

BAY BOTTOM HABITAT ASSESSMENT

DRAFT

FINAL REPORT

Prepared for: Sarasota Bay National Estuary Program
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I. EXECUTIVE SUMMARY

This project addressed the types and extent of the various submerged aquatic habitats of the Sarasota Bay system. A variety of distinct bottom habitats are contained within the system, yet all form a continuum where discrete functional boundaries are often difficult to define. Two elements were of primary importance, delineation of the submerged aquatic vegetation (SAV) and characterization of the different types of unvegetated bay bottom. For both components evaluations were made of the relative health of each habitat. The second element became more focused on the mapping of "disturbed" bay bottom as it became apparent that large areas of the bay bottom have been physically disturbed or altered, primarily by dredging activity. This mapping represents the first spatial quantification of such impacts.

The greatest single form of disturbance to the bottom of Sarasota Bay has been associated with dredge and fill activities. These activities have included major projects such as the creation of the Intracoastal Waterway, dredging of passes, the filling and closure of Midnight Pass, dredging of waterfront canals for waterfront homesites, dredging of numerous access channels to shoreline docks and dredging of large pits for borrow material for bridges, causeways and building sites. Dredge and fill activity has long been recognized as being environmentally destructive to wetlands. What has not been thoroughly documented, however, is the relative quality of the benthic habitat of dredged areas. This survey has found that, with a few exceptions, the benthic habitat resulting from dredging is of very poor quality and frequently an environmental liability. Dredging activities have resulted in the formation of many unnaturally deep holes and channels which act as "sinks" for fine particulate and organic matter. The depth of the dredge cut and the relative circulation are the key determinants in the post-dredge quality of benthic habitat.

Physical impacts associated with both recreational and commercial boating (primarily from propeller scarring) have also caused considerable damage throughout the bay. Propeller scarring was visible in virtually every grassbed of the bay system with the exception of small meadows isolated by mangrove barriers or oyster bars. Access paths for many shoreline docks are visible in aerial photographs as scarred seagrasses or propeller dredged channels through the shallow water grassbeds. Many shallow water docks exhibit halos of vegetation free zones caused by a combination of shading and disruption of the substratum

Sarasota Bay supports five of the seven species of seagrasses known from Florida. These grasses are *Thalassia testudinum* (turtle grass), *Syringodium filiforme* (manatee grass), *Halodule wrightii* (shoal grass), *Ruppia maritima* (widgeon grass), and *Halophila engelmannii* (star grass). Historical losses of deep seagrass meadows has been correlated with deteriorations in water quality. Poor water quality leads to a decrease in the ability of light to reach these deeper meadows. Loss of seagrasses exposes large quantities of silt-clay size particulates to erosion which in turn further decreases water quality. Many shallow grassbeds have been physically destroyed by dredge and fill activities. Today there are approximately 8,300 total acres of seagrass habitat within the Sarasota Bay system. In areas near Big Pass, New Pass and Longboat Pass, seagrasses may grow as deep as -2.5 meters MLW, while in areas of poor circulation, high turbidity or high color (such as Little Sarasota Bay),

seagrasses are often limited to very shallow areas less than 1 meter MLW. There has been an expansion of grass beds in the vicinity of the passes. For example, from 1984 to 1988 there was a 19% increase in seagrass cover in the vicinity of the New Pass flood tide shoal. This gain, however, was primarily in the "patchy" and, to a lesser extent, "sparse" distribution categories. At the same time, there was a 9 percent loss of "dense" seagrass beds in the same area. The expansion of seagrasses on flood tide shoals is cause for cautious optimism because of the transitory nature of pass habitats. The long term stability of pass areas will depend on a number of factors decided by pass management policy decisions.

Since 1984 the south bay region (Little Sarasota Bay, Roberts Bay) has been undergoing significant changes in benthic community structure, exhibited as changes in the composition of seagrass species and reductions in benthic faunal diversity. These changes are most evident in the Bird Keys and Midnight Pass areas and may be attributed to the closure of Midnight Pass, which has resulted in reduced circulation and increased light attenuation. As recently as 1984, turtle grass (*Thalassia testudinum*) was present in the vicinity of the former Midnight Pass. Today, this area is colonized by widgeon grass (*Ruppia maritima*), an ephemeral seagrass typically found in unstable environments. These meadows usually represent the final stage of seagrass meadow degradation followed by the complete absence of seagrass. Only time will tell if this scenario is played out in Little Sarasota Bay.

Seagrass meadows have a high capacity for trapping and storing fine grain particulates. Loss of the seagrass meadows results in the release of large quantities of fine particulates into the bay system. The build up of this material in dredge holes and in areas of poor circulation such as Roberts Bay and Little Sarasota Bay has probably made a significant contribution to the deterioration of water quality, by increasing turbidity, and further reductions in seagrass habitat.

In areas impacted by dredging activities, the recovery of the bay bottom and its subsequent potential to support biological communities ultimately depends upon, 1) the depth of the dredged or disturbed areas relative to the depth of the surrounding bay bottom and 2) the degree of flushing or water exchange in the vicinity of the disturbance and the velocity of exchange. Most of the dredged sites within the Sarasota Bay study area are relatively old and have reached a climax biotic community. Unfortunately the biotic quality of most of these dredged sites is very poor. There are relatively few disturbed bay bottom areas that are suitable for restoration. In addition any restoration that would involve depositing large quantities of fill material would likely be cost prohibitive, unless coordinated with maintenance dredging, wetlands or uplands restoration or other mitigation projects.

Restoration of seagrass beds may be more complicated than improving the quality of the freshwater inflow. Sarasota Bay supports a wide variety of seagrass meadow "types" for which the quality covers a wide range. Perceived impacts include light attenuation, excessive nutrients, alteration of circulation and physical disruption. For some areas (example, Roberts Bay and Little Sarasota Bay) the shallow nature of the bay and the poor sediment quality (high silt-clay content) result in frequent sediment resuspension due to wind and boat wake water turbulence. Seagrasses may not be able to colonize fine mud

subject to frequent resuspension regardless of water quality. The best quality seagrass beds in the Sarasota Bay area are those closest to passes, which benefit from a high level of tidal flushing.

Throughout the bay the impacts on seagrasses due to access and boat traffic will increase in proportion to the level of boating activity. Any increase in shallow water shoreline dock construction in areas of seagrass meadows will result in a proportional destruction of the adjacent seagrasses.

II. PROJECT BACKGROUND

An essential part of the National Estuary Program involved the assessment of status and trends for critical living and other natural resources. Following these guidelines, this project was designed to document changes in submerged aquatic vegetation and other habitats within Sarasota Bay, determine the causes of habitat change, define the extent and condition of remaining habitats, and help define restorative measures in the Comprehensive Conservation and Management Plan (CCMP).

Submerged aquatic vegetation (SAV) refers to seagrasses and rhizophytic algae, and also accumulations of drift algae where these are management issues. In Sarasota Bay, past bottom habitat assessments have focused primarily on seagrasses. Several site-specific descriptions of seagrass cover are available and trends have been assessed for some of these areas over variable time periods. However, there has been no one description for the entire study area, performed by uniform methods, to describe the distribution, abundance and/or condition of SAV. Vegetative cover has been determined for much of the bay, but bay-wide trend analyses have yet to be performed. Bay areas with improving or declining seagrass cover needed to be mapped, along with locations of propeller damage or grassbeds with heavy epiphyte burdens. Sites need to be identified where seagrasses might be planted or encouraged to recruit naturally once water quality improves. Estimates of the maximum possible seagrass coverage in the bay are needed for different CCMP management scenarios. Most of these information needs also apply to rhizophytic algae, particularly species which may have similar habitat value.

Data are likewise needed for other bay habitats in addition to seagrasses. Unvegetated benthic areas support large numbers of surface and burrowing fauna, including many valuable shellfish species. Their habitats may be muddy, sandy or shelly. Impacts to unvegetated benthos are more difficult to define than for vegetated sites, due to a lack of judgement criteria. Deep water benthos is also more difficult to discern from aerial photographs, a key tool for seagrass surveys. Nevertheless, a goal of this project was to quantify those areas of unvegetated bay bottom that have been altered from the "natural" condition. The distribution and abundance of "soft" and 'hard' bottom habitats have not been documented. Additional detail on the kinds of unvegetated bottom and an inventory of each type are needed, including open water habitats.

Combining the above elements in a comprehensive survey of the Sarasota Bay system was an NEP recognized goal that would aid bay resource management, provide for future comparisons and contribute to policy development.

III. INTRODUCTION

Benthos is a Greek word meaning "bottom" and refers to the depths or bottom of the sea. Benthic ecology is the study of the plants and animals that inhabit the benthos, together with their environmental requirements. Benthic organisms are excellent indicators of general habitat conditions. The distribution of the plants and animals that live on or within the aquatic substratum is regulated by a variety of environmental factors, the most important of which are salinity, temperature, tidal inundation (intertidal or subtidal) and substratum composition.

Benthic organisms are generally not highly mobile, that is the majority of the individuals will live their adult lives within a relatively small area. This is in contrast to many fishes that range over wide areas. It is due to this restricted mobility that benthic organisms are considered excellent indicators of habitat conditions and in some cases environmental quality.

Benthic organisms contain representatives of nearly every major life form. The most conspicuous elements are plants; consisting of algae and seagrasses, invertebrates; which include barnacles, shrimp, clams, corals and worms, and vertebrates; represented by certain species of fish.

III.A. Types of Benthic Habitats

Benthic habitats are classified according to salinity regimes (freshwater, estuarine, marine), type of substratum (hard or soft bottom) and the presence or absence of aquatic vegetation. Within the Sarasota Bay study area, the following five major categories of bottom habitat are found (ranked from most to least common):

- 1) unvegetated subtidal (sand and muddy/sand)
- 2) intertidal and subtidal seagrass meadows
- 3) artificial hard bottom (reefs, seawalls, and bridge pilings).
- 4) natural rock outcroppings (including the nearshore Gulf)
- 5) oyster bar habitat

III.B. Importance of Benthic Habitats

Benthic habitats are an important component of the coastal ecosystem. Seagrass beds are one of the most publicized habitats because of their role as primary producers, habitat for commercial and recreational fish and shellfish, and their ability to stabilize sediment. Recent reviews and analyses of aerial photographs indicate significant losses of Florida's seagrass habitat over the past few decades (Livingston, 1987). Non-vegetated benthic habitats also play a very important part in the coastal ecosystem but there have been no systematic studies to date on the effects of habitat alteration or loss.

Most benthic organisms have complex life cycles, including a planktonic egg or larval stage, that provide an immense food resource for pelagic organisms. The benthic fauna recycle the detritus and nutrients that result from primary production, which prevents buildup of organic material on the bay

bottom A variety of human food organisms, such as shrimp, clams, oysters, crabs and certain species of fish, are dependent on unvegetated bottoms.

The diversity of organisms living on and within the bottom is much greater than that of the water column. Within the Sarasota Bay study area (including the nearshore Gulf of Mexico) there are between 500 to 1,000 species of macroscopic benthic invertebrates, representing most of the major animal phyla. Because of their great diversity, limited mobility, and specific habitat requirements, benthic invertebrates are used as a measure of habitat quality by Federal and State regulatory agencies. From a resource management perspective these areas are important for the following reasons:

- Soft bottoms act as the major source of turbidity through wave generated resuspension in most bay systems. Therefore the location, surface grain size composition, and relative areal extent of the soft bottom areas is a major management concern.
- Soft bottoms act as a major sink or source for nutrients and toxic substances.
- Soft bottoms are not "barren". Invertebrate productivity is equivalent and sometimes greater than the benthos associated with submerged aquatic vegetation communities. This productivity translates into "fish food" for both bottom feeding and pelagic fishes. These productive soft bottom areas are affected by many of the same factors that affect aquatic vegetation, such as turbidity, urban effluent, pollutants etc..
- Modified or disturbed soft bottom areas can be the source of chronic environmental problems. Dredged areas such as canals and boat basins can act as sinks for fine organic particulates, resulting in anaerobic conditions and the production of hydrogen sulfide (a noxious, toxic gas). Periodic disturbance can result in fish kills, reduced turbidity and reduction in overall water quality.

IV. BOTTOM HABITAT DESCRIPTIONS

IV.A. Introduction

This section provides a detailed description of the bottom habitats from throughout the study area. Descriptions are arranged according to bay segment.

IV.B. Materials and Methods

Characterizations of the benthic habitats of Sarasota Bay are based on numerous field surveys conducted throughout 1990 and 1991. Field work began on February 8, 1990 and was completed during October, 1991. Prior to initiation of field surveys, a set of aerial photographs encompassing the entire study area was obtained. The photographs were used to identify conspicuous features and as a field guide to survey/sample locations. In 1990, twenty-two days (37 man-days) were spent in the field, which corresponds to a total of 168.20 man-hours of observation. During 1991, twenty days of field work (51 man-days) resulted in 159.50 man-hours of observation. Overall, more than 320 man-hours were spent collecting samples, running bathymetric transects, gathering video and still photography, and visually inspecting large areas of the bay bottom.

One of the primary field efforts involved ground truth verification of benthic habitats and bottom features outlined in a series of aerial photographs of the Project area. These photographs are products of true color aerial imaging from four separate fly-overs of the study area between October 26 and December 14, 1988. These efforts were sponsored by the Surface Water Improvement and Management (S.W.I.M) Program of the Southwest Florida Water Management District.

Shallow water features that are discernable from aerial photography include submerged aquatic vegetation (SAV), shoals and sandbars, oyster bars and reefs, shorelines, channels, and canals and other dredged areas. Ground truthing efforts involve the identification of SAV species composition, descriptions and characterizations of other distinct habitats, and analysis of surface sediment composition from unvegetated habitats (including channels, canals and dredged areas). Deep water habitats which do not appear on the aerial photographs were explored by running transects and bathymetric surveys. Stations were spaced along each transect so as to provide the most complete coverage of these areas.

When possible, observational determinations of the relative health of each habitat were conducted. No argument can be made on ecological grounds for ranking one naturally occurring habitat of greater value than another. Our objectives are similar to benthic habitat assessments conducted for other National Estuary Programs, whose objectives have been eloquently summed up by Simenstad, et al. (1991). They state:

Each habitat contributes to the estuarine ecosystem in a unique way, supports discrete fish and wildlife, and varies in its ability to generate, assimilate, or process nutrients, organic matter, and sediments. Furthermore, estuarine habitats are linked integrally

through pathways of materials (the transport of nutrients, detritus) and organisms (the movements of fish, macroinvertebrates, mammals, birds); they should never be considered as disjunct communities. The natural continuum of habitats across an estuary must be preserved or restored if we are to maintain and eventually restore value, if they must be made, belong in the realm of policy and management and outside the scientific scope of this assessment.

The benefits of this approach come from the uniform format of habitat assessment. This is accomplished by employing a standardized set of criteria to all habitats throughout the bay. In this way, areas that require special management considerations (from protection of rare and highly sensitive habitats to restoration of stressed or degraded habitats) become more apparent. During field investigations notes or comments (potential for restoration, occurrence of scars in grass beds, presence of trash or debris, etc.) were recorded as anecdotal information.

There are several limitations to a habitat survey such as this that must be addressed. First, conditions within any defined habitat change over a variety of time scales, which makes attempts at definitive or emphatic descriptions of habitat type inconceivable. Levels of epiphytes or drift algae, for example, can change dramatically from season to season. This is particularly true for any of the biological components of estuarine habitats. However, by conducting repetitive surveys over a broad time period, reliable distinctions can be drawn concerning relative conditions between functionally similar habitats. Secondly, in an aerially intense survey such as this, extrapolation becomes a common practice. During each survey, precautions were taken to visually inspect and sample sufficient area within each habitat to accurately reflect existing conditions. Only through considerable consultation and cautious interpretation of aerial photographs were observed conditions extrapolated to significantly larger areas of submerged bottom.

Observations and descriptions of benthic habitats are presented according to the bay segment scheme adopted for the Sarasota Bay Program, Figure 4.1 (Estevez, 1990). Observations begin at the southernmost portion of Blackburn Bay and continue north by Segment. Aerial mapping products, however, extend to the Venice Inlet. Aerial derived Figures referenced in the text are found in Appendix A, Seagrass Habitat and Appendix B, Disturbed Bay Bottom.

IV. C. Results.

Segment B16, Blackburn Bay. Bottom habitats in Blackburn Bay were dominated by two features: the Intracoastal Waterway (ICW) and shallow, extensive seagrass meadows (Appendix Figures A.1369, A.1262 and B.1369, 8.1260). Sediments in the southern portion of this segment consisted of well sorted, clean shell-hash and sand, with very little mud in the grassbeds. Sediments in the ICW samples contained gravel and large shell fragments along with shell-hash and sand. Seagrass beds located east of ICW Marker 13 (Loran coordinates 14159.8:44305.7) appeared very robust. All three dominant seagrasses were present in both pure and mixed assemblages. No drift algae was observed during the visit (26-June-91). Epiphytes were most often absent, although some grasses

had low to occasionally moderated epiphyte loads. *Thalassia* and *Halodule* blades near the ICW were stunted in size compared to the rest of the meadow. These conditions indicated that this area has excellent circulation and flushing.

Shallow water sites just to the north (east of ICW Marker 15; Loran coordinates 14160.5:44308.0)) also supported seagrass meadows. The outer border consisted of *Syringodium* (long-blade types in the deeper waters and short-blade types in the shallows), while the interior predominantly consisted of *Halodule* (with some *Thalassia*). Portions of the outer margin of this meadow (approximately three meters) were within the ICW; these areas contained quite a few prop scars. Large masses of blue-green algae were found on many interior grass blades. No drift algae was observed, at least along the outer margins of the grassbed. Sediments were relatively free of mud (silt/clay), consisting of sand and shell-hash.

Extensive seagrass meadows existed within the central section of Blackburn Bay on both sides of the ICW. Grass meadows to the west of the Intracoastal Waterway (ICW Marker 19, Loran coordinates 14160.9:44311.3) extended uninterrupted from the ICW to the shore. Grasses along the outer, deeper margin consisted of a fringe of *Syringodium* adjacent to a strand of *Thalassia* (occasionally intermixed with *Halodule*). After approximately 100 meters, the grassbed became a pure stand of *Halodule*. One of the few occurrences of stargrass (*Halophila engelmanni*) within the study area was found intermixed with this outer *Halodule* bed (although this grass is easily overlooked and the extent of its cover could not be ascertained). The nearshore grassbeds consisted of well-developed *Halodule* stands organized in a classic "patchy" distribution. All species of seagrass within this meadow had long, luxuriant blades with light to moderate epiphyte loads. Very little blue/green algae was present on any of the blades; little to no drift algae were present. Tunicates were present everywhere and sea urchins (*Lytechinus variegatus*) were abundant. Intracoastal Waterway sediments appear scoured, with little mud present.

The eastern side of central Blackburn Bay (Loran coordinates (14161.5:44312.6) was deeper than the adjacent western side. The deeper portions of this segment had an extremely sparse bed of *Halodule* as well as numerous biogenic surface features (i.e., worm tubes, burrows, trails, etc.) and numerous dead quahog (*Mercenaria*) shells. Near the shoreline was a fringe of *Halodule* intermixed with small patches of *Syringodium*. Very little *Thalassia* was present. Blade epiphytes were moderately dense with some blue/green algal clumps observed. Drift algae was sparse.

With a few exceptions, a similar pattern of seagrass distribution and condition, was found a little farther north in Blackburn Bay (between ICW Markers 21 and 23; Loran coordinates 14161.8:44321.1). Throughout the western portion of the bay, a fringe of *Halodule* was present along the border of the ICW followed by a wider stretch of *Syringodium* inside this fringe. All the seagrasses contained noticeably more epiphytes. Seagrasses in the eastern segment of the bay, while of the same composition as the western segment, were distributed more unevenly, typically in dense patches. *Thalassia*, which was not observed at this location, did not appear to extend this far north in Blackburn Bay.

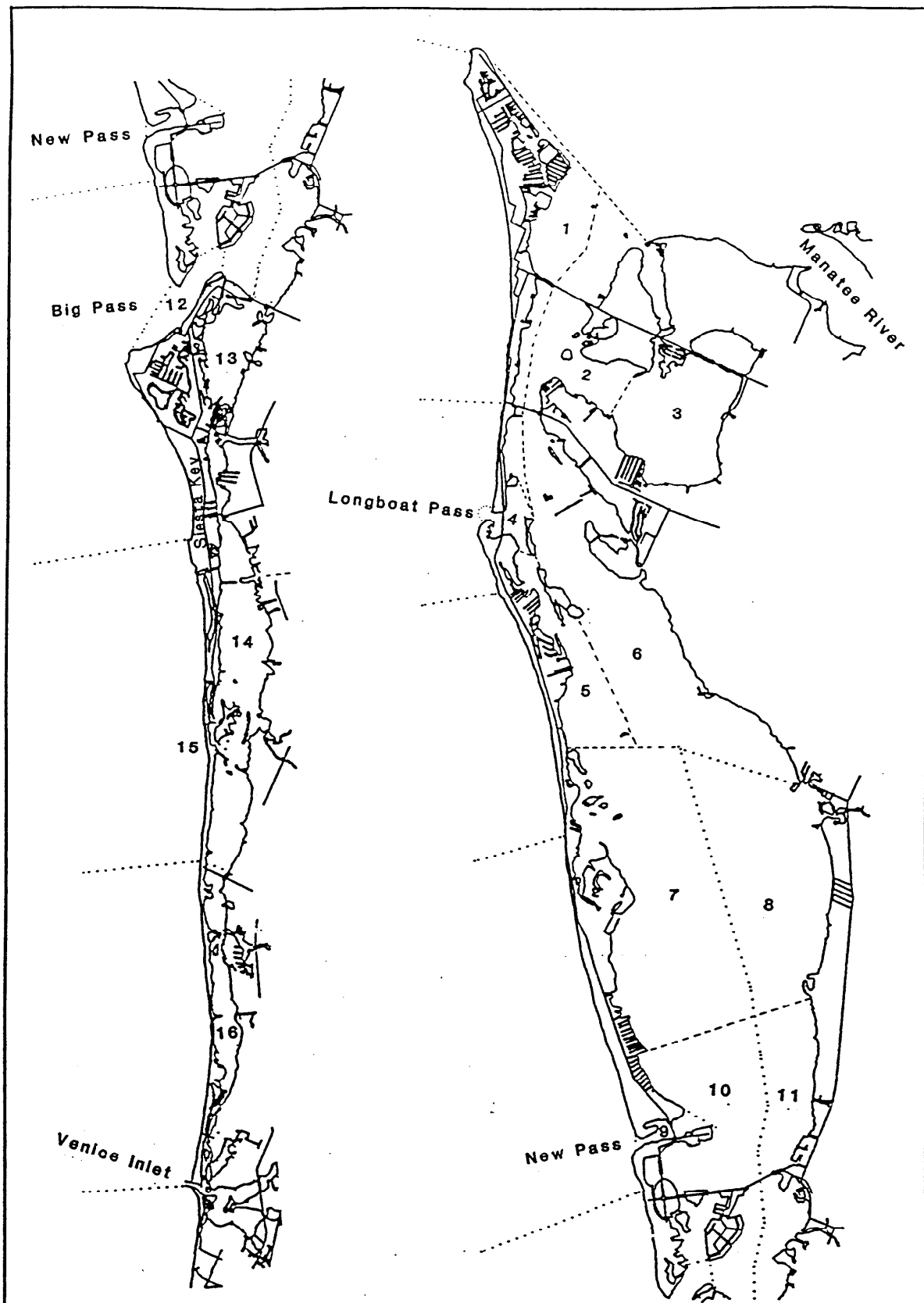


Figure 4.1. Sarasota Bay segmentation scheme adopted for the Sarasota Bay Program

Blackburn Bay constricts in the vicinity of the mouth of South Creek, with a fringe of Mangrove islands to the west of the ICW. Several small enbayments make up the remainder of Blackburn Bay to the north. One of these enbayments (west of ICW Marker #29A; Loran coordinates 14162.6:44328.9) was selected as a seagrass monitoring station and was visited several times during the course of the project. These shallow areas support the growth of monotypic stands of *Halodule*, which was the predominant seagrass in this region. Very little *Syringodium* was found here, which probably represents the northern boundary of this seagrass in the Little Sarasota Bay subestuary. These *Halodule* stands were located near shore and behind the spoil bars created during dredging of the ICW. During the winter, seagrasses were moderately dense, evenly distributed and continuous, with no large patches observed. Epiphyte cover was sparse. During the summer, grass blades had medium to extremely heavy epiphytic growth and large loads of blue/green algae were present. Seagrass cover was less continuous, with patches of exposed sediment. The attached green alga, *Caulerpa aschmedii*, was present during the summer. Drift algae were sparse in this area, and few conspicuous macroinvertebrates, except for the crown conch (*Melongena corona*) were present.

