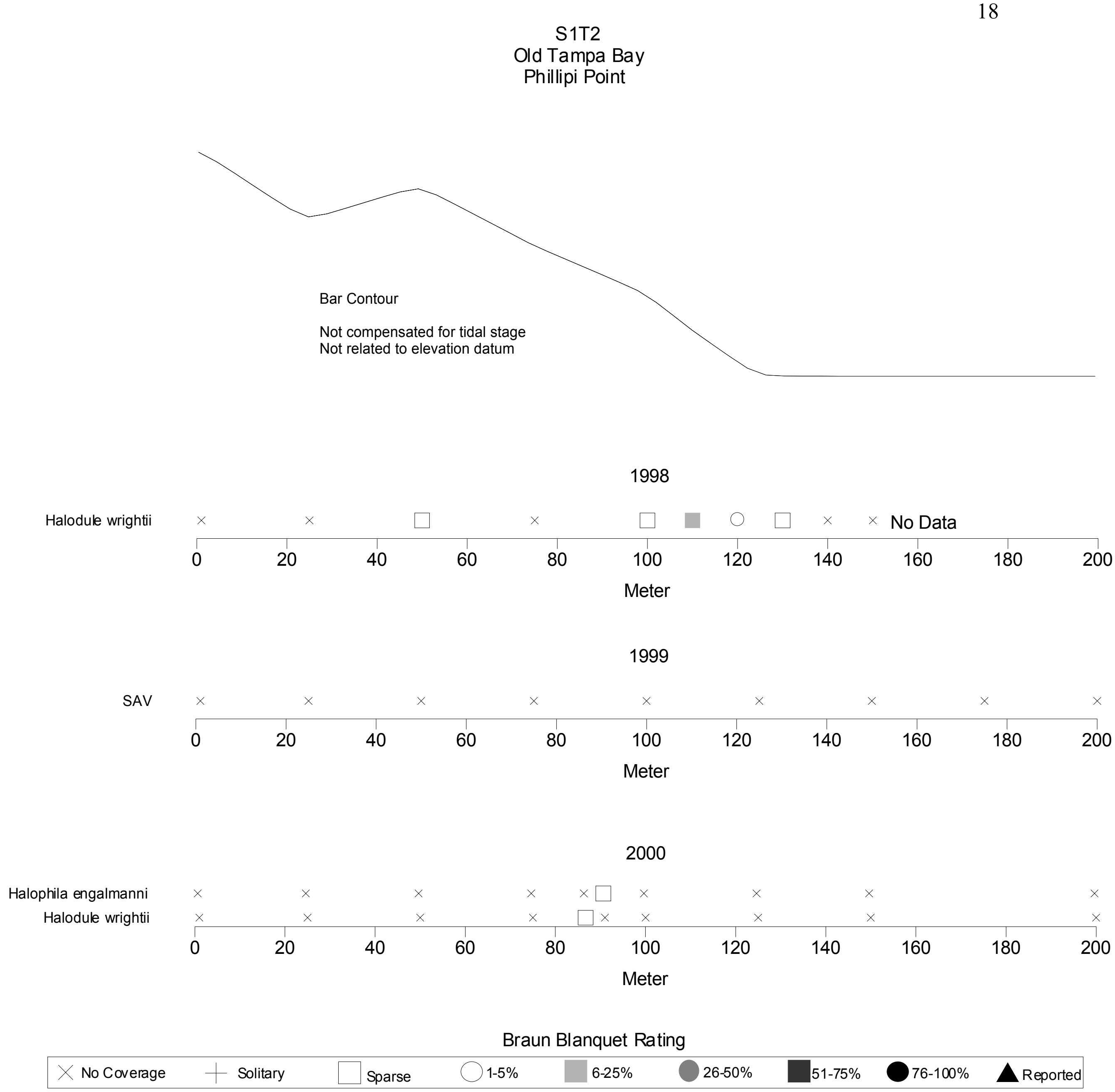

Figure 4. Seagrass species, abundance, and zonation at S1T2 from 1998-2000.

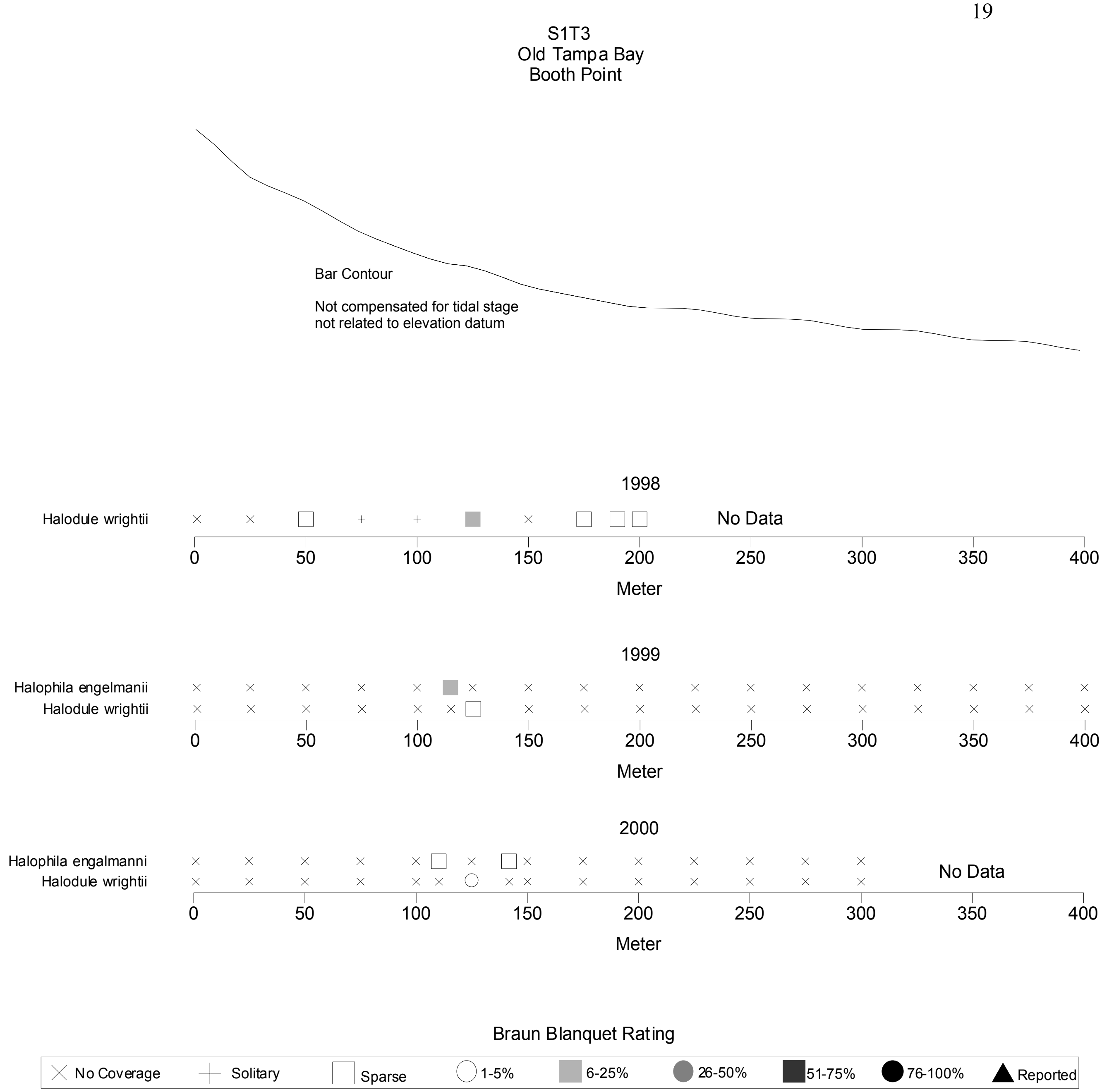

Figure 5. Seagrass species, abundance, and zonation at S1T3 from 1998-2000.

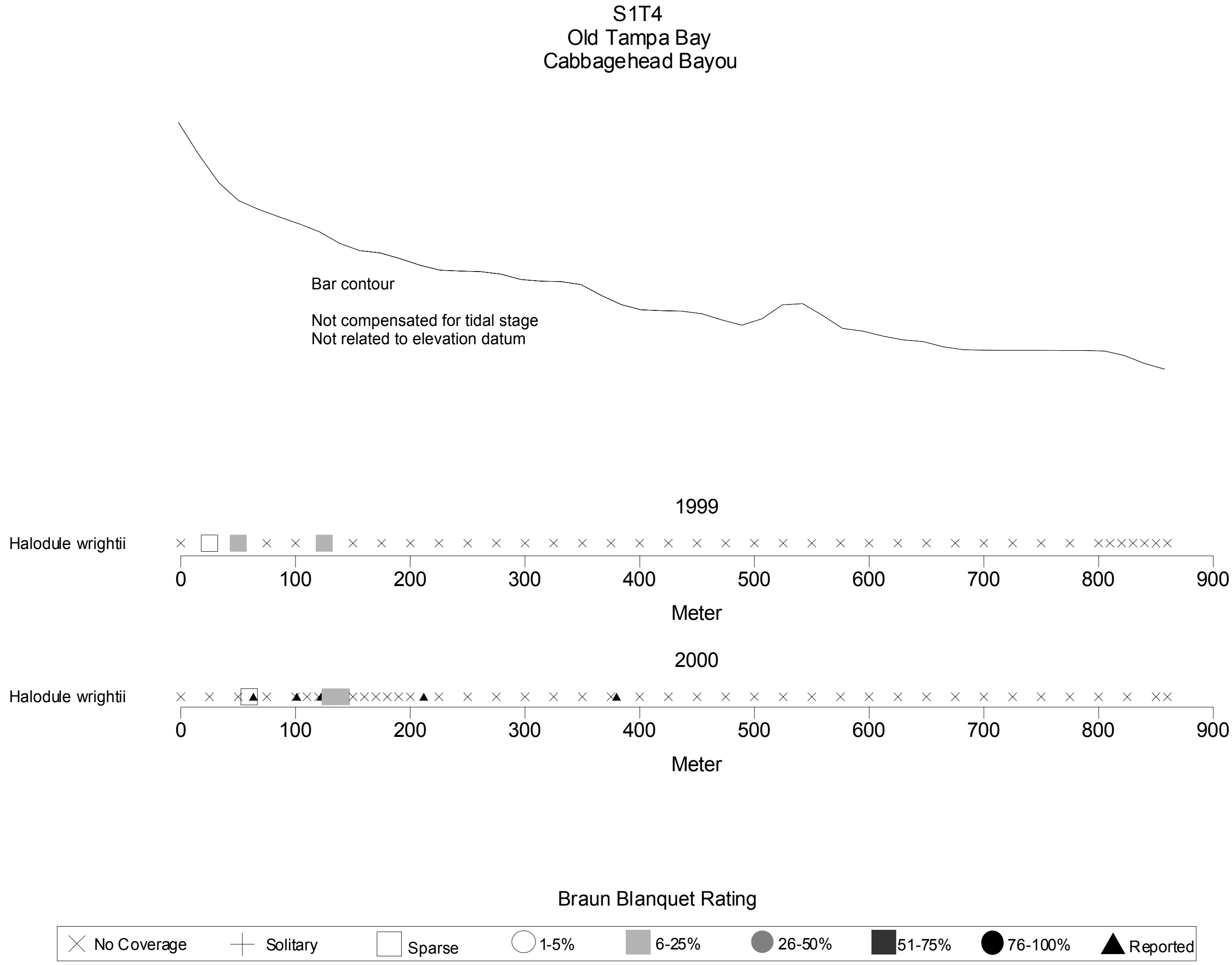

Figure 6. Seagrass species, abundance, and zonation at S1T4 from 1999-2000.

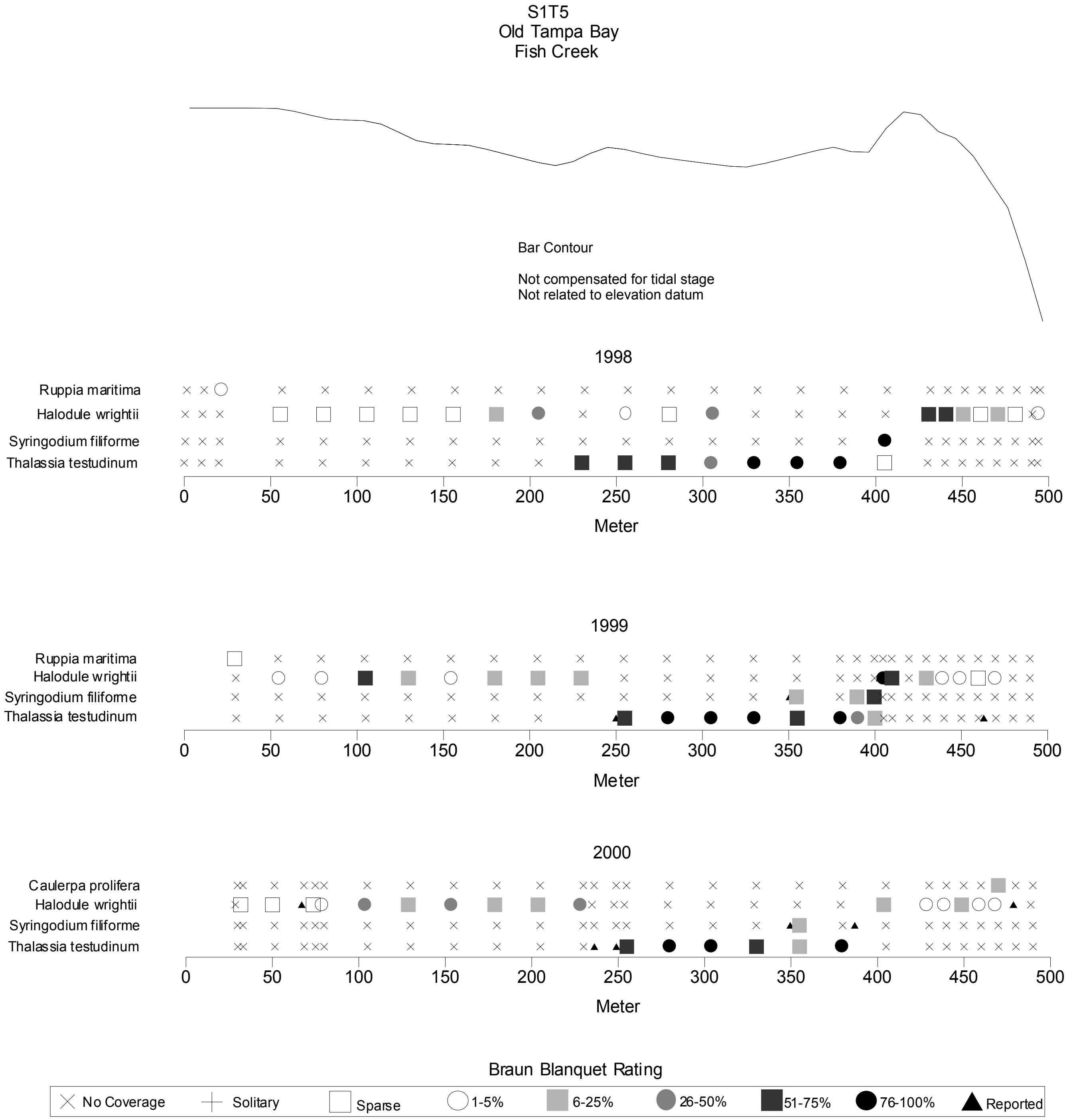

Figure 7. Seagrass species, abundance, and zonation at S1T5 from 1998-2000.

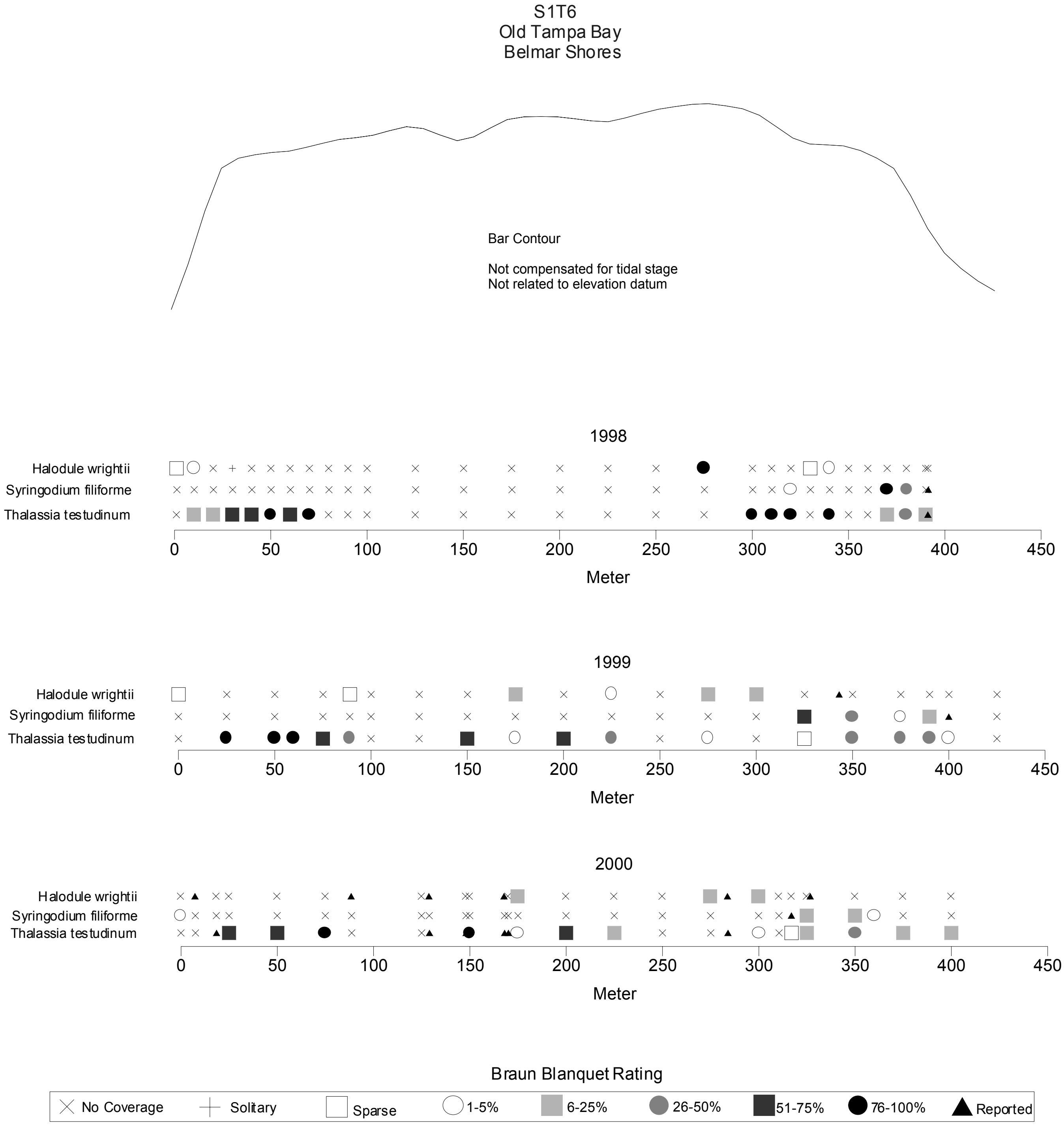

Figure 8. Seagrass species, abundance, and zonation at S1T6 from 1998-2000.

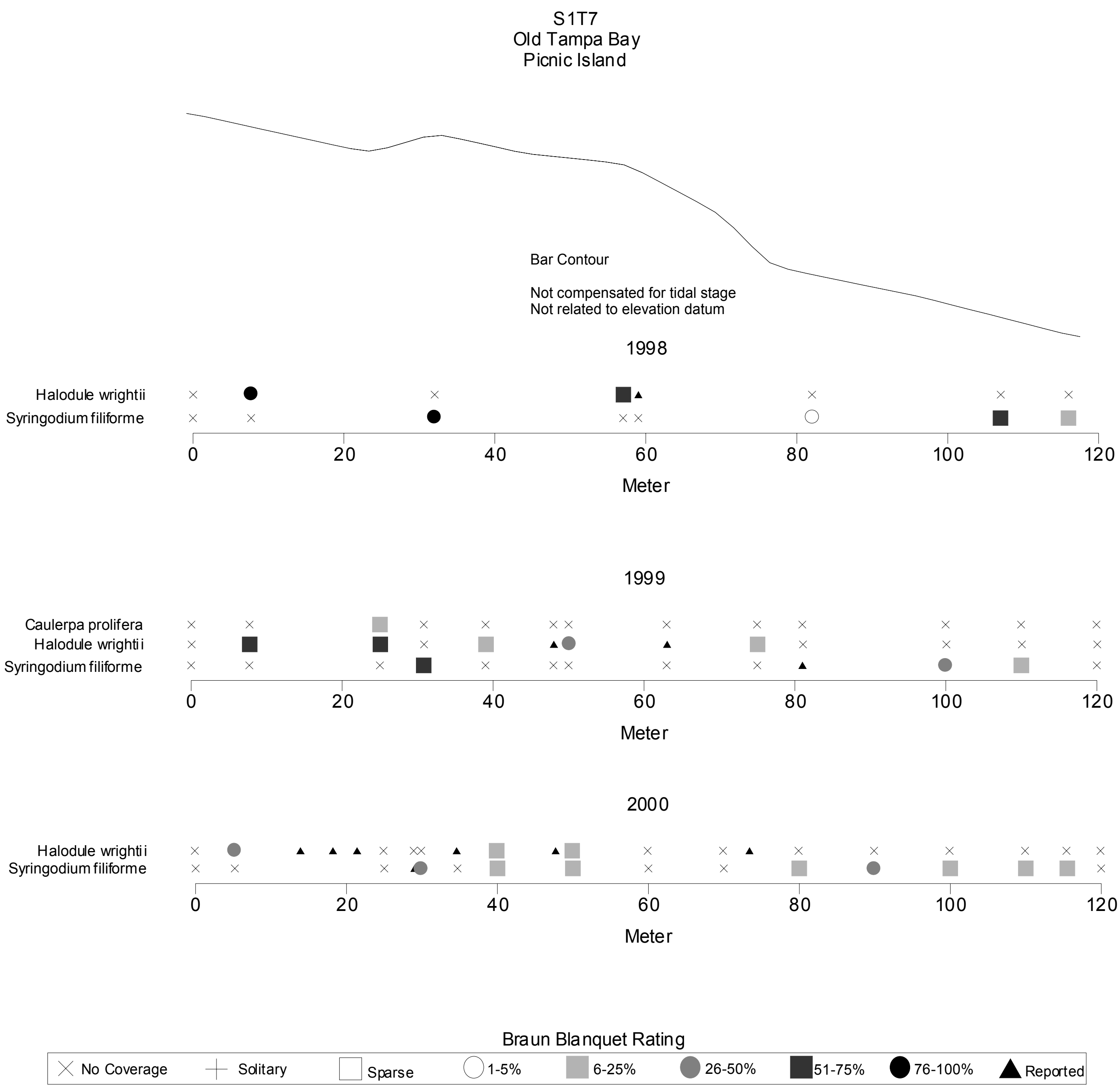

Figure 9. Seagrass species, abundance, and zonation at S1T7 from 1998-2000.

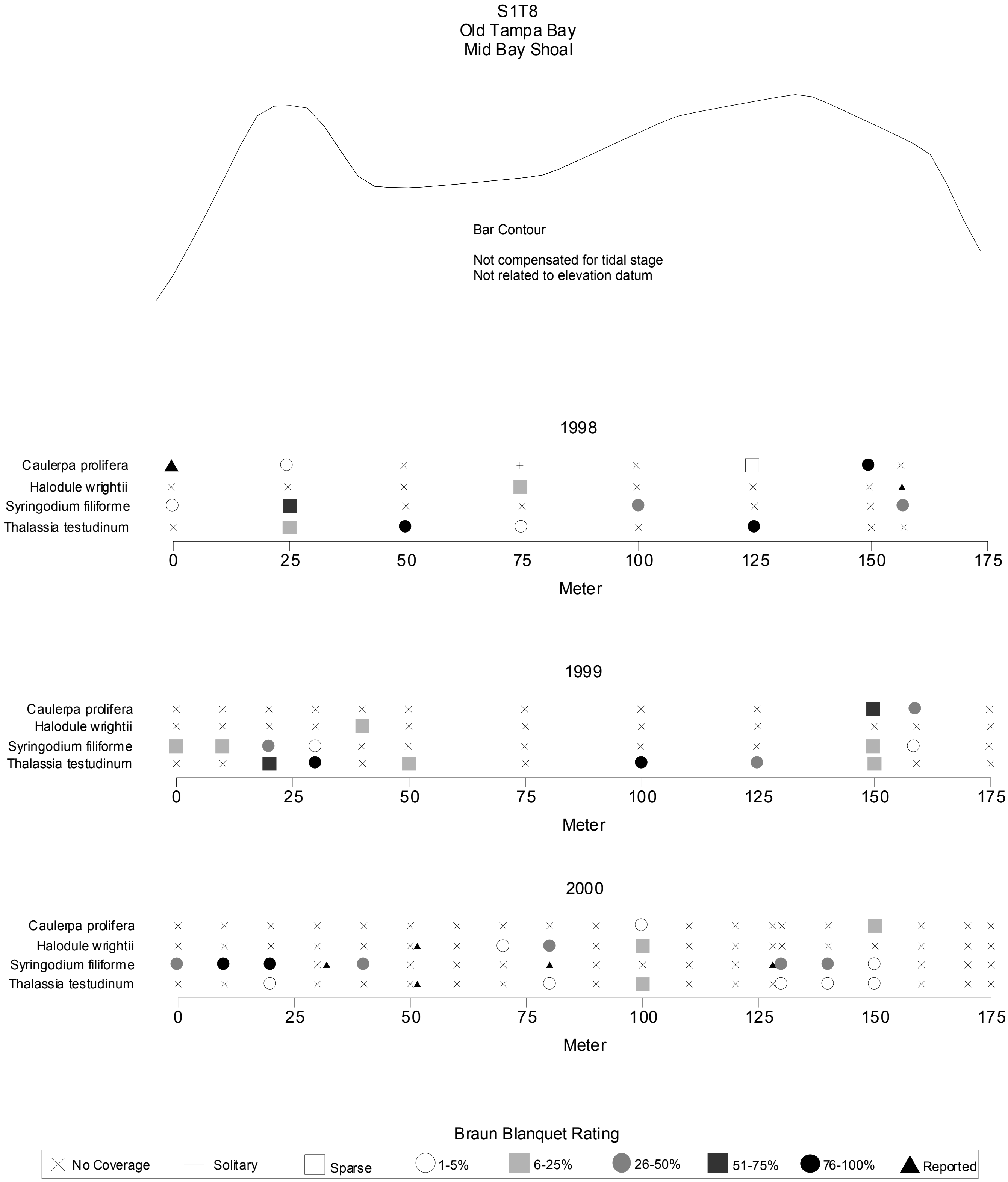

Figure 10. Seagrass species, abundance, and zonation at S1T8 from 1998-2000.

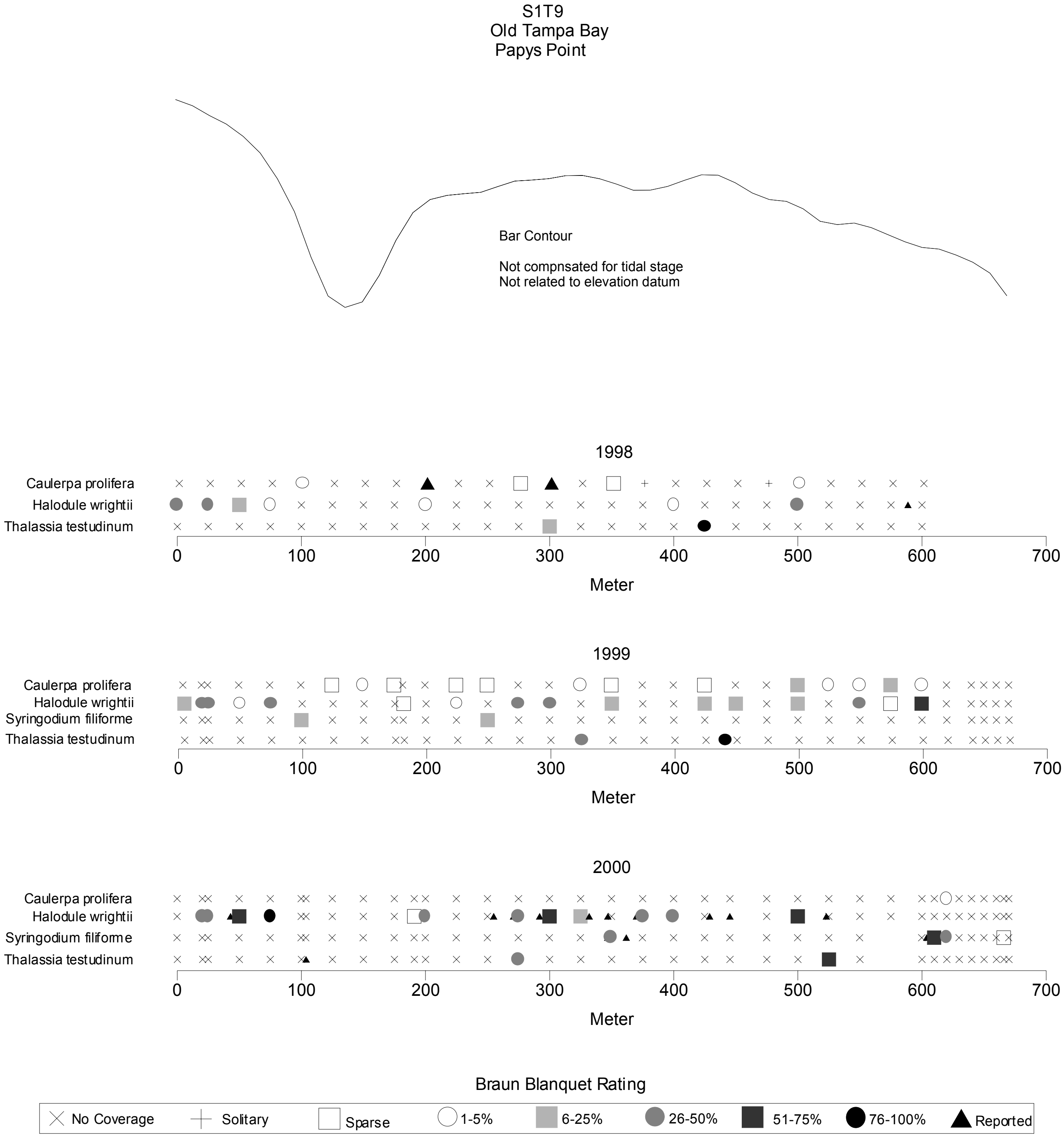

Figure 11. Seagrass species, abundance, and zonation at S1T9 from 1998-2000.

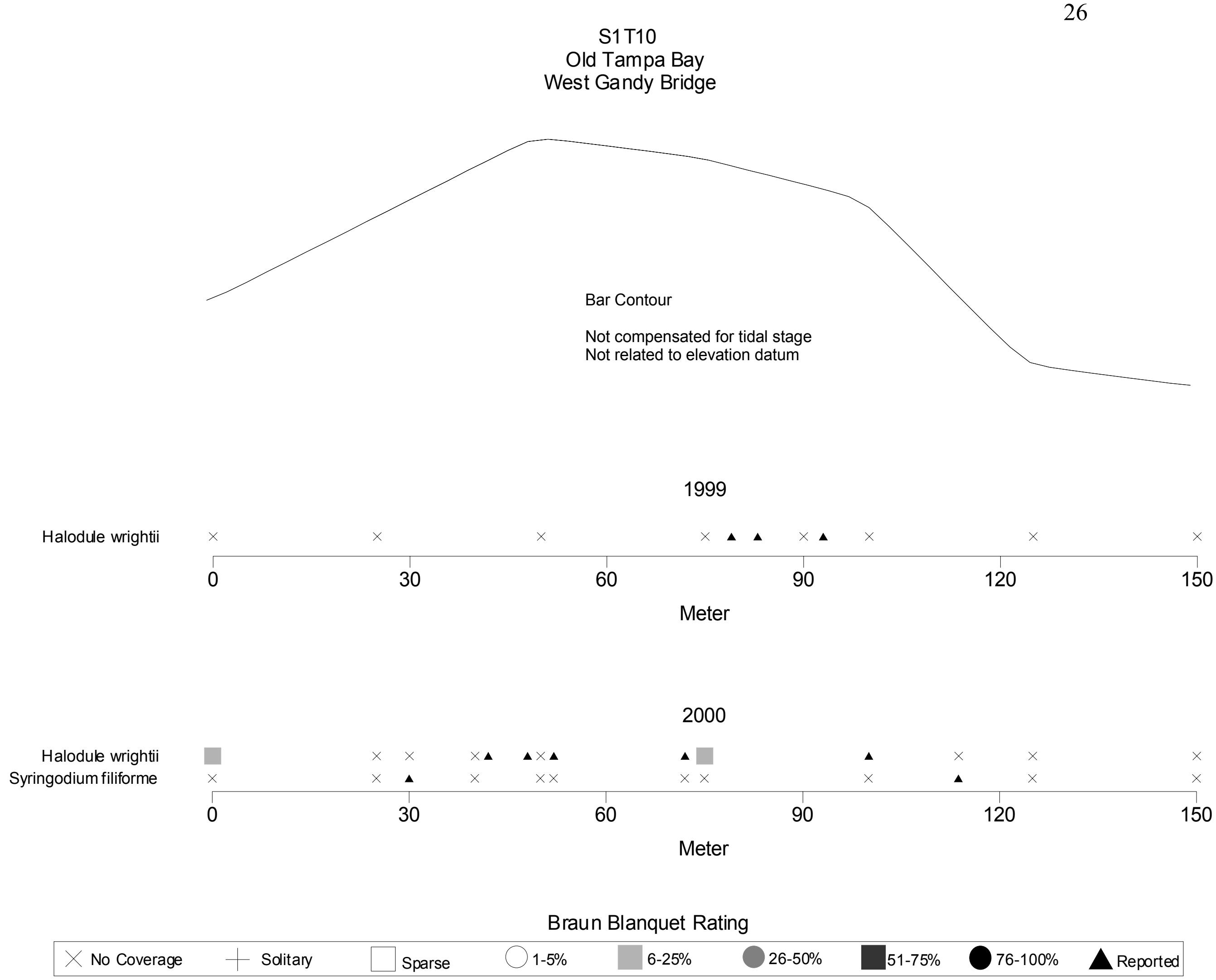

Figure 12. Seagrass species, abundance, and zonation at S1T10 from 1999-2000.

