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Seagrass and Caulerpa monitoring in Hillsborough Bay Twelfth Annual Report

City of Tampa Department of Sanitary Sewers

SEAGRASS AND *CAULERPA* MONITORING IN HILLSBOROUGH BAY
TWELFTH ANNUAL REPORT

SUBMITTED TO

THE FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

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CITY OF TAMPA

DEPARTMENT OF SANITARY SEWERS

BAY STUDY GROUP

EXECUTIVE SUMMARY

The City of Tampa, Department of Sanitary Sewers, Bay Study Group has been monitoring water quality in Hillsborough Bay since 1976 and has documented improvements in several water quality parameters since the early 1980's. The improvements in water quality were followed by the emergence of shoalgrass, *Halodule wrightii*, in several areas of Hillsborough Bay.

The Bay Study Group began a monitoring program in 1986 of the seagrasses *H. wrightii* and *Ruppia maritima*, and the alga, *Caulerpa prolifera*. The purpose of the study was to monitor changes in seagrass coverage, because seagrass may serve as an indicator of water quality. However, the study is not intended to link the discharge from the Howard F. Curren Advanced Wastewater Treatment Plant with changes in the seagrass community. *H. wrightii* baywide areal coverage was about 2000m^2 in the initial survey in 1986 and increased to about 69ha by 2000. The 69ha of *H. wrightii* coverage was an increase of 13ha over the 1997-1999 period, which had a constant coverage of about 56ha. *R. maritima* coverage decreased from about 3.3ha in 1999 to 2.2ha in 2000. This decline followed a decrease from 40ha in 1996 to about 6ha in 1997. Coverage *C. prolifera* coverage has varied greatly over the study period. After reaching maximum coverage of 280ha in 1988, *C. prolifera* meadows were reduced nearly an order of magnitude following a "25 year" rainfall event in the fall of 1988. The presence of *C. prolifera* was documented in Hillsborough Bay through 1994, however, no attached *C. prolifera* coverage has been noted in Hillsborough Bay since 1997.

Seagrass recolonization has occurred in the intertidal and shallow subtidal areas of Hillsborough Bay concurrent with improving water quality. Sizeable *H. wrightii* meadows are now established in southeastern Hillsborough Bay and along the Interbay Peninsula in western Hillsborough Bay.

INTRODUCTION

The City of Tampa, Department of Sanitary Sewers, Bay Study Group (BSG), created in 1976, has monitored the effects of pollution abatement that occurred in Hillsborough Bay when the Howard F. Curren Advanced Wastewater Treatment Plant (formerly Hookers Point Wastewater Treatment Plant) was upgraded to secondary treatment in 1978 and advanced treatment in 1979. During the mid 1980's, water quality improvements and evidence of minor seagrass revegetation in Hillsborough Bay prompted the BSG to initiate a seagrass study to compliment other programs assessing the environmental status of Hillsborough Bay.

Documentation of submerged aquatic vegetation (SAV) in Hillsborough Bay (including McKay Bay) began in April 1986 with a thorough groundtruthing effort which located and estimated the areal coverage of *Halodule wrightii* (shoalgrass), *Ruppia maritima* (widgeongrass) and the attached benthic alga, *Caulerpa prolifera*. Eleven additional intensive surveys of *H. wrightii* were completed the fall of 1989 and 1991-2000. Study sites were established to provide data on seasonal change in canopy height, short shoot density, and areal coverage for *H. wrightii*, *R. maritima* and *C. prolifera*, however, monitoring of *R. maritima* and *C. prolifera* at specific study sites has been discontinued. As *H. wrightii* areal coverage increased beyond the limits of the study sites, coverage assessments shifted from on site measurements to estimates using aerial photography. Generally, study sites were monitored three times a year until 2000 when winter assessments were added.

In 1996, the BSG established thirteen seagrass transects in anticipation of the Tampa Bay seagrass monitoring program coordinated by the Tampa Bay Estuary Program (TBEP) and the Southwest Florida Water Management District's Surface Water Improvement Management program (SWIM). The monitoring program, which commenced in the fall of 1998, incorporates many ideas outlined in the Comprehensive Conservation and Management Plan produced by TBEP. This plan aims to restore and protect Tampa Bay seagrass meadows principally through the management of nitrogen discharges to the bay. The BSG is one of several agencies involved in the coordinated seagrass monitoring program. Participation in this program may result in future changes to the BSG seagrass monitoring protocol.

The BSG transplanted *H. wrightii* into Hillsborough Bay in 1987 and 1989. Monitoring of *H. wrightii* transplants in Hillsborough Bay has been discontinued due to coalition with naturally occurring coverage. Data for transplants were included in the reports submitted through 1994. Transplant coverage is now included as part of the baywide *H. wrightii* areal coverage estimate.

The purpose of the BSG seagrass program is to monitor changes of SAV, excluding drift macroalgae, in Hillsborough Bay because seagrass is an important Tampa Bay habitat that may also serve as an indicator of water quality. However, the seagrass program is not intended to link the discharge from the Howard F. Curren Advanced Wastewater Treatment Plant with changes in the seagrass community.

This is the twelfth annual report submitted to the Florida Department of Environmental Protection (FDEP) to satisfy the requirements set forth in Reclaimed Water and Effluent Limitations and Monitoring Requirements condition #10 of the Howard F. Curren WWTP operation permit FL0020940-001-DW1P.

METHODS

The BSG seagrass program has been modified several times since 1986. A report by the BSG in 1988, "An Ongoing Survey of *Halodule wrightii, Ruppia maritima*, and the Alga, *Caulerpa prolifera* in Hillsborough Bay, Florida: Initial Assessment and Design" describes study site locations and monitoring design for the naturally occurring seagrass and *C. prolifera* projects through the 1991 spring survey. It does not, however, contain seagrass transplant information and project modifications made after the 1991 spring survey. Transplant information and methods used to evaluate SAV during 1991, 1992, and 1993 were discussed in the annual report submitted to DEP in March, 1994.

Study Sites

Halodule wrightii:

The intertidal and shallow subtidal flats around the perimeter of Hillsborough Bay were divided into twelve seagrass study areas (Figure 1). An additional seagrass study area was added in 1994 to include the northern spoil disposal island, 2-D. Within each of the thirteen seagrass study areas, at least one patch of *H. wrightii*, if present, was chosen as a seagrass study site.

Each study site is evaluated on a seasonal basis. During each visit to a study site, short shoot density, blades per short shoot, and blade length are measured. Short shoot density is determined using a $100cm^2$ (10cmx10cm) square. Blade length (emergence from the short shoot basal stalk to tip of the blade) is measured to the nearest centimeter. Subjective evaluations concerning epiphytes and seagrass health are recorded. Epiphytic cover is rated as clean, light, moderate, or heavy. Seagrass appearance is rated as poor, fair, good, or very good. Salinity, water temperature, dissolved oxygen, pH, and water depth are recorded. However, only the short shoot density and blade length data are presented as the purpose of this report is to present changes in SAV excluding macroalgae.

Ruppia maritima:

One *R. maritima* transect was established in western Hillsborough Bay in 1987 and discontinued in 1992. Species verification and observations on inflorescence are made during the seasonal visits to the thirteen seagrass study areas.

Caulerpa prolifera:

Five *C. prolifera* transects (Figure 2) in Hillsborough Bay were visited seasonally through the fall of 1994. However, due to the paucity of *C. prolifera* in Hillsborough Bay in 1995, the BSG discontinued detailed investigation of these five transects pending the potential return of significant *C. prolifera* coverage. Results for transect coverage through 1994 may be found in the 1995 report.

TBEP Transects:

The BSG established thirteen transects in the fall 1996 in order to follow spatial and temporal seagrass trends. Eleven transects are in Hillsborough Bay and two in Middle Tampa Bay (Figure 3). Four of these transects traverse historical SWIM seagrass study sites. The transects are divided into 100m sections and range between 160-1360m in length.

Each transect is visited annually, during the fall, and the coverage of each seagrass species is estimated using a 1x1 meter square. Along each transect, meter squares are placed at a minimum of 25m intervals except at the 100m section traversing the seaward edge of the seagrass meadow. Meter square placement is at 10m intervals along this section. Coverage for each seagrass species within each meter square is estimated using the Braun Blanquet rating system. The system incorporates ratings of 0-5 where: a) 0 represents the absence of coverage, b) 0.1 represents a single short shoot c) 0.5 represents less than 1 percent coverage, d) 1 represents 1-5 percent coverage, e) 2 represents 6-25 percent coverage, f) 3 represents 26-50 percent coverage, g) 4 represents 51-75 percent coverage, h) 5 represents 76-100 percent coverage, and I) "reported" represents coverage found along the transect, but which did not fall within meter square placements. Generally, the "reported" category is used for noting seagrass in areas which previously have not had coverage.

The water column depth is recorded at the meter square placements along each transect. The data are used to generate a bottom contour for each transect, however, the profile is not related to an elevation datum nor are the data corrected for tidal stage.

Information on seagrass characteristics, hydrographic conditions, and photosynthetic active radiation (when sufficient water column depth allows measurements) is collected where each transect traverses the mid and edge portion of the seagrass bed, and the two meter water depth contour. In addition, water sample from each collection site are taken at mid depth for chlorophyll *a* and turbidity analysis. These data are not included in this report (see above).

Areal Coverage

Photographs taken from high and low altitudes are used to aid in the determination of SAV coverage for each seagrass study area of Hillsborough Bay. Specifically, high altitude aerial photographs (ca. 1000-3000ft.) are used to estimate areal coverage where SAV is present in a large, continuous meadow. After a scale is determined for each photograph, a grid composed of 1x1mm squares is placed over the photograph. The number of $1mm^2$ squares covering a SAV signature in the

photograph is counted and the areal extent of the SAV is determined by multiplying the number of squares counted times the scale determined for a square. Further, low altitude (ca. 500ft.) overflights are generally conducted monthly and are used to locate and enumerate small *H. wrightii* patches not seen in the high altitude photographs. In addition, the monthly reconnaissance flights assist in tracking the development of SAV during the year.

Intertidal and shallow subtidal flats which have the potential for SAV coverage are visited on foot in the fall. During each visit, SAV seen in the low and high altitude photographs is groundtruthed. In addition, any SAV not seen on the photographs is documented. Small patches of *H. wrightii* are enumerated and measured and the area of each patch determined using the formula for an ellipse. There may be occasions where SAV, although widespread, is too patchy to determine the areal coverage from photographs. If the SAV coverage cannot be determined from photographs or groundtruth efforts, the areal coverage is estimated by calculating the percent cover of each species in an area of known acreage.

In the fall of 1997, the BSG began using a global positioning system (GPS) to accurately map large areas of seagrass. The GPS instrument is composed of a Trimble Pro XR differential receiver interfaced with a Trimble TDC1 Asset Surveyor and is capable of recording positions with sub-meter accuracy. The BSG employs the instrument by following the perimeter of a seagrass bed and automatically recording positions every five seconds. Subsequently, the data are downloaded into a PC using the Trimble Pathfinder Office software. In this software, seagrass coverage is mapped on a Tampa Bay base map (ARC-INFO Mapping Data, Southwest Florida Water Management District, 1996). Areal coverage calculations can then be performed.

The terms patchy and continuous are subjective terms used in this report to describe seagrass coverage. Patchy coverage may be viewed as small areas of seagrass or developing patches of seagrass. Generally, these patches are less than fifty meters in diameter and cover less than 2000m^2. Patchy coverage may, in time, coalesce into continuous coverage.

RESULTS AND DISCUSSION

Two species of seagrass, *H. wrightii* and *R. maritima*, and the attached alga, *Caulerpa prolifera*, have been documented in Hillsborough Bay during the course of the seagrass monitoring program. *H. wrightii* and *R. maritima* has been present in the bay each year, however, *C. prolifera* has not been observed since 1997.

Hillsborough Bay Seagrass Coverage in 2000

H. wrightii and *R. maritima* were observed during the 2000 Hillsborough Bay seagrass survey. *H. wrightii* coverage increased about 22 percent from 56.2ha reported in 1999 to about 68.8 ha in 2000 (Figure 4). *R. maritima* coverage decreased from about 3.3ha in 1999 to 2.2ha in 2000. This decline followed a decrease from 40ha in 1996 to about 6ha in 1997.

H. wrightii coverage was present in each seagrass study area (Figure 1), except Area 6 in McKay Bay, while most of the *R. maritima* coverage was found between the Alafia River and Pendola Point (Areas 4 and 5). *H. wrightii* areal coverage in each area for each year is summarized in Table 1.

H. wrightii coverage for the southeastern, northeastern, northwestern, and southwestern portions of Hillsborough Bay during 2000 is illustrated in Figures 5, 6 ,7, and 8, respectively. These figures are intended to present the general areal extent of *H. wrightii* and should not be used for areal coverage calculations.

Seagrass Study Areas and Transects

Results of areal coverage for each of the thirteen seagrass study areas of Hillsborough Bay (including McKay Bay) are reviewed concurrent with a discussion of seagrass distribution and abundance for the transect(s) within the specific study area. In addition, a general bottom contour of each transect is illustrated. There are no transects currently established in Areas 1, 7, and 13. Transects S3T12 and S3T13 are outside the boundaries of Hillsborough Bay and the results for these transects will be presented without a discussion of areal coverage.

Seagrass Study Area 1:

H. wrightii coverage in Area 1, near the Tampa Electric Company Big Bend power generating plant increased slightly from 3000m^2 in 1999 to about 3500m^2 in 2000. (Figure 9). Most of the coverage increase was observed on the east side of Fishhook Spoil. There was no *R. maritima* reported in this area.

Seagrass Study Area 2:

H. wrightii and *R. maritima* have been documented in Area 2, which includes the Kitchen in southeastern Hillsborough Bay (Figure 5). After reaching 40ha of *H. wrightii* coverage in 1997 and 1998, coverage losses have been noted for two consecutive years in this area. The 2000 coverage was about 29ha (Figure 10). *R. maritima* has been found predominantly along the shoreline in the eastern portion of the Kitchen. Coverage was reduced two orders of magnitude from about 10ha in 1996 to approximately 1000m^2 in 1997. *R. maritima* coverage remained at about 1000m^2 through 2000.

Transect S2T2 (Figure 11), which traverses east to west through the Kitchen, illustrates the distribution and Braun Blanquet coverage rating of seagrass in the area. Two features stand out between the *H. wrightii* distribution and abundance documented along the transect between 1997 and 2000. First, *H. wrightii* coverage between 0-200m increased between 1997-1999 before waning in 2000. Second, *H. wrightii* noted between 610-620m was the most seaward seagrass coverage documented on Transect 2 during 1997-1998. In 1999, small *H. wrightii* patches (generally less than 1m^2) with a low short shoot density were present along the 620-900m section of the transect, however, this coverage was absent in 2000. Although *R. maritima* was observed in the Kitchen, no coverage has been documented on the transect since 1997.

Seagrass Study Area 3:

In Area 3, between the Kitchen and the Alafia River, *H. wrightii* coverage decreased by more than 50 percent between 1998 and 1999 (Figure 12) and continued to decrease in 2000. Between 1997 and 1998, patches of *H. wrightii* developed and had coalesced into a narrow meadow from just north of the Kitchen to Bullfrog Creek (Figure 5). However, in 1999 and 2000, coverage waned as this meadow became fragmented. Areal coverage increased from nearly 1.1ha in 1997 to about 5.5ha in 1998, and then decreased to 2.7ha and 2.1ha in 1999 and 2000, respectively. *H. wrightii* was the only species noted in this area during 2000.

Braun Blanquet data from Transect S2T3 (Figure 13), which runs west from the mouth of Bullfrog Creek, illustrate the patchiness of *H. wrightii* in this area. Although several *H. wrightii* patches were reported along the transect during each year, only a single meter square placement contained any seagrass in each survey.

Seagrass Study Area 4:

After reaching 9000m^2 in 1997, *H. wrightii* coverage between the Alafia River and Archie Creek declined in 1998 and 1999 (Figure 14). Only a few patches were observed near Archie Creek (Figure 6) in 1999. In 2000, the *H. wrightii* coverage near Archie Creek began to coalesce and expanded to 2000m^2.

R. maritima coverage has continued to fluctuate near the mouth of Archie Creek. Only a few patches were seen in this area during 2000.

Seagrass was not present along Transect S2T4 (Figure 15), however, this transect is located to the south of most *H. wrightii* and *R. maritima* found in this area.

Seagrass Study Area 5:

H. wrightii between Archie Creek and Pendola Point decreased from 8000m^2 in 1997 to 1900m^2 in 1998 (Figure 16). In 1999, *H. wrightii* coverage increased to 4000m^2 and, in 2000, again increased to 4.4ha. Most of the new coverage was found between the Delaney Creek Pop-off Canal (Figure 6) and Transect S2T5 (Figure 3).

A nearly continuous band of *R. maritima* was documented in 1998 from north of Archie Creek to the Pendola Point peninsula. Coverage in a Area 5 declined from about 4ha in 1998 to about 2ha in 1999 and 2000.

In 1997, there was a mixture of *H. wrightii* and *R. maritima* along the first 120m of Transect S2T5 (Figure 17). Braun Blanquet data from the transect survey illustrate the decrease in abundance and loss of *R. maritima* and *H. wrightii* along the 10-120m section of the transect since 1997. *R. maritima* and *H. wrightii* coverage did not change significantly between 1998 and 2000 along Transect 5.

Seagrass Study Area 6:

H. wrightii has not been observed in McKay Bay (Figure 1) during the BSG seagrass study. There have been scattered patches of *R. maritima* in northwest and southeast McKay Bay prior to 1998, however, McKay Bay lacked seagrass coverage between 1998 and 1999. In 2000, some sparse *R. maritima* was noted along Transect S2T6 (Figure 18).

Seagrass Study Area 7:

This study area encompasses the Davis Island shoreline. About $300m^2$ of *H. wrightii* (Figure 19) was found in the northeast section of the seaplane basin (Figure 7) in 1997 and has been the only seagrass species noted in Area 7. *H. wrightii* coverage in this area has changed little since 1997.

Seagrass Study Area 8:

In the past three years, patchy *H. wrightii* and *R. maritima* coverage began to develop on the shallow flats near the intersection of Bayshore Boulevard and Bay to Bay Boulevard (Figure 7). *H. wrightii* coverage has fluctuated between $10m^2$ and $200m^2$ between 1996 and 2000 (Figure 20). However, the small patches of *R. maritima* that were noted in 1997 have been absent since 1998.

Sparse *H. wrightii* coverage was documented along Transect S2T8 (Figure 21) for the first time in 2000. Further, several small patches of *H. wrightii* are located just to the north and south of the transect line.

Seagrass Study Area 9:

H. wrightii has been the only seagrass species found in Area 9 since 1998. Coverage in this area has remained near 1ha since 1994 (Figure 22). Most of the coverage was found just north of Ballast Point along Bayshore Boulevard (Figure 7).

Seagrass distribution and abundance along Transect S2T9 in 2000 was similar to the 1997-1999 period. Braun Blanquet data from Transect 9 (Figure 23) indicate a band of continuous to patchy *H. wrightii* coverage beginning approximately 20m from the seawall and ending at the 70m mark. The coverage pattern found along this transect is typical of the *H. wrightii* distribution found in this area.

Seagrass Study Area 10:

H. wrightii coverage in Area 10 increased from 6ha to about 7.4ha between 1998 and 2000 (Figure 24). Most of the new seagrass developed between southern Ballast Point and the northern boundary of MacDill Air Force Base. Since 1998, there has been a narrow, nearly continuous band of *H. wrightii* between Ballast Point and the navigation channel on the east side of MacDill Air Force Base (Figure 8). In 2000, the areal coverage in Area 10 was estimated to be 7.4ha.

About 2000m^2 of *R. maritima* was found just north of the air base in 1997. In 1998, coverage was reduced less than 1000m^2 in Area 10 and was generally confined to an area just south of Ballast Point. This coverage did not change between 1998 and 2000.