While the ICW was undoubtedly the major bottom disturbance within Blackburn Bay there were numerous shallow water docks and access channels to deeper water. These docks and access points were visible as scoured areas in the aerial photographs. Several dredged deepwater boat basins were also present on the east side of the bay. South Creek west of Hwy 41 has been heavily altered by dredging of finger-fill canals and a boat access channel to the bay.

One additional habitat found in Blackburn Bay was a single, centrally located oyster bar. This bar, situated just south of the channel into South Bay, was positioned perpendicular to the main axis of the bay and extended from both shorelines towards the middle of the bay.

Segment B15. Midnight Pass. This segment, which included the subtidal areas around the Bird Keys, supported extensive *Halodule* seagrass meadows (Appendix Figures A.1256, B.1256, B.1258). (Seasonal information on seagrass standing crop from two sites in the vicinity of Midnight Pass is presented in section V- Submerged Aquatic Vegetation). The highest density grassbeds were found to the south and east of the Bird Keys, while sparser beds were found in the northern portions of this segment. Grasses in the southern section consisted of dense, continuous beds in deeper waters and sparse patches in the shallows. All had a growth of moderately heavy epiphytes, especially during the warmer months, when large "blobs" of blue/green algae were found attached to the blades. Numerous prop scars were evident throughout these grassbeds.

Seagrass distribution in the northern portion was very patchy and uneven, consisting of clumped areas of seagrass. Epiphyte loads were lighter than comparable stands to the south and little drift algae was present. The substratum of this area was extremely soft, consisting primarily of silt/clay. The substratum for other areas was highly variable; some areas were soft mud, others mud and sand, while others included shell fragments as well. *Diopatra* tube worms were very common among the grasses, and, to a lesser degree, *Melongena corona* (crown conch). Shells of recent dead *Mercenaria mercenaria* (quahog), *Macrocallista nimbosa* (sunray venus), *Ensis* (jackknife clam) and *Crassostrea virginica* (oyster) were quite common at the time of the survey.

After extensive searching one live large *Mercenaria* and a small clump of live oysters were observed. All of the above mollusc species were quite common prior to the closure of Midnight Pass.

The only confirmed stand of widgeongrass (*Ruppia maritima*) observed during this survey was found in the shallow waters located behind Midnight Beach. These grasses possess seeds throughout the summer months. This area was unvegetated sand, shell-hash as recently as 1988 (from aerial photointerpretation), indicating fairly recent colonization of this habitat. *Halodule* also appears to be colonizing this area as well. *Meionena* conchs are very abundant. Sediments were highly variable, ranging from soft mud to sandy shell-hash along the shallow subtidal margins.

The Midnight Pass bay segment has undergone several periods of disturbance. The ICW construction altered both the bottom character and the existing mangrove islands by the dumping of ICW material. To the east of the existing ICW there was a short blind section of channel that has filled with muddy sediment. Development of Siesta Key has resulted in a seawall hardened shore lined with boat docks. The substratum in this area was primarily silt-clay and exhibited a strong hydrogen sulfide smell when disturbed. In December of 1983 the area was impacted by the permitted closure of Midnight Pass, when the northward migration of the Pass threatened property of homeowners on Siesta Key. The required re-opening of the pass to the south failed. The change in circulation and water exchange to the bay altered the characteristics of the water in the vicinity of the Pass. In two related studies conducted for Sarasota County, in 1984 and 1989, respectively, Mote Marine Laboratory personnel documented substantial alterations and an overall reduction in diversity of the benthic fauna. Changes in seagrass composition in the area have occurred since 1984.

Segment B14, Little Sarasota Bay. For the purposes of this study, Little Sarasota Bay was divided into two geographical subbasins. These subbasins are essentially separated from each other by the Bird Keys, located in the vicinity of Midnight Pass. The southern subbasin stretches from the Bird Keys south to Blackburn Point. This section contains a series of six well developed oyster bars running perpendicular to the main axis of the bay. There are two major auxiliary channels from the ICW just north of Blackburn Point: the first provides access to a marina/boat basin complex on the eastern side, and the other channel, several hundred meters to the north, runs to residential docks along the western shore.

Deeper areas of the southern basin were covered with a continuous, relatively thin and monotypic layer of drift algae. Surface sediments, while muddy, were consolidated with a base of shell fragments. A sparse but extensive cover of *Caulerpa* sp. began several hundred meters from shore, and another attached alga (*Caulerpa prolifera*) was present in shallower waters. A thick fringe of *Halodule*, with a moderate to heavy epiphyte load, was found along the shores. A sparse cover of *Halodule* was found in the remaining shallow depths of this section.

The oyster bars contained some large, live oysters. Surrounding these bars were seagrass beds containing both *Halodule* and *Syringodium*. These oyster

bars appeared in good shape based on the condition of the oysters and related epifauna.

The northern subbasin contains three series of even more complex oyster bars perpendicular to the axis of the bay. These bars are over one hundred meters in length and dominate the bathymetry in this section. These beds contained many large clumps of live oysters. *Halodule* was present throughout the oyster bars except in the deeper interbar areas. *Thalassia* was found mixed with *Halodule* along the fringes of the oyster bars. Although *Thalassia*, was patchy in this area, it appeared very lush and dense. Furthermore, the only *Thalassia* found in Little Sarasota Bay was associated with oyster beds. *Caulerpa* sp. was found on hard substrates associated with the oyster beds.

No seagrass was found in the deeper waters between the oyster beds. Surface sediments had a layer of algae. Sediments were consolidated and contained a larger sand fraction than soft sediments in the southern subbasin. These sediments had a thin layer of drift algae covering them

Segment B13, Roberts Bay. This bay segment was further subdivided into three sections for purpose of discussion. The northern section is bounded to the north by the segment boundary (water south of a line 500 feet north of the Siesta Drive bridge) and to the south by the mangrove islands north of the mouth of Phillippi Creek where the bay width is restricted to the ICW. The central section extends south from this point to the Stickney Point bridge and includes Phillippi Creek and its tributaries. The southern section includes waters south of Stickney Point bridge to the southern border of the Roberts Bay segment at the narrows.

North Roberts Bay contained two large spoil islands to the west and one large and several smaller spoil islands to the east of the ICW. These spoil islands were fringed by red mangroves. A large, expansive, shallow sub-tidal sand bar and oyster bed formed as a southwest extension of the second, more westerly of the two large spoil islands west of the ICW. The sandy area was surrounded by seagrasses. *Thalassia* was the predominant grass with *Halodule* forming a fringe near the mangrove border of the island. Large clumps of drift algae had collected at the borders of the grasses, oyster and sand bars. Seagrass epiphytes were relatively moderate. Surrounding sediments consisted of a very dark mud. Conspicuous epifauna included tunicates, sponges and, on the oysters, the crown conch. Finally, a number of distinct "holes" (dredged areas) were present in this section both east and west of the ICW. The dredged areas in this section were generally much larger and deeper than necessary for navigation, indicating the need for fill material for shoreline construction.

Another large spoil island was located in the middle of Roberts Bay between the entrance to the Grand Canal system of Siesta Key and the ICW. The western shore of Roberts Bay in this section was lined by a *Halodule* grass bed (with very sparse *Thalassia* present). Unvegetated bay bottoms beyond the edge of the grassbed were covered with an uninterrupted mat of drift algae, approximately four to six inches deep. Two large areas of altered bay bottom (apparently dredged material borrow sites) were found in this section; one to the west and one off the southern tip of this spoil island. Sediments in these areas were somewhat anoxic (presence of a slight H_2S odor) and consisted of a very dark silt/clay with a thin, lighter-colored surface layer.

The southeastern sector of northern Roberts Bay (east of ICW Marker G75) supported a patchy *Halodule* grass bed, with a sparse growth of *Thalassia* along the outer margin. *Halodule* blades had moderate to heavy epiphyte loads, while the bare patches among the grasses contained large quantities of drift algae. Deeper regions of this section were unvegetated, with sediments of muddy sand. Oysters were located near shore.

The eastern and northeastern portions of the southern subbasin of Roberts Bay contained a series of small oyster bars oriented perpendicular to the shoreline. These bars were fairly wide and fringed by oyster shell and shell hash. Few living oysters were present. The green alga, *Caulerpa aschmedii* was found running throughout the oyster bars. Several sponge species were also present. A mat of blue/green algae was present in the mud surrounding these oyster bars. Remaining areas consisted of muddy sand sometimes vegetated by sparse to moderate *Halodule* with moderate epiphyte loads. Drift algae was light to moderate. Sediment surface features included worm tubes, burrows and fecal mounds. A fringe of *Halodule* bordered the eastern shore. The southeastern corner of this subbasin was covered by an almost continuous mat of drift algae of varying thickness. A narrow strip of *Halodule*, also covered by drift algae, was present near shore. Sediments consisted of firm muddy sand near shore to soft mud away from shore. Sediments in the southwestern corner of this section were anoxic, silt/clay mud. The entire area was covered by a thick, continuous layer of drift algae. No other habitat was present in this section.

Phillippi Creek flows into the narrow section connecting Roberts and Little Sarasota Bays. On falling tides the flow from the creek was observed to flow primarily into Roberts Bay, while on rising tides the flow seemed to split between Roberts and Little Sarasota Bay. There were numerous oyster bars in the mouth of the creek associated with the mangroves. The nature of the benthos of the creek was examined upstream to just beyond the Bee Ridge bridge. From U.S. highway 41 to Bee Ridge, the creek banks were generally highly modified, with various types of professional and amateur bank stabilization structures. The immediate uplands were developed primarily for residential homes. The central portion of the creek was well scoured with the substratum consisting primarily of coarse quartz sands. In a few places (downstream of Proctor Road bridge) exposed limestone was observed. The lower creek (downstream of Bee Ridge and including side canals) contained many boat docks, with over 300 boat slips counted at the time of the survey. The sediment quality within the side canals and boat basins was generally very poor consisting primarily of silt-clay material, void of fauna or macrophytes and exhibiting a strong hydrogen sulfide odor.

Segment B12, Big Pass. Benthic habitats in this bay segment were dominated by the deep water channel bordering the shoreline of Siesta Key and the extensive tidal flats and sandbars between the channel and southern Lido Key. A thin edge of seagrass separates the channel and the beach along the unmodified shorelines of Siesta Key. Sediments consisted of well-sorted sands at the margins and coarse sand and shell within the channel due to the influence of strong tidal currents. The channel area was classified as "disturbed" for the mapping portions of the project, because the natural meandering of the channel has been stopped by the north Siesta Key seawalls. In addition piles of concrete rubble bordered the seawall, and a submerged water utility pipeline

traverses from Siesta Key to Lido Key off Shell Road. The scoured channel contained a sparse fauna and the rock piles served as the point of attachment for organisms common to the nearshore Gulf patch-reefs. Attached fauna such as sponges, hydroids, gorgonians, bryozoans and tunicates and motile epifauna such as crabs and amphipods were common on the rock piles. Fish species including small grouper, spadefish, Sheepshead, and blenny's, were present but generally sparse at the time of observation.

The mouth of Big Pass contained a large ebb tide delta of clean medium to fine quartz sand and relatively little shell hash. The cephalochordate *Branchiostoma* characterized this habitat. Seagrass beds (probably *Halodule*) were reported on a small portion of the delta in the summer of 1992.

The bayside areas of this segment contained two separate tracts of seagrass. The first tract, a well-developed, isolated patch off the southern tip of Bird Key, was surrounded on all sides by channels. This patch contained all three seagrass species (*Thalassia* towards the center; *Syringodium* and *Halodule* towards the edge) as well as a large bare area consisting of clean, fine sands. Numerous *Diopatra* tubes, live *Mercenaria* clams and *Busycon* whelks were observed here. The other tract of seagrass was found along the backside of Lido Key in Brushy Bayou (Appendix Figure A.950). These meadows were predominantly *Thalassia*, with *Halodule* closer to shore. All grasses appeared healthy, with little epiphyte or drift algal cover. Depressions and prop scars in this meadow were colonized by the green alga, *Caulerpa*.

Segment B11, Sarasota. This segment contained a mixture of natural, artificial and "disturbed" benthic habitats (Appendix Figures A.2008, A.2010, B.2008, B.2010). Two types of seagrass communities were present, healthy fringe perennial meadows along the eastern shoreline and deeper mid-bay shoal perennial meadows in the middle of the bay. The fringing meadows were most extensive in front of Selby Gardens and around the mouth of Hudson Bayou. These grassbeds were primarily sparse *Halodule*, especially near Island Park and Selby Gardens. Further south, Hudson Bayou grassbeds exhibited some thin, short-blade *Thalassia* along with *Halodule*. Numerous *Mercenaria* clams, both dead and alive, were present. Sediments were mainly sandy mud, with a soft flocculent surface layer. Fringing grassbeds south of Hudson Bayou were less extensive and more patchy in distribution. These beds had very sparse *Thalassia*, being almost pure *Halodule* stands. Drift algae was most abundant in these grassbeds. There was sparse *Halodule* colonization on the north side of the John Ringling Causeway, east of the fishing pier. No other fringing perennial meadows were present in this segment north of Golden Gate Point until the Indian Beach area, where a narrow, discontinuing band of *Halodule* extended northward. The deeper, mid-bay perennial grassbeds consisted mostly of *Syringodium* and *Thalassia*. *Halodule* and the alga, *Caulerpa*, were also present, although not as abundant as the other two species. Sediments, while somewhat variable, ranged from clean sand within *Syringodium* beds to sandy mud with a slightly flocculent surface stratum in the surrounding unvegetated bottoms. Two large, shallow subtidal sand flats were located in this segment, one at the mouth of Hudson Bayou and the other situated just north of the Siesta Drive bridge along the eastern shore. Rose Coker artificial reef, composed of concrete and ceramic power line insulators, was located just outside this southern sand flat. The reef was heavily colonized with barnacles, tunicates, and colonial hydroids, as well as small motile epifauna.

Several major "disturbed" bottoms, created as a result of dredging activities, were located within this segment. A southward, shoreline channel extended from the mouth of Hudson Bayou around and through the Harbor Acres subdivision. Dredging of this channel undoubtedly resulted in the destruction of fringing grassbeds in this area. The Marina Jack boat basin, within a line connecting the southern tip of Golden Gate Point and the tip of Island Park, has been dredged to a depth of approximately 12 feet MLW. Sediments in this basin are anoxic silt/clays with virtually no benthic infauna. There was a thin fringe of *Halodule* and *Caulerpa* along the shallow northern edge of the basin. The Harts Landing basin (within a line connecting the tip of Golden Gate Point and the eastern end of the John Ringling Causeway) also was dredged to a depth of approximately 12 feet MLW. Sediment in this basin also consisted of flocculent, anoxic mud. The boat moorage to the south of Island Park has also undergone extensive dredging. A dredge cut to the west of the Selby Botanical Gardens interrupts the shallow water north-south continuum of *Halodule*. To the north of the John Ringling Causeway several shoreline dredge cuts (Sarasota Quay, and Payne Terminal) act as silt-clay particulate traps, containing anaerobic flocculent mud. Aerial photograph examination also revealed an extensive, unusually configured dredged area due north of the Tony Saprito fishing pier and west of 888 Condominiums (Appendix Figure B.2008). Sediments in this dredged tract differed from sediments from other, more typical, dredged systems. This area contained exposed rock with 3 to 5 feet of vertical relief. The rock was inundated with burrowing invertebrates (mostly polychaetes) and attached epifauna. Sediments were generally clean, slightly muddy sands and fine shell hash. Numerous worm tubes and sand dollars were also present. Sediments were not anoxic like those from most other dredged areas.

Remaining benthic habitats in the northern portion of this segment were all unvegetated and characteristic of deeper, open bay areas, with a substratum of consolidated sediments, which were a mixture of mostly sand and some mud. A thin layer of brown algae was present on the surface. Burrows, tubes and other biogenic features were also present, giving the sediment surface a low profile vertical relief.

Segment B10, Coon Key. This segment contained the most diverse and extensive seagrass meadows in the central portion of the Sarasota Bay estuarine system. It has also been highly modified by past dredging activity. The major meadows in this segment were located in the vicinity of Otter Key, Pansy Bayou, Coon Key-St. Armands-City Island, New Pass and southern Longboat Key. (The New Pass grassbed was selected for quantitative analysis in the Submerged Aquatic Vegetation section of this project). This segment also contained some of the deepest seagrass beds in the study area, located between Bird Key and the tip of City Island as well as toward the northward extension of the New Pass grassbed. The borders of each of these meadows (except for New Pass) were impacted by dredged cuts, thus preventing any possible expansion or proliferation of grasses in those directions (Appendix Figures A.948, 8, 948). These meadows were also exhibited physical impacts of the damage caused by motorboat propellers.

Two major grassbeds in this segment (New Pass and Bird Key) were unique in that each was established on the flood tidal delta of a major pass, New Pass and Big Pass. As a result, each was subjected to intense sediment transport and

loading mechanisms. Both grassbeds also had a major navigational channel along one axis. These beds contained a mixture of all major seagrass species. *Syringodium* was the dominant grass within the Big Pass meadow while both *Thalassia* and *Halodule* dominated within the New Pass meadow. The Big Pass meadow had a sand bar at its leading edge while the rest of the flat was nearly all vegetated. The New Pass flat was composed of sand bars and grassbeds in roughly equal proportions. Both beds tapered into deeper waters at their northern ends. While the Big Pass meadow seemed to be at its maximum in terms of cover, the New Pass bed appeared to have expanded, colonizing many of the bare sandy areas, over the past three-years.

The meadow enclosed by Coon Key, St. Armands and City Island represented one of the largest *Thalassia* beds in the study area. This meadow had also experienced drastic losses (estimated at 20-25%) in aerial cover over the last three years. Large sand patches now exist within this site and many of the grasses are restricted to isolated small patches. Horseshoe crabs, pen shells and hard clams made up some of the conspicuous macrofauna observed in this area. *Thalassia*, *Halodule* and *Caulerpa* comprised the fringing meadow along the western border of this meadow. The entire channel surrounding this meadow contained soft black, anoxic sediments with a moderately flocculent surficial layer (Appendix Figure B.948). Some substrata also had a thin algal mat and clumps of drift algae.

Pansy Bayou to the west was dominated by a shallow grass flat, similar in composition to the larger meadows to the east. Two other distinct features were found here. The first was an expansive sand flat originating from the southwestern shore and extending northeast over the shallow grass flats. From photo interpretation, this feature appeared to be a storm washover from nearby Lido Beach. It has hard compacted sediments of quartz sand and has a slightly higher elevation than the surrounding grasses. The other feature was a deep dredge cut through the middle of the grassbed connecting to the St. Armands Key perimeter canal and the entrance to Pansy Bayou. This channel contained anoxic mud similar to the other channels in this segment.

This bay segment also contained three of the six Sarasota County artificial reef sites located within Sarasota Bay. These reefs were the Pop Jantzen reef located north of Bird Key Park (Loran 14176.7: 44430.1), the Jim Evans reef south of the Ringling Causeway (Loran 14177.6-7: 44417.9-8.1) and the Bully Powers reef west of Otter Key (Loran 14173.7: 44418.8). These reefs were all constructed of concrete and ceramic electrical insulators. Of the three reefs the Jim Evans reef, constructed primarily of concrete block, appeared to have the greatest abundance and diversity of colonizing organisms. This reef was also located in an area with greater tidal water exchange than the other two reefs. The Pop Jantzen Reef was located in a dredge cut to the north of Bird Key, which reduces the amount of water circulation. Some of the reef material had been lost at this site by sinking into the soft bottom sediments. At the time of this writing, the Bully Powers Reef had not received a great deal of construction material and much of this had been lost by sinking into the soft muddy bottom

Segment B9, New Pass. This segment contained New Pass and the surrounding sand bars and shoals. Shallow, transient sand bars and shoals made up approximately half the bottom area of this segment. The pass was considered

a disturbed bay bottom due to presence of seawalls and riprap, periodic dredging and bridge construction that prevent normal successional changes, and the presence of two marinas and numerous boat docks. A large dredged area within the Sands Point region of southern Longboat Key constituted a major area of disturbed bay bottom. Sediments within this dredged region were very uncharacteristic for a pass system. They consisted of deep, soft mud with a high hydrogen sulfide content, indicating their anoxic condition. A layer of drift algae has settled in several areas throughout this deep, disturbed hole. A thin fringe of sparse *Halodule* was present along the northeastern shore (west side of the bridge). This was in sharp contrast to the surrounding pass sediments, which were comprised of medium-sized, clean quartz sands. The flood tide shoal within the pass appeared to be in the process of closing off boat access to the Sands Point boat docks and will probably require dredging at a future time to maintain boating access. Ripple patterns, indicating active shoaling, were present on the surface of these sediments.

