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Tampa Bay Estuary Program

HABITAT PROTECTION AND RESTORATION TARGETS FOR TAMPA BAY

FINAL REPORT

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HABITAT PROTECTION AND RESTORATION TARGETS FOR TAMPA BAY

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TABLE OF ACRONYMS

CCMP	Comprehensive Conservation and Management Plan
EPCHC	Environmental Protection Commission of Hillsborough County
FDNR	Florida Department of Natural Resources (Now within Florida Department of Environmental Regulation)
FDOT	Florida Department of Transportation
FLUCCS	Florida Land Use and Cover Classification System
GIS	Geographic Information System
MLW	Mean Low Water
NOAA	National Oceanographic and Atmospheric Administration
PCDEM	Pinellas County Department of Environmental Management
SAV	Submerged Aquativ Vegetation
SCS	(U.S.) Soil Conservation Service
SWFWMD	Southwest Florida Water Management District
SWIM	(SWFWMD) Surface Water Improvement and Management Program
TAC	(TBNEP) Technical Advisory Committee
TBNEP	Tampa Bay National Estuary Program
TBRPC	Tampa Bay Regional Planning Council
TIN	Triangular Irregular Network
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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EXECUTIVE SUMMARY

Habitat loss was identified by the Management Conference of the Tampa Bay National Estuary Program (TBNEP) as one of the seven major issues to be addressed by the program. Some of the critical habitats identified included seagrasses, tidal marshes, mangroves, oligohaline areas, and high marsh or salterns. To address the issue of habitat loss, the TBNEP contracted with Coastal Environmental, Inc. to perform the following primary tasks:

1. Map benchmark and current habitat coverages, and physically altered areas, for the purposes of developing areal targets for habitat restoration and/or protection.

2. Identify areas in the bay which are currently recognized as having environmental conditions sufficiently degraded as to make any restoration/protection actions problematic without improvement in these conditions.

3. Develop quantitative protection and restoration targets for emergent tidal wetlands and seagrasses.

A GIS overlay technique was utilized to compare circa 1950 and 1990 land use and cover data sets. The results of these analyses indicated the following:

Seagrass

- The total 1990 seagrass coverage was estimated to be 25,200 acres. This figure is recommended as the seagrass protection target.

- Approximately 27,600 acres of seagrasses have been lost since 1950.

- The total acreage of historically shallow areas now considered non-restorable for seagrass is 12,800 acres.

- A seagrass restoration target of 14,800 acres is recommended, which represents the difference between the acreage lost since 1950 and the acreage now considered non-restorable.

Emergent Vegetative Habitat

- The total 1990 emergent vegetative habitat (saltmarsh/mangrove forest) coverage was estimated to be 18,800 acres. This figure is recommended as the emergent vegetative habitat protection target.

- Approximately 9,700 acres of emergent tidal wetlands have been lost or converted since 1950. This figure is proposed as one alternative for an emergent vegetative habitat restoration target.

- Approximately 5,900 acres of saltmarsh and mangrove vegetation occurred in areas in 1990 where it did not occur in 1950. An analysis of this conversion reveals that of the 5,900 acres approximately 35% (2,065 acres) was converted from upland/range/urban land use categories; 30% (1,770 acres) was converted from other intertidal wetland habitat (e.g. flats/beaches); 26.7% (1,575 acres) was converted from open water and subtidal habitat (e.g. patchy and sparse seagrass); and 8.3% (490 acres was converted from freshwater wetlands. An operational definition of "new" emergent tidal wetlands would include the conversion of upland, subtidal and freshwater wetland cover types to emergent tidal wetlands; but would exclude the conversion of other types of non-vegetated intertidal wetlands (e.g. flat/beaches). Therefore, based upon this analysis it can be argued that approximately 4,100 acres of new emergent tidal wetlands were established in the bay between 1950 and 1990 (e.g. 5,900 - 1,770 rounded to the nearest hundred).

- An estimated minimum baywide net loss of emergent vegetative habitat since 1950 of approximately 5,600 acres (9,700 - 4,100) was calculated. This figure is proposed as another alternative for an emergent wetland restoration target.

- It is recommended that the TBNEP further consider the relative technical merits and feasibility of the two alternative emergent vegetative habitat restoration targets before establishing a final restoration target for these living resources.