Seagrass coverage along Transect S2T10 included *H. wrightii* and *R. maritima* in 1997 (Figure 25), however, only *H. wrightii* has been observed since 1998. In 2000, a narrow *H. wrightii* meadow was found along the 30-70m segment of the transect. Sparse coverage between 100-260m was similar to that found in 1999. However, several *H. wrightii* patches noted near the 200m area in 1999, coalesced into a 20m diameter patch in 2000.

Seagrass Study Area 11:

H. wrightii in Area 11 has been characterized by relatively large fluctuations in annual coverage since 1994 (Figure 26). In 1999, numerous *H. wrightii* patches had developed from just north of Catfish Point southward to Gadsden Point. In 2000, much of the coverage near Catfish Point coalesced into a sizable meadow (Figure 8) and coverage continued to develop between Catfish Point and Gadsden Point. *H. wrightii* coverage was estimated at 11.5ha in 2000, nearly four times more than what was reported in 1999.

Most of the *R. maritima* noted in Area 11 between 1997 and 2000 has consisted of a narrow band located shoreward of the *H. wrightii* meadow found just north of Catfish Point. In 2000, *R. maritima* coverage in Area 11 was less than 1000m^2.

There are two transects in Area 11 (Figures 1 and 3). In 2000, coverage along Transect S2T111 (Figure 27) was comprised of *H. wrightii* along the 30-80m portion of the transect. Further, *H. wrightii* noted near 250m probably represents the northern edge of the offshore coverage which developed between Catfish Point and Gadsden Point. Seagrass was found on Transect S2T112 for the first time in 1999 (Figure 28). Patchy *H. wrightii* coverage continued to develop in this area between 1999-2000 and several patchy areas began to coalesce. Results from Transect S2T112 illustrates the coverage pattern found between Catfish Point and Gadsden Point.

Seagrass Study Area 12:

Between 1997-2000, *H. wrightii* coverage in Area 12 increased an order of magnitude from 1.1ha to 11.2ha (Figure 29). In 2000, there was a band of patchy *H. wrightii* from Gadsden Point west to the MacDill AFB marina. In addition, patchy coverage located on the seaward portion of the shallow subtidal shelf began to coalesce into a meadow.

Patchy *R. maritima* was found between the MacDill AFB marina and Gadsden Point. Areal coverage for this species was determined to be about 1000m^2 during 1998. However, no *R. maritima* was noted in Area 12 in 1999.
Seagrass coverage documented along Transect T212 (Figure 30) in 2000 consisted of patchy *H. wrightii* in the initial 100m. Further, between 1999 and 2000, numerous patches developed and

coalesced along the 150-775m section of the transect. Prior to 1999, the only seagrass coverage noted between 100-900m was sparse *H. wrightii* near the 300m and 700m meter square placements.

Seagrass Study Area 13:

H. wrightii has been the only seagrass species reported in Area 13. *H. wrightii* coverage in this area increased an order of magnitude from 1500m^2 in 1999 to 1.5ha in 2000 (Figure 31). Most of the new coverage has developed along the eastern and northern shoreline of the spoil disposal island 2-D (Figure 6). Further, *H. wrightii* coverage near the small spoil island (Fantasy Island) off the southeastern end of 2-D increased in 2000.

Seagrass Study Transect S3T12:

Transect S3T12 is located at the mouth of Broad Creek on the south end of Interbay Peninsula. Information from Transect S3T14 (Figure 32) indicates that *H. wrightii* coverage has continued to increase both shoreward and seaward along the transect between 1997 and 2000. Sparse to patchy *R. maritima* found in the first 100m of Transect 14 in 1997-1998 (Figure 32) was absent in 1999 and 2000.

Seagrass Study Transect S3T13:

Transect S3T13 is located at the mouth of Wolf Branch Creek south of Apollo Beach. Data from this transect in 2000 (Figure 33) indicate that the seaward edge of the *H. wrightii* meadow has continued to recede into shallower water from the location of the edge found in 1998. In addition, scattered coverage present between 500-700m and 900-1100m in 1999 was virtually absent in 2000. Very sparse *R. maritima* persisted in the first 100m segment of the transect between 1998-1999, however, this coverage was not observed in 2000.

Seasonal Trends for *Halodule wrightii* Short Shoot Density and Blade Length

Seasonal values for *H. wrightii* blade length (seagrass canopy height) are presented in Figure 34. These data indicate that blade lengths are short in the spring, usually attaining maximum canopy height in the summer, and may retain the summer canopy height through the fall. Generally, blade lengths are significantly shorter in the spring as compared to summer and fall. The median blade lengths are generally longest in the summer, although the lengths are not significantly different than the fall values. Assessment of winter values began in 2000 and measurements indicate that winter blade lengths appeared to be similar to those found in the spring of 2000.

Seasonal values for *H. wrightii* short shoot density are presented in Figure 35. Generally, the short shoot mean density is lowest in the spring. The short shoot mean density usually increases by the summer and is similar to the density found in the fall. Although there appears to be seasonal trends, generally there are no significant differences between seasonal short shoot densities. Finally, there appears to be an interannual trend of decreasing short shoot density between 1996 and 1999.

Assessment of winter values started in 2000 and measurements indicate that winter shoot density appear to be similar to those found in the spring of 2000.

Caulerpa prolifera

Two *C. prolifera* meadows have developed and then degenerated in Hillsborough Bay since 1986. In western Hillsborough Bay, a 40 fold increase in coverage was documented between April and December of 1986 (Figure 36). The areal coverage of this meadow was reduced by 90 percent in the fall of 1988 immediately following a "25 year" rainfall event which lowered salinities to 2ppt in some areas of Hillsborough Bay. The decline of *C. prolifera* in this area is probably a result of extended exposure to unusually hyposaline conditions. Similarly, in an area south of Pendola Point, the alga expanded from 800m^2 in 1987 to 190ha in 1990. *C. prolifera* coverage in this area quickly diminished to 10ha in 1991 and was not noted after 1994. However, losses in this area do not appear to be related to major rain events. *C. prolifera* has not been observed in Hillsborough Bay since 1997.

CONCLUSION

Recolonization of *H. wrightii* into most intertidal and shallow subtidal areas of Hillsborough Bay has occurred concurrent with improving water quality. The majority of the *H. wrightii* recolonization has taken place in the Kitchen, however, sizeable meadows have also developed in the western and northeastern sections of the bay. Between 1997 and 1999, areal coverage changed little as the amount of *H. wrightii* declined in some areas and remained stable or increased in other areas. *H. wrightii* recolonization between 1999-2000 resulted in a 13ha net increase of seagrass coverage in Hillsborough Bay.

The increase in *H. wrightii* coverage in Areas 4, 11, and 12 in 2000 is encouraging. *H. wrightii* meadows have developed in Area 4 through recolonization and coalition and has resulted in an order of magnitude expansion between 1999-2000. Similarly, recolonization and coalition documented in Area 11 (Catfish Point, Transect S2T112) and Area 12 (Gadsden Point, S2T12) have resulted in an order of magnitude increase of coverage between 1997-2000. With the increases noted in Areas 4, 11, and 12, the expansion of Hillsborough Bay seagrass meadows was renewed in 2000 after two years of virtually no net gain in coverage.

In contrast to the substantial increases in Areas 4, 11, and 12, there was, over the same time period, a 10ha decrease in *H. wrightii* coverage in Area 2. The cause of the loss of seagrass in Area 2 is not known, however, it may be related to the above normal rainfall in 1997-1998. The high rainfall amounts resulted in reduced salinity, increased phytoplankton biomass, and lower Secchi depth. These factors in combination, or by themselves, are detrimental to seagrass growth. Water quality in Hillsborough Bay for this period was discussed in the City of Tampa report entitled "Results of the City of Tampa Compliance Monitoring Program for the Year 1999 and Examination of Long-Term Water Quality and Biological Indicator Trends in Hillsborough Bay" submitted to the Florida Department of Environmental Protection on May 1, 2000.

Several areas of Hillsborough Bay have *R. maritima* meadows which vary in size from year to year. In recent years, this species has become a minor component of the seagrass coverage in Hillsborough Bay, although in 1996, it increased to about 40ha, equaling the amount reported for *H. wrightii*. In 1999, *R. maritima* coverage was estimated to be about 2.2ha, less than 4 percent of the *H. wrightii* coverage in Hillsborough Bay.

C. prolifera has been a major contributor to SAV coverage in the past decade. This alga has been observed growing in deeper waters than *H. wrightii*, suggesting that the alga may be a pioneer SAV species in areas with relatively low light penetration. *C. prolifera* can vegetate large areas in a short period and, conversely, undergo sudden, large scale die-offs. For example, a 90% reduction of the *C. prolifera* meadows in western Hillsborough Bay occurred immediately following exposure to unusually low salinities for an extended period of time in 1988. In other areas, reductions in areal coverage do not appear to be salinity related and occurred more gradually.

Table 1. *Halodule wrightii* coverage (m^2) by area in Hillsborough Bay for the years 1986, 1989, and 1991-2000.

	1986	1989	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AREA												
1	690	700	400	500	2000	2630	2500	3000	5600	3000	3000	3500
2	1125	3300	16300	40801	34000	135000	167000	296000	400000	400000	390000	290000
3	0	0	40	350	250	1200	2500	4500	10800	54300	27000	21000
4	0	0	200	475	500	600	500	1000	9000	1900	200	2000
5	0	0	15	150	600	1200	750	1500	7900	1900	4000	44300
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	300	160	200	200
8	0	0	0	0	0	0	0	10	80	90	200	10
9	85	140	800	1900	7000	10400	8700	11000	11000	9000	10000	11000
10	40	750	1600	6750	22400	32400	54000	60000	59000	60000	72000	74000
11	0	65	200	650	5000	10500	28500	15000	40000	16700	24000	115200
12	20	20	20	250	1300	2800	17000	11000	11700	22000	30000	112000
13	0	0	0	0	30	100	400	500	600	500	1500	15000
TOTAL	1960	4975	19575	51825	73080	196830	281850	403510	555980	569550	562100	688210

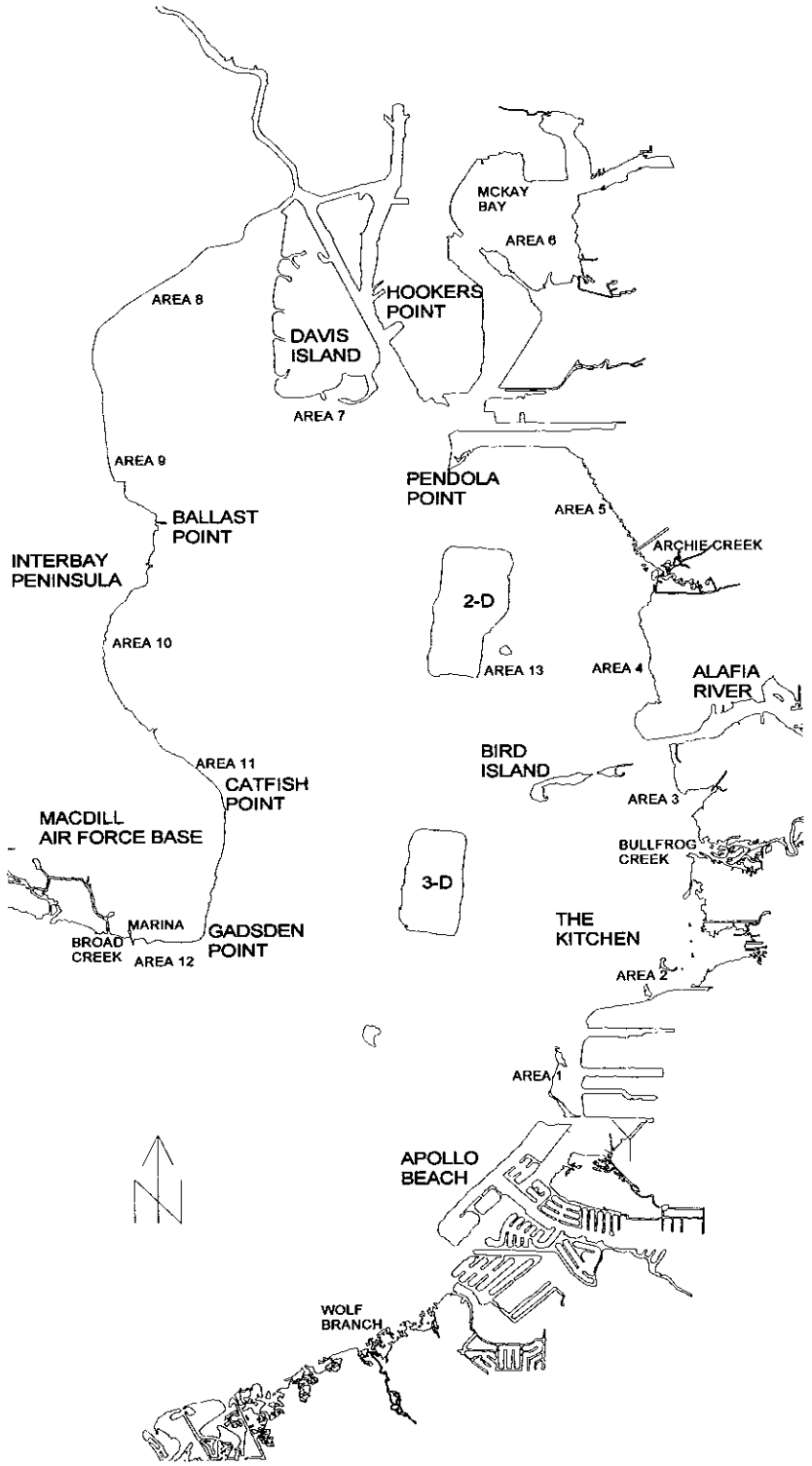


Figure 1. Location of the thirteen seagrass study areas in Hillsborough Bay.

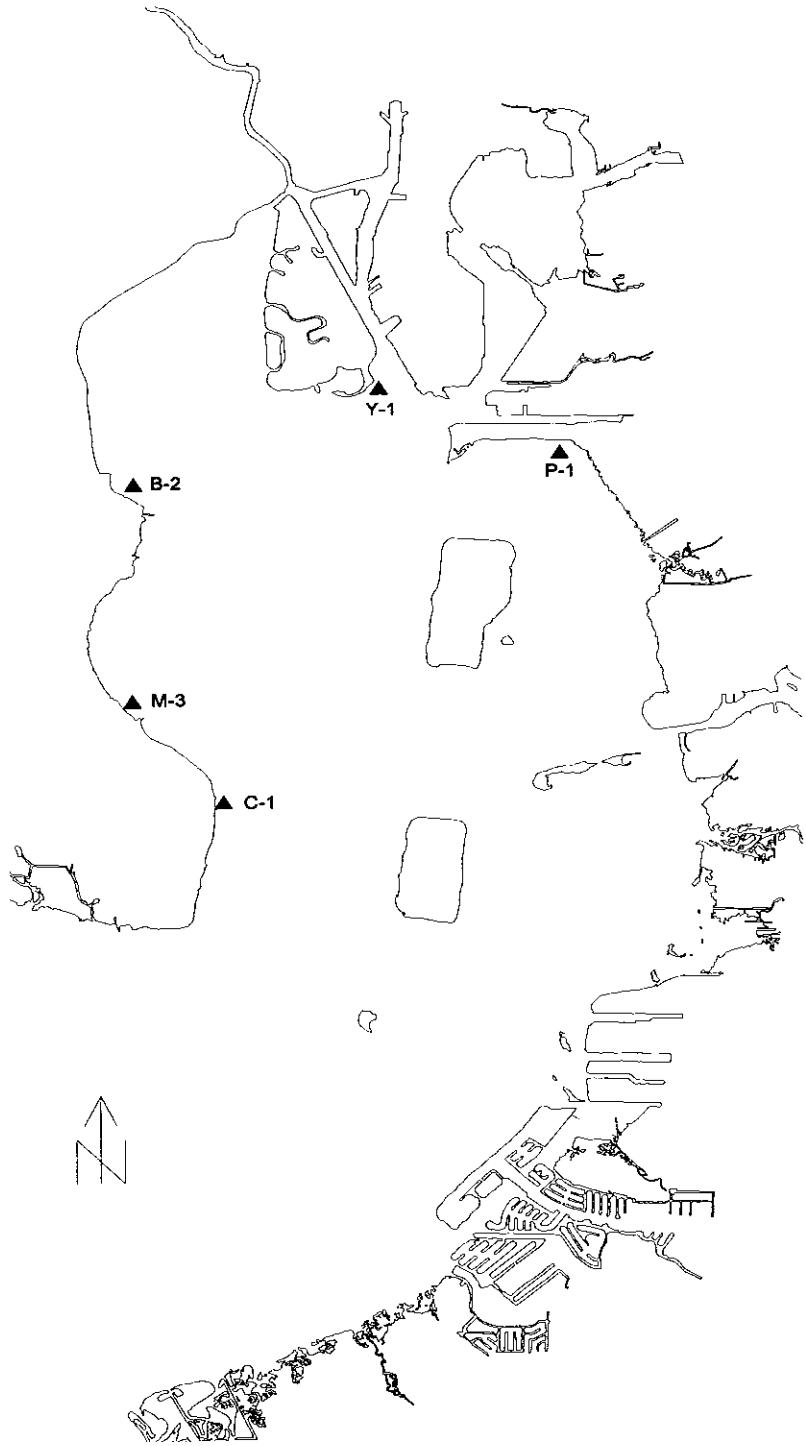


Figure 2. Location of the five *Caulerpa prolifera* transects in Hillsborough Bay.

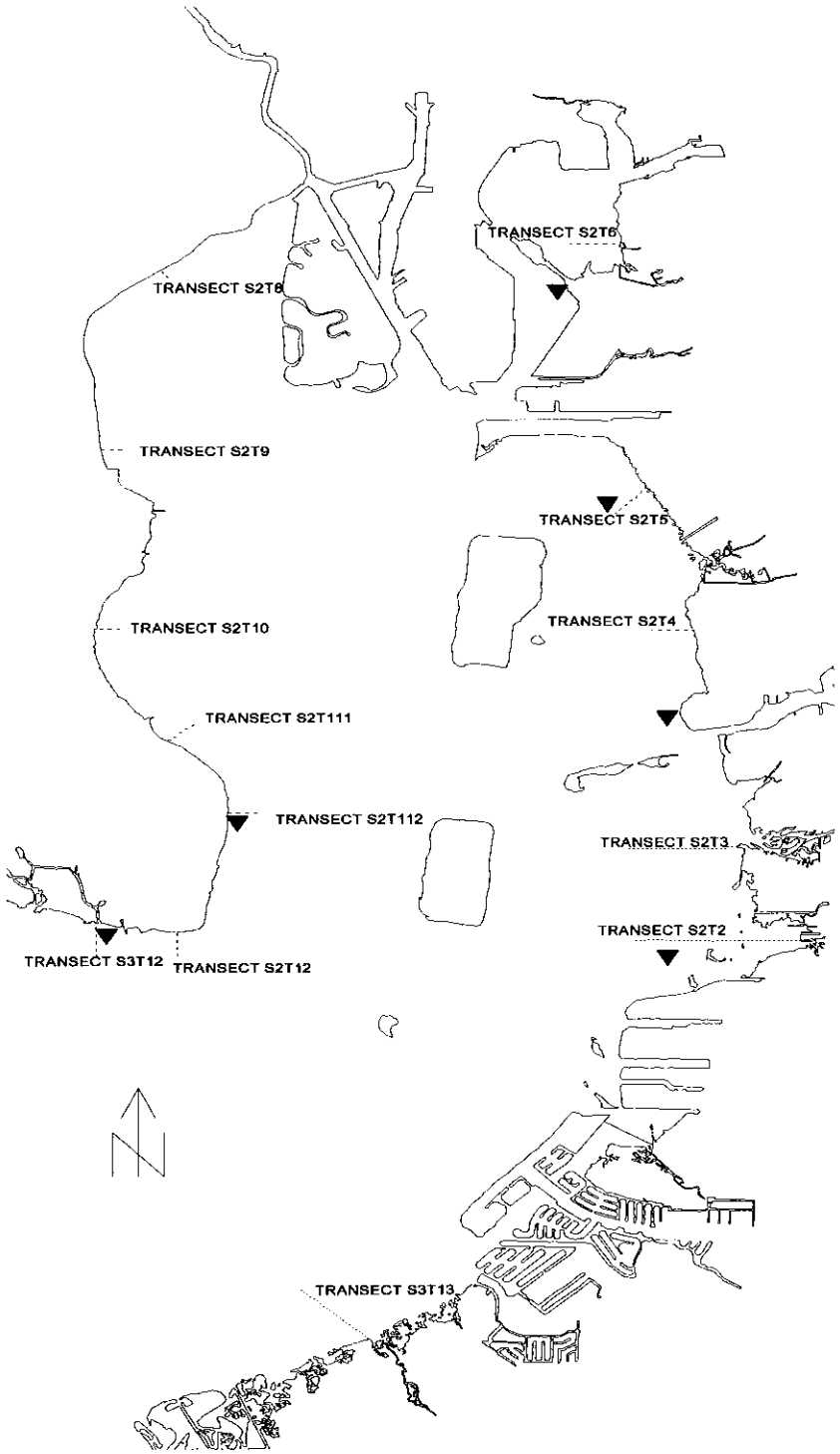


Figure 3. Location of the thirteen Bay Study Group seagrass transects and the SWIM study sites (▼) in Hillsborough Bay.

