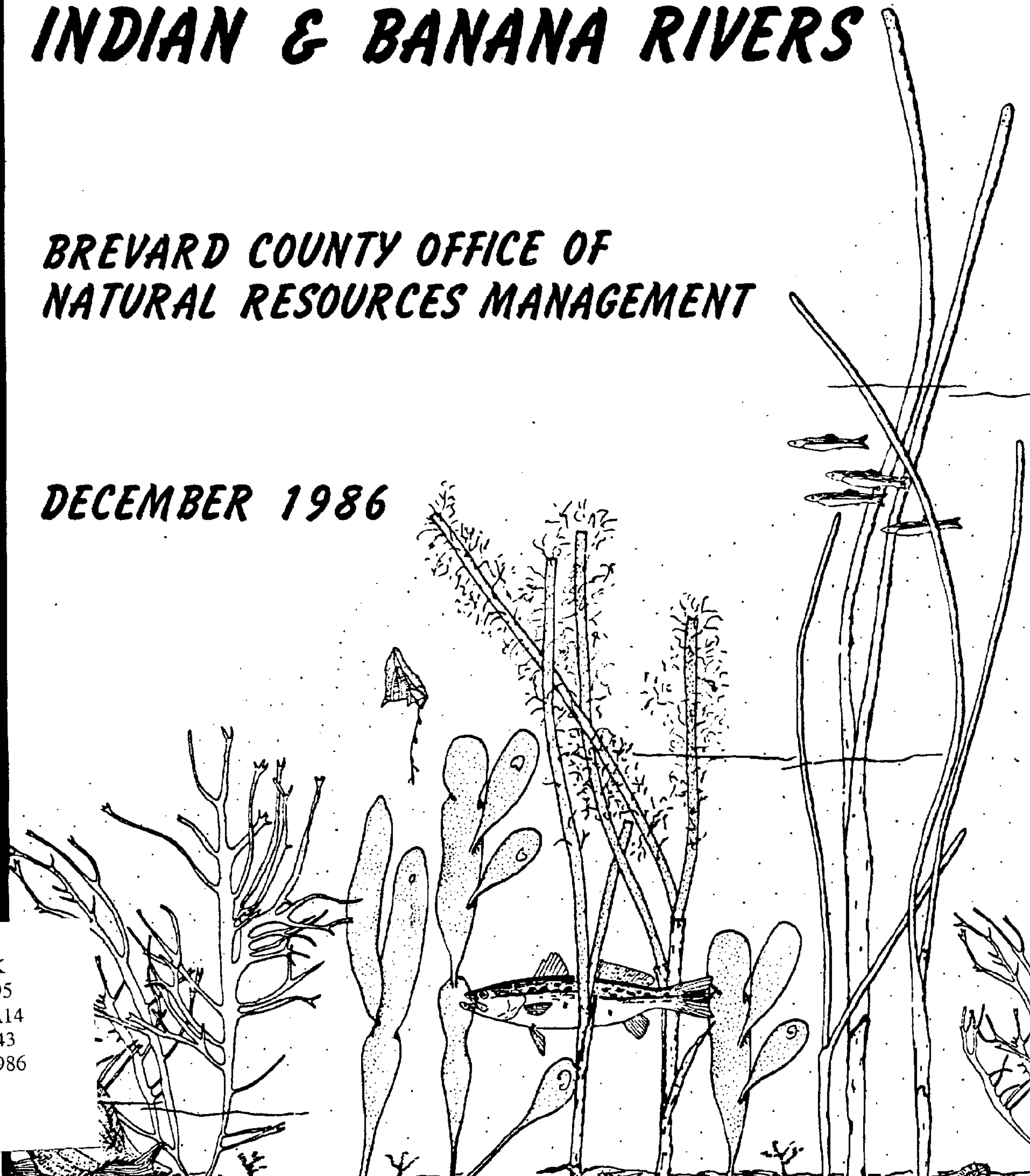
Task 3.23, NA84AA-D-CZ050 CM-121

SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

BREVARD COUNTY OFFICE OF
NATURAL RESOURCES MANAGEMENT

DECEMBER 1986



Funding for this project was provided by the Department of Environmental Regulation, Office of Coastal Management utilizing funds provided under the federal Coastal Zone Management Act of 1972 administered by the National Oceanic and Atmospheric Administration.

SEAGRASS MAPS OF THE INDIAN and BANANA RIVERS

Conrad B. White
Office Of Natural Resources Management
Brevard County
2575 North Courtenay Parkway
Merritt Island, Florida 32952

ABSTRACT:

Low altitude aerial photography, coupled with intensive groundtruthing was used to map (1" = 2,000 ft) the seagrasses and other submerged aquatic vegetation (SAV) along 170 km of an east-central Florida lagoon. The final maps were reduced to 1:40,000 scale to correspond to readily available NOAA navigation charts.

SAV coverages were estimated by separating densities into four classes. The final map contours were drawn with a combination of aerial and groundtruth information. Out of 53,900 ha available for SAV growth in the Indian and Banana Rivers, 31,170 ha had SAV.

The dominant seagrass was **Halodule wrightii** followed in order of relative abundance by **Syringodium filiforme, Halophila englemanni, Ruppia maritima**, and **Halophila johnsonii**. The attached benthic macroalga, **Caulerpa prolifera** was the dominant SAV in the lagoons; **C. ashmedii** was also found, but was restricted to a small area. Seasonal assemblages of drift algae (**Gracilaria** spp., and other algae) played an important role in the SAV habitat structure of the Indian River.

Comparison of this year's study with photographs taken in 1965 indicated that the areal extent of submerged aquatic vegetation has increased at numerous sites over the past twenty years. The dramatic increase in SAV coverage was attributed to the rapid expansion of **C. prolifera**.

Aerial photographs are not satisfactory, by themselves, for determining long-term spatial and temporal trends of SAV.

Table of Contents

INTRODUCTION

The Indian and Banana Rivers are a major physical feature along the east-central coast of Florida. East of a low lying coastal ridge, the rivers are separated from the Atlantic Ocean by a heavily developed barrier island. They are shallow, non-tidal, eoline mixed saline lagoons with an average water depth of 1.5 m, and a maximum of 4 m. The normal salinity regime varies from 18 $^{o}/oo$ to 26 $^{o}/oo$. The primary bottom type is a dense sand/shell/mud sediment.

Within lagoon systems, seagrasses, and to a lesser extent mangroves and other shoreline vegetation, are the most important biological component relative to productivity (Wood et al., 1969). Seagrasses, and other attached flora (collectively known as submerged aquatic vegetation, or SAV), also serve other equally important functions (see Bridges et al., 1978, for a good bibliography on seagrasses): (1) the roots serve to stabilize the upper portions of the sediment, (2) the blades decrease water currents thereby allowing the finer sediments to drop out of the water column, (3) the blades and roots act as a sink for macronutrients, (4) SAV serve as a nursery and feeding area for commercially and recreationally important fish, such as the spotted seatrout, (5) the roots and blades are a direct source of food for invertebrate and vertebrate species, including the endangered West Indian manatee, and as an indirect source of food via biomass production that eventually becomes part of the detrital food web, and (6) SAV serve as a habitat for many animals that use the blades and roots during their entire life cycle.

Past efforts to document the extent of seagrasses (and SAV) in the Indian and Banana Rivers have led to mixed results. The majority of an early effort by Brevard County (Down, 1983, study performed in 1975), concentrated on photointerpretation with only minimal groundtruthing to complement the photographs. Thompson's (1976) survey did not extend north of the southern tip of Merritt Island, leaving better than 60% of the east-central Florida lagoons unmapped.

The present mapping effort was targeted toward correcting some of the inadequacies with the previous surveys by (1) providing a consistent method that could produce reasonable results in an efficient manner, and could be easily duplicated, (2) furnishing detailed maps showing bottom vegetation density contours for the entire lagoon system, and (3) describing major trends in species distribution.

METHODS

Mapping was done with a combination of aerial photography and intensive groundtruthing. To insure results were as compatible as possible with a similar project in the southern portion of the Indian River (Virnstein, 1986) aerial photographs were taken from St. Lucie Inlet to SR 528 in the Indian River and in the Banana River on the same day with a single aircraft, using the same type of film.

Aerial photographs of the lagoons south of SR 528 were acquired April 10, 1986 by Hamrick Aerial Surveys (2028 Palmetto Street, Clearwater, Florida 33575) using a twin engine Piper Aztec Aircraft, outfitted with a Zeiss Jena MRB Camera System, with a 12.2 cm focal length Lamegon B lens; the camera was equipped with the appropriate filters to properly expose Kodak Aerial Ektachrome true color positive transparency film in roll form. Flight line navigation was accomplished with Arnav loran "C" flight line positioning system. A 60% photographic overlap and 30% sidelap was used where multiple flight lines occurred. The final photographic scale was 1:24,000.

Imagery in the Indian River for the area between SR 528 and Turnbull Hammock , and the Banana River north of SR 528 was obtained on March 15, 1985. Field observations taken in early 1986 of the area photographed in 1985 indicated conditions **in these areas** had changed little in the intervening year. Aerial photographs of the Indian and Banana River north of SR 528 were acquired on March 15, 1985, by the Florida Department of Transportation using a light plane flying at 3,658 meters; the plane was equipped with a Zeiss camera with an 30.5 cm focal length lens and bandpass filters to properly expose #2443 Kodak Aerochrome Infrared film in roll form. These photographs were furnished by NASA's Environmental Operations and Research Laboratory at the Kennedy Space Center, Florida. The final photographic scale was 1:9,600.

To insure equability existed during the photo interpretation phase between this mapping project and the one being performed by Virnstein (1986) a single interpreter was chosen. Most of the photographic interpretation was performed by Ms. Jane Provancha, Bionectics Corporation, Kennedy Space Center, Florida (methods described by Provancha and Willard, 1986). A standard botanical crown density scale was used during photointerpretation and groundtruthing (Orth and Moore, 1983) that divided vegetation densities observed into four categories. The four categories were:

1. < 10%
2. 10 - 40%
3. 40 - 70%
4. 70 - 100%

Standard U.S.G.S. topographic quadrangle maps (1:24,000 scale) were used as base maps. Vegetation polygons were drawn onto small rectangular mylar sheets placed over the aerials. The maps for northern lagoons were xerographically enlarged to fit the larger scale photographs used in that region, and then the finished product was reduced to 1:24,000 scale. All the rough mylars for each quadrangle were then assembled into a mosaic and the finish copy drawn onto a single quadrangle size mylar sheet. These mylar sheets were then photographically reduced to 1:40,000 scale.

The reduced maps (1:40,000) were produced so that clear overlays could be made to fit onto standard NOAA navigation charts, as well as provide maps that could be easily handled in the field. The navigation charts are accessible to most individuals so that direct comparisons with the seagrass maps could be easily made by any individual.

Groundtruthing work was achieved with either direct observation from the boat with a view box, or with divers towed behind a small boat on a sled at slow speed. Because of the poor visibility found in the deeper waters, most the field effort was done by the divers. The dive sled consisted of a small board with handles that allowed the diver to maneuver vertically in the water column. Vegetation densities and species were observed by the diver as he was towed close to the bottom at idle speed, or by having the diver free swim the area if water clarity was too poor to allow towing; the information was then relayed verbally, or by hand signals to individuals on the boat who recorded position and vegetation patterns.

Much of the groundtruthing positioning in the area mapped had to be done electronically. Many of the basins surveyed had seagrass areas that were too far from the shoreline to allow accurate triangulation with known points. Electronically determined positions were made possible with the use of loran "C" (Furno, models LC-80 and LC-90). The loran units were calibrated each sampling period against known points which generally gave a repeatability of roughly 20 m. In addition to direct diver observations, color contact prints of the aerials were annotated in the field to further refine coverage information. The prints were especially useful in the narrow areas of the lagoons where shoreline features were easily viewed making accurate positioning possible; this gave the field team the option of placing the SAV information directly onto the photographs with a permanent marker.

As the aerials were of limited use relative to (1) distinguishing bottom features in water depths over 1.5 m, (2) locating areas vegetated by **Halophila englemanni**, (3) showing SAV where the coverage was less than 10%, and (4) where turbidity reduced visibility drastically, we concentrated our efforts on determining the waterward perimeter of the seagrasses. Once the perimeter was established, the detailed shore-to-shore transects where SAV species and coverage information were recorded.

The waterward perimeter of the seagrass areas was delineated every 400 m by close, visual inspection of the bottom. The perimeter was determined by moving the diver into deeper water where no seagrasses were present, and then moving landward until seagrasses were first observed. This procedure was followed several times until it was assured that the waterward position was accurate. Invariably this procedure led to waterward contours where densities rarely exceeded 10%. A gradual decline in densities was commonly observed. Few sharp cutoffs between the vegetated and unvegetated zones were observed in this area, and those that were recorded, were located primarily near Sebastian Inlet.

After a perimeter point was found, the diver was towed parallel to the shoreline at high speed for 400 m where another seagrass perimeter point was found. To move rapidly (about 30 km/hr) the diver had to climb onto a rectangular piece of 0.6 cm thick clear plexiglass that was attached to the dive sled by movable joints (the joints allowed the diver to maneuver vertically). The clear plexiglass permitted the boat to reach planning speeds between perimeter points without the diver ever having to leave the water; this reduced the amount of time needed to sample an area immensely and at the same time did not restrict the diver's observations of the bottom. An added benefit of the plexiglass was that it afforded some measure of protection to the diver from the chance of being hit by stingrays (it was a "good" year for seagrasses **and stingrays**).

Once the seagrass perimeter was established for the lagoons, detailed shoreline to shoreline transects were performed on predetermined latitudinal lines where species (SAV) and density coverages were recorded. During this phase the divers stayed submerged almost continuously which allowed recording of any large differences in coverages and species more accurately. For the purposes of this report, however, only density polygons were recorded on the maps.

Over 2,000 points were established during 80 field days between April and October in the Indian and Banana Rivers. At each point submerged aquatic vegetation information such as species, densities, water depth, sediment type, and visibility, were recorded. Seventy detailed shoreline to shoreline transects were performed; the majority of the transects were over 1.5 km in length, and at least a dozen were over 5 km. Additional SAV information will be gathered during 1986-87, and the SAV maps further refined.

RESULTS

Five species of seagrasses were found in the two lagoons. In order of decreasing abundance, these were: Shoal Grass, **Halodule wrightii**, Manatee Grass, **Syringodium filiforme**, Star Grass, **Halophila englemanni**, Widgeon Grass, **Ruppia maritima**, and Johnson's Seagrass, **Halophila johnsonii.** All the species (except for **H. johnsonii**) were found in all the basins we studied; **H. johnsonii** was only found adjacent to Sebastian Inlet. The pattern of seagrass distribution, however, was not uniform in all areas.

In general, submerged aquatic vegetation (SAV) growth was keyed to water quality and depth (see Appendix B for maps). Areas that had little development on the nearby shorelines had the most SAV. The obviously degraded seagrasses areas were located near the cities that line the lagoons.