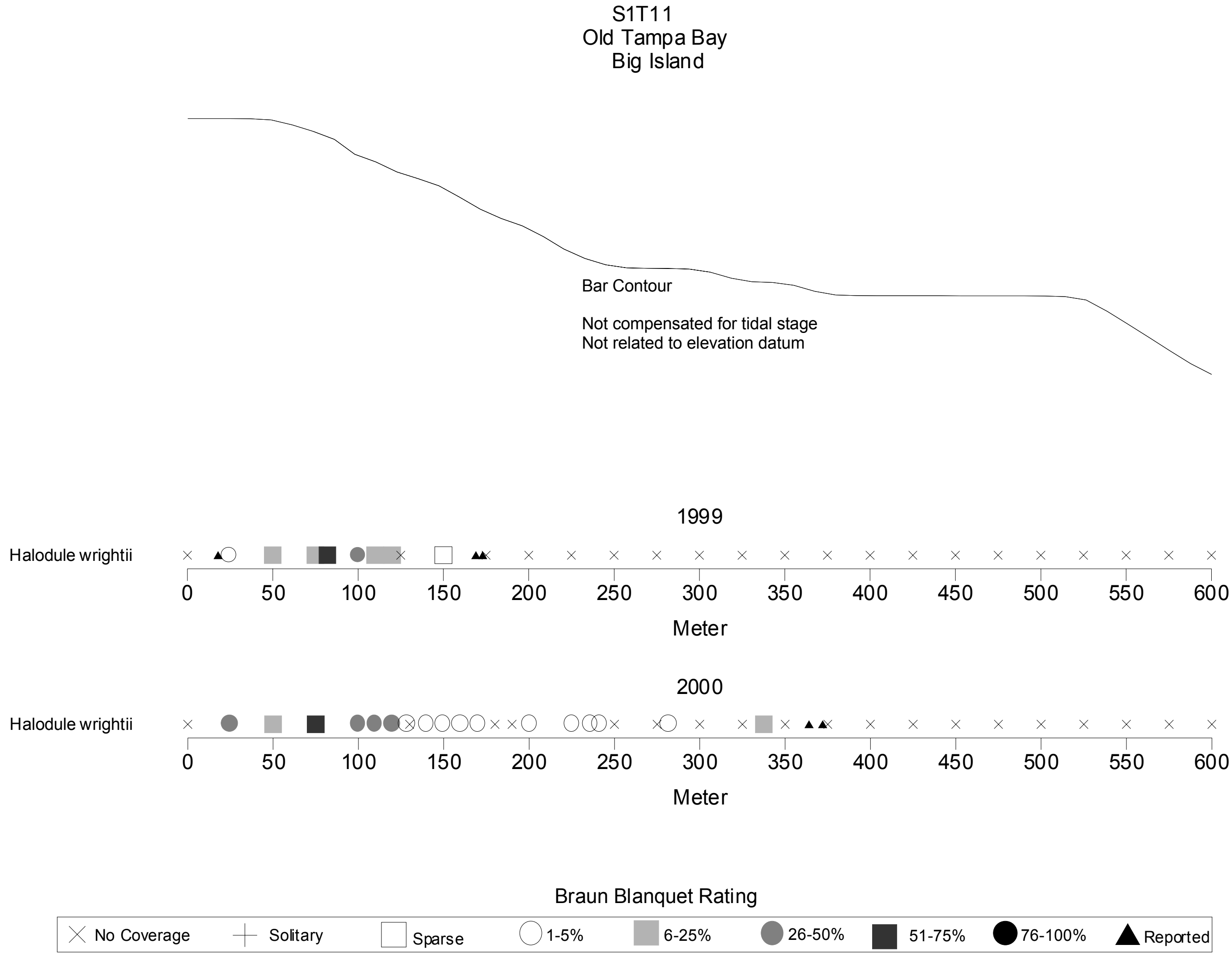

Figure 13. Seagrass species, abundance, and zonation at S1T11 from 1999-2000.

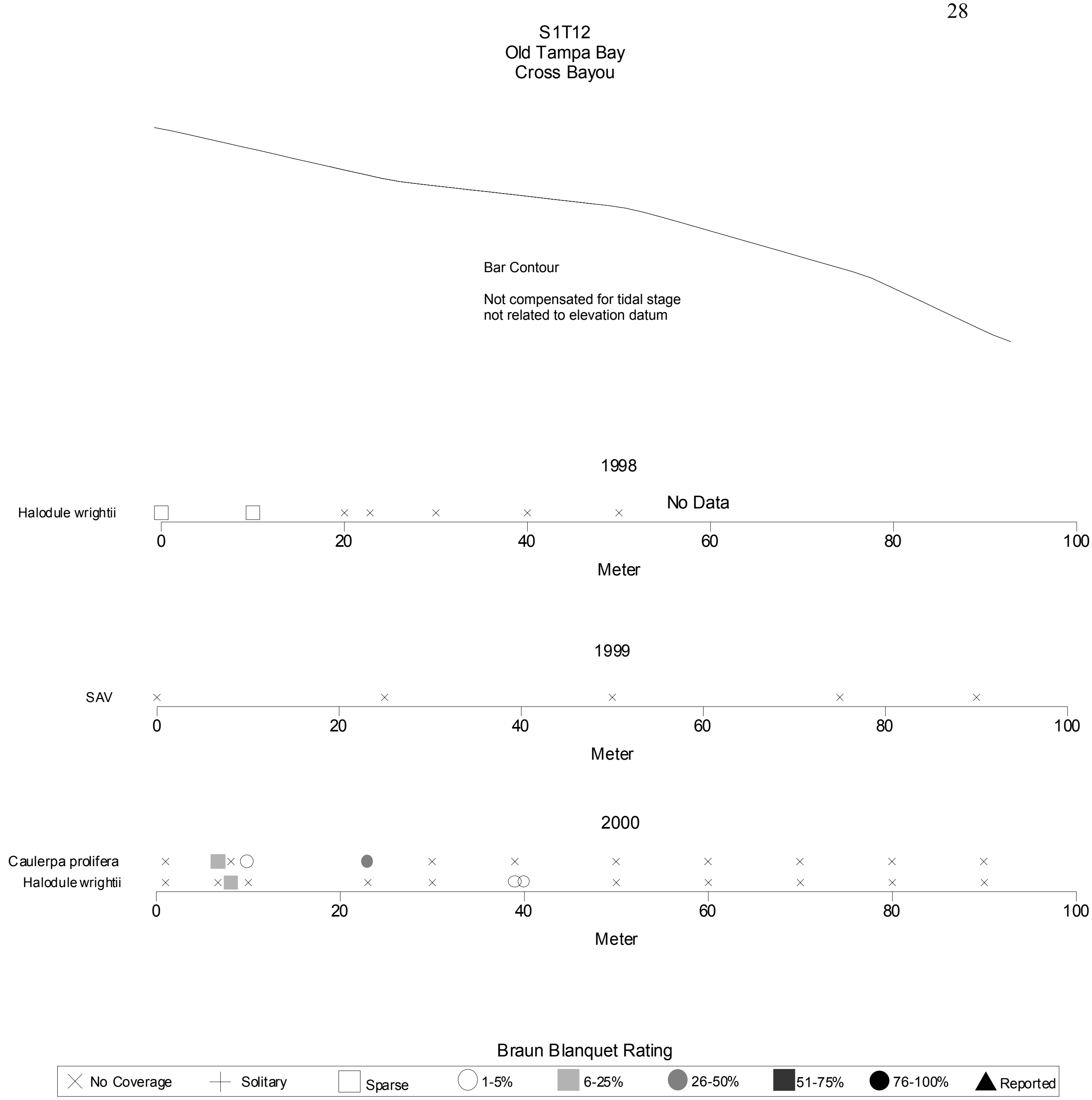

Figure 14. Seagrass species, abundance, and zonation at S1T12 from 1998-2000.

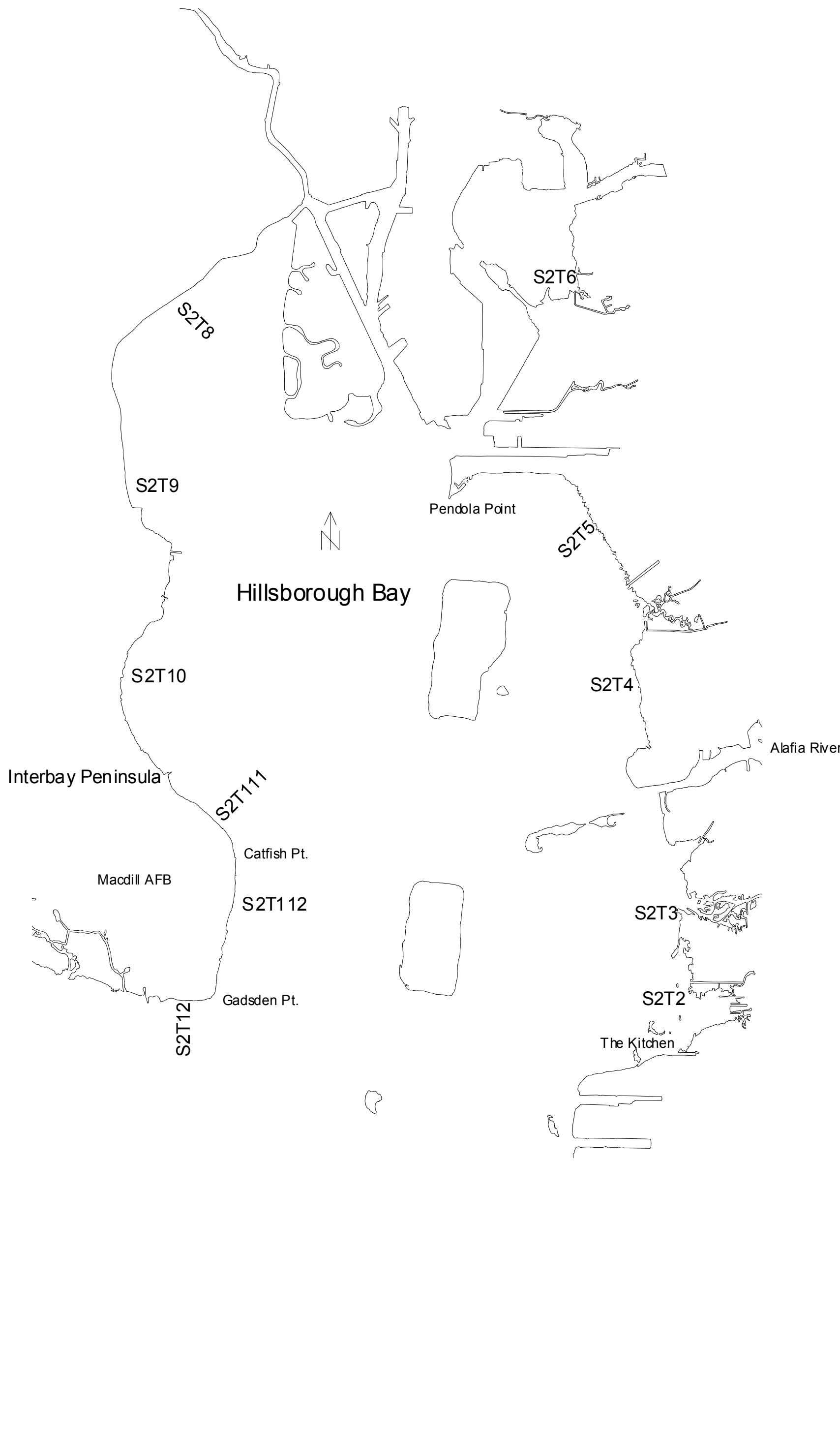

Figure 15. Location of the 11 seagrass monitoring transects in Hillsborough Bay.

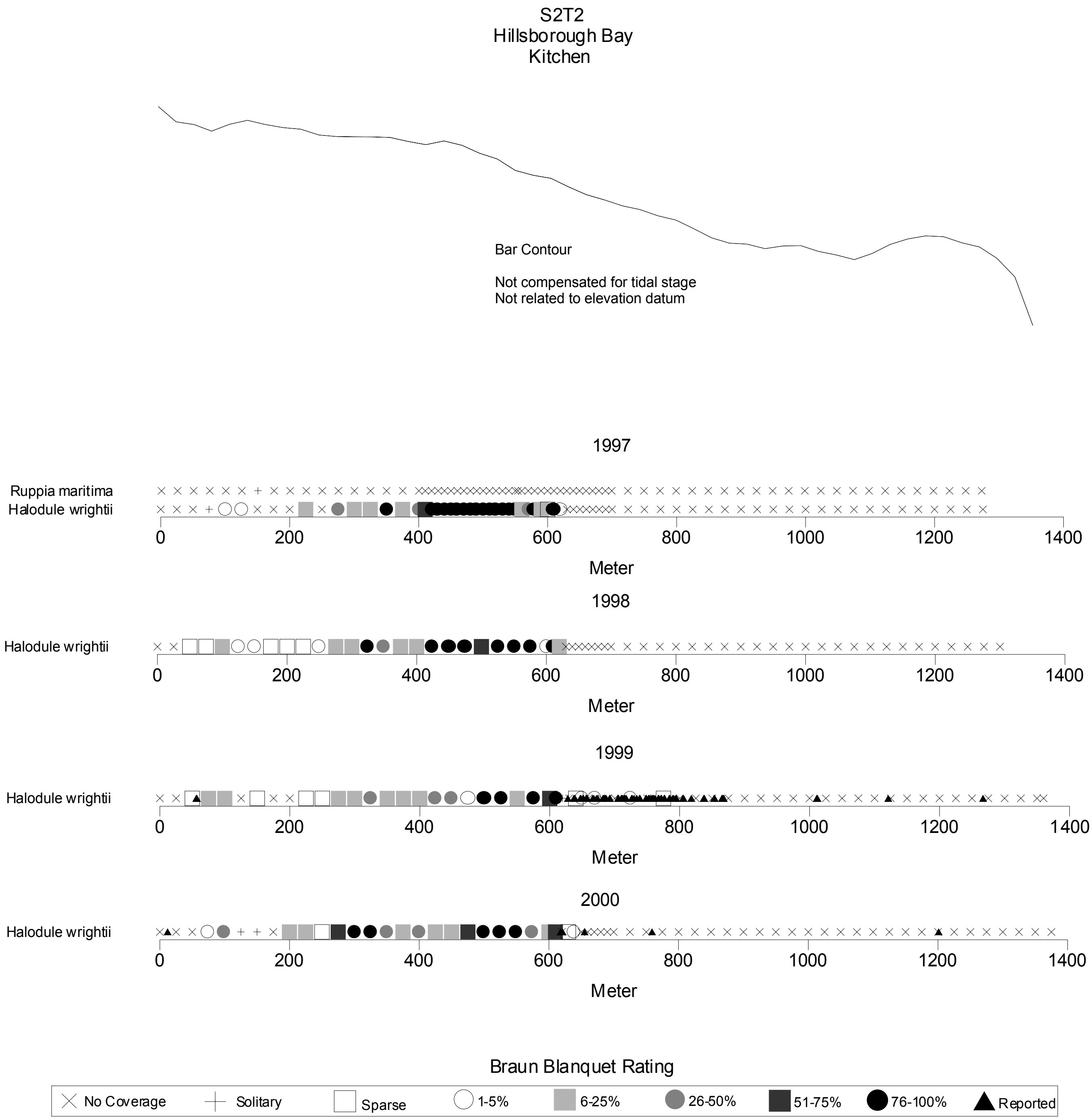

Figure 16. Seagrass species, abundance, and zonation at S2T2 from 1997-2000.

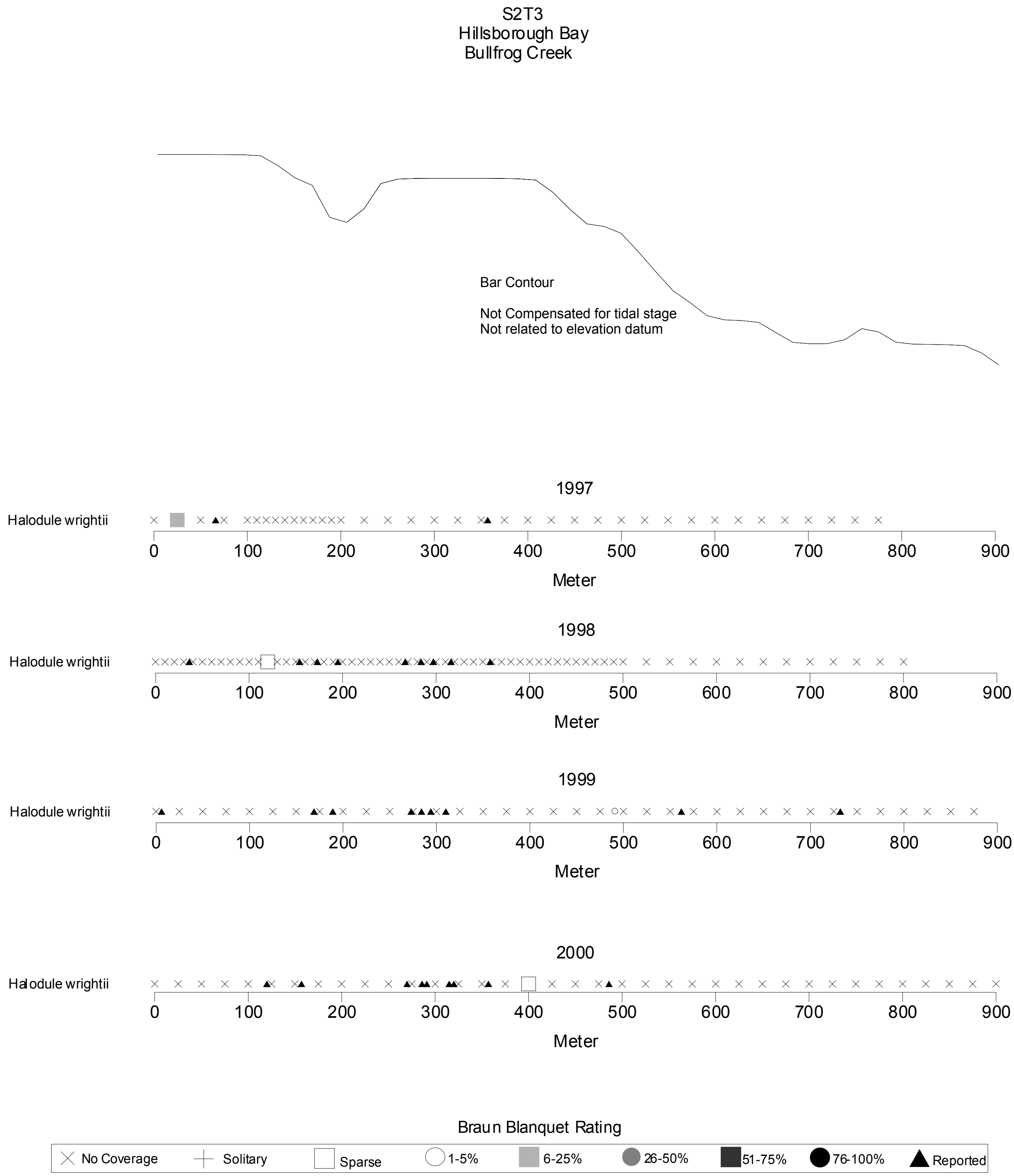

Figure 17. Seagrass species, abundance, and zonation at S2T3 from 1997-2000.

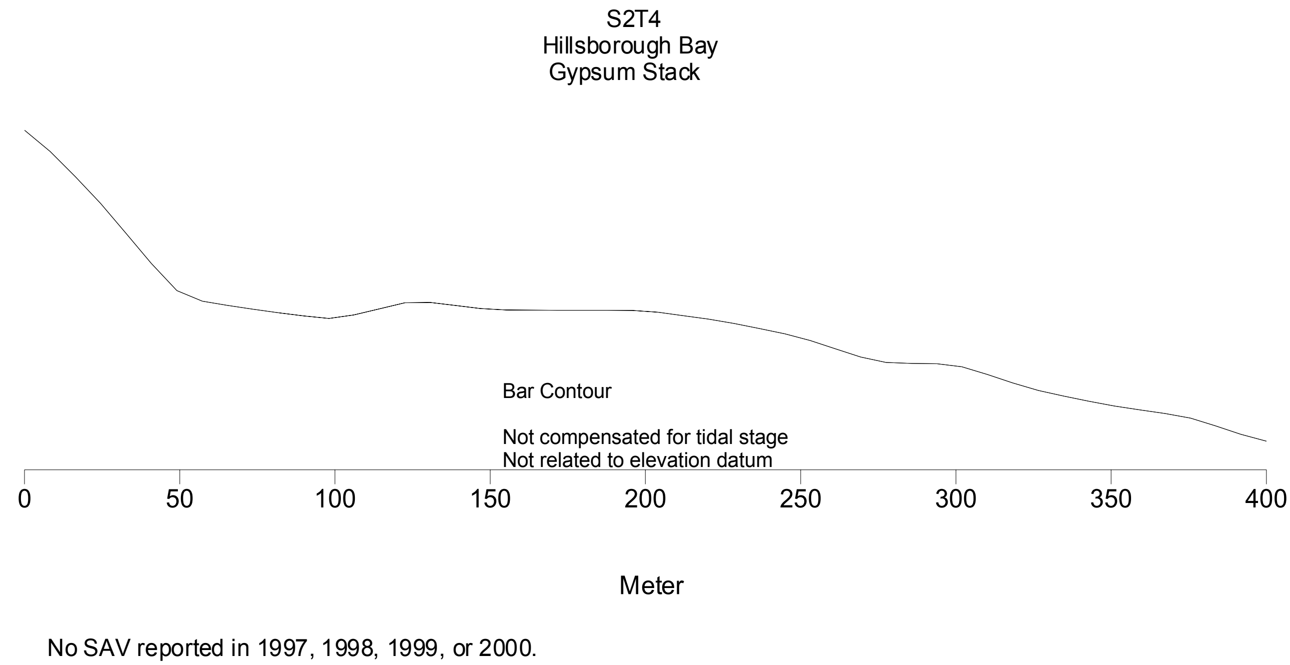

Figure 18. Seagrass species, abundance, and zonation at S2T4 from 997-2000.

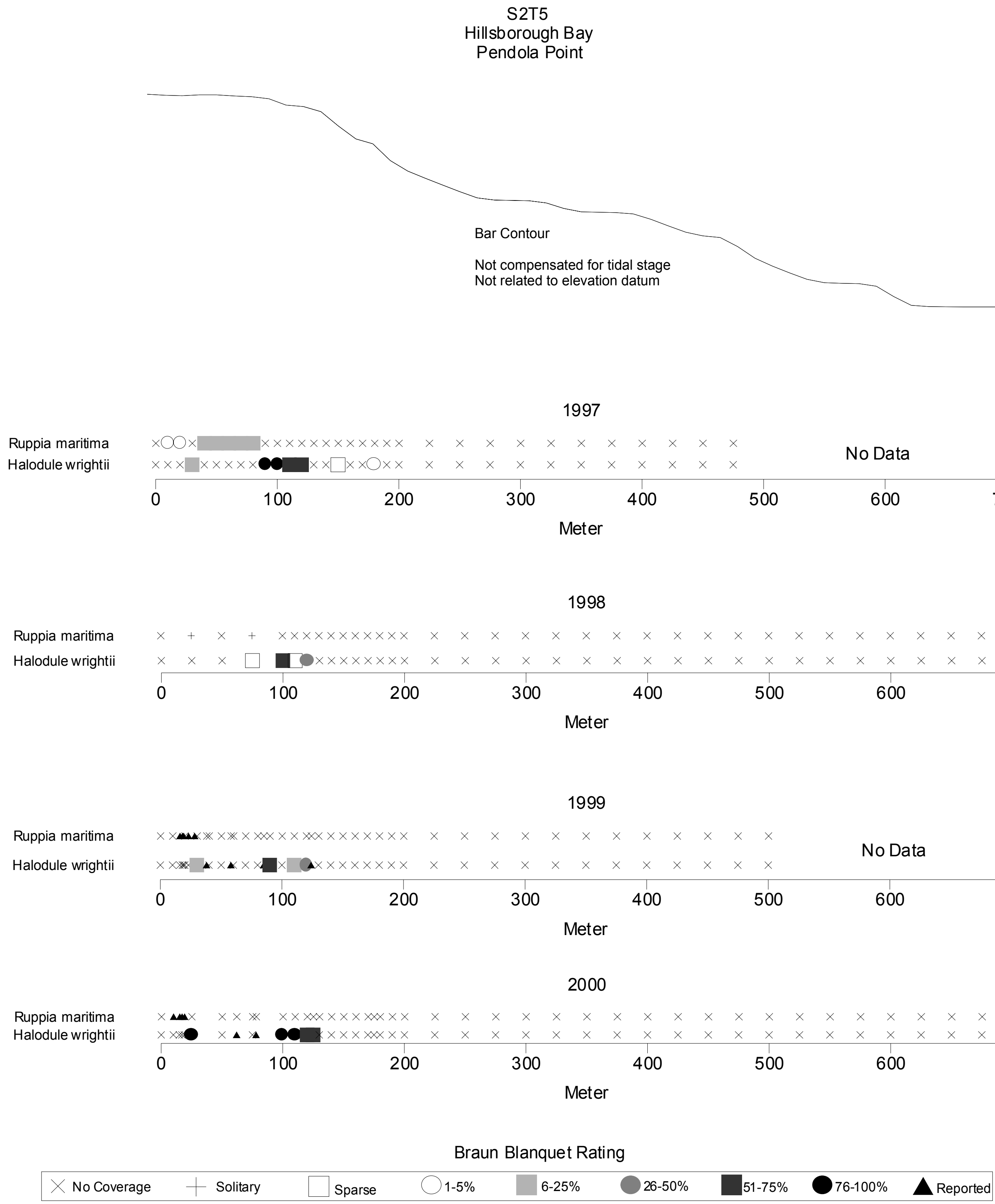

Figure 19. Seagrass species, abundance, and zonation at S2T5 from 1997-2000.

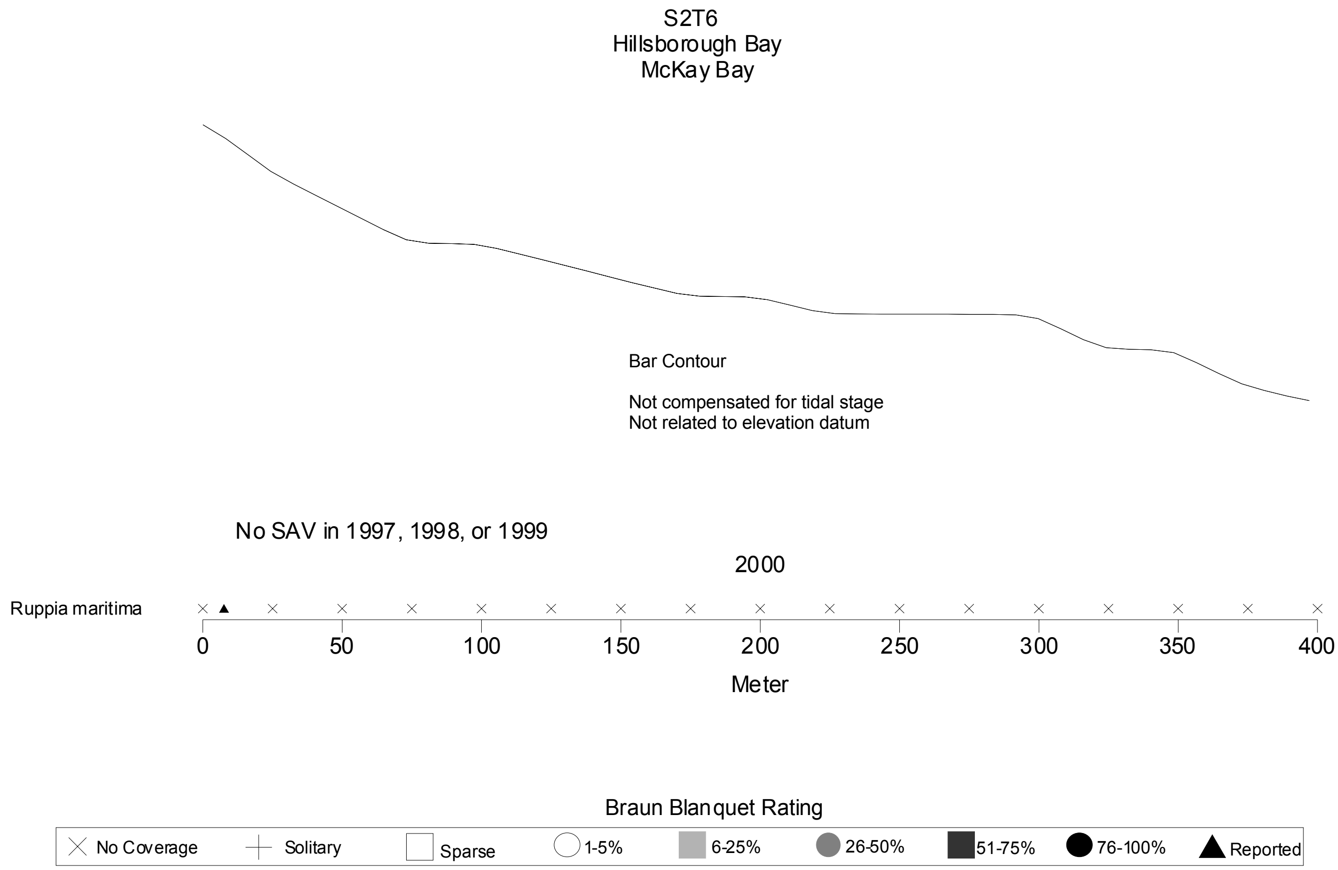

Figure 20. Seagrass species, abundance, and zonation at S2T6 from 1997-2000.

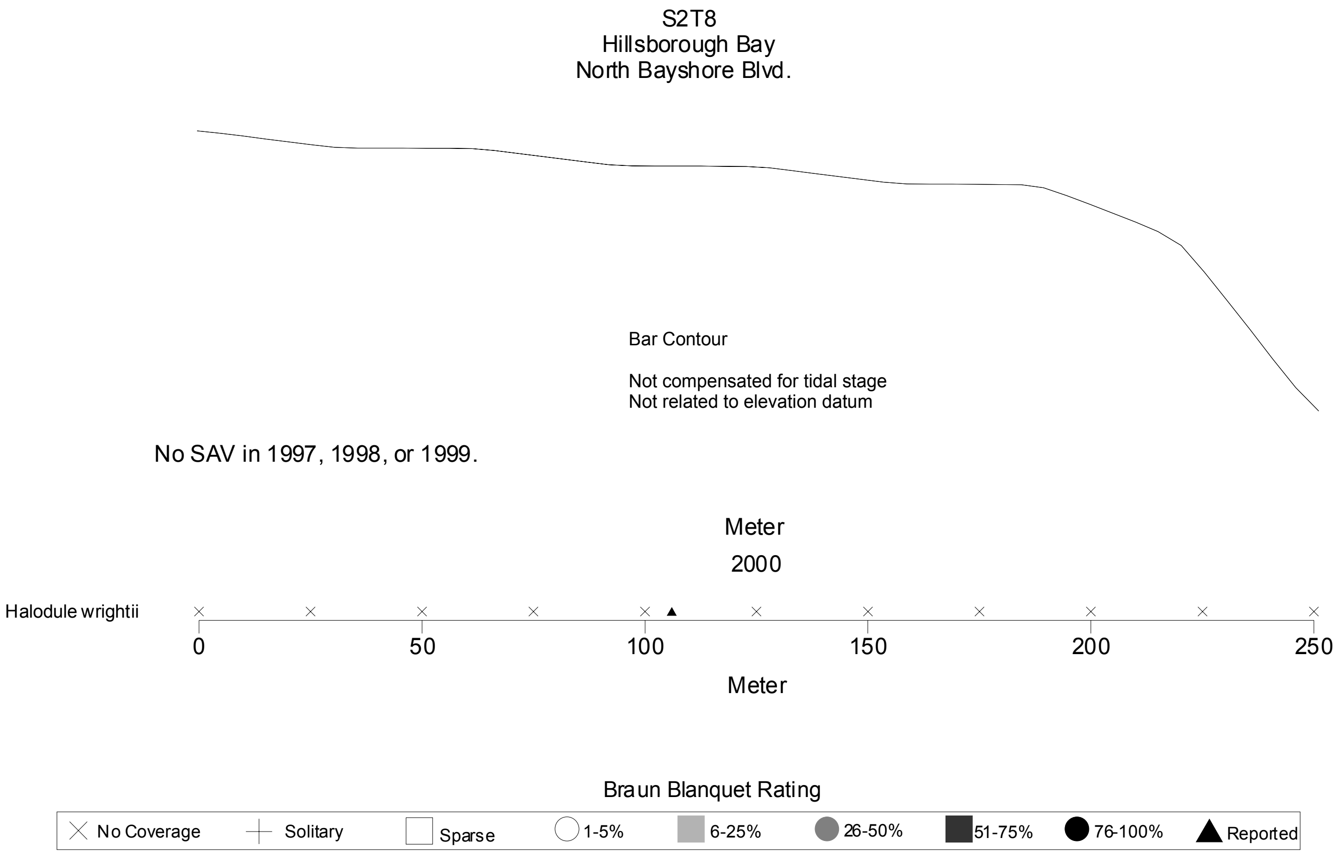

Figure 21. Seagrass species, abundance, and zonation at S2T8 from 1997-2000.