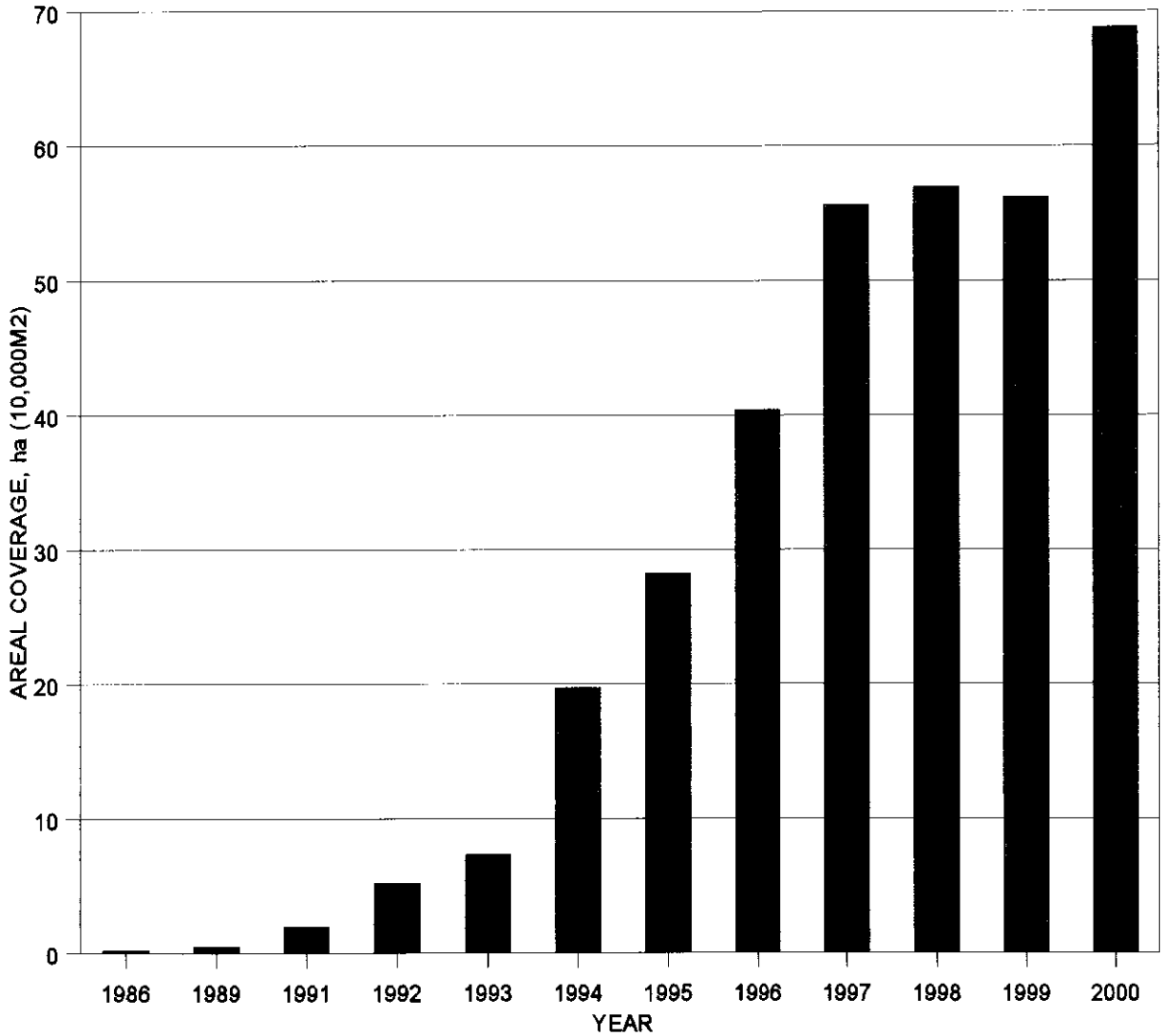


Figure 4. Total *Halodule wrightii* coverage in Hillsborough Bay from 1986-2000.

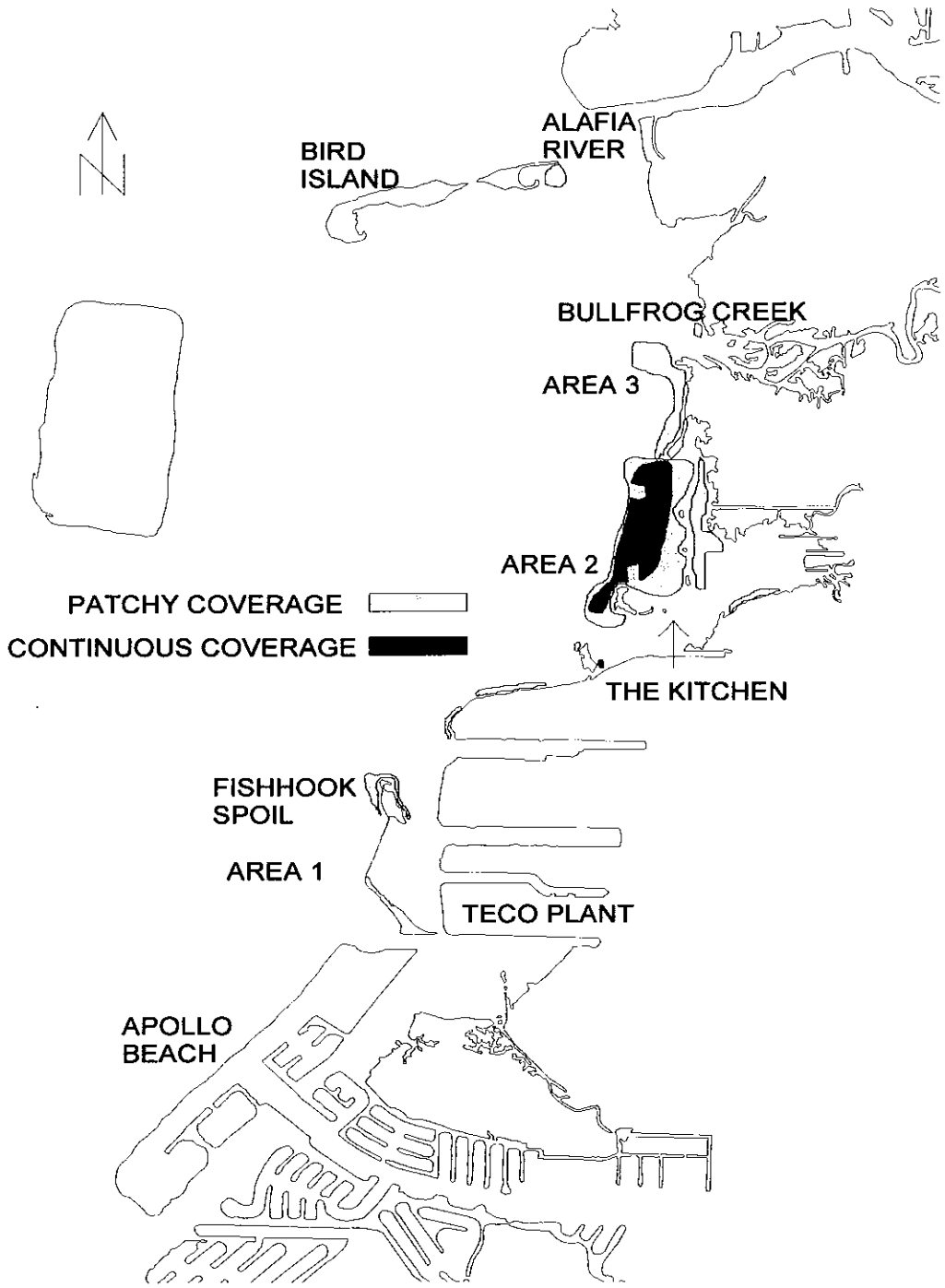


Figure 5. Distribution of *Halodule wrightii* in southeastern Hillsborough Bay (Areas 1, 2, and 3) in 2000.

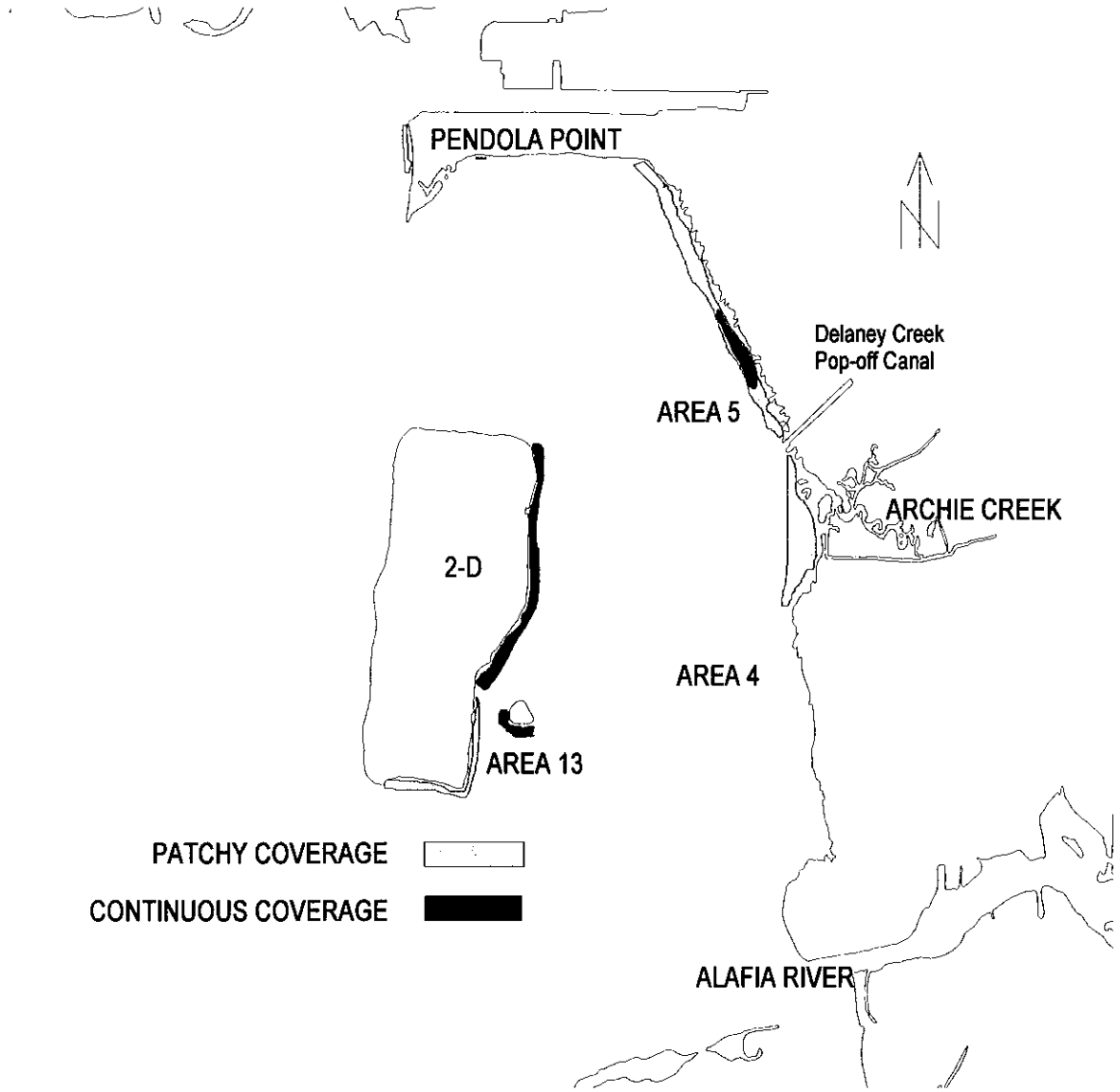


Figure 6. Distribution of *Halodule wrightii* in northeastern Hillsborough Bay (Areas 4, 5, and 13) in 2000.

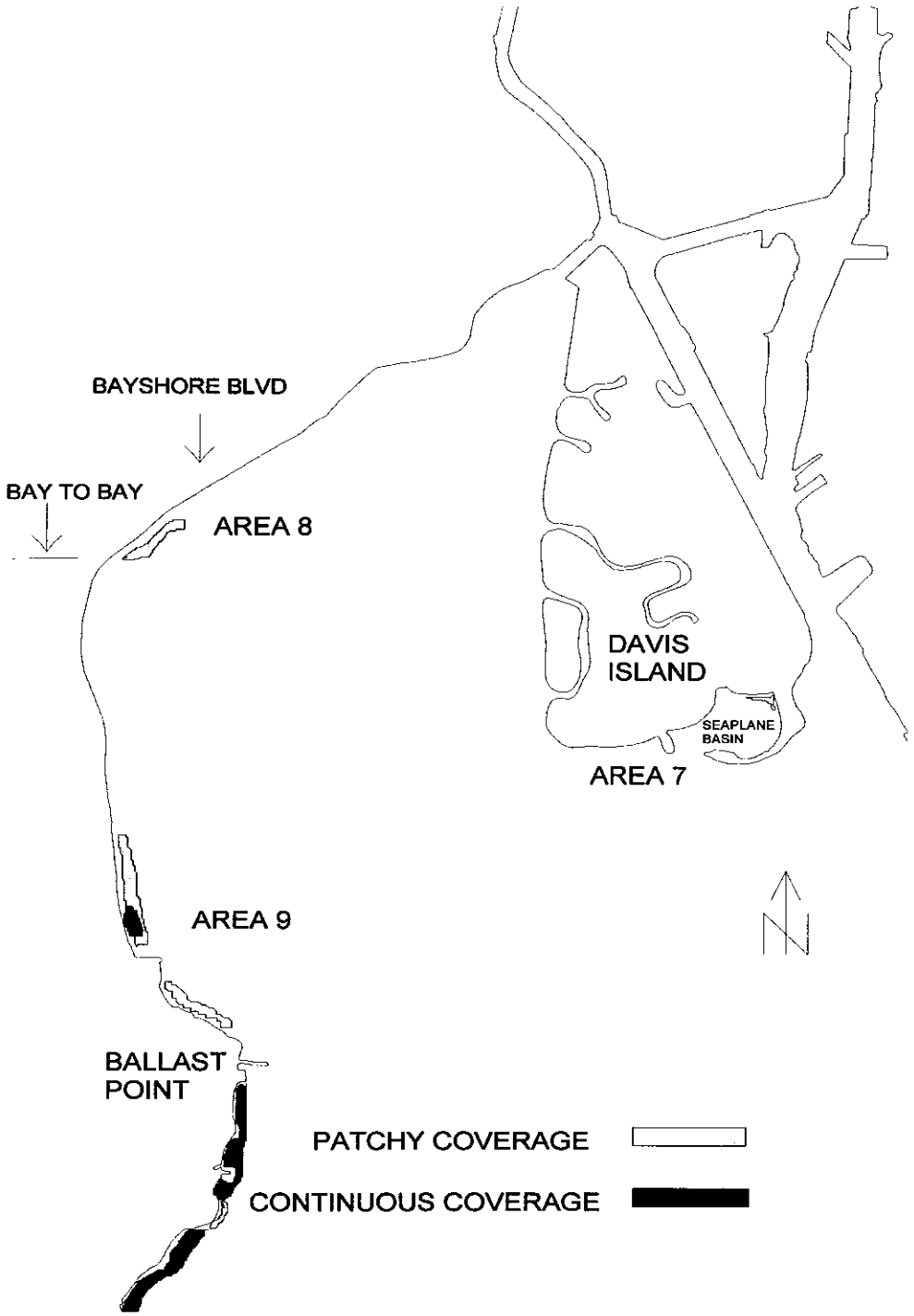


Figure 7. Distribution of *Halodule wrightii* in northwestern Hillsborough Bay (Areas 7, 8, and 9) in 2000.

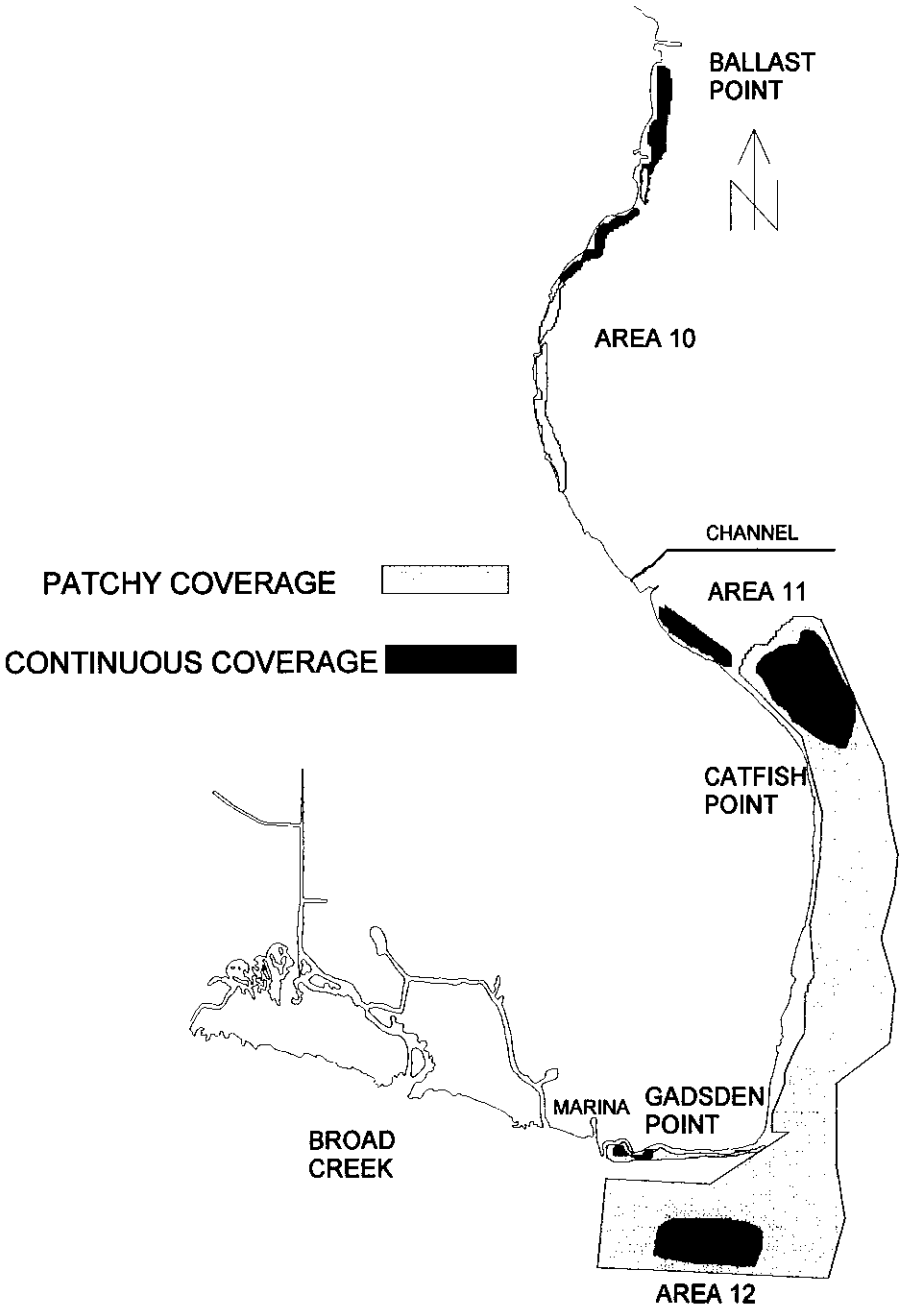


Figure 8. Distribution of *Halodule wrightii* in southwestern Hillsborough Bay (Areas 10, 11, and 12) in 2000.