Water depth, however, had the greatest affect on SAV growth and species structure. Our observations of species distribution over a range of water depths led us to partition the rivers into five depth zones. The intertidal areas, where seagrasses could be exposed at low water, were depauperate of SAV. The likely reason for this was thermal shock. The intertidal zone during June through September often had water temperatures that exceeded 40°C. It should be noted that although there are no daily tidal fluctuation in the lagoons, water depth has been known to change several feet over a week; these changes are associated with dominant wind patterns and sea level changes. In addition, many of the intertidal zones had large vegetation wrack caused by the winds piling floating material along the shore; these wrack effectively smothered any SAV growth.

The next depth zone occurred from the intertidal area to a depth of about 30 cm. This area was predominantly vegetated by **Halodule wrightii,** interspersed with **Ruppia maritima.** Coverages of seagrasses in this zone often exceeded 70% in areas minimally affected by development. In many of the river areas surveyed, this zone was usually 100 m wide.

From the 30 cm to about the 60 cm depth contour, there occurred a mixed area of **H. wrightii** and **Syringodium filiforme.** Even though we have labeled this area as a transitional zone, more often than not **H. wrightii** was dominant.

The next zone occurred below 60 cm. Even though the dominant seagrass in this area was **S. filiforme**, the stands rarely equaled the dense coverages seen in the **H. wrightii** zone. **S. filiforme** often had either **H. wrightii** , or **H. englemani** mixed throughout the zone. At about the 1.5 m contour **Halophila englemani** became the dominant seagrass, and formed the last depth zone. It was apparent that **H. englemani** may have a high tolerance of low light conditions as compared to the other seagrasses. It was consistently found in water with visibilities of less than 15 cm; it was a rare occasion to find either **H. wrightii**, or **S. filiforme** below 2 m.

The other major finding was immense areas with sparse seagrass growth, that 20 years ago had dense stands of SAV. When we compared aerials taken in the mid 60's with those taken in 1986, we found large areas that were now either totally denuded of vegetation, or the density was so low (less than 10 percent) the SAV was not discernible on the aerials. This situation was evident in the more populated areas of Melbourne and Palm Bay, where in the 60's SAV coverages were estimated to be at least 70%. In 1986 the same areas showed a 20% coverage - a 50% loss in twenty years.

In contrast to the depauperate areas, some zones surrounding highly developed areas, such as Cocoa Beach, had seagrass areas that presumably contributed functionally to the surrounding lagoon in 1986; **Caulerpa prolifera**, however, was still the dominant bottom vegetation. As an example, one area in Cocoa Beach that was bounded by SR 520 on the north and the Thousand Islands on the south, had the densest stand of **Ruppia maritima** found within the lagoon system; coverage in this area was estimated to be at least 90%.

One interesting result of this study was observed when certain areas that 20 years ago appeared to have little SAV in the photographs were compared with what was mapped during this project. We were amazed to find that some areas that appeared to be barren, or at least with < 10% coverage in the 1960's, were now vegetated with some type of submerged aquatic vegetation; the more noteworthy areas were found in the Indian River between SR 420 and the NASA Causeway.

Because of the extreme complexity of the SAV patterns found in the lagoons, especially in the area heavily vegetated by **Caulerpa prolifera,** we felt that a descriptive narrative of each river segment would be beneficial toward eliminating confusion over the distribution of **seagrasses** versus other submerged aquatic vegetation (Appendix A). The narrative will be helpful because of the shifts in map conventions that we needed to implement because of the **C. prolifera** problem.

CONCLUSIONS

It was a "good" year for seagrasses and other SAV in the Indian and Banana Rivers. It was also a "good" year for seagrasses throughout Florida (personal communication R. Virnstein and K. Haddad). Although there were many factors that could have contributed toward producing the good year for seagrasses, we felt that the combination of low rainfall and low plankton growth (i.e., good water clarity) throughout the lagoon until June, coupled with **good weather** conditions (i.e., the absence of the typical afternoon thunder showers) combined to give an exceptional **"Year Of The SAV"**.

It was reassuring to find seagrass beds that appeared to be in outstanding condition, and probably existed in much the same state as they did before the east-central coastline began to be developed forty years ago. These areas could best be described as "**lush**", with densities well above 70%, and with the assemblage of invertebrates and fishes normally seen in "pristine" areas. What was even more surprising was that many of these areas continued to increase their relative coverages up to, and thru November 1986.

Although we based many of these observations on comparisons with older black and white photographs from the 50s and 60s, much of the "background data" came from researchers and individuals who have observed the lagoons month by month, year after year, over the past five to ten years. Even though these observations could not be quantified, they contributed greatly to the understanding of the long-term mosaic of spatial and temporal SAV patterns.

However, it was also painfully apparent that most of the areas that were exceptional for seagrasses and animals were few; most of the "good" areas were located north of the NASA Causeway in the Indian River, and north of SR 528 in the Banana River. The rest of the lagoon system showed some sign of perturbation, either by way of man-induced changes via wastewater/stormwater inputs and shoreline development, or through "natural" introduction of vegetation other than seagrasses (i.e., **Caulerpa prolifera, C. ashmedii** and drift algae).

The most conspicuous example of a "natural perturbation" was finding **Caulerpa prolifera** growing from shoreline to shoreline in enormous stands (70 - 100% coverages), especially in the Banana River. We assumed that the dramatic increase in

Caulerpa prolifera was a "natural perturbation" because in the short study period no real link with "pollution"was found. Several investigators familiar with the Banana River have indicated that **C. prolifera** has recently expanded its range within the past two years, particularly into the Indian River.

We felt that the comparisons of older photographs with the aerials taken this year, combined with observations made by investigators over the past few years in the Banana River, that **C. prolifera** has colonized the lagoons to its present extent (assuming almost none was present at year one) over the past 15 to 16 years (around 1970).

Information gathered during the 1986 mapping project also indicated that **C. prolifera** might be rapidly expanding northward in the Indian River. Small patches of **C. prolifera** were found scattered throughout the Indian River basin north of Titusville almost to Turnbull Creek; these patches (the patches are really ten to twenty blades found in groups, every 30 to 40 m) may be the vanguard growth of the algae as it expands northward. The patches will be monitored intensively over the next year during a recently DER funded study of **Caulerpa prolifera**, to determine the rate of expansion, if any.

Besides the determination of the areal extent of the seagrasses, and the finding of the **C. prolifera** phenomena, another important outcome was the conclusion that the use of aerial photographs was limited when mapping seagrasses in the lagoons. This was attributed to (1) the depth to which seagrasses were found versus the depth to which aerial photographs could be used to distinguish bottom features, and (2) the dense coverage of **Caulerpa prolifera** that confounded aerial photo interpretation. Much to our surprise, seagrasses were found growing in water depths of 3.5 m, which was well beyond the resolution of the aerials; in our photographs bottom features could be defined accurately to a water depth of 1 m. The reduced effectiveness of aerial photography was due largely to turbid water that limited distinguishing bottom characteristics in water depths greater than 1 m. This problem could be rectified in the future by obtaining photographs during winter months when planktonic algae is reduced and water clarity is good.

We have made observations during the groundtruthing, however, that seagrass coverages in certain areas increased dramatically during August, September and October despite an obvious increase in planktonic algae. Areas that in April had a density coverage of <10%, in October had a coverage of 40%, and in some areas that we recorded as having no seagrasses in May, had coverages of 20% in September. What this information led us to assume was that with aerial photographs targeted specifically toward SAV monitoring in the Indian and Banana Rivers, the best you can hope for is a trade off between water clarity (winter water clarity (winter months) and high SAV growth (summer months); photographs in January would show bottom features well, but the summer and fall months are when the SAV growth reaches its peak.

Examination of the photographs also revealed that there was no way to distinguish seagrasses from benthic algae based on photographic signature alone. This meant that for the Indian River from Titusville, south to the Pineda Causeway, and the Banana River south of the NASA Causeway, that any contours drawn would depict submerged aquatic vegetation (SAV), not seagrasses alone. Only groundtruthing in great detail, throughout the lagoons would allow creation of maps which depict species and densities. Given the constraints of this study it was not possible to include species on the maps.

Acknowledgments

I must thank several individuals who contributed greatly toward completing this project. I am especially thankful to the primary divers, Larry Bauer and Terry Peterman, and Brevard County employee Joel Snodgrass, for performing most of the diving during the project under dirty and sometimes hazardous conditions. Other divers who contributed to the groundtruthing effort were Carl Mayers, Chuck Turner and Mark James. I would also like to gratefully acknowledge Becky Smith, who did an excellent job generating the final maps.

LITERATURE CITED

Biological and environmental studies at the Florida Power and Light Company and the Orlando Utilities Commission Indian River Plant. Volume II. 1980. Applied Biology, Inc.. 641 DeKalb Industrial Way, Atlanta, Georgia 33033

Bridges, K.W., J.C. Zieman and C.P. McRoy. 1978. Seagrass literature survey. Tech. Rpt. D-78-4 U.S. Army Corps Of Engineers, U.S. Army Engineer Waterways Experimental Station, Vicksburg, MS: 174 pp.

Down, C. 1983. Use of aerial imagery in determining submerged features in three east-coast Florida lagoons. Fla. Sci. 46(3/4):355-362.

Thompson, M.J. 1976. Photomapping and species composition of seagrass beds in Florida's Indian River estuary. Harbor Branch Foundation Technical Report No. 10: 34 pp.

Virnstein, R.W., and K.D. Cairns. 1986. Seagrass maps of the Indian River lagoon. Final report to Florida Department of Environmental Regulation, Office of Coastal Management.

Wood, E.J.F., W.E. Odum and J.C. Zieman. 1969. Influence of seagrasses on the productivity of coastal lagoons. Lagunas Costeras, Un Simposio. Mem. Simp. Intern. Costeras. UNAM-UNESCO, Nov. 28-30, 1967, Mexico, D.F.:495-502.who

APPENDIX A

BASIN ANALYSES

The following narrative describes the vegetative patterns in each basin. A basin, in this instance, was defined as the water body between two causeways, or other significant land formation. The number between the parenthesis relate to Brevard County planning segments. The following categories refer to density classifications used during the mapping:

1 - < 10%
2 - 10 - 40%
3 - 40 - 70%
4 - 70 - 100%

BANANA RIVER

The Banana River was broken into several large basins. Each basin appeared to have a distinct differences of seagrass coverage patterns and densities (see APPENDIX B for maps). The Banana River also had **Caulerpa prolifera** covering more of the available bottom than the Indian River.

NASA Causeway to SR 528 (B-1 and B-2)

This area is located within the boundaries of the Cape Canaveral Wildlife Refuge. It is bordered by a natural shoreline and receives little point or non-point pollution discharges. The dense seagrass in this basin was found in shallow areas within 200 meters of the shore. Winter **horizontal** visibilities often exceed 10 m. Out of a possible 5,763 ha, 5,509 was vegetated (96%). This was due to **C. prolifera** covering most of the available bottom.

The dominant seagrass was **Halodule wrightii** . **H. wrightii** was usually found in water depths of less than one meter. In water greater than one meter the, seagrass domination shifted from **H. wrightii** to **Syringodium filiforme** and back again until depths of two meters were reached at which **S. filiforme** became the dominant seagrass. Seagrasses were found to a water depth of 2.5 meters in this basin.

The benthic algae **Caulerpa prolifera** was the dominant benthic vegetation throughout the basin. Only the shallow areas (< 45 cm), navigational channels and areas dredged for spoil did not have **C. prolifera**. Density coverages varied from 10 to 90 % with an approximated average of 70%. Dense areas of **C. prolifera** in shallow water of 45 cm to 60 cm depths along the eastern shoreline of this basin almost totally excluded seagrasses.

Another algae species observed in the northern Banana River, but not quantified accurately, was a species of sargassum, **Sargassum** sp.. This attached benthic algae was not seen in large amounts in the Banana or Indian Rivers until 1985-1986; observations during the groundtruthing indicated that it increased in coverage and at the same time extended its range into the northern Indian River between April and October. In deeper areas (> 1 meter) it showed density coverages of between 1 to 10 % regularly .

In addition to **Sargassum**, large, extremely dense patches of **Penicillus capitatus** were present along the eastern shoreline from the shore of the Canaveral Locks north about six kilometers. The patches varied in width from 5 to 50 m; in some areas **Penicillus** formed an almost monotypic bed. During the groundtruthing period no other area of the lagoon system had this much **Penicillus capitatus.**

SR 528 TO SR 520 (B-3)

This basin deviates not only in its degree of shoreline development, but also in organic pollutants being discharged into the system. The shorelines are highly developed with many residential canals. The City of Cape Canaveral discharges its secondarily treated wastewater into the northeast quadrant, and the area receives large inputs from stormwater systems. Out of a possible 2,684 ha, we found 1,783 vegetated; this was a drop in coverage of 30% from the basin immediately to the north. Once again, most of the SAV coverage was due to **C. prolifera.**

Halodule wrightii was the dominant seagrass in this basin (the dominant seagrass in every area was **H. wrightii**). Along the western shoreline **H. wrightii** formed dense beds in a band from the shoreline to about 200 m from shore. In this area coverages varied considerable, but in general were density coverage of 3. The seagrass **Ruppia maritima** was also present but never greater than a coverage of 1. The width of the seagrass area decreased toward the SR 520 causeway until it was a band less than 50 m. The outer seagrass area was mixed heavily with **C. prolifera.**

Along the eastern shore of this basin conditions varied greatly. Turbid water was present throughout most of the year. Seagrasses were present along the shore in patches of coverage class 3 or 4 within the first 10 m from shore, but quickly changed to coverage class 1 thereafter until almost 1200 m from shore where coverages increased dramatically (> 2) for 50 m. This area of increased seagrass coverage was associated with a shallow water zone where the depth ranged from 30 to 60 cm. Except in extremely shallow areas (< 30 cm), **C. prolifera** was present all the time , and once water depths increased past 30 cm, became the dominant vegetation.

SR 520 to George Island (B-4)

This area includes all the area south of SR 520, including the Thousand Island area adjacent to the city of Cocoa Beach, and the area in the south of the golf course called Shortys Banks. The trends established in the basin to the north continued below SR 520; the seagrass areas along the west coast continued to decline until they were remnant patches close to shore, and along the eastern shoreline (including the south shore of the SR 520 Causeway), seagrasses made up a large portion of the total plant coverage. Of the 2,533 ha of bottom available for SAV, 2,093 was vegetated (83%). Like the other areas to the north **C. prolifera** was generally the dominant macrophyte.

During the time this area was mapped between May and July, the area between Shell Point and SR 520 was dominated by **Ruppia maritima**. Coverages of **R. maritima** in this area reached 90% during June. Between the **R. maritima** area west about 750 m, the SAV was predominantly **Caulerpa prolifera**, with sparse **H. wrightii** and **R. maritima**; the total submerged aquatic vegetation coverage class varied between 3 and 4. At this point (750 m west of the **R. maritima** area), the water depth became shallow (30 to 60 cm) much like the area north of SR 520 where there was a sudden increase in seagrasses far from the shoreline. Within this shallow area, **H. wrightii** intermixed with **C. prolifera**, but was rarely greater than a coverage classification of 2; generally coverage was usually 3 or 4. The area of increased seagrass coverage extended south to the northwest point of the golf course in a sickle shaped pattern that varied in width from 5 m to 50 m.