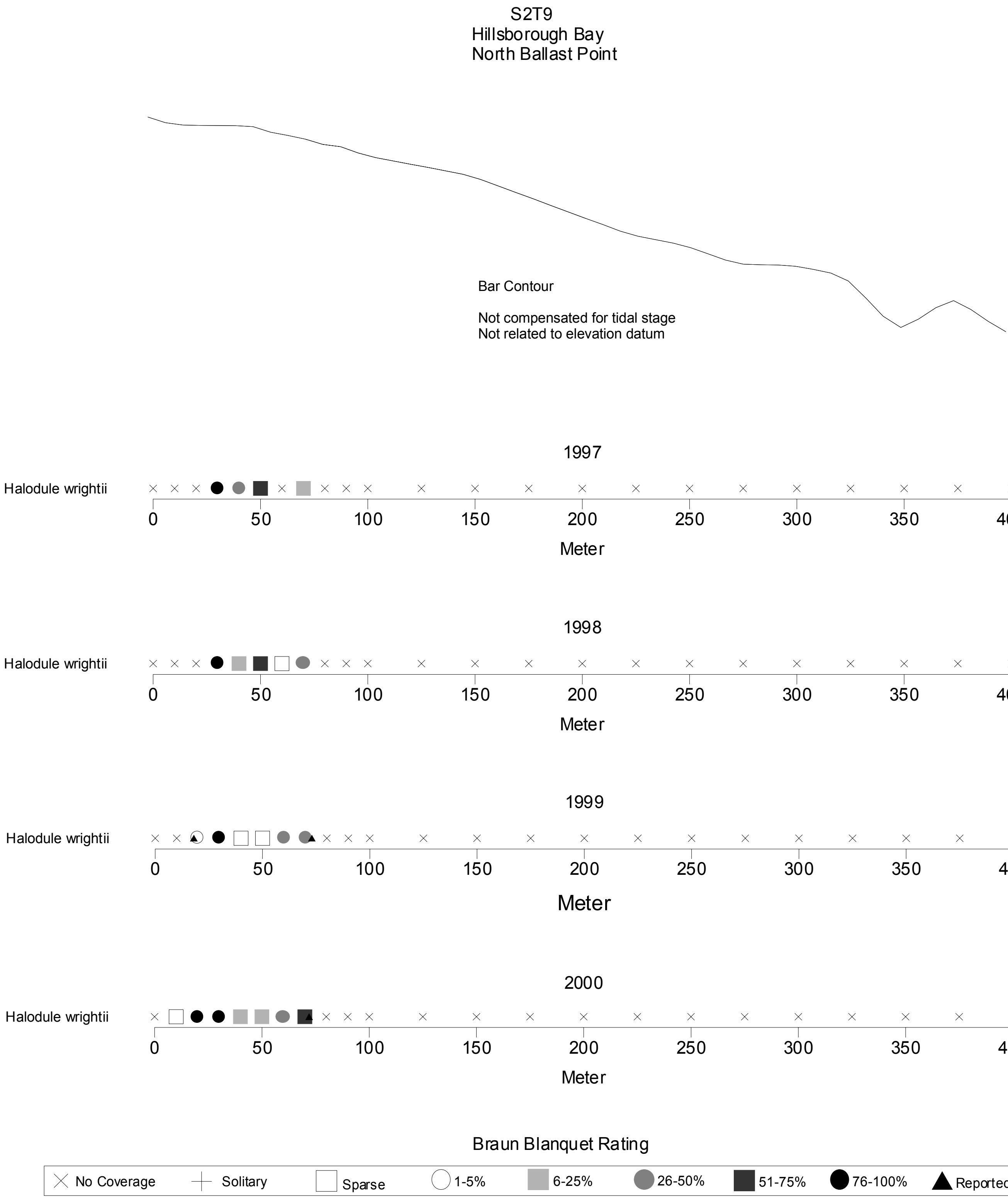

Figure 22. Seagrass species, abundance, and zonation at S2T9 from 1997-2000.

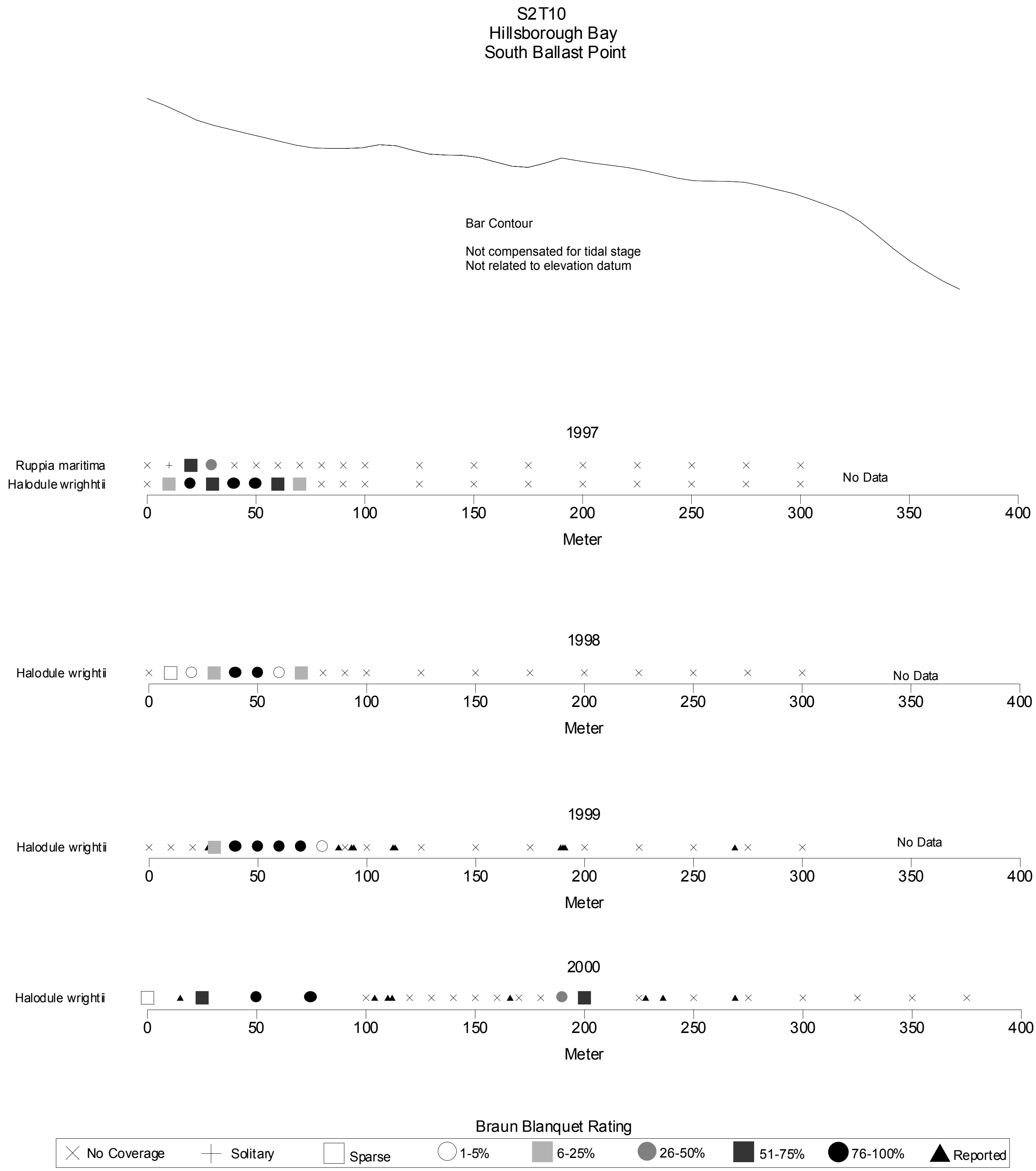

Figure 23. Seagrass species, abundance, and zonation at S2T10 from 1997-2000.

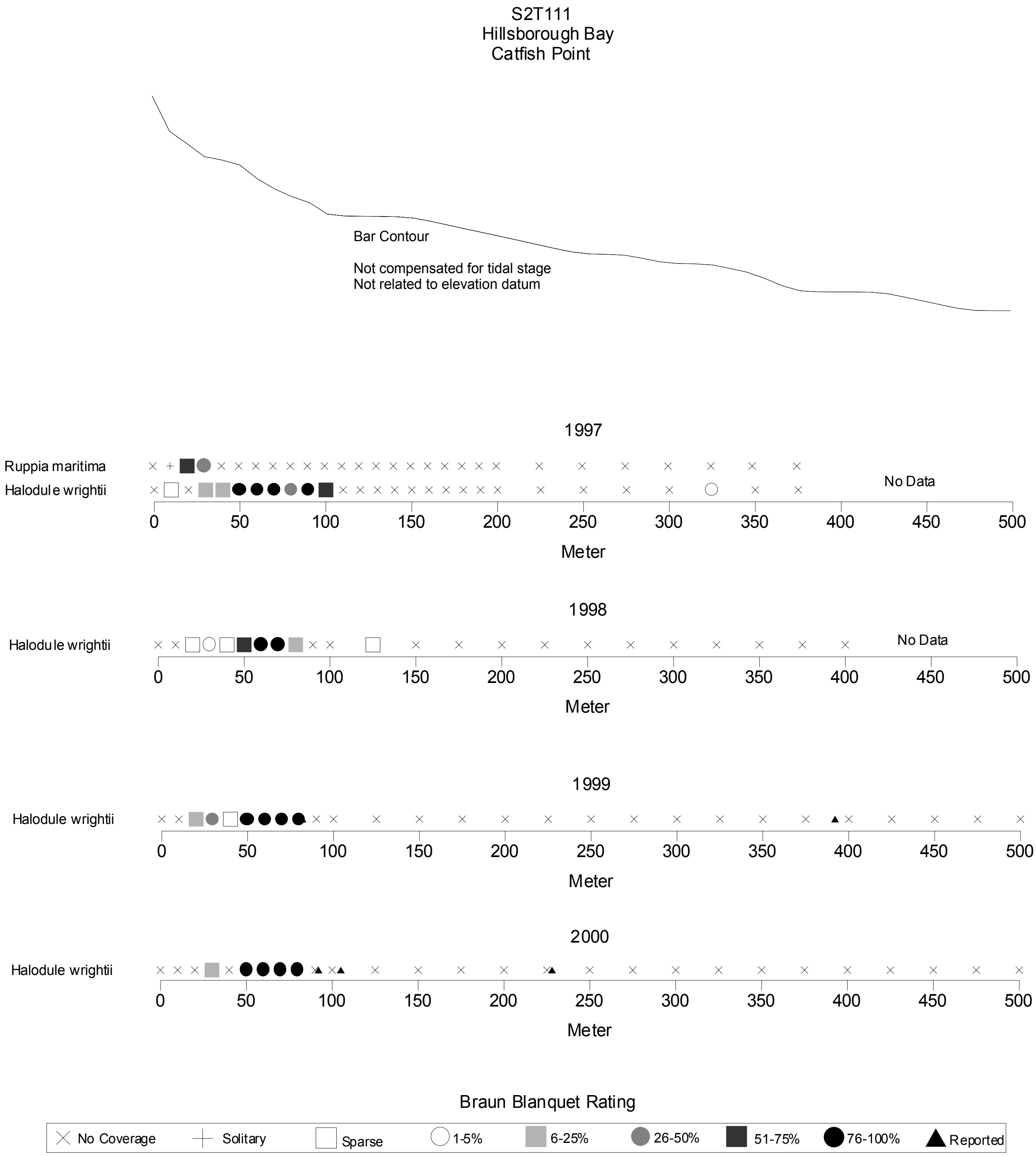

Figure 24. Seagrass species, abundance, and zonation at S2T111 from 1997-2000.

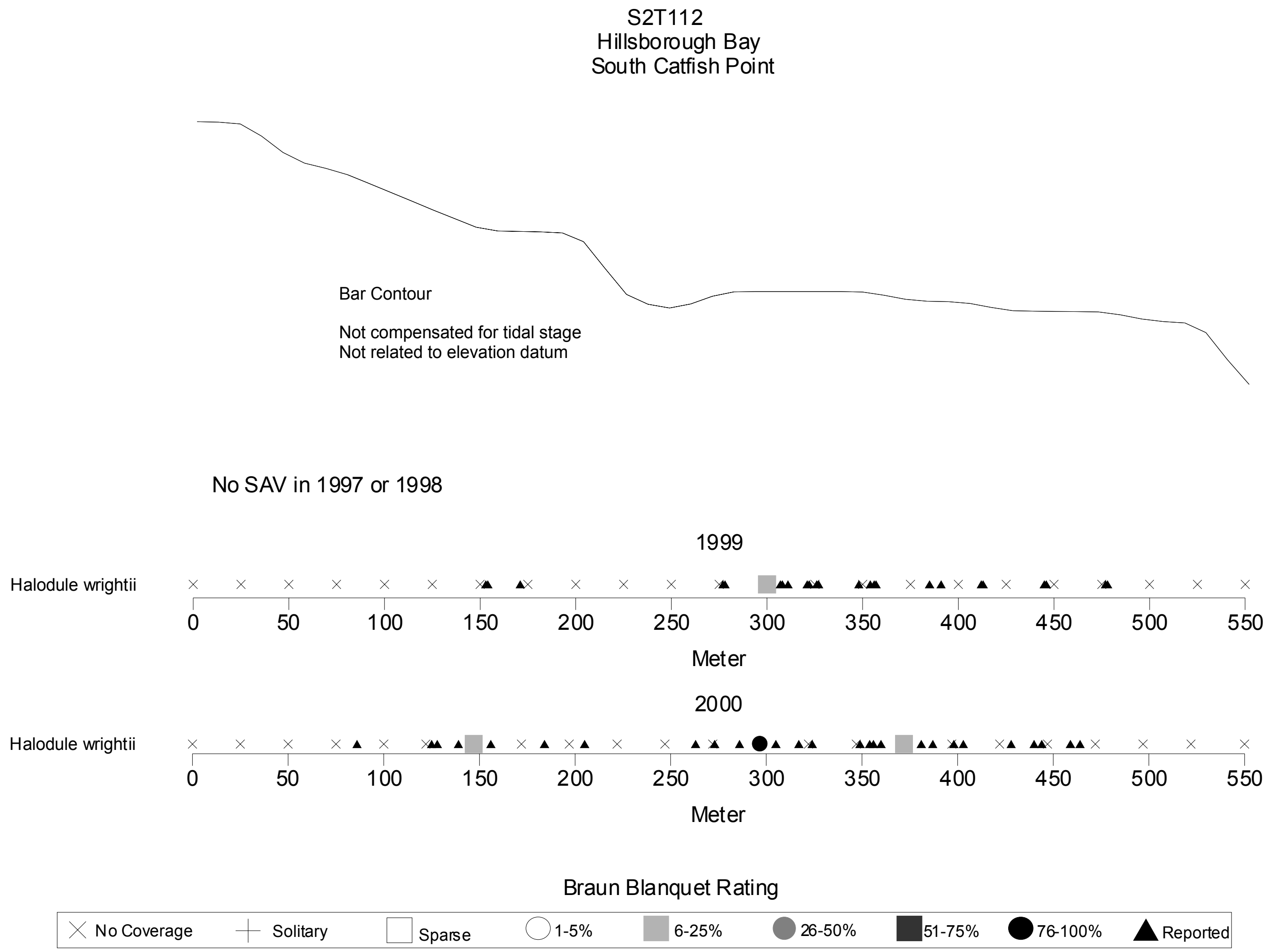

Figure 25. Seagrass species, abundance, and zonation at S2T112 from 1997-2000.

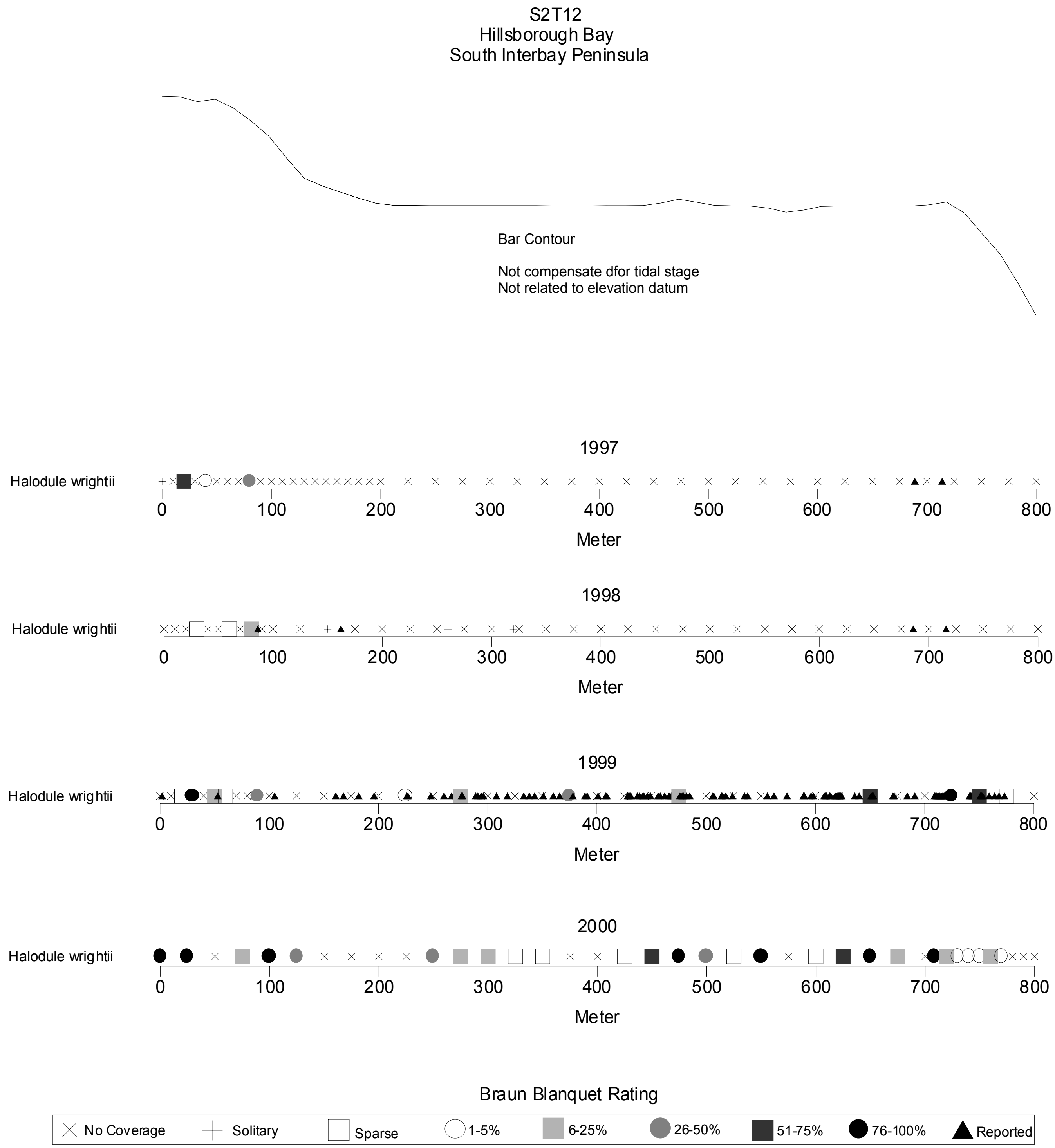

Figure 26. Seagrass species, abundance, and zonation at S2T12 from 1997-2000.

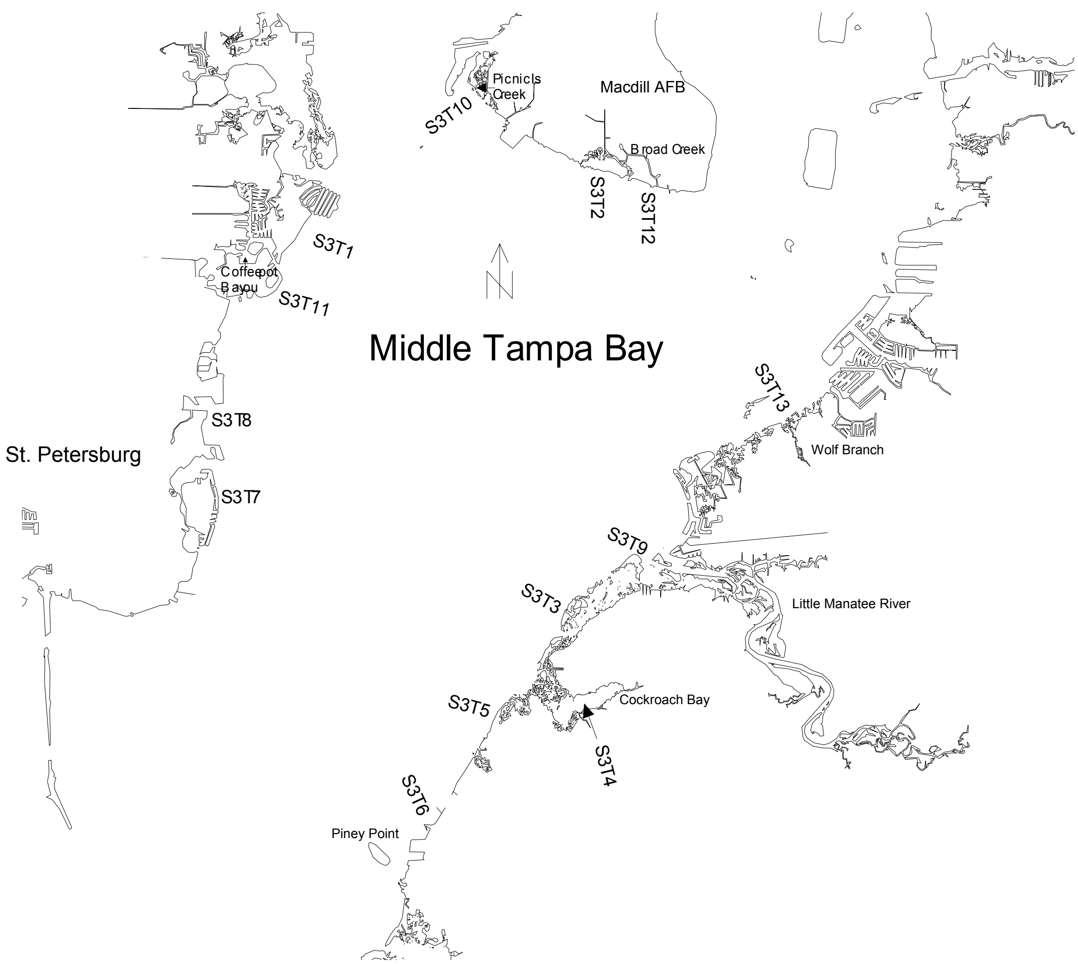

Figure 27. Location of the 13 seagrass monitoring transects in Middle Tampa Bay.

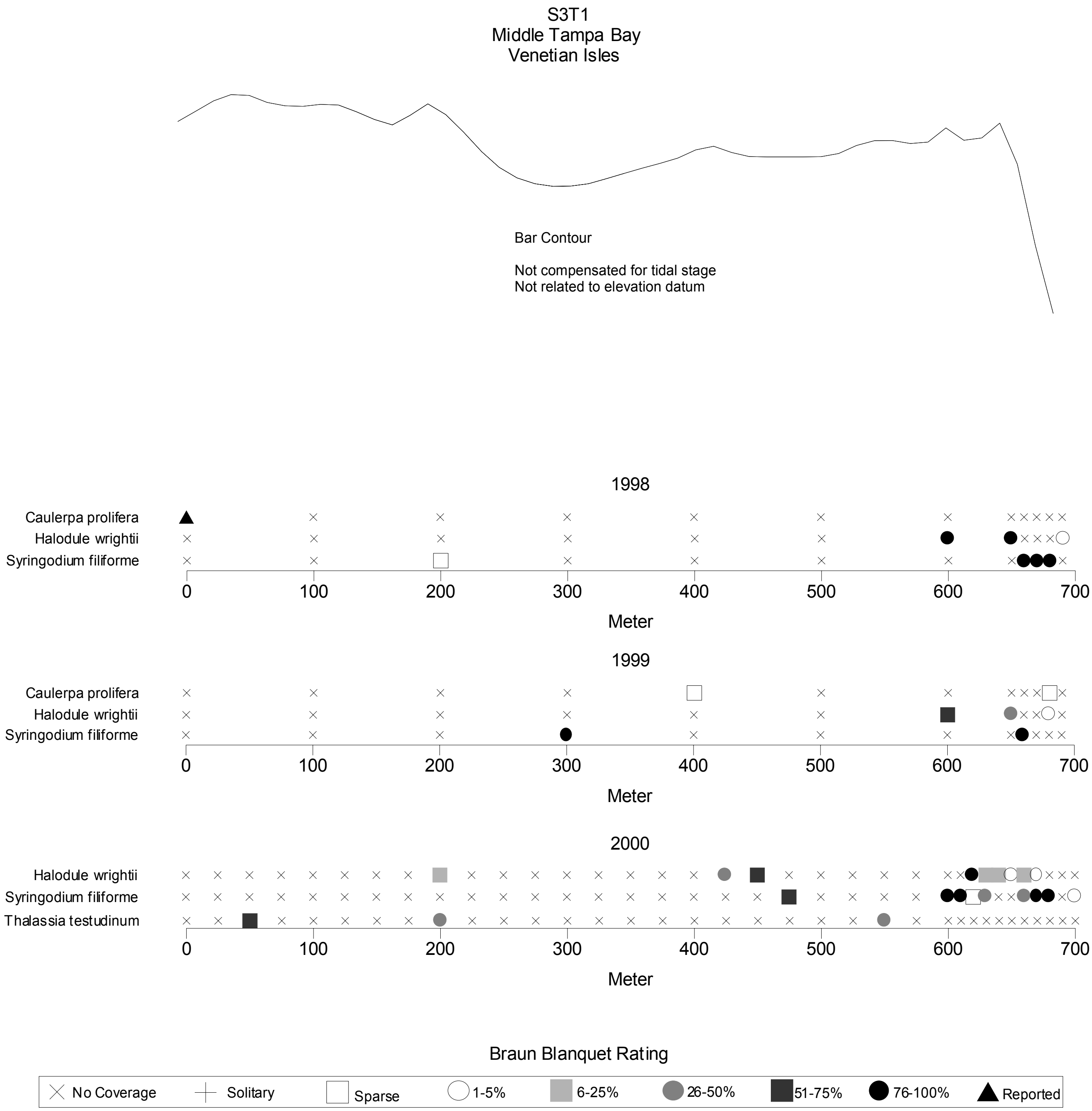

Figure 28. Seagrass species, abundance, and zonation at S3T1 from 1998-2000.

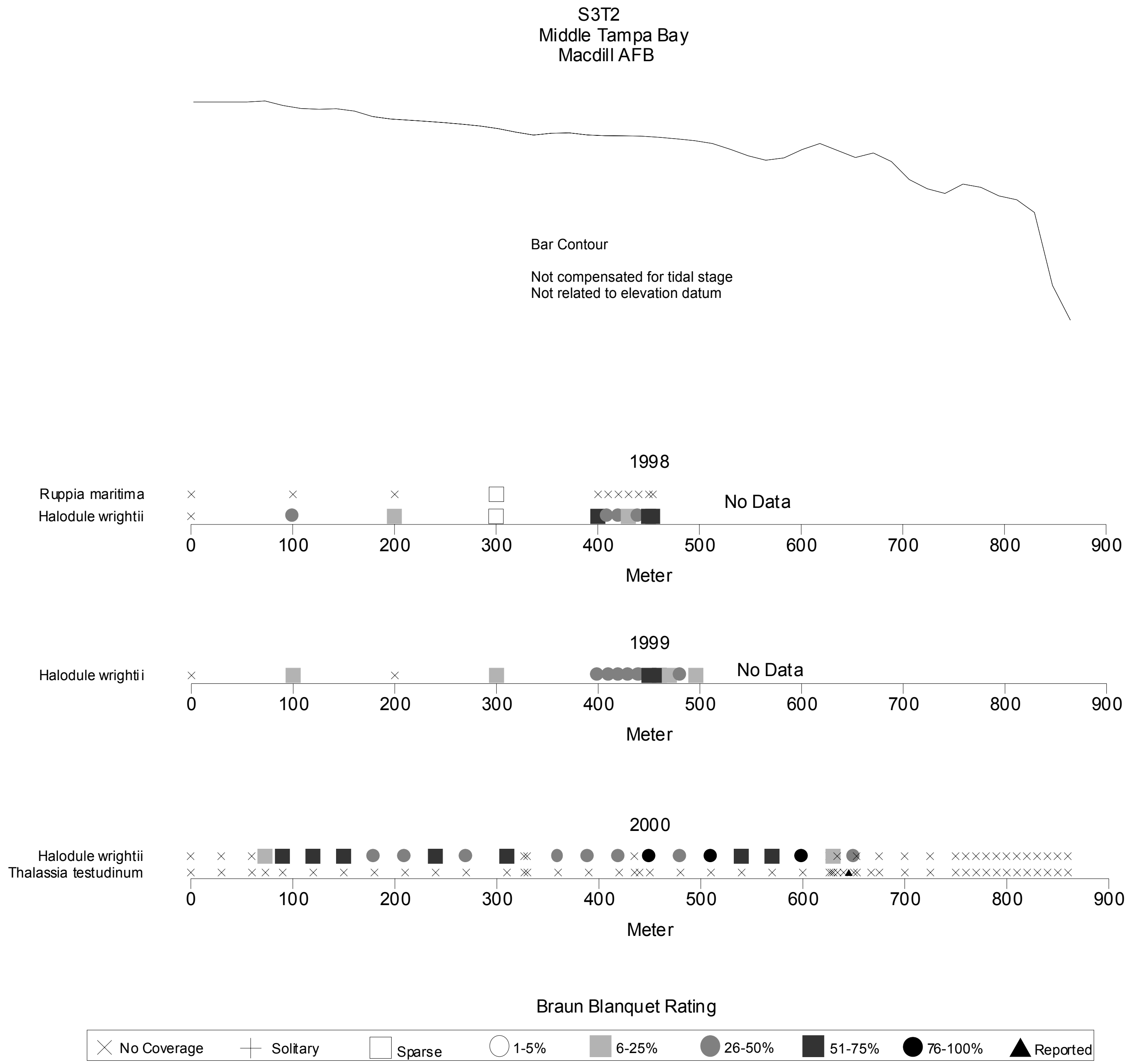

Figure 29. Seagrass species, abundance, and zonation at S3T2 from 1998-2000.

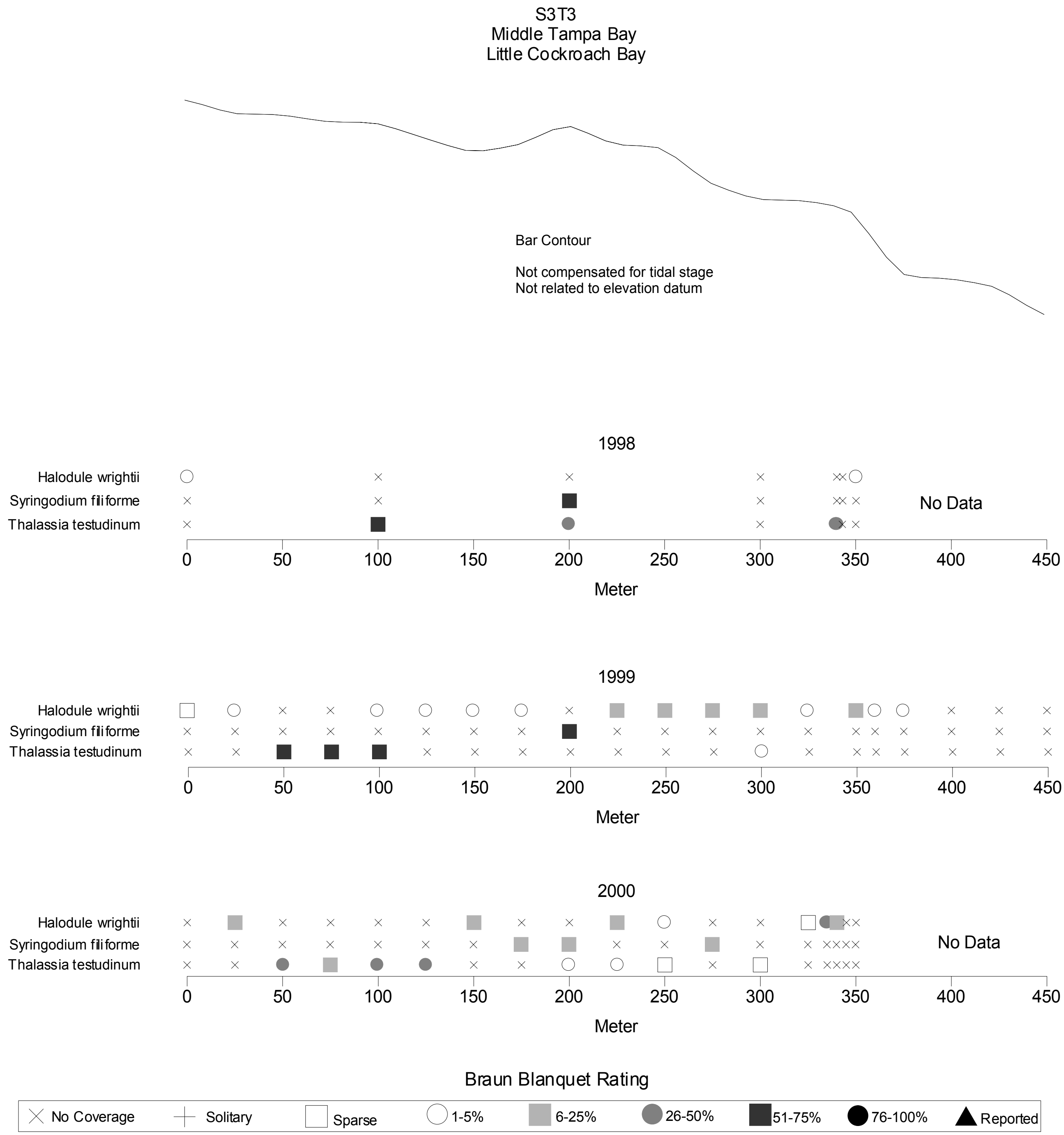

Figure 30. Seagrass species, abundance, and zonation at S3T3 from 1998-2000.

