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

SUBMITTED TO

THE FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

TAMPA OFFICE

MARCH 1, 1999

CITY OF TAMPA

DEPARTMENT OF SANITARY SEWERS

BAY STUDY GROUP

EXECUTIVE SUMMARY

The City of Tampa, 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 has now increased to about 57ha. Coverage for *R. maritima* fluctuated between 2000m^2 in 1986 to 40ha in 1996. However, following the maximum reported in 1996, *R. maritima* coverage decreased to about 6ha and 5ha in 1997 and 1998, respectively. *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 1996.

Seagrass recolonization is occurring in the intertidal and shallow subtidal areas of Hillsborough Bay in response to improved 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, 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 documented the location and areal coverage of *Halodule wrightii* (shoalgrass), *Ruppia maritima* (widgeongrass) and the attached benthic alga, *Caulerpa prolifera*. Nine additional intensive groundtruthing efforts to document *H. wrightii* were completed in 1989 and 1991-1998, all during the month of October. Study sites were established for *H. wrightii*, *R. maritima* and *C. prolifera*, however, monitoring of *R. maritima* and *C. prolifera* at specific study sites has been discontinued. Generally, study sites have been monitored three times a year.

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 1997, is a part of 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.

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. Seagrass is an important Tampa Bay habitat and may 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 tenth annual report submitted to the Florida Department of Environmental Protection (FDEP) to satisfy the requirements set forth in specific condition #14 of FDEP operation permit D029-184532B.

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 experimental 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.

Seagrass coverage in an embayment east of the north end of Apollo Beach (Figure 1), had been included in reports after 1989. It is unclear if this area should be included within the boundary of Hillsborough Bay, however, the BSG decided to omit this area as part of the study. Therefore, Hillsborough Bay seagrass estimates reported after 1989 were revised in the sixth annual report to FDEP submitted on March 1, 1995.

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 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. Three of the original study sites, B-1, K-3, and K-5 (see reports prior to 1995 for study site locations), have been retained for study.

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, temperature, dissolved oxygen, pH, and depth are recorded.

Ruppia maritima

One *R. maritima* transect was established in western Hillsborough Bay in 1987 and discontinued in 1992. Currently, data on *R. maritima* is collected during seasonal visits to the thirteen subdivisions in Hillsborough Bay. *R. maritima* patches are selected at random and measurements of blade length, short shoot density, and inflorescence, if present, are taken. Short shoot density is determined with a $100cm^2$ square.

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 return of significant *C. prolifera* coverage. In the interim, data will only be collected where the alga is present. Information from five randomly tossed meter squares (1x1m) will include: percent *C. prolifera* coverage, frond density and length, percent drift macroalgae cover, the number of the polychaete, *Diopatra cupraea*, depth, temperature, and salinity. Results for transect coverage through 1994 may be found in the 1995 report.

TBNEP 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 SWIM seagrass study sites. The transects are divided into 100m sections and range between 160-1300m 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 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) 0.5 represents less than one percent coverage, c) 1 represents 1-5 percent coverage, d) 2 represents 6-25 percent coverage, e) 3 represents 26-50 percent coverage, f) 4 represents 51-75 percent coverage, and g) 5 represents 76-100 percent coverage.

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, samples from each data collection site are taken at mid depth for chlorophyll *a* and turbidity analysis.

AREAL COVERAGE

Photographs taken from high and low altitudes aid in the determination of SAV coverage for each seagrass study area of Hillsborough Bay. High altitude aerial photographs (ca. 1000-3000ft.) are utilized 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 are counted and the areal extent of the SAV is determined by multiplying the number of squares counted times

the scale determined for a square. Low altitude (ca. 500ft.) overflights are generally conducted monthly. Photographs taken at this level are useful in locating and enumerating 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.

All intertidal and most of the shallow subtidal flats which have the potential for SAV coverage are visited on foot in the fall. During each visit, SAV recorded by the 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 a 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 XL 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 is downloaded into a PC using the Trimble Pathware 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 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

H. wrightii coverage described in Hillsborough Bay for 1991, 1992, and 1993 has been revised, due to the change of bay area definition, to 2.0ha, 5.2ha and 7.3ha respectively, nearly thirty percent below coverage previously reported.

Two species of seagrass, *H. wrightii* and *R. maritima*, were observed during the 1998 Hillsborough Bay seagrass survey. *H. wrightii* coverage in Hillsborough Bay increased nearly 40 percent from 40.4ha reported in 1996 to about 55.6ha in 1997. However, from 1997 to 1998, *H. wrightii* coverage increased just over two percent to about 57.0ha (Figure 4). *R. maritima* coverage, however, decreased from 40ha in 1996 to about 6ha and 5ha in 1997 and 1998, respectively. *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 is summarized in Table 1.

The survey of the thirteen recently established seagrass transects was completed in the fall of 1998. Results for seagrass distribution and abundance for each transect are reviewed concurrent with a discussion of seagrass areal coverage for each of the thirteen seagrass study areas of Hillsborough Bay (including McKay Bay). There are no transects currently established in areas 1, 7, and 13. In addition, transects 14 and 15 are outside the boundaries of Hillsborough Bay and the results for the transects will be presented without a discussion of areal coverage.

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

Seagrass Study Area 1

H. wrightii coverage in area 1, near the Tampa Electric Company Big Bend power generating plant, decreased from 5600m^2 in 1997 to 3000m^2 in 1998 (Figure 9). Coverage which developed in the TECO turning basin in 1997 was not found in 1998. Further, the *H. wrightii* coverage on the east and west sides of Fishhook Spoil (Figure 5) decreased in 1998. 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). *H. wrightii* coverage did not change between 1997 and 1998 and remained at 40ha (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 and 1998.

Transect 2 (Figure 11), which traverses east to west through the Kitchen, illustrates the distribution and Braun Blanquet coverage rating of seagrass in the area. A change in the *H. wrightii* coverage between 1997 to 1998 is apparent in the first 250m of the transect. *H. wrightii* growth begins about 20m closer to shore in 1998 and coverage has begun to coalesce along the 150m to 250m portion of the transect. A solid band of continuous coverage from about 380m to over 500m from shore is similar to the abundance found in 1997. The coverage becomes patchy in the 550-620m range and coverage has not extended beyond 620m. Although *R. maritima* was reported in the Kitchen, no coverage was evident on the transect.

Seagrass Study Area 3

In area 3, between the Kitchen and the Alafia River, patches of *H. wrightii* have been developing in a band from just north of the Kitchen to Bullfrog Creek (Figure 5). This trend continued through 1998 and some of the coverage began to coalesce. Areal coverage increased from nearly 1.1ha in 1997 to about 5.5ha in 1998 (Figure 12). *H. wrightii* was the only seagrass species noted in this area during 1998.

Braun Blanquet data from transect 3 (Figure 13), which runs west from the mouth of Bullfrog Creek, illustrates the patchiness of *H. wrightii* in this area. Although a considerable number of shoalgrass patches were observed out to the 300m portion of the transect, only the meter square placed at the 120m mark contained any seagrass. The *H. wrightii* coverage noted at the 50m mark in 1997 was absent in 1998.

Seagrass Study Area 4

H. wrightii coverage between the Alafia River and Archie Creek decreased from 9000m^2 in 1997 to 1900m^2 in 1998 (Figure 14). Generally, the seagrass remains patchy with the bulk of the coverage seen near Archie creek (Figure 6).

About 2ha of *R. maritima* was observed in area 4 during 1997. However, in 1998, only very sparse coverage was seen near Archie Creek.

Seagrass was not present along transect 4, however, this transect is located to the south of most *H. wrightii* found in this area.

Seagrass Study Area 5

H. wrightii coverage between Archie Creek and Pendola Point decreased from 8000m^2 in 1997 to 1900m^2 in 1998 (Figure 15). The majority of this seagrass was documented about 1km north of Archie Creek. This coverage, which had been described as continuous in 1997, became fragmented and patchy in 1998 (Figure 6). In addition, some patchy *H. wrightii* was noted just north of Archie Creek and along the western end of Pendola Point (Figure 6).

Nearly all of the Hillsborough Bay *R. maritima* was found in area 5. About 4ha of coverage extended in a narrow band along the shoreline from the mouth of Archie Creek north to the east end of the Pendola Point peninsula.

There was a mixture of *H. wrightii* and *R. maritima* along the first 100m of transect 5 (Figures 16 and 17). Braun Blanquet data from the transect survey also illustrates the decrease in abundance and loss of *H. wrightii* in 1998 along the 90-120m and 180m section of the transect, respectively.

Seagrass Study Area 6

H. wrightii has never 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 in 1998.

Seagrass Study Area 7

This area encompasses the Davis Island shoreline. About 300m^2 of *H. wrightii* (Figure 18) was present in the northeast section of the seaplane basin (Figure 7) in 1997 and was the only seagrass species noted in area 7. This seagrass area was reduced to about 160m^2 in 1998.

Seagrass Study Area 8

In the past three years, patchy *H. wrightii* and *R. maritima* coverage began to develop on the shallow flats near of the intersection of Bayshore Boulevard and Bay to Bay Boulevard (Figure 7). About a dozen *H. wrightii* patches with a total area of 90m^2 were documented in 1998 (Figure 19). However, the small patches of *R. maritima* that were noted during 1997 were absent in 1998.

There was no seagrass coverage documented along transect 8 although several small patches of *H. wrightii* are located just to the north and south of the transect line.

Seagrass Study Area 9

H. wrightii was the only seagrass species reported in area 9 during 1998. Coverage in this area did not change between 1996 and 1998 and remained at an estimated 1.1ha (Figure 20). Most of the coverage was found just north of Ballast Point along Bayshore Boulevard (Figure 7).

Seagrass distribution and abundance along transect 9 in 1998 was similar to 1997. Braun Blanquet data from transect 9 (Figure 21) indicates a band of continuous to patchy *H. wrightii* coverage beginning approximately 30m 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 did not change appreciably between 1996 and 1998 (Figure 22). In 1998, there was a narrow, nearly continuous band of shoalgrass between Ballast Point and the navigation channel on the east side of Macdill Air Force Base (Figure 8). The areal coverage was estimated at 6.0ha.

About 2000m^2 of *R. maritima* was found just north of the air base in 1997. In 1998, coverage for this seagrass was reduced less than 1000m^2 in area 10 and was generally confined to an area just south of Ballast Point.

Seagrass coverage along transect 10 included *H. wrightii* and *R. maritima* in 1997 (Figures 23 and 24). Only *H. wrightii* was observed in 1998, although the coverage was not as abundant as found in 1997. In 1998, *H. wrightii* (Figure 23) began about 20m from the beginning of the transect. Continuous coverage was found in the 20-60m range and no seagrass was found beyond 80m.