The SAV in the Thousand Islands, and the immediate vicinity was a complicated mixture of the seagrasses **H. wrightii, S. syringodium, R. maritima, Halophila englemanni**, and algae **C. prolifera** and **Gracilaria** spp.. In general, the seagrasses **H. wrightii** and **H. englemani** dominated the vegetation in the shallow waters between the islands and close to the island shorelines on the river side. **Caulerpa prolifera** and **Gracilaria** spp. dominated the areas outside the immediate vicinity of the islands, with all three of the seagrasses intermixing with the **C. prolifera** occasionally (coverage class 1).

The SAV along the west shore out to and including the boat channel, was vegetated with **C. prolifera**, with a coverage class of 3 to 4. AT the time of the first ground inspection of this area (April), **C. prolifera** was dense with a coverage of 3 to 4 and the blades 12 cm long and 0.5 cm wide. Reinspection of the area in August showed that coverage was a 2 and that the C.

prolifera blades appeared to be stunted, with the blades less than 6 cm long and less than 0.5 cm wide. This pattern was noticed in the Indian River in the central part of Brevard County; the same stunted blade pattern was noticed within the northern Banana River above SR 528, but the extent of the pattern was much less then what was seen below SR 520.

George Island to the Pineda Causeway (B-5)

This area, and the area immediately south of the causeway showed some degradation of vegetation cover. The lack of SAV along the eastern shoreline south of Cocoa Beach was attributed to high turbidity. A total of 472 ha within this basin was vegetated out of a possible 3,438 (14%).

In contrast, the western shoreline had dense SAV from the shoreline waterward for 200 m. The nearshore area was vegetated primarily with **Halodule wrightii** and **Ruppia maritima,** which blended into an area of **Caulerpa prolifera** and **Gracilaria** spp. below the 30 cm depth contour. Sparse (< 1% density coverage) seagrass was evident to almost 400 m offshore and in water depths of 3 m. The deeper areas of this basin (3 to 5 m) had a conspicuous lack of SAV. The bottoms were primarily a fine silt/clay/shell sediment.

Pineda Causeway to the southern tip of Merritt Island (B-6)

Inputs from a wastewater treatment plant and an extensive series of residential canals along the eastern shore appeared to have affected this basin. The only seagrass area of note was found in the northwestern portion of the basin. Only 10% of this basin had SAV (68 ha out of a possible 697 ha). The eastern shoreline had little seagrass. There were several large areas of **Gracilaria** spp. in the northeast corner.

Newfound Harbor (S-2)

Newfound Harbor showed signs of degradation; the primary cause was attributed to stormwater and wastewater discharges into the upper reaches of the harbor, and wastewater discharges into the Sykes Creek basin immediately to the north. Sixty-five percent of the area was vegetated (938 out of 1,439 ha).

The area bounded by SR 520 and the Merritt Island Airport had scattered seagrass stands, limited areas of **C. prolifera,** and large quantities of drift algae near the center. The middle area of Newfound Harbor had increased quantities of **C. prolifera** near the center, and the shorelines exhibited increased quantities of seagrasses.

The southern portion of Newfound Harbor mimicked the Banana River ecology found immediately to the east. The shorelines had seagrasses in the same pattern as seen along the western shore of the Banana River between George Island and the Pineda Causeway, with **H. wrightii** dominant nearshore and **S. filiforme** dominant in the deeper area. The middle of this portion was vegetated with **C. prolifera**, but unlike the Banana River the coverage did not exceed 30% often.

INDIAN RIVER

The Indian River was separated into basins for the narrative portion of the report much like the Banana River. Essentially the basins were areas bounded by causeways, or significant geographical features, such as the Sebastian Inlet (see APPENDIX B for maps).

The dominant seagrass in the Indian River was **Halodule wrightii**, followed by **Syringodium filiforme**, **Halophila englemanni**, and **Ruppia maritima**. **S. syringodium** was significant large monotypic stands only in the Indian River north of Titusville.

This pattern was significantly different from the dominance pattern reported by Virnstein (1986) where he found that **S. syringodium** was the major seagrass species south of Sebastian Inlet. It was apparent from our observations during the mapping combined with other data that there were major shifts in flora and fauna near the Sebastian Inlet area. As an example of this change the seagrass **Thalassia testudinum** was a common constituent in seagrass areas south of Sebastian Inlet. It is also the major seagrass in the Florida Keys and is common in the Gulf Of Mexico, yet it is not found north of Sebastian Inlet. To date there has been much speculation about the apparent Sebastian Inlet shift, but little solid information exists on which to formulate an answer to why the shift exists.

Another readily apparent pattern that was gleaned from the maps was the conspicuous decrease in SAV between the Pineda Causeway and Cape Malabar. The change was attributed to two major causes, 1) a change in shoreline configuration in many areas from a gently sloping sandy littoral zone to coquina rock outcrops that limit SAV growth areas, and 2) excessive cultural enrichment from a variety of sources within the Melbourne - Palm Bay area. The latter cause has led to high phytoplankton concentrations and a concomitant decrease in light penetration to the benthic region, which in turn has led to a loss of SAV.

Turnbull Creek to the Railroad Bridge (I-2)

If any basin within the study could be classified as being

"GOOD" relevant to seagrass coverages, water visibilities and an abundance of invertebrates and fishes, this basin would be it. Except for several deep (3 m+) water areas north of the Intracoastal Waterway (ICW), the ICW itself, and the area immediately surrounding the entrance to the Haulover Canal, the entire basin was vegetated with seagrass. Out of a possible 8,892 ha of bottom, 7,551 were vegetated (85%); the difference between this area and the Banana River was that most of the SAV was seagrass, not **C. prolifera.**

The pattern of coverages mimicked many of the other areas in that the shallow zones (< 60 cm) were vegetated with dense **Halodule wrightii** to a depth of 60 cm; thereafter **Syringodium filiforme** became the dominant SAV. **Ruppia maritima** was also found in the shallow areas with **H. wrightii. Caulerpa prolifera** was found in small patches about 50 cm in diameter from the Railroad Bridge to near the center of the basin, and was present in water less than 2 m in patches with only 10 to 15 blades; at no time did we observe areas of dense **C. prolifera** that matched those found in the Banana River.

The dominant seagrass in the deeper areas of this basin was **Halophila englemanni** (stargrass). Typically it was found growing in small patches nearly 50 cm in diameter. This seagrass was consistently found growing in water 3 m deep that had extremely poor visibility, as well as in water < 60 cm deep and with excellent visibility. Unlike what Virnstein (1986) found where **H. englemanni** sometimes grew in large, dense beds we did not observe it growing in that fashion, but found it in small patches over a wide geographical area during April through August. Observations of the grass in October showed that it had increased its coverage to a point where it was no longer patchy; the density, however, rarely exceeded 20%.

Railroad Bridge to SR 402 (I-3)

This basin showed the same pattern as the basin north of the railroad bridge, with **H. wrightii** as the dominant seagrass, and **C. prolifera** present as small patches in shallow water (60 cm). A section of the shoreline in the southeast quadrant showed degraded (enriched) conditions, with little seagrass, or **C. prolifera**, and increased amounts of drift algae. Inputs from wastewater and stormwater near the city of Titusville were thought to be the primary cause of the SAV structure shift. Of the 1,000 ha in this basin, 612 were vegetated.

SR 402 to the NASA Causeway (I-4)

The seagrass, **Halophila englemani**, contributed greatly to the extension of the waterward edge of the seagrass line in this basin. It should be mentioned that it was extremely difficult to see because of limited diver visibility, and because the small blades (< 7 cm) were covered with a fine silt that blended into the surrounding sediment; the divers were required to continually stop and brush away the silt to determine if the grass was present.

The shallower seagrasses areas showed the same basic structure that was found to the north. **Caulerpa prolifera,** however, was found in much higher amounts and extended into the deeper areas. Typically **Gracilaria** spp. (drift algae) was the dominant SAV in the deeper areas of the basin (> 2m).

NASA Causeway to SR 528 (I-5a and I-5b)

This basin showed the first significant departure from the structural pattern that was observed in the basins to the north. **Caulerpa prolifera** was observed in this basin right to the edge of the ICW along with **Gracilaria** spp.. Together **C. prolifera,** and **Gracilaria** spp. made up a major portion of the SAV; in some cases, particularly toward the SR 528 bridge, **C. prolifera** was found in densities classifications of 3 to 4 from shoreline to shoreline, **including the ICW channel.**

This pattern did show some seasonality in the shallower areas where in June **C. prolifera** was dense along the eastern shoreline, but in late September - early October densities within the first 200 m of shore had changed to a classification of 1 or 2. In some areas that were investigated thoroughly in April and had dense beds of **C. prolifera** showed no **C. prolifera** in October.

The western shoreline showed a different seagrass pattern in comparison to the eastern shoreline in that the nearshore areas had very little seagrasses. The seagrass contours depicted on the maps were mostly small patches of **Halophila englemanni** growing in water > 1 m. The change was attributed to the influence of the two power plant's combined thermal loading (Florida Power and Light, and Orlando Utility Commission power generation plants); the thermal effects were estimated to influence from 600 to 900 hectares of SAV (Applied Biology, 1980).

SR 528 to SR 520 (I-6)

The SAV pattern in this basin showed the effects from wastewater and stormwater inputs, as well as a change in the vegetation pattern owing to a change in the shoreline topography. Along the eastern shoreline seagrasses were present in a pattern much like the one observed to the north with **H. wrightii** dominant in the shallower areas with **R. maritima** interspersed occasionally, followed by **S. syringodium** in the deeper zones; the difference was that the densities of **S. syringodium** and **R. maritima** were less.

Along the western shoreline seagrasses were present only in a thin band nearshore (< 100 m), and eventually ceased to be present near the mid-basin point. The loss of seagrasses was attributed to the combined effects of a wastewater discharge from the city of Cocoa and to the present of coquina rock outcrops that eliminated the gently sloping littoral zone. At one point near the wastewater outfall the filamentous alga, **Enteromorpha intestinalis**, was found growing in large beds near shore much like what was observed for seagrasses. We have observed this alga growing in other highly enriched areas of the County, but never to the extent that was found in the Cocoa area.

SR 520 to the Pineda Causeway (I7a and I-7b)

The SAV pattern was more varied in this basin then in the two previous ones. Along both shorelines the coquina outcrops severely limited the littoral zone where seagrasses were found in other basins. **Caulerpa prolifera** was present throughout the basin, and in the southern portion of the basin extended from shoreline to shoreline. What seagrasses were found were within the first 10 m from the shoreline and for the most part were density classification 1. The zone in the northwestern quadrant appeared to be affected by cultural enrichment from the city of Rockledge wastewater outfall and various stormwater inputs. The sediment characteristics in this area were different from other areas in that the organic fraction was visually greater (i.e., more muck, less sand and shell).

Pineda Causeway to the Eau Gallie Causeway (I-8)

This basin had little seagrass, and only small amounts of **C. prolifera** was found. Most of the SAV in this area was **Gracilaria** spp. (drift algae); also present on the bottom in large numbers were unidentified sponges.

Along the eastern shoreline the dominant littoral structure was coquina rock outcrop; water depths along this area reached 1 to 1.5 m within the first 0.5 m from shore. The western shoreline also mimicked this pattern with large sections of the shoreline dominated by rock outcrops. The rocky areas effectively limited the zones that could be colonized by seagrasses and was a major reason that seagrasses were not present. The other major reason we felt that seagrasses, and **C. prolifera** were not found was that water clarity in this area was poor. At the time this area was mapped (June) diver visibility was less than a 0.25 m at the bottom, and sometimes near shore, visibility was less than 6 cm and the diver had to use his hands to determine if any vegetation was present.

Eau Gallie Causeway to SR 192 (I-9)

The seagrasses in this basin were confined to a narrow band close to 15 m wide along the western shoreline. The dominant seagrass was **Halodule wrightii**; no **Caulerpa prolifera** was found. Along a few areas on the eastern side **Gracilaria** spp. was found in dense patches, however, most of the shore had no submerged aquatic vegetation.

The primary shoreline type in this basin was a gently sloping sand/shell bottom that appeared to be suitable for submerged aquatic vegetation colonization. Even in the deeper areas (3 m) of the basin near the ICW, the sediment type was a packed sand/shell type suitable for vegetation growth. However, midsummer secci disk values varied between 30 to 60 cm, and diver visibilities that were often less than 30 cm indicated that the low light levels near the bottom could have effected photosynthesis to a point where it was no longer possible for the SAV to survive, even in water less than 60 cm. Hence, the large zones without any vegetation. The basin receives inputs from wastewater plants and many stormwater outfalls.

SR 192 to Cape Malabar (I-10)

Although this area has no real definable southern boundary, such as a causeway, the change in the vegetation pattern between SR 192 and Sebastian Inlet required that this large area be divided into two basins. The area between SR 192 and Cape Malabar mimicked the basin just to the north in that almost no SAV was present along the eastern shoreline, and only a thin band of SAV along the western shoreline. The dominant seagrass was **Halodule wrightii**, with only **Ruppia maritima** present occasionally; **Syringodium filiforme**, or **Caulerpa prolifera** was not found.

Just like the basin to the north of SR 192, this area has received inputs from wastewater and stormwater and showed the effects in lowered water clarity.

Cape Malabar to Sebastian Inlet (I-11)

South of Cape Malabar the submerged aquatic vegetation began to increase in aerial extent as well as in density with **Halodule wrightii** the dominant seagrass, followed closely by **Syringodium filiforme**, with **Ruppia maritima** and **Halophila englemani** a distant third and fourth. The increased seagrasses became more apparent along the eastern shoreline where the SAV reached density classifications of 3 and 4 for the first 75 to 100 m from the shore of many of the islands present in the area.

The western shoreline was characterized as having a depauperate SAV from the Cape Malabar region to just south of

Grant. Thereafter the seagrasses areal coverage and density increased greatly. Interestingly, the many spoil islands in the area along the ICW showed the same shifts in submerged aquatic vegetation patterns, even though there were obvious sediment type differences between the islands and the "natural" shoreline. The sediments along the natural shoreline were characterized as a fine grain sand/shell/muck type, although the sediment along the islands was much coarser, with large amounts of shell fragments. The spoil islands north of Grant had a depauperate SAV, and those to the south, including Grant Farm Island, had increased amounts of seagrasses.

The eastern shoreline south of Grant had an abundance of seagrass in amongst the islands to a water depth of nearly 1 m. The dominant seagrass pattern followed the usual depth - species relationship, with **Halodule wrightii** dense in the shallower regions, followed by **Syringodium filiforme** in the deeper areas. Around the entrance to Sebastian Inlet the seagrasses were primarily **H. wrightii, S. syringodium, H. englemani,** and **H. johnsonii**; no **Thalassia testudinum** was found north of the inlet.