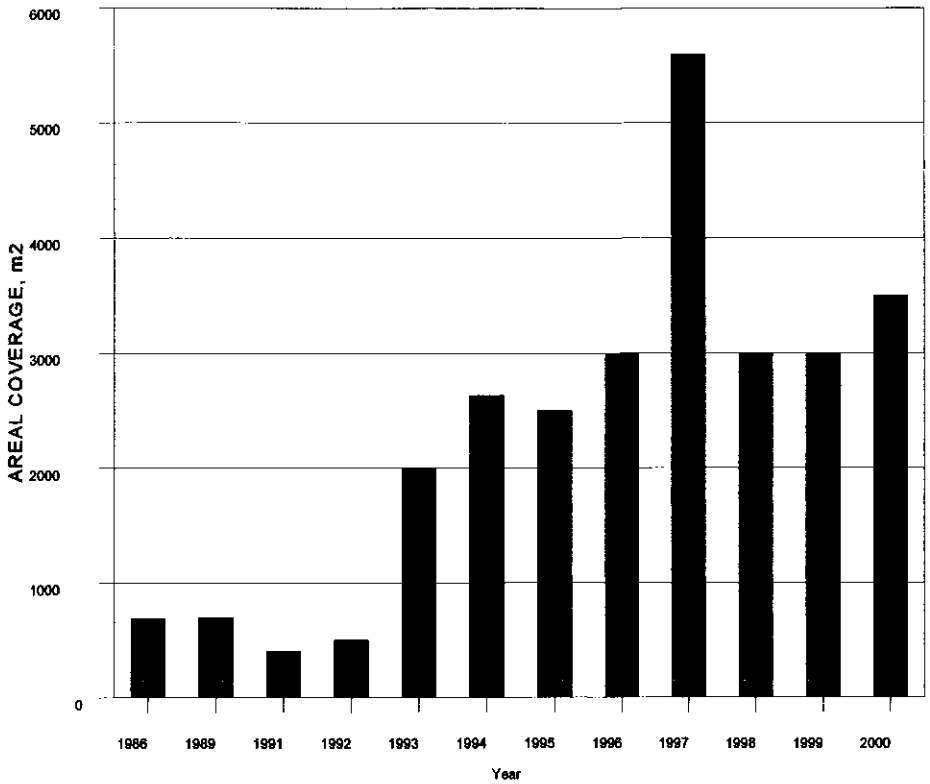


Figure 9. *Halodule wrightii* coverage in Area 1 from 1986-2000.

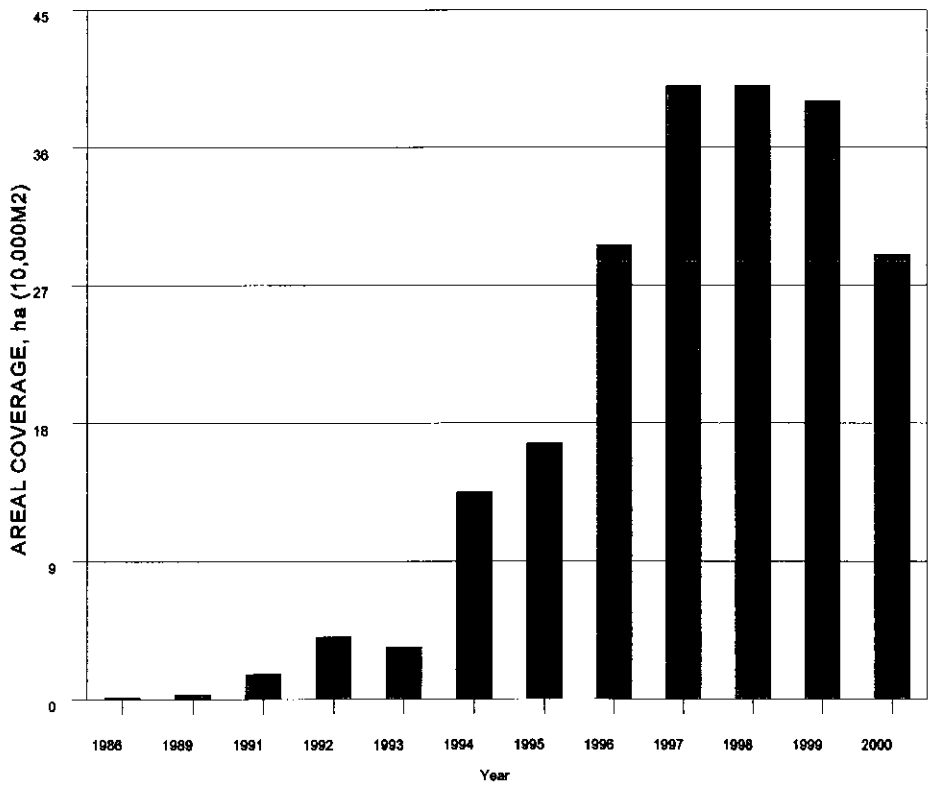


Figure 10. *Halodule wrightii* coverage in Area 2 from 1986-2000.

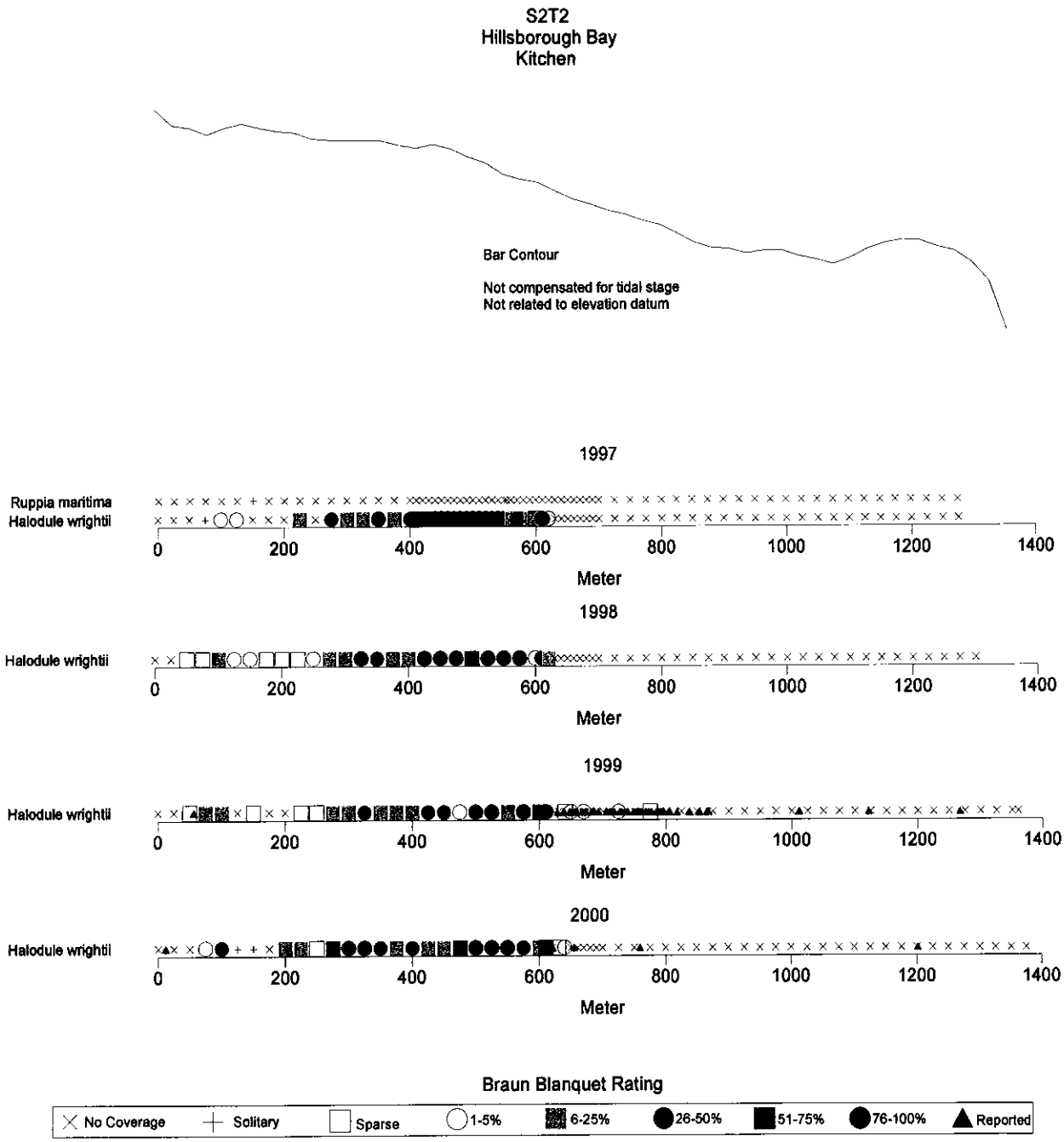


Figure 11. Distribution and abundance of *Ruppia maritima* and *Halodule wrightii* along Transect S2T2 from 1997-2000.

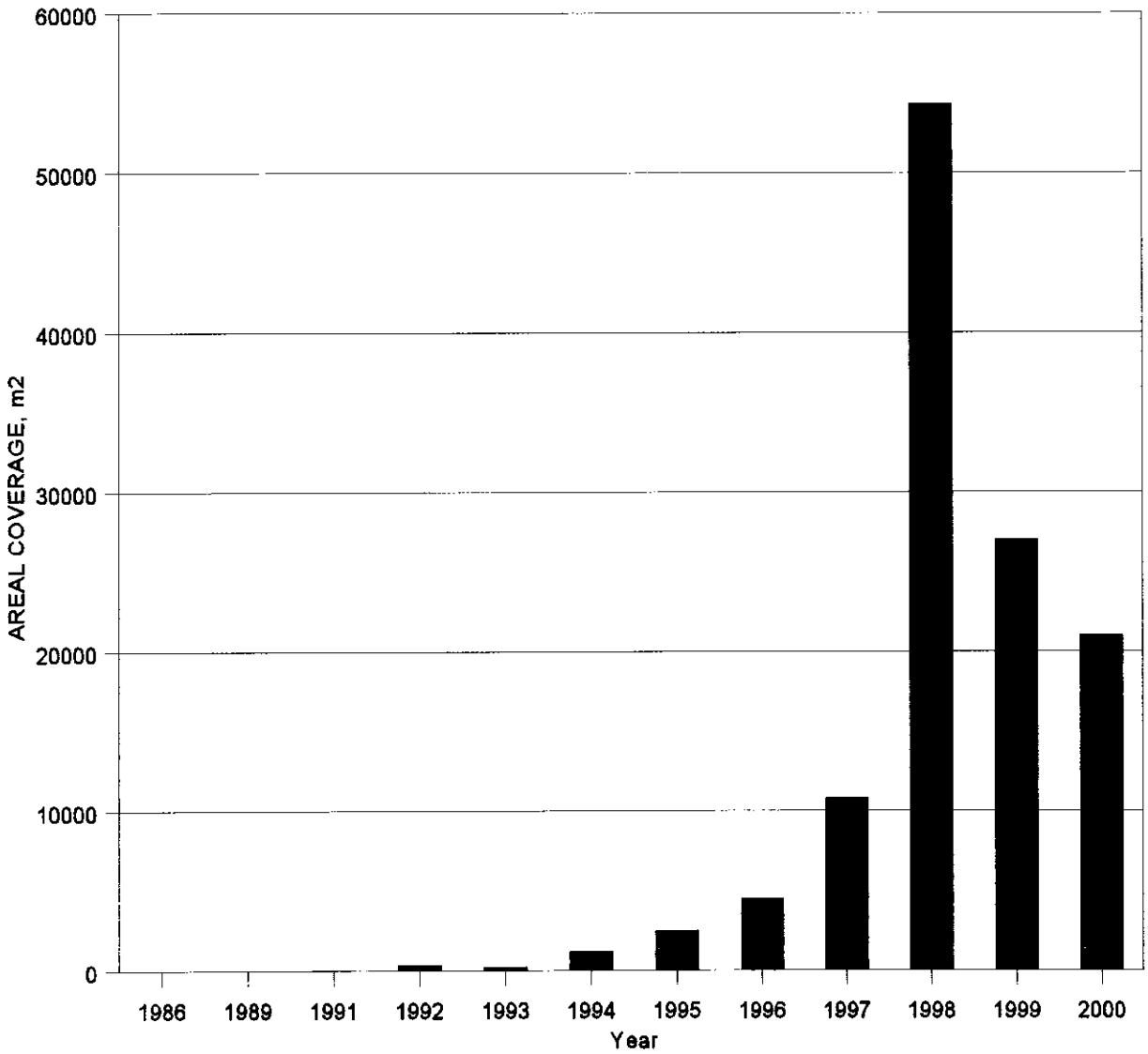


Figure 12. *Halodule wrigjhtii* coverage in Area 3 from 1986-2000.

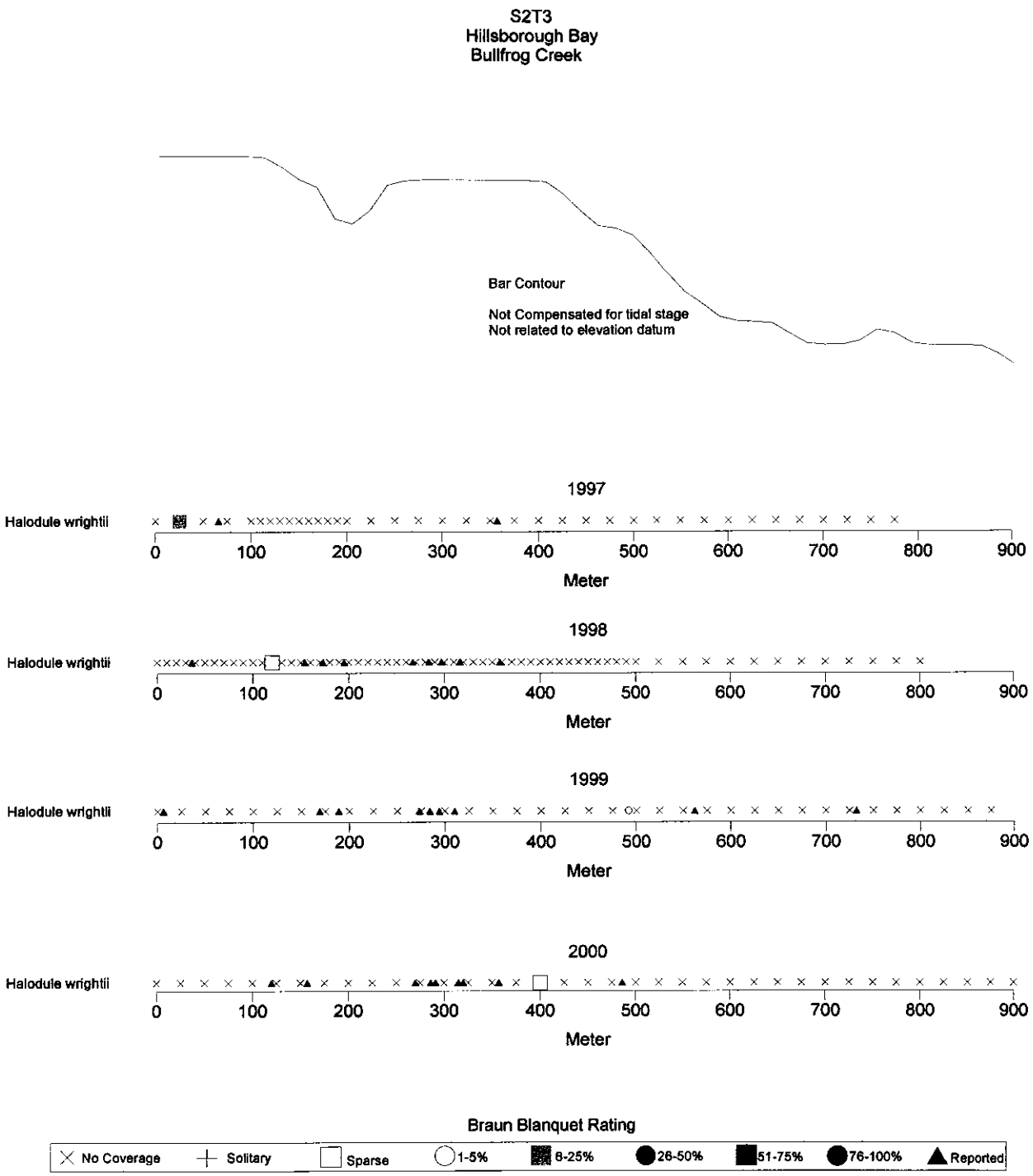


Figure 13. Distribution and abundance of *Halodule wrightii* along Transect S2T3 from 1997-2000.