Seagrass Study Area 11

H. wrightii in area 11 has been characterized by fluctuations in annual coverage since 1994. In 1997, coverage increased 170% to an estimated 4ha following a nearly 50% loss reported in 1996. (Figure 25). In 1998, coverage again decreased as the seaward edge of a meadow located north of Catfish Point (Figure 8) receded nearly 50m. Further, over 1ha of continuous coverage that was seen 350-500m from shore in 1997 was reduced to extremely patchy coverage with very low short shoot density. The *H. wrightii* areal coverage in area 11 was determined to be about 1.7ha in 1998.

Most of the *R. maritima* noted in area 11 during 1998 consisted of a narrow band located shoreward of the *H. wrightii* meadow found just north of Catfish Point. The areal estimate was determined to be 2000m^2 or about 50% less than what was found in 1997.

There are two transects in area 11. Coverage along transect 11.1 (Figures 26 and 27) was comprised of *H. wrightii* and *R. maritima* in the initial 30m. A continuous stand of *H. wrightii* was found between the 50-80m portion of the transect. Seagrass was not found on transect 11.2.

Seagrass Study Area 12

H. wrightii coverage in area 12 nearly doubled between 1997 and 1998 (Figure 28). Most of the coverage was located just east of the marina on Macdill AFB (Figure 8). In addition, scattered patches were found east to Gadsden Point. Areal coverage was estimated to be about 2.2ha which is double the area found in 1997.

Patchy *R. maritima* was found from the marina on Macdill AFB east to Gadsden Point. Areal coverage for this species was determined to be about 1000m^2 during 1998.

Seagrass coverage along transect 12 (Figure 29) consisted of patchy *H. wrightii* coverage in the initial 100m. A small area of shoalgrass not falling within a Braun Blanquet meter square placement has continued to persist near the 725m point of the transect.

Seagrass Study Area 13

H. wrightii was the only seagrass species reported in this area during 1998. Coverage documented along the eastern and northern shoreline of the spoil disposal island 2-D (Figure 6) in 1997 was not observed in 1998. There were several patches along the small spoil island just to the east of island 2-D. Coverage was estimated at 500m^2 in 1998 (Figure 30).

Seagrass Study Transect 14

Transect 14 is located at the mouth of Broad Creek on the south end of Interbay Peninsula. Information from transect 14 (Figure 31) indicates that *H. wrightii* coverage increased both shoreward and seaward along the transect between 1997 and 1998. Also there appears to be a trend

of increased abundance in the 100-200m portion. The densest portion of the meadow was located along the 100-400m portion of the transect. In addition, patchy shoalgrass was found in the 600-850m section.

There was no *R. maritima* found on this transect in 1997, however, patchy *R. maritima* developed in the first 120m of transect 14 in 1998 (Figure 32).

Seagrass Study Transect 15

Transect 15 is located at the mouth of Wolf Branch Creek south of Apollo Beach. Data from transect 15 in 1998 (Figure 33) indicates *H. wrightii* was patchy in the first 150m of the transect and became more abundant between 150-375m. Also, it should be noted that scattered *H. wrightii* has developed along the 700-1000m section of the transect, however, no seagrass was detected using the Braun Blanquet rating system on 25m intervals. There has been no *R. maritima* documented along this transect.

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. The data indicates 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.

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 density usually increase by the summer and are 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 an interannual trend of decreasing short shoot density between 1996 and 1998.

Caulerpa prolifera

C. prolifera has been observed in four general areas of Hillsborough Bay: 1) along southeastern Interbay Peninsula; 2) near Ballast Point; 3) between Pendola Point and the Alafia River; and 4) along Davis Island.

C. prolifera in Hillsborough Bay has exhibited both rapid increase and rapid loss in coverage since monitoring began in 1986. For example, in 1986, between April and December, a 40 fold increase in coverage to 200ha was documented in western Hillsborough Bay. A 90 percent reduction in coverage occurred 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 these areas is probably a result of extended exposure to unusually hyposaline conditions. Similarly, in an area south of Pendola Point, the alga expanded from 8000m^2 in 1987 to 190ha in 1990. Following this maximum, coverage steadily declined, however, the decline does not appear to be related to major rain events.

Three major areas of *C. prolifera* were reported in 1994: 1) between Gadsden Point and the marina on the south end of Macdill AFB (25ha), 2) Ballast Point (1ha), and 3) south of Pendola Point (3ha). Coverage in Hillsborough Bay for 1995 rapidly declined to less than 2000m^2 with scattered coverage observed in each of the three areas. In 1996, no *C. prolifera* was observed around Ballast Point or Pendola Point, however, sparse coverage was observed just east of Gadsden Point.

The development and decline of *C. prolifera* coverage has been documented in other areas of Hillsborough Bay. Sparse *C. prolifera* was found along southeastern Davis Island between 1986-1989 and on the west end of Bird Island (Figure 1) from 1993-1994.

In summary, *C. prolifera* has rapidly colonized large intertidal and subtidal areas of Hillsborough Bay since 1986. Furthermore, this alga appears to be sensitive to low salinity for extended periods. Although, some drift *C. prolifera* was occasionally noted during surveys, attached *C. prolifera* coverage has not been observed in Hillsborough Bay since 1996.

CONCLUSION

Improving water quality in Hillsborough Bay has allowed recolonization of *H. wrightii* into most intertidal and shallow subtidal areas of Hillsborough Bay within the past decade. The majority of the *H. wrightii* renewal has occurred in the Kitchen, however, sizeable meadows have also developed in the western and northwestern sections of the bay. In 1998, *H. wrightii* coverage declined in some areas while increasing or remaining stable in other areas. For example, coverage which has developed in the past few years between Pendola Point and the Alafia River (area 5) and near Macdill Air Force Base (area 11) decreased in 1998. Patchy *H. wrightii* coverage has continued to develop and coalesce on the flats north of the Kitchen (area 3) and increased about 500% in 1998. In the Kitchen (area 2), where annual coverage increases have been the greatest since 1986, the *H. wrightii* meadow remained nearly unchanged between 1997 and 1998.

The reason for seagrass declines in some areas of Hillsborough Bay is not clear. However, above normal rainfall in 1998 led to a reduction of salinity, increased phytoplankton biomass, and lower Secchi depth. Any of of these factors or a combination of these factors could lead to a reduction of seagrass biomass. Water quality in Hillsborough Bay during 1998 will be discussed in the City of Tampa report entitled " Results of the City of Tampa Compliance Monitoring Program for the Year 1998 and Examination of Long-Term Water Quality and Biological Indicator Trends in Hillsborough Bay" to be submitted to the Florida Department of Environmental Protection on March 31, 1999.

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 total seagrass coverage in Hillsborough Bay, although in 1996, it increased to about 40ha, equaling the amount reported for *H. wrightii*. In 1998, *R. maritima* coverage was estimated to be about 5ha, less than 10% of the total seagrass 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 appear to have occurred more gradually.

Table 1. *Halodule wrightii* coverage (m^2) by area in Hillsborough Bay for the years 1986, 1989, and 1991-1998.

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

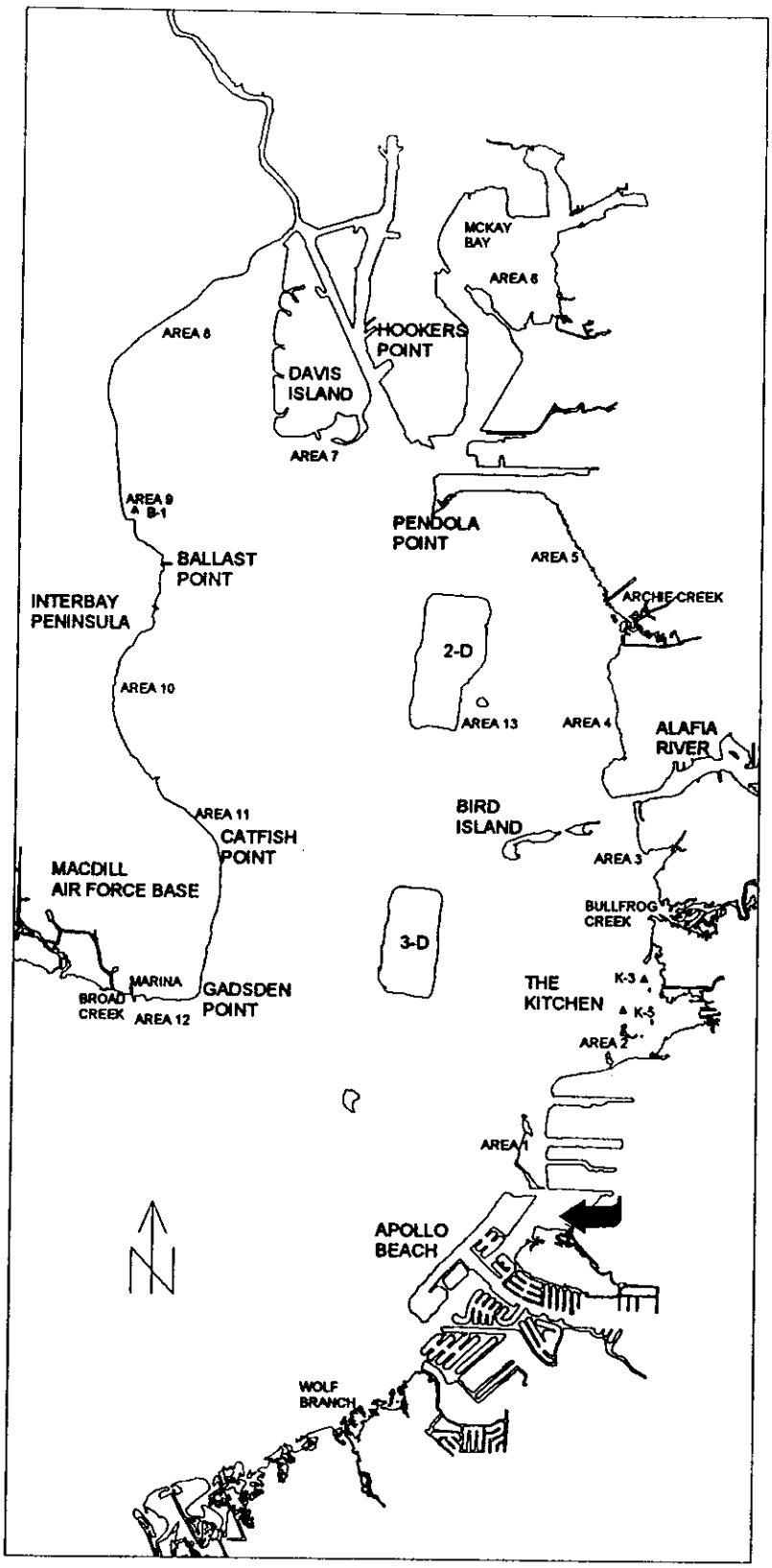

Figure 1. Location of the thirteen seagrass study areas and the three original study sites B-1, K-3, and K-5 in Hillsborough Bay. Arrow indicates embayment previously included as part of Hillsborough Bay.