APPENDIX B

MAPS AND MAP CONVENTIONS

Seagrass maps are 1:40,000 scale and correspond to available NOAA navigation charts for the Indian River. Polygons were drawn to fit the four SAV density classifications:

1 - < 10%
2 - 10 - 40%
3 - 40 - 70%
4 - 70 - 100%

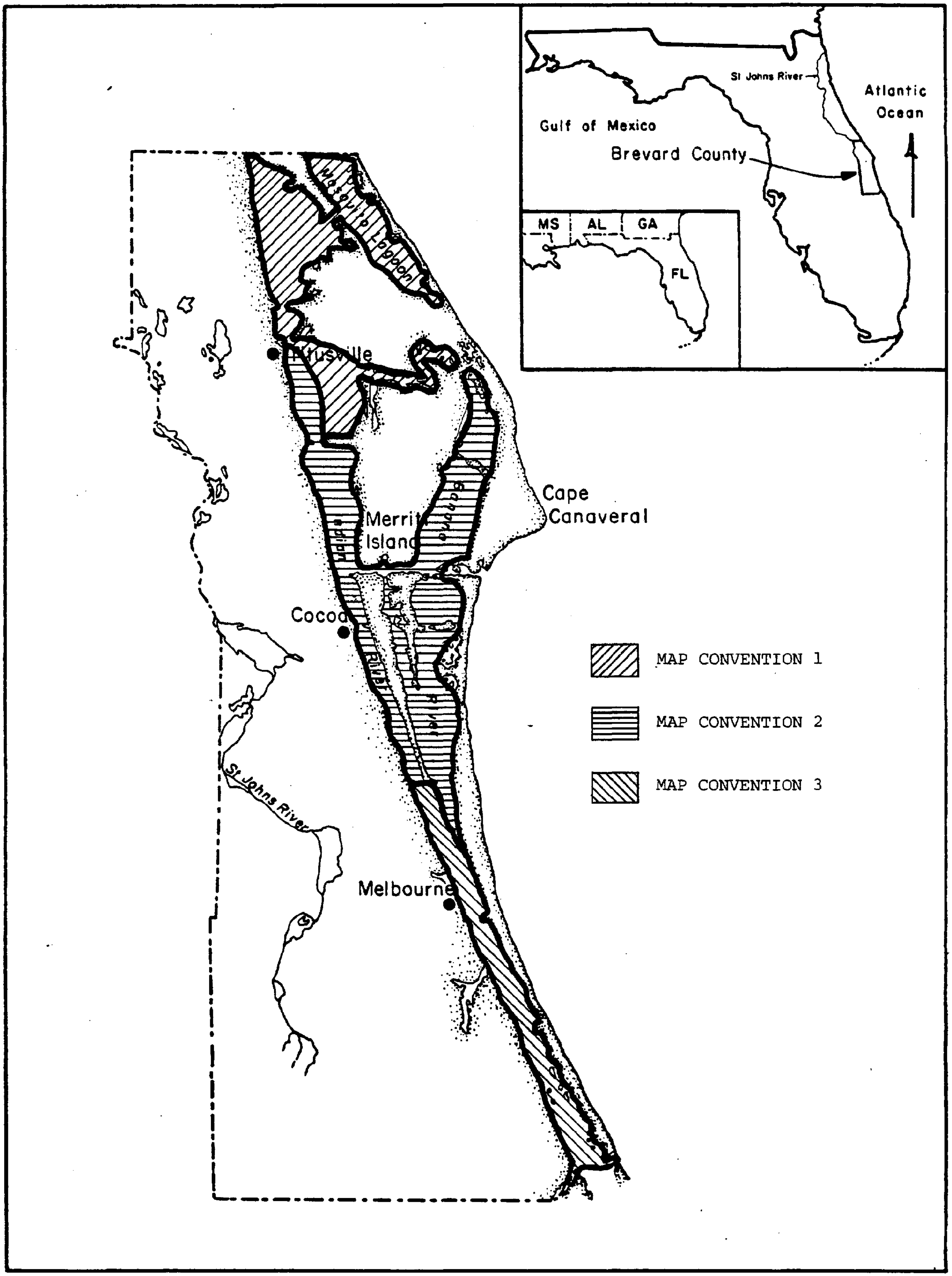
Owing to the complicated seagrass - algae coverage pattern, map conventions were changed three times (see boundary map).

1.) Within the area bounded by Turnbull Creek in the north and SR 402 in the south, and the eastern half on the river between SR 402 and NASA Cswy., all density contours depict **seagrasses.** The dotted line contour indicates the seagrass perimeter beyond the resolution of the aerial imagery. The waterward seagrass perimeter contour was provided in this fashion to emphasize the point that aerial photography should not be relied upon as the sole source of information.

2.) In the Indian River, along the western half, from SR 402 south to the NASA Cswy, the Indian River from NASA Cswy south to the Pineda Cswy, and the entire Banana River, all density contours depict **seagrasses** and/or **algae.**

3.) The density contours in the Indian River between the Pineda Cswy and Sebastian Inlet depict **seagrasses** only. As in 1.) above, the dotted contour lines depicts the waterward perimeter of the seagrass beyond the resolution of the aerial photographs.

The original photographs, maps (1:24,000 scale, 1 inch = 2,000 feet) and all groundtruth data are on file in the Brevard County, Office Of Natural Resources Management.


St Johns River
Atlantic
Ocean
Gulf of Mexico
Brevard County
MS
AL
GA
FL
Mosquito Lagoon
Titusville
Merritt
Island
Cape
Canaveral
Banana River
Indian River
Cocoa
St Johns River
Melbourne
MAP CONVENTION 1
MAP CONVENTION 2
MAP CONVENTION 3

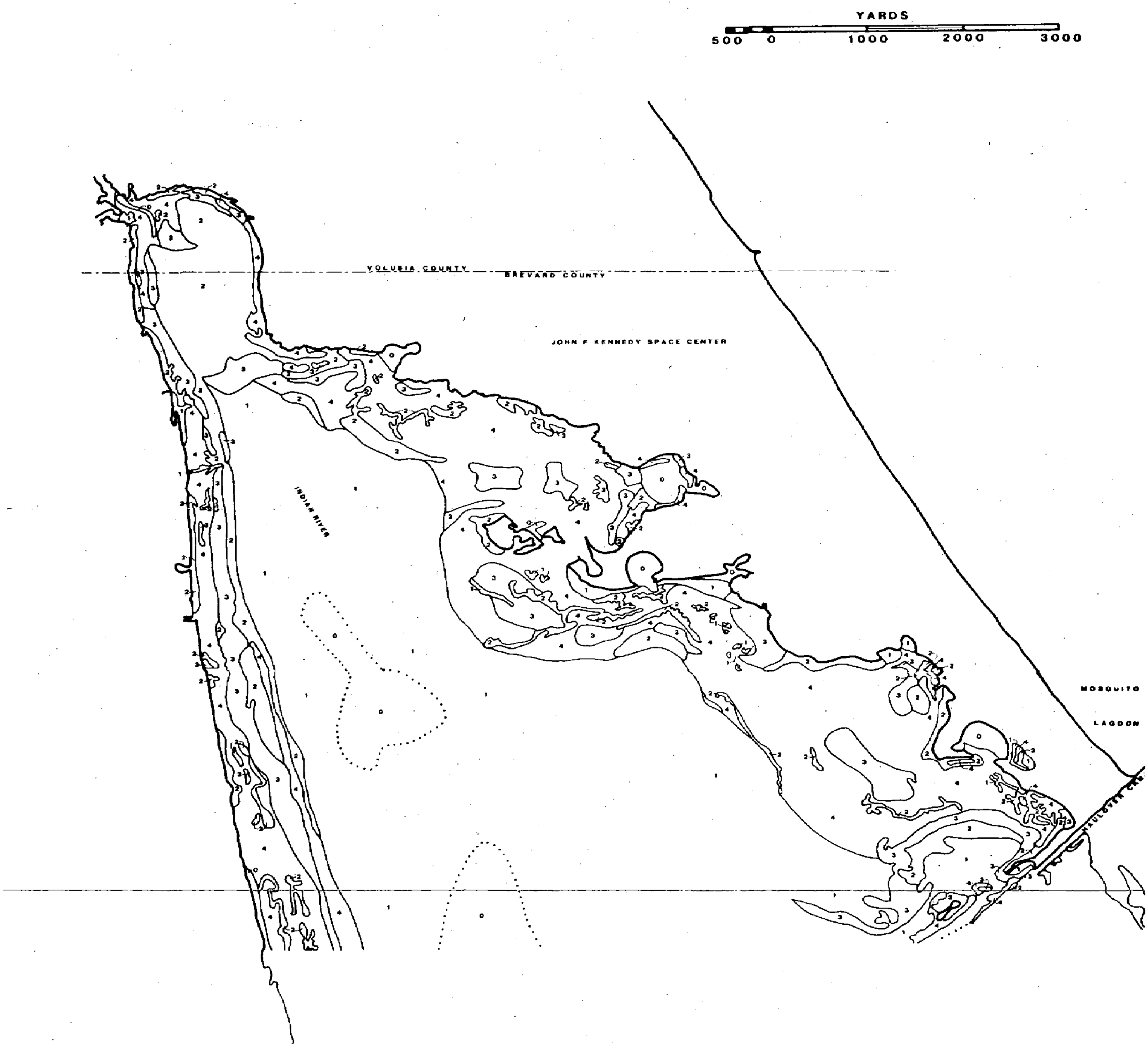
LOCATOR MAP

SUBMERGED AQUATIC VEGETATION
(hectares)

Basin Location	Bottom Area	SAV Area	% Coverage
Indian River			
Turnbull Creek - R.R. Cswy	8892	7551	85
R.R. Cswy - SR 402	1000	612	61
SR 402 - NASA Cswy	6749	3969	59
NASA Cswy - SR 528	5434	3787	70
SR 528 - SR 520	1055	589	56
SR 520 - Pienda Cswy	2843	1963	69
Pienda Cswy - Eau Gallie Cswy	2093	94	4
Eau Gallie Cswy - SR 192	1677	111	7
SR 192 - Cape Malabar	1973	88	4
Cape Malabar - Grant Farm Isl	3012	638	21
Grant Farm Isl - Sebastian Inlet	2683	909	34
Subtotal	37,411	20,311	54
Banana River			
NASA Cswy - SR 528	5763	5509	96
SR 528 - SR 520	2684	1783	66
SR 520 - George Island	2533	2093	83
George Isl - Pienda Cswy	3438	472	14
Pienda Cswy - Indian River	697	68	10
Newfound Harbor	1439	938	65
Subtotal	16,554	10,863	66
TOTAL	53,965	31,174	58

SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

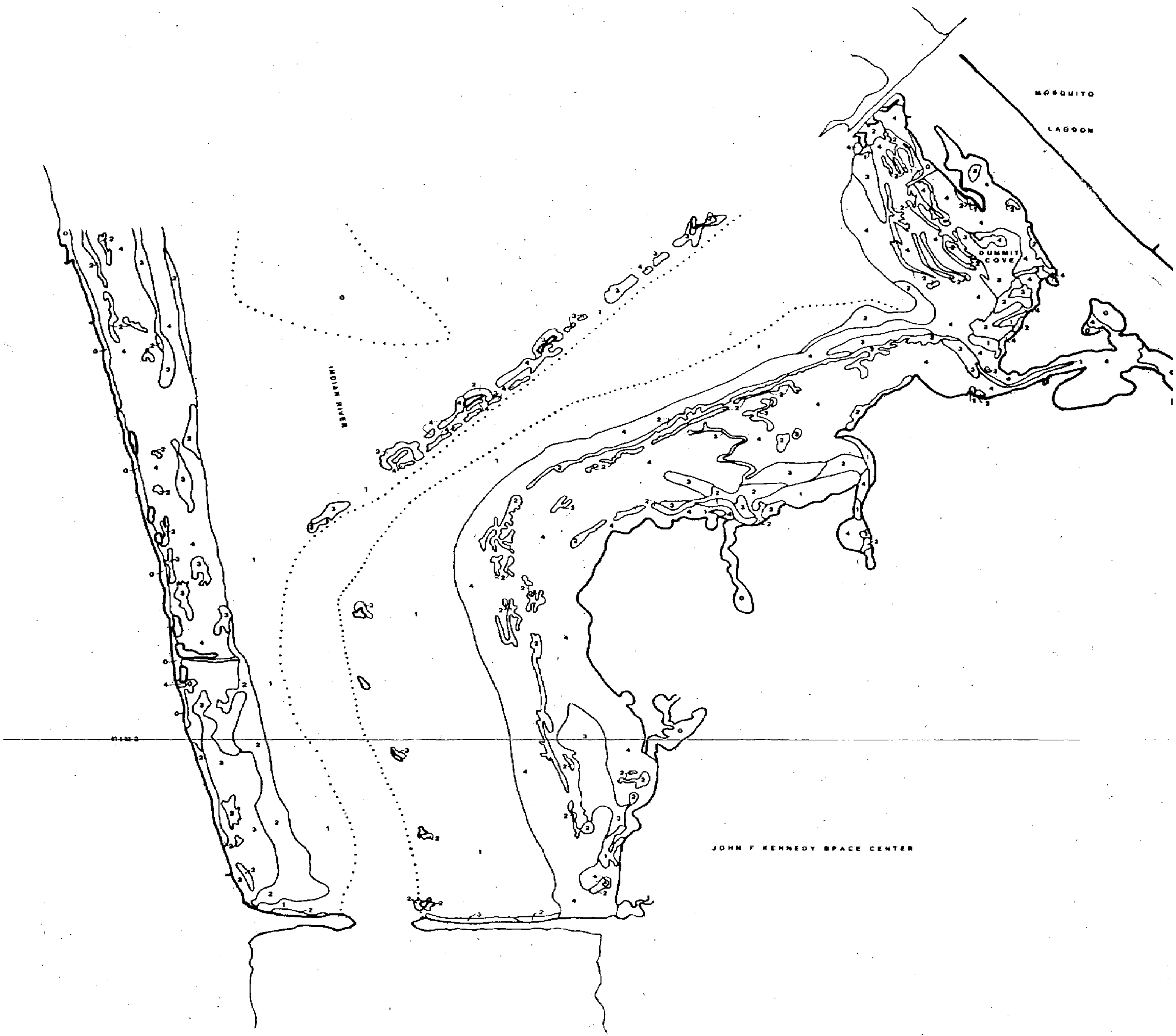


SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

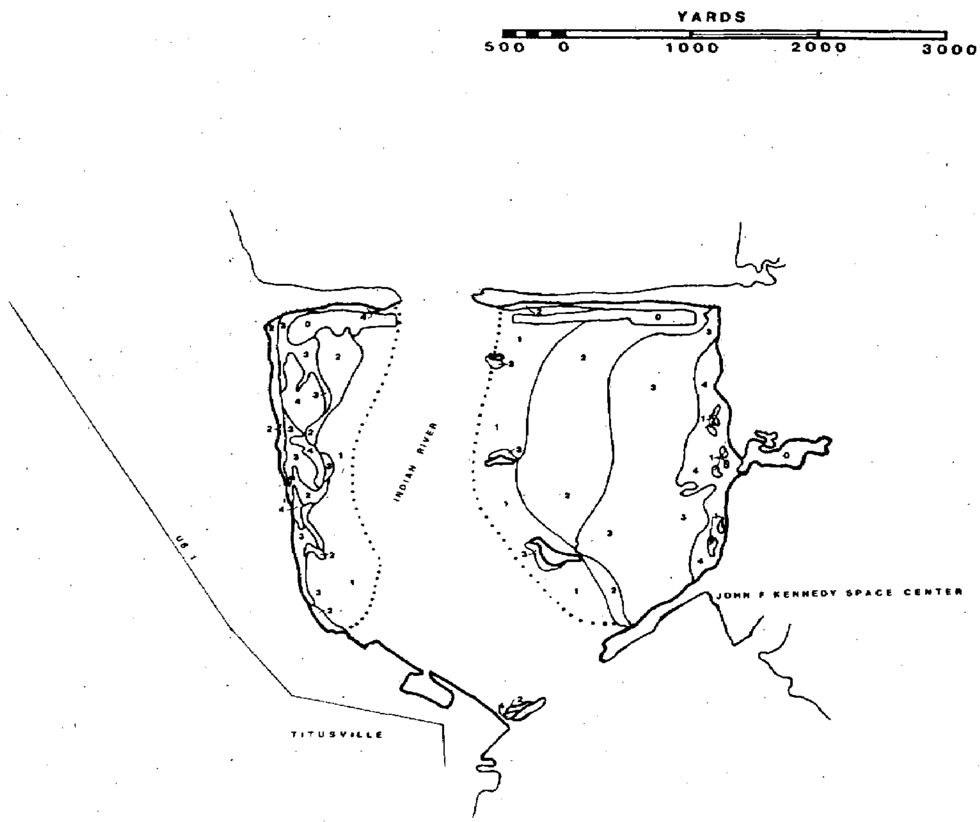
YARDS

500 0 1000 2000 3000



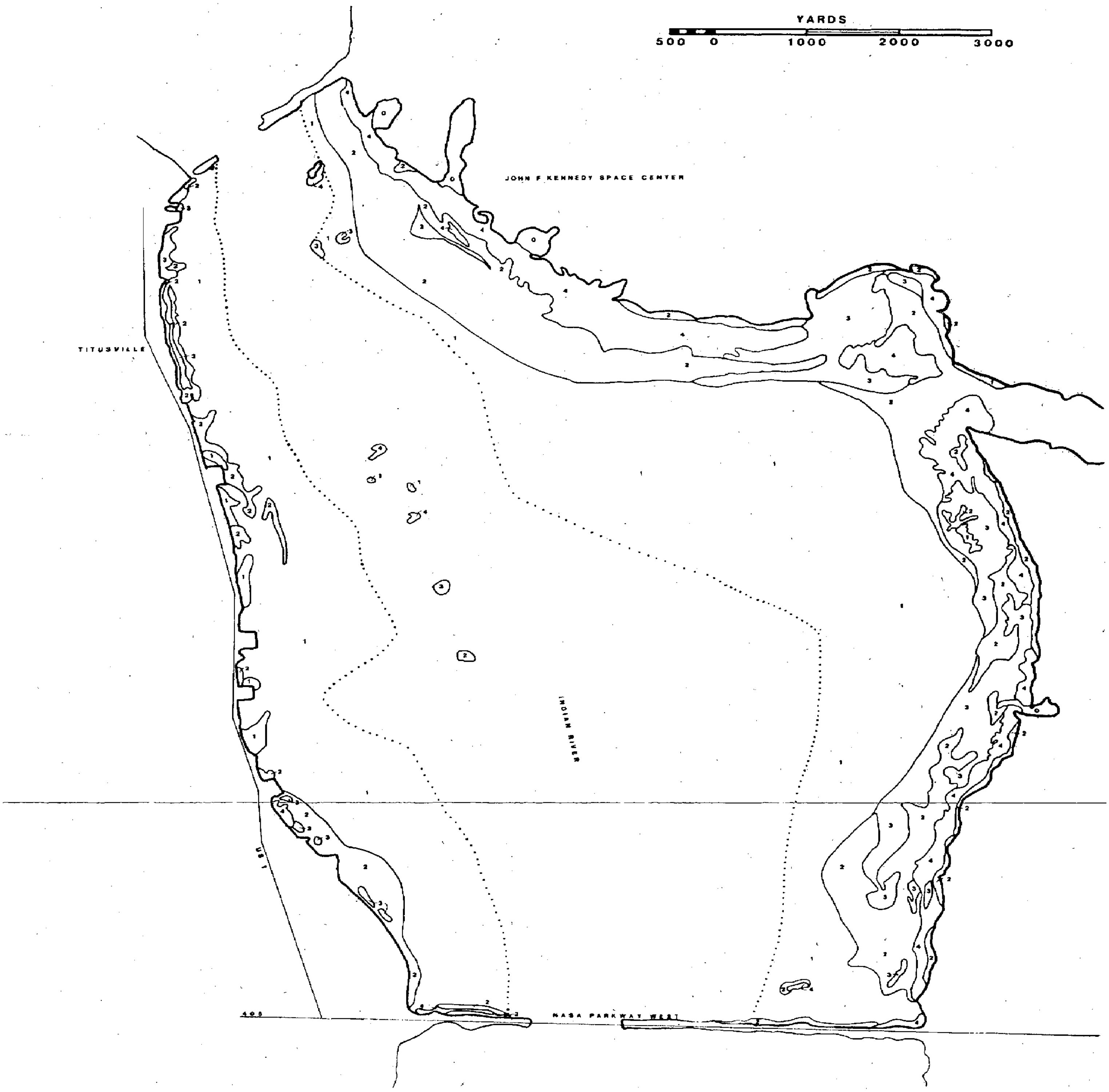
SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000



SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

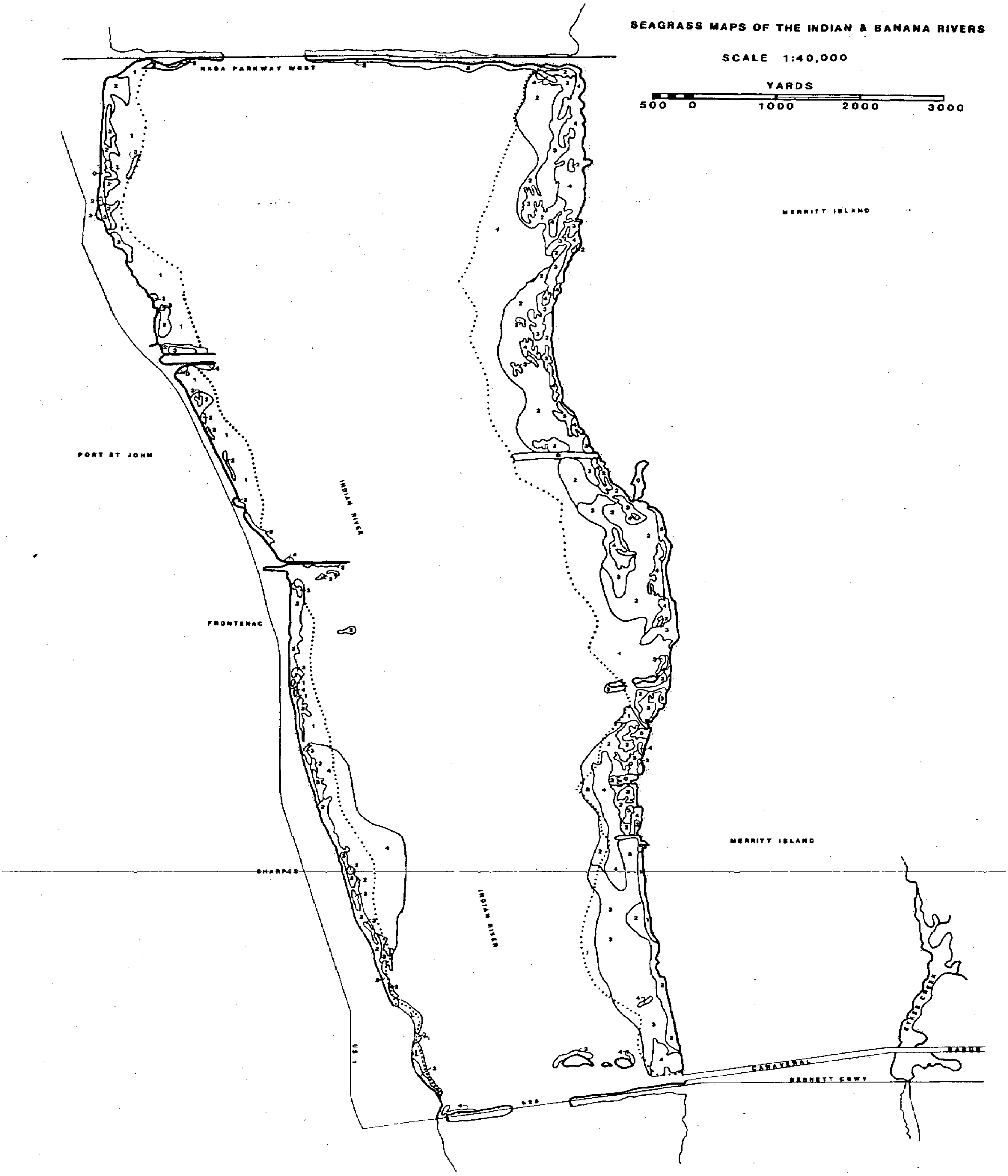


SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000

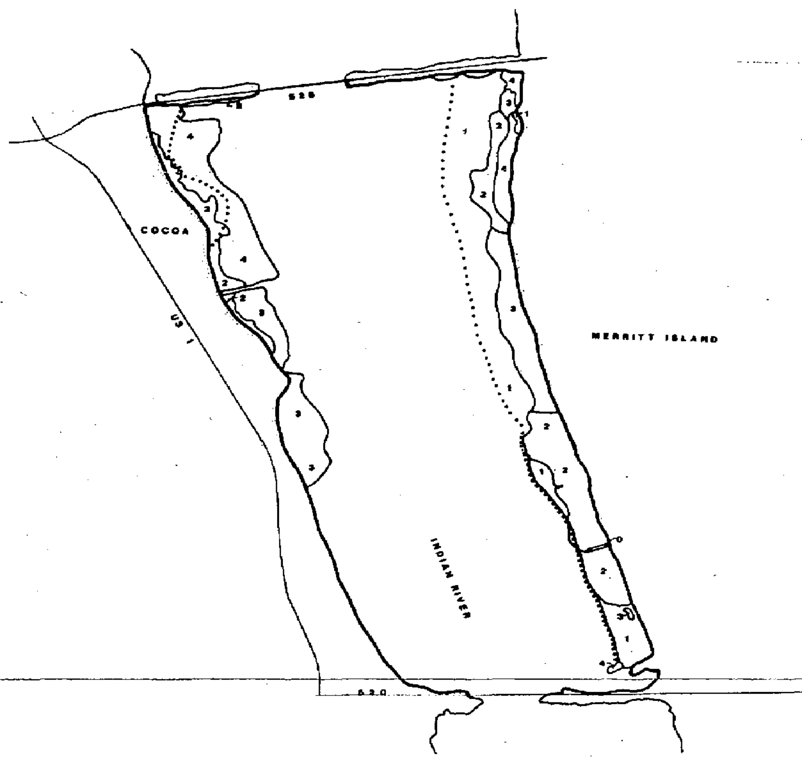


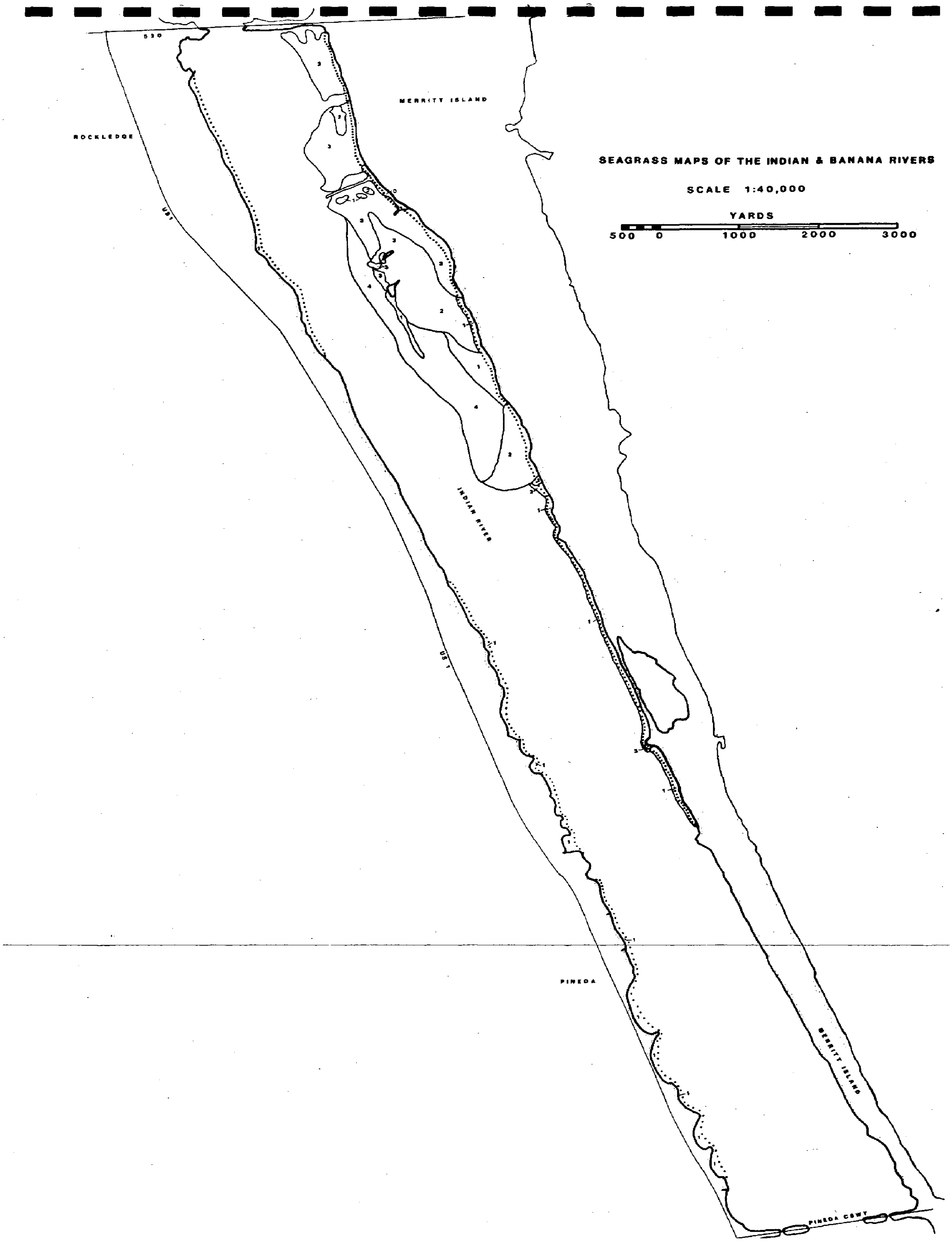
SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000