1.0 BACKGROUND

The Tampa Bay National Estuary Program (TBNEP) has chosen to establish quantitative targets for the protection and restoration of living resources within the Tampa Bay Estuary. The TBNEP will develop and implement management actions to achieve these protection and restoration targets, as set forth in the Comprehensive Conservation and Management Plan (CCMP). This report presents and discusses the living resource targets and the methods used to define them.

With regard to the objectives of this report, living resources are defined as vegetative communities which serve as critical estuarine habitats for fish and wildlife. The vegetative living resource targets focus on emergent tidal wetlands and submerged seagrass beds. It should, however, be recognized that the vegetative communities addressed herein are only a subset of the living resources which may be addressed in the CCMP (e.g., fish, shellfish, birds, etc.).

1.1 The Tampa Bay Estuary

Tampa Bay is Florida's largest estuary. It extends approximately 35 miles into the west central coast of Florida (Figure 1.1), and is 5 to 10 miles wide along the majority of its length. Surface water flow is provided by over forty minor tributaries and the Hillsborough, Alafia, Little Manatee, and Manatee Rivers. One major freshwater point source is the Hooker's Point wastewater treatment facility. This facility contributes up to 15% of the total surface freshwater inflow to Hillsborough Bay (the northeastern arm of Tampa Bay) during dry periods (TBNEP, In Review). The mainstem of the bay is greatly affected by the exchange of seawater from the Gulf of Mexico, and median bottom salinities of greater than 20 ppt are common throughout the bay (Figure 1.2).

Tampa Bay is an urbanized estuary. Urban areas within the watershed include the metropolitan areas of Tampa and St. Petersburg, yet the bay still retains a diverse mosaic of habitats such as mangrove forests, saltmarshes, seagrass meadows, salt barren/high marshes, and live bottom communities. These habitats are home to a diverse assemblage of invertebrates, fish, bird, and mammal populations. Some of the more notable species which are commonly associated with the bay are shrimp, blue crabs, mullet, spotted seatrout, snook, red drum, brown pelicans, white ibises, roseate spoonbills, wood storks, reddish egrets, west indian manatees, and bottlenose dolphins. Growing urban areas have displaced and degraded much of the original habitats within the bay, and hence, populations of much of the bay's wildlife have declined. Several previously abundant species such as the bay scallop have effectively been lost from the bay.

Several summaries of the state of scientific knowledge of the Tampa Bay Estuary have been produced in recent years. The most comprehensive of these documents include a NOAA estuarine seminar (Estevez, 1989); two U.S. Fish and Wildlife Service ecological characterization reports (Lewis and Estevez, 1988; Wolfe and Drew, 1990); and the published proceedings of two bay area scientific symposia (Treat et al., 1985; Treat and Clark, 1991). These documents provide a summary of the history, ecology, and environmental problems of the bay. All of these documents identify the loss of estuarine habitat as a primary problem of concern for the bay. The TBNEP and other agencies are continuing efforts to address habitat loss through this and other projects, and a recent review of these efforts is provided by a 1993, Tampa Bay Status and Trends report (TBNEP, 1993).

1.2 Emergent Vegetative Habitats

Emergent tidal wetlands provide vital habitat for the fish and wildlife of Tampa Bay, and were identified by the TBNEP as a key living resource. Three broad classes of saltwater wetlands are generally recognized including: mangrove forests, tidal marshes, and salt barren/high marsh. Lewis and Estevez (1988), Estevez and Mosura (1985), and Schomer et al. (1990) present reviews of the distribution and ecological function of these wetlands. The saltwater wetlands occur primarily along a natural intertidal shelf which rims the bay, and to a lesser extent they occur along filled intertidal areas created by urban development projects. The saltwater wetlands are typically composed of a mosaic of red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*) forests interspersed with smooth cordgrass (Spartina alterniflora) and black needle rush (*Juncus roemerianus*) marshes. Other plant species commonly found in these wetland areas include leather fern (*Acrostichum danaeofolium*) and the brackish water cattail (*Typha domingensis*). Exotic plants species such as the brazilian pepper tree (*Schinus terebinthifolius*) have invaded many of the native communities throughout the bay. Carlton (1975) provides a descriptive botanical summary of the common Florida saltwater wetland vegetation.