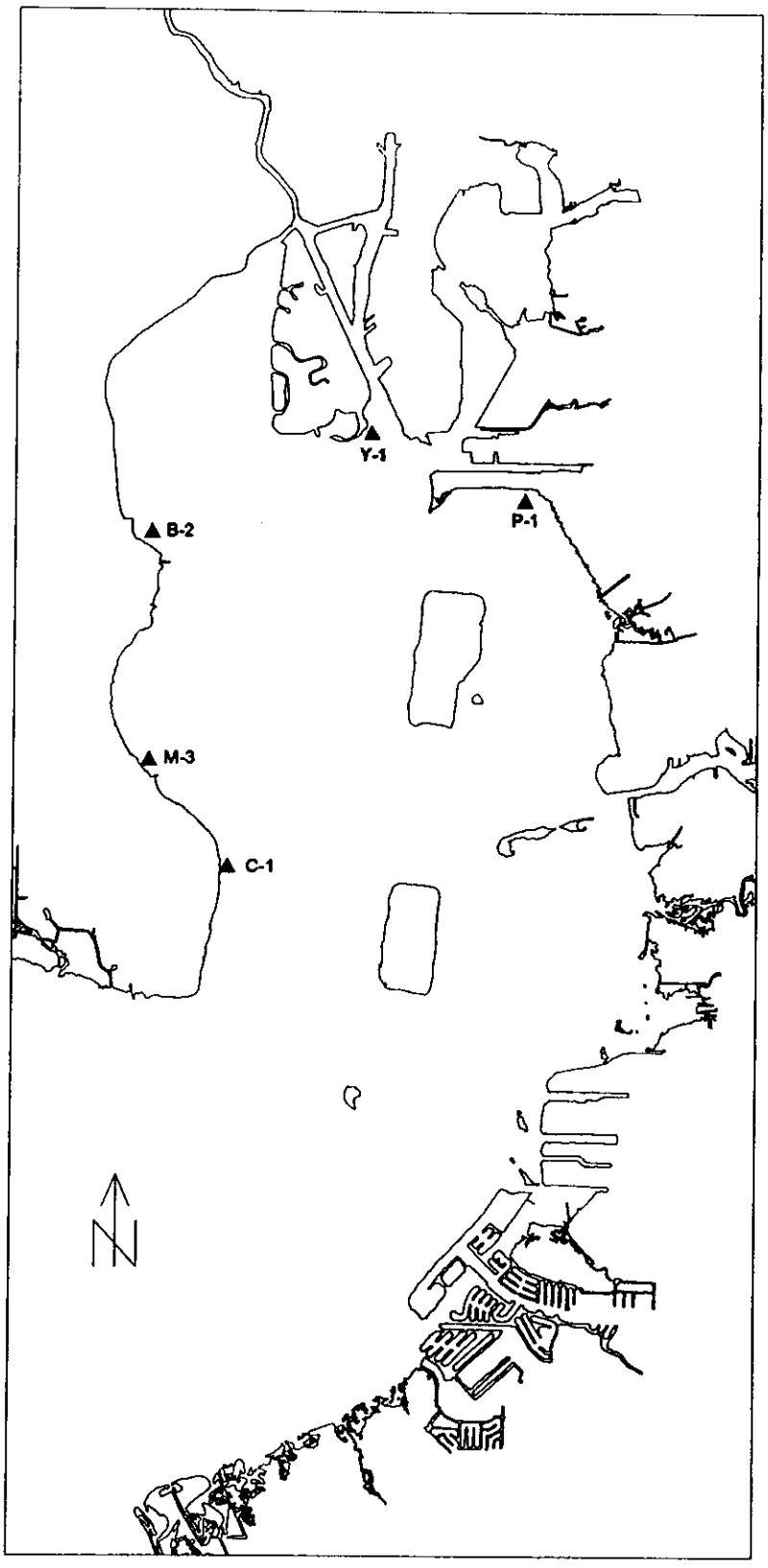

Figure 2. Location of the five *Caulerpa prolifera* transects in Hillsborough Bay.

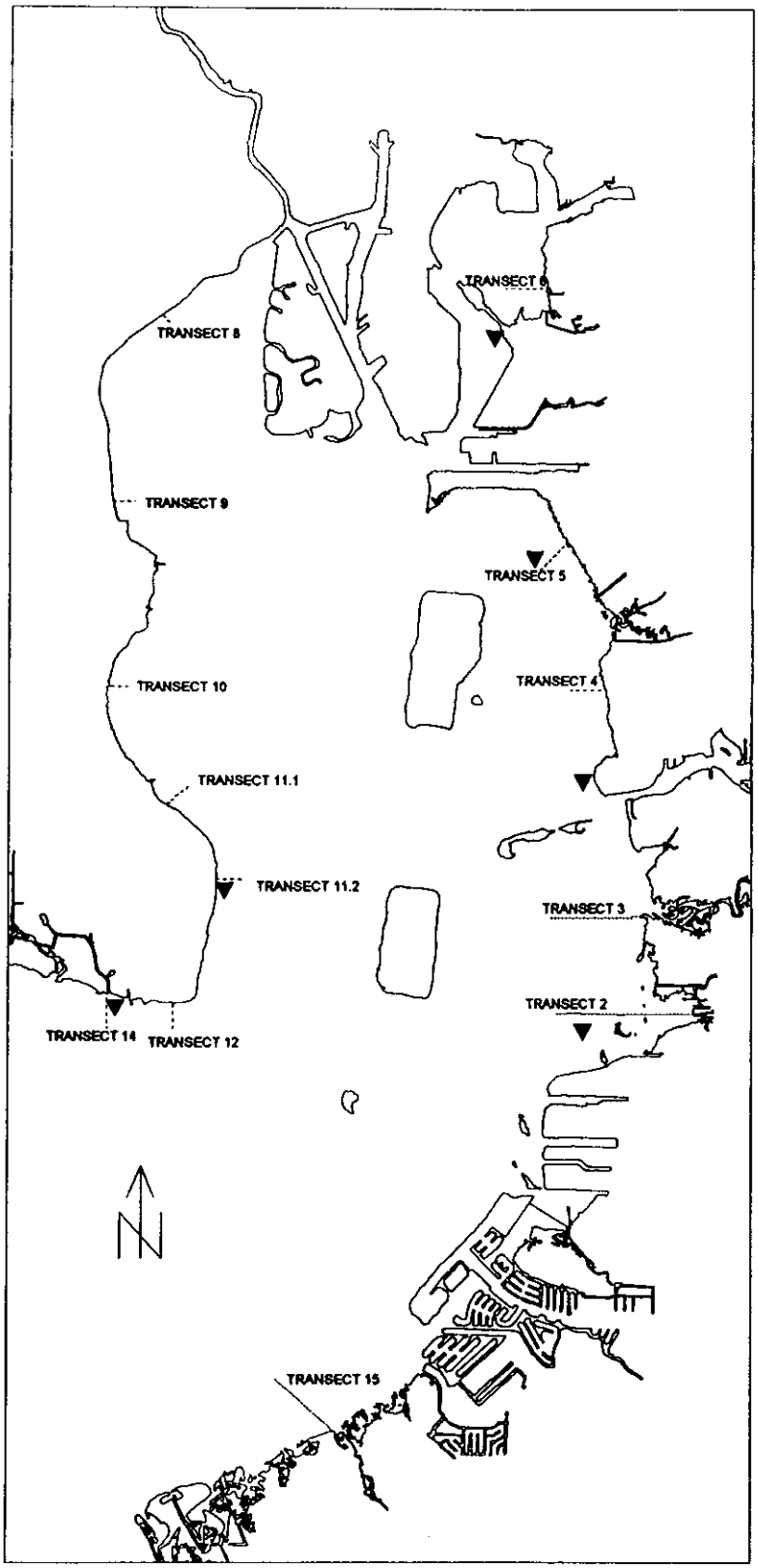

Figure 3. Location of the thirteen COT seagrass transects and the SWIM study sites(▼) in Hillsborough Bay.