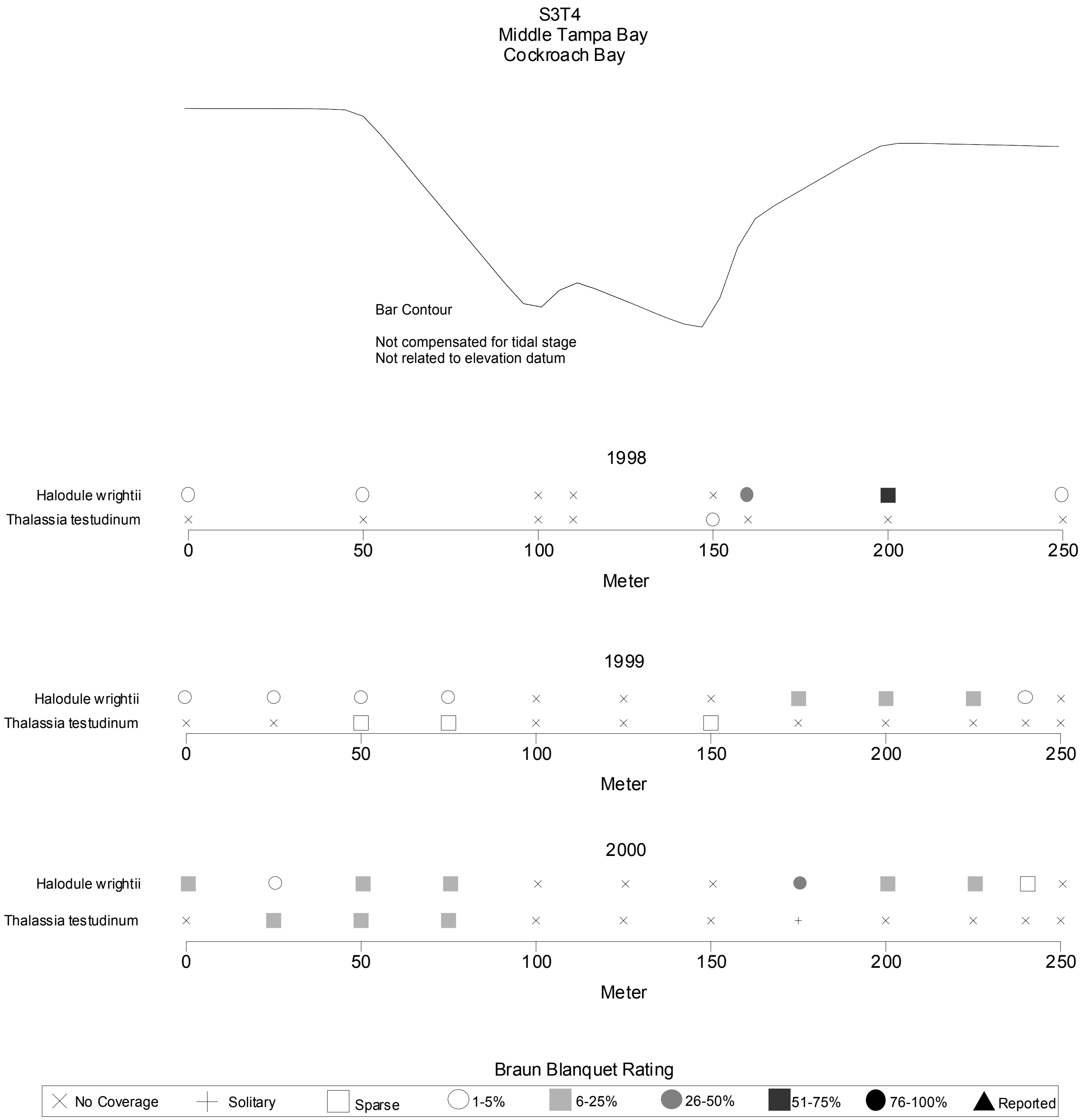

Figure 31. Seagrass species, abundance, and zonation at S3T4 from 1998-2000.

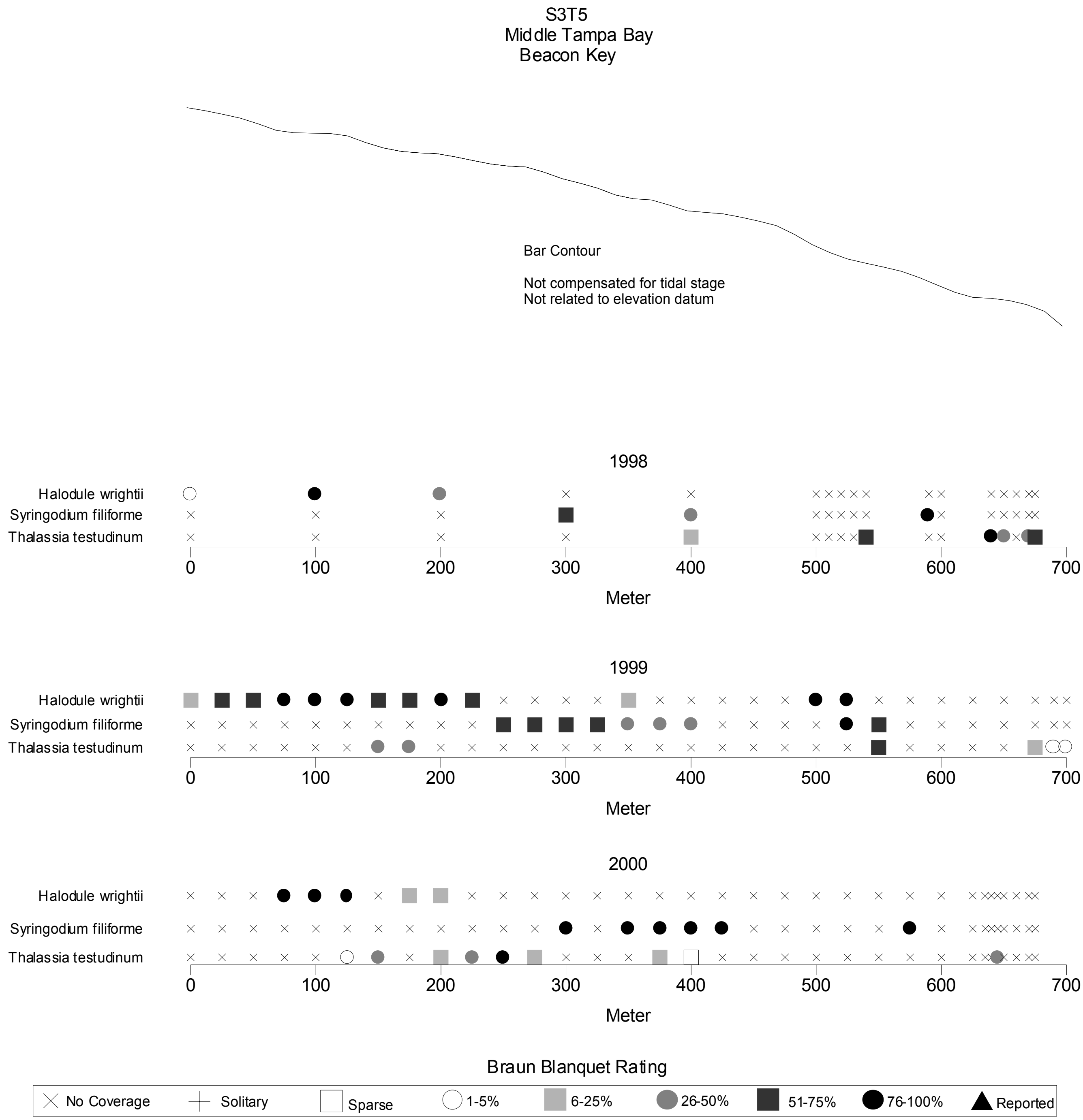

Figure 32. Seagrass species, abundance, and zonation at S3T5 from 1998-2000.

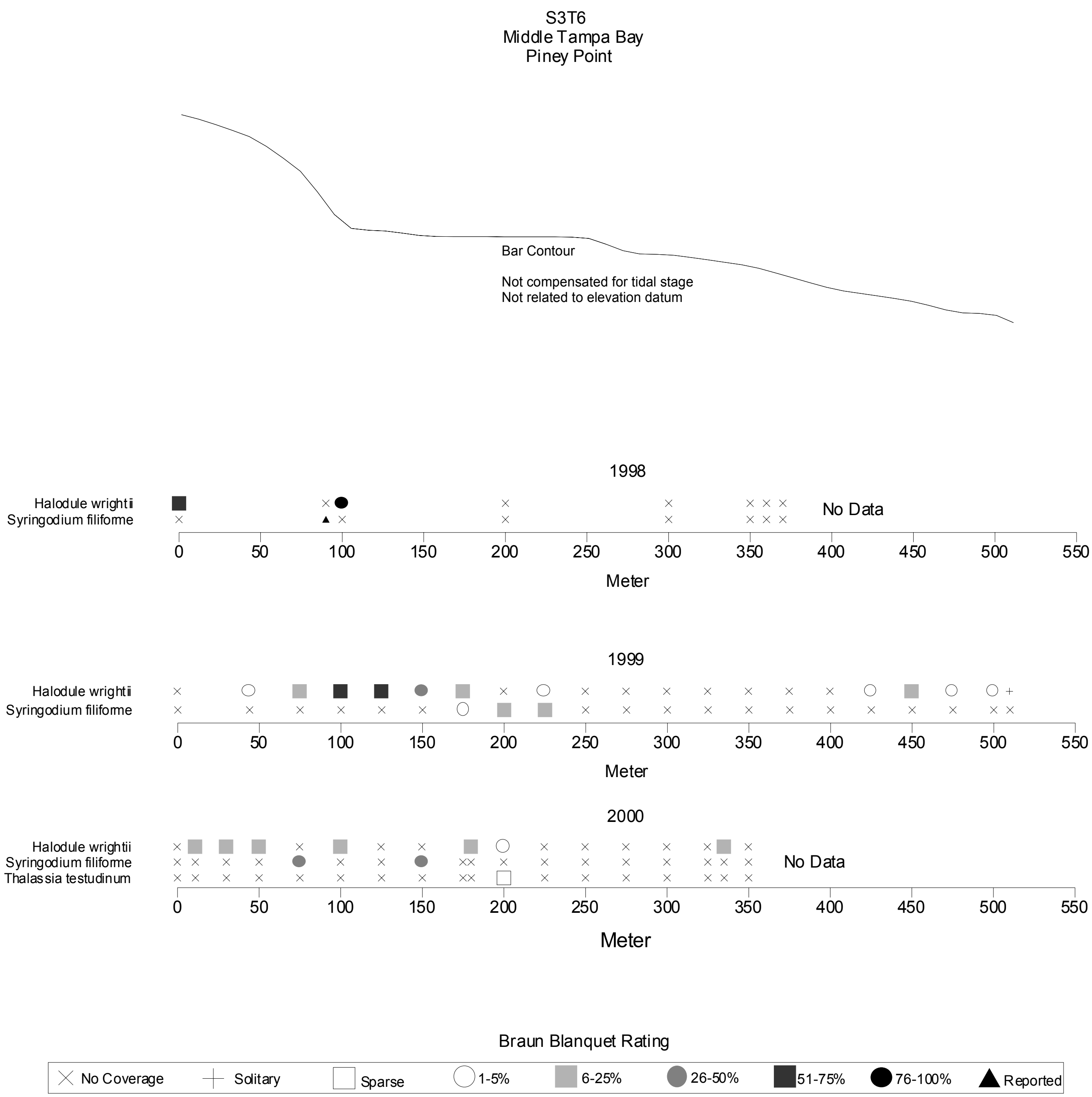

Figure 33. Seagrass species, abundance, and zonation at S3T6 from 1998-2000.

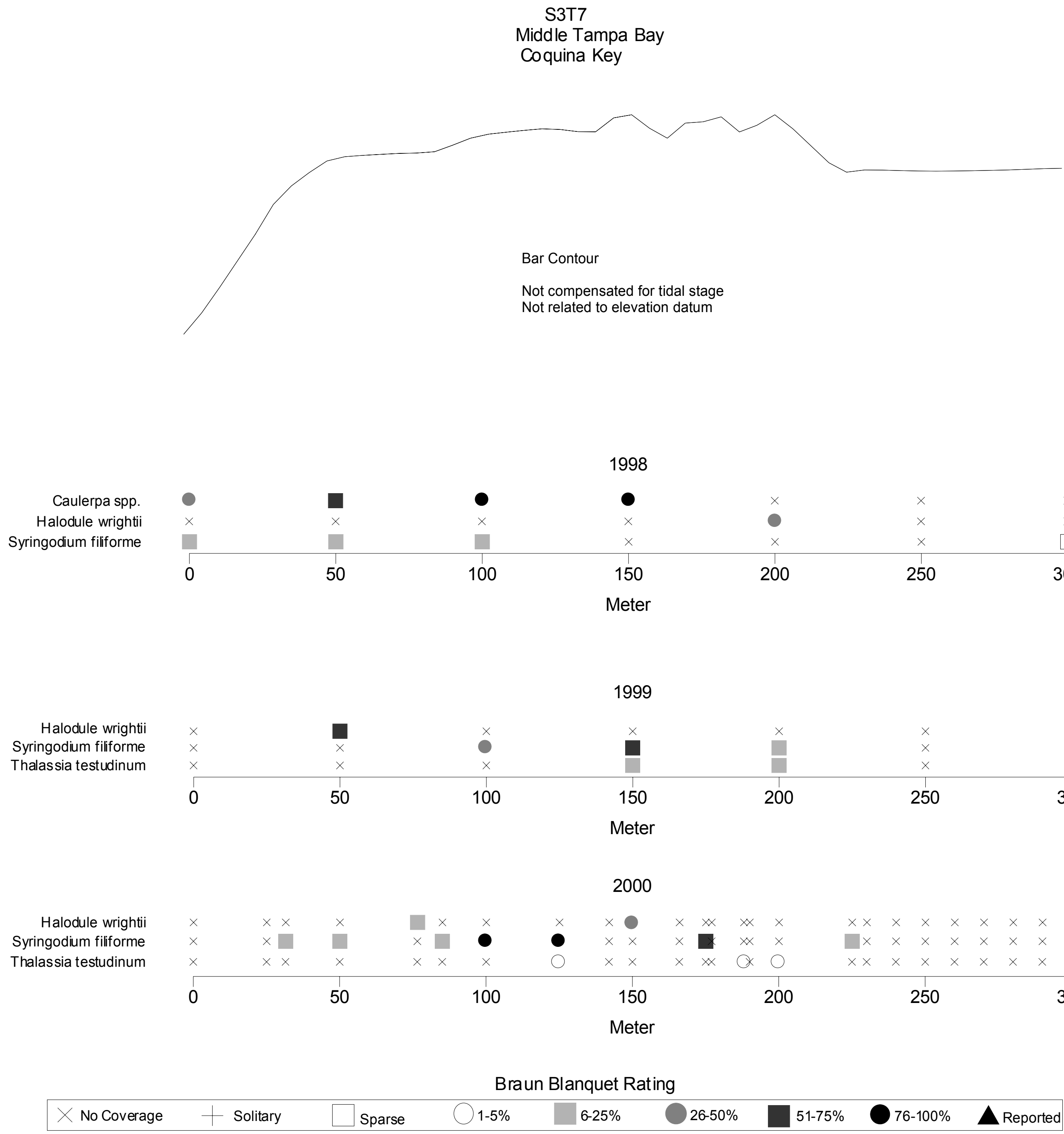

Figure 34. Seagrass species, abundance, and zonation at S3T7 from 1998-2000.

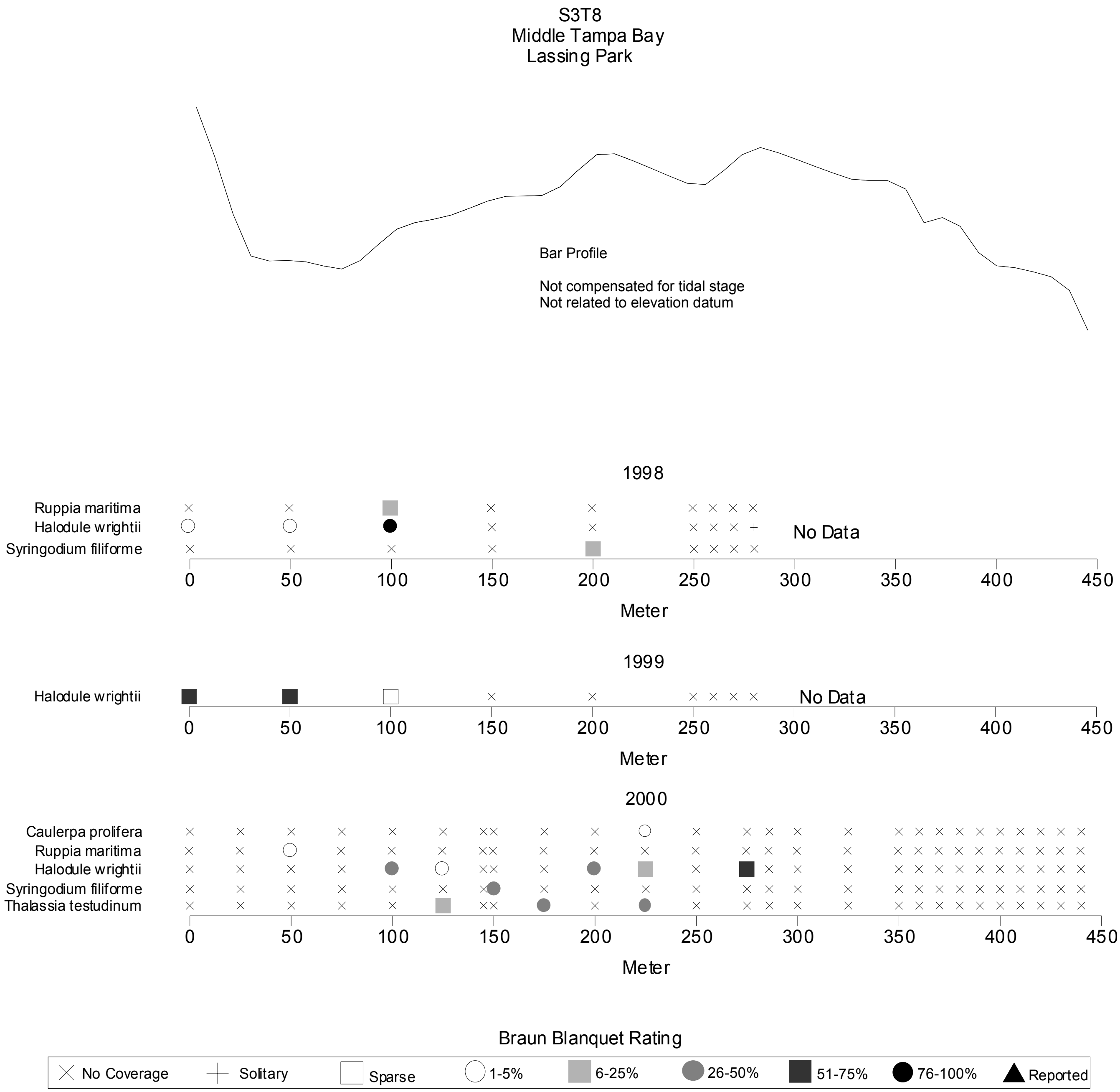

Figure 35. Seagrass species, abundance, and zonation at S3T8 from 1998-2000.

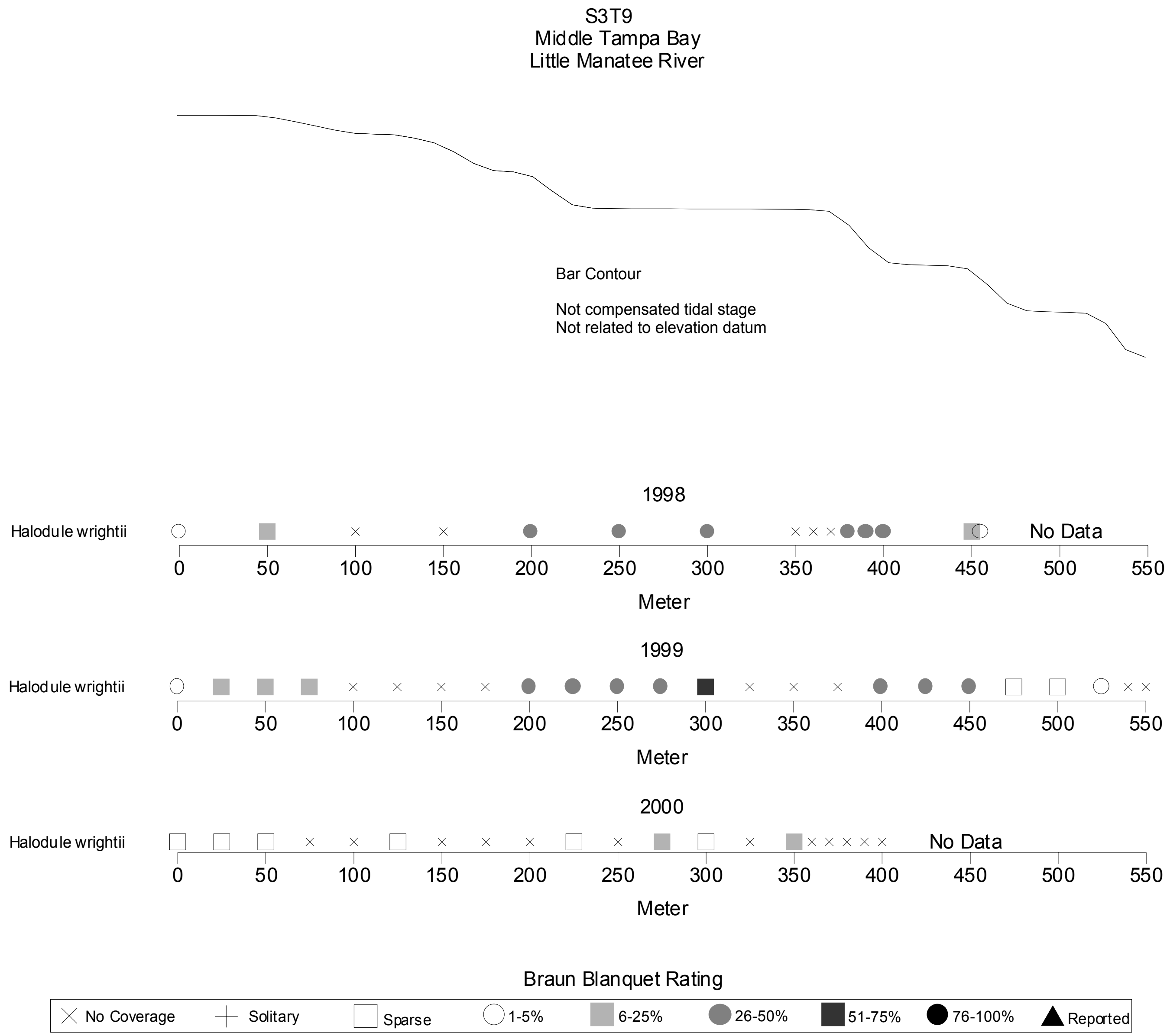

Figure 36. Seagrass species, abundance, and zonation at S3T9 from 1998-2000.

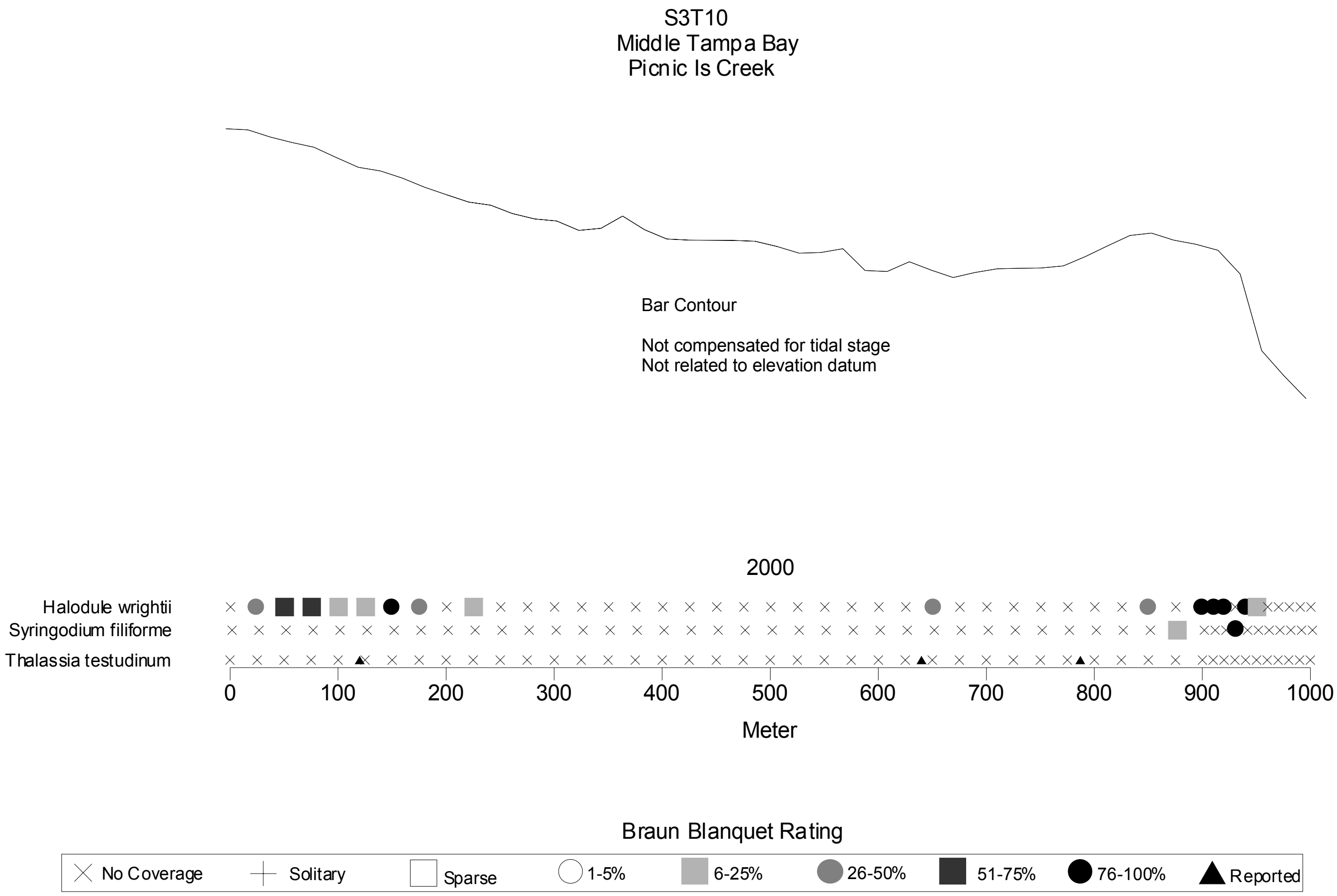

Figure 37. Seagrass species, abundance, and zonation at S3T10 during 2000.

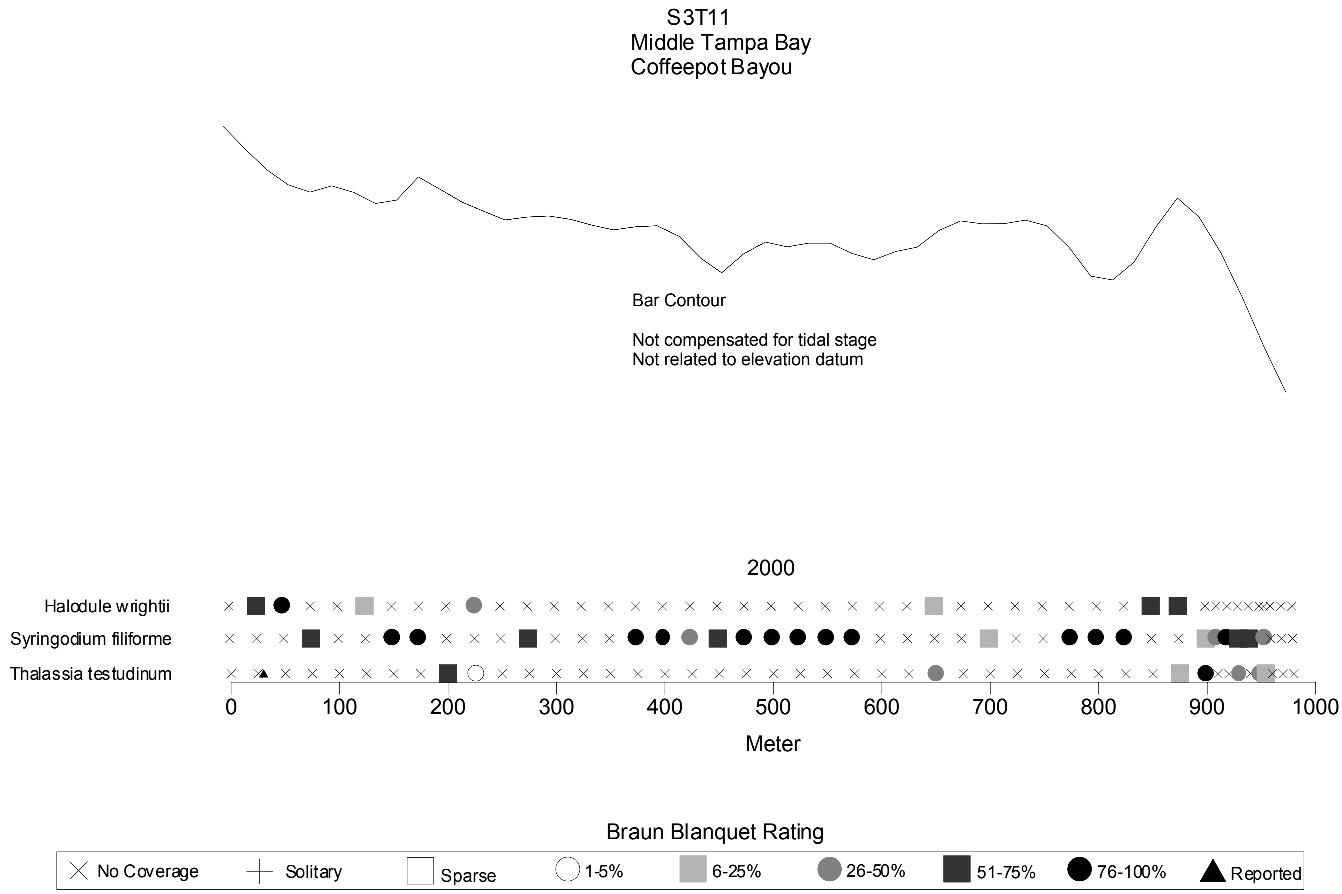

Figure 38. Seagrass species, abundance, and zonation at S3T11 during 2000.

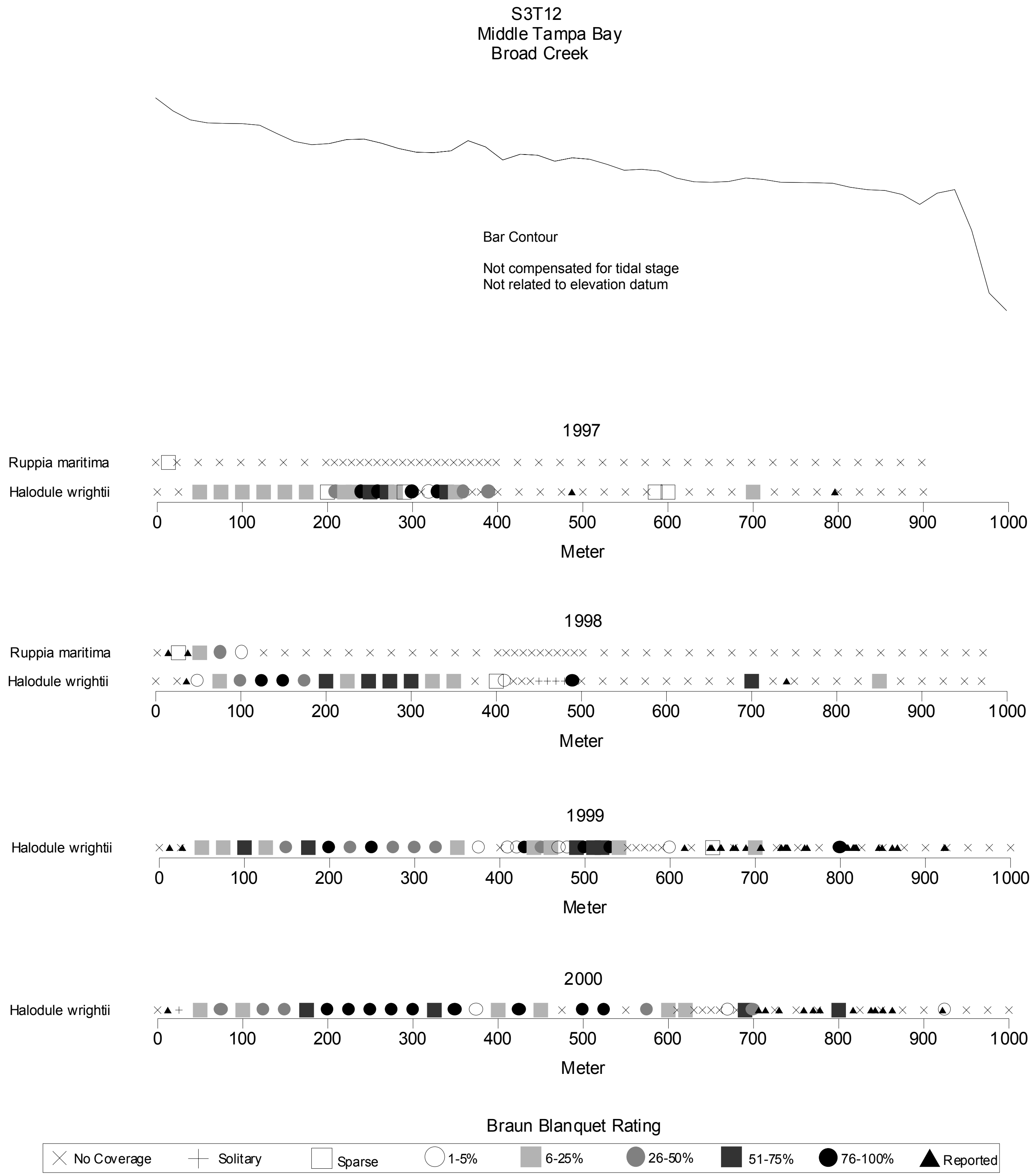

Figure 39. Seagrass species, abundance, and zonation at S3T12 from 1997-2000.