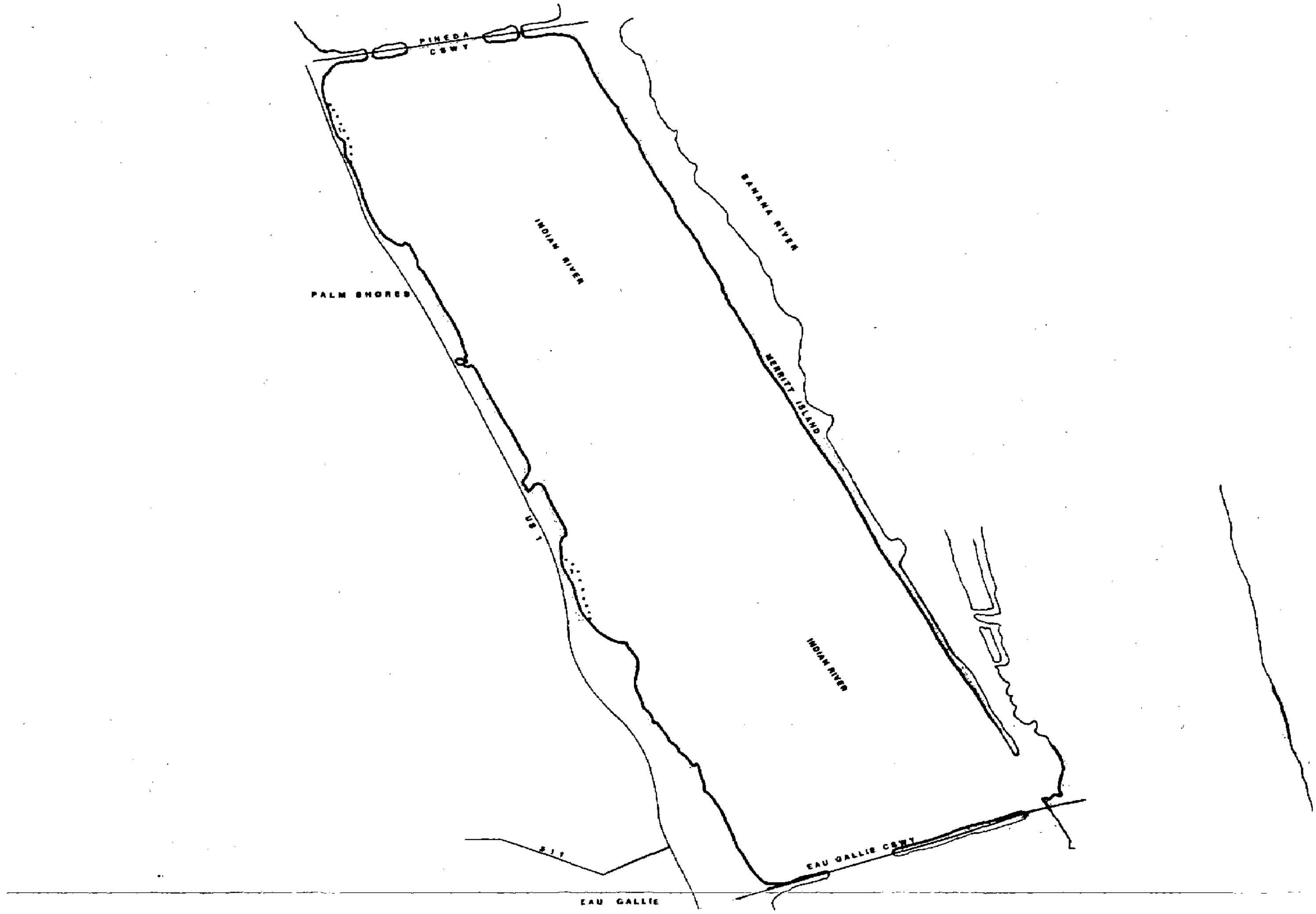

SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS
SCALE 1:40,000
YARDS
500 0 1000 2000 3000
520
MERRITT ISLAND
ROCKLEDGE
US 1
INDIAN RIVER
US 1
PINEDA
MERRITT ISLAND
PINEDA CSWY

SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000

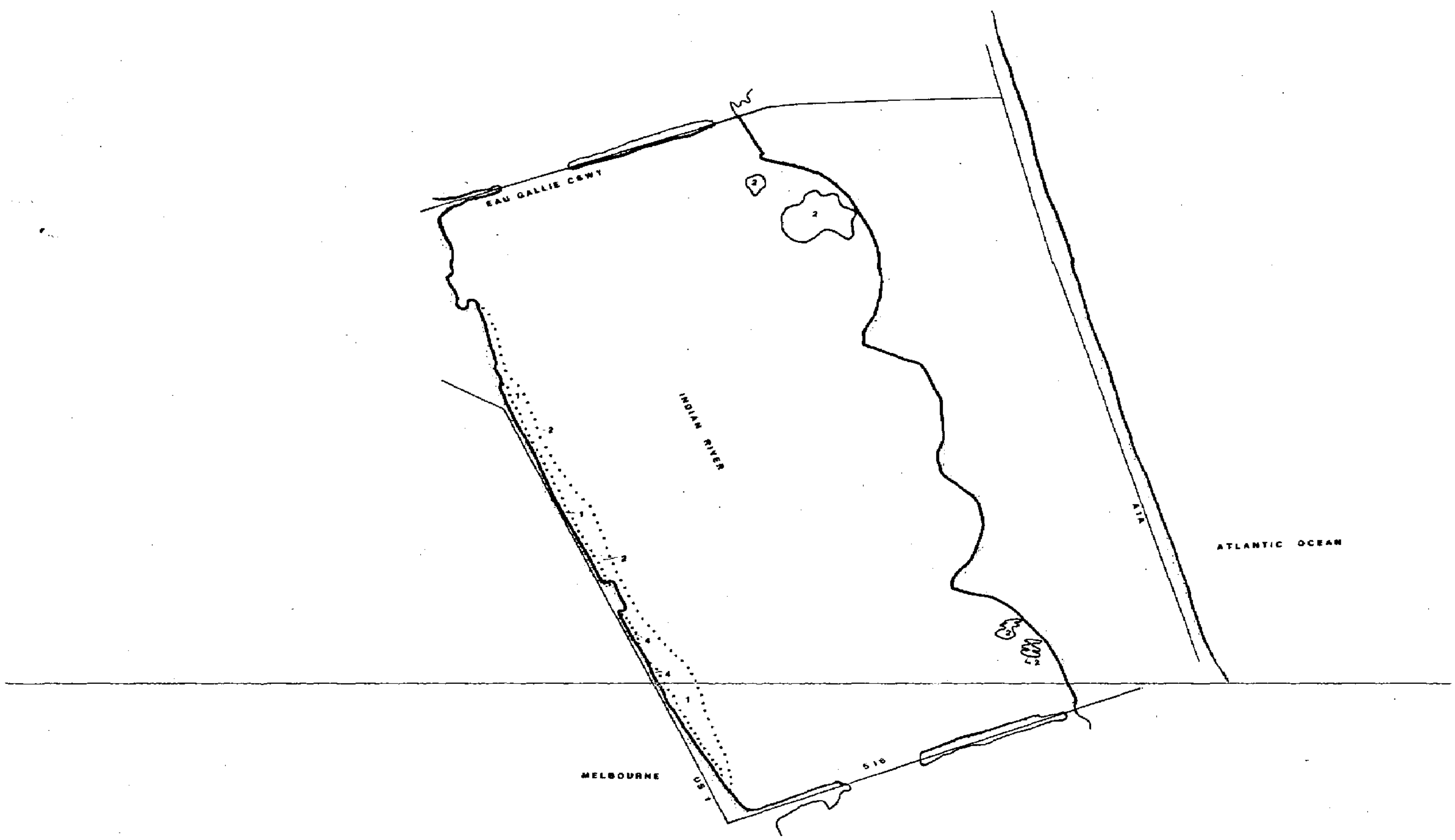


SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000

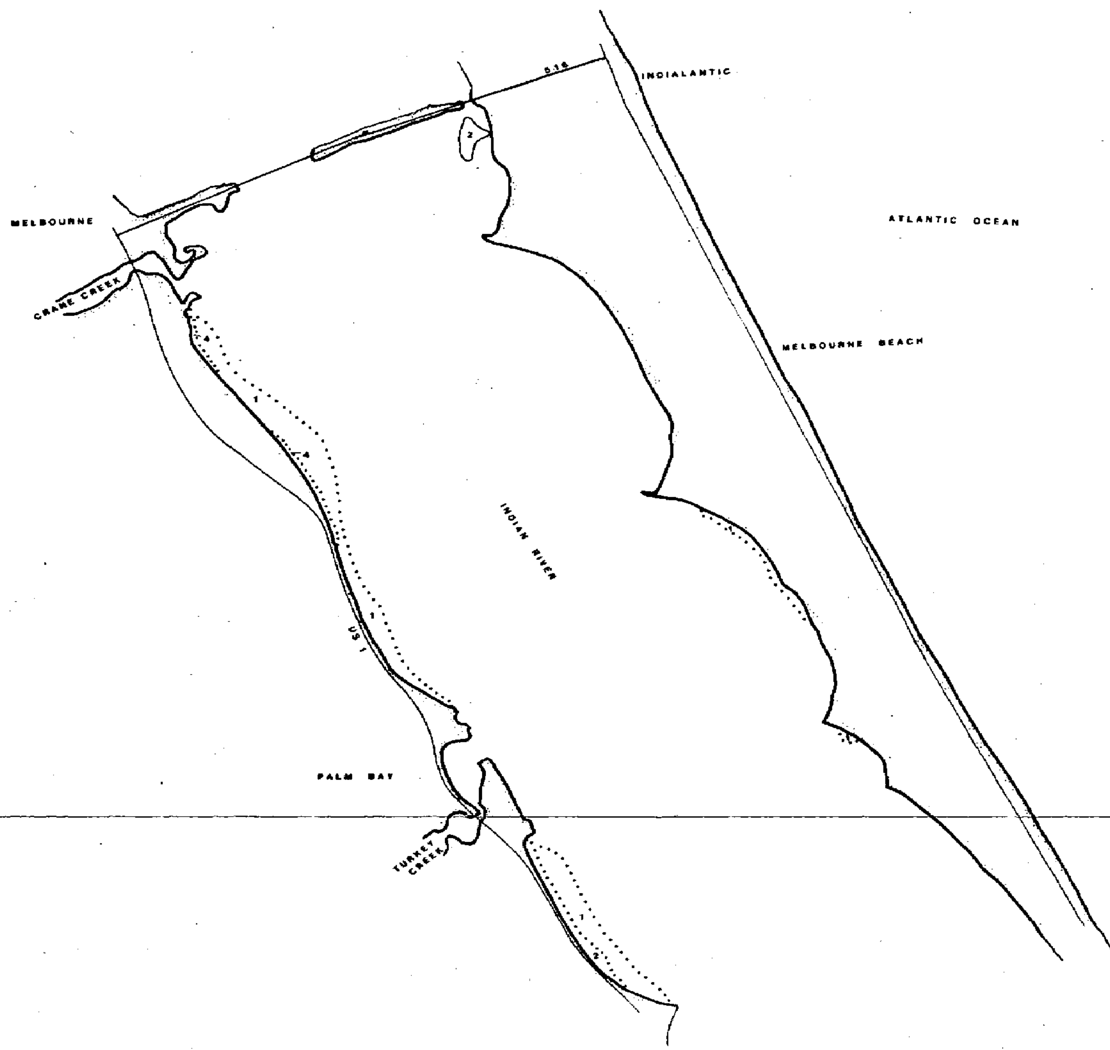


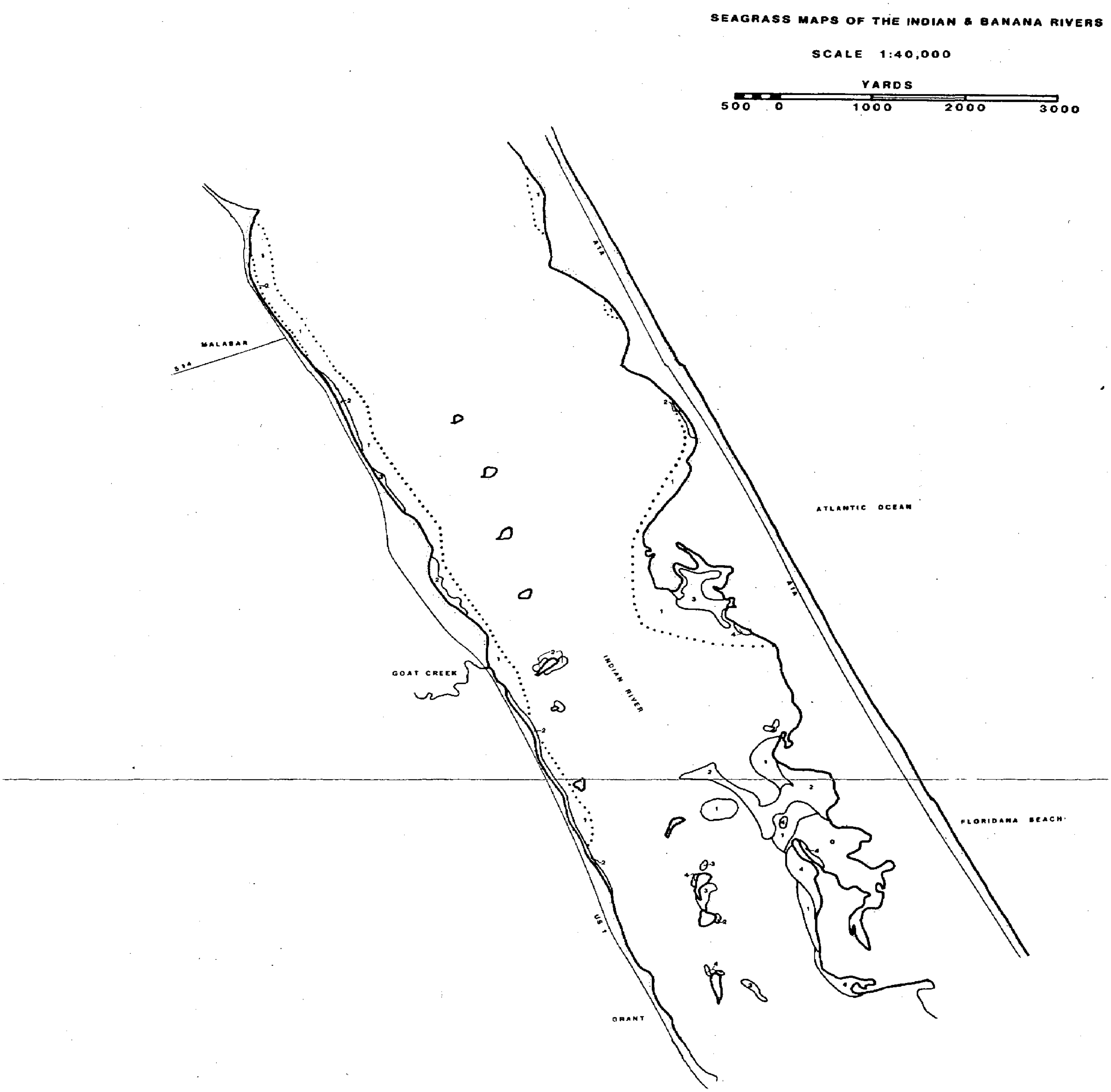
SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