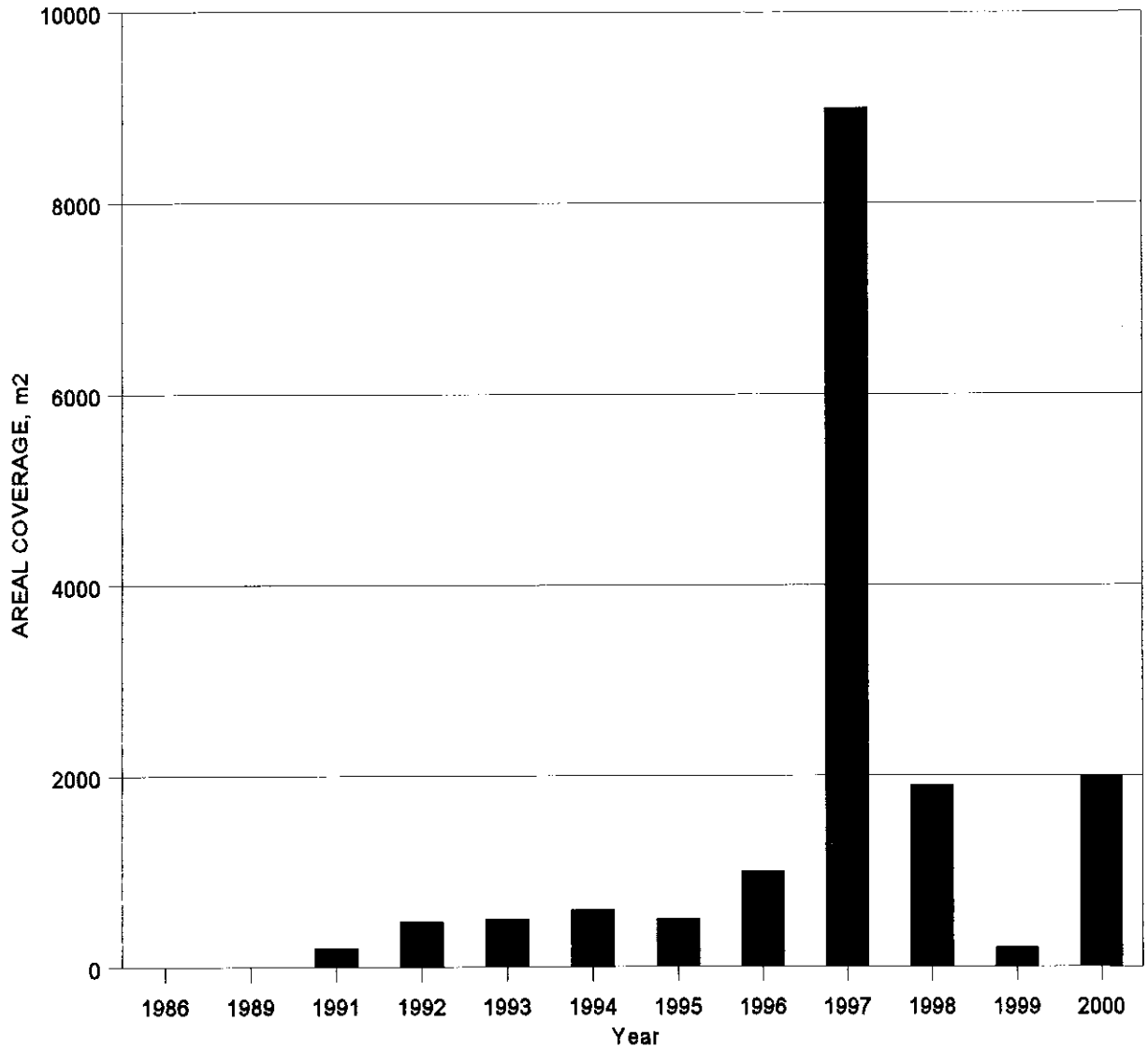
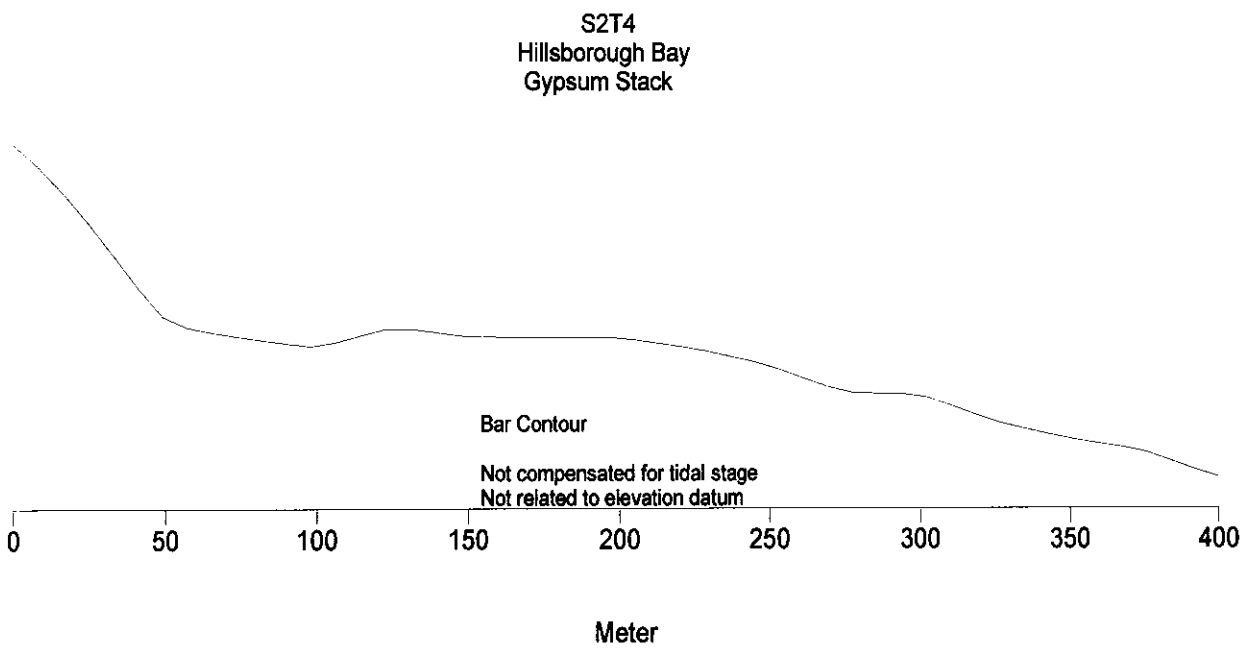


Figure 14. *Halodule wrightii* coverage in Area 4 from 1986-2000.



No SAV reported in 1997, 1998, 1999, or 2000.

Figure 15. Distribution and abundance of submerged aquatic vegetation along Transect S2T4 from 1997-2000.

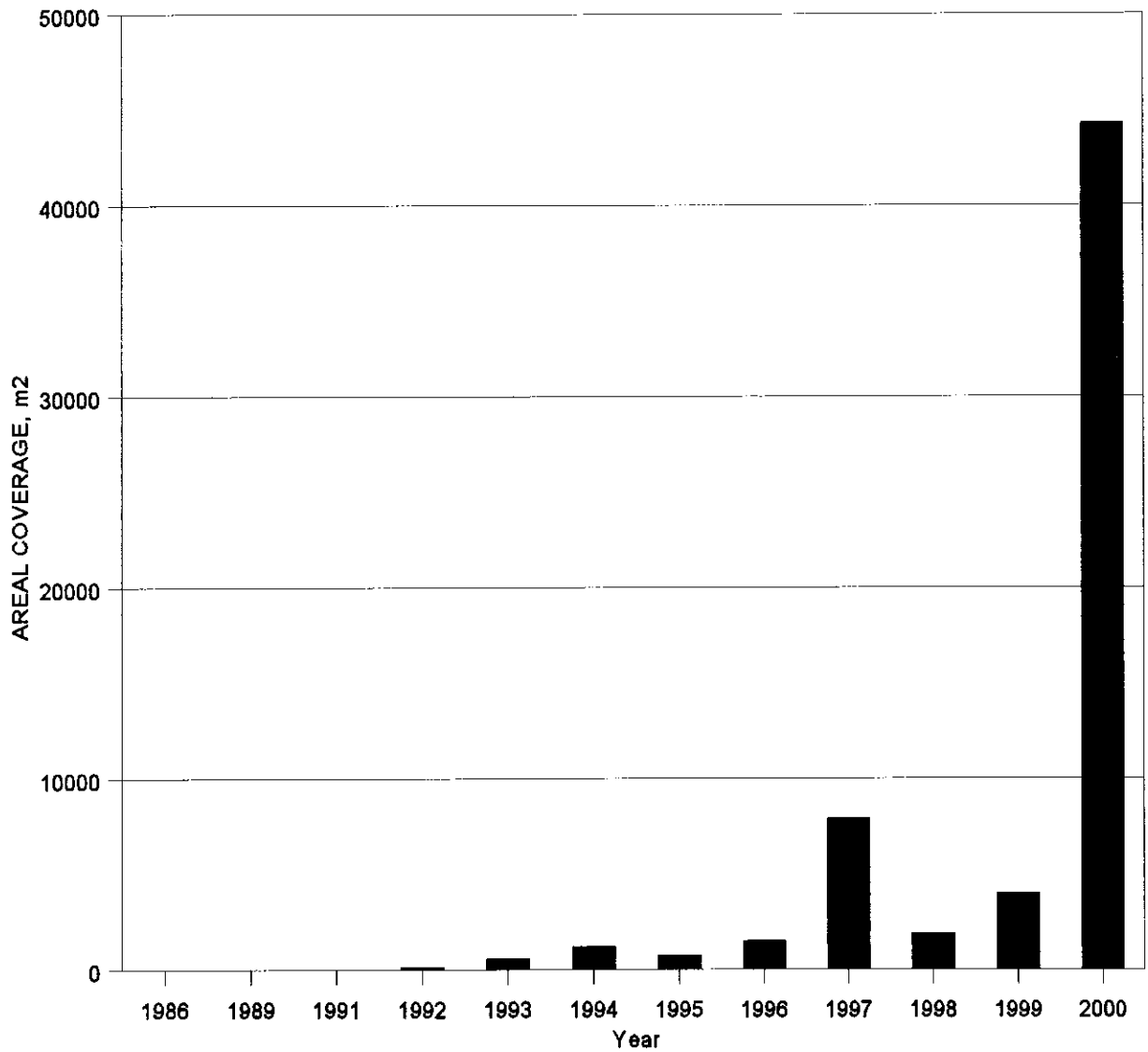


Figure 16. *Halodule wrightii* coverage in Area 5 from 1986-2000.

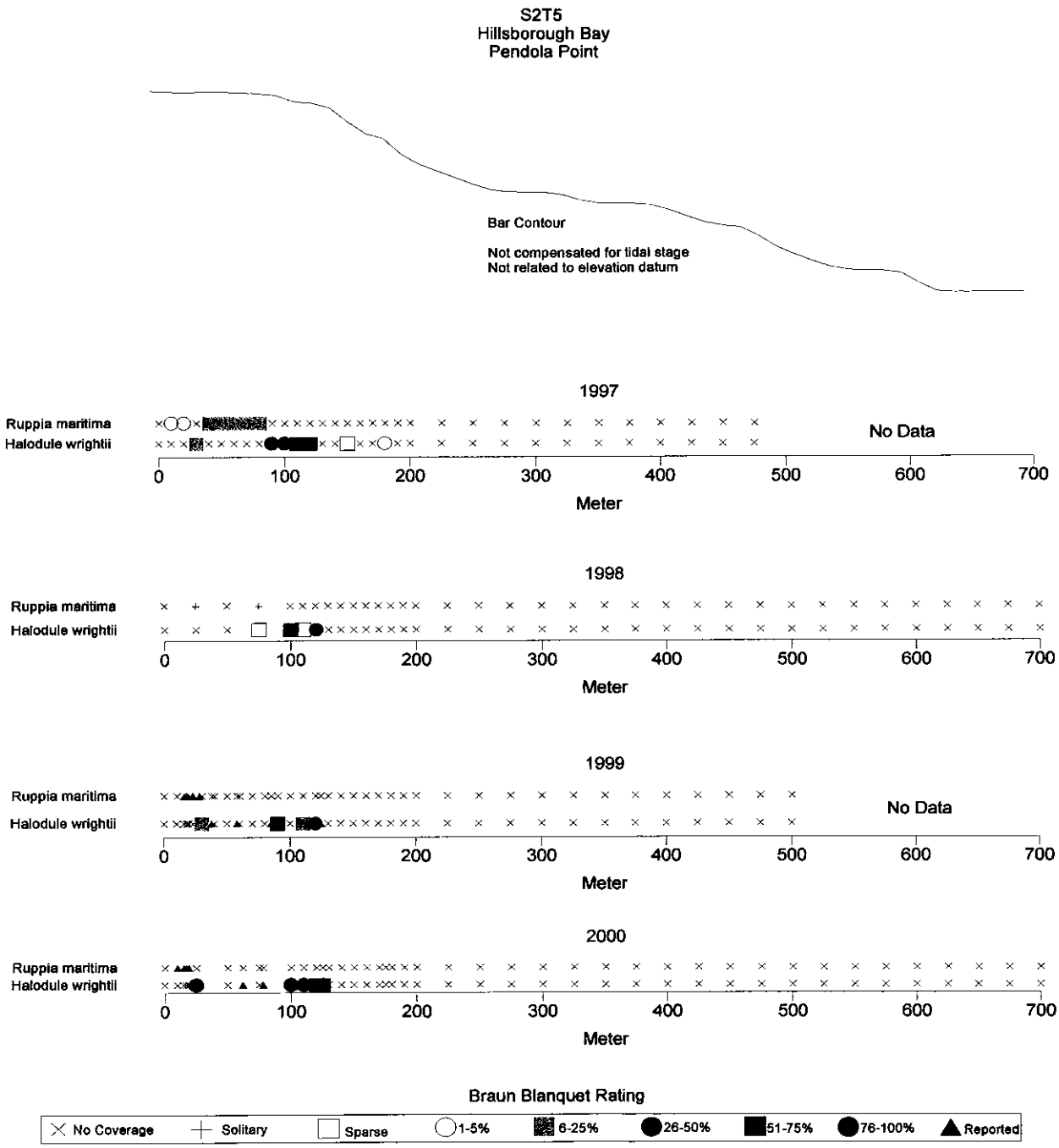


Figure 17. Distribution and abundance of *Ruppia maritima* and *Halodule wrightii* along Transect S2T5 from 1997-2000.

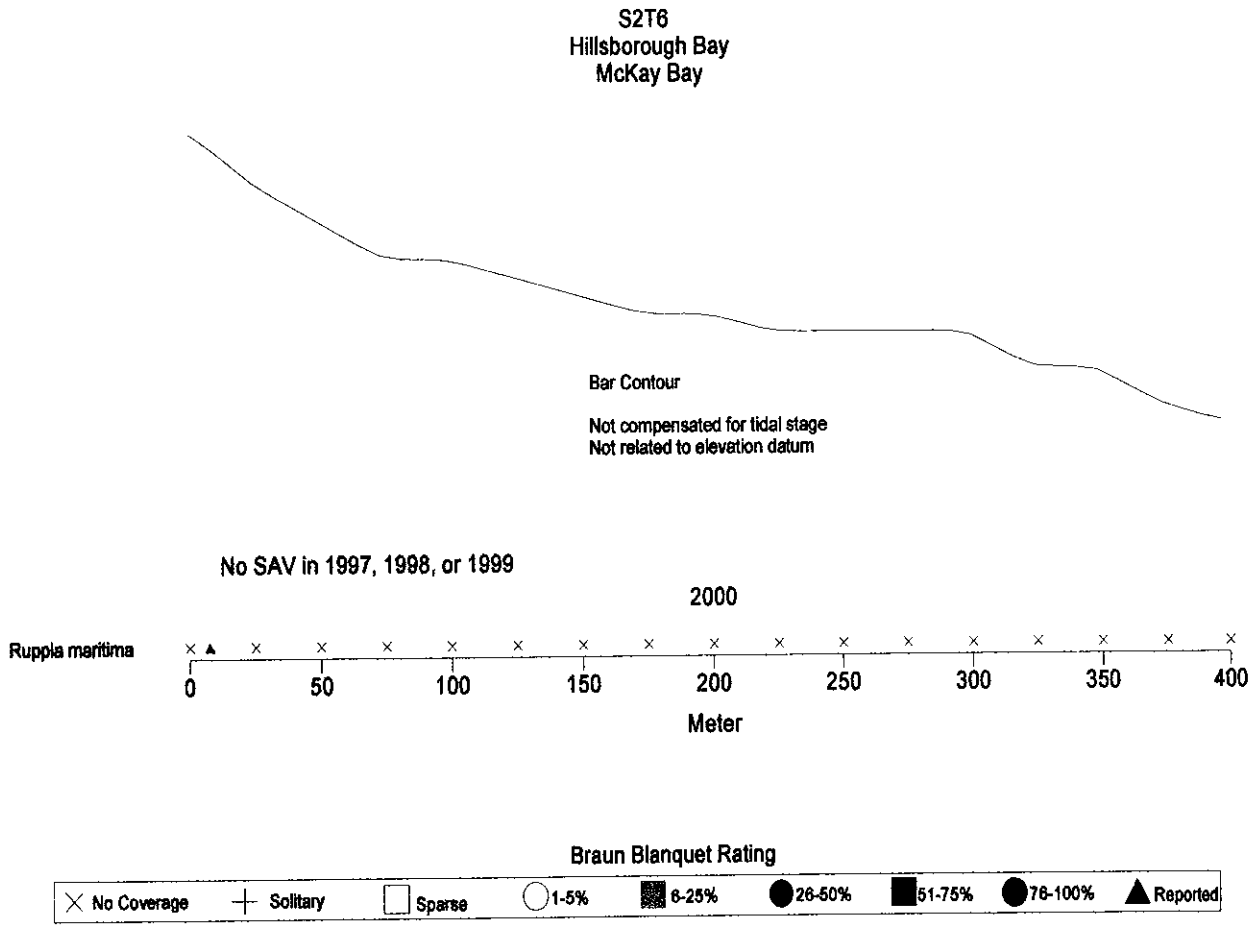


Figure 18. Distribution and abundance of *Ruppia maritima* along Transect S2T6 from 1997-2000.

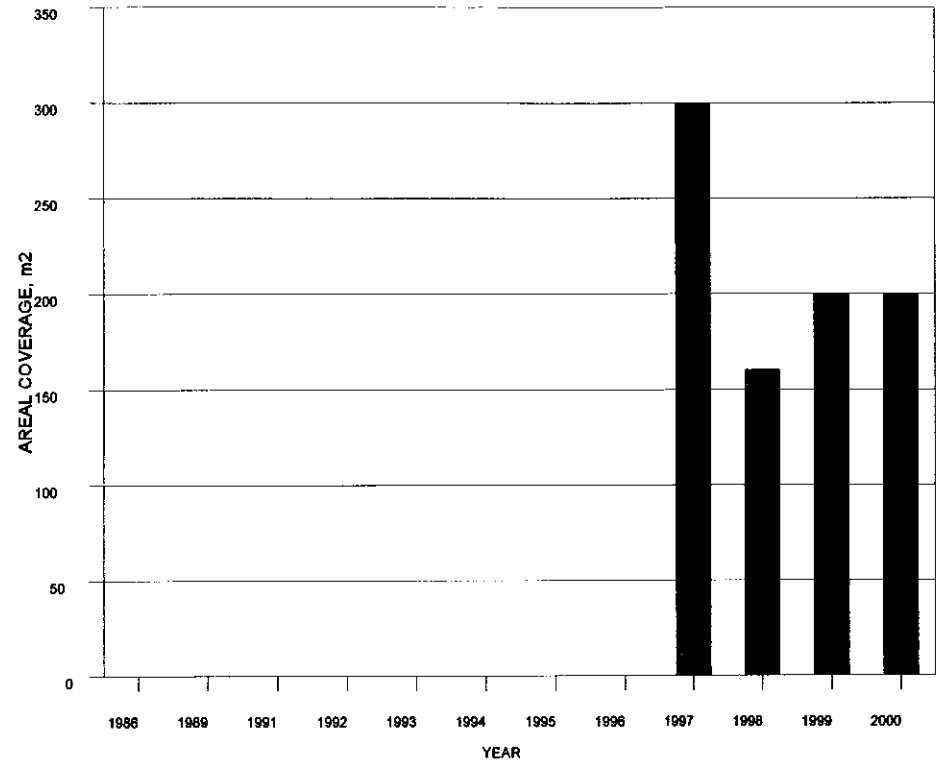


Figure 19. *Halodue wrightii* coverage in Area 7 from 1986-2000.