A stable sand flat was present on the north shore of New Pass just inside (bayside) the New Pass bridge. This sand flat (and a similar area directly across the pass bordering City Island) supported a small grass flat. Both grass flats exhibited a fringe of *Syringodium* with a mix of *Thalassia* and *Halodule* interiorly. On rare instances one or two bay scallops, *Argopecten irradians*, have been found within these grass beds. A small channel leading to the bayside of southern Longboat Key bisected both the flood tidal delta and grassbeds of New Pass in the area of Quick Point. Erosional processes were removing sand and seagrasses (*Thalassia*) from this area. Deep propeller scars (30 centimeters deep) were observed to be actively eroding on flood tides. If the erosion were to be balanced by accretion the seagrass beds in this area may remain in relatively good condition. The seagrass mapping portion of the project found that the acreage of seagrasses within the New Pass area had increased in coverage since the last evaluation, based on 1986 aerial photos.

Segment B8, New College. Seasonal conditions of nearshore seagrass beds from this segment (Bowlees Creek/Trailer Estates) are presented in the SAV chapter (V). Appendix Figures A.942, A.944, B.942, B.944 illustrate the areas of seagrass habitat and disturbed bay bottom. A general characterization of the shallow subtidal benthic communities, including seagrasses, is presented here. Unvegetated mud flats extended outward from shore for approximately 300 feet. Intertidal oyster bars were common throughout this unvegetated mud flat zone. Sediments within the mud flats (including the oyster bars) were high in silt/clay content. This zone was followed by a shallow zone of pure *Halodule*, followed by a deeper zone of mixed *Halodule/Thalassia*. Beyond this zone bottom topography varied in a rise and swail pattern, with *Thalassia* occupying the swails and *Halodule* the rises in predominantly monotypic stands. Sediments were generally muddy sand, with coarse shell hash occurring throughout. Drift algae was moderate to heavy; seagrass epiphytes were generally light.

Deeper benthic habitats (open bay) were unvegetated. Sediments were consolidated muddy sand; occasionally with some shell fragments. Bottom topography had a slight relief. The sediment surface had a thin, patchy algal layer, but no flocculent material was present. Numerous biogenic features were present (tubes, mounds and burrows), and occasionally a large concentration of dead *Mercenaria* shells were evident. No unusual features or modifications in bottom type were encountered in the open bay bottoms of Sarasota Bay.

Deamus Hart artificial reef was located in this segment (Loran coordinates 14181.4: 44441.1). Concrete block artificial substrates supported a poorly developed barnacle fouling community. Surrounding sediments consisted of sand with a fine silt layer. Lack of strong tidal currents and poor tidal exchange in this area probably limit the diversity of colonization on this reef.

Segment B7, Bishops Point. This segment was equally divided into two sections based on the six foot contour line. The first section contained open-water, unvegetated habitats similar to previously described open bay bottoms. Sediments, however, were slightly more muddy and contained a thin flocculent layer on the surface. The sediment surface also contained a thin, patchy algal layer. A small, shallow shoal area marked by two pilings (marked "shipwreck-1982" on nautical chart) was located ENE of Whale Key. This area contained a healthy *Thalassia* patch with low levels of epiphytes on the blades. Sediments were predominantly old clam shells and shell fragments with some rock. Yellow sulphur sponges were common on this shoal. Unvegetated habitats further west (near Whale Key) become more muddy. The bottom was covered with a 1/4 inch (0.64 cm) layer of unconsolidated fine sediments; underlying sediments were muddy sand with little or no shell fragments. This area had a lower profile (less vertical relief) and fewer signs of animal activity than areas to the east.

Shallow subtidal areas (within the six foot contour) contained sandy shoals at the deep edge which graded into a rise and swale topography similar to the configuration along the eastern shore of Big Sarasota Bay. Seagrass meadows behind this bar were more extensive than their eastern shore counterparts (Appendix Figures A.860, A.858, A.774. From Buttonwood Harbor to the northern boundary of this segment, including Whale Key, White Key and remaining mangrove islands, these meadows were dominated by well-developed *Thalassia*. Both epiphytes and drift algae were moderate. The channel and deep navigable waters within Buttonwood Harbor, the perimeter canal, and the south longboat fingerfill canals, represented the major disturbed bay bottoms from this segment (Appendix Figures B.860, B.774). The Buttonwood Harbor channels, which cut through shallow seagrass meadows, limited the potential for seagrass expansion in this area by acting as a deep, physical barrier. These channels are acting as sediment sinks for fine particulate sediments. A narrow mangrove barrier separated the Longboat perimeter canal, to the south of Buttonwood Harbor, from the open bay. The substratum supporting the mangroves was exhibiting rapid erosion due to the breaching of the narrow barrier by wave action. Much of the barrier is likely to be lost to erosion unless maintained. This barrier was characterized by a relatively coarse shelly substratum with patchy live oysters in clumps and attached to the mangrove roots.

To the south of this segment were the Longboat Key fingerfill canals. The canals open perpendicular to the long axis of the bay. The quality of the substratum on the bottom of these canals varied considerably depending on depth. The shallower canals typically had a relatively clean sand bottom and occasional patches of the seagrass *Halodule* near the seawalls at the mouth of the canals. Seagrasses were generally absent and substratum quality poorer at the inland terminus of the canals. The deeper canals were of poor quality benthic habitat with a high silt-clay component and accumulated organic debris.

Segment B6, Long Bar Point. Major features of this segment were Long Bar shoal and Tidy Island. Sarasota Bay's least altered shoreline was found along the southern reaches of this segment. Shallow, near shore, subtidal regions consisted mainly of unvegetated muddy sands. One particular section south of Tidy Island (Loran coordinates 14183.5-6: 44502.4; referred to as "Gladiola Fields" in the seagrass chapter) had a thin veneer of sand overlying rock. This rocky substrate was densely inhabited by numerous "tube" worms (polychaetes). An additional area of exposed bedrock had been reported from just south of Cortez village in this bay segment, but was unverified during this study. A marked access channel just to the north of Tidy Island (east of ICWW marker 44) crosses the underlying limestone at markers 7 & 8. The limestone at this location supported a hard bottom community including the yellow sponge *Cliona* and the hard coral *Solenastrea* sp.

Several live, intertidal oyster bars were located within the shallow flats. Shallow grasses nearest to shore consisted of isolated patches of well developed *Halodule*. These grasses graded into patches of moderately dense *Thalassia*. Drift algae, present throughout the year, becomes very dense throughout this section during spring and summer. Grassbeds further offshore became more continuous (less patchy) and comprised a mix of *Thalassia* and *Halodule*. Epiphyte loads were light (spring) to moderate (summer) and both species had long blades and well developed root structures. The deep, leading edge of seagrasses contained a mix of *Syringodium*, *Thalassia* and *Halodule*. Many of the deeper seagrasses in this section appeared to be receding based on changes in cover since 1988, by aerial photointerpretation. Sediments in the deeper, unvegetated portions of this segment were moderately well sorted sands and muddy sands.

North of Tidy Island, seagrasses became more dense and continuous, although sand patches and evidence of thinning were seen at the northern end of the meadow near the village of Cortez. These beds consisted of moderately dense *Thalassia* (50% of bottom visible through the canopy). Grass blades were not particularly long, but they did appear wider than normal. Epiphytic coverage was light. Drift algae was dense on the inside of the meadow and sparse towards the outer edge (however, drift algae accumulates at the edge of the bed along the channel). Sediments were primarily sandy mud with shell fragments and shell hash. The top five centimeters of sediment was soft but consolidated. Two long, narrow navigation channels cut through these meadows to residential canals along the eastern shore. Unlike other channels, these shallow channels (4-5 feet deep) had sediments of muddy sand and shell hash. The southernmost channel also exhibited a section of hard bottom habitat as described above. No large deposits of anaerobic silt/clay were found, except for the extreme inland reaches of these canals, where sediments became more characteristic of canal bottoms.

Segment B5, Sister Keys. This long and narrow bay segment contained primarily shallow water habitats (Appendix Figures A. 772, B. 772). These habitats were conspicuously bisected by the Intracoastal Waterway. This segment's western border (the bayside shorelines of northern Longboat Key and southern Anna Maria Island) was highly developed and consists of many residential canals and seawalls. Sister Keys and Jewfish Key, the major land features, were surrounded by luxuriant seagrass meadows. An expansive *Thalassia* grassbed surrounded Sister Keys, with most of the bed extending east and south.

This bed was continuous in coverage with average to high shoot densities. Numerous propeller scars were visible throughout this meadow. Drift algae was present in large clumps. Sulphur sponges and *Mercenaria* clams were abundant. Other grass beds were healthy mixes of the three main grasses. Sediments within the grass beds were muddy sand, while outside sediments were well sorted sands (due to tidal currents through nearby Longboat Pass). Seagrasses behind Jewfish Key have become more dense over the last three years; however, the deeper edges of this and other beds within this segment appear to be receding. In addition a washout area and shallow channel have been created on the east side of Jewfish Key as the result of the mooring of a motorboat.

North of Longboat Pass, a large tri-lobed dredged hole was located on the bayside of Coquina Beach, just north of the Bradenton Beach boat ramp (Loran coordinates 14180.4: 44533.1, Appendix Figure 8.692). Bottom sediments consisted of a layer of fine, black "muck"- anoxic silt/clay that was over 3.7 meters thick (12 feet) at the center. Additional dredged canals were observed to run along the bayside of Bradenton Beach from this point to the Cortez bridge. Bay bottoms bordering Longboat Pass (Segment B4) consisted primarily of clean sands and shoals characteristic of pass areas.

Segment B4, Longboat Pass. This small segment contained Longboat Pass and adjacent shallow embayments along north Longboat Key. A large flood tidal delta was located adjacent to the northwestern shore of Jewfish Key. A smaller shoal area was located west of Longboat Pass bridge and south of the channel. These shoals and sand flats had substrates of clean sorted sands. Sediments from the deeper pass bottoms also consisted of sorted sands as well as shell and shell fragments.

Seagrasses were situated around the southern end of Longboat Pass bridge and within the lagoon on the bayside of Beer Can Island on north Longboat Key. Seagrass composition and condition was similar to other fringing meadows in this vicinity. Luxuriant stands of all grass species were present. Drift algae was absent and epiphytes were light to moderate. Sediments were cleaner (less mud) than seagrass meadows further from the inlet.

Segment B3, Palma Sola Bay. The majority of Palma Sola Bay bottom habitats consisted of unvegetated muddy sands with little silt/clay or shell hash. Seagrass meadow types included healthy fringe perennial and deeper mid-bay shoal perennial. Fringe perennial meadows were most developed along the southeastern and northern shores of Palma Sola Bay. Seagrass composition was consistent with fringe perennial meadows; continuous to patchy *Halodule* closest to shore becoming intermixed with *Thalassia*, followed by moderately dense *Thalassia* and finally sparse *Thalassia* towards the outer margin. Meadows along the northern border had a higher percentage of *Halodule* than other meadows in this segment. Sediment within grassbeds (and near shore) contained more mud than surrounding unvegetated sediment. Epiphytes were few, consisting mostly of serpulid worm tubes.

Mid-bay shoal perennial meadows were present on both sides of the navigation channel in lower Palma Sola Bay. Grasses east of this channel consisted of sparse patches of *Thalassia*. Grass blades were short with many broken tips. Encrusting tunicates and bryozoans (especially during summer) covered the basal portions of the seagrasses. Grassbeds west of the channel

consisted of larger, contiguous meadows of *Thalassia* interrupted occasionally by broad sand patches. Grass blades were long with more complete tips than grasses east of the channel. However, this area was covered by a thick, continuous layer of drift algae up to three feet deep in places. Epiphytes consisted primarily of serpulid worm tubes. These mid-bay shoal perennial grasses had the appearance of some of the most stressed *Thalassia* within the study area.

Three discrete channels (two along the northern shore and one along the eastern shore below Palma Sola Park) bisect seagrass meadows providing residential access to the bay. Small, isolated oyster beds were located in the southeastern corner near the mouth of Palma Sola Creek.

Segment B2, Perico Island. Over ninety percent of the bottom habitats in this segment were seagrass meadows. All seagrasses in this segment were fringe perennial meadows, which can be further divided into two types. The first type pertains to those fringing meadows along open shorelines of the bay. Composition and structure of these meadows was similar to other fringing meadows described from adjacent bay segments. These beds consisted of a mix of *Halodule* and *Thalassia*, except for the shallow nearshore border, which consisted only of *Halodule*. The shoreline of this segment, north of the Palma Sola Channel, was virtually unmodified over its entire length. The other type of fringing meadow was found within the protected, shallow embayments, most noticeably Perico and Prices bayous. These meadows consisted of lush, continuous monotypic stands of *Halodule* which abruptly changed to monotypic stands of *Thalassia* in the slightly deeper swales. These grasses rarely occurred as mixed assemblages in this meadow type. Factors controlling the distribution of these grasses were unclear, although depth may have a role. Several isolated oyster bars were located within these embayments. Seagrasses became patchy and less developed near these oyster bars and crown conchs (*Melongena*) become very abundant.

An extensive unvegetated sand flat was situated in the center of a large seagrass meadow east of Prices Key on the south side of Perico Island (Loran coordinates 14185.2: 44535.8). This sand flat did not appear to be shallower than the surrounding seagrasses (which might explain the lack of vegetation). Sediments were muddy sand, but were less muddy than surrounding seagrass sediments. Surface features indicated the presence of numerous deposit feeding worms. Well sorted sandy sediments, indicative of active shoaling processes, were found at the entrance to Palma Sola Bay.

Segment B1, Anna Maria Sound. This segment contained an intricate and highly productive seagrass community in both deep and shallow waters. The highest relative percentage of *Syringodium* was found in shallow meadows of this segment. Deep water grassbeds consisted of mixed stands of well developed *Thalassia* and *Halodule*. Small sandy patches commonly interrupted seagrass distribution. No rhizophytic algae or *Syringodium* were found within these deep beds. Sparse clumps of drift algae were occasionally present, but most of the area was free of algae. Shallow grassbeds along the bayfront of Anna Maria Island were dominated by *Syringodium*. Seagrass composition typically ranged from pure stands of *Syringodium* along the deeper margin, to a mix of approximately 90% *Syringodium* 10% *Thalassia* (the most common arrangement), to occasional small swaths of *Thalassia*. Grassbeds in the southwestern portion of this segment (south of the Shell Point channel) had a higher percentage of

Thalassia. These grasses had more epiphytes than grasses from other meadows in the Sound. Sediments within the grassbeds consisted of muddy sands. Several major navigational channels cross the grassbeds of Anna Maria Sound. At the same time, however, there was a noticeable lack of propeller scars throughout the Sound.

Natural unvegetated habitats comprised roughly 25% of this segment. The substratum consisted mostly of sand with small percentages of mud and shell fragment. A large, sandy shoal was located in the middle of the unvegetated area (Loran coordinates 14188.3: 44558.6). Shoal sediments consisted of clean sorted sands, large shell fragments and shell hash. Empty tubes of the polychaete worm *Owenia* were abundant. This shoal was approximately five feet shallower than the surrounding bay bottom

IV. D. Discussion

The inability to locate a particular habitat component during a survey does not necessarily preclude its presence, only that through our investigations we were unable to substantiate its presence.

Grassbeds in the west-central section of Blackburn Bay are an excellent site for further study. These healthy meadows, which support four species of grass, are located in a relatively shallow, confined portion of the bay, yet appear to be in excellent condition. Seagrasses in the central portion of Blackburn Bay and throughout Little Sarasota Bay, however, seem to be limited to shallower depths due to higher light attenuation. Improved water clarity in these areas could produce extensive grassbed recolonization of deeper areas.

Seagrass signatures in segment B11 (Sarasota Bay) suggest a colonization of mid-bay perennial meadow type. There seems to be the potential for extensive recolonization in this segment of the bay. This same signature is found in New Pass, where grasses have definitely increased in cover over the last two years. These trends need to be monitored over the next several years.

The absence of fringing grassbeds in segment B11 north of the Ringling Causeway is historically substantiated. However, *Halodule* is now appearing along the shore from Indian Beach northward. Given the potential for improved water clarity as a result of the elimination of treated wastewater from Whitaker Bayou, the Sarasota Bay NEP Program has planted seagrass along the shore south of Whitaker Bayou to determine if conditions have improved sufficiently enough to make recolonization possible.

A large dredged area due west of the 888 Condominium complex has exposed large areas of exposed limestone bedrock. This unusual condition has provided a novel habitat for this portion of the bay, with the presence of gorgonian soft coral and encrusting colonial organisms.

From aerial photointerpretation, many of the deeper seagrasses in segments B5 and B6 appear to have receded since 1988. At the same time, grasses along the edges of channels approaching Buttonwood Harbor seem to be recolonizing.

As Sauers (1980) noted, the curvature of the shoreline along Long Bar Point creates a catchment for wind-driven drift algae and debris, especially during periods of prevailing southerly or southwesterly winds which are commonly associated with warm frontal passages. In spring, during peak growth periods of benthic macroalgae (*Ulva* and *Enteromorpha*) and red and brown drift algae (*Gracilaria* and *Acanthophora*), large accumulations of these materials appear on the shore, and much gets trapped in the swales dominated by *Thalassia*. Accumulations one to two feet thick are commonly seen, and this undoubtedly causes stress to *Thalassia* due to light limitation and degradation of water quality during decomposition.

Mid-bay shoal perennial grasses in Palma Sola Bay appeared to be some of the most stressed *Thalassia* meadows within the study area. The beds were fairly sparse and the stunted short shoots were encrusted with huge masses of colonial ascidian and bryozoan. The exposed tips of the *Thalassia* blades were covered with filamentous algae. The surface sediments were covered with a blue-green algal mat. The causes of these conditions are unclear.

Seagrass cover and composition in segment B1 (Anna Maria Sound) was complimented by work by the SWFTMD- SWIM Department which conducted transect surveys during August-September, 1991. They used the Florida Department of Transportation FLUCCS Code to categorize their surveys. They also reported "dense" *Syringodium* on sandy substrate from the nearshore area. However, while they reported no *Halodule* from offshore, this survey found abundant amounts of it intermixed with *Thalassia*. Their data support the conclusion that *Syringodium* is the dominant seagrass in this segment.

Throughout the study area, there was a conspicuous absence of attached rhizophytic algae (other than *Caulerpa*). This is unlike the situation in grassbeds further north, such as Tarpon Springs, where several other species of attached algae (such as *Halimeda* and *Penicillus*) are present.

Sauers (1980) found encrusting epiphytes (*Spirorbis* and diatoms) on grasses from Long Bar Point and Horton Flats, but no growth of comparable density by these organisms were ever seen at the South Lido Station. However, he found large encrusting masses of colonial tunicates (*Didemnum* and *Botryllus*) at South Lido. Solitary tunicates (*Styela* and *Molgula*) were commonly observed in adult form by early spring at Long Bar Point and Horton Flats, usually localized within the low swales of *Thalassia* beds, but were seldom seen at South Lido.

There were relatively few areas that could be identified as potential restoration sites. Extensive shallow water areas in the southern portions of the study area (Roberts Bay and Little Sarasota Bay) have potential for recolonization with appropriate improvements in water quality, but protection from boating impacts in these shallow areas would also have to be a consideration. The fate of most intertidal vegetation and much of the nearshore grass beds lies in the hands of waterfront property owners. One potential restoration site is a sandy overwash delta along the western edge of Pansy Bayou, that would be an excellent site for a marsh grass, *Spartina alterniflora*, habitat creation project.

V. SUBMERGED AQUATIC VEGETATION

V.A. Introduction

V.A.1. Background

Submerged aquatic vegetation (SAV) refers to seagrasses and rhizophytic algae, and also accumulations of drift algae where these are management issues. Seagrasses, which form conspicuous and highly productive meadows throughout the Sarasota Bay estuary, have long been recognized as an important estuarine resource both as a food source and as habitat for fish and benthic invertebrates.

The importance of seagrasses to the ecology of estuarine systems is well established and manifested through a host of valuable attributes. Through their complex physical structure, seagrass meadows serve as habitat by providing shelter for both adult and juvenile crabs, shrimp, and fish. Seagrass blades act as a substrate for an entire community of marine organisms, including microalgae, micro- and macroinvertebrates, protozoa and diatoms. Herbivores which graze directly on the grass blades include fishes, manatees, sea turtles and sea urchins, while the attached epiphytes provide a valuable food source for a host of other marine life. Dead leaves and epiphytic growth falling to the bay bottom make up the majority of the material in the detrital food web.

Seagrass leaves slow water currents and promote the deposition of organic and inorganic particles from the water column. Their presence also inhibits the resuspension of sediments. The roots, runners and rhizomes form an interlocking grid which tends to lock in the accumulated sediments and retard erosion of the bay bottom. The physical energy of waves and currents tends to be dissipated by the presence of seagrass leaves, helping to protect adjoining shorelines from erosion. With their photosynthetic ability, seagrasses are a major contributor of dissolved oxygen to the water column.

Finally, seagrasses play an important role in the nutrient cycle. Seagrass leaves take up dissolved nutrients from the water column, while the roots take up and store nutrients from the bottom sediments. The removal of excess nutrients improves water quality with respect to light penetration.

V.A.2. Previous Seagrass Research in Sarasota Bay

Research priorities for seagrass meadows in recent years have focused on a number of issues (Phillips and Lewis, 1987). Aerial mapping and measurements of areal seagrass cover have determined historical as well as current gains and losses of seagrass habitat. Light requirement and water quality studies have calculated light climates, amounts of light necessary to support healthy meadows, and factors influencing downwelling irradiance. Geological and hydrological research has included the effects of existing geological features and current patterns on meadow shape and size. Comprehensive biological sampling programs have been particularly aimed at important commercial and recreational species of fish and invertebrates. Research topics with a focus on management include the development of restoration techniques for the creation or replacement of seagrass meadows, boat usage studies, and the development of target water quality criteria that are designed to insure seagrass meadow protection.