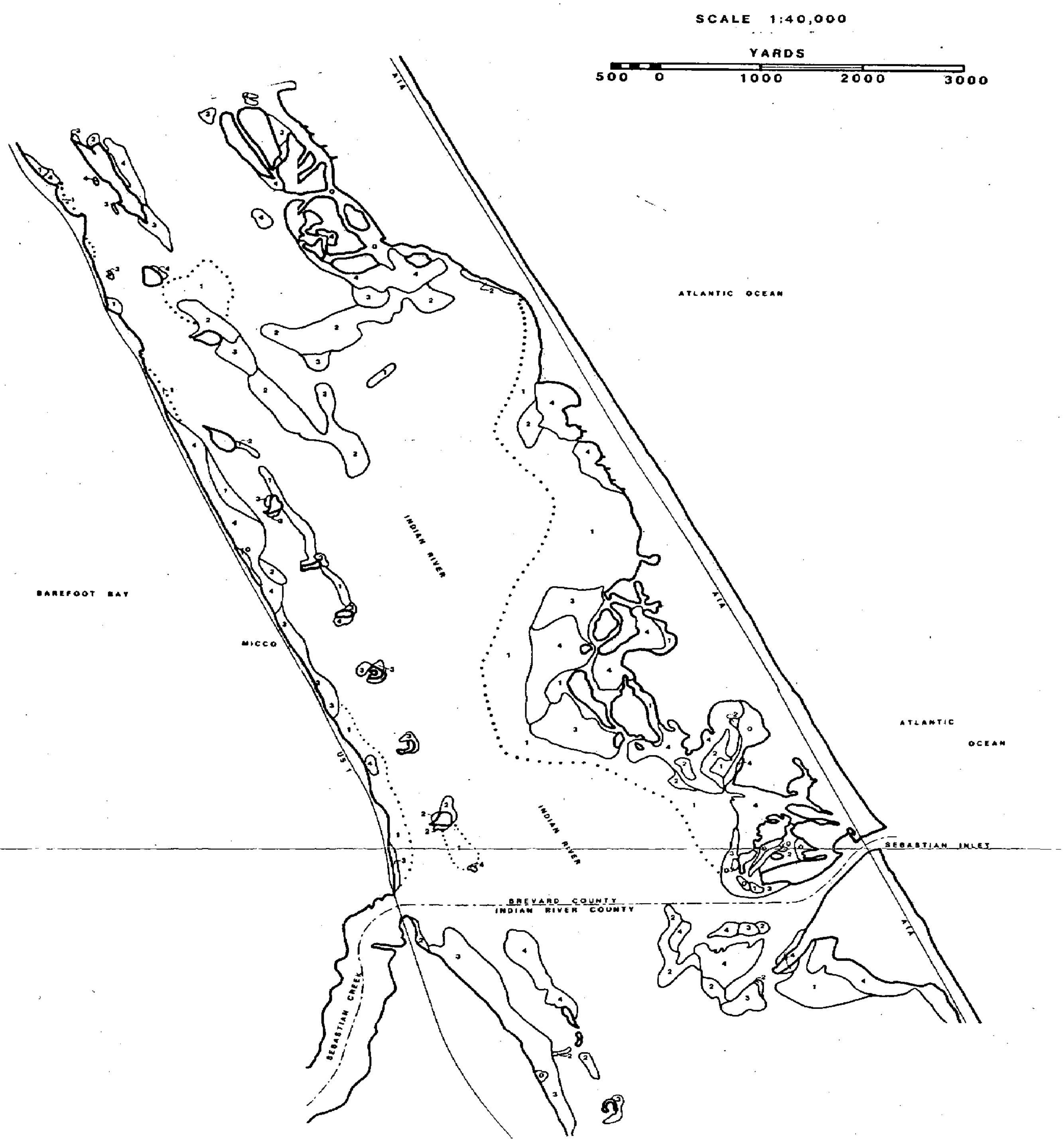
YARDS

500 0 1000 2000 3000



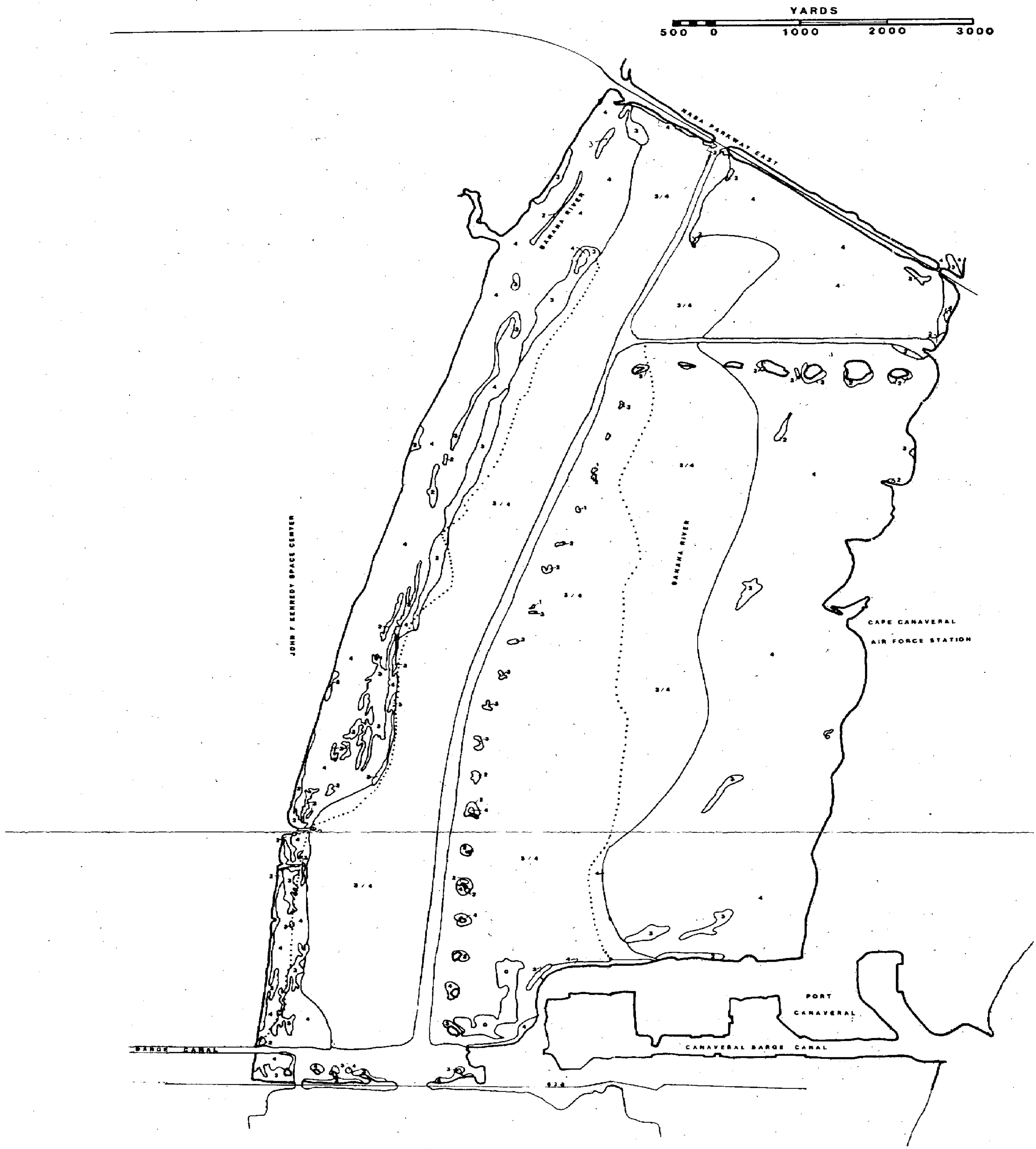

SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS
SCALE 1:40,000
YARDS
500 0 1000 2000 3000
MALABAR
ATLANTIC OCEAN
A1A
INDIAN RIVER
GOAT CREEK
FLORIDANA BEACH
US 1
GRANT

SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS



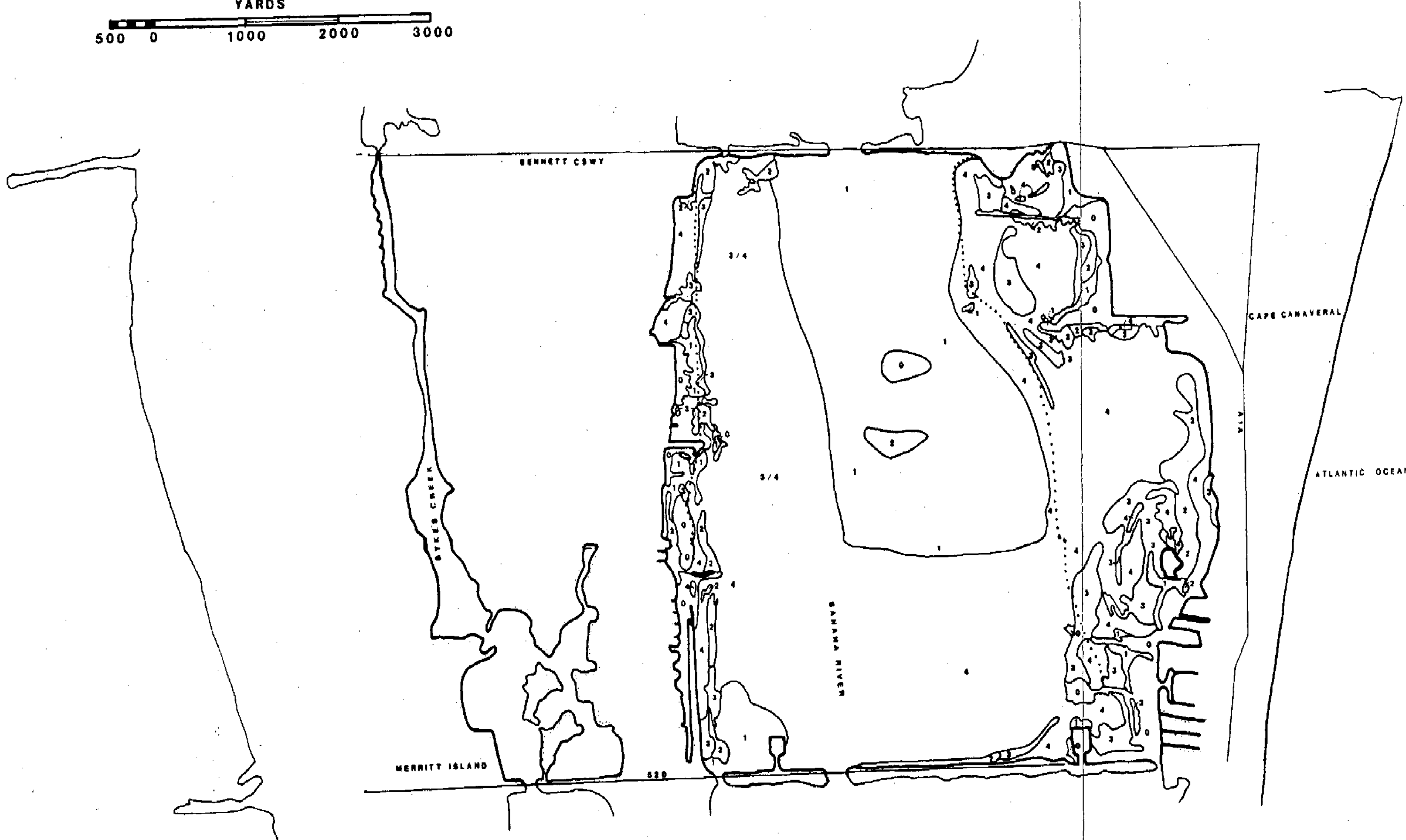
SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000



SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

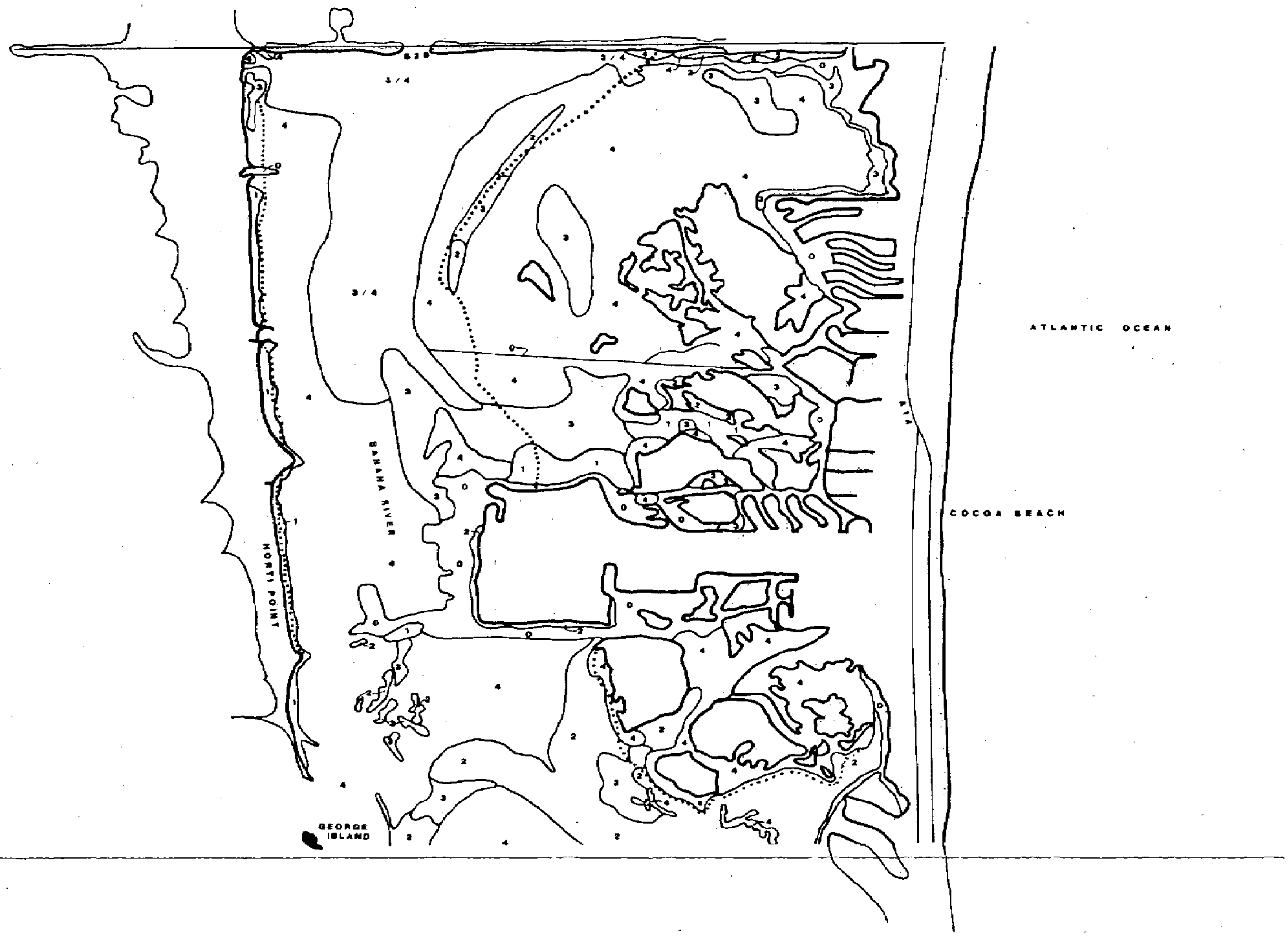


SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000

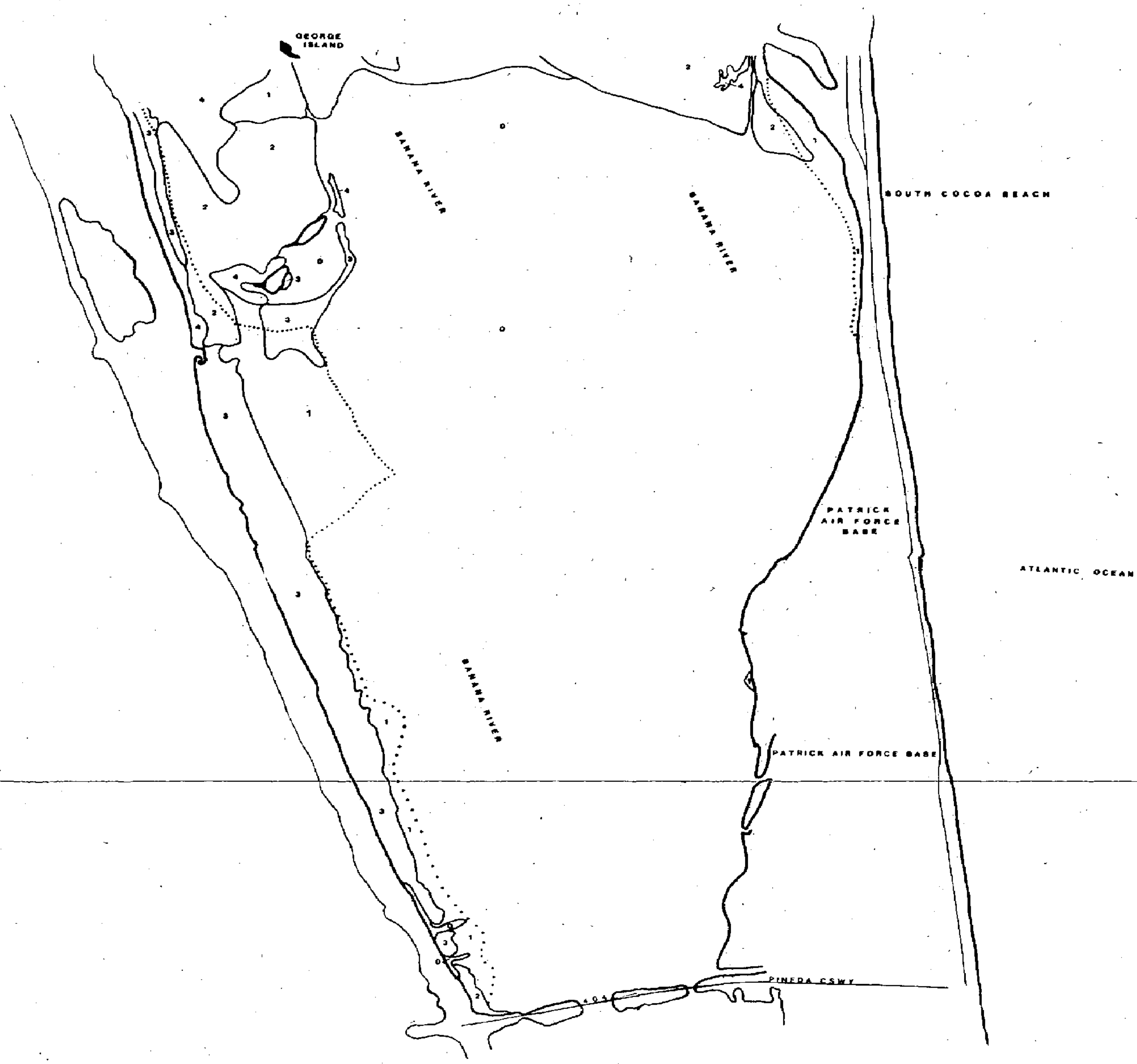


SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000

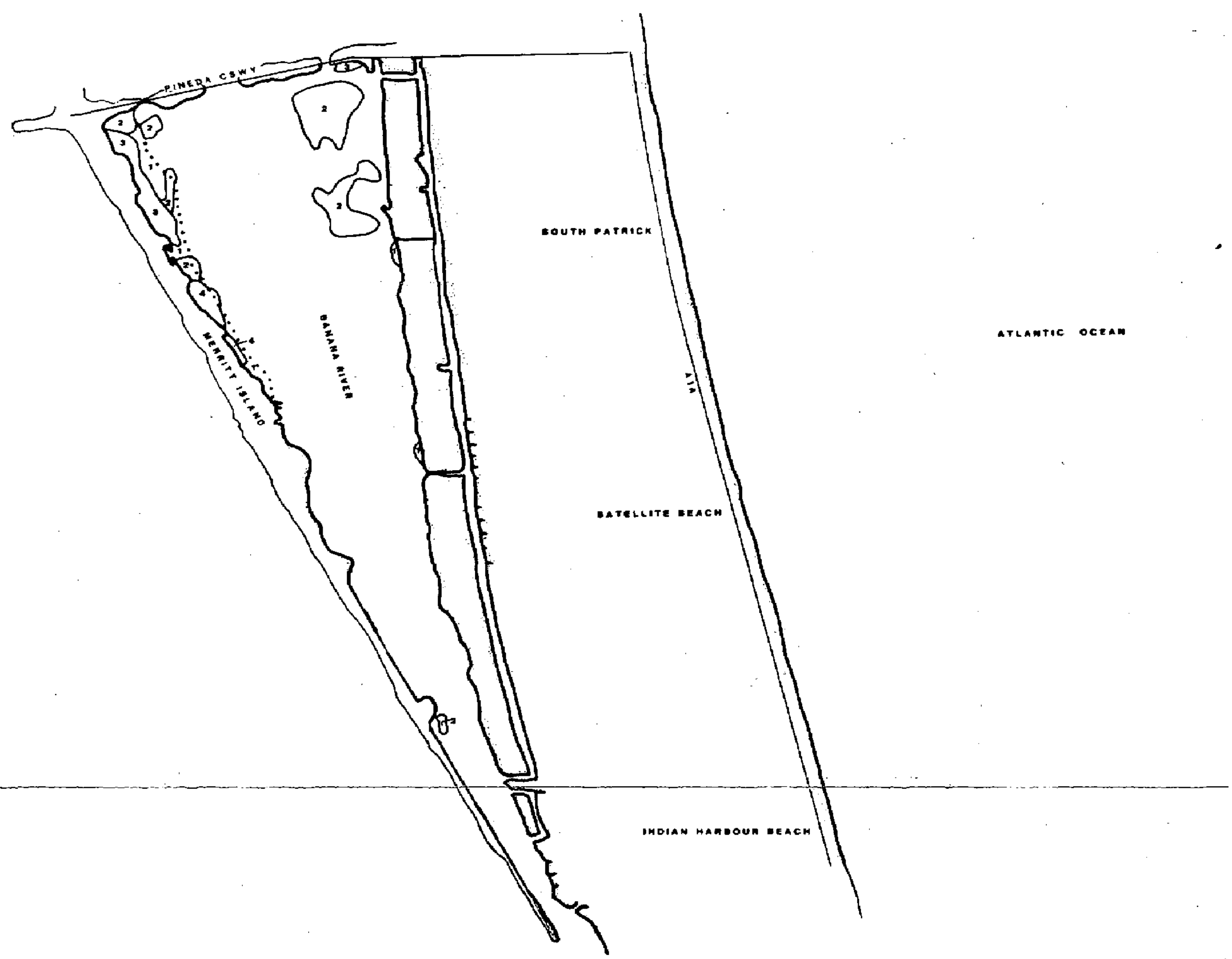


SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000

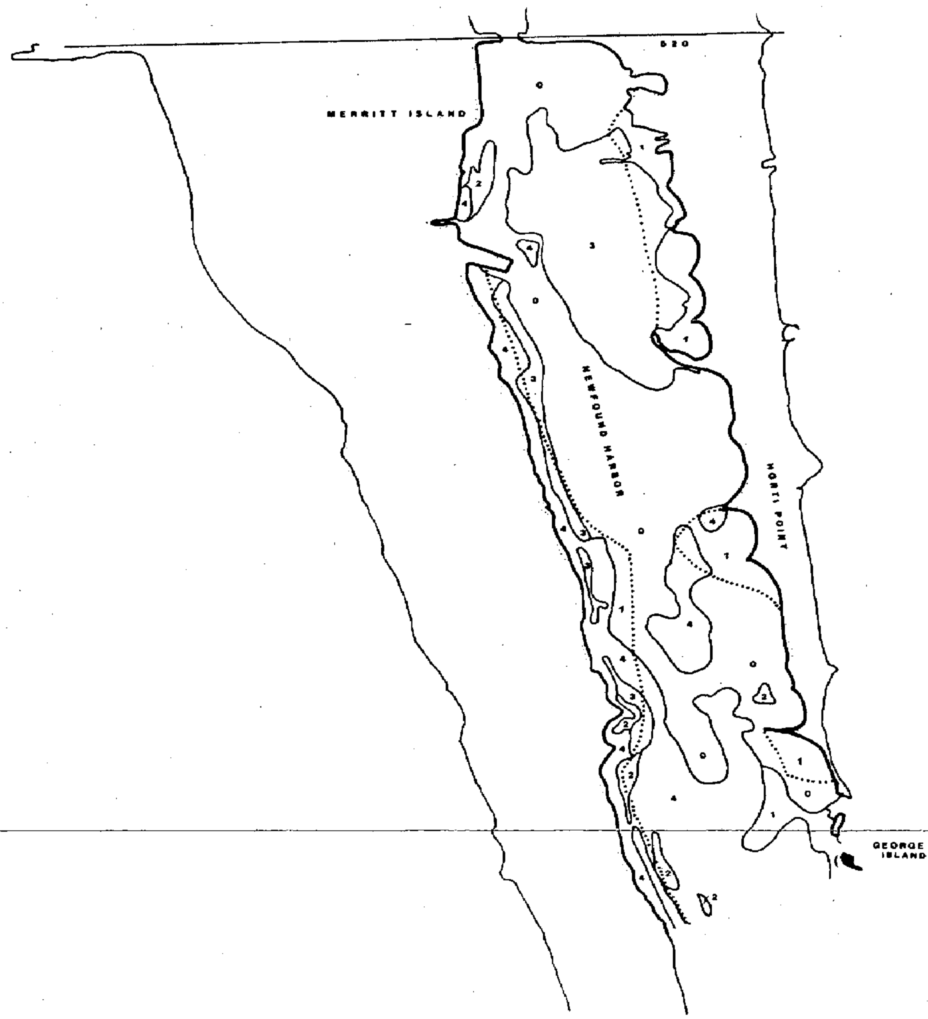


SEAGRASS MAPS OF THE INDIAN & BANANA RIVERS

SCALE 1:40,000

YARDS

500 0 1000 2000 3000



APPENDIX C

RECOMMENDATIONS

The importance of seagrasses to the ecology of estuarine and lagoon systems can be demonstrated from data presented in the scientific literature (Bridges et al, 1978). Even though much information is available on seagrasses from different areas of the U.S., site specific information such as past and present spatial and temporal SAV fluctuations, and SAV habitat values is a requisite to sound management of a stressed ecosystem.

What is unsettling to most individuals familiar with the lagoons is that this "Year Of The Seagrasses" may lull managers and administrators into complacency about the need for continued research and monitoring of the submerged aquatic vegetation (SAV). We need a program of monitoring to insure that 1986 was not just a "freak" year. We need additional research on species of **special interest,** such as **Caulerpa prolifera** and **Halophila englemani.**

We need basic research on what makes the seagrass (read SAV) valuable - what are the relationships with commercially and recreationally valuable species. Much of what we now base important management decisions with for regulating our fragile ecosystems is data from twenty years ago, and although some of the data still reflects present conditions, a good deal of the historical information relating to fisheries simply may no longer be true. As an example of new information coming out, preliminary findings from a habitat value study of **C. prolifera,** indicated that the number of different fish species associated with seagrasses was not as high as expected, and that the number of invertebrates associated with **C. prolifera** was higher than expected.

During the 1986 mapping project we have become intimately familiar with the bottom ecology of the Indian and Banana River lagoon system and the best techniques that can be applied to rapidly and effectively monitor the SAV. The following list gives some of our recommendations:

1. We recommend that intensive groundtruthing always be used with aerial photographs of the Indian and Banana River. We found that aerial photography revealed SAV in water less than 1 m deep. Areas that we thought were deep because of a dark photographic

signature, when groundtruthed were found to have a 70 - 100% SAV coverage. In addition, we found we could not distinguish seagrass from algae based on the photographs alone.

2. It is advised that monitoring be accomplished every two years by groups highly familiar with the techniques needed to do the work accurately, and who also have an intimate knowledge of the bottom ecology of the lagoons. The intimate knowledge of the lagoon bottoms could reduce the time required to groundtruth the photographs. The two year interval was suggested because of the temporal and spatial variability we observed over just a six month period. The changes implied that conditions may be changing so rapidly (i.e., accelerated loss of seagrasses with a concomitant increase in **Caulerpa prolifera**) that significant management decisions could not be made with a longer interval.

We also recommend that the entire system be mapped, not just limited areas. With the changes occurring so rapidly throughout the lagoon system, restricting monitoring to several areas might allow significant changes to escape detection.

3. We recommend that false-color infrared film be used during future mapping projects. Comparisons of true color film and infrared film indicated that little water penetration difference exists between the two films within the lagoon. With infrared film, not only does the film disclose submerged features as well as true color film, but the film also reveals the fringing wetlands better than true color film. This gives the researcher(s) much more useful information about the local environment as compared to true color photographs.

4. We strongly advise that funding for research on SAV (not just seagrasses) and animals associated with SAV, be increased exponentially. Without research on our specific systems, on the habitat values of each component of the system, and on the life histories of the important organisms associated with each structural component, effective management **cannot** take place. It has been our experience that basic research often takes a backseat to administrative and managerial issues and projects; but without the knowledge that research brings, decisions reached during the administration and management programs can be faulty, expensive, and possibly too late.