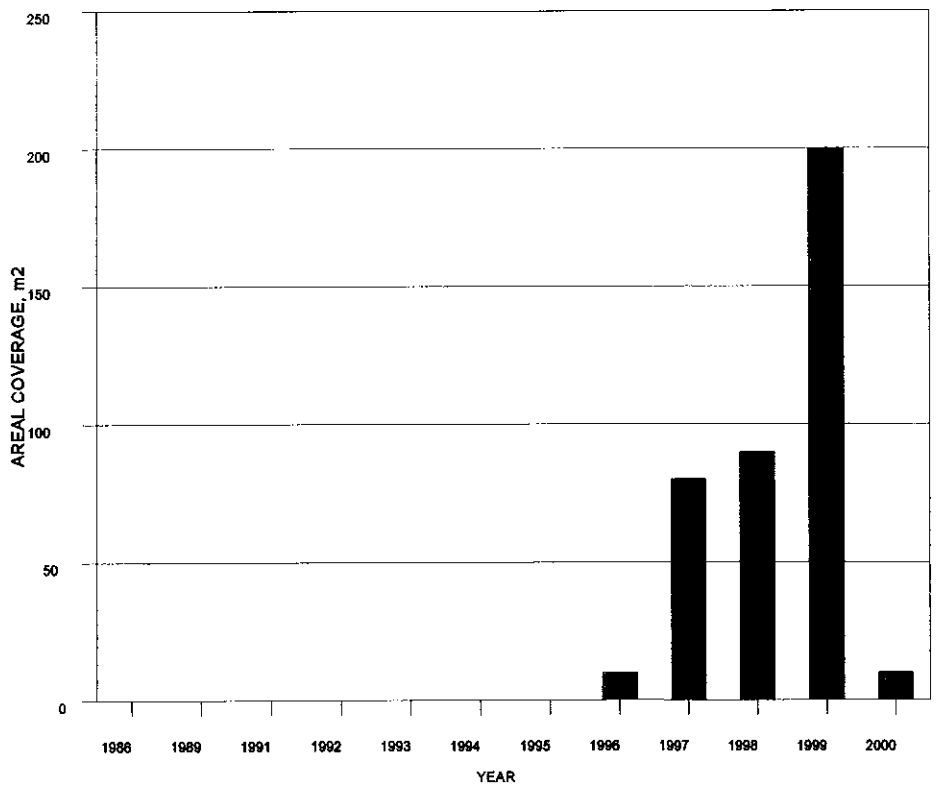


Figure 20. *Halodule wrightii* coverage in Area 8 from 1986-2000.

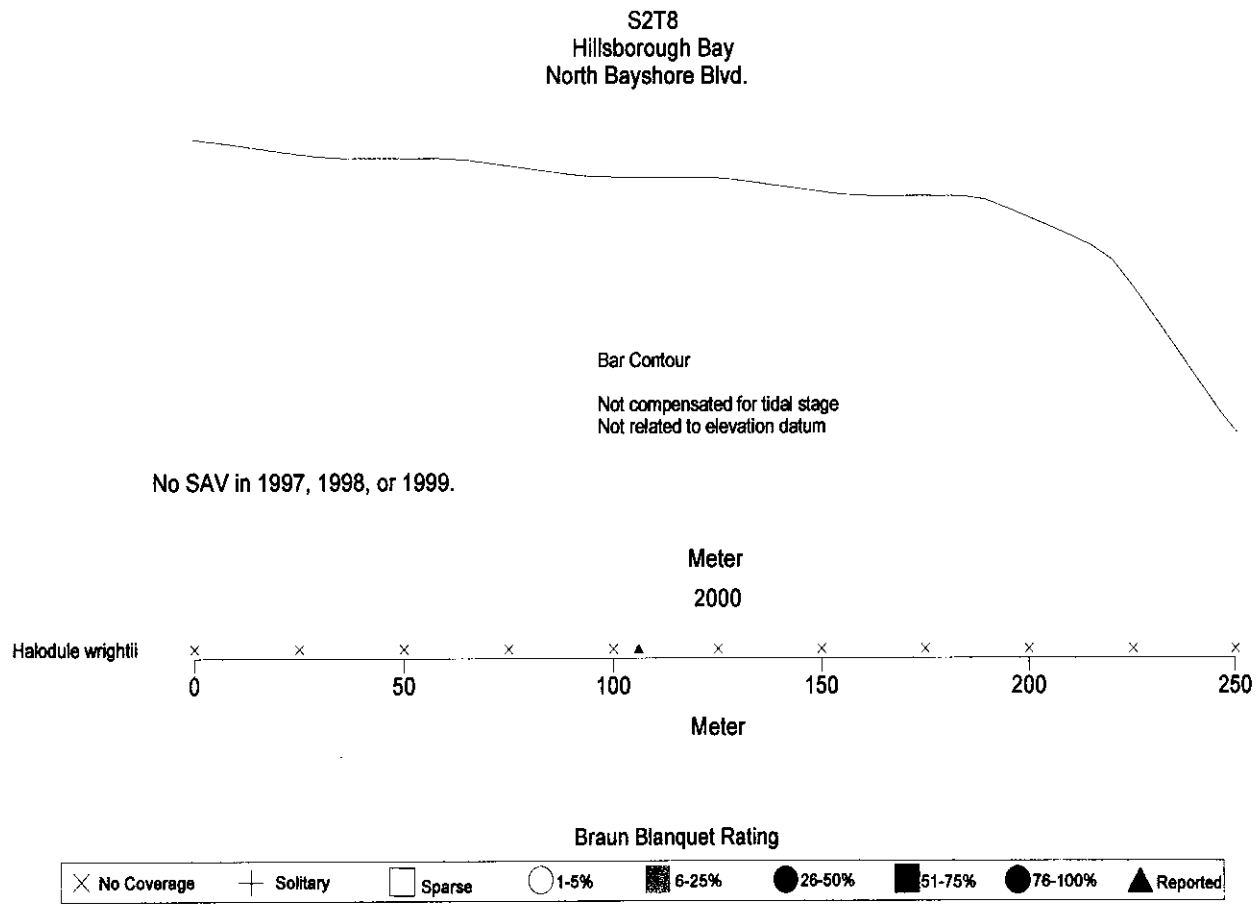


Figure 21. Distribution and abundance of *Halodule wrightii* along Transect S2T8 from 1997-2000.

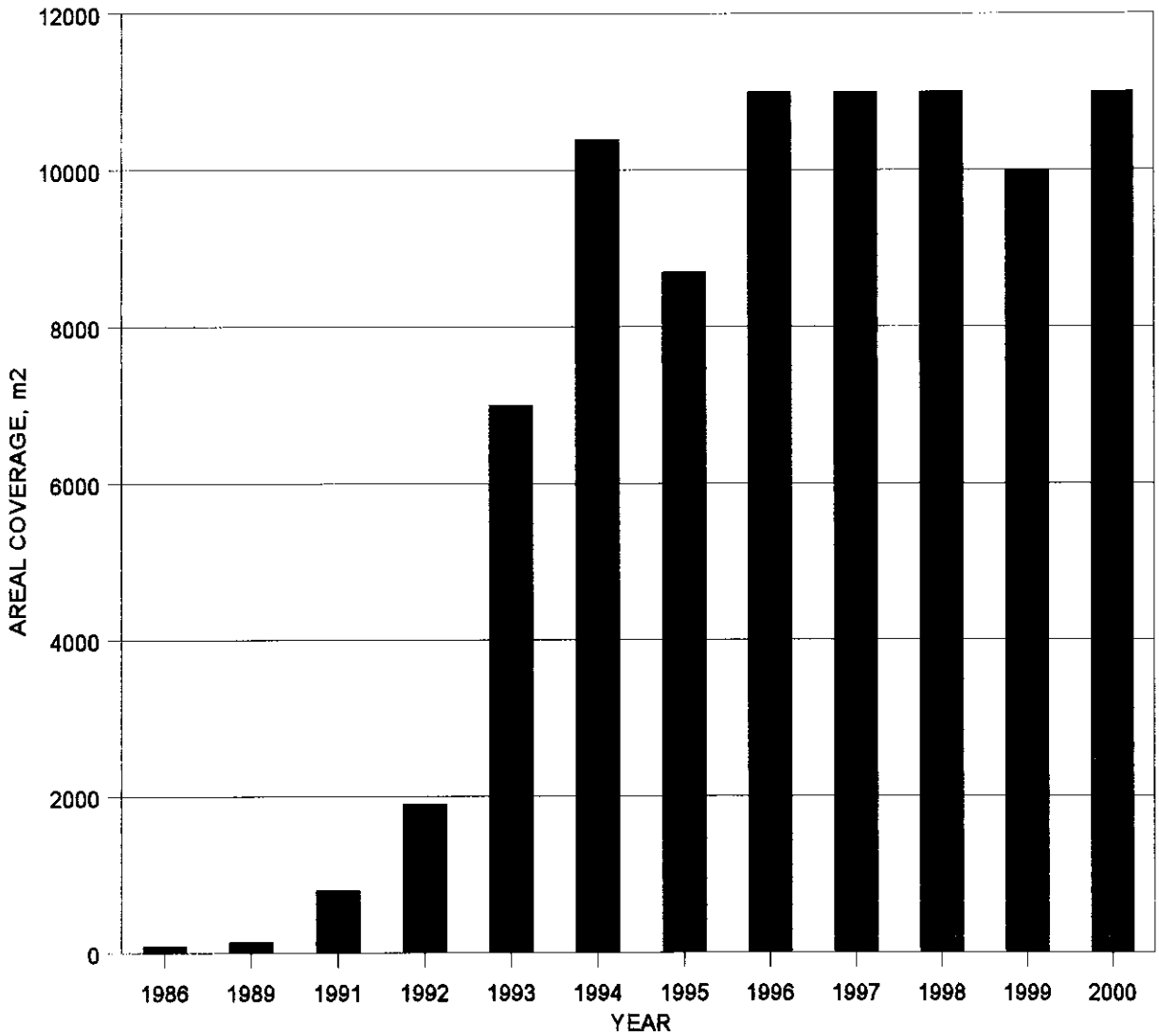


Figure 22. *Halodule wrightii* coverage in Area 9 from 1986-2000.

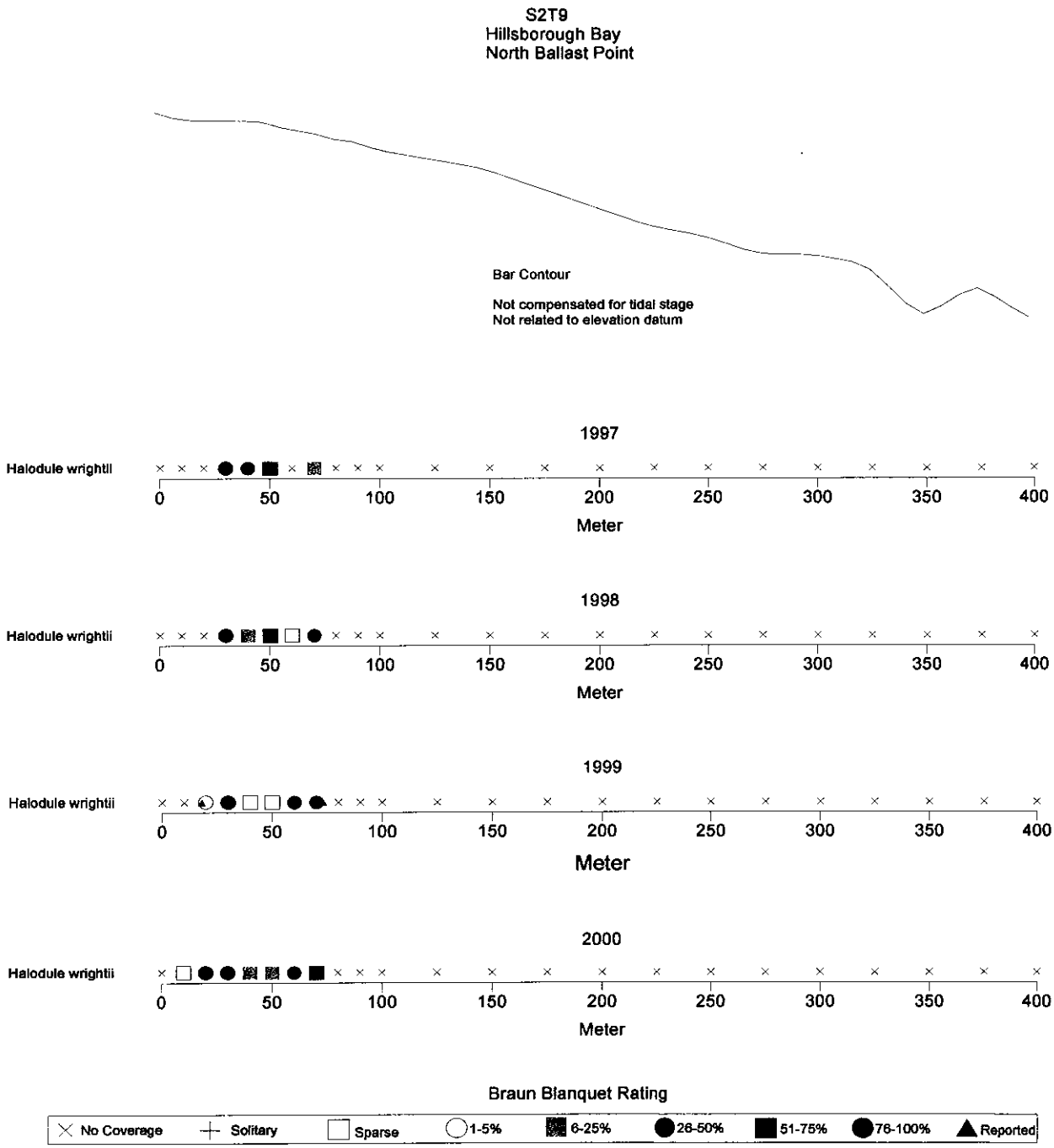


Figure 23. Distribution and abundance of *Halodule wrightii* along Transect S2T9 from 1997-2000.

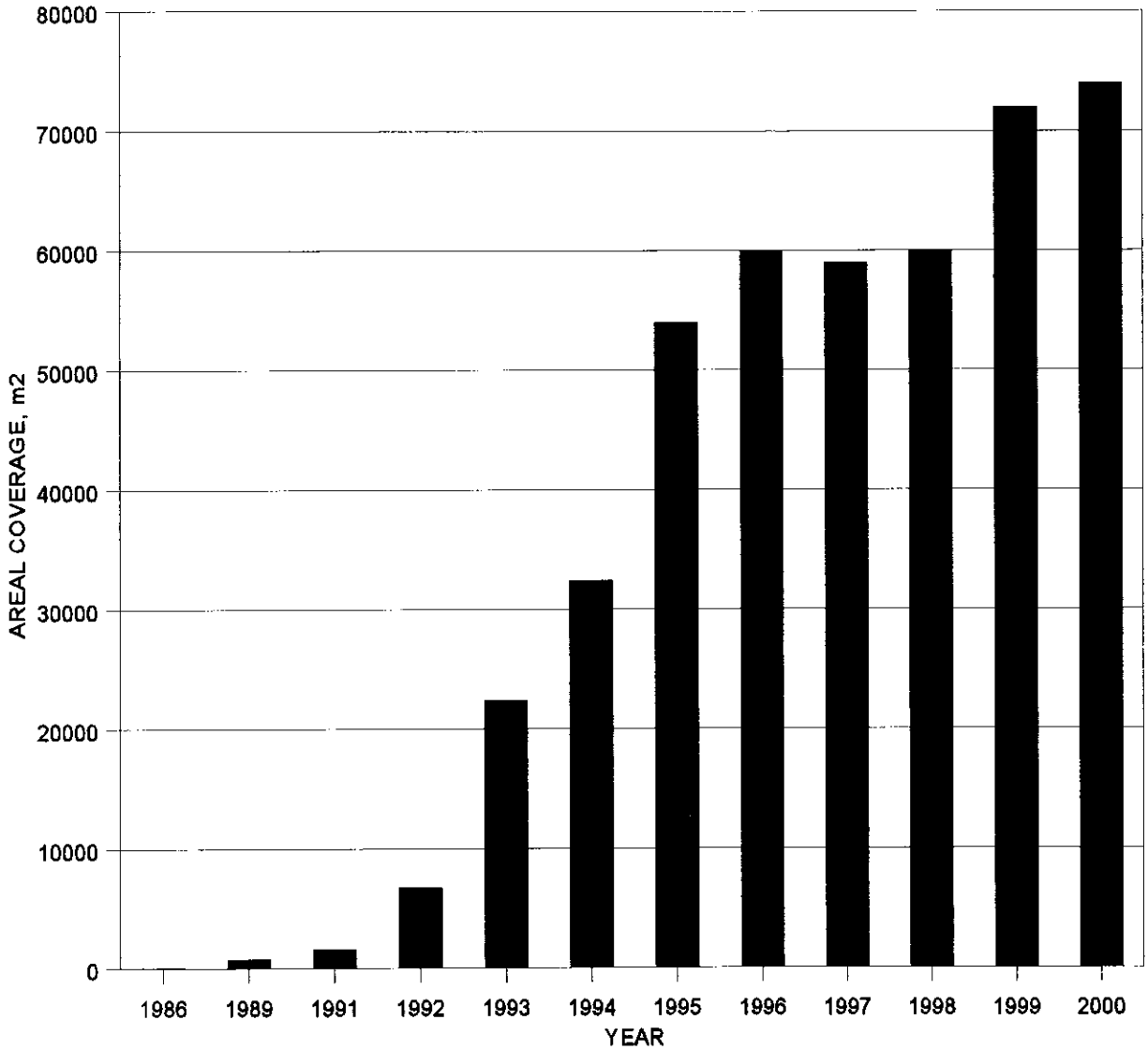


Figure 24. *Halodule wrightii* coverage in Area 10 from 1986-2000.

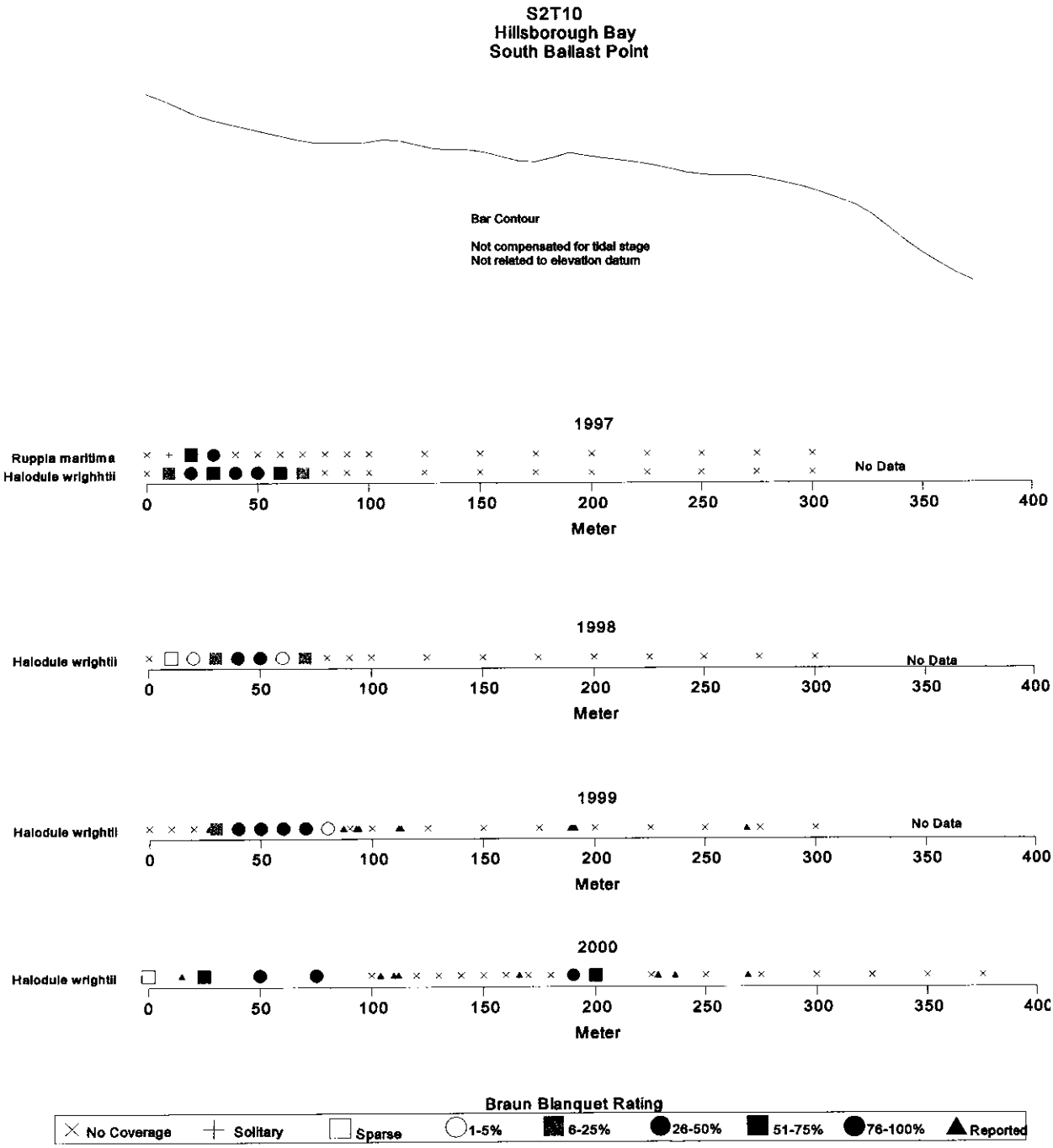


Figure 25. Distribution and abundance of *Ruppia maritima* and *Halodule wrightii* along Transect S2T10 from 1997-2000.