The earliest report on seagrass conditions in Sarasota Bay comes from Dequine (1969), who conducted ecological studies for the Arvida Corporation on submerged lands on the southeastern side of Longboat Key. These studies identified six distinct ecological zones within the nearshore submerged lands. Each zone was described in terms of the predominant seagrass, the nature of the substratum and the conspicuous faunal components. Crude biomass determinations were made for vegetation (seagrasses and algae), animals and plankton. Conners (1974) studied the effects of domestic sewage outfall on the distribution and abundance of benthic macrofauna within *Halodule* and *Thalassia* meadows as well as adjacent sandflats. The seagrass meadows in this study included impacted beds near the entrance to Bowlees Creek, along the eastern shore of Sarasota Bay, and control beds near Whale Key, which is located near the entrance to Buttonwood Harbor behind Longboat Key. Study elements included community analysis of the polychaete and molluscan fauna from each habitat, dry weight of total plant material from each station and sediment grain size analysis. The seagrass biomass results should allow for appropriate comparisons with biomass estimates from the current study.

The most intensive study of seagrasses within the study area was performed by Sauers (1980) as part of a series of studies on the environmental status of Sarasota Bay. Seasonal growth cycles of the dominant seagrasses, *Halodule wrightii* and *Thalassia testudinum* were studied at three locations within the bay. Above- and belowground biomass was determined for each species. For *Thalassia*, shoot number, blade number, blade length and width, presence or absence of original leaf tip, rhizome depth, number of leaf scars on short shoot base, intershoot distance along intact rhizome fragments bearing two or more shoots, and number of internodes along this intershoot distance were determined.

Several environmental studies in Little Sarasota Bay were initiated following the closing of Midnight Pass in 1973. Seagrasses were monitored at five locations on a biweekly basis throughout the warm wet season (May-October) of 1984 as part of a comprehensive study conducted by the Coastal Zone Management Division of the Sarasota County Department of Natural Resources (County of Sarasota, 1985). The Midnight Pass Society (1990) undertook a single seagrass survey at three of these sites plus one additional site in the historic mouth of Midnight Pass on December 2, 1989. Both studies looked at spatial cover and relative density of grasses in the vicinity of Midnight Pass. The present study has two sampling sites in this area with which to compare temporal trends in seagrass condition.

During October 1990, the American Littoral Society (1991) developed a study for the Sister Keys Conservancy to provide information on the aquatic environment around the Sister Keys in northern Sarasota Bay. Study elements included the location of the major seagrass species around the island, the compilation of fish and invertebrate species lists based on collections from the area, and bathymetry measurements from four transects around the islands. However, no data were collected or observations made regarding seagrass condition or distribution from this locality.

Although differences exist with respect to the purposes and methodologies among these various studies, collectively they offer a very useful overview of the conditions that have existed over time throughout the Sarasota Bay system

Information from these sources will help to document losses of submerged aquatic vegetation and their possible causes. This information will be useful in augmenting findings from the current seagrass status report.

V.B. Materials and methods

V.B.1. Study design.

This study was designed to address several concerns that relate to seagrass habitats within Sarasota Bay. One objective was to qualitatively evaluate the species composition of seagrass meadows (including attached macroalgae). This included identifying meadows that were monospecific versus those with mixed seagrass assemblages. A second issue involved describing the general condition of major grassbeds to determine their current condition or "health". Information gathered included aerial extent of the seagrass bed, relative density of seagrass species, morphometric measurements of blades and shoots, sediment characteristics, and the relative percent of epiphytic growth and macroalgal cover. The third purpose was to determine seasonal changes in seagrass beds and macroalgal communities. This was accomplished by making two visits to each site: one during maximum foliage (spring-summer) and another during minimum seagrass growth (winter). This data may also provide clues to short term changes in grassbed composition as well. Finally, this study attempted to relate visual observations of grassbed density (i.e., dense vs. sparse) to the various biological components. Collectively, these results will help to estimate the historic loss of submerged aquatic vegetation, provide detailed descriptions of their present status, and offer opportunities for seagrass habitat restoration and protection.

V.B.2. Station Locations

A total of eight seagrass sites were investigated. Four locations were based on areas identified by the NEP Nomination Document to be of special concern due to localized stress or nutrient enrichment. These areas were Whitaker Bayou, Midnight Pass, Tidy Island, and Bowlees Creek. Two locations were chosen on the criterion that they were relatively undisturbed "healthy" sites. Two sites located in the vicinity of Longboat Pass and New Pass were also selected to address the potential for short term changes in seagrass cover. Based on the selection criteria, the following sites were selected for seagrass evaluation accompanied by reasons for their inclusion. Station locations are illustrated in Figure 5.1.

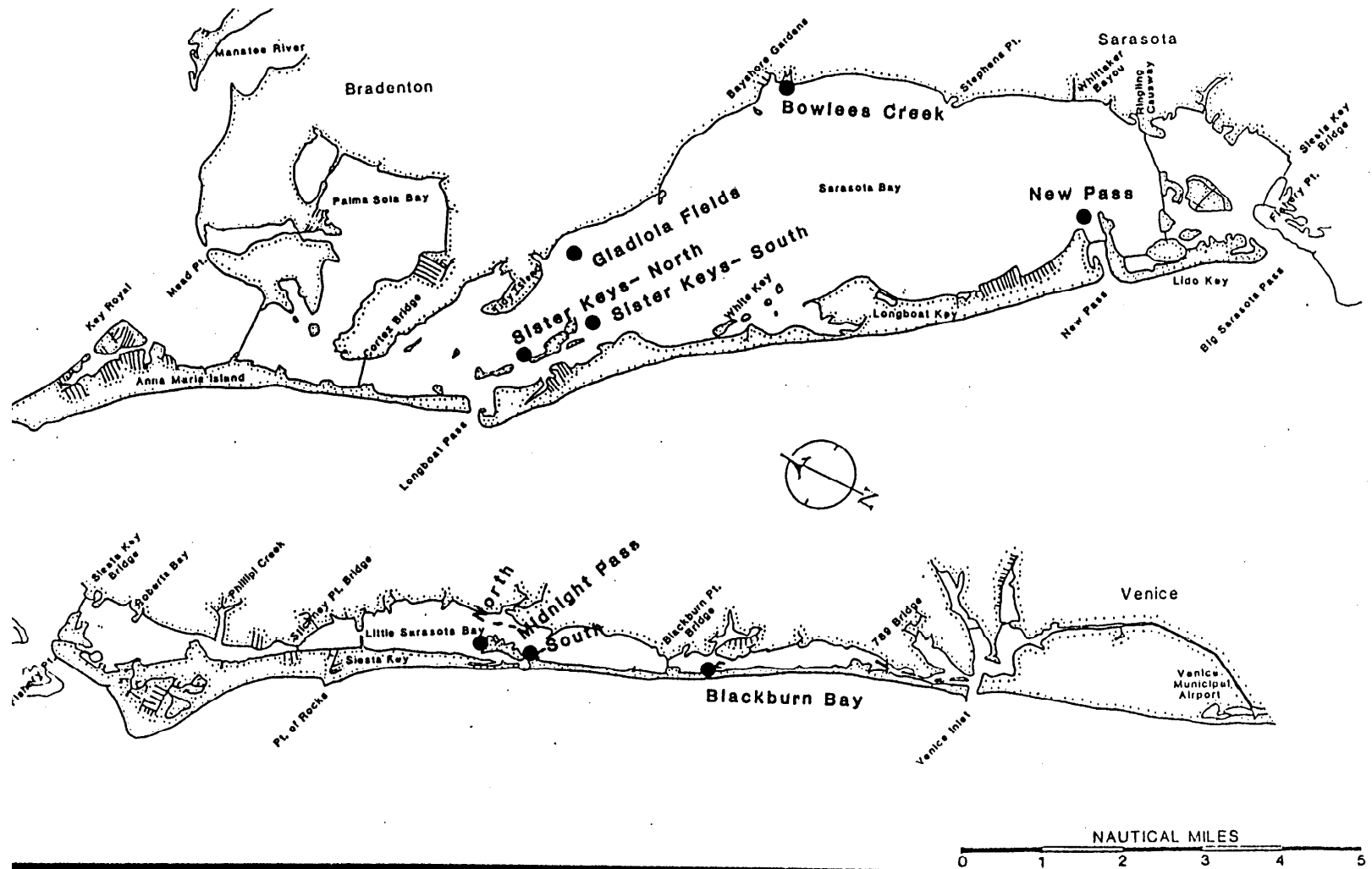


Figure 5.1. Seagrass station locations.

Sister Keys- North. (Loran Coordinates 14179.9/44516.0). Located on the north side of the northwest island, it was representative of mid-bay shoal/healthy fringe perennial seagrass meadows. This area constituted an undisturbed "healthy" grass bed that was also under the influence of Longboat Pass. It was located in the northern portion of Program study area and was the most northern of the seagrass sites. This site also coincided with station 4 of the Sister Keys Conservancy study of 1990.

Sister Keys- South. (Loran Coordinates 14181.4/44502.4). This site encompassed the extensive meadows to the south-southeast of the Sister Keys. This area was chosen because it represented one of the largest monospecific stands of *Thalassia testudinum* within the study area. It was considered a "healthy" meadow and served as a control site for the Gladiola Fields/Tidy Island area to the east. This site coincided with station 8 of the Sister Keys study.

Gladiola Fields- North. (Loran Coordinates 14183.3-6/44502.4-5). This site was located at the northern end of the Gladiola Fields, approximately 300 meters south-southeast of Tidy Island. This site was subdivided into two sections: a nearshore "Inside" section and a section along the deeper fringe of the bed called "Outside." An additional site located at the southern end of the Gladiola Fields (Loran Coordinates 14183.8-44492.1) was examined during the Winter/Spring sampling for comparison.

Bowlees Creek. (Loran Coordinates 14186.5-7.8/44460.0-2.2). This site was delineated by the channel markers of Bowlees Creek to the south and the channel markers for Trailer Estates to the north. Several observations were made within this area. This area was also considered a "hotspot" by the baywide monitoring program (runoff, boat traffic and contaminants). Conditions found here may well represent conditions of seagrass beds along the eastern shore of Big Sarasota Bay. Conner's 1974 study was conducted in this area.

New Pass. (Loran Coordinates 14188.2/44429.3). This site was located on the inside of New Pass to the northeast of the tip of City Island. Sampling was conducted on the largest of the grass beds to the north of the sandbar lining the channel. It was representative of a mid-bay shoal perennial seagrass meadow and was under the direct influence of New Pass. This site was in proximity to the fringing seagrass meadows studied by Dequine in 1969 along the southern portions of Longboat Key.

Midnight Pass- North. (Loran Coordinates 14167.0-1/44356.6). This site was located in a small, shallow embayment on the northeast side of the Bird Keys. Located in Little Sarasota Bay, it was within the bay segment that includes the Midnight Pass area. It was situated between seagrass quadrats 1 and 2 of the two previous Midnight Pass studies.

Midnight Pass- South. (Loran Coordinates 14166.1-2/44348-1-2). This site was located in the area that has been referred to as the "Midnight Pass back bay area". It was located at the southern tip of the Bird Keys, in shallow water, just north of the channel leading to the beach at Midnight Pass.

Blackburn Bay (Loran Coordinates 14162.7/44328.6). This site was located in the northern portion of Blackburn Bay. It was located in a small embayment west of the ICW at Marker 29A. This area supported a large meadow of *Halodule* and was considered a 'healthy' control site for this seagrass. It was also fairly representative of the grassbeds in the southern portion of the Program area.

V.B.3. Sampling Procedures- Qualitative Observations

At each site, seagrass meadows were surveyed for species composition, including attached and drift macroalgae. This was accomplished by extensive underwater observation. During these surveys, notes were recorded on the general condition of the entire seagrass community. The following observations were made.

Relative density of seagrasses (and attached algae) was determined by observing the percent of sediment visible through the canopy. Density ranged from sparse (greater than 50% of bottom visible) to moderate (50-25% bottom visible) to dense (less than 25% bottom visible).

Relative density of drift macroalgae was determined by observing the percent of bottom visible through the algal layer. Density ranged from sparse (greater than 50% of bottom visible) to moderate (50-25% bottom visible) to dense (less than 25% bottom visible).

Percent cover of epiphytes' on the grass blades was estimated for each season. Values ranged from light to heavy.

Sediment characteristics were classified as either mud, sand shell or a combination of the three. The presence of surface features, including the presence of algal mats or flocculent layers, were noted. Biogenic activity (burrows, tubes, mounds, etc.) was recorded as well.

Conspicuous macrofauna were noted along with their relative abundance.

V.B.4. Sampling Procedures- Quantitative Measurements.

Quantitative measurements were made on the two major seagrass species, *Thalassia* and *Halodule*, (when present) from each site. For *Thalassia*, shoot density was determined by random sampling with a 1/4 meter square quadrat and counting all emergent shoots. Mean maximum blade length was calculated from ten shoots at each station. *Halodule* shoots do not lend themselves to accurate and reliable density measurements in the field except under optimum conditions. Therefore, biomass measurements for this grass were determined by dry weight of blades (including short shoots) and roots (which includes roots and rhizomes). Coring instruments (13 x 13 cm) were used to collect six replicates at each site. In the laboratory, samples were washed and gently scraped to remove loose and attached epiphytes and split into blades and root/rhizome portions. Each portion was dried to constant weight at 105°C. Biomass values are expressed as grams dry weight per meter square.

V.C. Results and Observations

V.C.1. Meadow Description

Sister Keys- North. Luxuriant stands of *Thalassia*, *Halodule*, and *Syringodium* were present. Drift algae was absent in winter to very light during summer. All seagrasses were sparsely covered with epiphytes, although they were slightly heavier in the summer. Sediments were cleaner (less mud) than most of the other seagrass meadows.

Sister Keys. This site was located within the expansive *Thalassia* grassbed surrounding Sister Keys, with most of the bed extending east and south. This bed was continuous in coverage with average to high shoot densities. Drift algae was present in isolated, large clumps. Sulphur sponges and *Mercenaria* clams were abundant. Sediment within the grass beds were muddy sand, while outside sediments were well sorted sands (due to tidal currents through nearby Longboat Pass). Numerous propeller scars were visible throughout this meadow. No *Halodule* was present within this seagrass meadow.

Gladiola Fields. Shallow grasses nearest to shore were isolated patches of well developed *Halodule*. These grasses graded into patches of moderately dense *Thalassia*. Drift algae, present throughout the year, was very dense throughout this section during spring and summer. Grassbeds further offshore became more continuous (less patchy) and were comprised of a mix of *Thalassia* and *Halodule*. Epiphyte loads were light (spring) to moderate (summer) and both species had long blades and well developed root structures. The deep, leading edge of seagrasses contained a mix of *Syringodium*, *Thalassia* and *Halodule*. Many of the deeper seagrasses in this section appeared to be receding based on changes in cover since 1988 and photointerpretation. Sediment in the deeper, unvegetated portions of this segment were moderately well sorted sands and muddy sands.

Bowlees Creek. Unvegetated mud flats extended outward from shore for approximately 300 feet. Intertidal oyster bars were common throughout this unvegetated mud flat zone. Sediment within the mud flats (including the oyster bars) were high in silt/clay content. This zone was followed by a shallow zone of pure *Halodule*, followed by a deeper zone of mixed *Halodule/Thalassia*. Beyond this zone bottom topography varied in a rise and swale pattern, with *Thalassia* occupying the swales and *Halodule* the rises in predominantly monotypic stands. Sediments were generally muddy sand, with coarse shell hash scattered throughout. Drift algae was moderate to heavy; seagrass epiphytes were generally light. Sampling within the Bowlees Creek grassbeds was separated into the nearshore shallow stands of pure *Halodule* ("inside") and the stands of *Halodule* from the deeper rises ("outside").

New Pass. This bed was unique in that it was established on the flood tidal delta of a major pass. In this regard, it was similar to N. Sister Keys grassbeds. The substratum is subjected to intense transport and loading mechanisms. Both New Pass and N. Sister Keys have major navigational channels along their axis. This bed contained a mixture of all major seagrass species, although *Thalassia* and *Halodule* were dominant. The bed tapered into deeper waters at its northern end. The area is not stable with erosion of existing *Thalassia* occurring on the channel edge off Quick Point. This area is used as

a short cut channel from the pass to the open bay, and as a result there is significant prop scarring and destabilization of the beds. The New Pass meadows appeared to have expanded, colonizing many of the bare sandy areas, over the past three years. The center of this bed was shallower and the grasses appeared less dense than those from the deeper perimeter. Consequently, one station (referred to as "sparse") was located within the shallow interior of the bed, while a deeper station ("dense") was positioned in the deeper, perimeter bed.

Midnight Pass stations were located within the subtidal area surrounding the Bird Keys. This area supported extensive monotypic *Halodule* seagrass meadows. The most dense grassbeds were found to the south and east of the Bird Keys, while more sparse beds were found in the northern portions of this segment. Since the initial surveys were conducted in 1990 and 1991 the grass beds in this area have largely undergone a transition to *Ruppia maritima*, a brackish water seagrass species that is a rapid colonizer.

Midnight Pass- South. Seagrasses in the southern section consisted of dense, continuous beds in deeper water and sparse patches in the shallows. Because of this spatial arrangement, dense and sparse areas were sampled separately. *Halodule* from both areas had a growth of moderately heavy epiphytes, especially during the warmer months, when large "blobs" of blue/green algae were found attached to the blades. Sediments were highly variable; some areas were soft mud, others mud and sand, while others included shell fragments as well. *Diopatra* tube worms were very common among the grasses, and, to a lesser degree, *Melongena* (common crown conch). Numerous prop scars were evident throughout these grassbeds.

Midnight Pass- North. Seagrass distribution in the northern portion was very patchy and uneven, consisting of sparse, clumped areas of seagrass. Epiphyte loads were lighter than comparable stands to the south and little drift algae was present. Sediments in this area were extremely soft, consisting entirely of very fine sand and silt/clay.

Blackburn Bay. This shallow station supported the growth of a monotypic stand of *Halodule*, which was the predominant seagrass in northern Blackburn Bay. These *Halodule* beds were located near shore and behind the spoil bars created during dredging of the ICW. During the winter, seagrasses were moderately dense, evenly distributed and continuous, with no large patches observed. Epiphyte cover was sparse. During the summer, grass blades had medium to extremely heavy epiphytic growth and large loads of blue/green algae. Seagrass cover was less continuous, with patches of sediment present. The attached green alga, *Caulerpa aschmedii*, was present during summer. Drift algae was sparse, and few conspicuous macroinvertebrates, except for the crown conch (*Melongena corona*) were present.

V.C.2. *Halodule wrightii* (shoal grass) Condition

Above and below ground biomass (grams/square meter) of *Halodule* blade and root tissue during the winter, 1990, are presented in Figure 5.2. Total biomass (blades and roots) was highest at New Pass (245.36 grams dry weight/square meter) and lowest at Blackburn Bay (73.02 g dry wt/m²). Total biomass was equally low at the Midnight Pass (sparse) station (73.53 g dry wt/m²). Stations

in the northern project area (N. Sister Keys and Gladiola Fields) had similar, relatively high total biomass during the winter. Roots comprised the majority of plant biomass. Root biomass ranged from a low of 65% of total biomass at the Gladiola Fields station to a high of 89% at Midnight Pass (sparse).

Above and below ground biomass (grams/square meter) of *Halodule* during the summer, 1990, are presented in Figure 5.3. New Pass had the highest total plant biomass (288.73 g dry wt/m²); Blackburn Bay had the lowest (59.92 g dry wt/m²). North Sister Keys and Midnight Pass (dense) had similar total biomass (191.41 and 214.84 g dry wt/m², respectively). Overall, the percentages of total plant biomass attributable to roots during summer were similar to values recorded during the winter. Root biomass ranged from a low of 68% at the Gladiola Fields to a high of 81% at both Blackburn Bay and Midnight Pass (sparse).

Seasonal differences in *Halodule* blade biomass (grams dry weight/square meter) are shown in Figure 5.4. While most stations had higher blade biomass in the summer, two stations (Gladiola Fields and Blackburn Bay) had higher blade biomass in the winter. From winter to summer, the greatest relative gain in blade biomass occurred at Midnight Pass (sparse) (+230%), followed by N. Sister Keys (+119%) and Midnight Pass (dense) (+72%). Blackburn Bay experienced a 48% relative loss of blade biomass from winter to summer.

Seasonal comparisons of *Halodule* root biomass (grams dry weight/square meter) are shown in Figure 5.5. Station differences and seasonal changes in root biomass were similar to differences in blade biomass. *Halodule* from the Gladiola Fields and Blackburn Bay exhibited net losses in root dry weight biomass from winter to summer, while all other stations showed increases. Seasonal changes in relative root biomass were less dramatic than changes in blade biomass. The greatest change in root biomass occurred at both Midnight Pass stations; +80% at the dense site and +79% at the sparse site. Very little change occurred in root biomass at the Gladiola Fields and Blackburn Bay.

Shoot density of *Halodule* was determined for the summer sampling period. Results are shown in Figure 5.6. The highest shoot density (5920/m²) was found at the inside grassbed at Bowlees Creek. Several stations had relatively high shoot densities (3,500-4,000/m²). These were New Pass (center), N. Sister Keys and Midnight Pass (sparse). Lowest densities were found at stations in the southern portions of the study area.