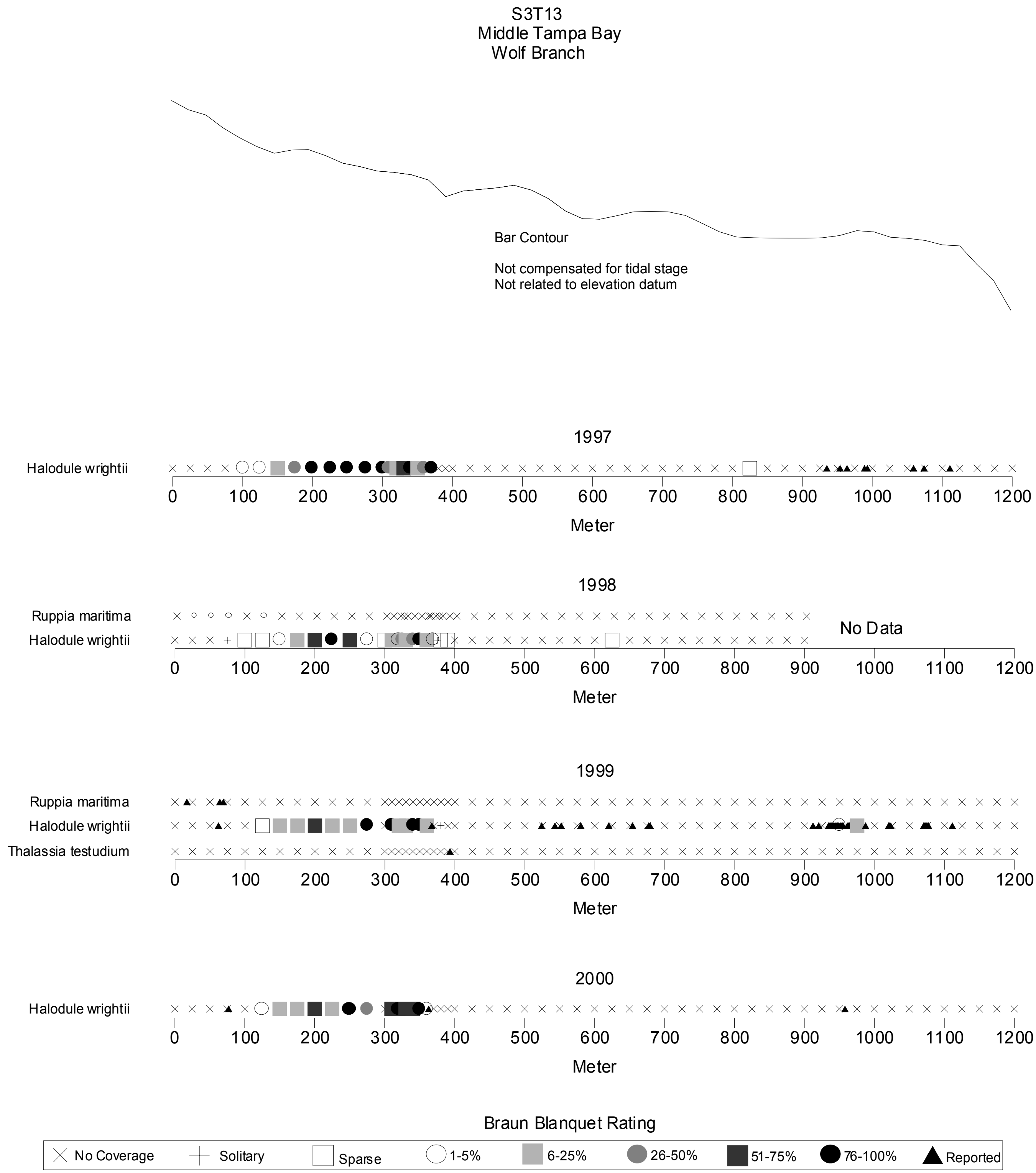

Figure 40. Seagrass species, abundance, and zonation at S3T13 from 1997-2000.

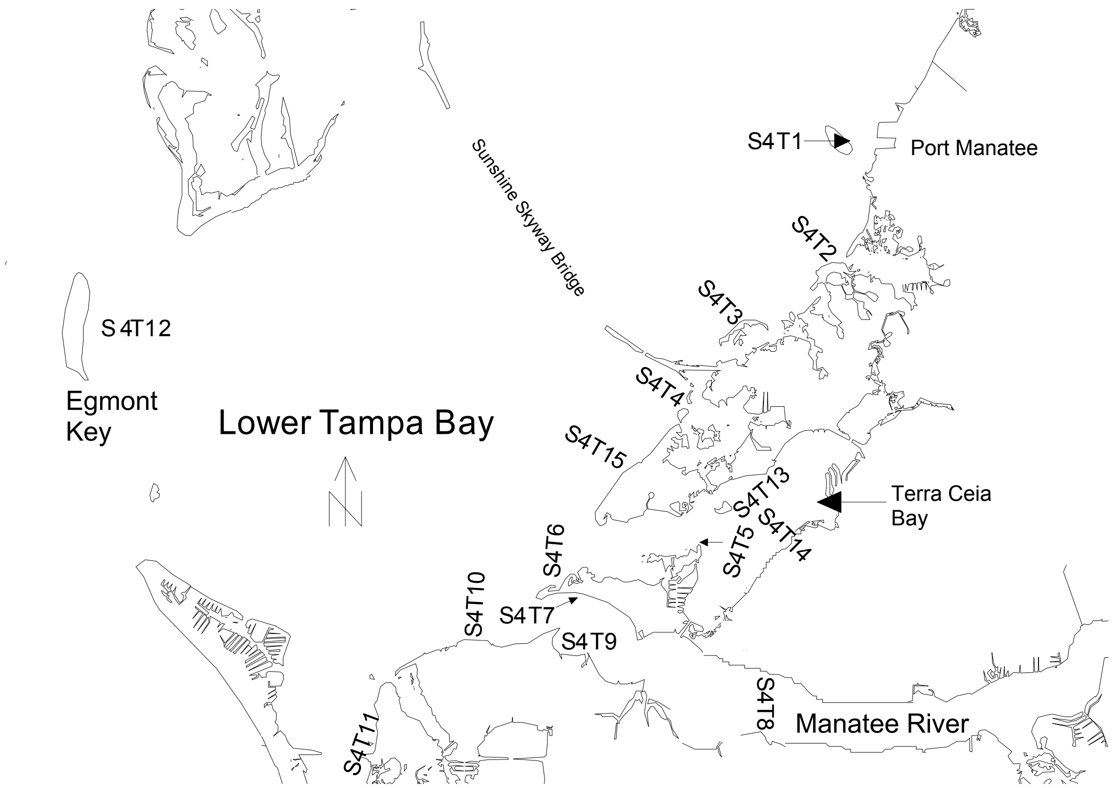

Figure 41. Location of the 15 seagrass monitoring transects in Lower Tampa Bay including Terra Ceia Bay and the Manatee River.

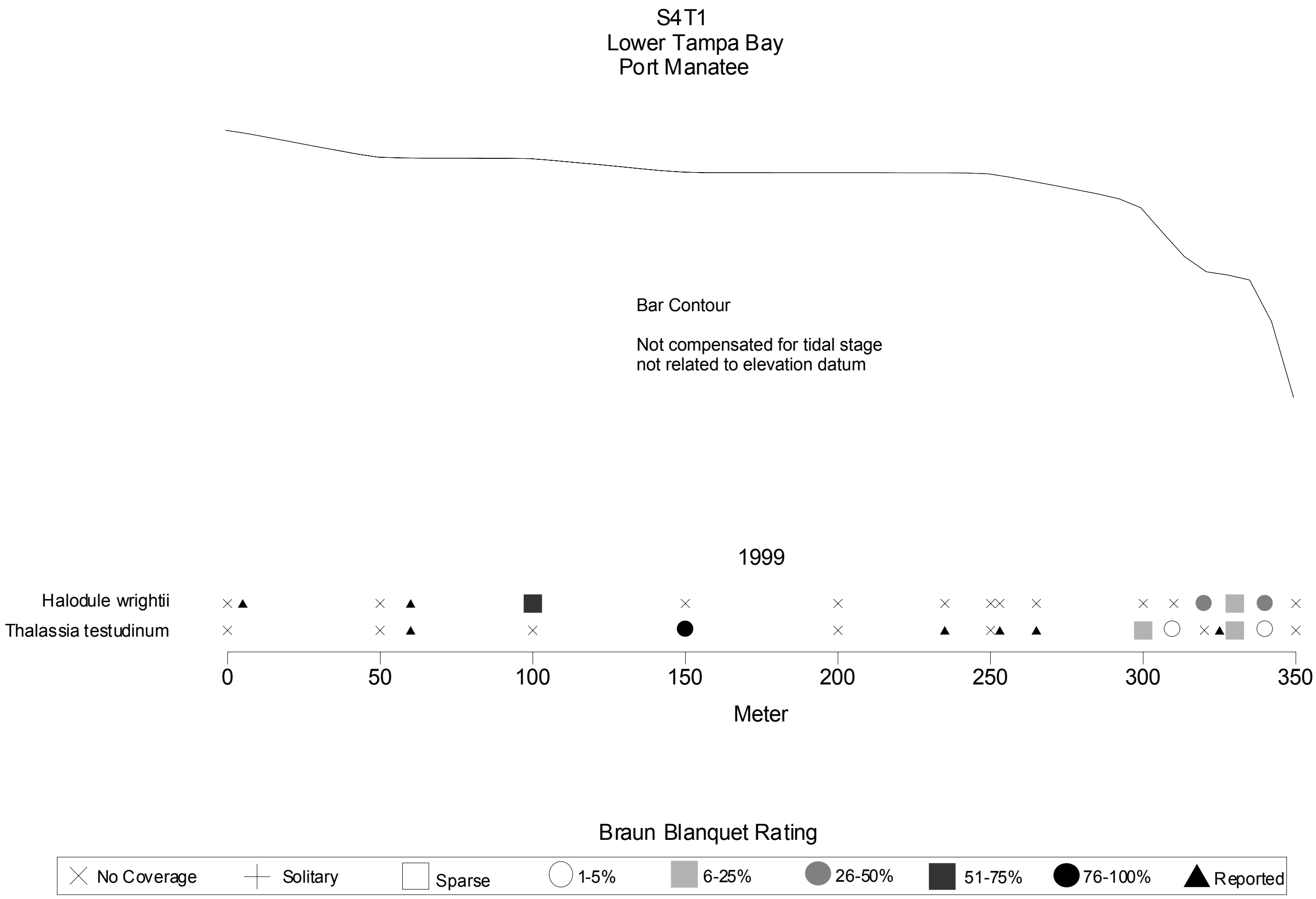

Figure 42. Seagrass species, abundance, and zonation at S4T1 during 1999.

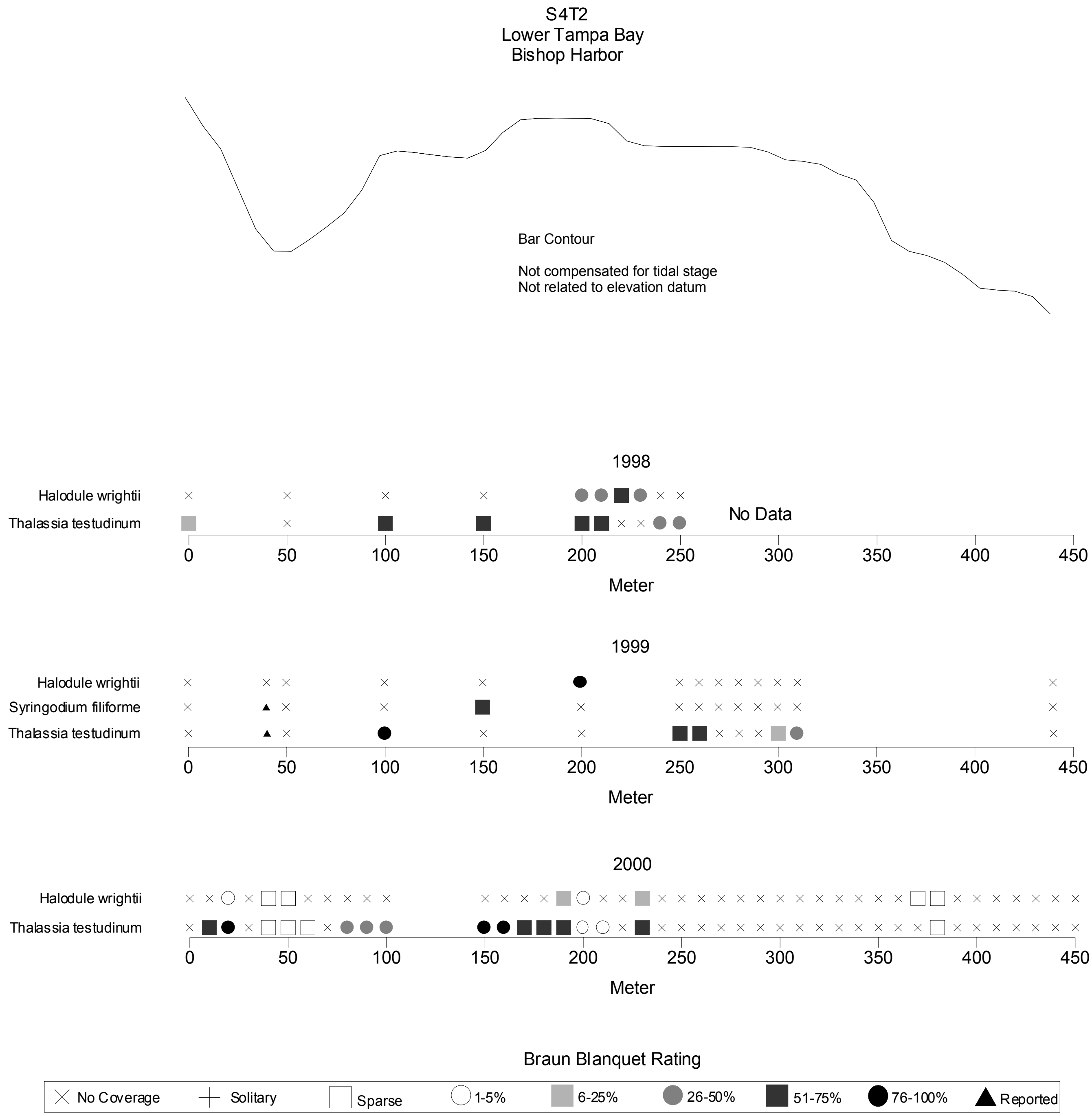

Figure 43. Seagrass species, abundance, and zonation at S4T2 from 1998-2000.

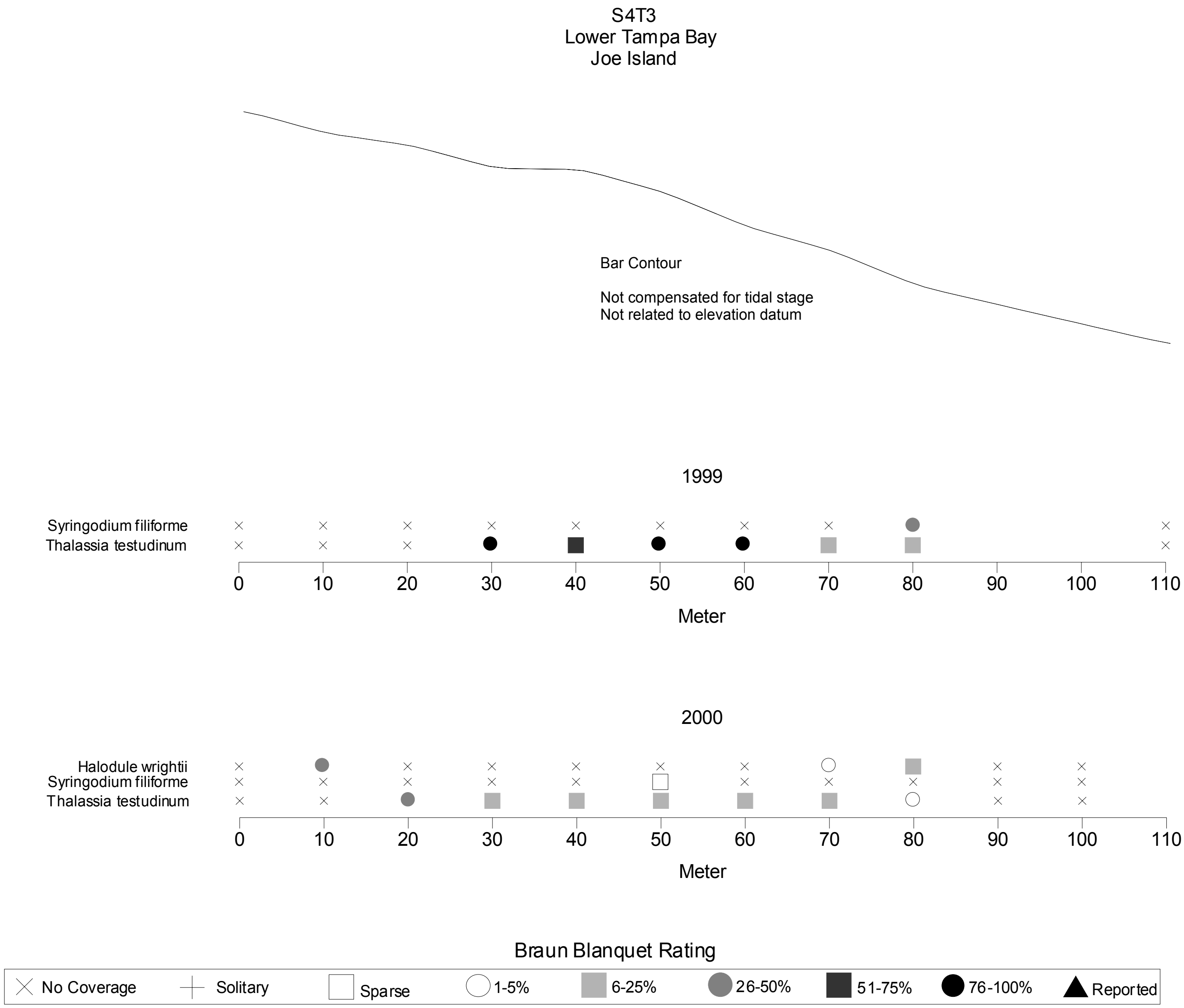

Figure 44. Seagrass species, abundance, and zonation at S4T3 from 1998-2000.

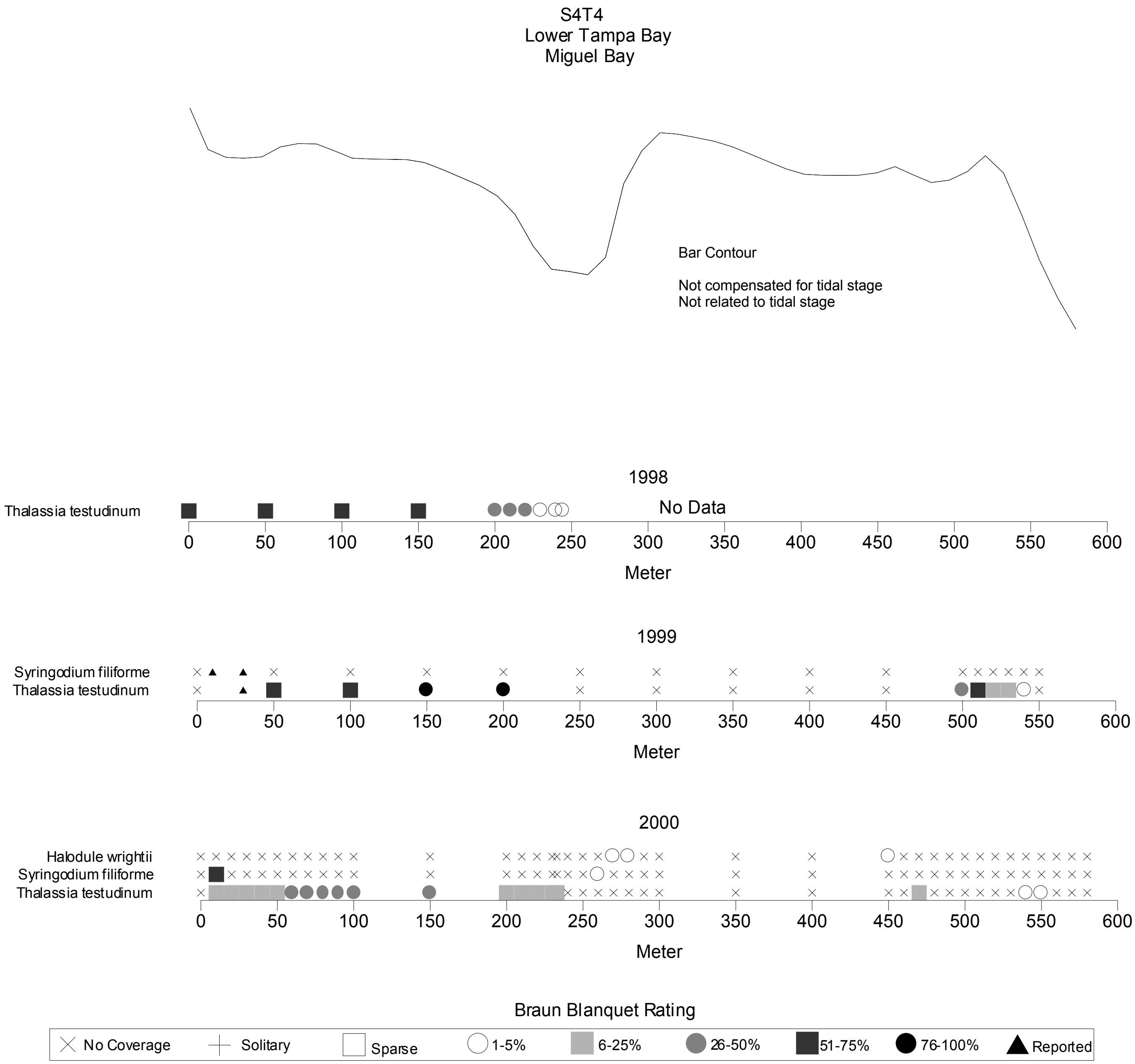

Figure 45. Seagrass species, abundance, and zonation at S4T4 from 1998-2000.

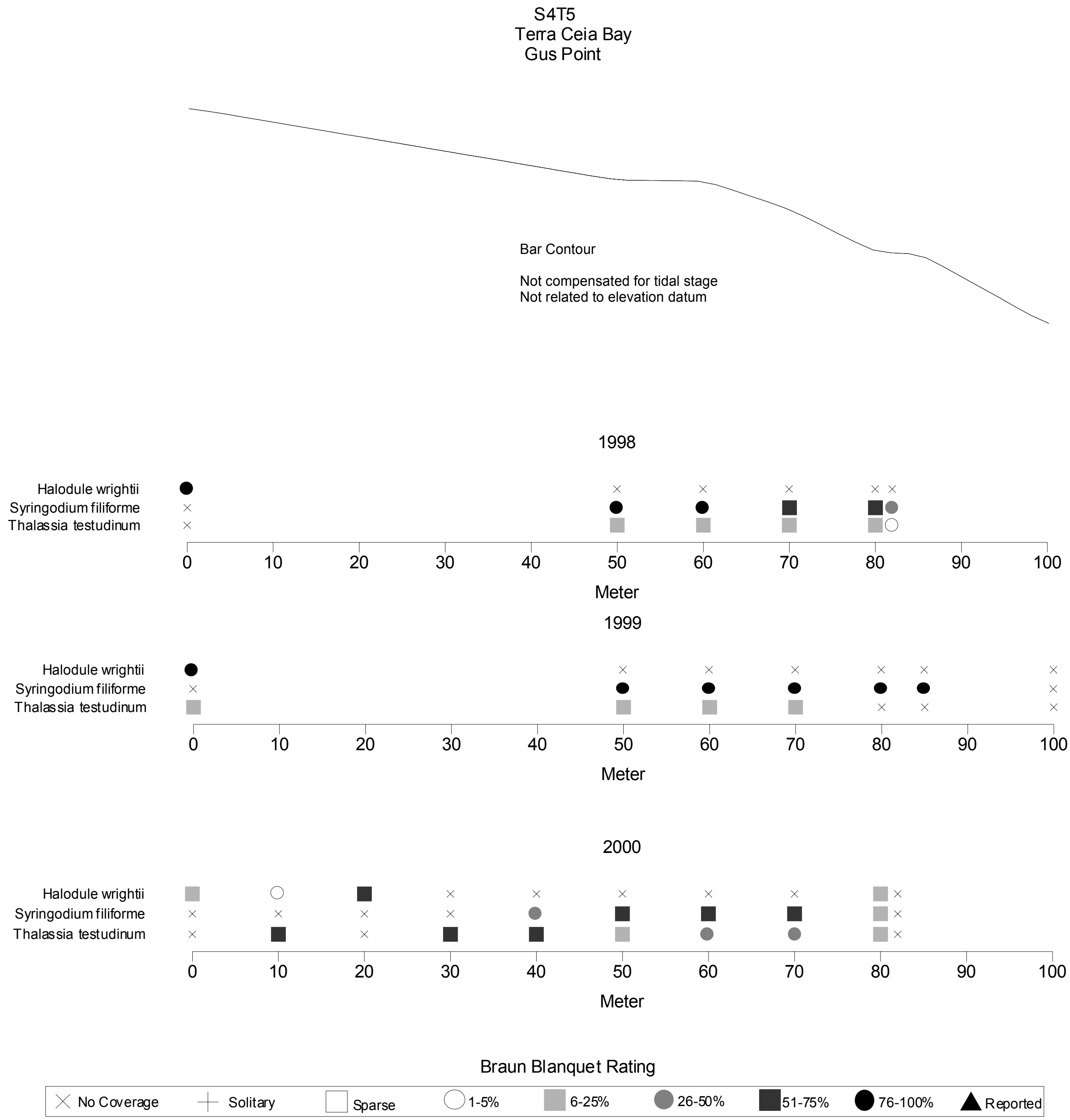

Figure 46. Seagrass species, abundance, and zonation at S4T5 from 1998-2000.

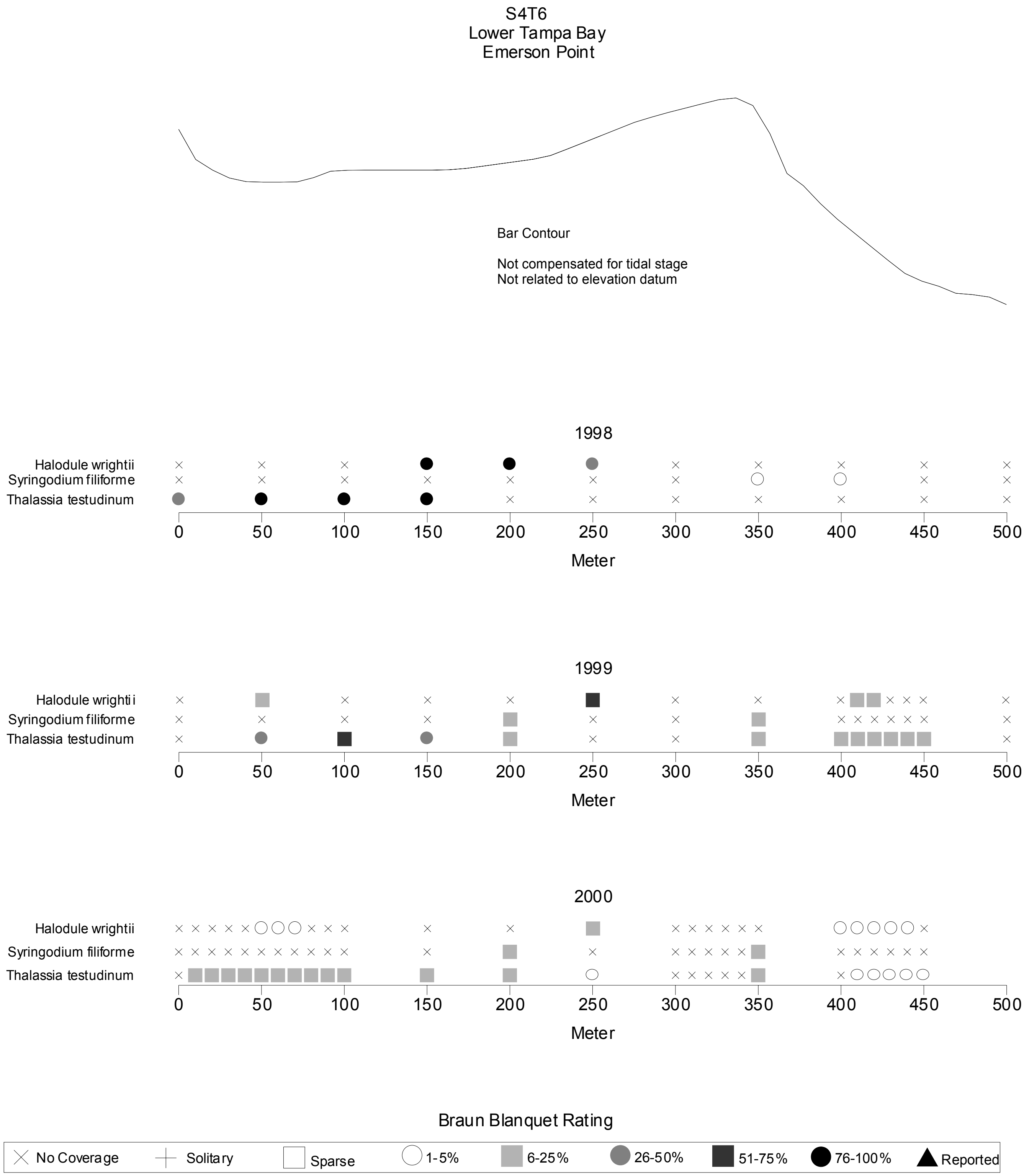

Figure 47. Seagrass species, abundance, and zonation at S4T6 from 1998-2000.

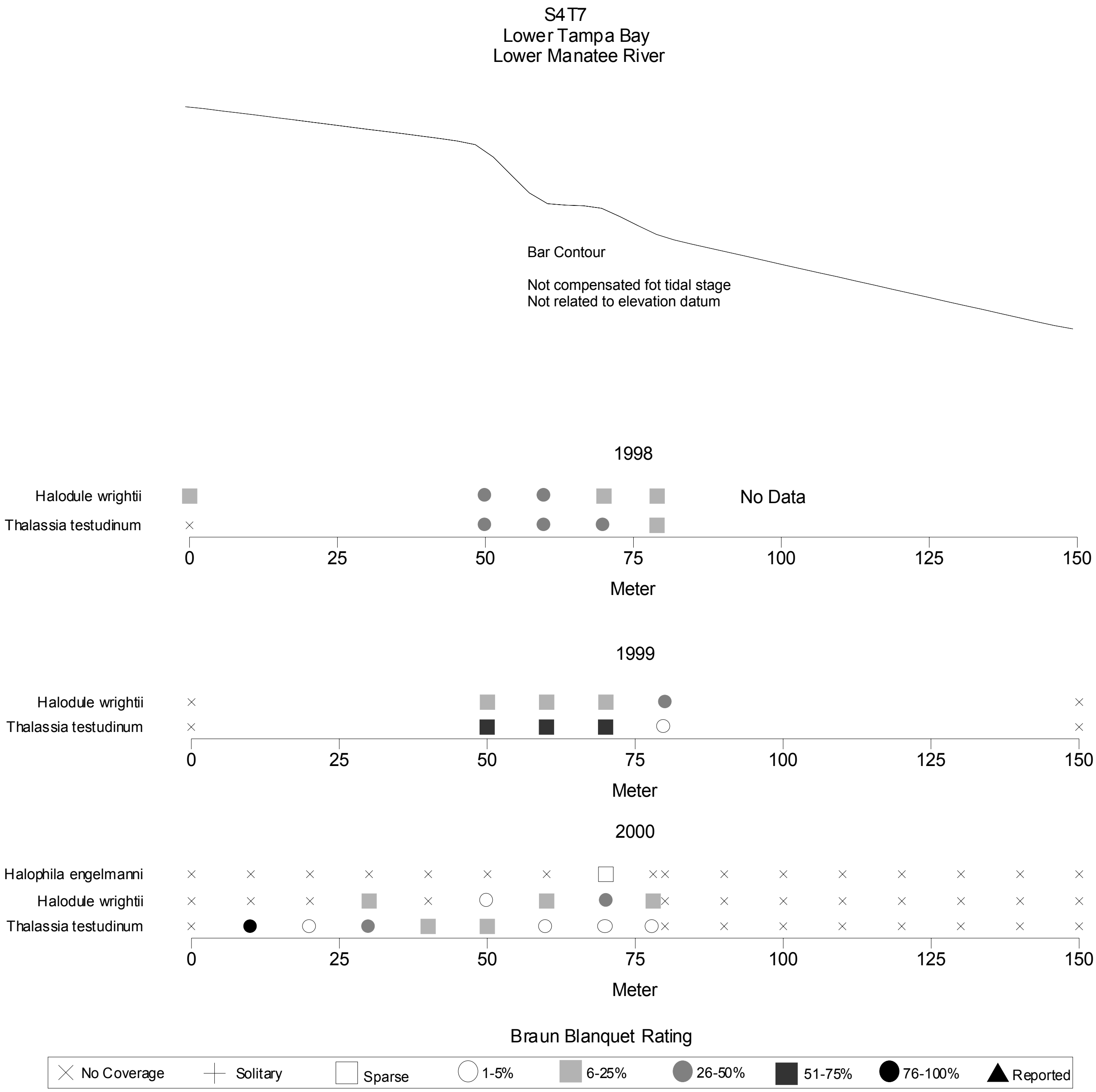

Figure 48. Seagrass species, abundance, and zonation at S4T7 from 1998-2000.