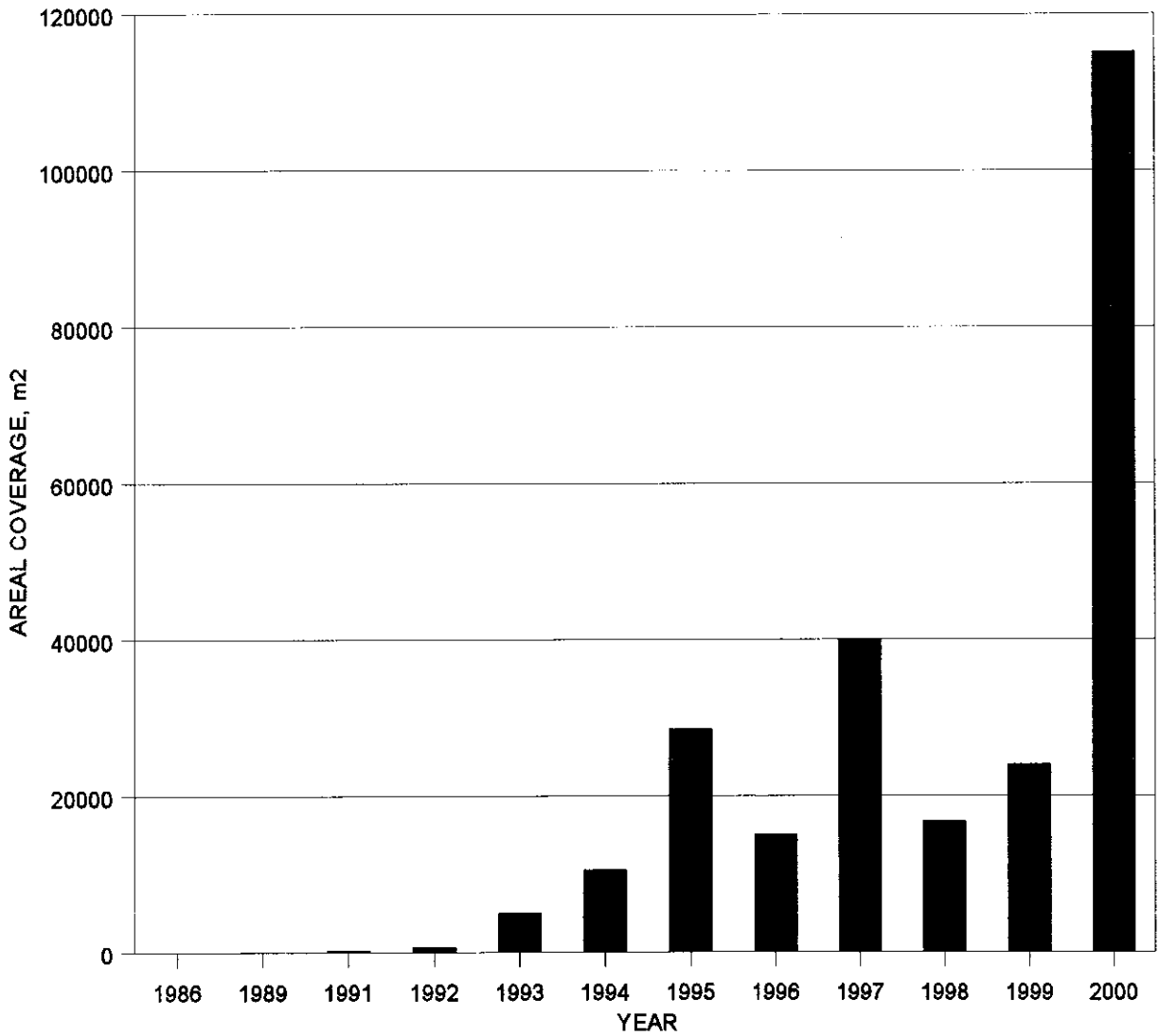


Figure 26. *Halodule wrightii* coverage in Area 11 from 1986-2000.

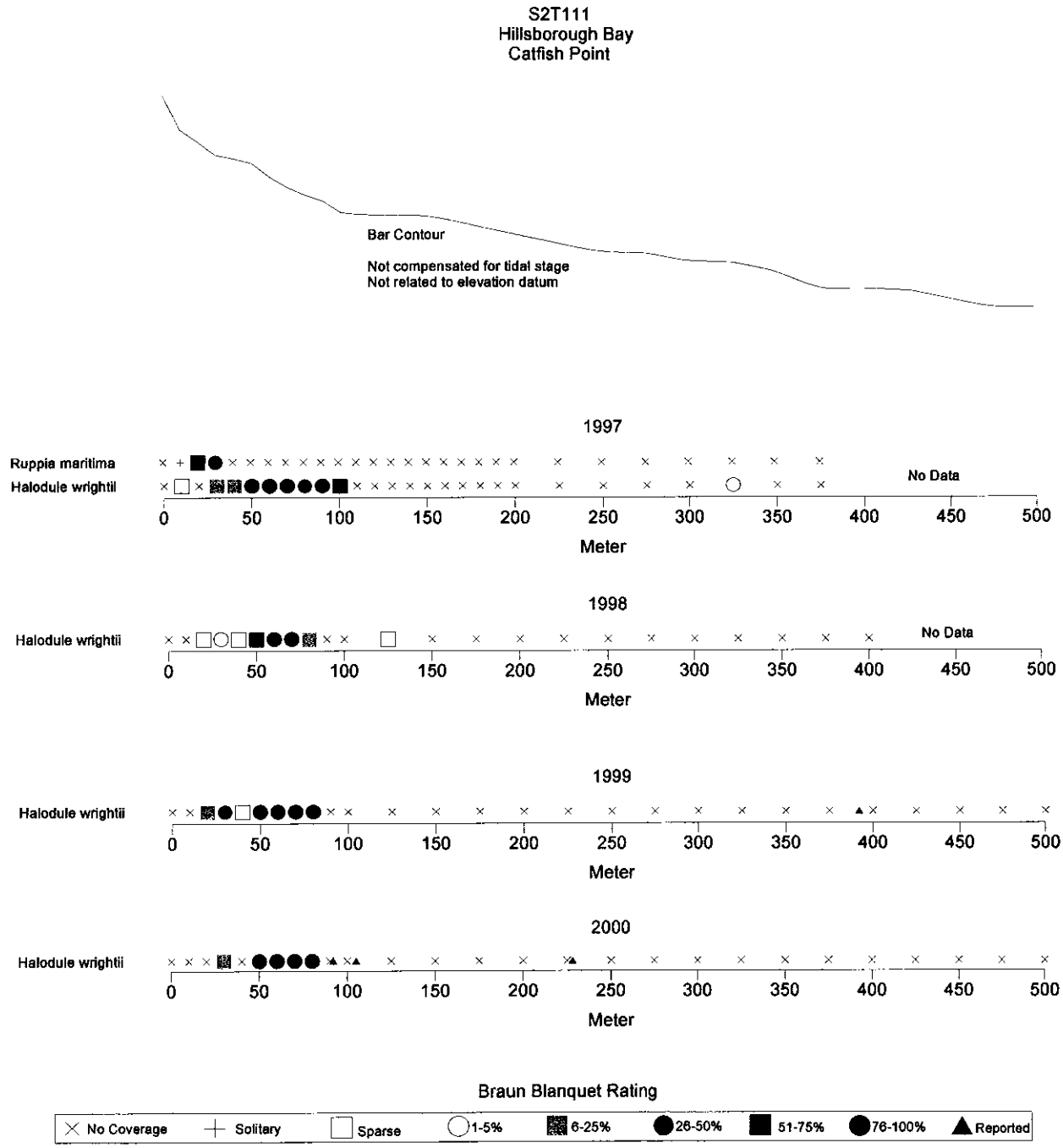


Figure 27. Distribution and abundance of *Ruppia maritima* and *Halodule wrightii* along Transect S2T111 from 1997-2000.

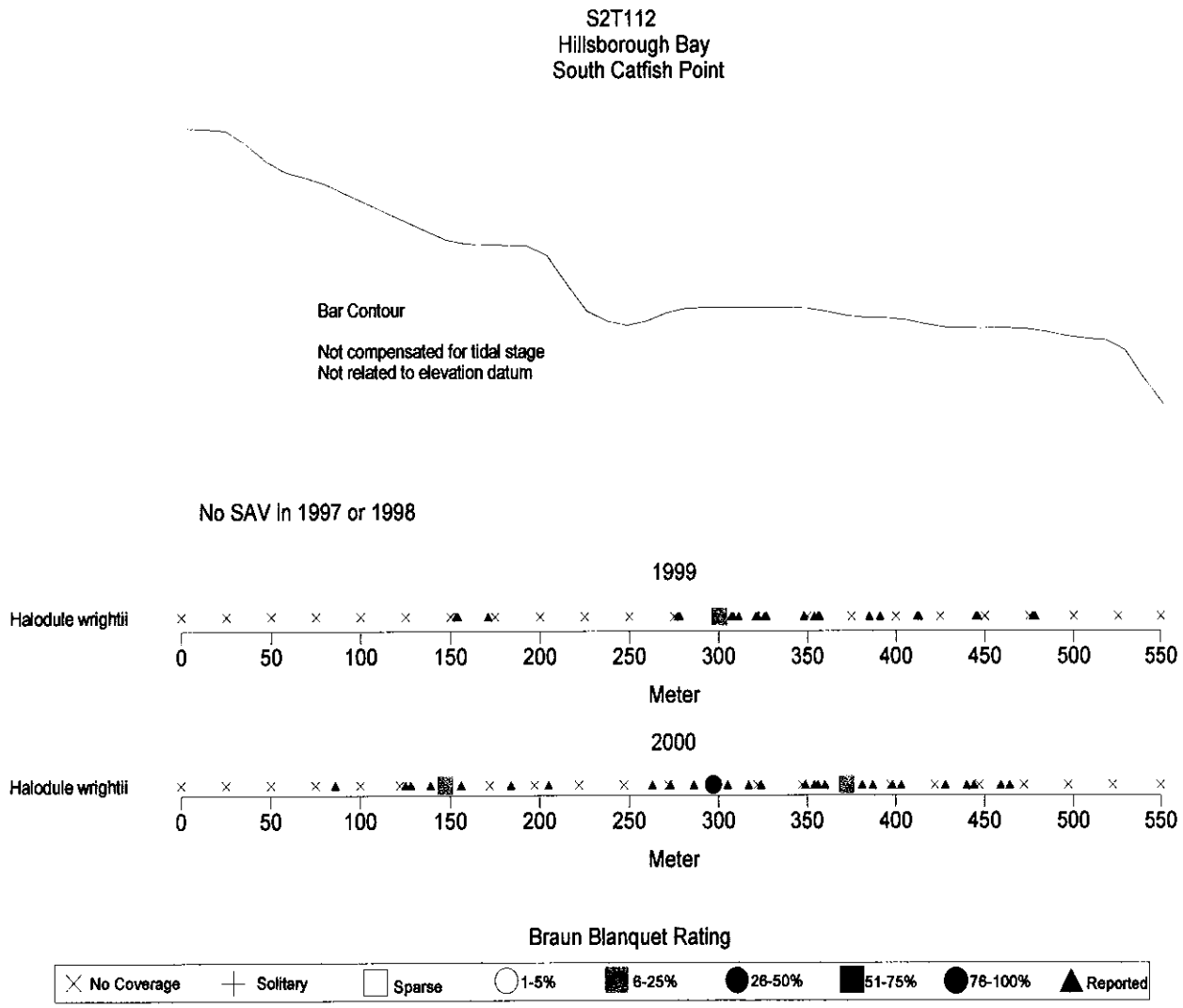


Figure 28. Distribution and abundance of *Halodule wrightii* along Transect S2T112 from 1997-2000.

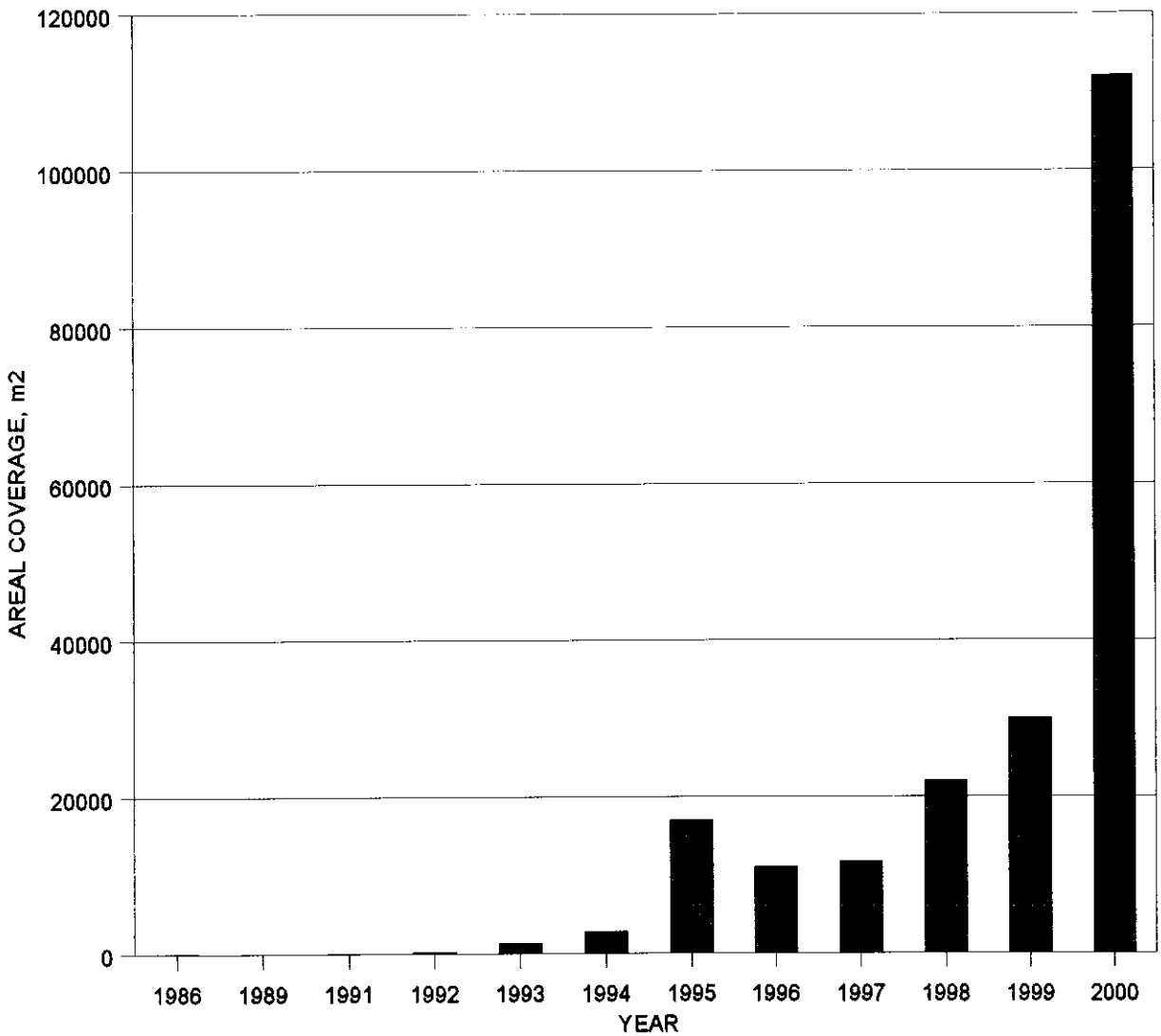


Figure 29. *Halodule wrightii* coverage in Area 12 from 1986-2000.

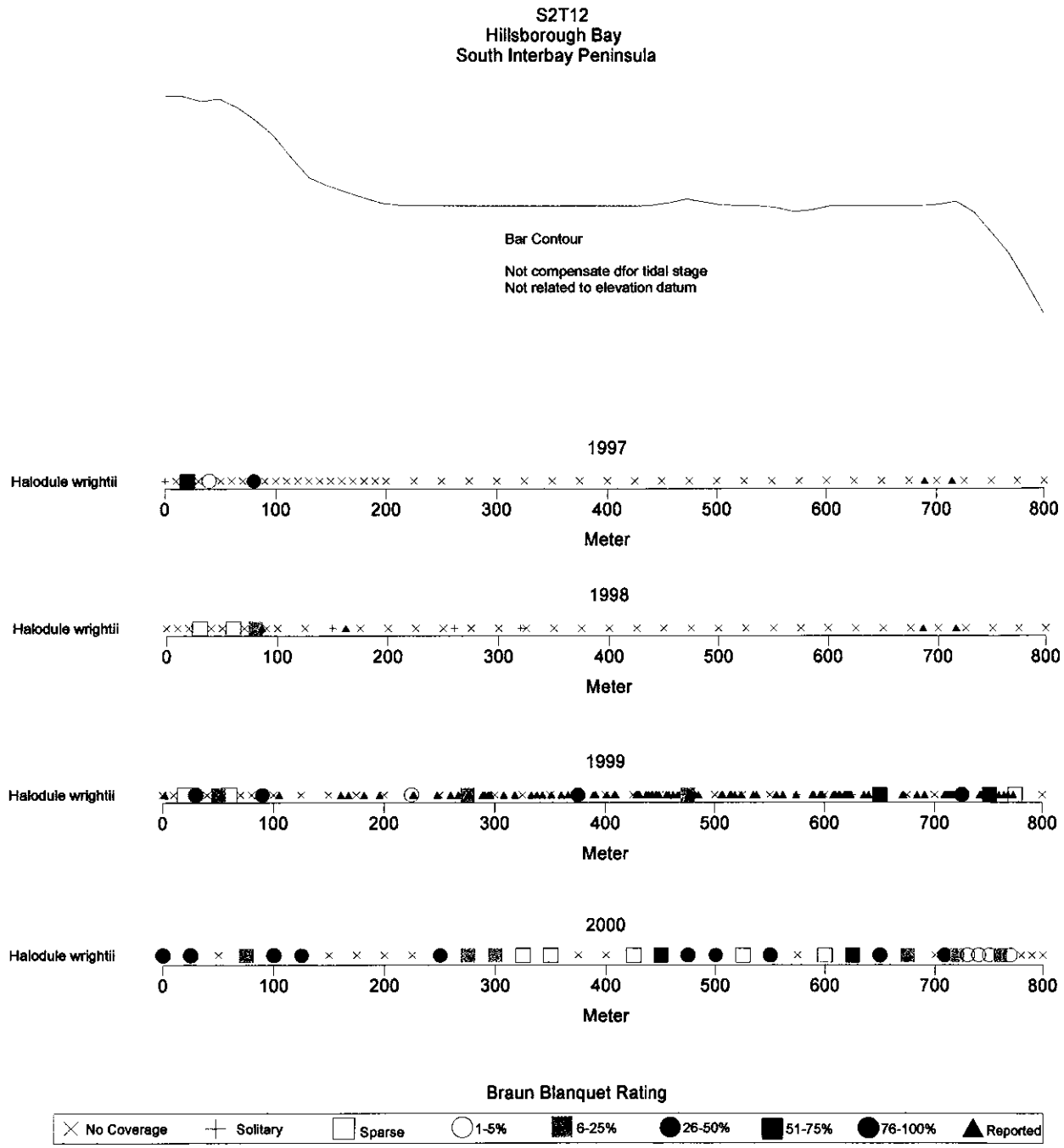


Figure 30. Distribution and abundance of *Halodule wrightii* along Transect S2T12 from 1997-2000.