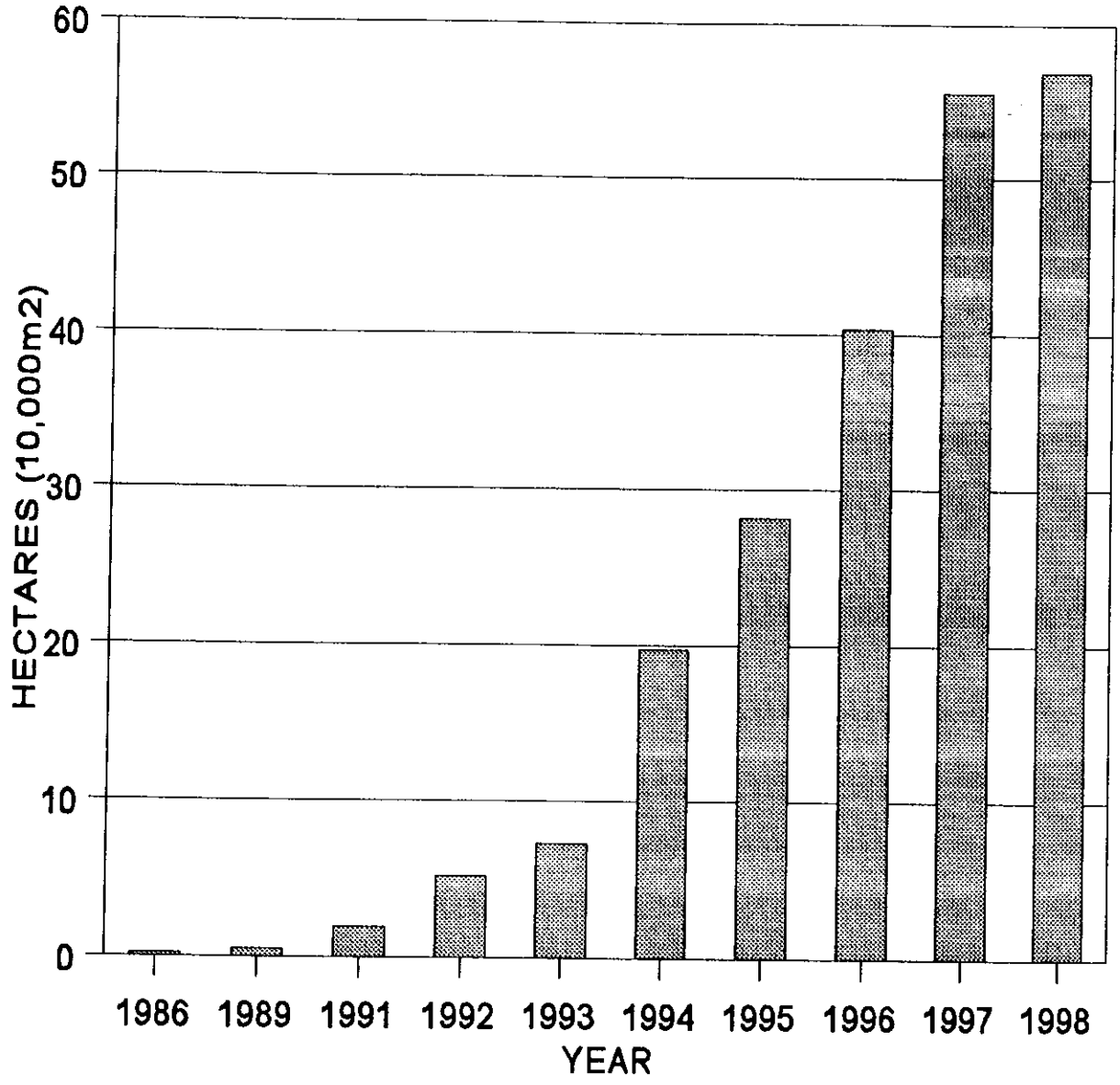

Figure 4. *Halodule wrightii* coverage in Hillsborough Bay from 1986-1998.

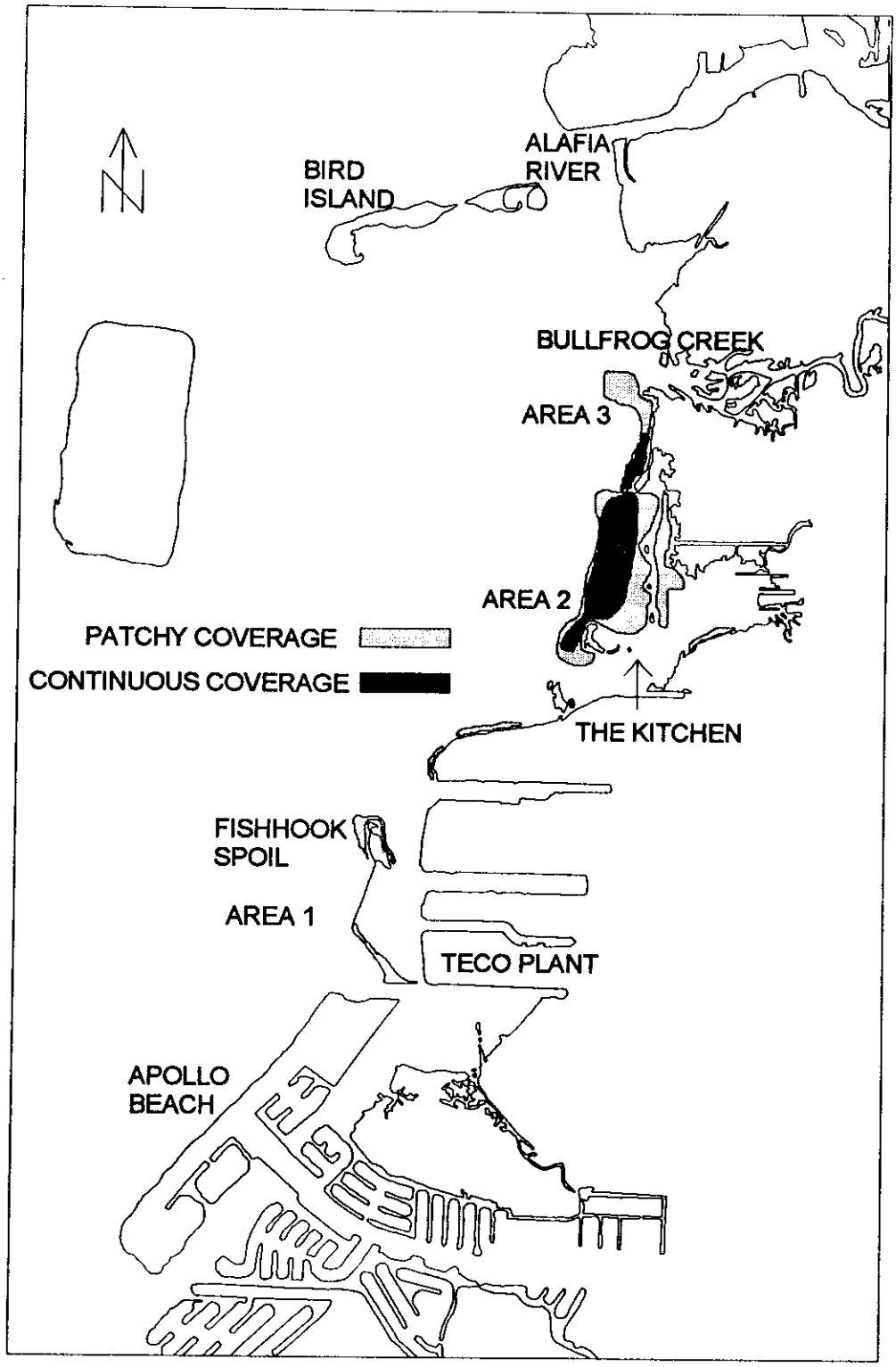

Figure 5. Distribution of *Halodule wrightii* in southeastern Hillsborough Bay (areas 1, 2, and 3) in 1998.

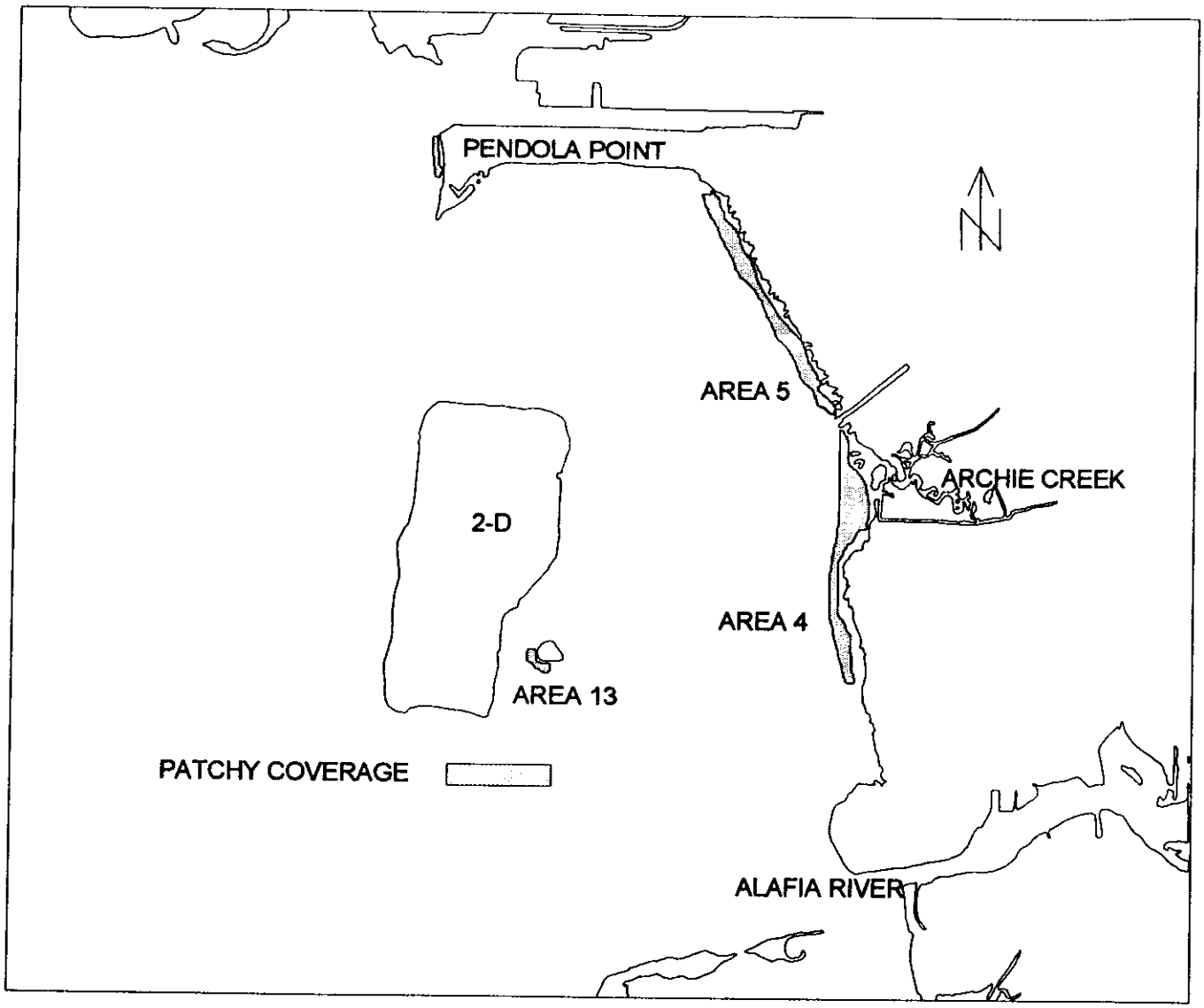

Figure 6. Distribution of *Halodule wrightii* in northeastern Hillsborough Bay (areas 4, 5, and 13).