Halodule Biomass
Winter, 1990

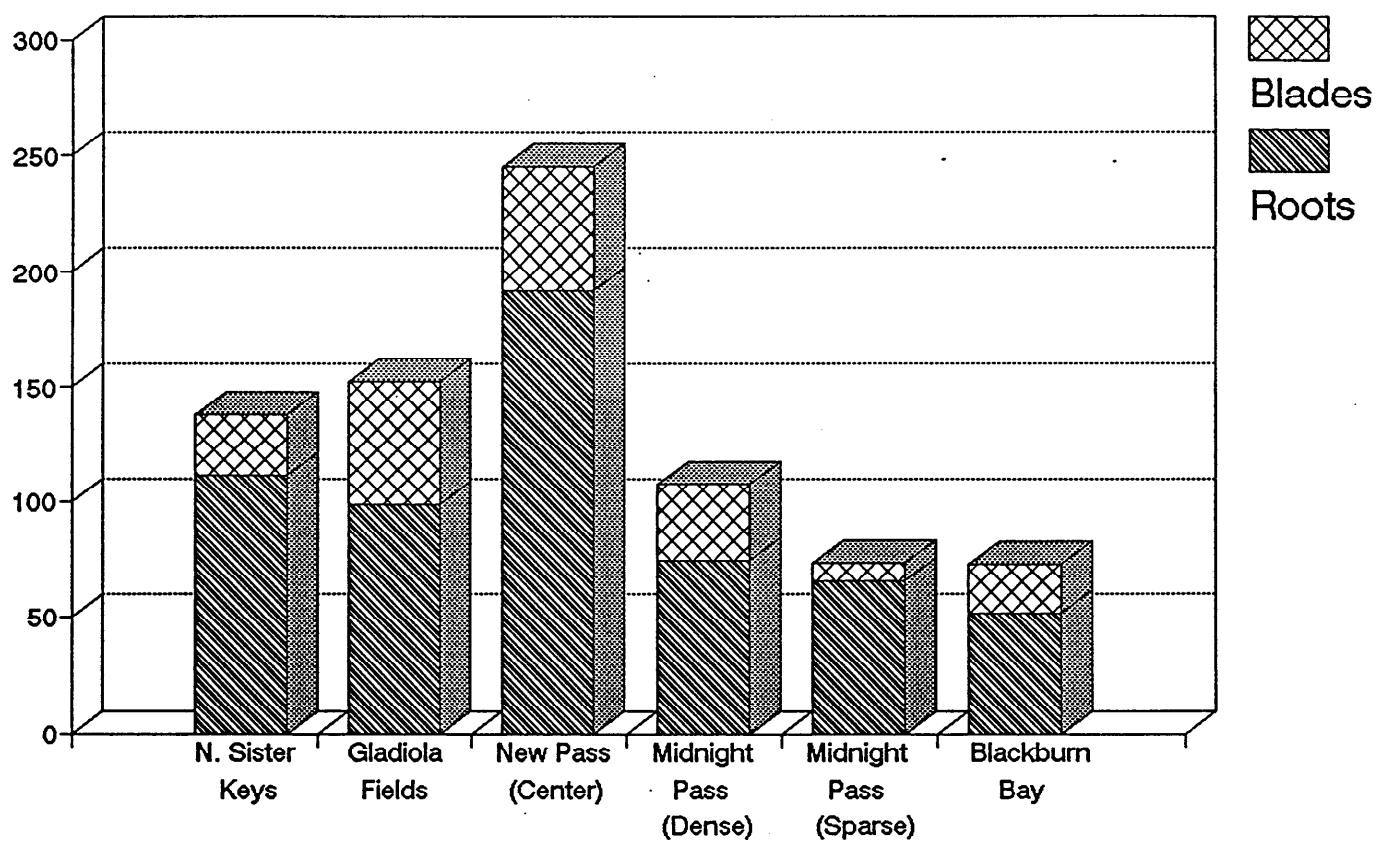


Figure 5.2. *Halodule* biomass (grams dry weight/square meter) from five Sarasota Bay seagrass stations during winter, 1990.

Halodule Biomass
Summer, 1990

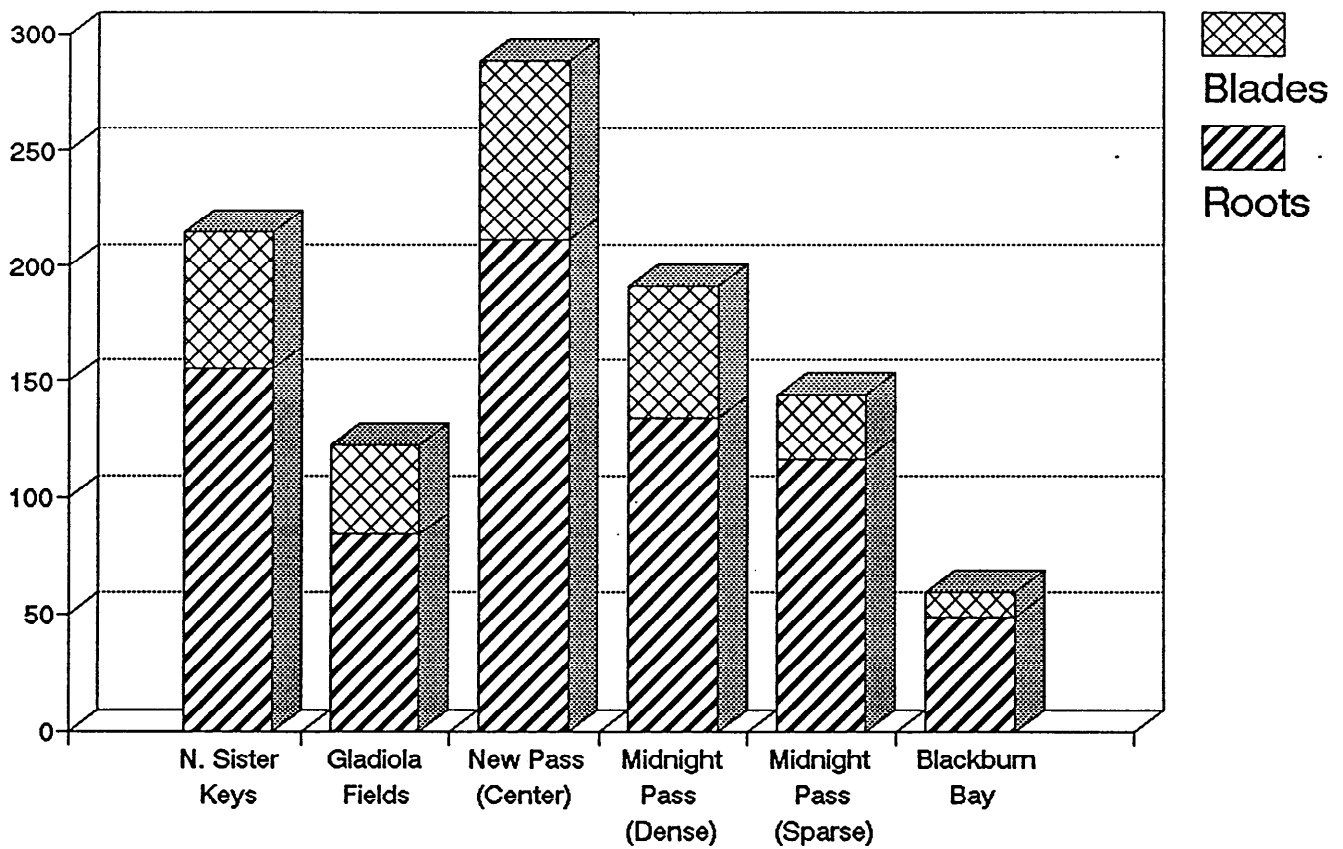


Figure 5.3 *Halodule* biomass (grams dry weight/square meter) from five Sarasota Bay seagrass stations during summer, 1990.

Halodule Blade Biomass Blade Biomass vs. Season

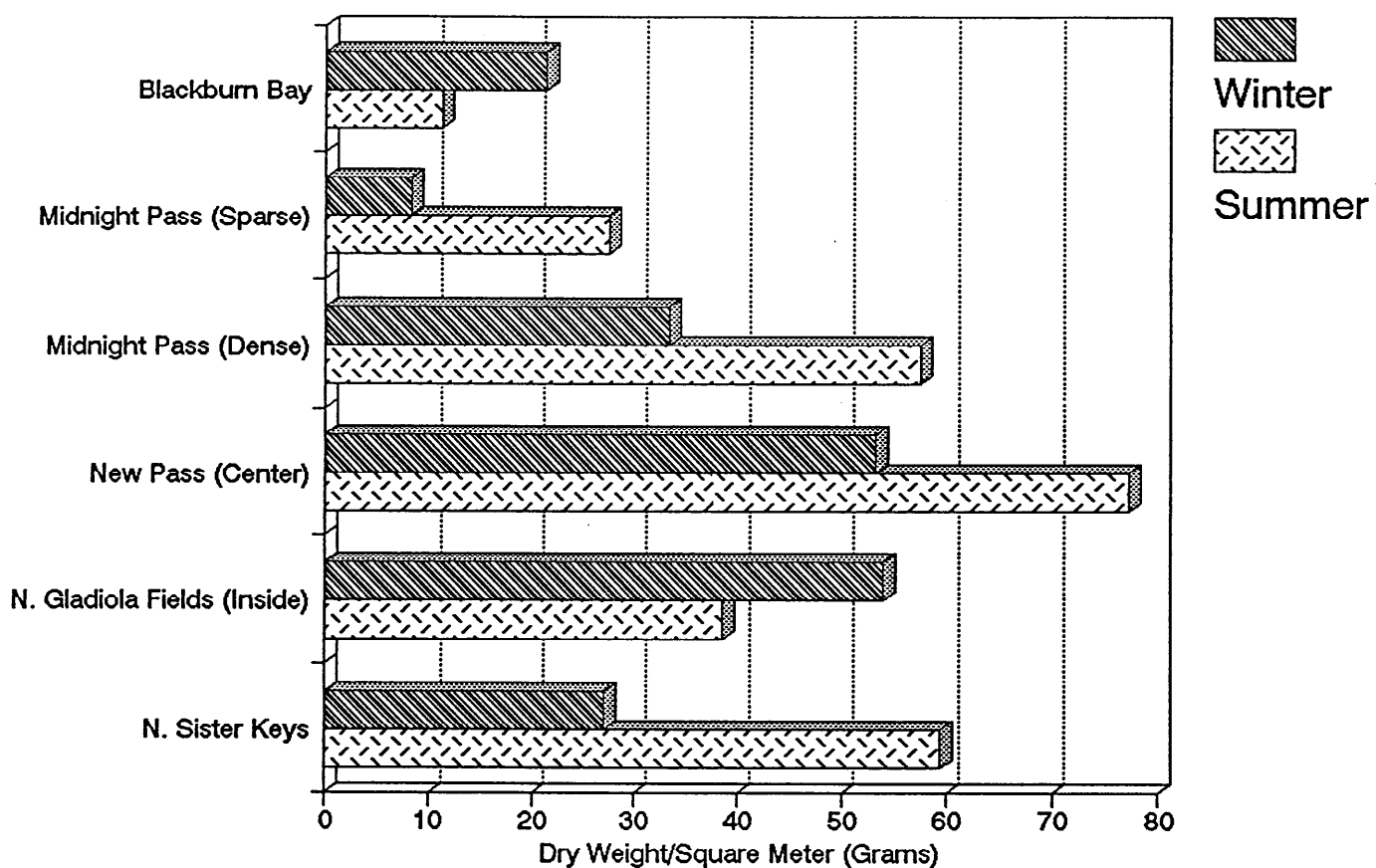


Figure 5.4. Seasonal differences in *Halodule* blade biomass (grams dry weight/square meter) for six Sarasota Bay seagrass stations.

Halodule Root Biomass Root Biomass vs. Season

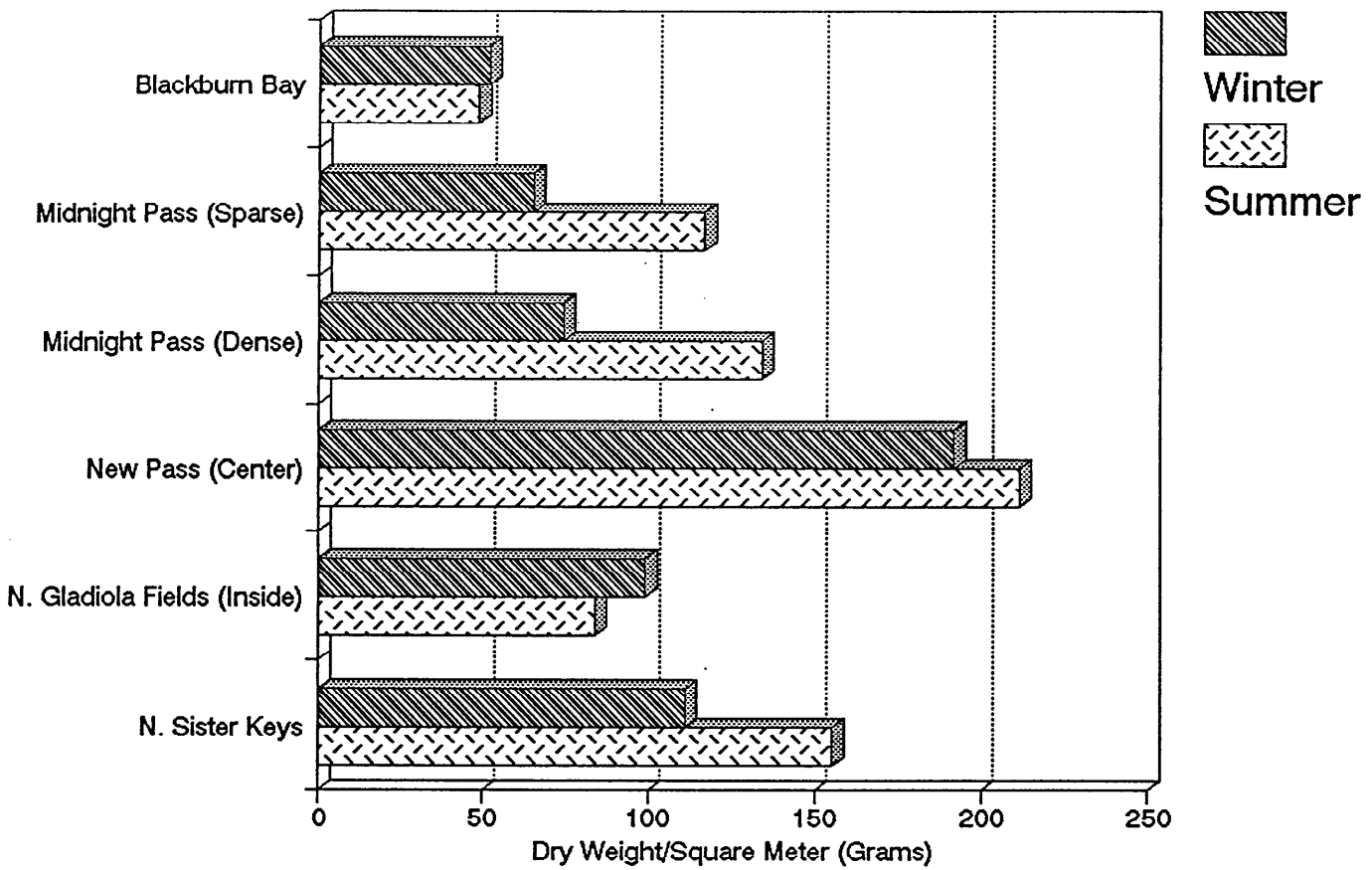


Figure 5.5. Seasonal differences in *Halodule* root biomass (grams dry weight/square meter) for six Sarasota Bay seagrass stations.

Halodule Shoot Density Summer, 1990

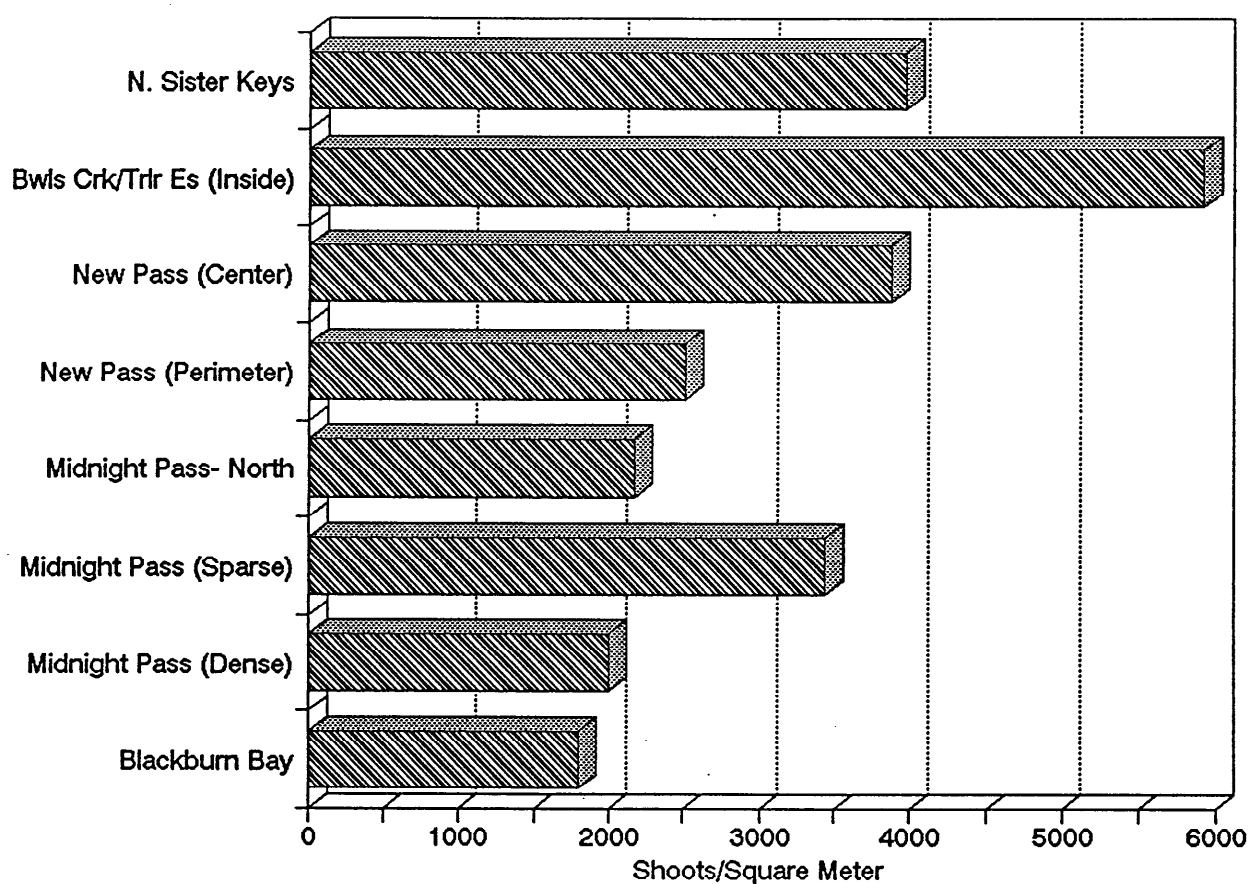


Figure 5.6. *Halodule* shoot density (short shoots/square meter) at five Sarasota Bay seagrass stations during summer, 1990.

Average blade *Halodule* length is shown in Figure 5.7. Blade length was not determined for grassbeds in the southern regions. Average blade length was greatest for the deeper grassbeds from Bowlees Creek and New Pass. All other stations had similar blade lengths.

V.C.3. *Thalassia testudinum* (turtle grass) Condition

Short shoot densities of *Thalassia* for summer and winter, 1990 are shown in Figure 5.8. For winter the greatest densities coincided with qualitatively "dense" grassbeds from Bowlees Creek (429 shoots/square meter) and New Pass (413 shoots/square meter). Correspondingly, "sparse" meadows from Bowlees Creek and the Gladiola Fields had the lowest densities (136 and 168 shoots/square meter, respectively). Relative station values of summer short shoot densities corresponded to winter values. Dense grassbeds from Bowlees Creek had the highest summer densities (712 shoots/square meter). High densities were also found at N. Sister Keys (492 shoots/square meter) and New Pass (dense) (442 shoots/square meter). Low shoot densities were found at "sparse" *Thalassia* meadows throughout the study area as well as at S. Sister Keys (247 shoots/square meter). A comparison of seasonal shoot densities shows in all cases, summer densities were higher than winter densities. Overall shoot densities for the study area increased by roughly 65%. Dense grassbeds from the Gladiola Fields exhibited the greatest relative increase (98%) from winter to summer. Shoot densities from New Pass dense beds, on the other hand, increased only 7% during the same period. In terms of absolute densities, dense grassbeds from Bowlees Creek showed the largest increase.

Seasonal changes in maximum *Thalassia* blade length from these same grassbeds were much more dramatic (Figure 5.9). Average blade length from all stations during winter was 15 cm, average summer blade length was 42 cm. Dense beds from Bowlees Creek had the shortest blades (especially during the summer) followed by Gladiola Fields. All other stations had very similar blade lengths.

V.C.4. Seagrass Faunal Utilization

A seagrass faunal survey was recently conducted within select seagrass beds within the study area. This study was designed to provide data on the utilization of seagrass meadows by local populations of fish and invertebrates. Habitat utilization is a critical link between habitat structure and environmental factors such as water quality and circulation. Additional data on the faunal component of seagrass beds throughout the study area would help to establish the functional role of these habitats and provide a clearer basis for the development of the Framework for Action.

This survey focused on shallow (less than one meter water depth), monospecific stands of turtle grass (*Thalassia testudinum*) and shoalgrass (*Halodule wrightii*). For each seagrass species, two beds exhibiting lush, dense growth served as control sites, while two beds of limited, sparse growth served as "stressed" or impacted sites. The selection of study beds was determined by a review of field notes taken during the Bottom Habitat Assessment seagrass surveys conducted during 1990 and by reconnaissance trips by MML scientists and Dave Tonasko of the SBNEP office. The seagrass faunal survey was conducted during May, 1992.