The mature saltwater wetland community along the mainstem of the bay is typically composed of mangrove forests, but the dominance of the mangrove trees at this northern limit of their distribution is ephemeral. Occasional winter freezes and human disturbances can kill individual mangrove trees or portions of mangrove trees. Freeze induced mortality of mangroves trees was observed recently in Tampa Bay following cold weather periods in 1977 and 1983 (Lewis, 1989). The death and defoliation of mangrove trees due to freezes, violent storms, and human disturbances creates areas open to sunlight. These open areas can then be colonized by the marsh grasses, and eventually mangroves can become reestablished to shade out the marsh grasses. This pattern of natural succession has also been observed on newly created intertidal areas in the bay such as transportation causeways. Smooth cordgrass (*Spartina alterniflora*) often appears as a pioneer species in these areas (Lewis, 1989). The physical structure provided by planted and natural colonies of cordgrass reduces wave energy and facilitates settling and growth of mangrove seedlings.

The plant community and ecology of salt barren/high marsh habitats (i.e. "saltern", "salt prairie") in Tampa Bay were also reviewed by Lewis and Estevez (1988). On extremely high tides, saltwater from the bay enters sand flats termed salt barrens, and the water which pools in these areas is subsequently evaporated by the sun and wind. The residual salt content within the sediments of these sand flats often exceeds 100 ppt, and these areas provide habitat for a unique community of salt tolerant plants. These halophytic species typically include sea purslane (*Sesuvium portulacastrum*), glasswort (*Salicornia virginica*), saltwort (*Batis maritima*), sea oxeye daisy (*Borrichia frutescens*), and sea lavender (*Limonium carolinianum*). Carlton (1975) provides a botanical description of these and other halophytes common to Florida saltwater wetlands.

The three types of saltwater wetlands (mangrove, marsh, and saltbarren/high marsh) collectively form an important habitat in Tampa Bay. These wetlands provide critical habitat for much of the bay's wildlife, are an important component of nutrient cycles, stabilize submerged shoreline sediments, and minimize shoreline erosion. Emergent wetlands provide attachment sites for algal and invertebrate communities, and provide habitat below the water surface for hundreds of recreational and commercially important species of fish, shrimp, and crabs, and other shellfish (Haddad, 1989). These species include pink shrimp, menhaden, blue crabs, mullet, red drum, tarpon, and snook. The marsh grasses and mangrove trees also provide critical feeding, nesting, and sheltering habitat above the water surface for an enormous variety of birds such as pelicans, cormorants, herons, ibises, roseate spoonbills, and reddish egrets.

1.3 Submergent Vegetative Habitats

Submergent vegetative habitats were also identified by TBNEP as a key living resource. These habitats include attached macro-algae beds (e.g. *Caulerpa*), and vascular seagrass meadows. Collectively, these habitats can be referred to as submerged aquatic vegetation (SAV). Of these, however, seagrass meadows are the primary focus of this living resource targets project.

An ongoing project is being conducted by the TBNEP to identify and map the distribution of (SAV) within the oligohaline portions of the tributaries to Tampa Bay. The results of the oligohaline SAV study were not able to be included in this report. However, preliminary results of a literature and common knowledge survey conducted for the TBNEP SAV study indicate that the distribution of SAV within Tampa Bay tributaries is very limited.

Consideration was also given to inclusion of live or hard bottom habitat within this phase of the target setting effort. These habitats support a diverse community of organisms such as sea fans, sea whips, hydroids, sponges, algae, and encrusting corals, which are usually associated with hard substrates such as exposed limestone bedrock. A general pattern of distribution of this habitat within the bay is presented by Derrenbacker and Lewis (1985). It should, however, be noted that the TBNEP and its advisors decided to exclude live bottoms from the mapping tasks to be performed under this project to avoid public disclosure of specific locations of this very sensitive habitat. The TBNEP, based on input from its Technical Advisory Committee (March 1992) and further discussions with the Florida Marine Research Institute, has since funded a separate project to map protection areas for live bottom habitat. These protection areas for live bottom habitat will be included in the draft CCMP.

The distribution and ecology of seagrass meadows along the west coast of Florida has been reviewed by Zieman and Zieman (1989), and literature concerning the seagrass meadows within Tampa Bay has been reviewed by Lewis et al. (1985), Lewis and Estevez (1988), Lewis (1989), and Schomer et al. (1990). The seagrass species are true vascular plants which are capable of producing root systems, vascular leaves, flowers, and seeds. The five species of seagrasses occurring within Tampa Bay are *Thalassia testudinum* (turtle grass), *Syringodium filiforme* (manatee grass), *Halodule wrightii* (shoal grass), *Ruppia maritima* (widgeon grass), and *Halophila engelmannii* (star grass). The seagrass species are commonly referred to individually by their generic names (e.g. "*Thalassia*"). For the purposes of this project they are referred to collectively as "seagrass".