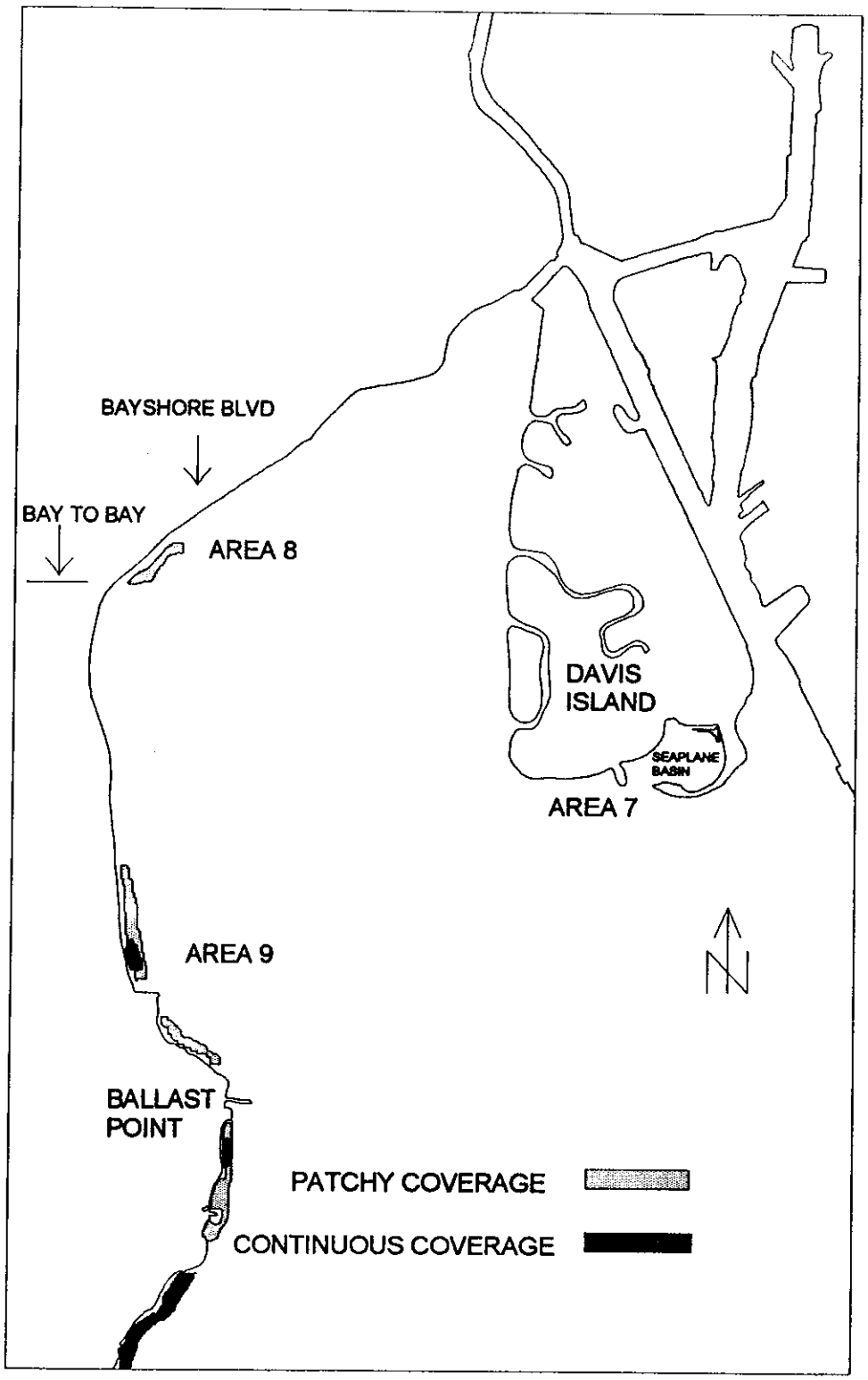

Figure 7. Distribution of *Halodule wrightii* in northwestern Hillsborough Bay (areas 7, 8, and 9) in 1998.

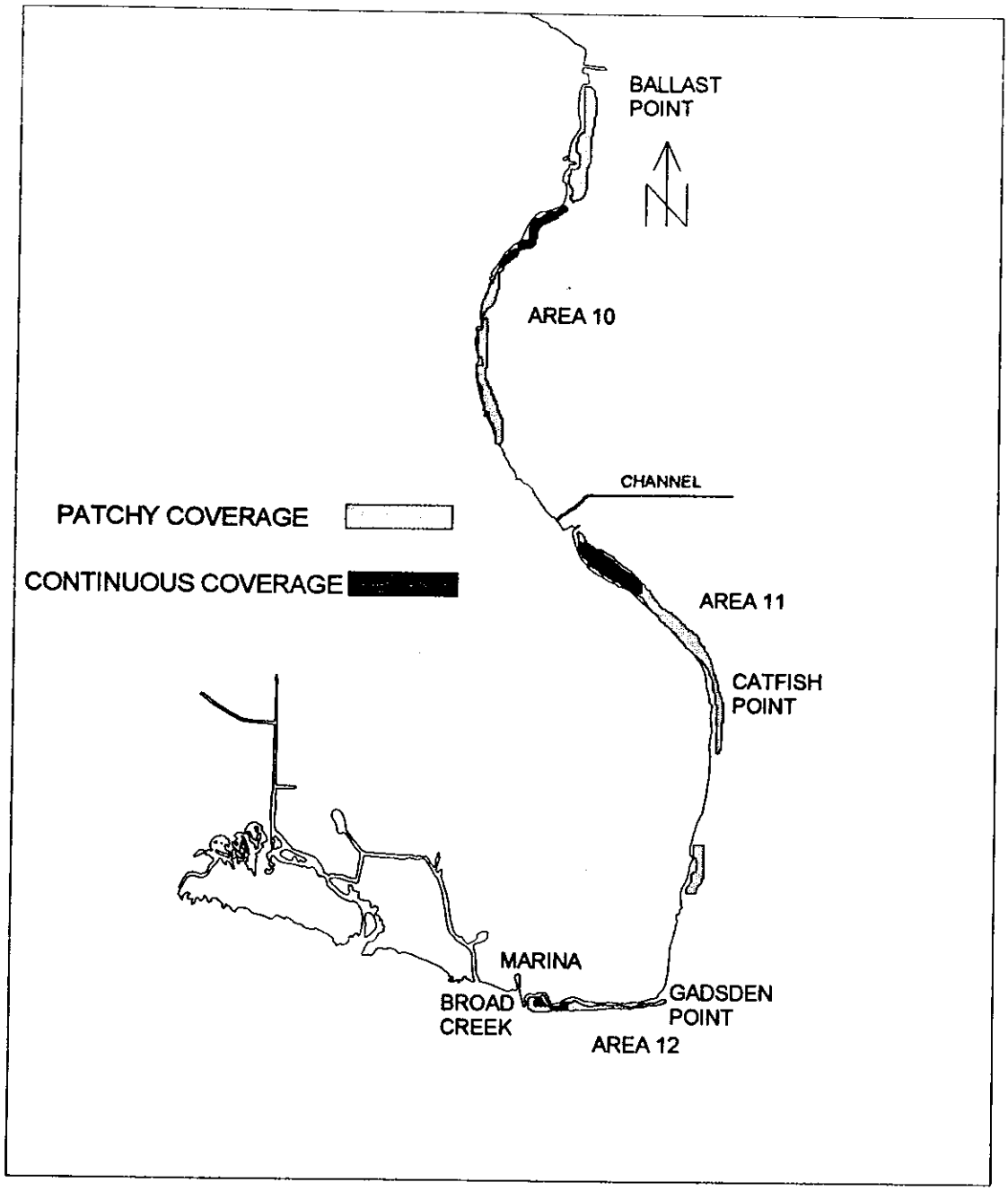

Figure 8. Distribution of *Halodule wrightii* in southwestern Hillsborough Bay (areas 10, 11, and 12).

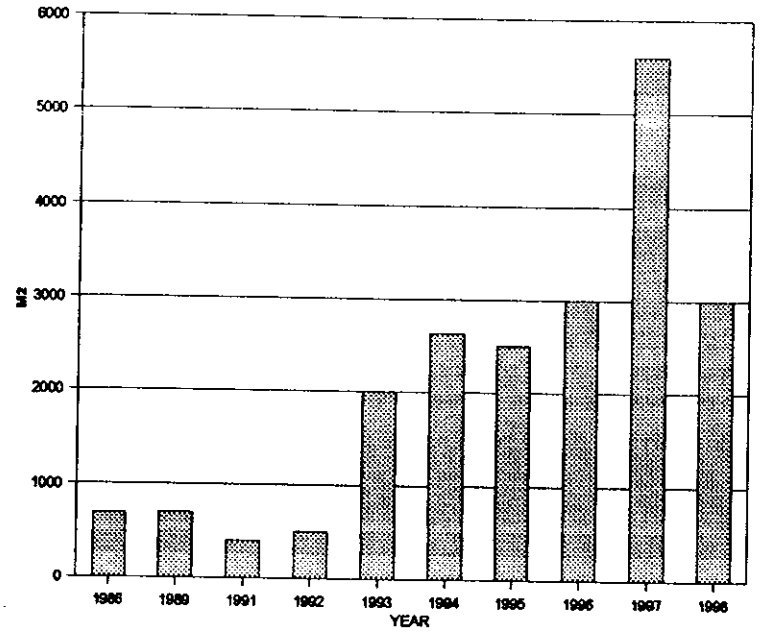

Figure 9. *Halodule wrightii* coverage in area 1 from 1986-1998.

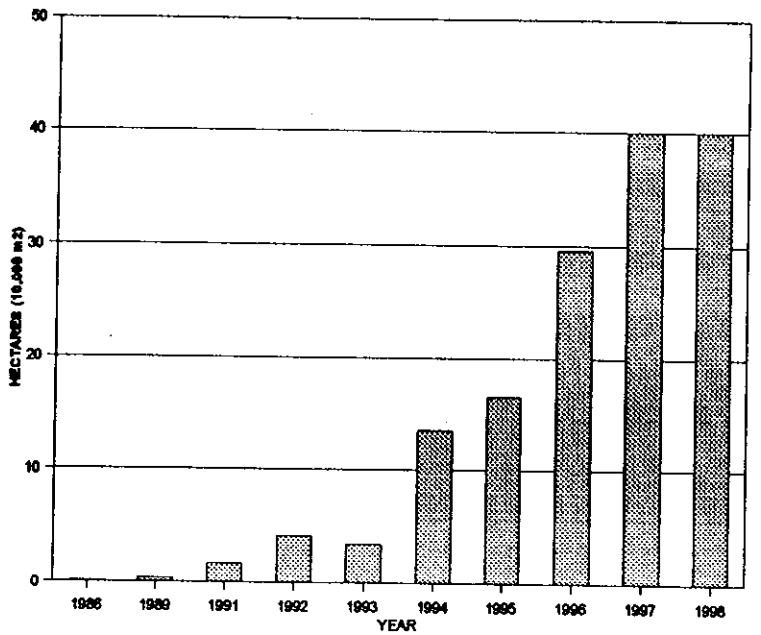

Figure 10. *Halodule wrightii* coverage in area 2 from 1986-1998.