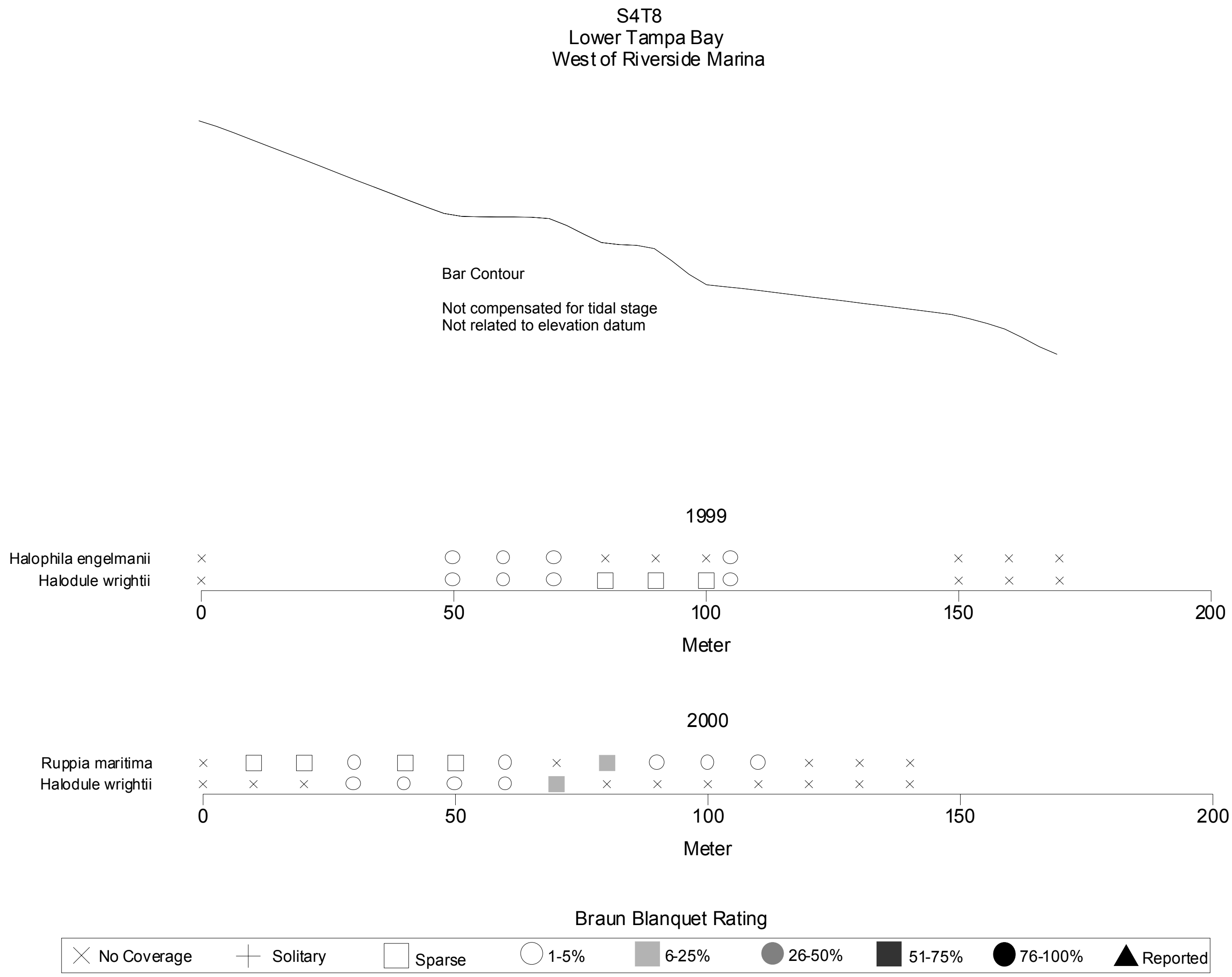

Figure 49. Seagrass species, abundance, and zonation at S4T8 from 1999-2000.

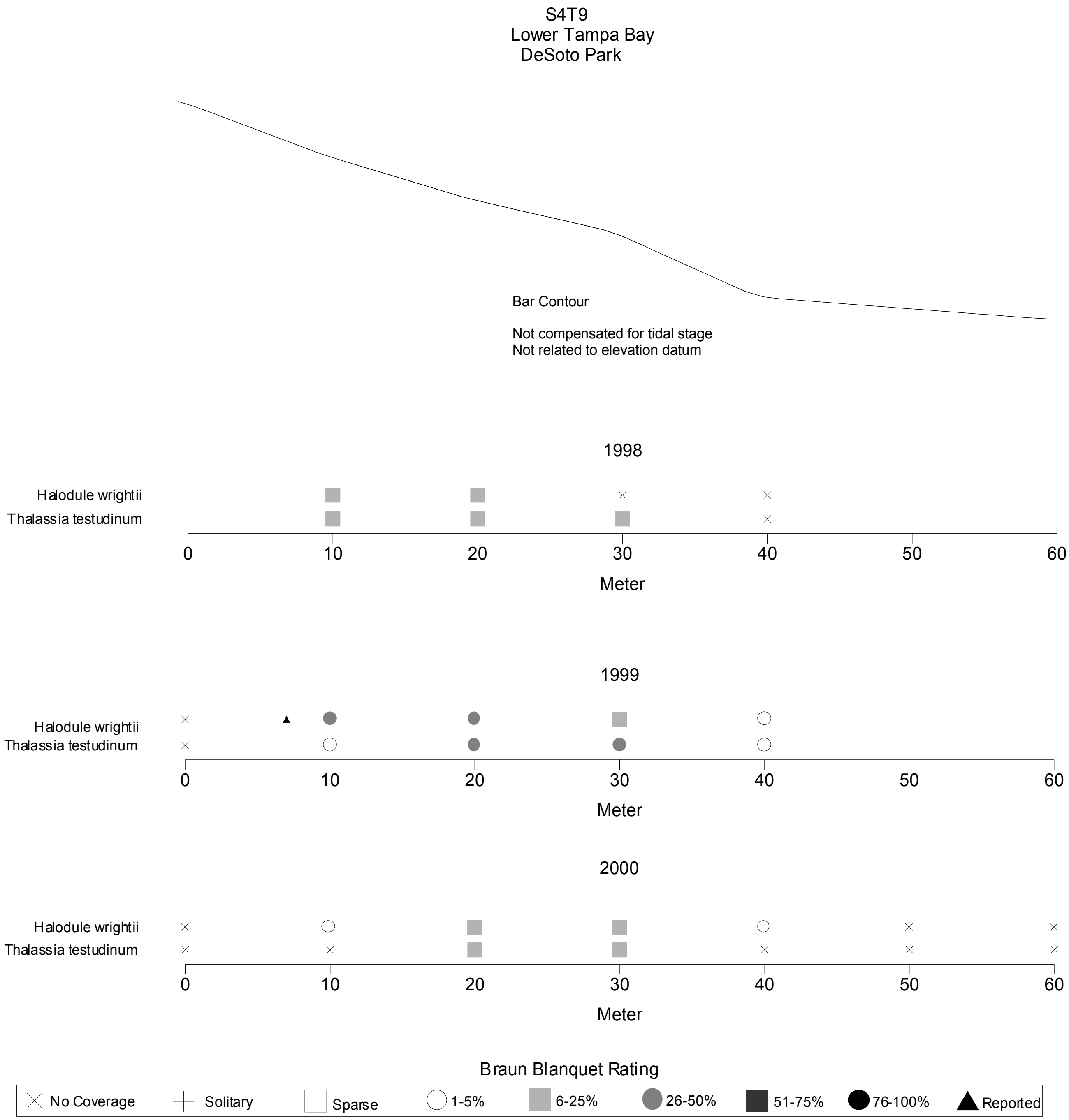

Figure 50. Seagrass species, abundance, and zonation at S4T9 from 1998-2000.

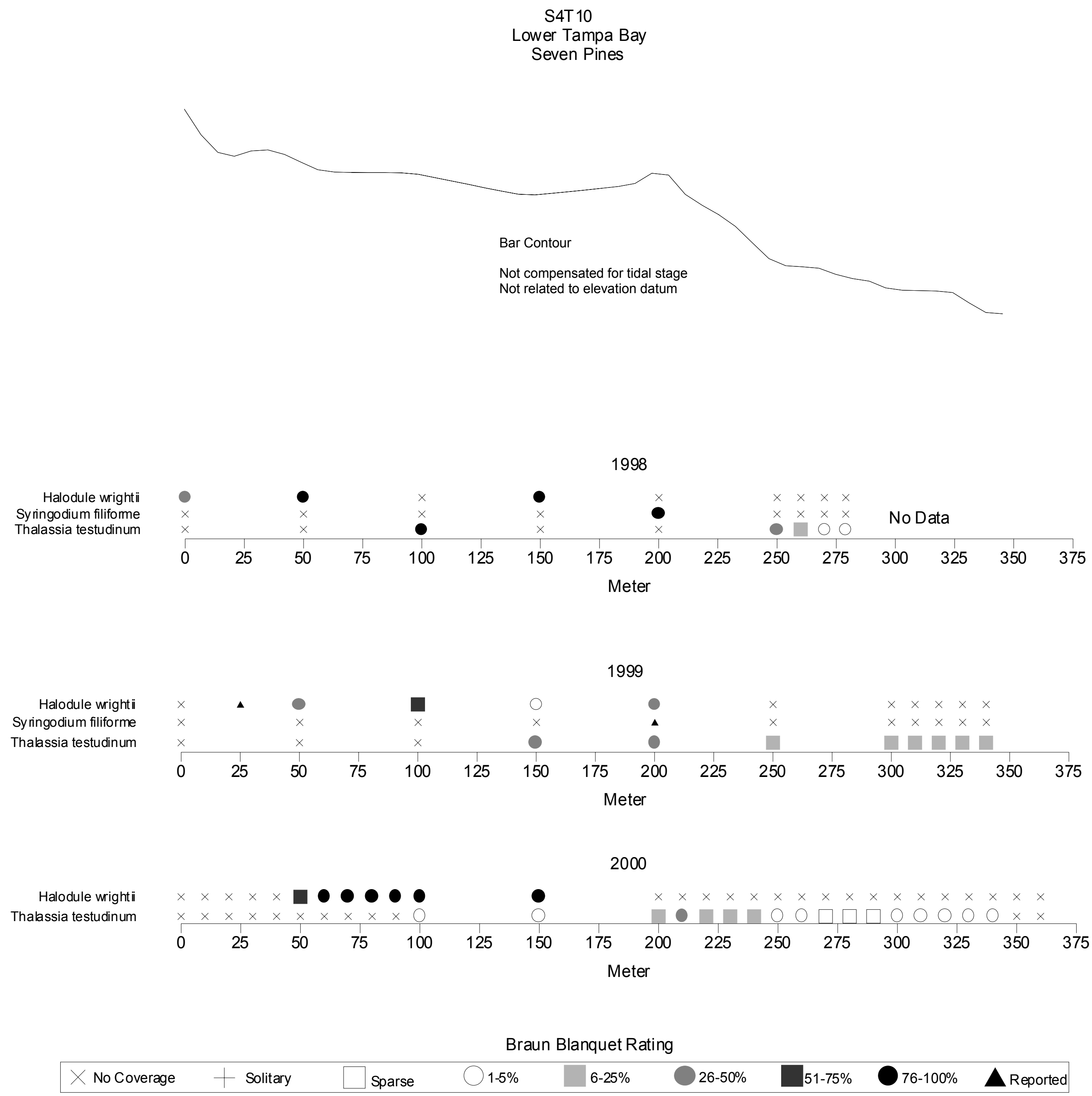

Figure 51. Seagrass species, abundance, and zonation at S4T10 from 1998-2000.

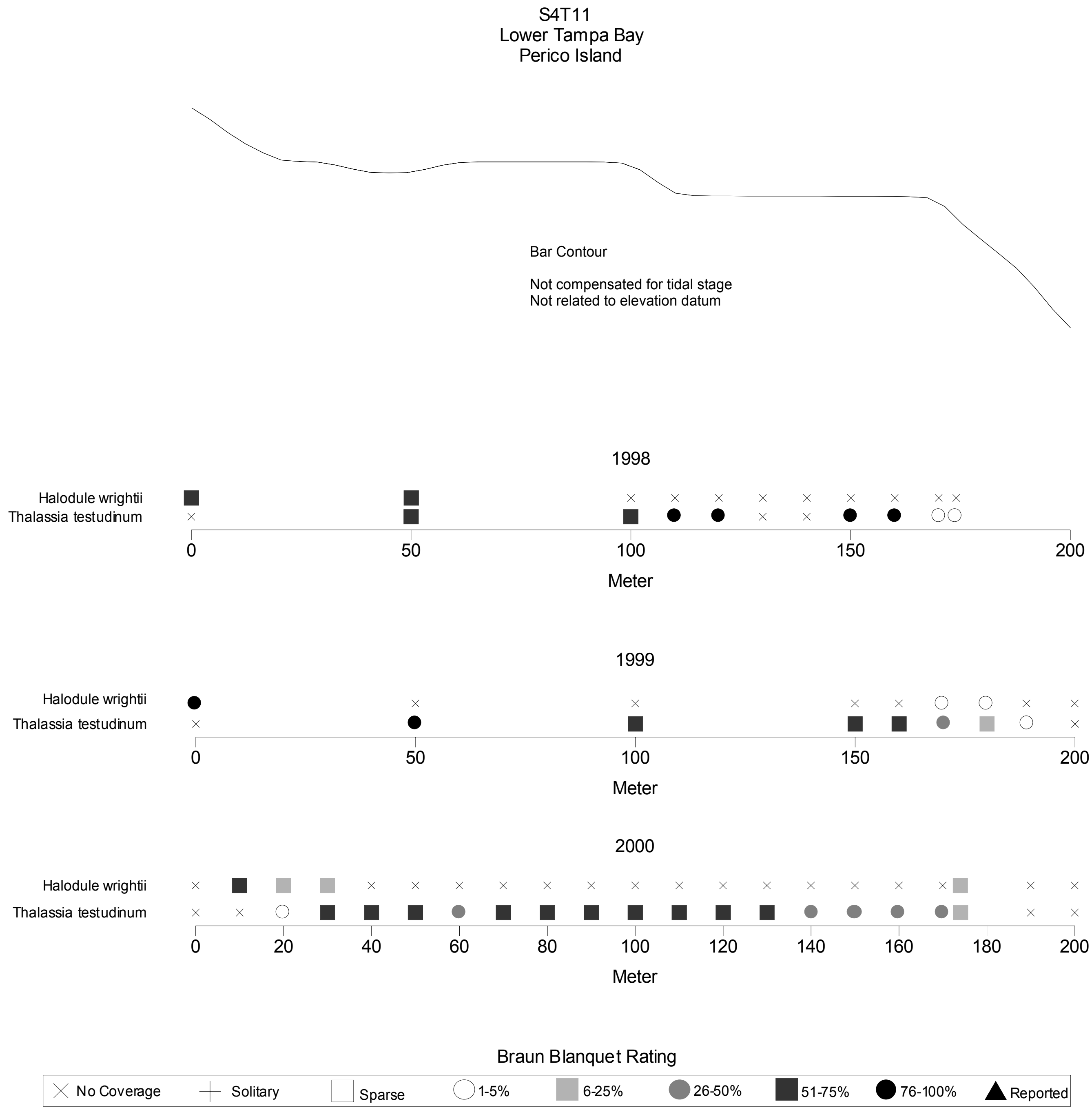

Figure 52. Seagrass species, abundance, and zonation at S4T11 from 1998-2000.

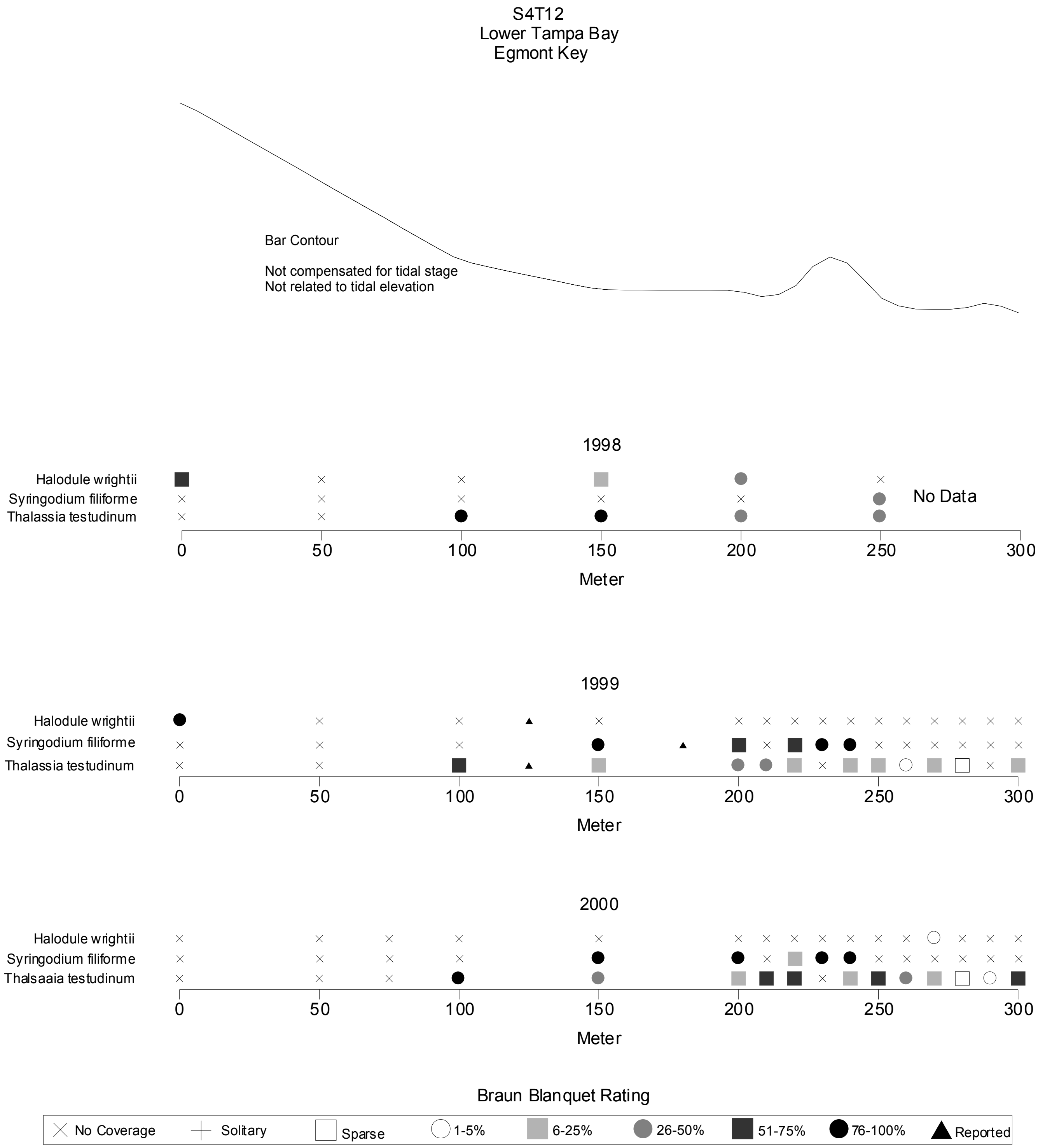

Figure 53. Seagrass species, abundance, and zonation at S4T12 from 1998-2000.

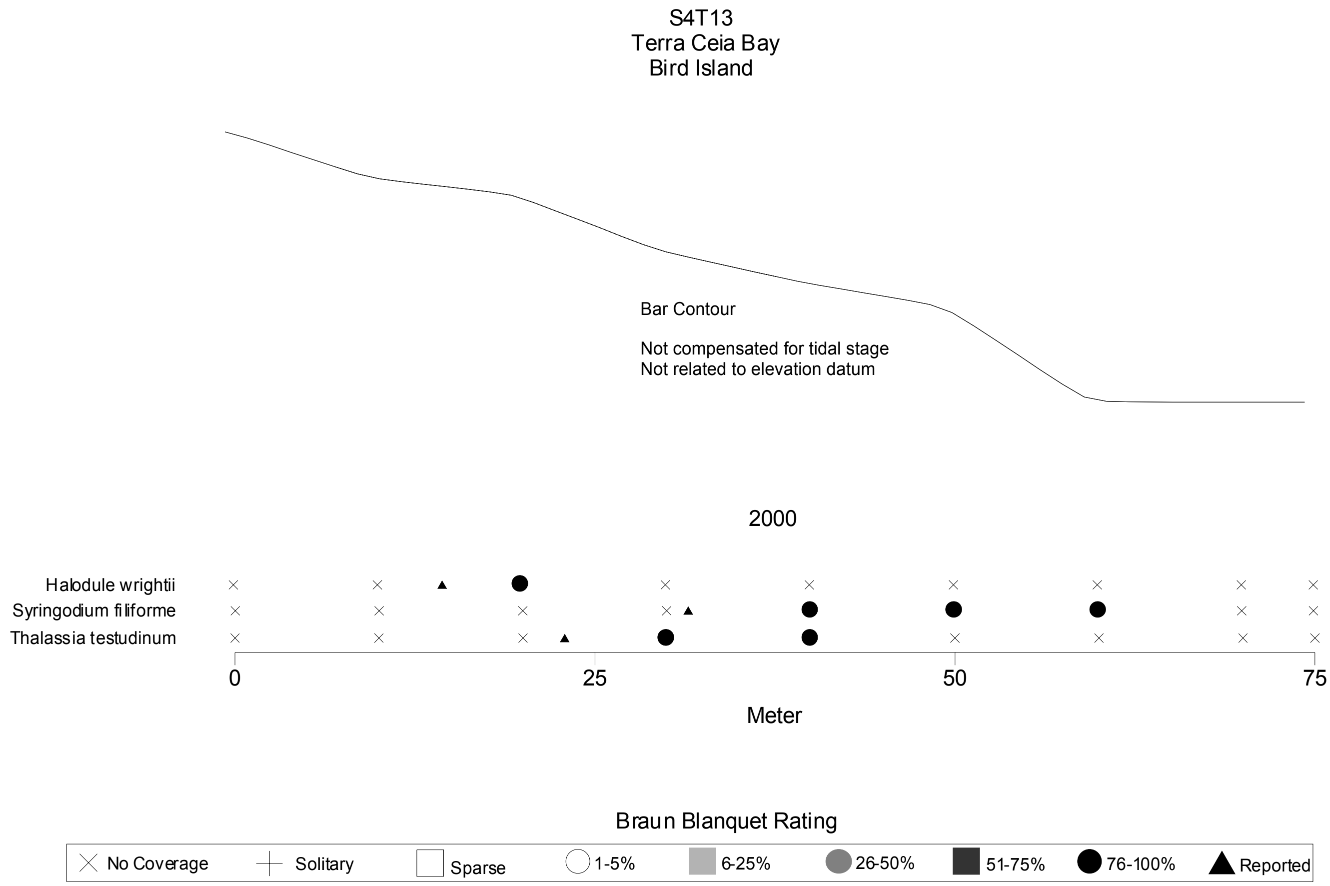

Figure 54. Seagrass species, abundance and zonation at S4T13 during 2000.

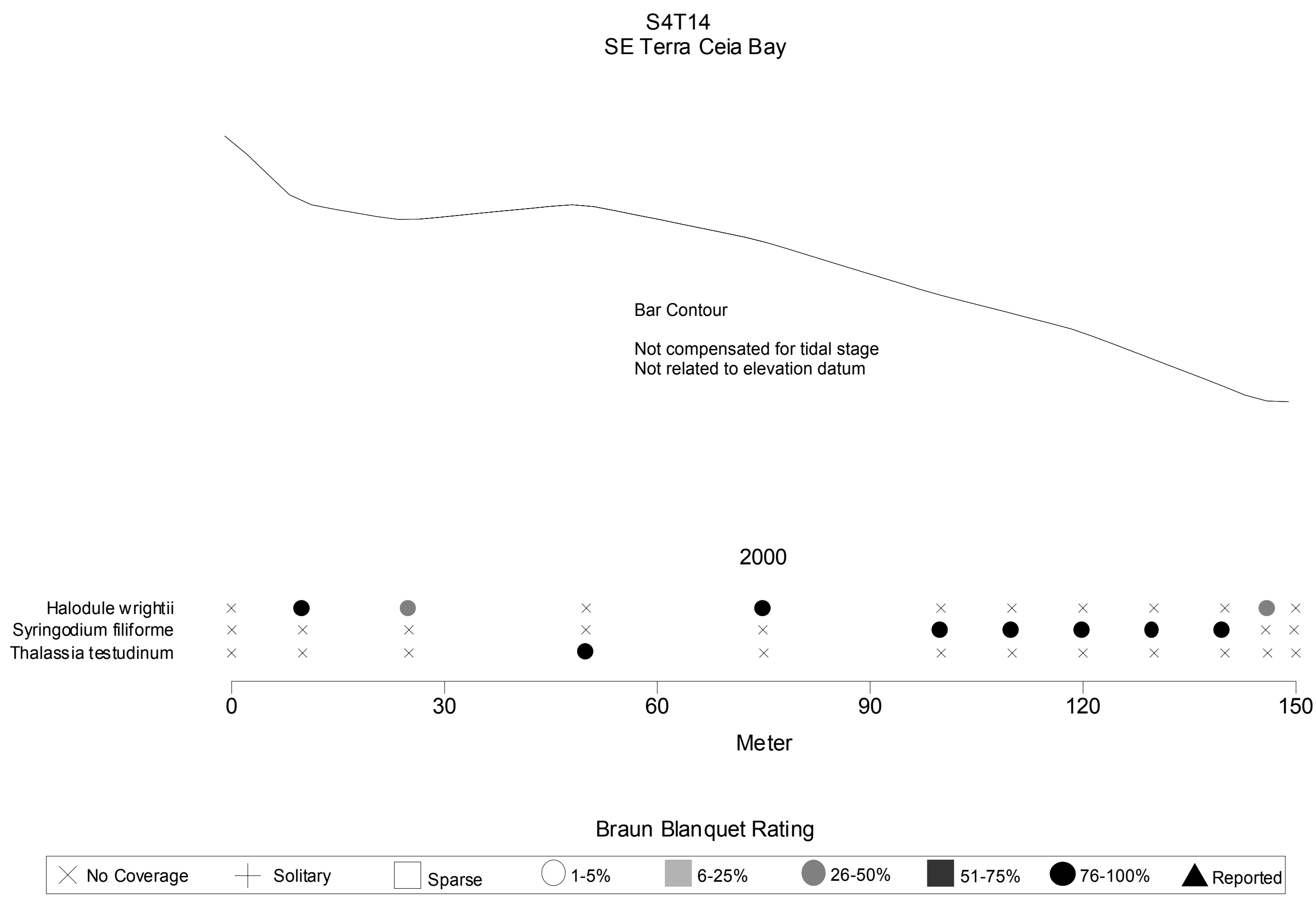

Figure 55. Seagrass species, abundance, and zonation at S4T14 during 2000.

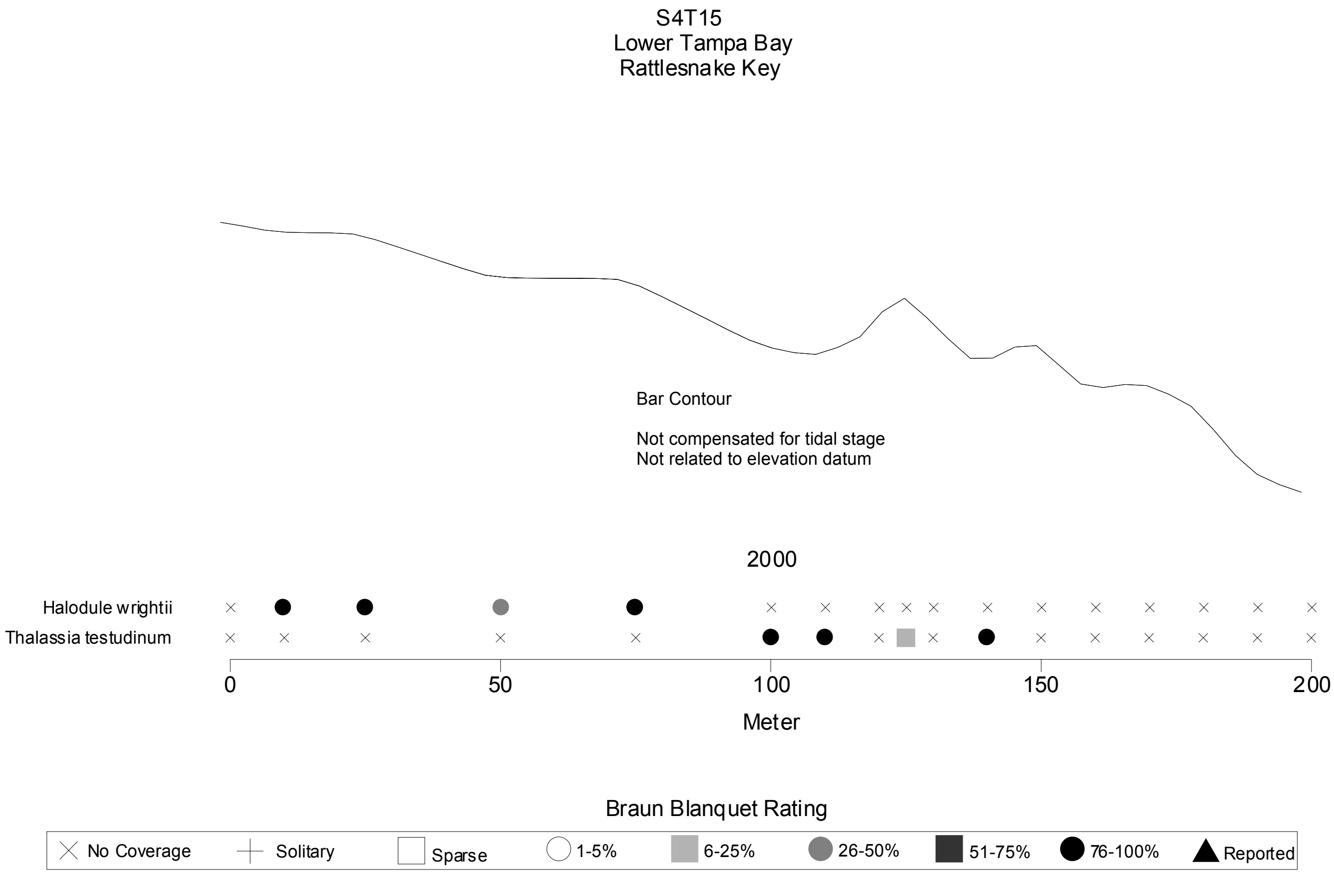

Figure 56. Seagrass species, abundance, and zonation at S4T15 during 2000.

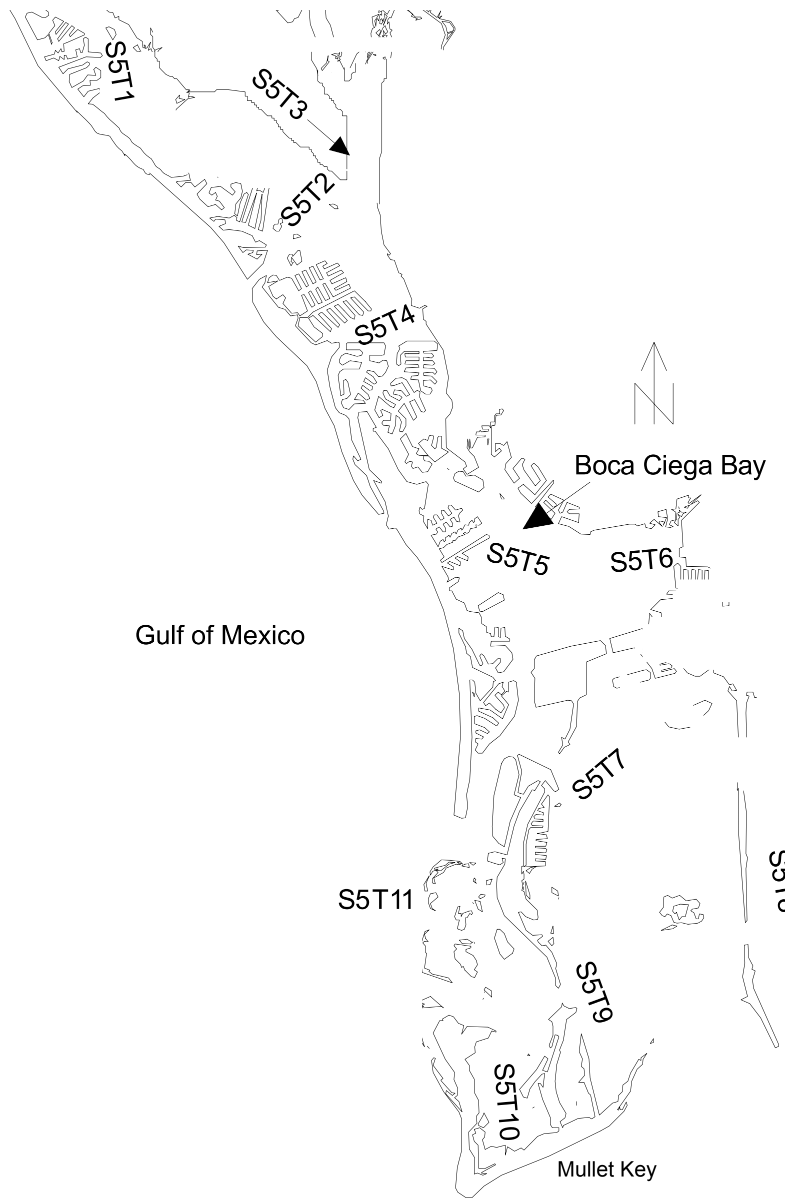

Figure 57. Location of the 11 seagrass monitoring transects in Boca Ciega Bay.