Halodule Blade Length Summer, 1990

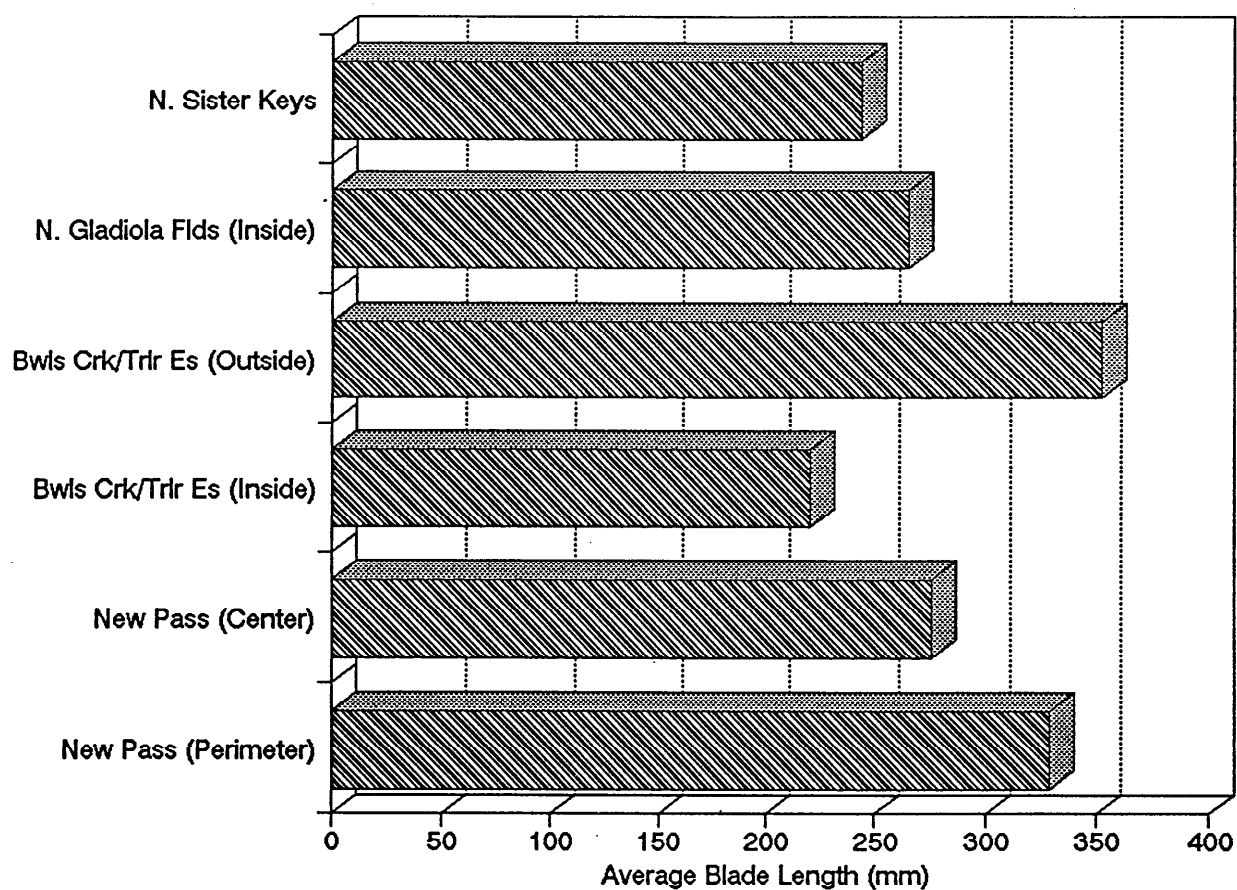


Figure 5.7. *Halodule* blade length for six Sarasota Bay seagrass stations during summer, 1990.

Thalassia Shoot Density Density vs. Season

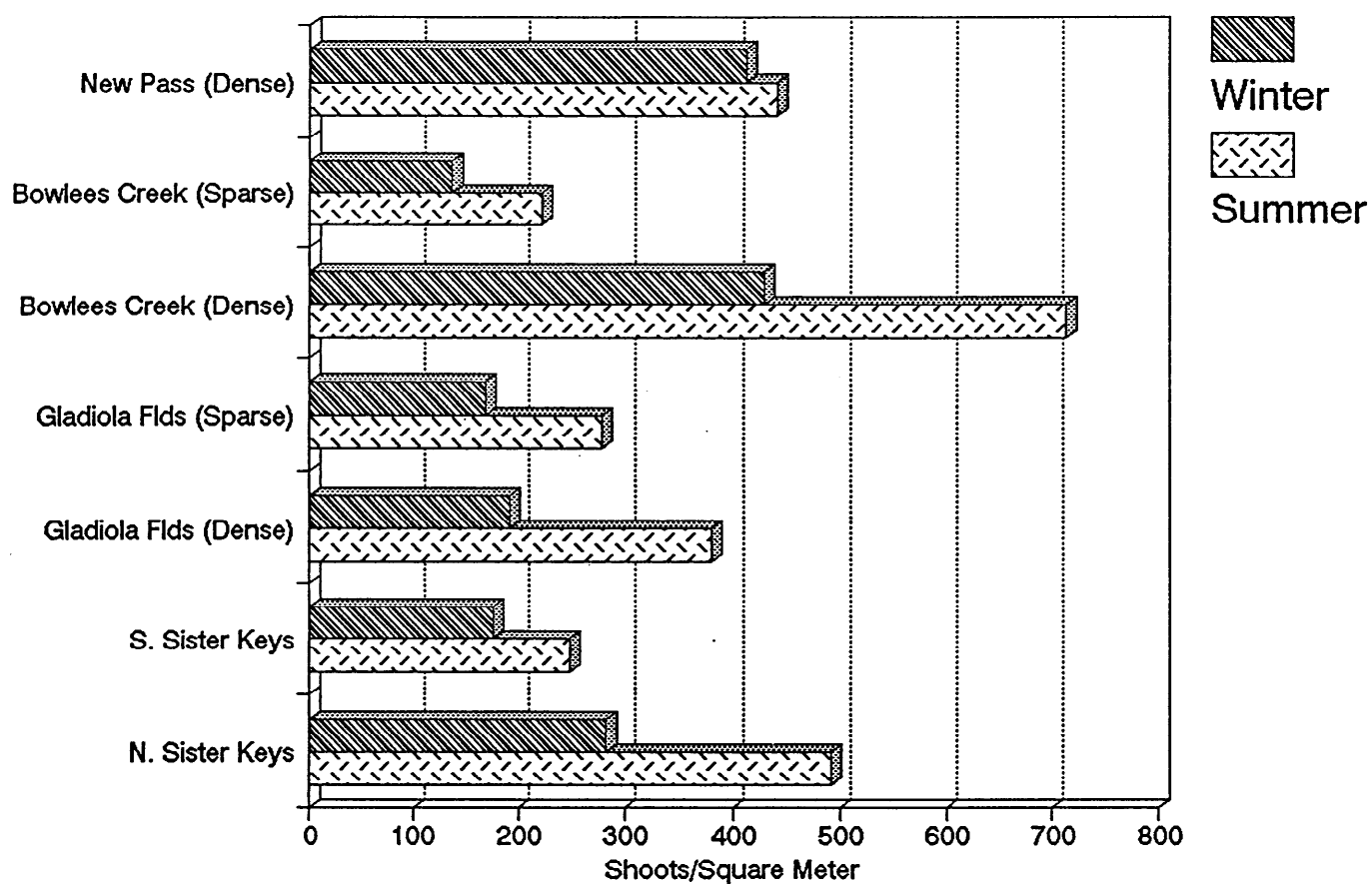


Figure 5.8. Seasonal differences in *Thalassia* short shoot density at seven Sarasota Bay seagrass stations.

Thalassia Blade Length Length vs. Season, 1990

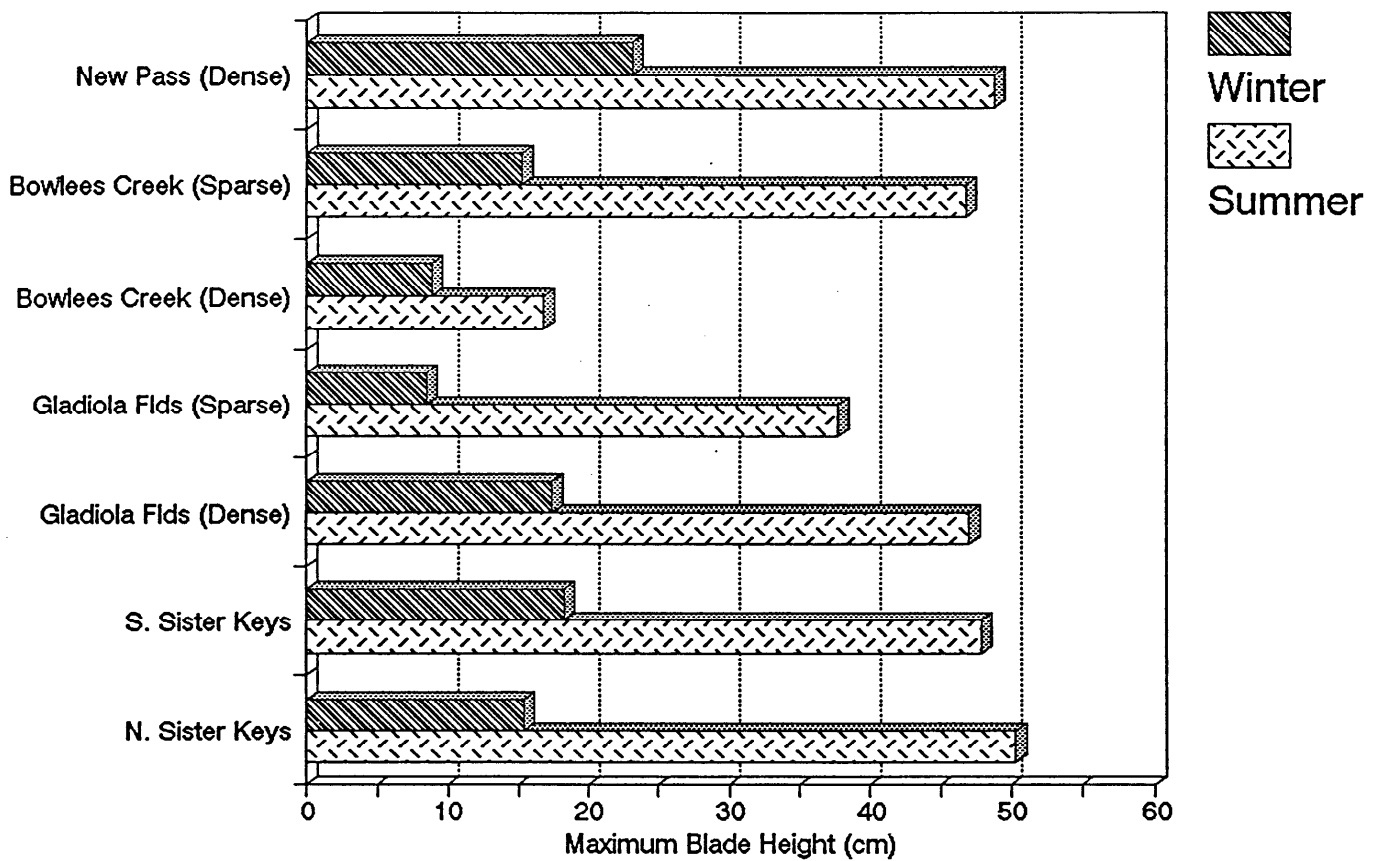


Figure 5.9. Seasonal differences in *Thalassia* blade length at seven Sarasota Bay seagrass stations.

In summary, this survey showed that there was no difference in abundance of fauna (crabs, shrimp and fish) between stressed and lush beds of *Thalassia*, while there were very large differences between beds of *Halodule*. These differences were largely due to the greater abundance of Caridean shrimp in the healthy beds as compared to the stressed beds. This is most likely due to the greater structural complexity of the lush beds which can hold more shrimp than seagrass meadows with less grass.

V. D. Discussion

Sarasota Bay supports five of the seven species of seagrasses known from Florida. These grasses are *Thalassia testudinum* (turtle grass), *Syringodium filiforme* (manatee grass), *Halodule wrightii* (shoal grass), *Ruppia maritima* (widgeon grass), and *Halophila engelmannii* (star grass). Furthermore, seagrasses form five different types of meadows in our area which have been defined and illustrated by Lewis (1985). These meadow types are: 1) mid-bay shoal perennial, 2) healthy fringe perennial, 3) stressed fringe perennial, 4) ephemeral, and 5) colonizing perennial. Healthy and stressed fringe perennial meadows are the most common types in Sarasota Bay and extend from the mean low water mark into water depths of approximately six feet below mean low water.

Losses of seagrass have been documented throughout the region and have been attributed to two principal factors: direct mechanical destruction by dredge and fill and boating operations and indirect losses due to deteriorating water quality. Changes in water quality can be attributed to multiple causes associated with coastal development. Losses of upland and wetland vegetation affect the rainwater runoff filtering capacity. Expansion of agriculture and industrialization increase sedimentation and suspended particles in the water column and urbanization, which generates wastewater and stormwater disposal problems. Dredging which causes long-term release of fine sediments into the bay environment and restructures circulation patterns (Haddad, 1989).

Winter conditions were mild during 1990. Sampling did not take place until March. Grasses had an early start to the growing season, and no severe dieback from winter storms (from prolonged exposure during high low tides) was noted. However, a seasonal increase in seagrass biomass during summer is typical. Seasonal differences in Blackburn Bay are probably the result of reduced circulation and poor flushing. The long fetch and exposure to prevailing winds at the Gladiola Fields site during the summer accounts for the heavy load of drift algae. Heavy epiphyte loads and drift algal cover may stress these grasses during the summer, while conditions for high standing crop during the winter are more favorable. Sauers (1980) also noted that the curvature of the shoreline along this portion of the bay margin created a catchment for wind-driven drift algae and debris, especially during periods of prevailing southerly or southwesterly winds which are commonly associated with warm frontal passages. In spring, during peak growth periods of benthic macroalgae (*Ulva* and *Enteromorpha*) and red and brown drift algae (*Gracilaria* and *Acanthophora*), large accumulations of these materials appear on the shore, and much gets trapped in the swales dominated by *Thalassia*. Accumulations one to two feet thick are commonly seen, and this undoubtedly causes stress to *Thalassia* due to light limitation and degradation of water quality during decomposition.

Halodule wrightii. Shoal grass was found within meadows where it is typically reported- along the fringes of grassbeds and in shallow waters. Root systems were most developed at New Pass, which may help secure the grasses in this shifting environment. *Halodule* was more developed in the open, northern regions of the bay, especially during winter. During summer, the Gladiola Fields area appeared "depressed" with respect to other grassbeds. The Blackburn Bay beds, although moderately extensive, were the least developed in terms of standing crop. The County of Sarasota (1985) observed significant losses of aboveground cover due to smothering and shading by floating mats of macroalgae.

Halodule blade length was greater at deeper grassbeds. Blade length may be limited by mean low water, even though *Halodule* blades have the ability to lay over during low tides. Shallow water grassbeds, however, seemed to have higher shoot densities. Grasses along the perimeter of beds were observed to be more sparse or patchy.

Pulich (1985) reported that *Halodule* from Redfish Bay, Texas had 66% of total biomass below the sediment surface. Phillips (1962) found that all seagrasses in Tampa Bay grew in muddy sand, while sandy substrates remained unvegetated. However, this is partly due to the trapping- effect seagrasses impart to fine particulate sediments, thereby gradually creating muddier sediments in the areas they colonize.

Thalassia testudinum Low shoot densities from S. Sister Keys reflected the conditions observed at this meadow during field surveys. This meadow did not have dense clumps, patches or fringes of *Thalassia*. Cover was continuous throughout the meadow, with much of the substratum visible through the canopy. Numerous prop scars cut through this meadow, although no effect on the arrangement or distribution of short shoots was apparent. This meadow would probably benefit from a signage program similar to those instituted in other regions of the study area.

Thalassia blade lengths were very reduced during winter. During this time, seasonally low tides expose *Thalassia* beds, causing blades to break off. However, underground components (roots and rhizomes) typically survive such exposure. Shoot densities were not as drastically reduced during winter.

Mixed assemblages of seagrasses are common for the west coast of Florida (Iverson and Bittaker, 1986), while south Florida exhibits more monospecific beds of *Thalassia* and *Syringodium*. However, in many shallow habitats of Sarasota Bay *Halodule* exist in large monospecific stands.

In Sarasota Bay, barring direct physical impacts, seagrass meadows decline in diversity and abundance with increasing distance from open Gulf waters. The observed increases of seagrass coverage on the New Pass shoal and east and southeast deep water areas off City Island, can be interpreted with cautious optimism as a result of improved water quality due to advanced wastewater treatment and reduced nutrient and sediment loads from Whitaker Bayou.

VI. SURFICIAL SEDIMENT DISTRIBUTION

VI.A. Introduction

A major controversy in the field of marine benthic ecology is whether pre- or post-settlement factors dominate the establishment, structure and densities of benthic invertebrate populations (Underwood and Denley, 1984, Roughgarden et al, 1988). Factors influencing the benthic community composition include conditions of the water column as well as post-settlement conditions and predation. Substratum composition and relative roughness is known to be a selection factor of benthic faunal recruitment (Eckman 1990, Meadows and Campbell 1972, Gray 1974, Woodin 1986). In a shallow estuary, such as Sarasota Bay, the surface sediment structure is important for the selection of habitat by planktonic larvae, and for the influence on water quality during periods of sediment resuspension due to water turbulence.

This project examined the composition of the top two centimeters of substratum from various habitat types, because of the importance of the surface layer to larval recruitment and water quality. Grain-size analysis was conducted for over 100 surface sediment samples taken throughout the Bay. This type of analysis reveals the various proportions of shell, coarse sand, medium sand, very fine sand and silt/clay material.

VI.B. Materials and Methods

Sediment samples were collected for various habitat types throughout the bay. At each site precision diver controlled samples of the top two centimeters of sediment were gently scraped from the bottom with a rectangular aluminum scoop. The scoop was brought to the surface, the overlying water decanted off, and the remainder of the sample placed into a 250 ml plastic jar. The presence of hydrogen sulfide odor was noted, when present. Samples were placed on ice and returned to the laboratory for processing.

Grain-size analysis generally followed the methods of Folk (1974). The first stage of analysis was to remove an aliquot of material, from the thoroughly mixed sample, and rinse through a 0.063 mm mesh sieve to separate the silt-clay fraction from the coarser sediments. The silt-clay fraction was then concentrated by centrifugation, removed, and dried to a constant weight at 105-110° C. The coarse material was dried, aggregates crushed, and sieved through a Wentworth series of 1 phi interval nested sieves for 30 minutes. The sieve sizes were (in millimeters) 2.0, 1.0, 0.5, 0.25, 0.125, 0.0625. Grain size composition was then determined based on the combined dry weights of the coarse and fine fractions. Calculated sediment statistics included mean grain size, median grain size, graphic skewness and graphic kurtosis according to the formulas shown in Tables 6.1. Results were graphically depicted as pie diagrams.

Table 6.1. Formulas for calculating sediment grain size statistics, mean grain size, median grain size, graphic skewness and graphic kurtosis, and descriptive categories based on calculated phi (-) values. Sediment classification by particle size (Wentworth classification); and explanation of descriptive statistics.

Class	Phi	Grain Size Millimeters
Gravel	< -1	>2.0
Very coarse sand	0	>1.0 ≤ 2.0
Coarse sand	1	>0.5 ≤ 1.0
Medium sand	2	>0.25 ≤ 0.5
Fine sand	3	>0.125 ≤ 0.25
Very fine sand	4	>0.0625 ≤ 0.125
Silt clay	> 4	≤ 0.0625

Degree of sediment sorting based on inclusive graphic standard deviation (Folk, 1974).

Standard deviation	Degree of sorting
<0.35 Ø	Very well sorted
0.35 Ø - 0.50 Ø	Well sorted
0.50 Ø - 0.71 Ø	Moderately well sorted
0.71 Ø - 1.00 Ø	Moderately sorted
1.00 Ø - 2.00 Ø	Poorly sorted
2.00 Ø - 4.00 Ø	Very poorly sorted

Classification of sediment by skewness (Folk, 1974).

Sk values	Degree of skewness
+1.00 - +0.30	Strongly fine-skewed
+0.30 - +0.10	Fine-skewed
+0.10 - -0.10	Near symmetrical
-0.10 - -0.30	Coarse skewed
-0.30 - -1.00	Strongly coarse-skewed

Classification of sediment by kurtosis (Folk, 1974).

Kg values	Degree of kurtosis
<0.67	Very platykurtic
0.67 - 0.90	Platykurtic
0.90 - 1.11	Mesokurtic
1.11 - 1.50	Leptokurtic
1.50 - 3.00	Very leptokurtic
>3.00	Extremely leptokurtic

Table 6.1 Continued.

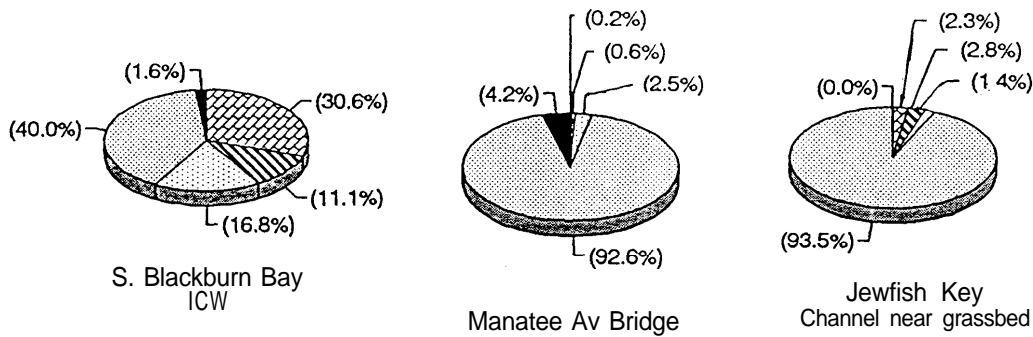
Formulas used to calculate sediment grain size statistics.	
a)	Phi (ϕ) = $\log_2 x$; x = particle size in millimeters.
b)	Median grain size, Md: $Md = \phi 50$
c)	Mean grain size, Mz: $Mz = \frac{\phi 16 + \phi 50 + \phi 85}{3}$
d)	Inclusive graphic standard deviation (sorting coefficient): $\sigma = \frac{\phi 84 - \phi 16}{4} + \frac{\phi 95 - \phi 5}{6.6}$
e)	Inclusive graphic skewness, Sk: $Sk = \frac{\phi 16 + \phi 84 - 2\phi 50}{2 (\phi 84 - \phi 16)} + \frac{\phi 5 - \phi 95}{2 (\phi 95 - \phi 5)}$
f)	Graphic kurtosis, Kg: $Kg = \frac{\phi 95 - \phi 5}{2.44 (\phi 75 - \phi 25)}$

It is important to remember that the percentages are based on dry-weight analysis and are not representations of volume percent. One percent of the silt-clay size fraction occupies a much greater volume in the natural pre-dried condition, than one percent of shell or sand particles due to the ability of the small particles to contain water in a slurry consistency. The net result is that a relatively low dry-weight percentage of silt-clay (5-10%) indicates a substratum that observed in the field appears very muddy and soft to the touch. A very high percentage of silt-clay (50-90%) is very much like chocolate pudding in appearance and texture.