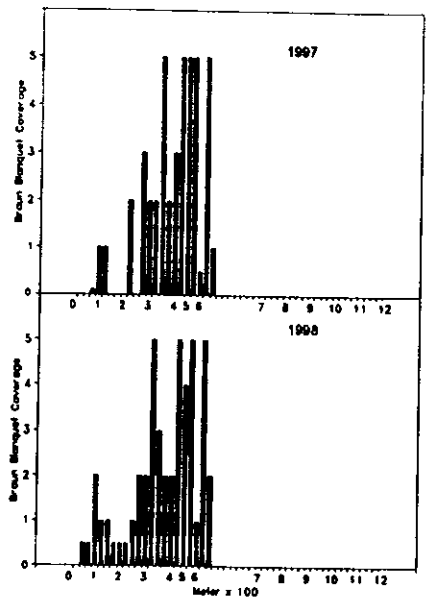

Figure 11. Distribution and abundance of *Halodule wrightii* along transect 2 in 1997 and 1998.

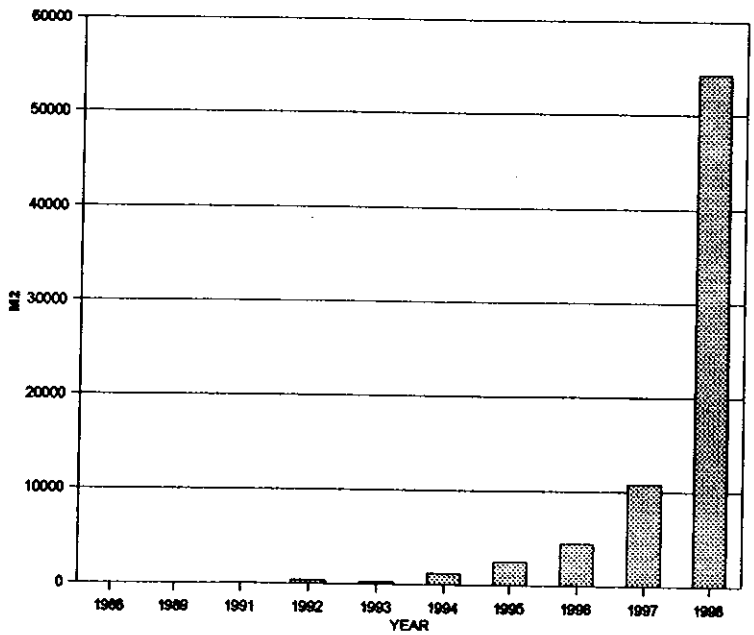

Figure 12. *Halodule wrightii* coverage in area 3 from 1986-1998.

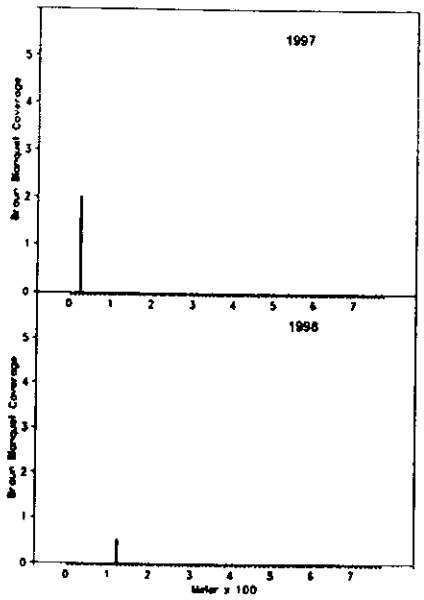

Figure 13. Distribution and abundance of *Halodule wrightii* along transect 3 in 1997 and 1998.

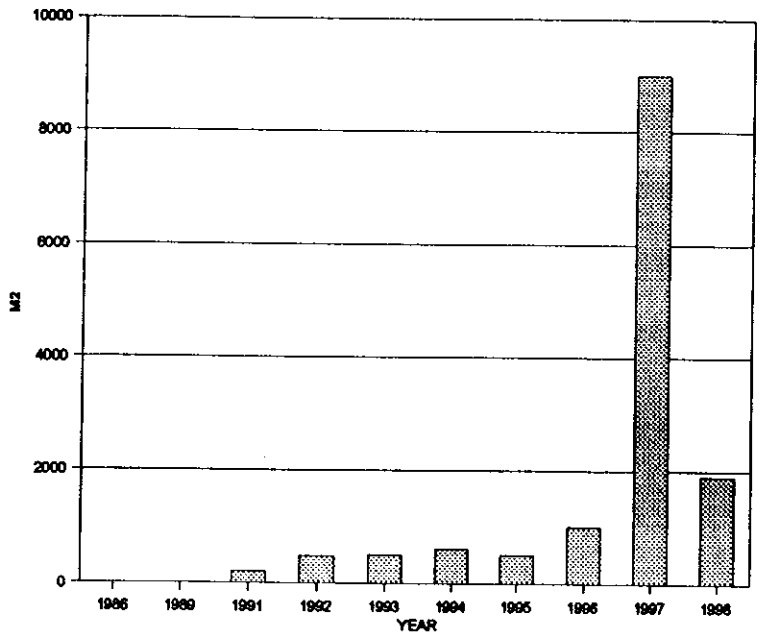

Figure 14. *Halodule wrightii* coverage in area 4 from 1986-1998.

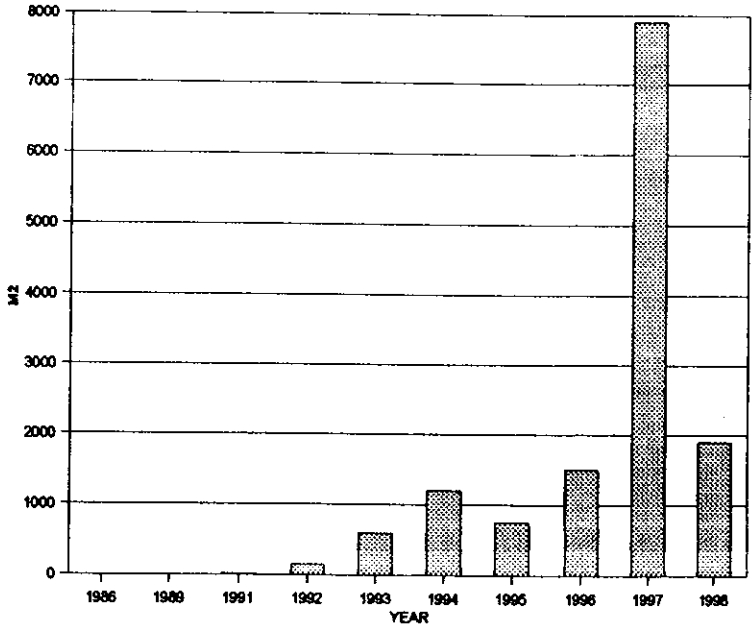

Figure 15. *Halodule wrightii* coverage in area 5 from 1986-1998.

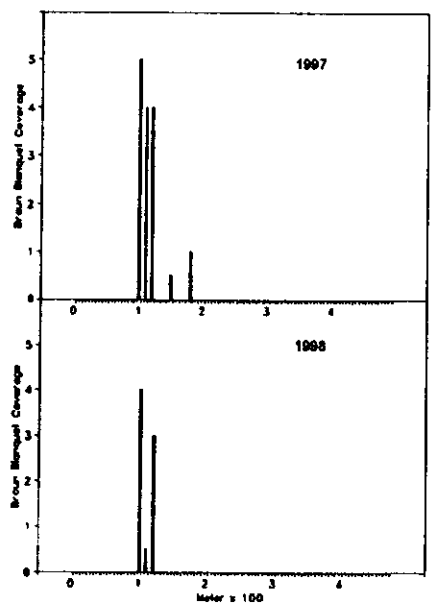

Figure 16. Distribution and abundance of *Halodule wrightii* along transect 5 in 1997 and 1998.

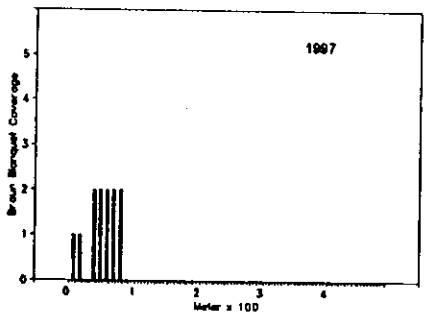

Figure 17. Distribution and abundance of *Ruppia maritima* along transect 5 in 1997. There was no *Ruppia maritima* coverage recorded within a Braun Blanquet meter square placement in 1998.

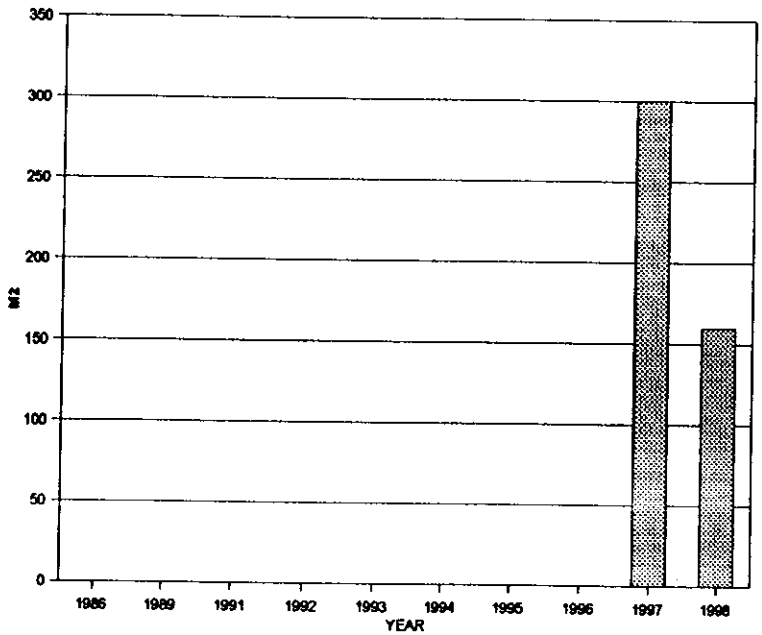

Figure 18. *Halodule wrightii* coverage in area 7 from 1986-1998.