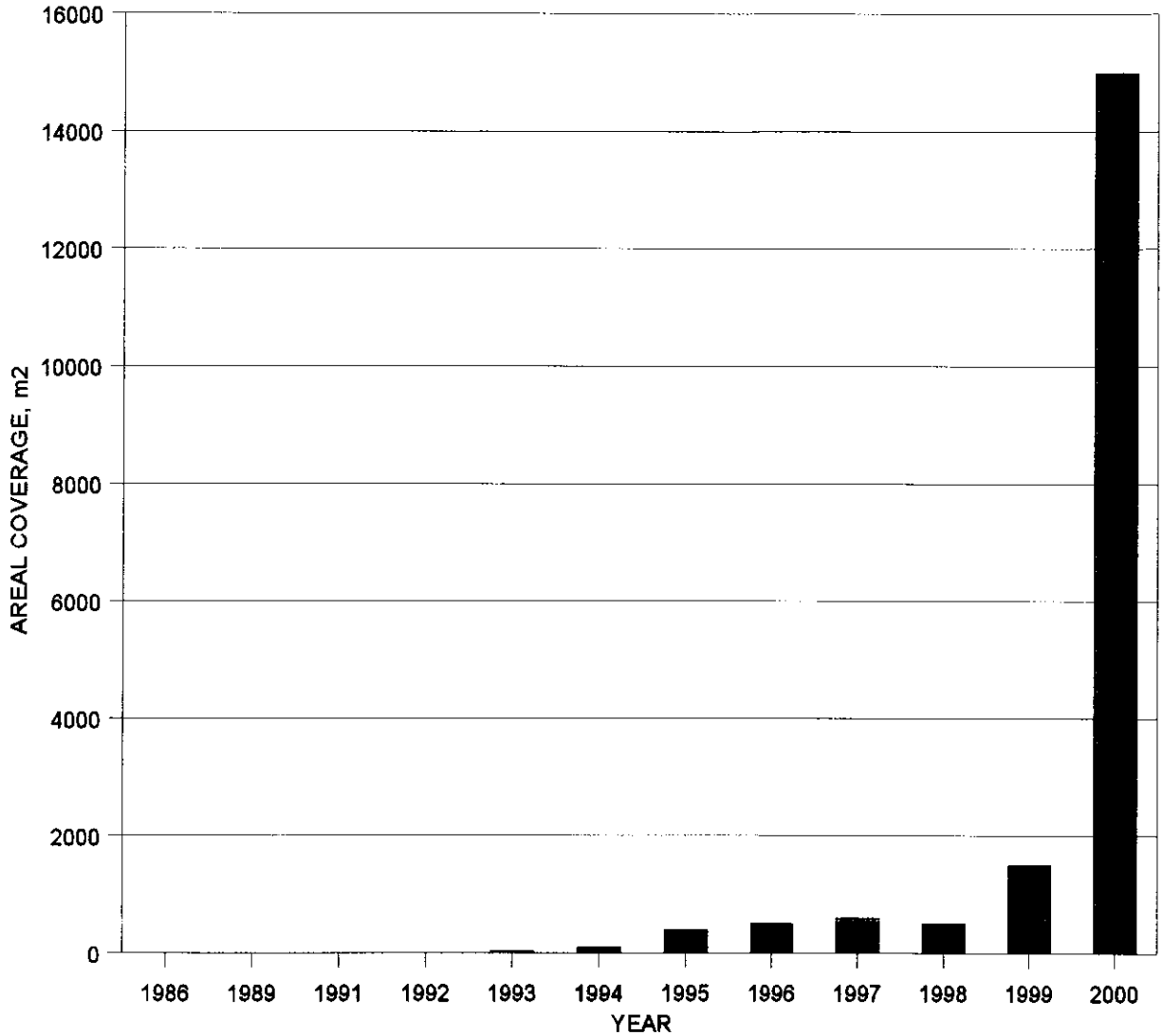


Figure 31. *Halodule wrightii* coverage in Area 13 from 1986-2000.

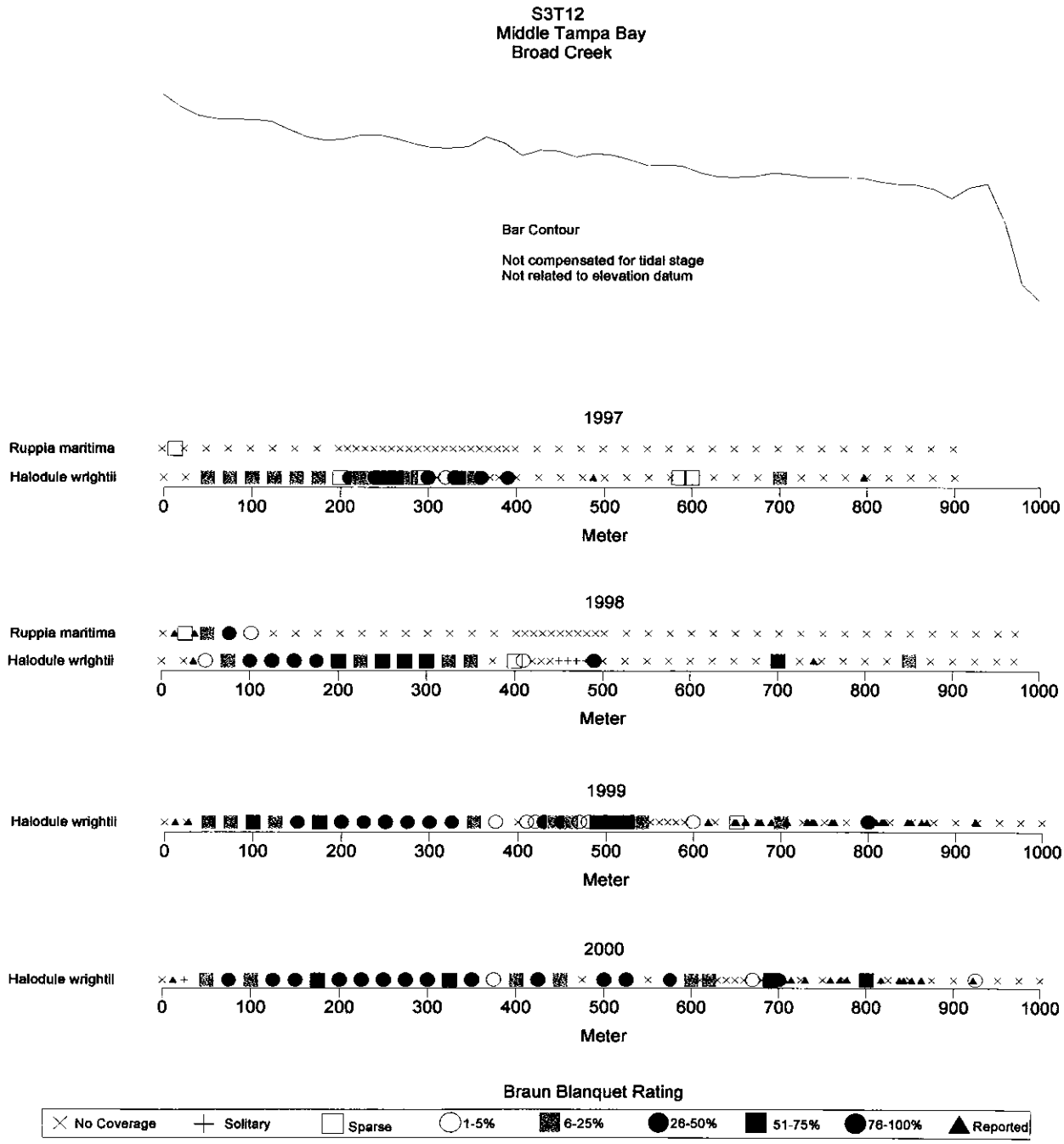


Figure 32. Distribution and abundance of *Ruppia maritima* and *Halodule wrightii* along Transect S3T12 from 1997-2000.

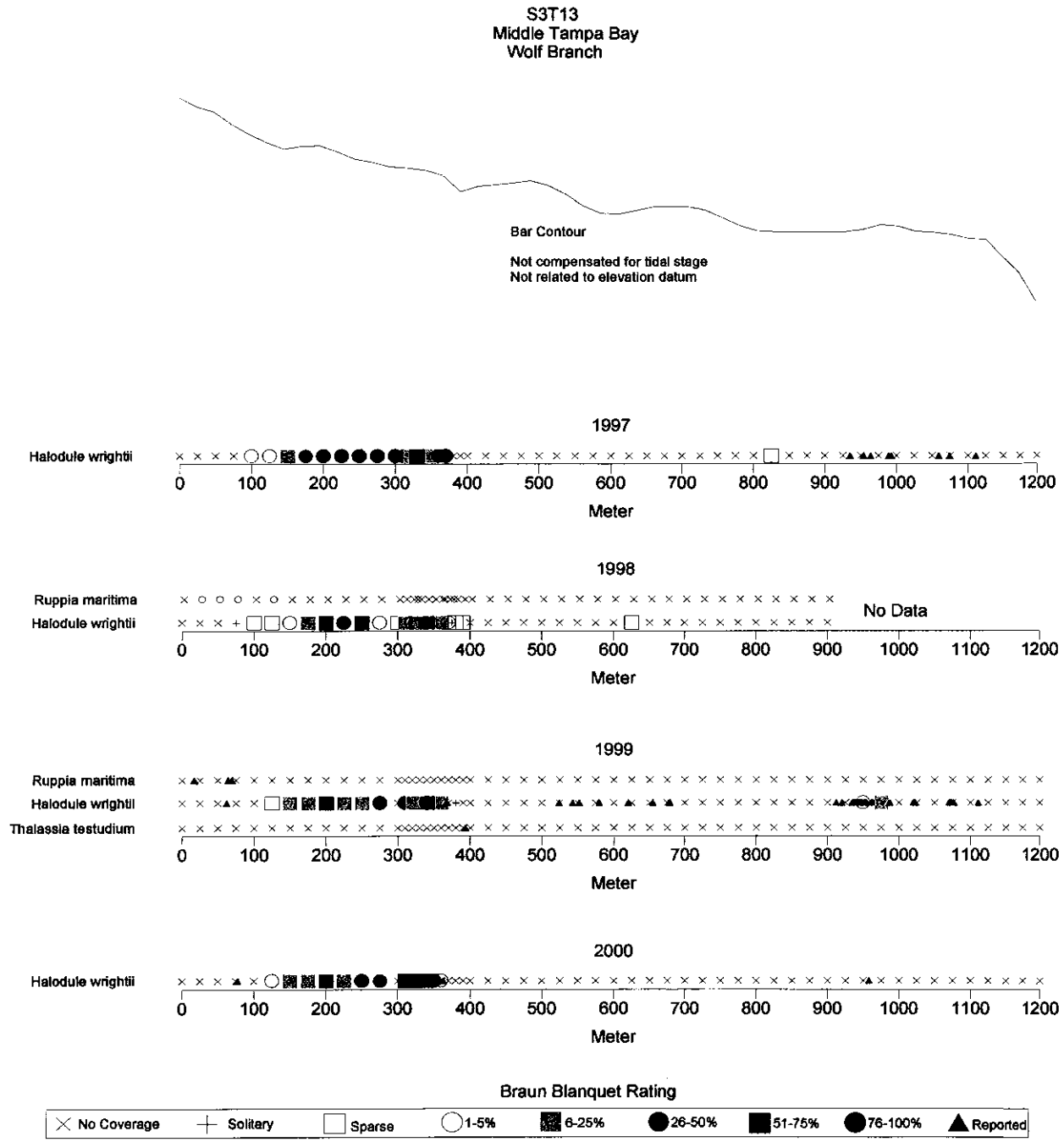


Figure 33. Distribution and abundance of *Ruppia maritima*, *Halodule wrightii*, and *Thalassia testudinum* along Transect S3T13 from 1997-2000.

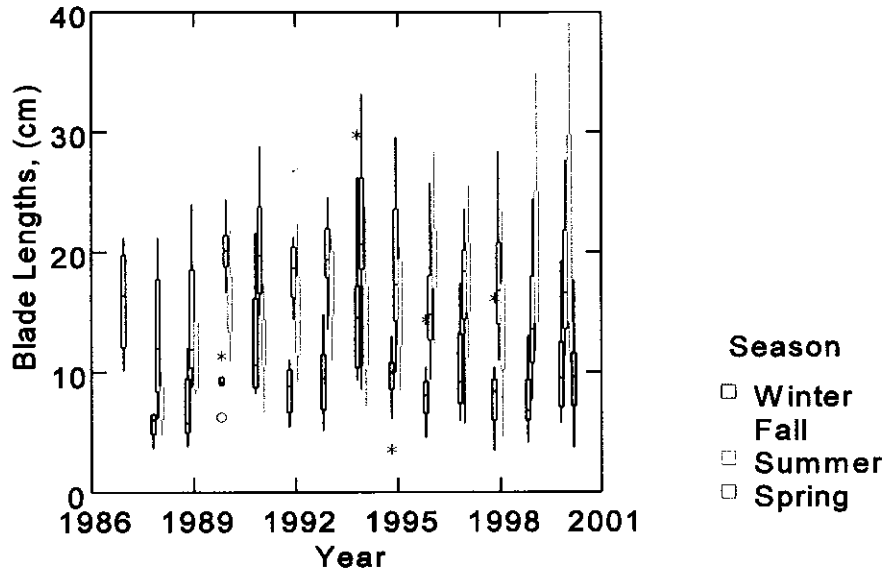


Figure 34. Box plot of seasonal blade lengths for *Halodule wrightii* in Hillsborough Bay from 1987 through 2000.

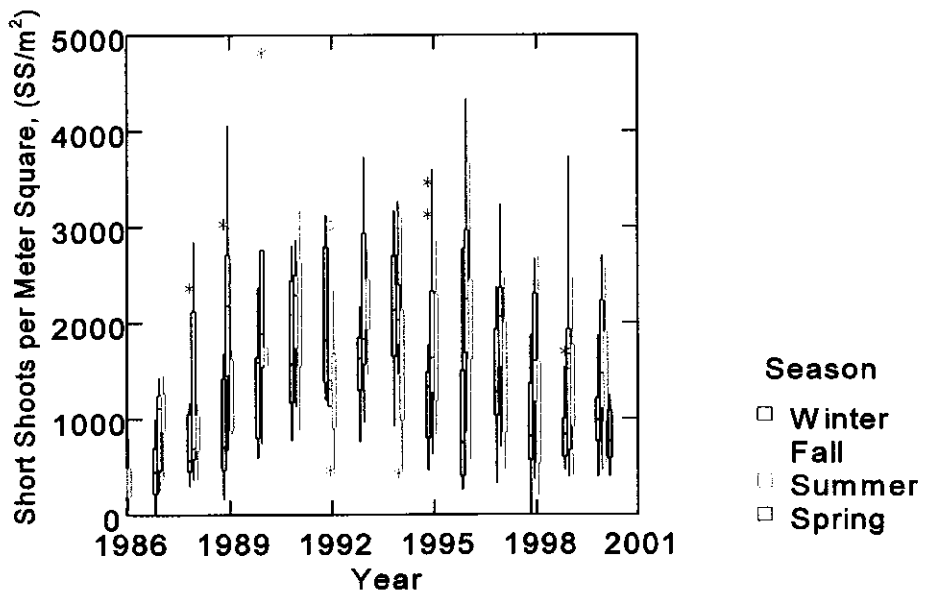


Figure 35. Box plot of seasonal short shoot densities for *Halodule wrightii* in Hillsborough Bay from 1986 through 1999.

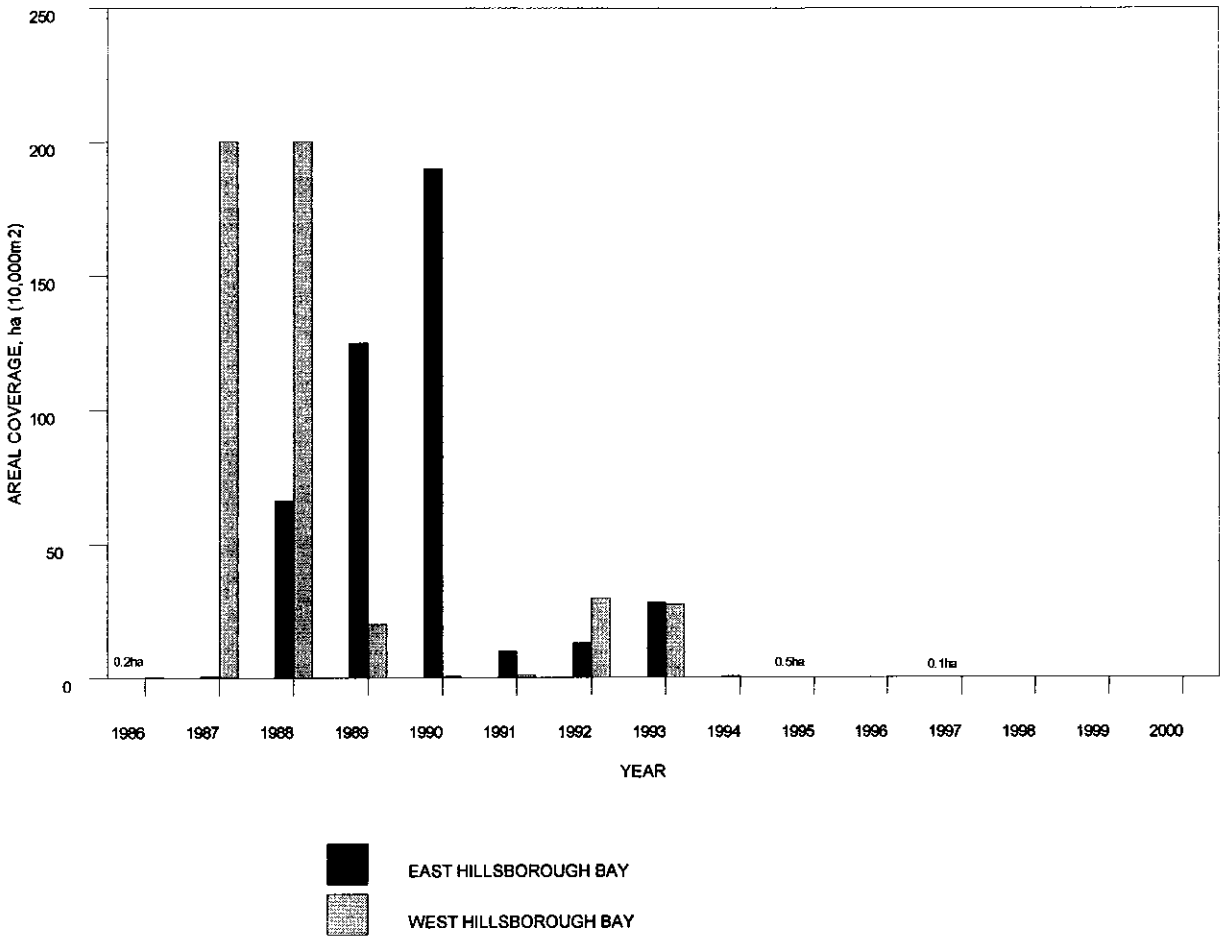


Figure 36 . *Caulerpa prolifrea* coverage in Hillsborough Bay from 1986-2000.