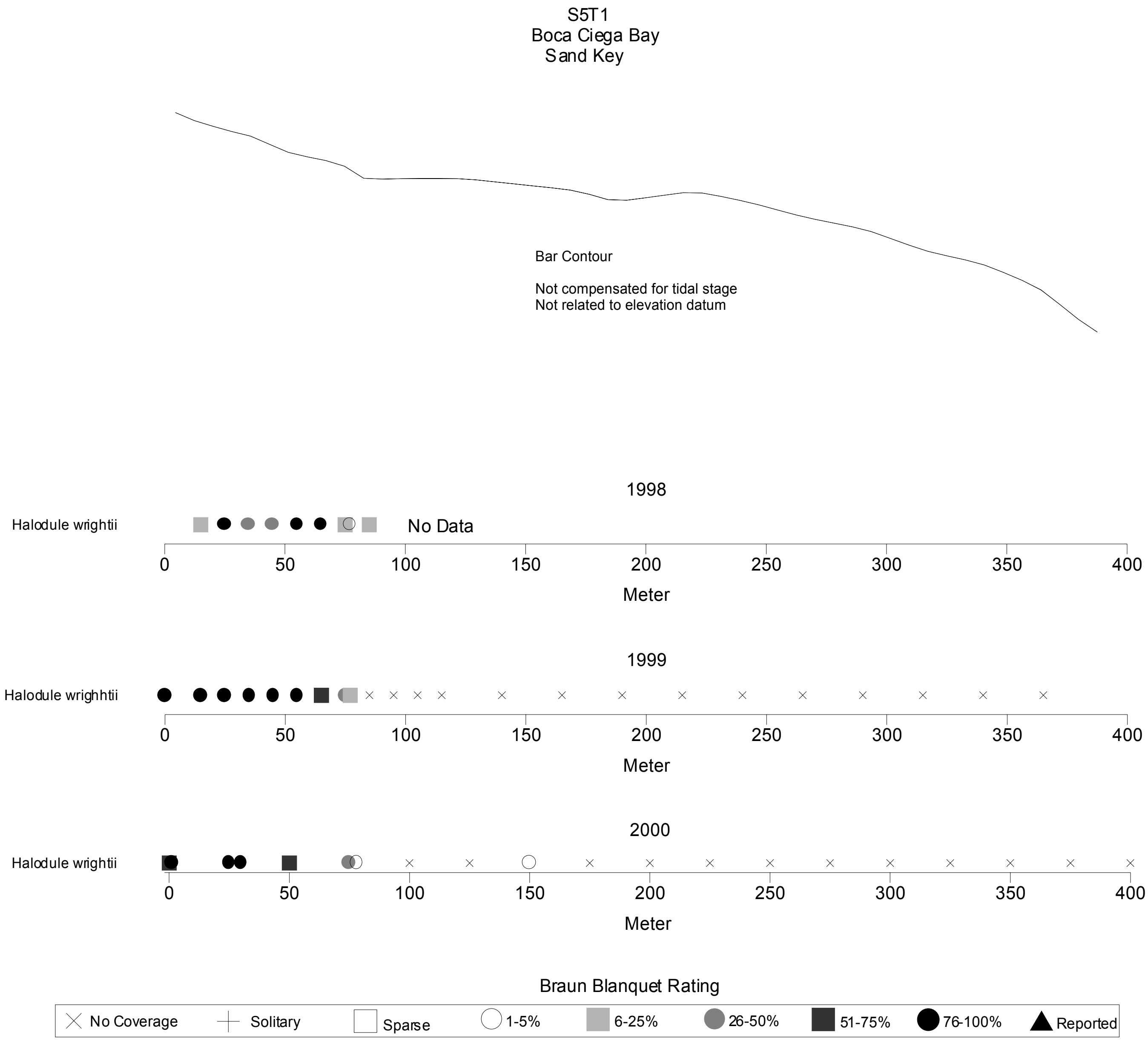

Figure 58. Seagrass species, abundance, and zonation at S5T1 from 1998-2000.

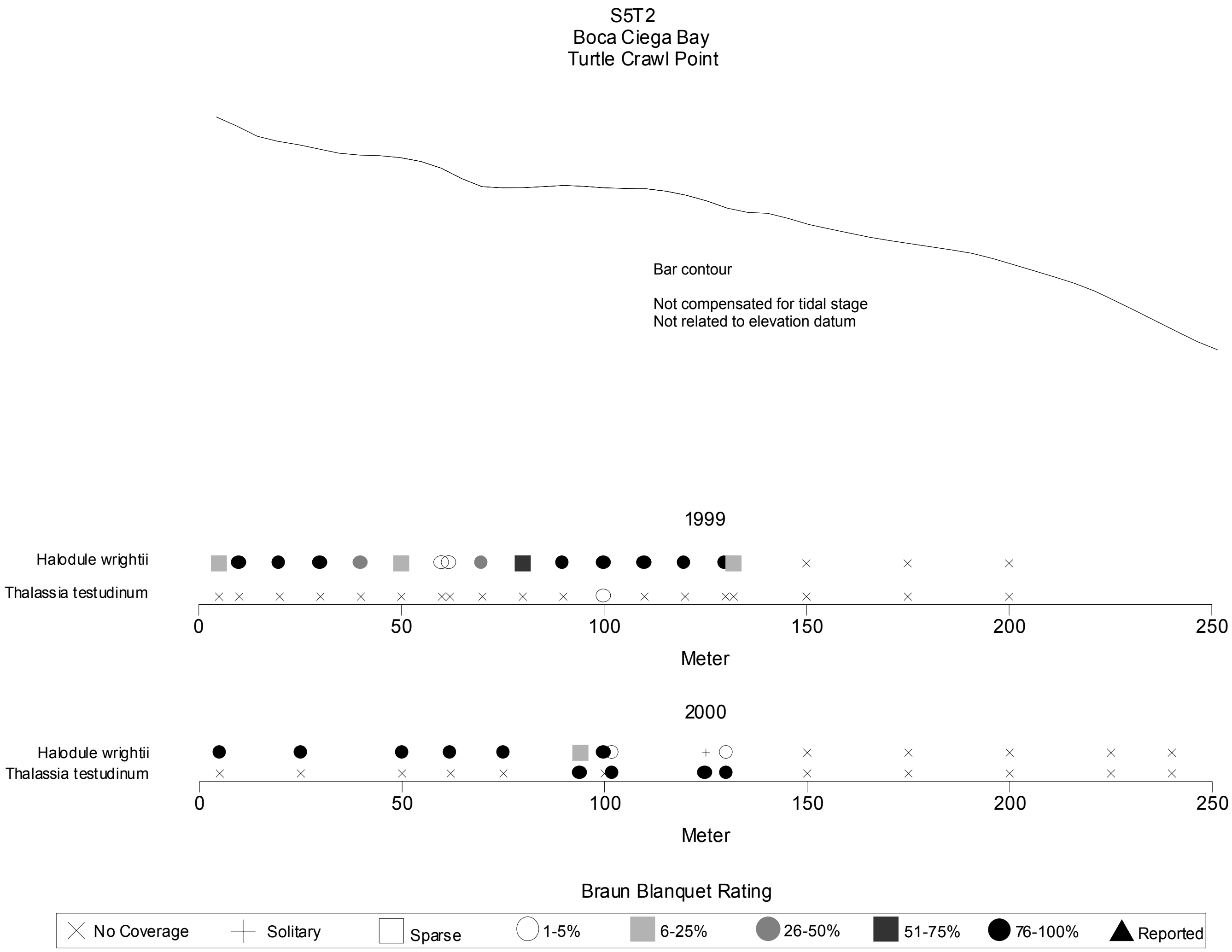

Figure 59. Seagrass species, abundance, and zonation at S5T2 from 1999-2000.

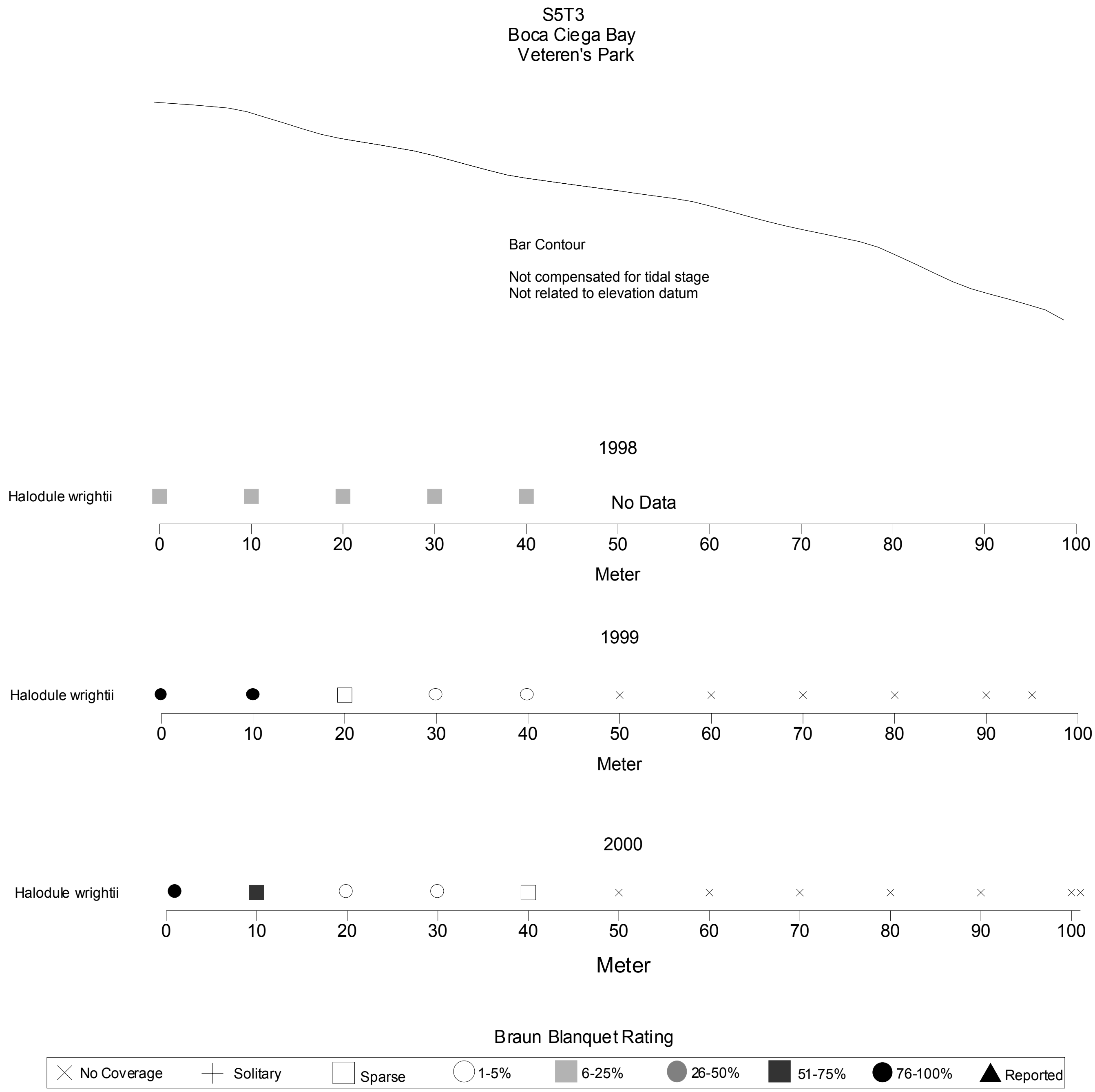

Figure 50. Seagrass species, abundance, and zonation at S5T3 from 1998-2000.

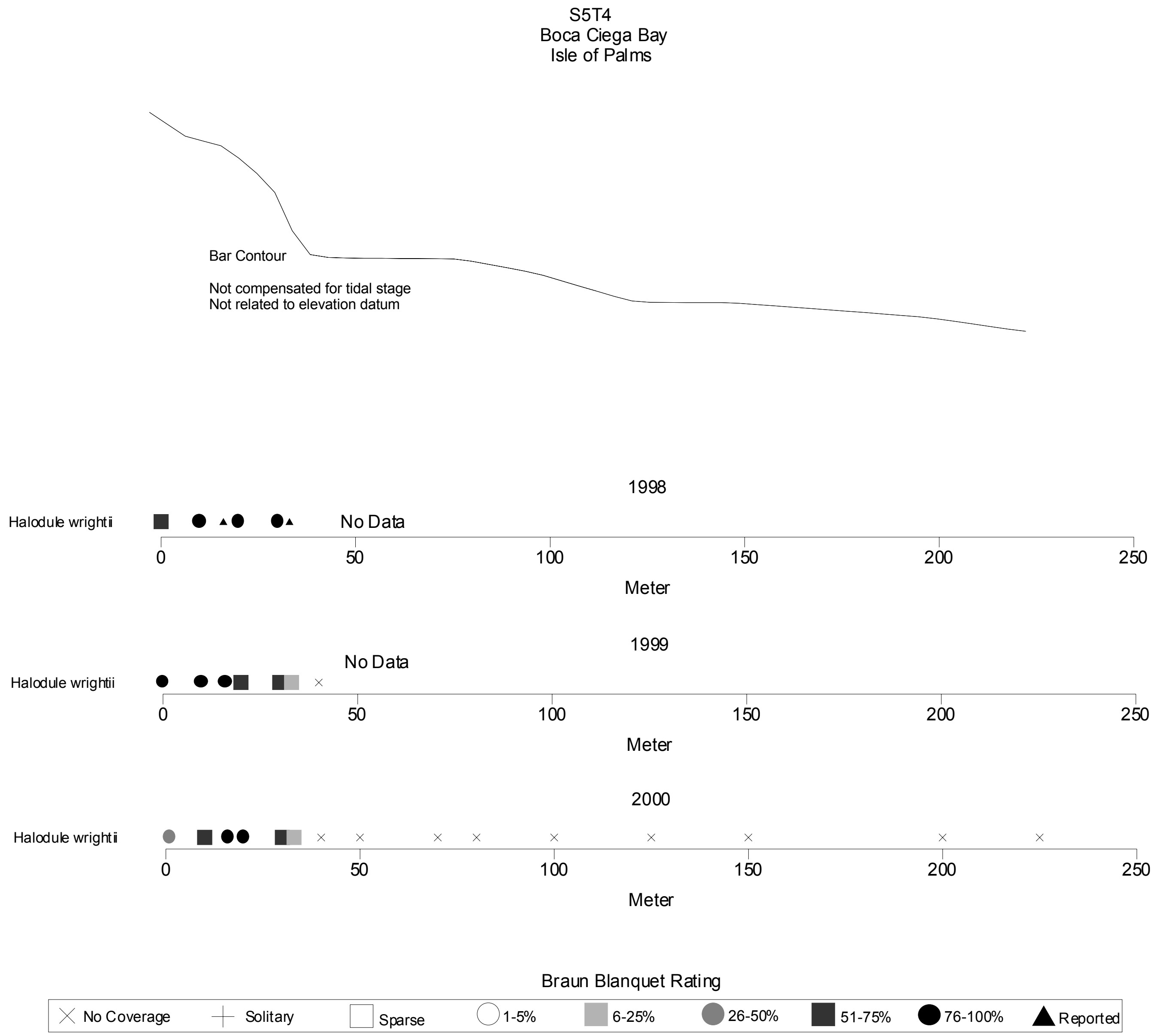

Figure 61. Seagrass species, abundance, and zonation at S5T4 from 1998-2000.

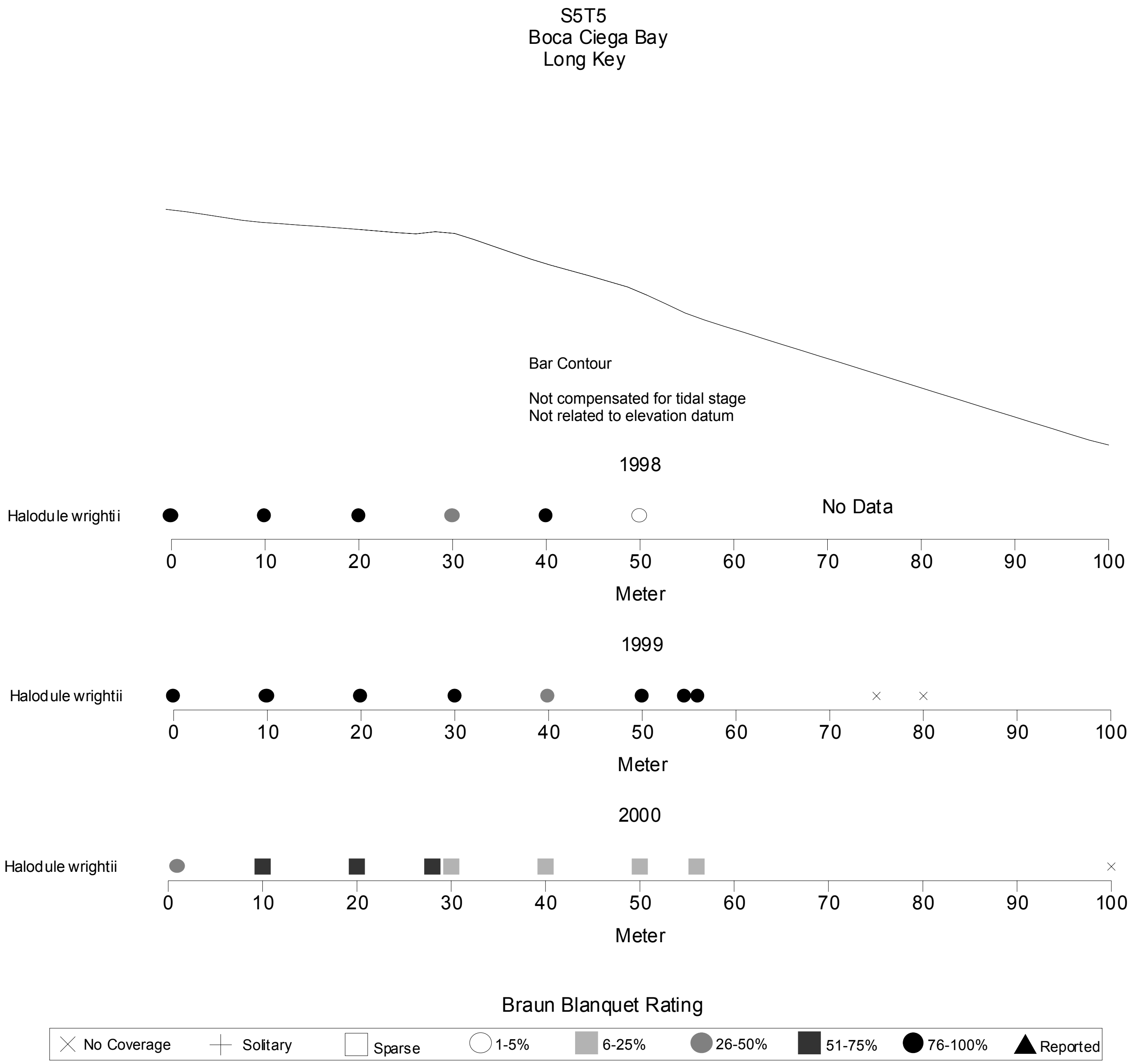

Figure 62. Seagrass species, abundance, and zonation at S5T5 from 1998-2000.

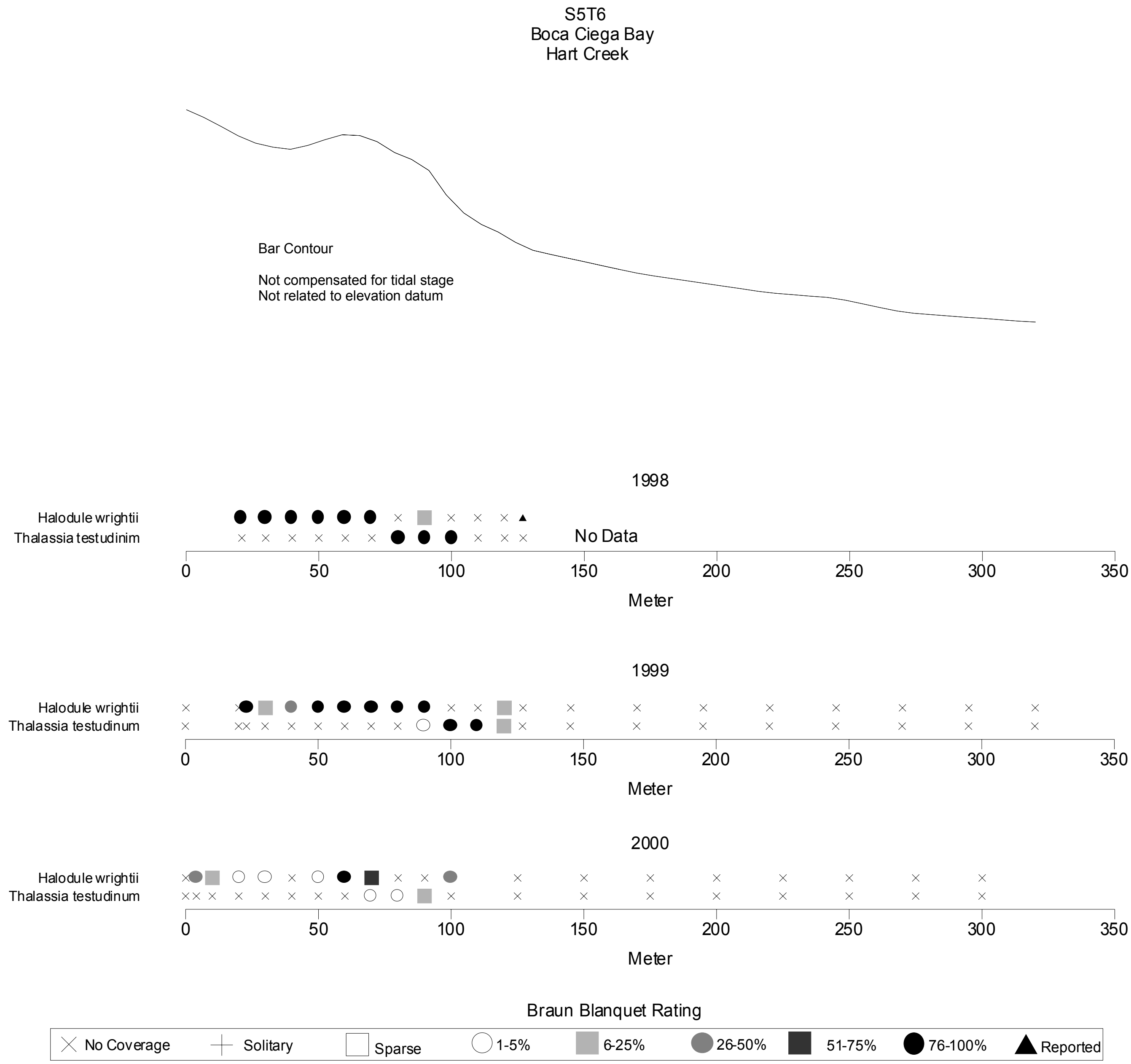

Figure 63. Seagrass species, abundance, and zonation at S5T6 from 1998-2000.

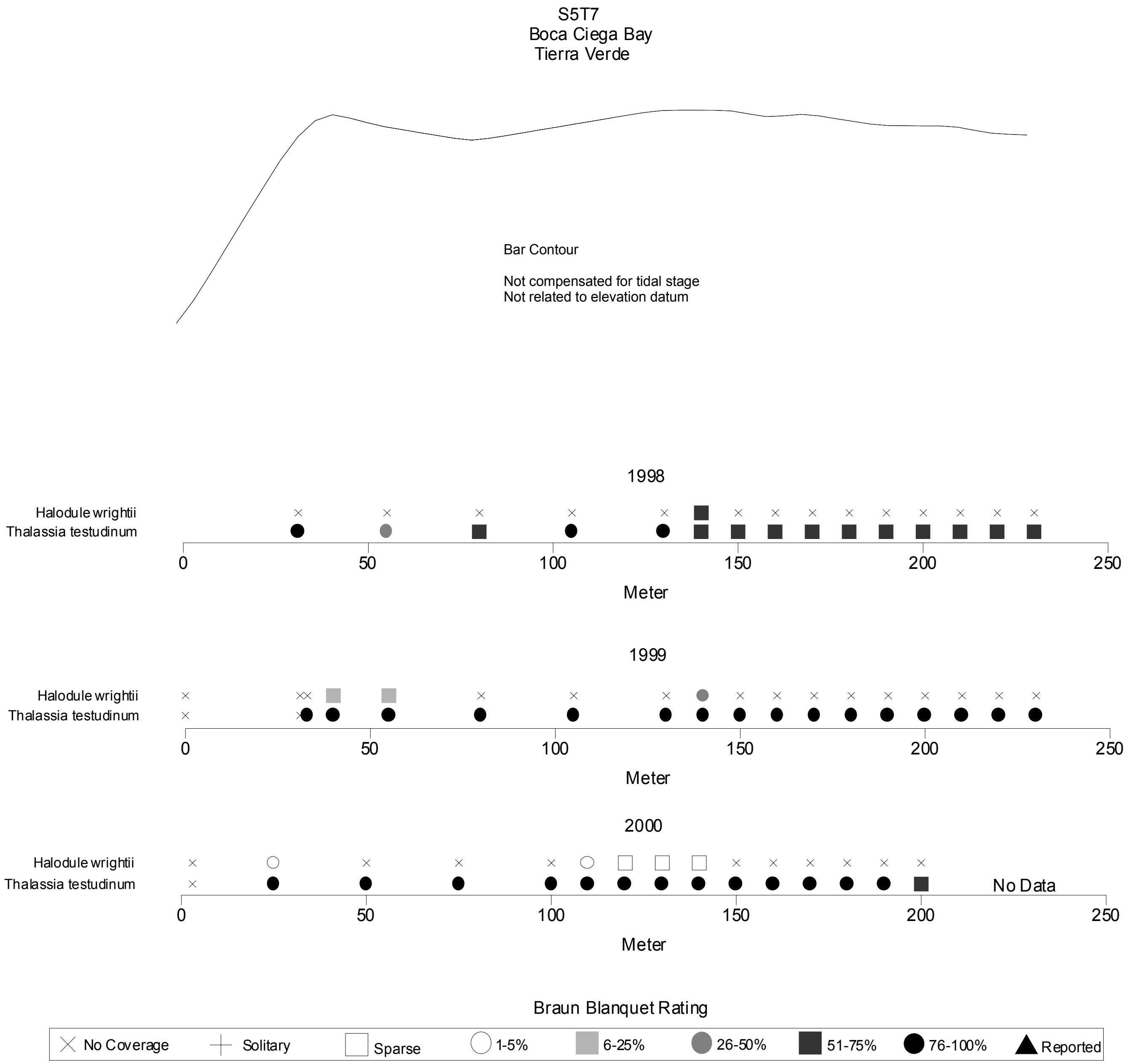

Figure 64. Seagrass species, abundance, and zonation at S5T7 from 1998-2000.

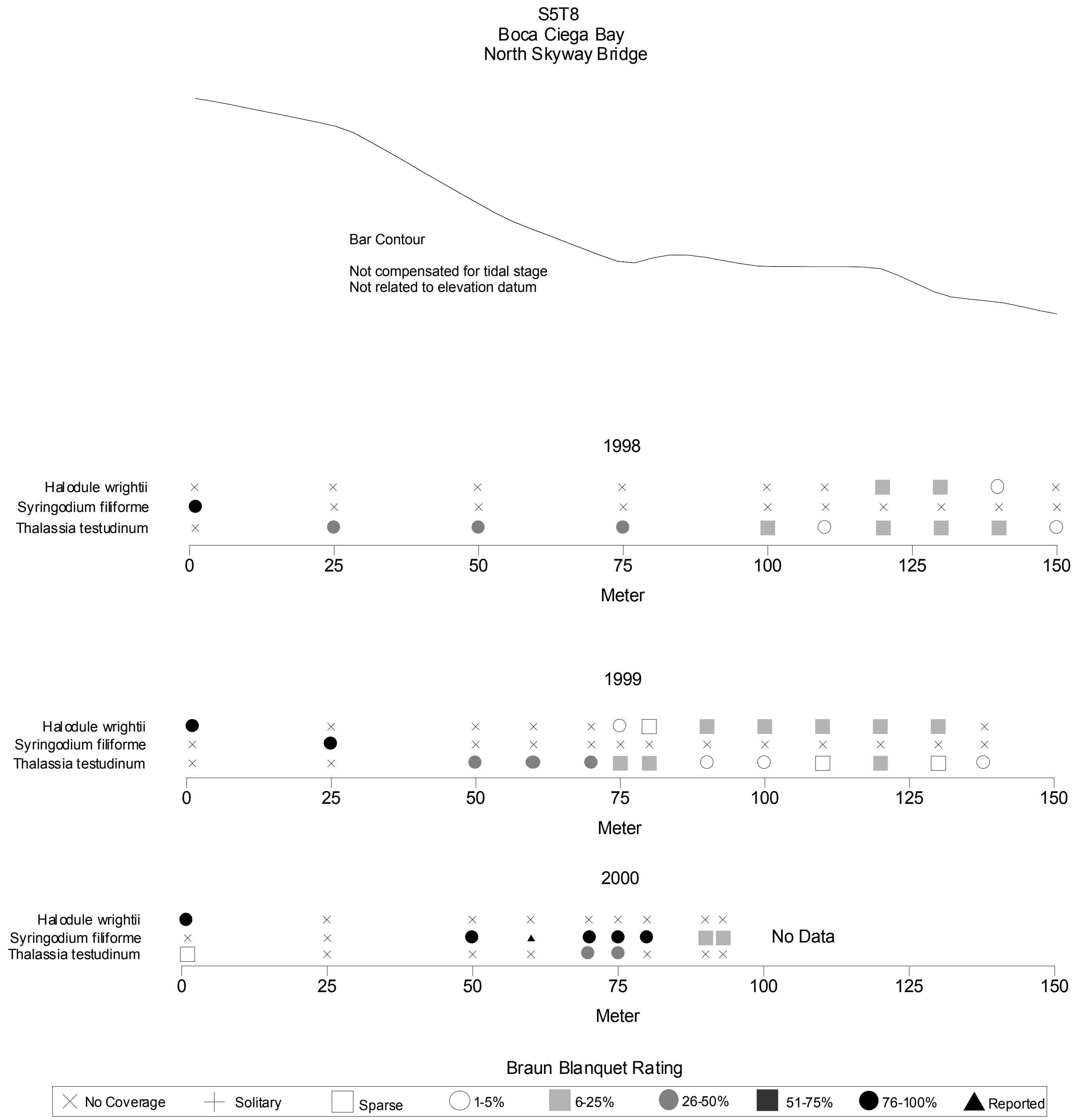

Figure 65. Seagrass species, abundance, and zonation at S5T8 from 1998-2000.

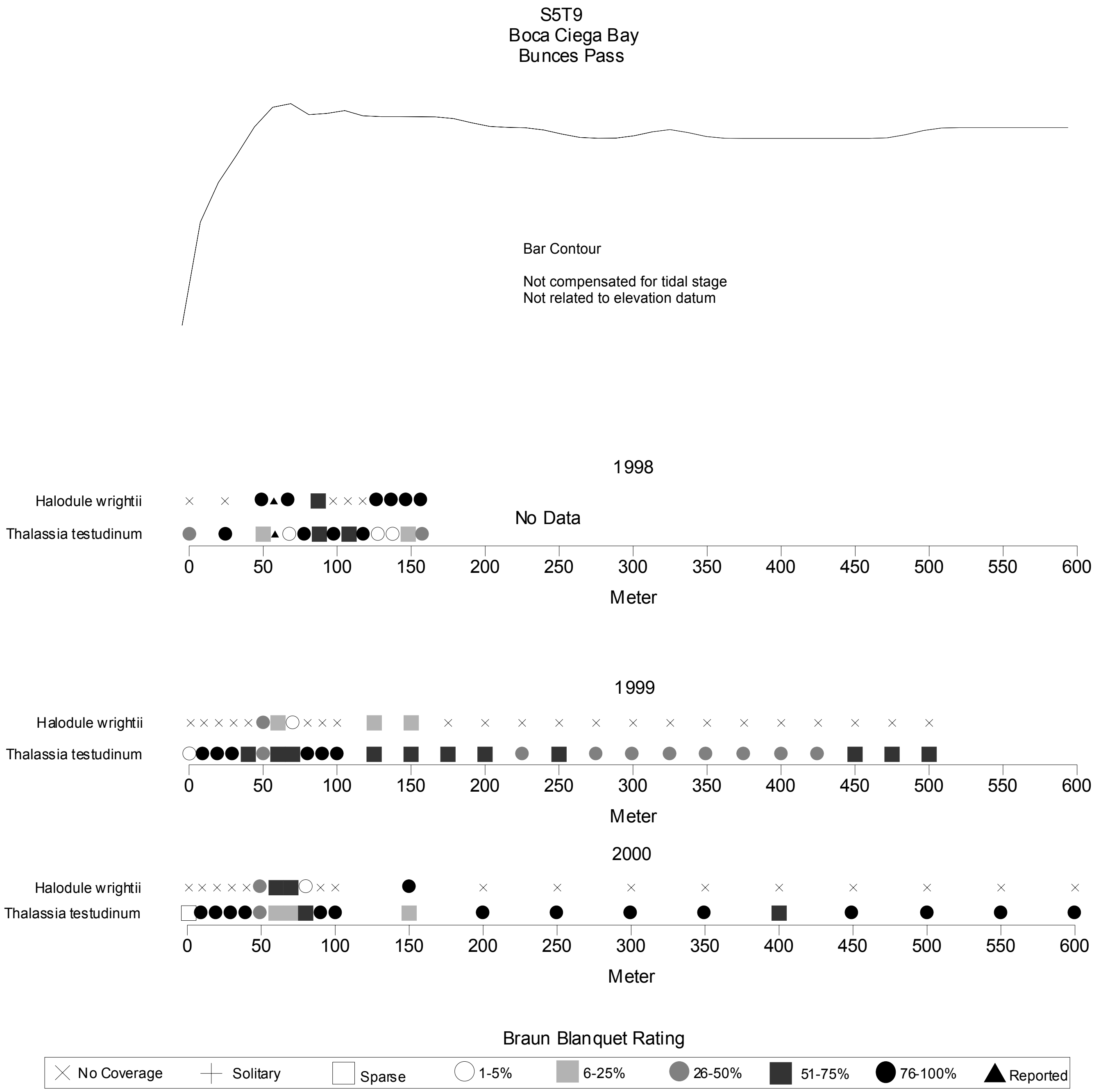

Figure 66. Seagrass species, abundance, and zonation at S5T9 from 1998-2000.