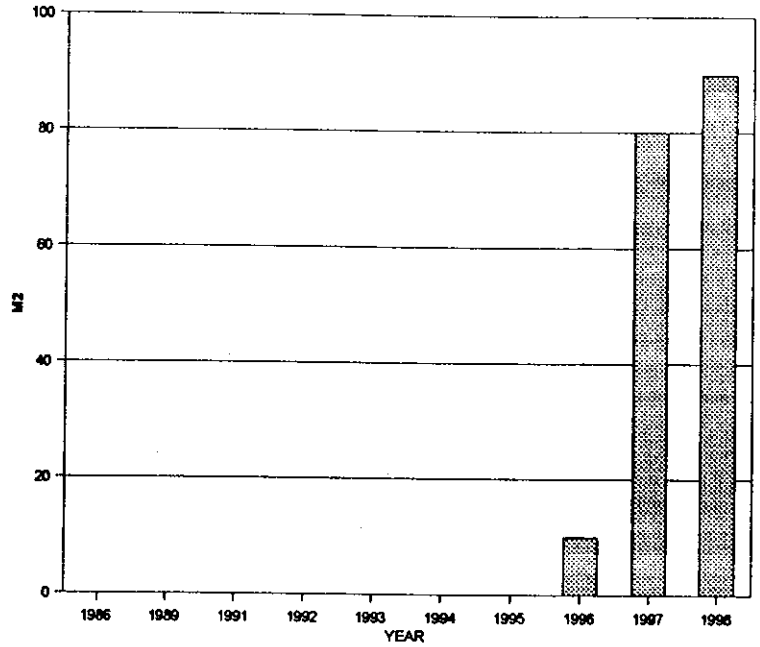

Figure 19. *Halodule wrightii* coverage in area 8 from 1986-1998.

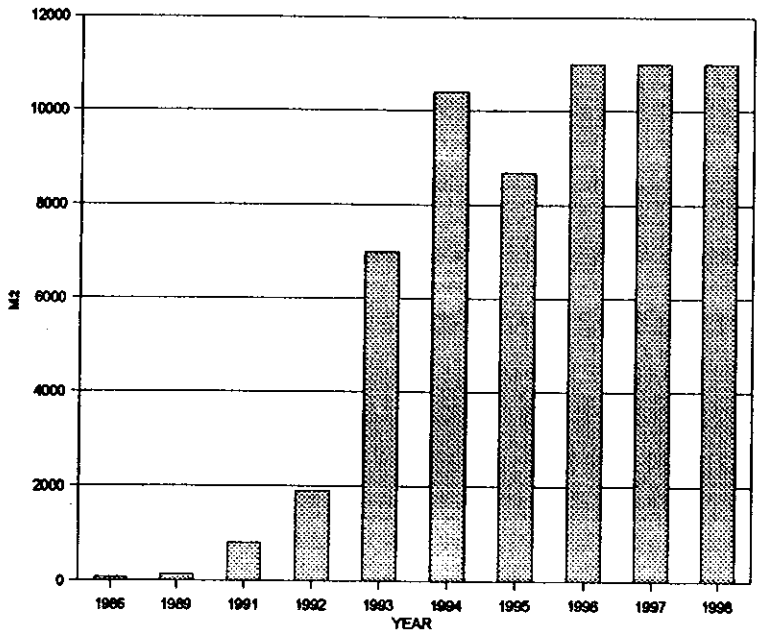

Figure 20. *Halodule wrightii* coverage in area 9 from 1986-1998.

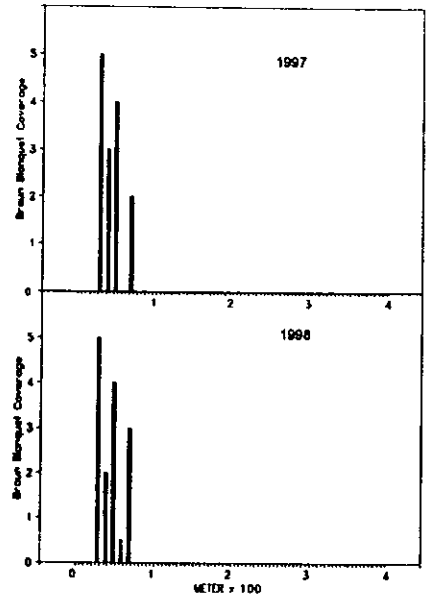

Figure 21. Distribution and abundance of *Halodule wrightii* along transect 9 in 1997 and 1998.

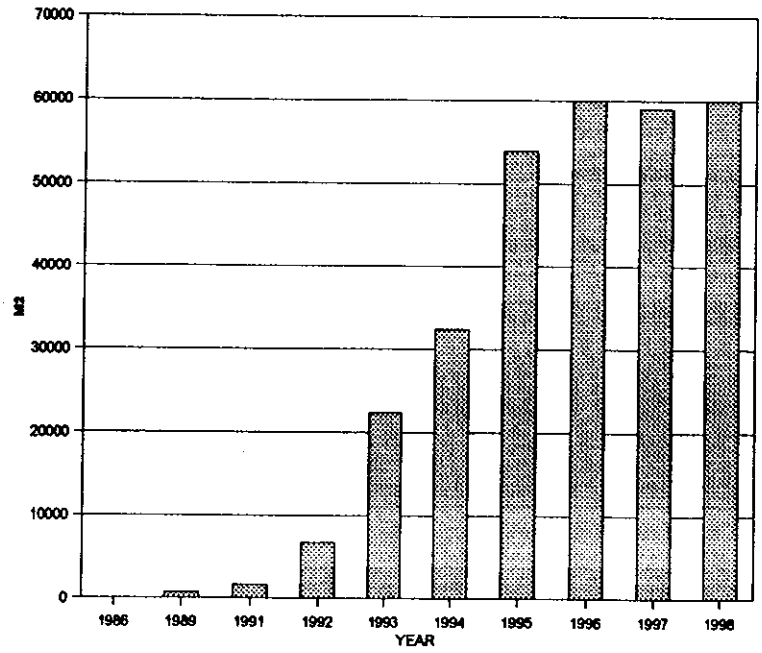

Figure 22. *Halodule wrightii* coverage in area 10 from 1986-1998.

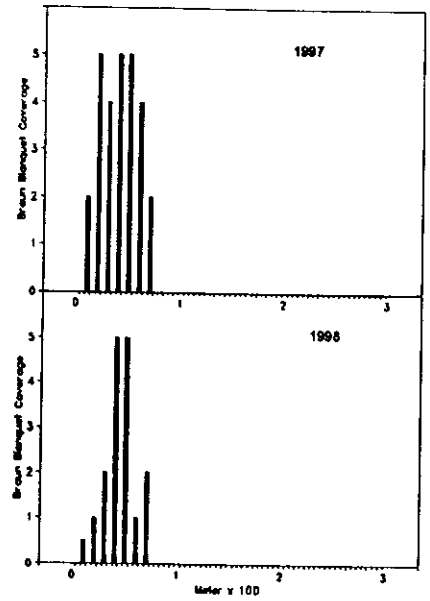

Figure 23. Distribution and abundance of *Halodule wrightii* along transect 10 in 1997 and 1998.

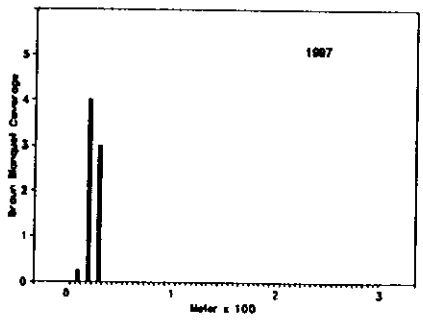

Figure 24. Distribution and abundance of *Ruppia maritima* along transect 10 in 1997. There was no *Ruppia maritima* coverage recorded within a Braun Blanquet meter square placement in 1998.

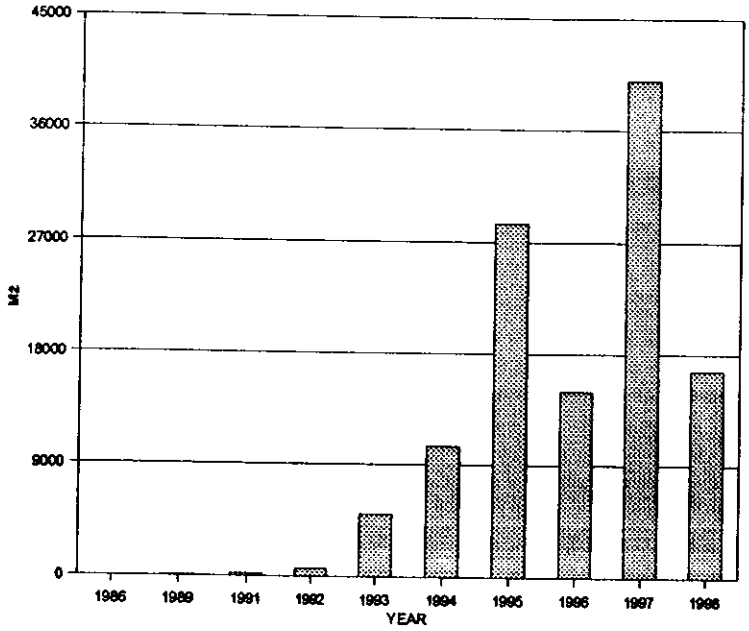

Figure 25. *Halodule wrightii* coverage in area 11 from 1986-1998.

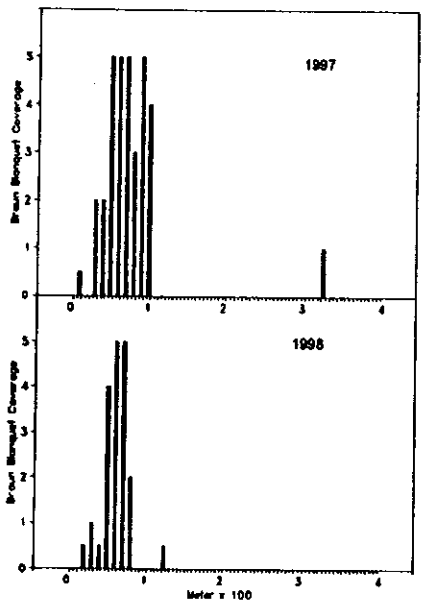

Figure 26. Distribution and abundance of *Halodule wrightii* along transect 11.1 in 1997 and 1998.