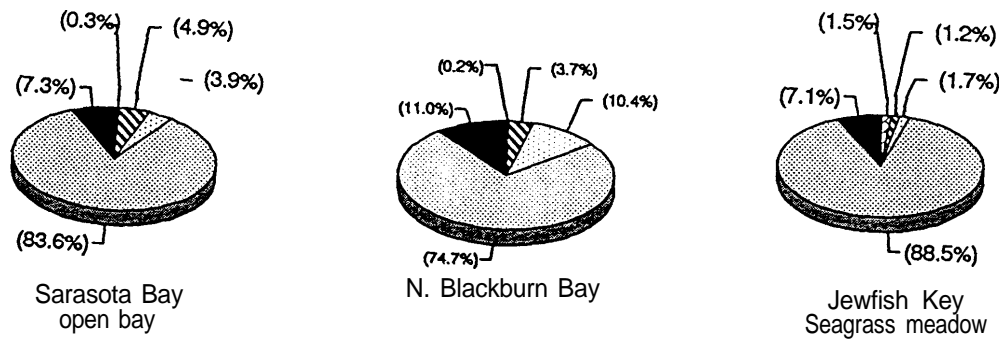
Terminology Certain conventions of grain size analysis must be understood prior to reading this section. The size designations presented on the pie charts refer to five descriptive categories, gravel, coarse-sand, medium-sand, fine-sand, and silt-clay. These categories were consolidations of the above described sieve series. Therefore what is referred to as *gravel* indicates particles retained on a 2.0 mm mesh sieve, and in this region of Florida is generally composed of shell fragments, rather than rock gravel. The category of coarse-sand (>0.5 mm and < 2.0 mm) contains material composed primarily of small bits of shell and large quartz sand grains. The categories of medium and fine sands are what most people would recognize as a fine beach sand (>0.063 mm and < 0.5mm). The category of silt-clay represents particles smaller than 0.063 mm. Within Sarasota Bay the silt-clay size material is typically black or dark brown in color and slippery to the touch, rather than gritty.

VI.C. Results and Observations

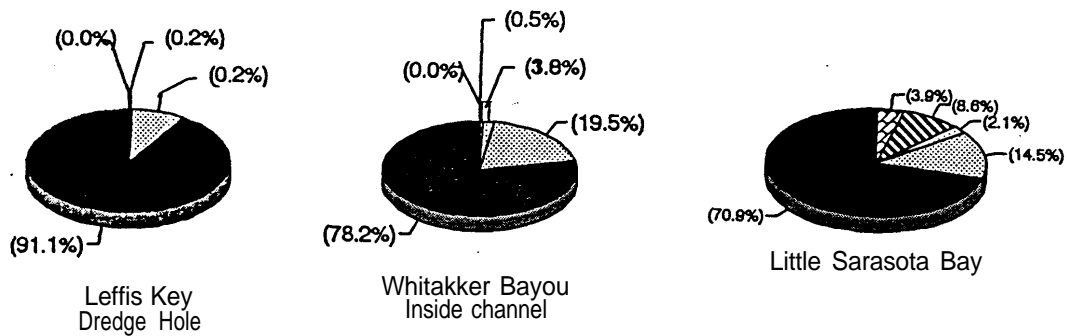
Surface sediments illustrated a considerable range of grain size structure throughout the bay. To illustrate this variation sediment samples were organized according to a relatively simple scheme based on area of collection as follows: dredged basin, dredged channels, intracoastal waterway (ICW), open bay, seagrass beds, passes/shoals/bars, and tributaries. For each category a simple mean value for each grain size class was calculated. These values are presented in Table 6.2. Examples of the distribution trends in surface sediment structure are represented by the pie diagrams illustrated in Figure 6.1. The sites from which the samples were obtained are illustrated in Figure 6.2.



Samples from areas of high **water flow illustrating coarser sediments with relatively** low levels of silt/clay material.



Samples from areas of moderate water circulation. Note the trapping effect of fine particulates in the seagrass bed of Jewfish Key compared to the channel area of adjacent to the grassbed (above).



Samples from dredged locations that now serve as sinks for fine particulates, illustrated by the high percentage of silt/clay material.

Figure 6.1. Representative graphs of sediment composition from various habitats within Sarasota Bay. Top - areas of high circulation, Middle - areas of moderate to low circulation Bottom - Dredged and quiescent water areas.

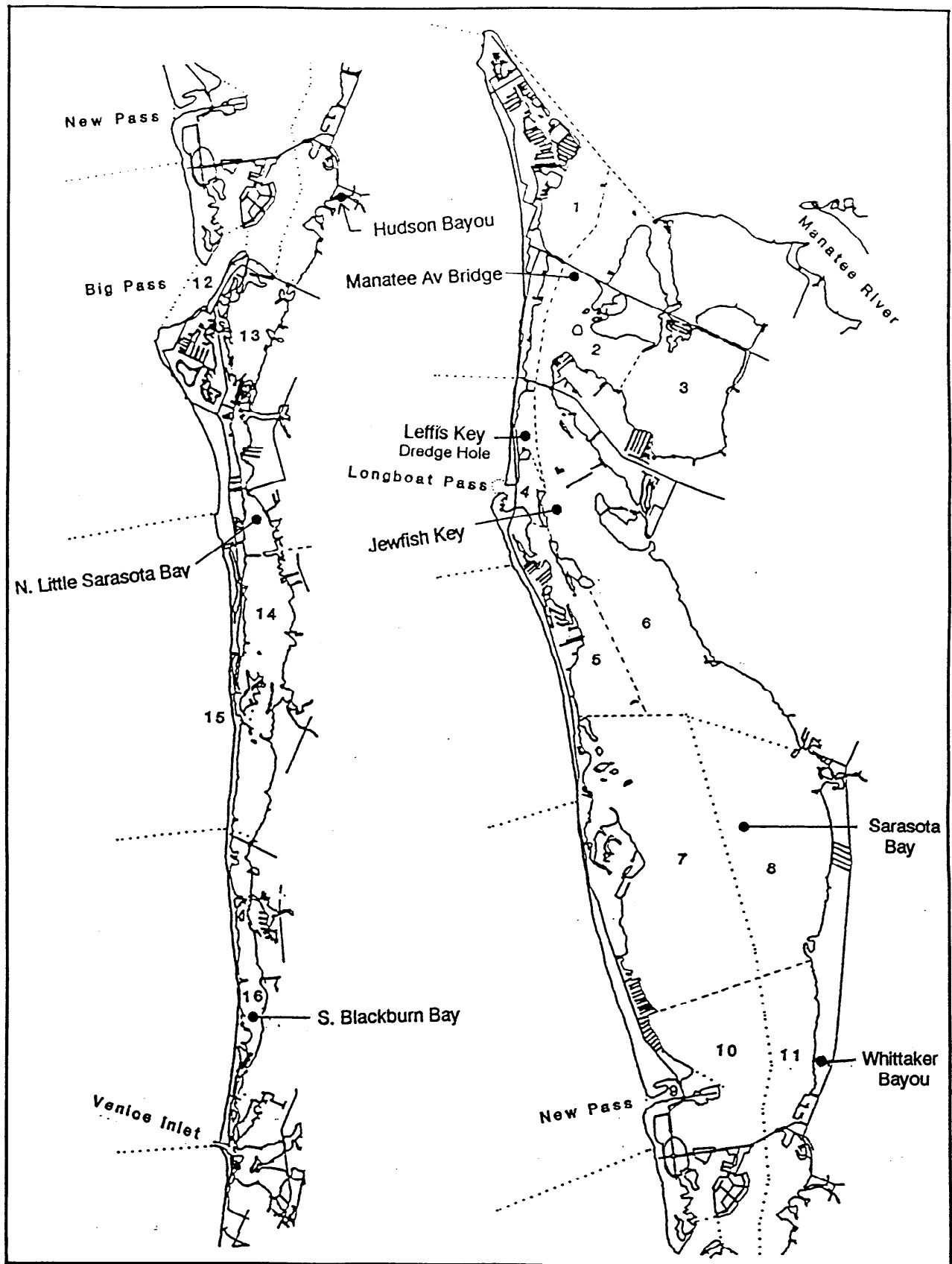


Figure 6.2. Map showing the locations from which the sediment samples, illustrated in Figure 13, were obtained. Numbers 1 - 16 illustrate Bay segments.

Table 6.2. Mean sample percentage for each grain size category for seven habitat types within Sarasota Bay.

<u>Habitat</u>	<u>(n)</u>	<u>Gravel</u>	<u>Sand</u>	<u>Coarse Sand</u>	<u>Medium Sand</u>	<u>Fine Silt/Clay</u>
Dredged basin	6	0.0	0.2	0.5	44.8	54.5
Dredged channel	9	1.1	1.9	4.1	86.3	6.6
ICW	3	10.4	4.4	7.0	54.9	23.4
Open bay	35	0.6	2.0	4.7	82.3	10.5
Seagrass bed	24	1.0	2.4	4.4	82.7	9.6
Pass/shoal/bar	12	10.6	10.0	8.4	66.2	4.8
Tributaries	8	1.1	3.5	12.7	54.6	28.2

Most notable are the differences in silt/clay content between the two classifications of dredged bay bottom. Both types of bay bottom have been severely altered through dredging. Differences in magnitude of water circulation account for the large difference in grain size composition. Areas of quiescent water accumulate fine particulates, while areas subject to the rapid tidal movement of water are often scoured clean of fine sands and silt/clay material. However, even areas that generally exhibit high levels of water movement and exchange may have dredge pits that collect thick layers of silt/clay size material. A good example is the dredge borrow hole near Longboat Pass, north of Leffis Key. Overall this area illustrates good water exchange, but the dredged area was constructed much deeper than the surrounding grass beds, and the resultant hole has trapped a thick layer of anoxic muck.

Surface grain size distribution is determined by the physical movement of the overlying water column, and the distribution or input of source material. Dredged areas tend to act as a sink for fine particulates and organic material and therefore have a much finer overall grain size (depending on depth and circulation) than do natural open bay areas. Seagrass beds also act as traps for fine particulates as was determined by this project.

Appendix C contains a graphic presentation of substratum composition for 97 sites throughout the bay. Examination of Appendix C Figures illustrate the nature of the surface sediment distribution. For the northern sections of the study area Figures C.1 and C.2 (Anna Maria Sound, Palma Sola Bay) the substratum consists primarily of fine sand (70-95%). Sites containing high levels of silt-clay were restricted primarily to disturbed dredged areas and seagrass beds. The Leffis Key dredge hole exhibited the highest percentage of silt-clay (91.1%) of any location within the study area. This section of the bay generally exhibits good water clarity and a high level of water exchange with southern Tampa Bay and the Gulf of Mexico. Shoreline canal bottoms in this area generally exhibit high levels of silt-clay (not shown) comparable to other segments of the bay. A notable exception were many of the canals of north Anna Maria many of which illustrated relatively clean sandy substratum. This is likely a result of the overall shallow nature of the canals (4-5 ft) which

enable them to be relatively well flushed and reduces the accumulation of fine particulate material.

Figures C.3 and C.4 illustrate the heterogeneity of substratum based on habitat for the section of bay south of Longboat Pass. Three samples taken near Jewfish Key show the differences between grassbeds, that act to trap silt-clay material, and a shallow adjacent channel which is scoured by currents and free of silt-clay sized particles. To the south east there is a notable difference in grain size between samples taken from a *Halodule* grass bed and an area near an oyster bar (Trailer Estates, Figure C.3) when compared to the dredged channel samples near (Cedar Hammock, Figure C-4). This again illustrates the concentration of silt-clay material within dredge-cuts.

Figures C.5 and C.6 illustrate examples of the sediment composition within the bay between Longboat Key and the mainland. Figure C.5 shows that the grain size of sediments on the east shore is generally more coarse than the west side of the bay. The near shore substratum also has an overall lower percentage of silt-clay sized particles (0.8-4.3%) than the open bay locations (3.4-25.1%) illustrated by Figure C.6. Both nearshore and open water bottoms are dominated by the fine-sand category of sediments (62-97%).

Figures C.7, C.8 and C.9 illustrate the wide variety of substratum habitats in the bay section between south Longboat and north Siesta Key. The area known as Pansy Bayou is dominated by seagrass meadows. A dredge cut encircling St. Armands and a second cut into the middle of the grassbed have structurally altered the original habitat. Fine anoxic silt-clay particulates, emanating a hydrogen sulfide odor, have collected in these dredge cuts with the exception of the dredged area at the mouth of the bay which is scoured clean by the current flowing in and out of the basin. Coarser materials were also found within the grassbeds, and within the sand flat on the western perimeter. The sand flat seems to be the remnants of an overwash of the Gulf beach dune that may have occurred during some past storm event prior to the dredging of the channels.

The sample from the area described as Coon Key was an anomaly with relatively large percentages of silt-clay as well as gravel and coarse-sand sized particles. The large sized particles are a result of the barnacle growth from the bridge pilings as well as exposure of buried shell material as the fine materials are washed away. This area is well flushed by tidal action between the bridge connecting Coon Key with Bird Key.

On the east side of the bay a number of disturbed sites are illustrated (Figures C.7, C.8, C.9) including the area around Island Park, and Hudson Bayou. There is a high level of silt-clay material in this area with all the dredged sites containing varying thicknesses of the black anoxic muck. Also notable is the high level of silt-clay material (80.7%) contained within the mixed seagrass bed west of Island Park (Figure C-8). There are no historical data available to determine if this level of silt-clay can be considered normal for a seagrass bed within the Sarasota Bay area. This bed appeared to be healthy. A sample taken adjacent to the Rose Coker artificial reef illustrates what may be a sediment altering effect of artificial reef structures. Located in an area containing high levels of silt-clay there was also a fair quantity of medium and coarse grained material representing barnacle shell residue detached from the

reef substrate. Stone crabs play an important role in harvesting barnacles and shellfish for food, and in the process crushing and distributing the shell over the bottom

Samples from Roberts bay are illustrated by Figures C-8, C-9 and C.10. Again the substratum was dominated by fine sand although the silt-clay fraction was relatively large for open bay locations. A number of samples were obtained for the Phillippi Creek system. The creek empties into the narrow waterway between Roberts and Little Sarasota Bays. Observations on the quality of the benthic habitat were conducted upstream to the Bee Ridge Bridge. The lower Phillippi Creek is highly modified with several large boat basins and canals for waterfront homes. The dredged boat basins and canals have very poor sediment quality as determined by a predominance of silt-clay particles, strong hydrogen sulfide odor, accumulations of organic detritus and a general lack of fauna and macrophytes. The main channel of the creek has a relatively coarse quartz sand substratum with occasional outcrops of limestone. The mouth of the creek is dominated by mangroves and oyster bar habitat, both of which serve to trap silt-clay material. Loss of these habitats would release large amounts of silt-clay particulates into the bay system

The substratum types of Little Sarasota Bay are illustrated by Figures C.10 and C.11. Samples taken from locations where water flow occurs such as Clower Creek, and North Creek exhibit lower levels of silt-clay than areas of more quiescent water such as the intracoastal waterway or open bay. The samples labeled S. Midnight Pass, and Midnight Pass exhibited lower levels of silt-clay than areas north of the pass. This is a lingering effect of tidal action of the former pass which kept the bottom free of organic detritus and silt-clay sized particles. Observational evidence indicates that such material is accumulating within the former pass channel.

Blackburn Bay, to the south of Little Sarasota Bay, seems to have accumulated less silt-clay sized particulates. Blackburn Bay is closer to Venice inlet and therefore has better circulation and water exchange than Little Sarasota Bay. Examples of the substratum from this area are illustrated by Figure C.12. Several samples exhibited high levels (> 5%) of silt-clay material, but generally there was a larger component of coarser materials from samples from this area, when compared to the more northern areas of the bay system

VI. D Discussion

Few studies of grain size have been conducted within the Sarasota Bay system. Most of the analyses that have been conducted are contained in unpublished technical reports (Taft and Goldstein 1979, Mahadevan et al 1981, Knowles 1983, Estevez 1983). Bland and Davis (1988) reported that tidal circulation within Little Sarasota Bay is a major factor controlling sediment distribution. They describe a null circulation zone centered on the former Midnight Pass area which accumulates fine silt-clay particulates and organic detritus. While the publication does not state the depth of the "surface" sediment sample used for analysis, the observations made by this project concur with the conclusions of Bland and Davis. The surface two centimeters of substratum varies greatly in composition throughout the bay system. The

dominant components are medium and fine grained quartz sand and silt-clay components.

In areas that are protected from wind and boat generated turbulence seagrasses may thrive on a substratum with a high proportion of silt-clay material. In addition established seagrass meadows serve to trap additional particulates and organic material. When conditions are altered such that the seagrasses are killed or thinned by stress the particle trapping ability is compromised or lost. This loss further increases turbidity by releasing the fine surface particulates into the water column. Much of the silt-clay material within the bay may have been previously contained within the seagrass meadows. As the meadows were destroyed or otherwise impacted this material was again available for resuspension by the turbulence caused by wind and boating activity.

Consideration of potential improvements in Sarasota Bay water quality by reduction of point and non-point sources of input need to be tempered with the realization that conditions in some portions of the bay may be regulated by the existing composition of surficial sediments. For instance, the open bay sediments of Little Sarasota Bay appear to be much finer grained than the open bay sediments of Sarasota Bay north of the Ringling Causeway. Resuspension of surface sediments in the shallow, poorly circulating Little Sarasota Bay may play a strong role in regulating long term light climate and nutrient flux.

Sediment resuspension can have a dramatic immediate effect on light quality and depth of penetration. The effect of short or intermediate term reductions of light penetration on the health of seagrass beds needs to be documented before relying exclusively on controls of point and non-point source run-off sources. Seagrasses may not be able to colonize a flocculent silt-clay substratum subject to periodic resuspension. If this is true then improvements in quality of the stormwater and tributary input into areas with substrata having a high percentage of surficial silt-clay, such as Little Sarasota Bay, may have a low probability for increasing seagrass distribution.

VII. BOTTOM HABITAT MAPPING ANALYSIS.

VII.A. Introduction

The specific objectives of this task were to define the status of submerged aquatic vegetation (SAV) and other submerged benthic habitats within the project area relative to historic conditions in a manner that would serve as an environmental planning aid.

VII.B. Methods and Materials

VII.B.1. Photointerpretation

The most recent and complete set of aerial photographs available to the project were through the Surface Water Improvement and Management (SWIM) Program, Southwest Florida Water Management District. These photographs covered the complete study area as outlined by the NEP Sarasota Bay guidelines and were available in true color at a scale of 1:24,000.

Identification of features visible on the SWIM aerial photographs concentrated on seagrass coverage and identification of "disturbed" bay bottom. Acetate overlay drawings of these features were constructed for each bay segment. Estimates of the coverage of both seagrasses and disturbed bottom were obtained by processing the acetate drawings with a computerized image analysis system. The system is capable of calculating the area of complex shapes. The areas thus measured were then converted to units of acres and hectares for each bay segment. Detailed characterizations of the Sarasota Bay seagrass meadows were presented in previous sections. Descriptions of the types of "disturbed" bay bottom are presented below followed by the mapping results for both the seagrasses and disturbed areas.

Disturbed Bay Bottom This category included only currently existing inter- or subtidal habitats. For classification purposes it was considered to be the exclusive result of removal or redistribution of substratum and took into account only relatively large disturbances that have become permanent features of the Bay bottom. The greatest single form of disturbance to the bay bottom has been dredge and fill activity for waterfront development, followed by dredging for the Intracoastal Waterway, and access channels to shoreline docks. Areas that were historically inundated but are now uplands due to such activity as dredge and fill are not considered as disturbed bay bottom. For example, most of what is now Bird Key (off Ringling Causeway) was at one time a subtidal grass flat, but for this survey only the Bird Key canal system was considered a disturbed bay bottom habitat.

The relative level of recovery for disturbed areas varies greatly within the Bay system. Recovery was defined as a return to a flora and fauna characteristic of natural undisturbed areas within the bay system. Any dredged area can be considered as being 100 percent altered at the time of dredging. The recovery of the bottom and the ability to support some variation of the normal bay flora and/or fauna depends on, 1) the depth of dredging beyond the existing grade, 2) the relative flushing or water exchange ratio and velocity of exchange and 3) degree of re-disturbance and time between successive disturbance events.

VII. B. 2. Disturbed Bay Bottom Categories

There were various levels of habitat value associated with disturbed bay bottom. Disturbed areas were classified as follows:

Deep Dredged Quiescent Water. This type of bottom was typically created by dredge-fill land building activity, or for boat access or traffic. Deep dredged is an arbitrary designation, but it usually refers to depths of 7 to 20 feet (2.1 - 6.1 meters) in depth. Typically these areas are considerably deeper than the adjacent natural Bay bottom. Most of these areas are located in conditions of moderate to very low circulation. As a result they act as depositories for very fine particulates and organic debris. The result is a substratum consisting of very soft, fine particulates (classified as silt/clay material) with a high organic content. Almost without exception within Sarasota Bay, this type of bottom material is anoxic (without oxygen), produces hydrogen sulfide gas and lacks any significant infauna or flora. Epifauna are usually absent as are any macrophytes. Blue-green algal mats, sulfur bacteria and fungi often provide a thin (1 cm or 0.4 inch) mat-like covering over the substratum. The sediment often exhibits a pudding-like consistency. This type of habitat is a liability to the Bay system. Many of these areas could be restored to some extent, and at a few locations it would be technically feasible to completely restore the bottom to a functional native habitat.

Deep Dredged, Moderate to Good Circulation. This habitat was typically limited to the passes of the Intracoastal Waterway (ICW) system. For this type of habitat tidal circulation keeps the bottom scoured clean of the fine particulates associated with the previously described deep dredged areas. These areas are characterized by a coarse-sand and shell substrate (depending on current speed). Epifauna may be common, attached to large shell or rock, but are not usually abundant. In a few areas where concrete rubble or rock was present a productive "reef" fauna with species typical of the Gulf was present. Overall the deep dredged areas with high circulation were not highly productive bottom types but probably represent a net asset to the Bay system.

Shallow Dredged, Poor Circulation. Typical of many of the finger canals on Longboat Key and the Siesta Key canal system. The quality of the habitat within canals of this type varies greatly dependent on relative degree of flushing which is dependent on total canal length as well as the circulation null zones present within the bay. Generally, these types of canals were classified as poor to moderate habitat quality. The bottom consisted of fine muddy sand, or organic silt/clay material. In many instances the sediment was anoxic with a distinct hydrogen sulfide odor.

Shallow Dredged, Moderate to Good Circulation. Typified by many of the canals of Anna Maria Island. These areas were observed to support a normal unvegetated bottom community, and in some instances sparse macroalgae or seagrass growth. The plant growth usually occurred near the banks (or seawalls) which tend to be shallower and removed from the scouring action of propwash.