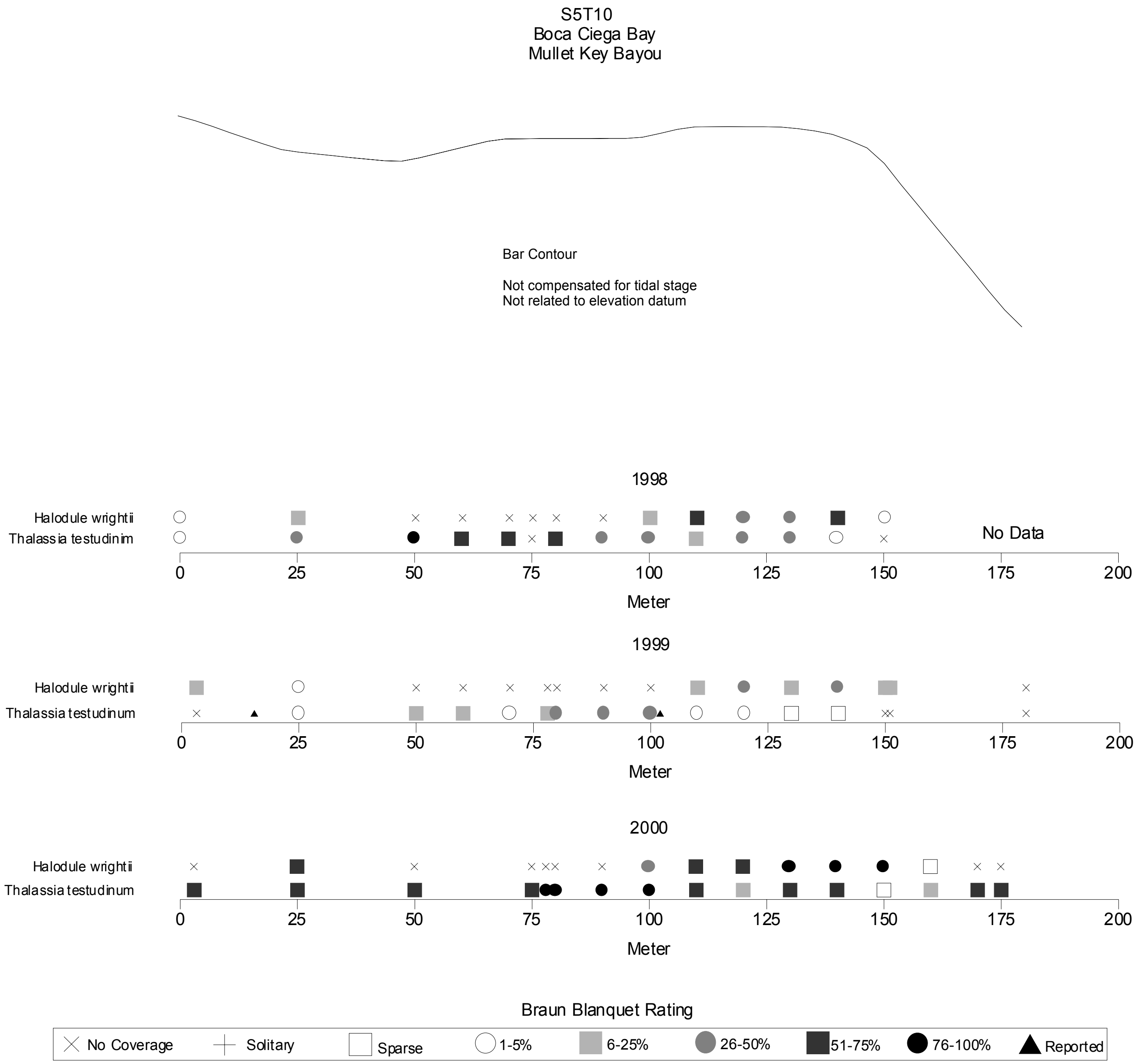

Figure 67. Seagrass species, abundance, and zonation at S5T10 from 1999-2000.

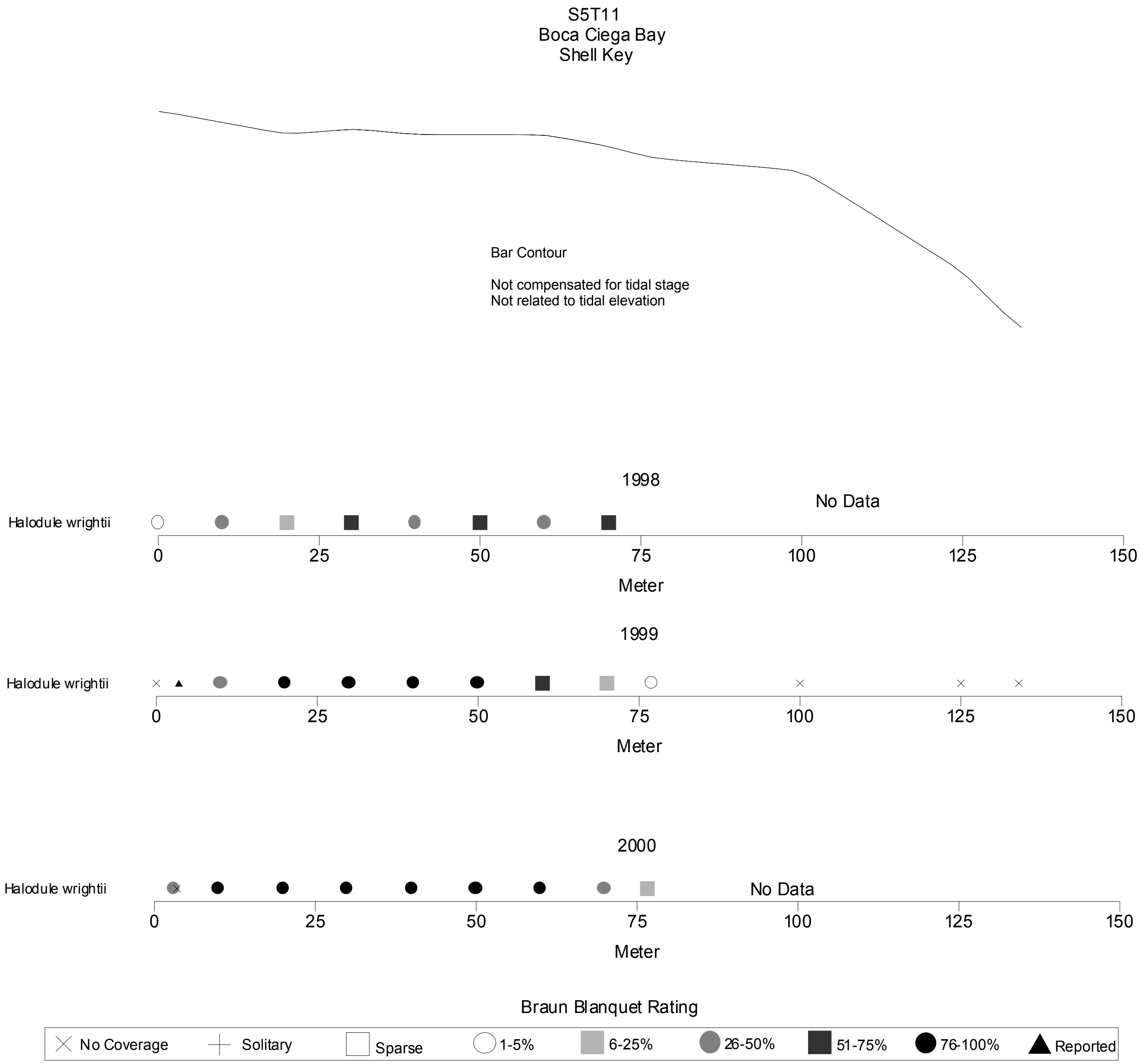

Figure 68. Seagrass species, abundance, and zonation at S5T11 from 1998-2000.

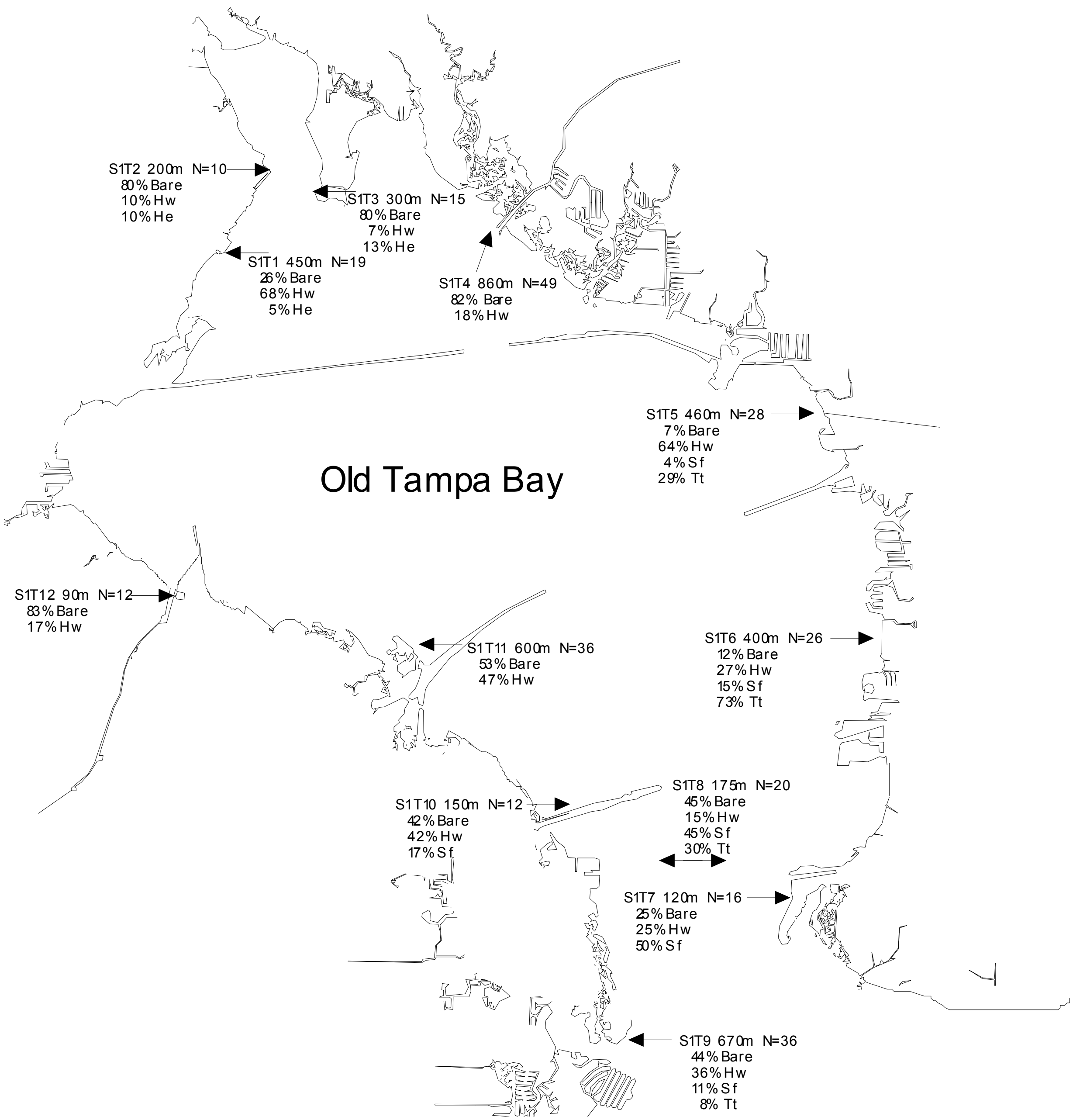

Figure 69. The occurrence of each seagrass species and bare bottom expressed as the percent of the total meter square placements (% of N) along each transect in Old Tampa Bay during 2000. N = number of meter square placements. Hw – *Halodule wrightii*; He – *Halophila engelmanni*; Rm - *Ruppia maritima*; Sf – *Syringodium filiforme*; Tt – *Thalassia testudinum*.

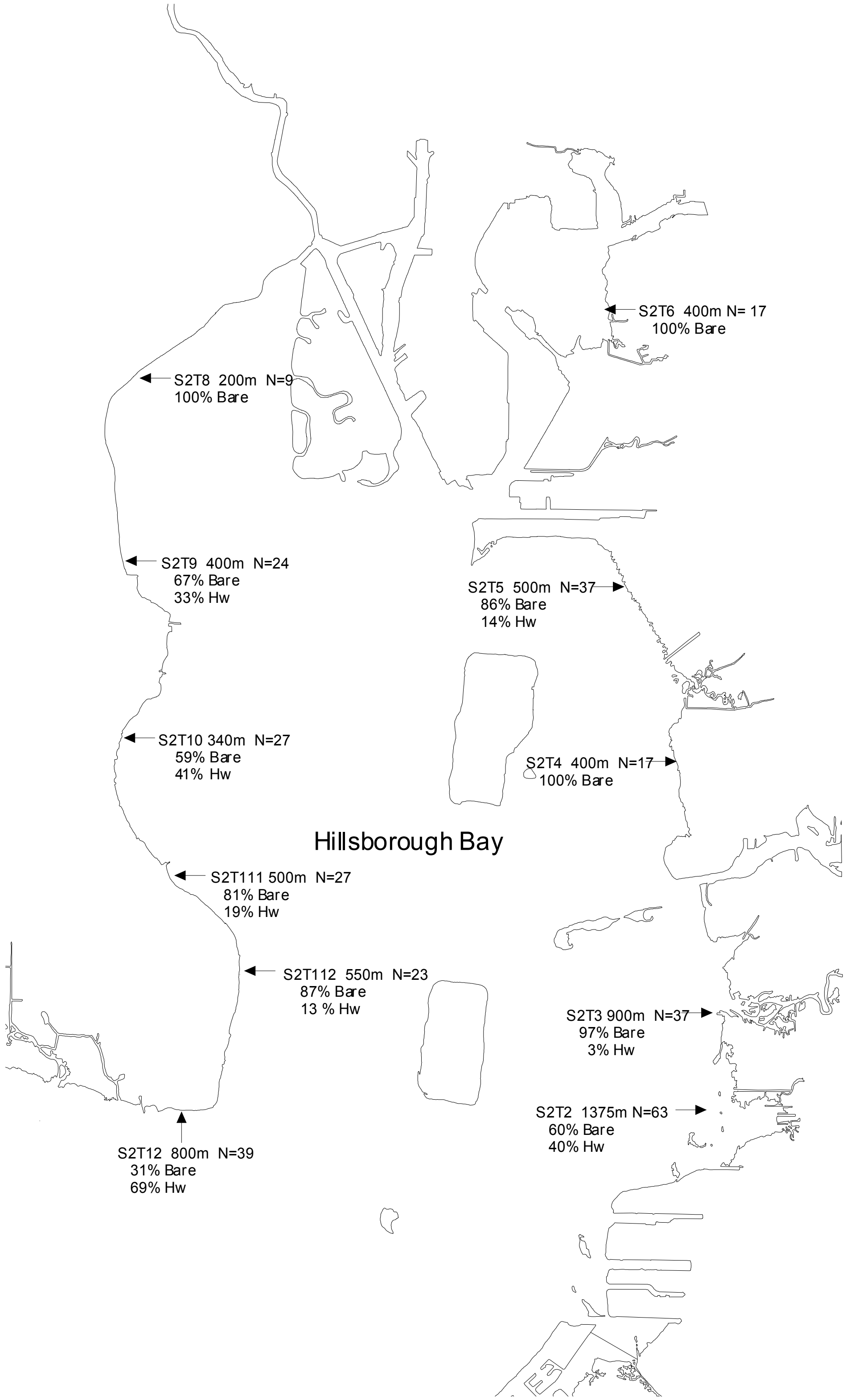

Figure 70. The occurrence of each seagrass species and bare bottom expressed as the percent of the total meter square placements (% of N) along each transect in Hillsborough Bay during 2000. N = number of meter square placements. Hw – *Halodule wrightii*.

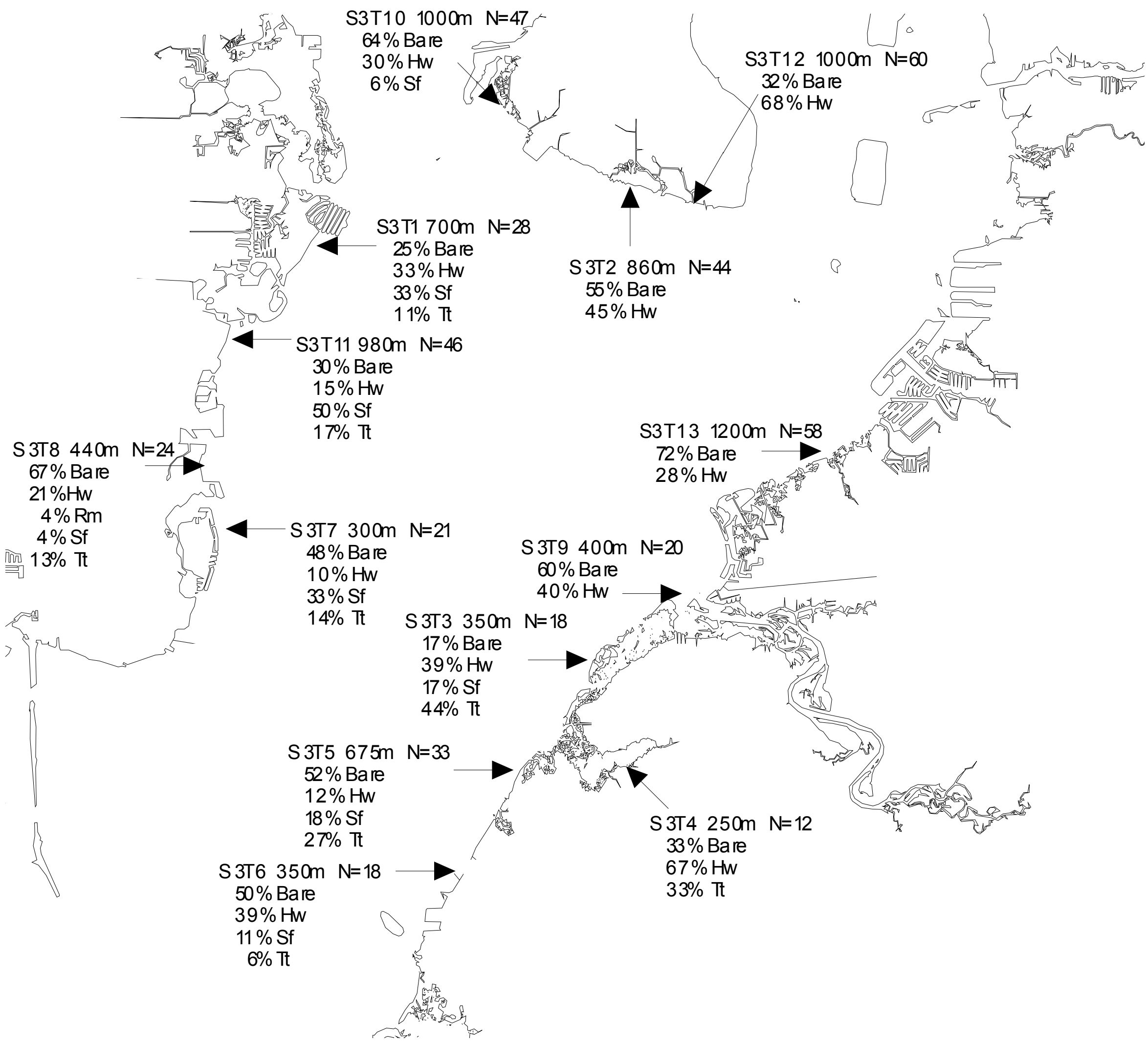

Figure 71. The occurrence of each seagrass species and bare bottom expressed as the percent of the total meter square placements (% of N) along each transect in Middle Tampa Bay during 2000. N = number of meter square placements. Hw – *Halodule wrightii*; Rm - *Ruppia maritima*; Sf – *Syringodium filiforme*; Tt – *Thalassia testudinum*.

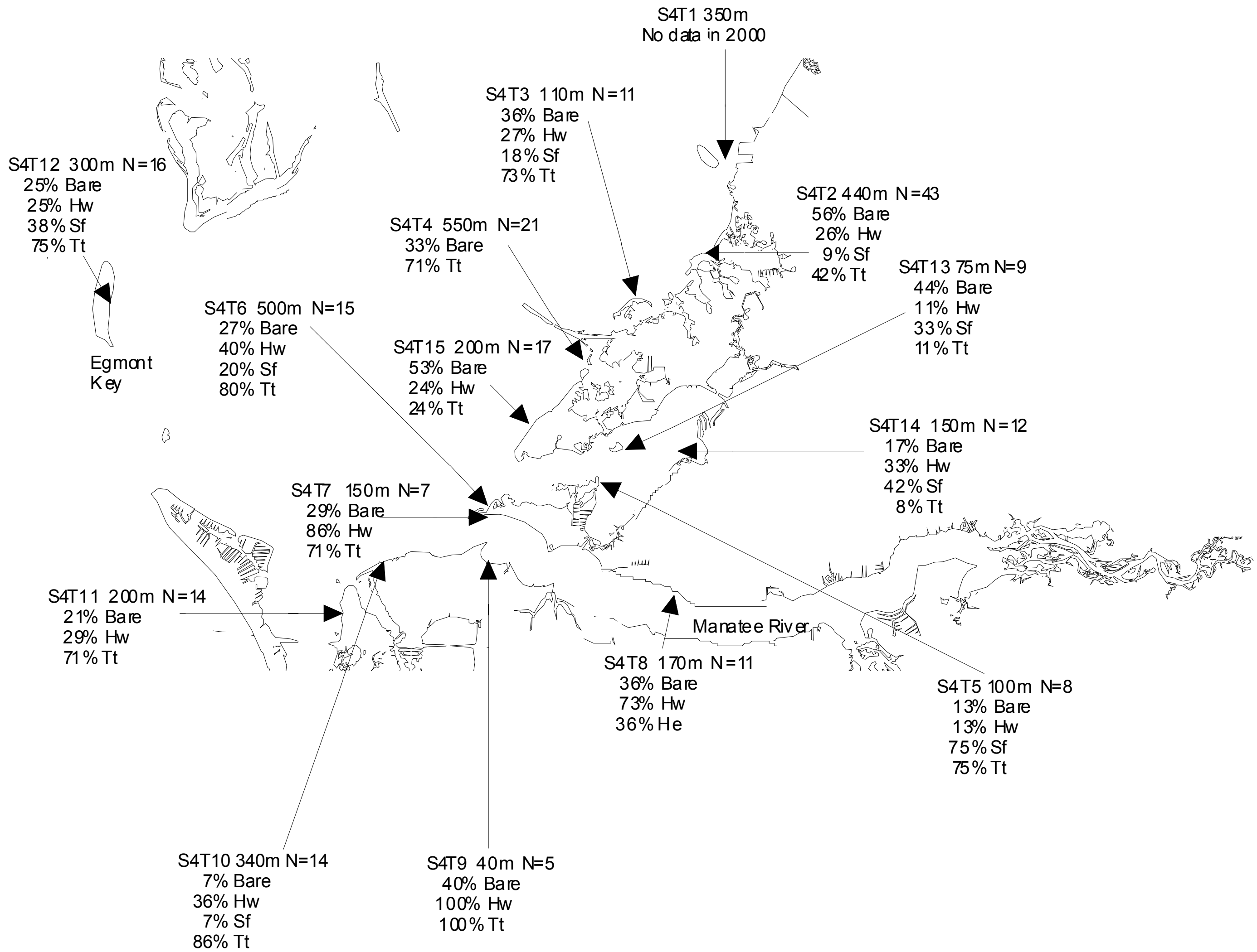

Figure 72. The occurrence of each seagrass species and bare bottom expressed as the percent of the total meter square placements (% of N) along each transect in Lower Tampa Bay during 2000. N = number of meter square placements. Hw – *Halodule wrightii*; He – *Halophila engelmanni*; Rm - *Ruppia maritima*; Sf – *Syringodium filiforme*; Tt – *Thalassia testudinum*.

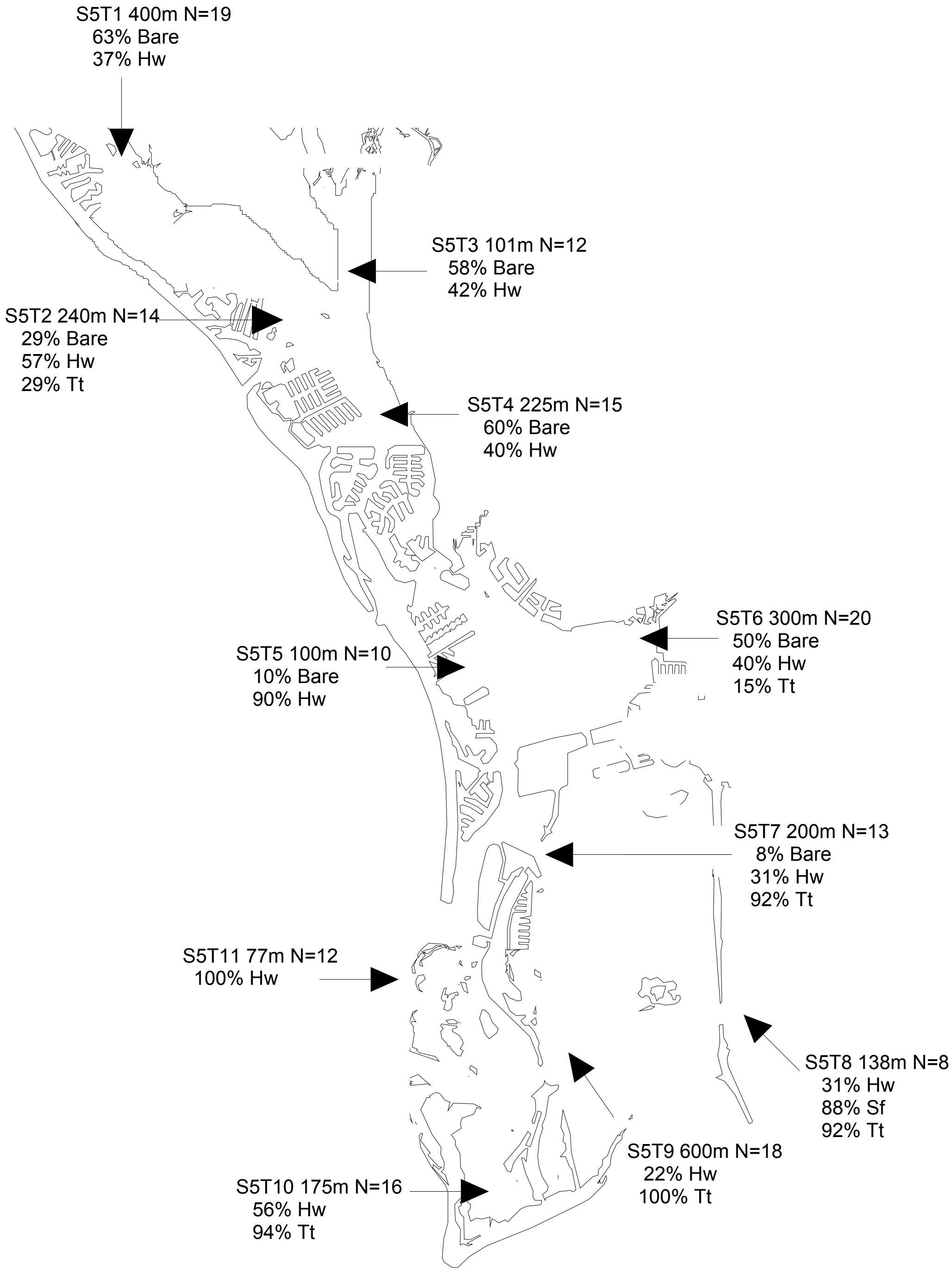

Figure 73. The occurrence of each seagrass species and bare bottom expressed as the percent of the total meter square placements (% of N) along each transect in Boca Ciega Bay during 2000. N = number of meter square placements. Hw – *Halodule wrightii*; Rm - *Ruppia maritima*; Sf – *Syringodium filiforme*; Tt – *Thalassia testudinum*.

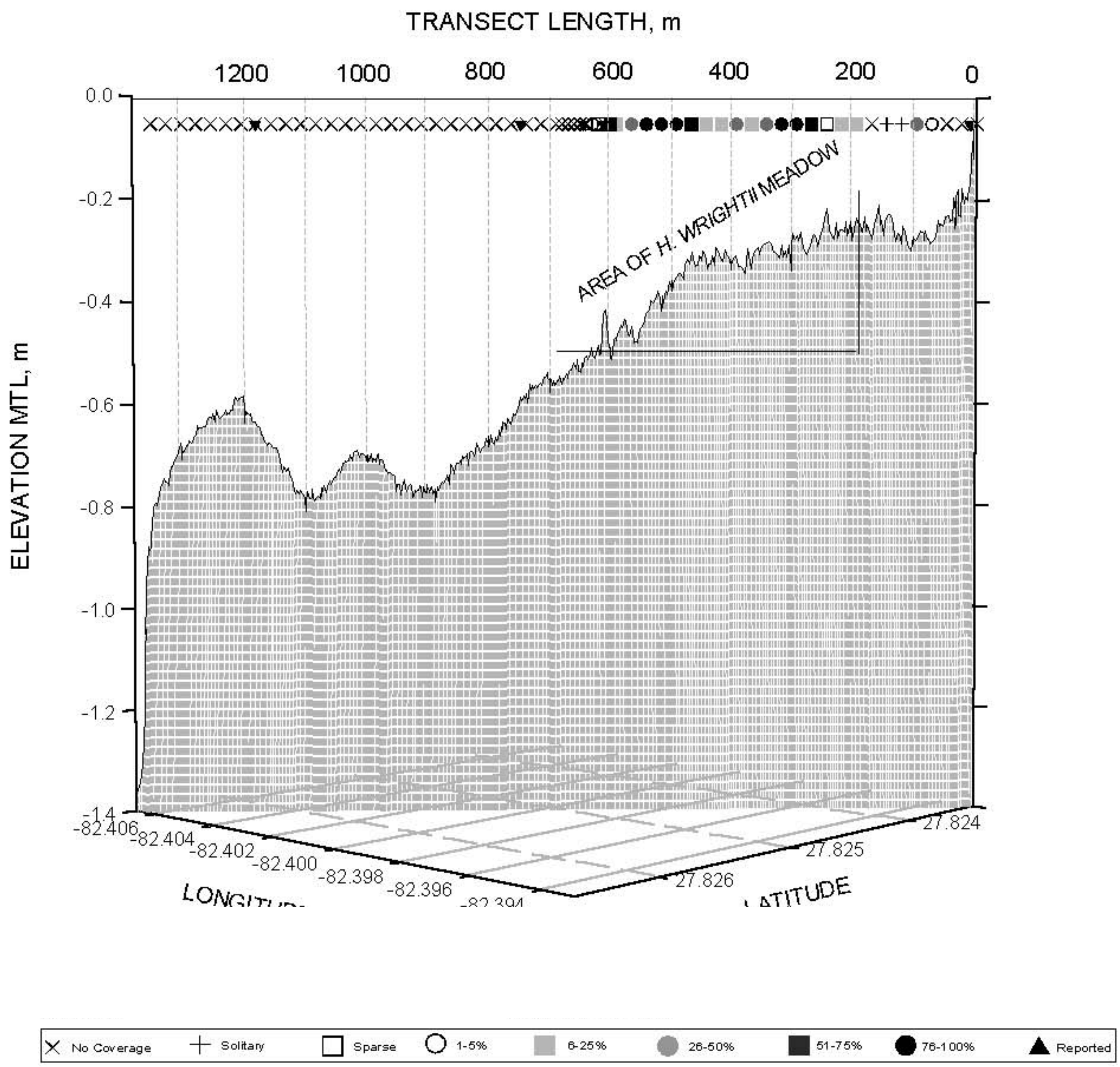

Figure 74. GPS determined depth contour and geographic location of transect S2T2 in the Kitchen area of Hillsborough Bay. GPS measurements were conducted on Feb. 15, 2001. Also shown is seagrass abundance information (Braun-Blanquet ratings) collected during the fixed transect seagrass monitoring survey on Oct. 6, 2000.

Figure 75. Areas of significant seagrass change in Tampa Bay between 1998-2000.