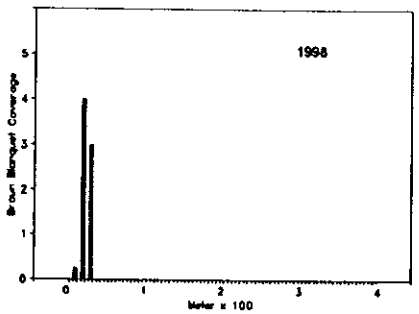

Figure 27. Distribution and abundance of *Ruppia maritima* along transect 11.1 in 1997. There was no *Ruppia maritima* coverage recorded within a Braun Blanquet meter square palcement in 1998.

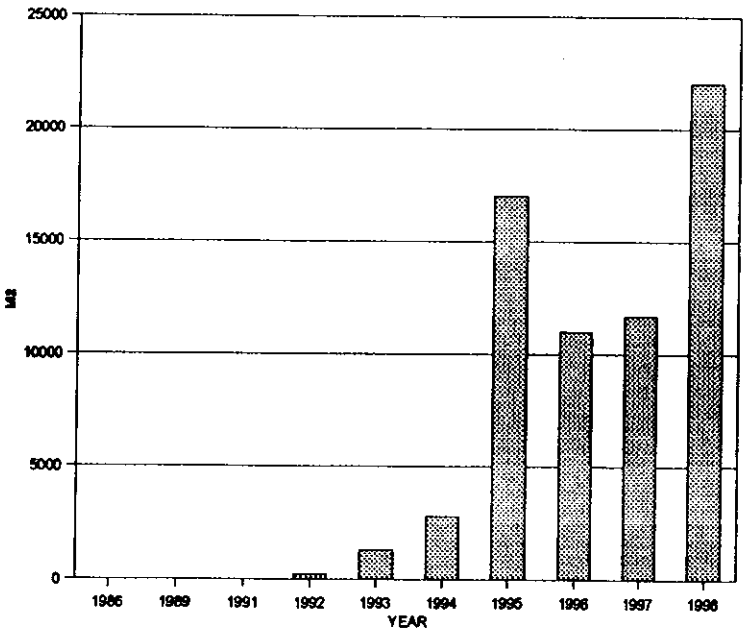

Figure 28. *Halodule wrightii* coverage in area 12 from 1986-1998.

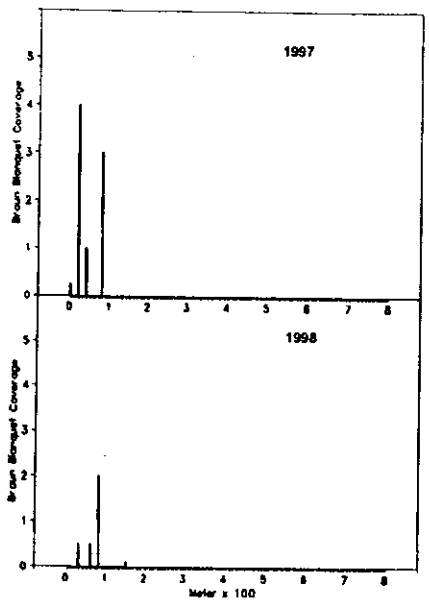

Figure 29. Distribution and abundance of *Halodule wrightii* along transect 12 in 1997 and 1998.

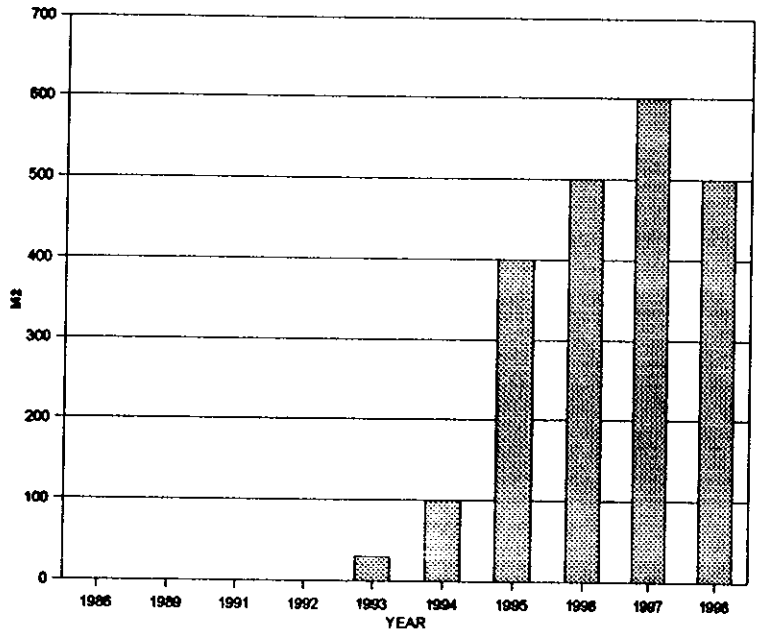

Figure 30. *Halodule wrightii* coverage in area 13.

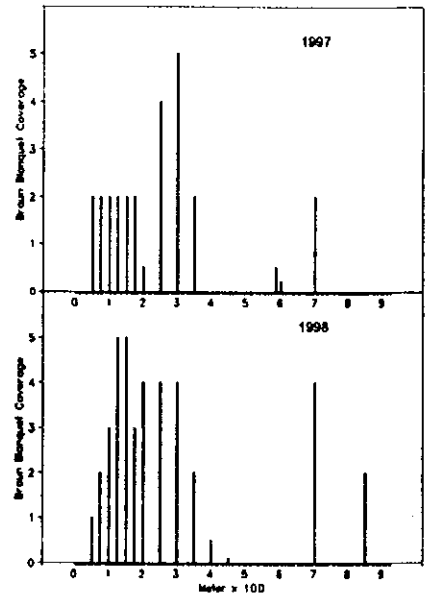

Figure 31. Distribution and abundance of *Halodule wrightii* along transect 14 in 1997 and 1998.

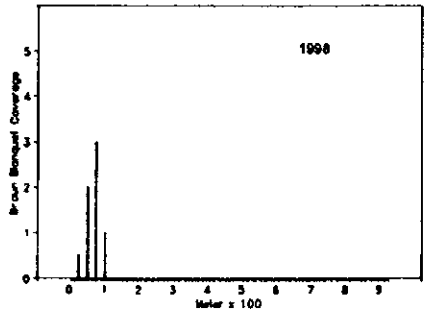

Figure 32. Distribution and abundance of *Ruppia maritima* along transect 14 in 1998. There was no *Ruppia maritima* coverage recorded within a Braun Blanquet meter square placement in 1997.

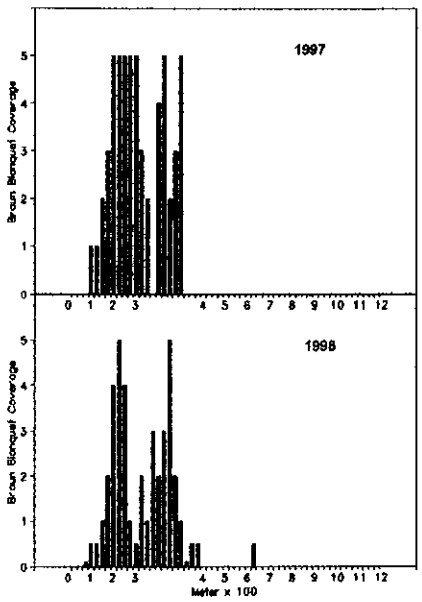

Figure 33. Distribution and abundance of *Halodule wrightii* along transect 15 in 1997 and 1998.

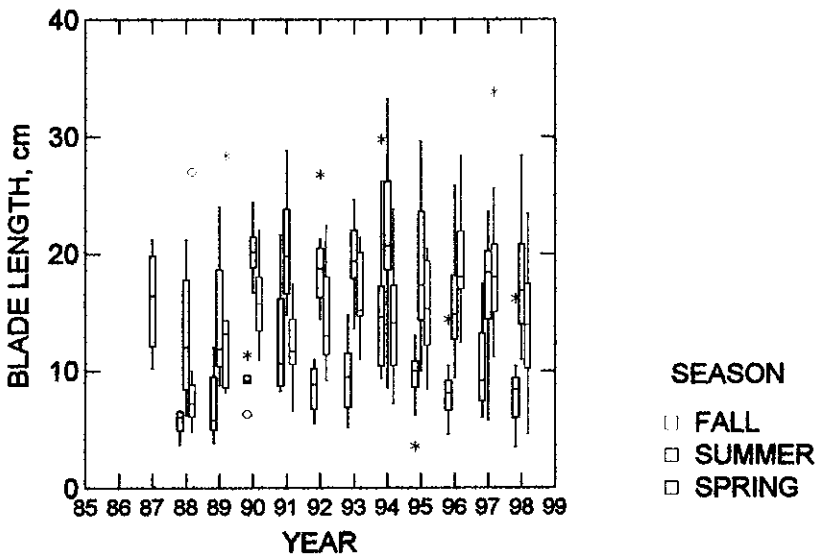

Figure 34. Box plot of seasonal blade lengths for *Halodule wrightii* in Hillsborough Bay from 1987 through 1998.

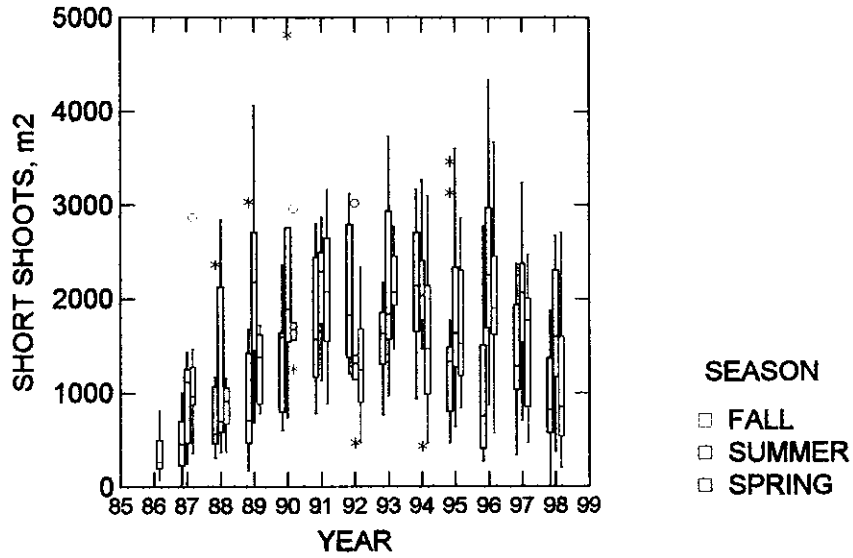

Figure 35. Box plot of seasonal short shoot densities for *Halodule wrightii* in Hillsborough Bay from 1986 through 1998.