Propeller-Dredged. This classification consisted of areas in which the nature of the substratum was altered by chronic exposure to propwash. Active propeller or prop dredging is an illegal activity conducted by anchoring a boat in a fixed position, for the purpose of removing sediment from a particular

location by directing the stream of water from the boat prop. A prop-dredged channel can be recognized in aerial photographs by a slight elevation (lighter color and often unvegetated) of the substratum on one or both sides of the channel, which is where the sediments from the washout were deposited. Prop-dredged access channels from shoreline docks to deep water were a commonly observed feature along much of the perimeter of the Bay system

Tidal Channels. Tidal channels are features created by the flood and ebb of tidal water masses, associated with any shallow bay system. The channels are typically deeper (to a varying degree) than the adjacent bay bottom and unvegetated due to the scouring action of currents. In this respect tidal channels are not "disturbed" habitat. In Sarasota Bay most tidal channels are also heavily used as boat navigation routes. In this respect many of the tidal channels are disturbed habitat, due to the high level of boat activity, being wider and deeper than for an undisturbed condition. In addition these channels are maintained by the scouring activity of boating and are not likely to exhibit significant colonization of macrophytes even in areas where currents and depths are favorable.

Deep Water High Circulation. Areas that have been dredged located in the vicinity of passes may have relatively good circulation due to tidal currents. In these situations the currents provide a flushing action which prevents the accumulation of detritus and fine particulates. The substratum of these areas are typically a coarse sand/shell hash mix. These areas are typically devoid of macroflora. The fauna are relatively diverse and "healthy" although the scouring action of the tidal currents may result in reduced densities of organisms.

VII.C. Results

VII.C.1. Photointerpretation

Mapping of seagrasses proved more difficult than mapping of disturbed bay bottom areas. While the SWM photos were generally of good quality, baywide differences in water transparency were evident. The southern portions of the study area encompassing Little Sarasota Bay (southern end), Roberts Bay, and Blackburn Bay, had poorer transparency as represented in the photographs.

VII.C.2. Disturbed Bay Bottom

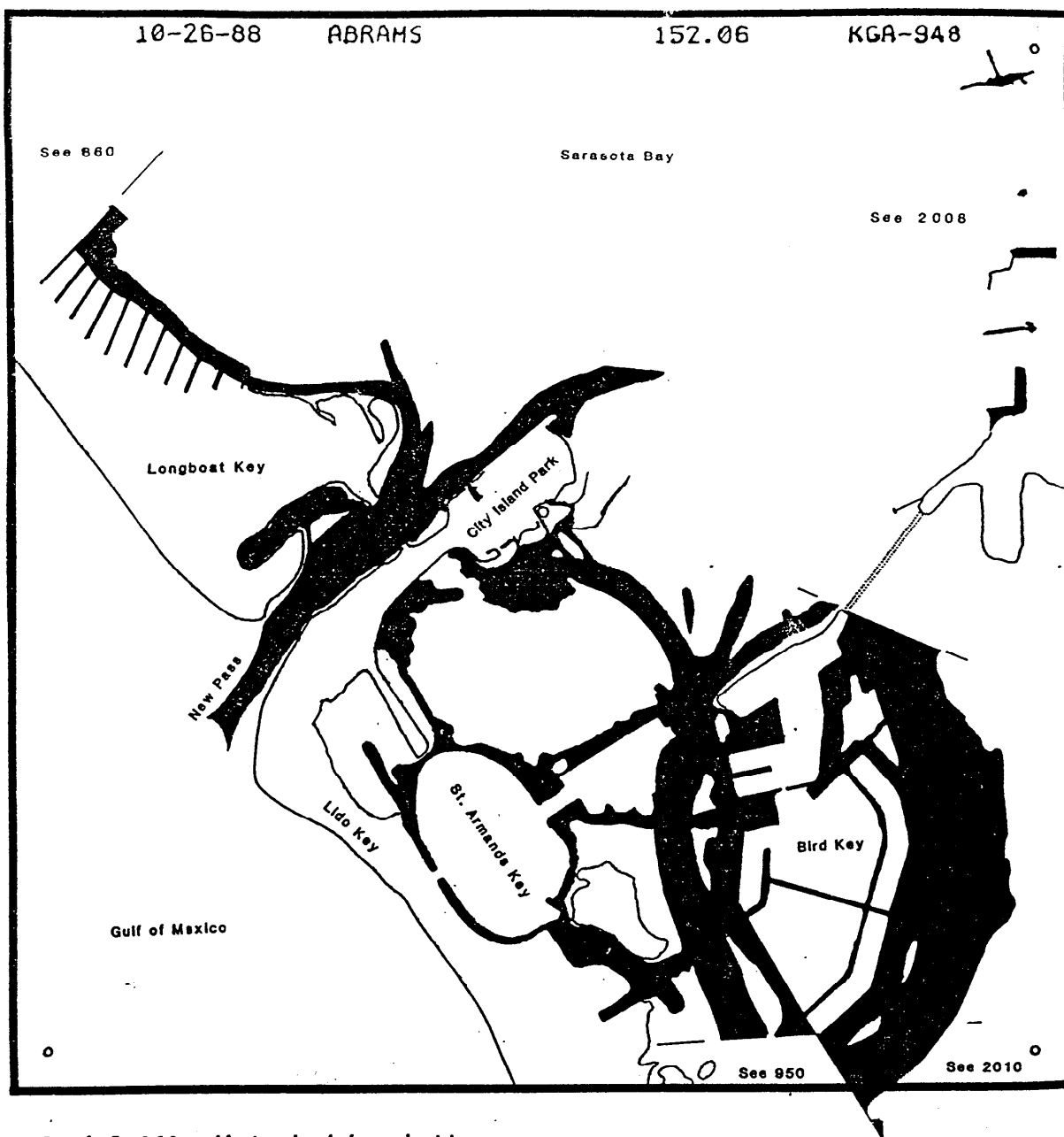
Table 7.1 presents the area of disturbed bay bottom for each bay segment, and an estimate of the percent of each segment that has been impacted. Areas include canal systems. Excluding passes as disturbed area, slightly greater than 4,400 acres of bay bottom (6.9 square miles) have been impacted by human activity. This represents 13 % of the total estimated area of the bay under consideration.

The majority of the disturbed bottom areas were found in shallow water adjacent to the shoreline. However, there were several locations that were located further from shore, areas that apparently served as borrow sites for fill material. Figure 7.1 illustrates a disturbed bottom map for a portion of the Sarasota Quadrangle, containing Bay segments 9, 10 and 11. Most of these features are not recognizable from water level but become apparent from an aerial perspective.

VII.C.3. Seagrass Cover and Trend Analysis

Seagrass habitat area by bay segment is presented in Table 7.2. A total of 8,318 acres (13 square miles) of bay bottom were characterized as seagrass habitat. With the exception of the City Island segment (10) the majority of high quality seagrass habitat is contained in the north bay. The role of Gulf influence in maintaining abundant seagrasses was obvious.

A trend analysis comparison of the seagrass mapping conducted in 1987 for Sarasota County (Mangrove Systems, Inc. 1988) with the current project was conducted for the New Pass area. Figures 7.2 and 7.3 illustrate seagrass coverage for the 1987 project (using 1984 aerials) and the present study (1988 aerials) respectively. Table 7.3 exhibits the changes in the categories of seagrass coverage. The same categories of seagrass density (dense, sparse - medium, and patchy) were used for both mapping products. Areas of sparse to medium coverage are designated "1" (light to medium color on aerial photo), areas of dense grass labeled as "2" (very dark on aerial photo), and areas of small patches listed as "3" (numerous small dots on aerial photos). From 1984 to 1988 there was a net gain of seagrass habitat in this area of approximately 19 percent. This was due primarily to increases in the patchy (+ 149%) and sparse(+ 45%) classifications. The dense category showed a decline of 9.4 percent.



Aerial 948, disturbed bay bottom.

Figure 7.1. A map of disturbed bay bottom for a portion of the Sarasota Quadrangle, containing Bay segments 9, 10 and 11.

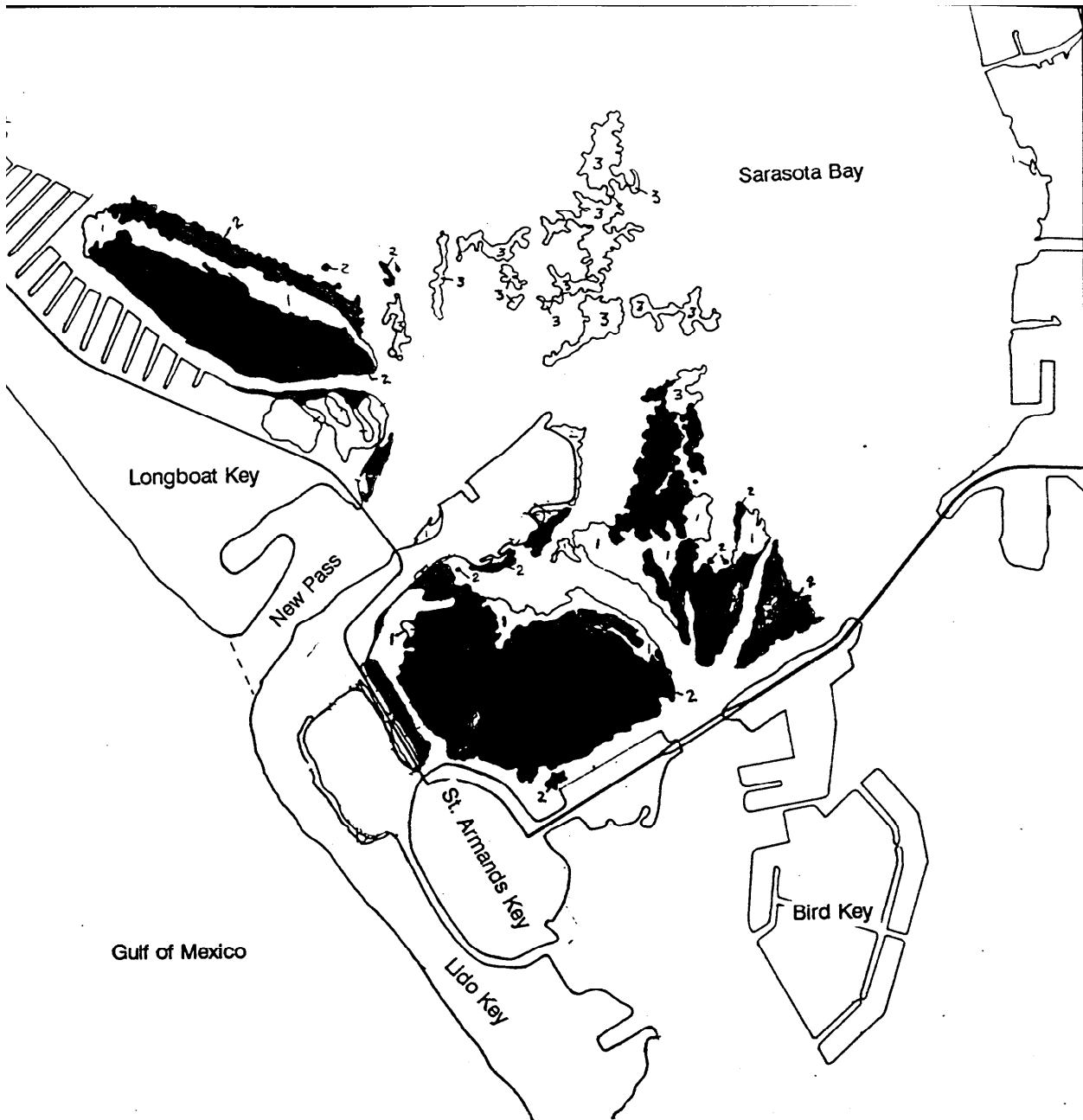


Figure 7.2 Seagrass habitat in the vicinity of New Pass as interpreted from 1984 aerial photographs, (modified from Mangrove Systems, Inc. 1988). No. 1 indicates sparse to medium coverage, No. 2 (Black areas) indicate dense coverage and No. 3 indicates patchy coverage.

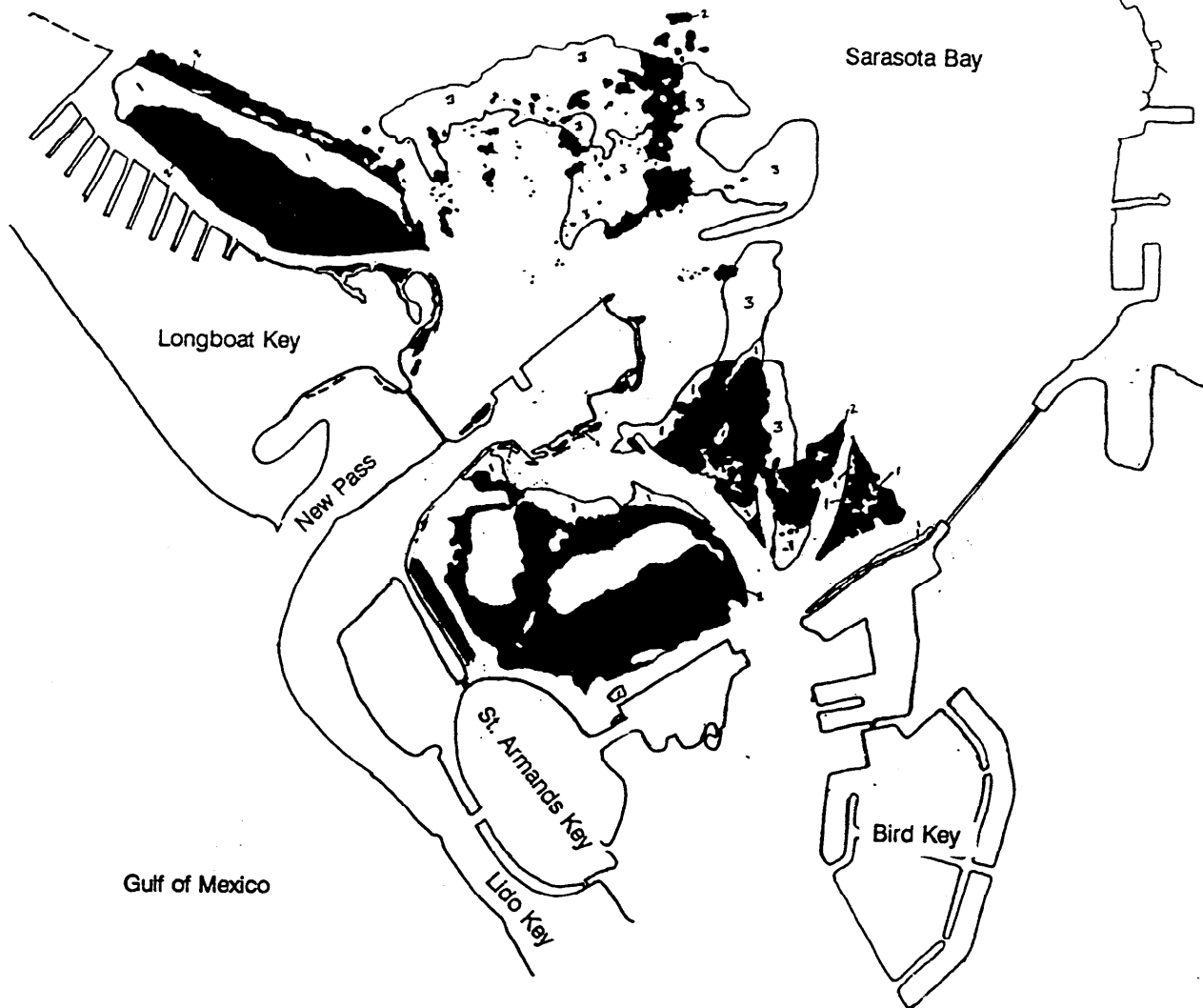


Figure 7.3 Seagrass habitat in the vicinity of New Pass as interpreted from 1988 aerial photographs truthed to 1991. No. 1 indicates sparse to medium coverage, No. 2 (Black areas) indicate dense coverage and No. 3 indicates patchy coverage.

Table 7.1. The area of disturbed bay bottom for each bay segment, and an estimate of the percent of the total area of each segment that has been impacted. Areas include canal systems.

<u>Segment</u>	<u>Description</u>	<u>Aerial Nos.</u>	<u>Area Acres</u>	<u>Percent of Segment Area</u>
1	Anna Maria	606, 688, 690	512.9	28.6
2	W Palma Sola	688, 690, 692	583.3	26.8
3	E. Palma Sola	768, 766	380.8	21.3
4	Longboat Pass	692	167.6	NA ¹
5	N. Longboat	692, 772	219.1	9.5
6	Tidy Island	692, 768, 772 942	440.0	9.4
7	Mid-Longboat	774, 860	247.5	4.4
8	E. Sarasota B.	942, 944	162.2	4.8
9	New Pass	948	157.9	82.2
10	City Island	948 & 2014	706.1	21.7
11	Ringling Bridge	2008, 2010	436.0	17.9
12	Big Pass	950	299.0	66.7
13	Philippi Creek	2014	92.9	NA ²
13	Roberts Bay	2014 & 2018	313.8	20.4
14	Little Sarasota Bay	2018, 1256, 1258, & 1260	238.2	13.3
15	Midnight Pass	1258 & 1256	65.2	50.9
16	Blackburn Bay	1260 & 1369	31.8	4.1
TOTAL:			5,054.3	15.5
TOTAL NOT INCLUDING EXISTING PASSES:			4,429.9	13.5

1, Not calculated due to different areas used in segmentation.

2, Not calculated.

Table 7.2. Area of seagrass habitat by bay segment.

Segment	Description	Aerial Nos.	Area		Percent of Segment Area
			Hectares	Acres	
1	Anna Maria	606, 686 688, 690	368.2	909.8	50.8
2	W Palma Sola	690, 688, 686	445.8	1101.7	50.6
3	E. Palma Sola	768, 766	252.7	624.4	34.8
4	Longboat Pass	692	12.3	30.3	23.7
5	N. Longboat	692, 772, 774	207.7	513.2	22.3
6	Tidy Island	692, 772, 770 856	673.8	1665.0	35.6
7	Mid-Longboat	774, 860, 858	288.4	712.7	12.7
8	E. Sarasota B.	942, 944	91.4	225.9	6.7
9	New Pass	948	2.9	7.2	3.8
10	City Island	948, 950, 2010	420.2	1038.4	32.0
11	Ringling Bridge	2010	54.4	134.4	5.5
12	Big Pass	950	4.2	10.4	2.3
13	Roberts Bay	2014, 2018	104.3	257.8	16.8
14	Little Sarasota Bay	2018, 1260 1258	261.8	646.9	36.1
15	Midnight Pass	1256	51.0	126.0	48.8
16	Blackburn Bay	1260, 1262 1369	127.2	314.4	40.9
TOTAL:			3366.3	8318.5	

1, Not calculated due to different areas used in segmentation.

Table 7.3. A trend analysis comparison of the seagrass mapping conducted in 1987 for Sarasota County (Mangrove Systems, Inc. 1988) with the current project for the New Pass area showing the changes in the categories of seagrass coverage. The same categories of seagrass density (dense, sparse - medium, and patchy) were used for both mapping products.

<u>Seagrass coverage changes (acres)</u>			
	<u>dense</u>	<u>patchy</u>	<u>sparse</u>
1984	464.9	83.1	98.3
1988	421.3	206.9	142.8

<u>Net Change and (percent) 1984 - 1988 (acres)</u>			
	<u>dense</u>	<u>patchy</u>	<u>sparse</u>
	-43.63 (-9.4)	123.82 (149)	44.50 (45)

Total Coverage 1984 (MSI): 646.30 acres
Total Coverage 1988 (MML): 771.00 acres
Net Gain 1984 - 1988: 124.70 acres (19.3 % gain)

VIII. CONCLUSIONS AND RECOMMENDATIONS

The Sarasota Bay estuary system exhibits a complex mosaic of underwater habitats. With the exception of the central open-water portion of Sarasota Bay (Segments 7 and 8), habitat type and condition change on a very small scale. Many of the habitat types, oyster bar, shoals, seagrasses, shallow mud bottom create their own micro-scale water conditions by modifying or responding to the physical forces of water movement.

Grassbeds in the vicinity of passes exhibit the highest diversity of grass species, grow to the greatest depths, and exhibit the fewest number of indicators of nutrient stress. Grassbeds in the west-central section of Blackburn Bay would be an excellent site for further study, as would those of Anna Maria Sound. The seagrasses in central portion of Blackburn Bay seem to be limited by depth and light attenuation, with increasing distance from Venice Inlet. Improved water clarity (reduced light attenuation) could result in extensive bed recolonization for this area.

The seagrass signature in segment B11, Sarasota Bay, suggests an ongoing recolonization of mid-bay perennial. There is some potential for extensive recolonization of the shallow waters in this area (off Hudson Bayou). This same signature is found in New Pass, where grasses have definitely increased in cover over the last two years. These trends need to be studied more closely, to determine if depth of growth in pass areas is limited by the transparency of the Gulf of Mexico waters or by the effect of the lesser transparency of the outflowing bay waters.

The absence of fringing grasses in B11 north of Ringling Causeway is historically documented (although *Halodule* is found along Indian Beach). The NEP Program has recently initiated a small scale experimental planting program to determine if recolonization is possible in this area. The assumption being that water clarity should be improving as a result of the elimination of treated wastewater discharge from Whitaker Bayou.

Restoration of seagrass beds through planting programs are generally ineffective and cost prohibitive. Seagrasses such as *Halodule* and *Ruppia* and the rhizophytic algae may colonize rapidly when conditions become favorable, but they may also die quickly when conditions become too stressful. The greatest potential for preserving and increasing seagrass acreages will depend on improvements of quality of the water flowing into the bay, reducing boating impacts through signage and reduction of shoreline docks, controlling boat induced turbidity in the narrow sections of the bay, and improving Gulf water exchange in the southern bay portions by reopening Midnight Pass or other circulation enhancement measures.

The Sarasota Bay system was historically a very shallow estuary, with the exception of the major pass channels. To accomodate urbanization and water transport dredge and fill operations were conducted. Extensive areas of "dredge holes" are located throughout the bay. Most of these holes are of very poor habitat quality. An unusual habitat was created by the dredging of the area west of the 888 Condominium (bay segment 11 north of the Ringling Causeway). The large expanses of exposed bedrock are unusual habitat for the bay. While

the habitat is not natural for the bay system it was of better quality than the majority of the dredge holes throughout the bay.

Restoration of these unnatural areas is technically feasible, but for most cases the costs associated with "moving sand" would be prohibitive. In certain circumstances restoration of such sites would be both feasible and cost effective, and this type of restoration needs to be integrated as a management option for restoration of Sarasota Bay.

Few other intertidal or subtidal sites within the bay are suitable for active restoration. Pansy Bayou offers an excellent site for a salt marsh habitat creation, on an unvegetated sandy overwash delta. Some enhancements of diversity and productivity may be possible through artificial reef programs, or seawall reef habitats such as those being investigated at Mote Marine Laboratory under NEP sponsored research.

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**Appendices available upon request
(See table of contents for description)**