With the exception of *Ruppia*, which is commonly found in the less saline portions of the estuary, seagrass species do not exhibit widescale flowering and seed production in Tampa Bay (Lewis et al., 1985). Expansion of seagrass meadows is typically accomplished by vegetative growth and propagule colonization into unvegetated bottom habitat. Detached *Halodule* and *Syringodium* rhizome propagules drift away from seagrass meadows to colonize new areas. *Thalassia* rhizome propagules are more buoyant, and hence, they are less likely to take root and complete successful colonization. Shifting sediments, hardened shorelines, and heavy boating traffic in the bay likely decrease the chances of successful revegetation of seagrass meadows by propagule dispersion into areas where they have been lost. For this reason habitat restoration projects often include efforts to lessen wave energy and physical boat prop damage, stabilize sediments, and plant mature seagrass plants.

Seagrass meadows are unquestionably a critical habitat in Tampa Bay. The meadows provide structural habitat for recreationally and commercially important fish and invertebrate species, provide support for macro and epiphytic algae, are an important component of nutrient cycles, and stabilize submerged shoreline sediments. Seagrasses provide direct food supplies for west indian manatees and loggerhead sea turtles, and indirect food supplies for detritivores such as blue crabs and pink shrimp

(Haddad, 1989). Zieman and Zieman (1989) have reviewed the recreationally and commercially important fish species which utilize Florida seagrass meadows as juvenile nursery and adult feeding areas. These species include red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), spot (*Leiostomus xanthurus*), silver perch (*Bairdiella chrysoura*), sheepshead (*Archosargus probatocephalus*), and the snook (*Centropomus undecimalis*).

1.4 Habitat Loss and the Tampa Bay National Estuary Program

Habitat loss was identified by the Management Conference of the Tampa Bay National Estuary Program as one of the seven major issues to be addressed by the program. Some of the critical habitats identified included seagrasses, tidal marshes, mangroves, oligohaline areas, and high marsh or salterns.

The decline of seagrasses in Tampa Bay has been well studied (Lewis et al., 1985; Haddad, 1989; Lewis et al., 1991). Dredge and fill activities have resulted in direct loss of seagrasses in Tampa Bay. It is likely that increased light attenuation due to elevated chlorophyll and suspended solids in the water column has also contributed significantly to reduced seagrass growth and eventual declines.

Losses of mangroves and saltmarshes have been documented and discussed by Lewis (1977), Estevez and Mosura (1985), Lewis et al. (1985), Haddad (1989). Dredge and fill activities associated with shoreline development (residential, public, and commercial) are responsible for most of the loss of these emergent tidal wetlands in Tampa Bay.

Oligohaline habitats are critical to many of the bay's resources, including many finfish species which use these habitats as nursery areas. The extent of these oligohaline habitats may also be shrinking due to alterations in patterns of freshwater inflow to the bay, but some of these areas have been lost due to dredging and filling in support of shoreline development.

The TBNEP recognized the need for the development of living resource targets to provide a focus for the management strategies to be defined in the Tampa Bay Comprehensive Conservation and Management Plan (CCMP). Living resource targets are operationally defined as the quantitative goals for habitat restoration in Tampa Bay. Thus, the success of the habitat restoration activities can be assessed relative to these goals or targets. The living resource targets defined in this project, therefore, will be used to guide the development of specific management strategies. These management strategies can be classified into three groups:

- restoration of areas that supported living resources in the pre-development period, but are currently lacking those living resources;

- protection of critical areas that currently support the living resources; and,

- enhancement of critical areas that currently support the living resources.

1.5 Approach to the Development of Restoration and Protection Targets

Figure 1.3 depicts a conceptual approach to a development of the restoration and protection strategy. Initially, the extent of the pre-development distribution of the living resources should be estimated. Ideally, this would be accomplished using existing maps and/or geographic distribution data. However, in some cases, neither maps nor geographic distribution data will be available for the historical benchmark period. In such cases, methods must be developed to infer the likely pre-development extent of the living resources. The Tampa Bay basin has experienced major urban development over the last 40-50 years, and some areas have been altered to the extent that they have no reasonable potential for restoration. The extent of these areas can be overlaid and subtracted from the pre-development extent to define the potential maximum current extent of a living resource. By overlaying the current extent of the living resource with the maximum potential current extent, candidate areas for both protection/enhancement and restoration of the living resource can be identified.

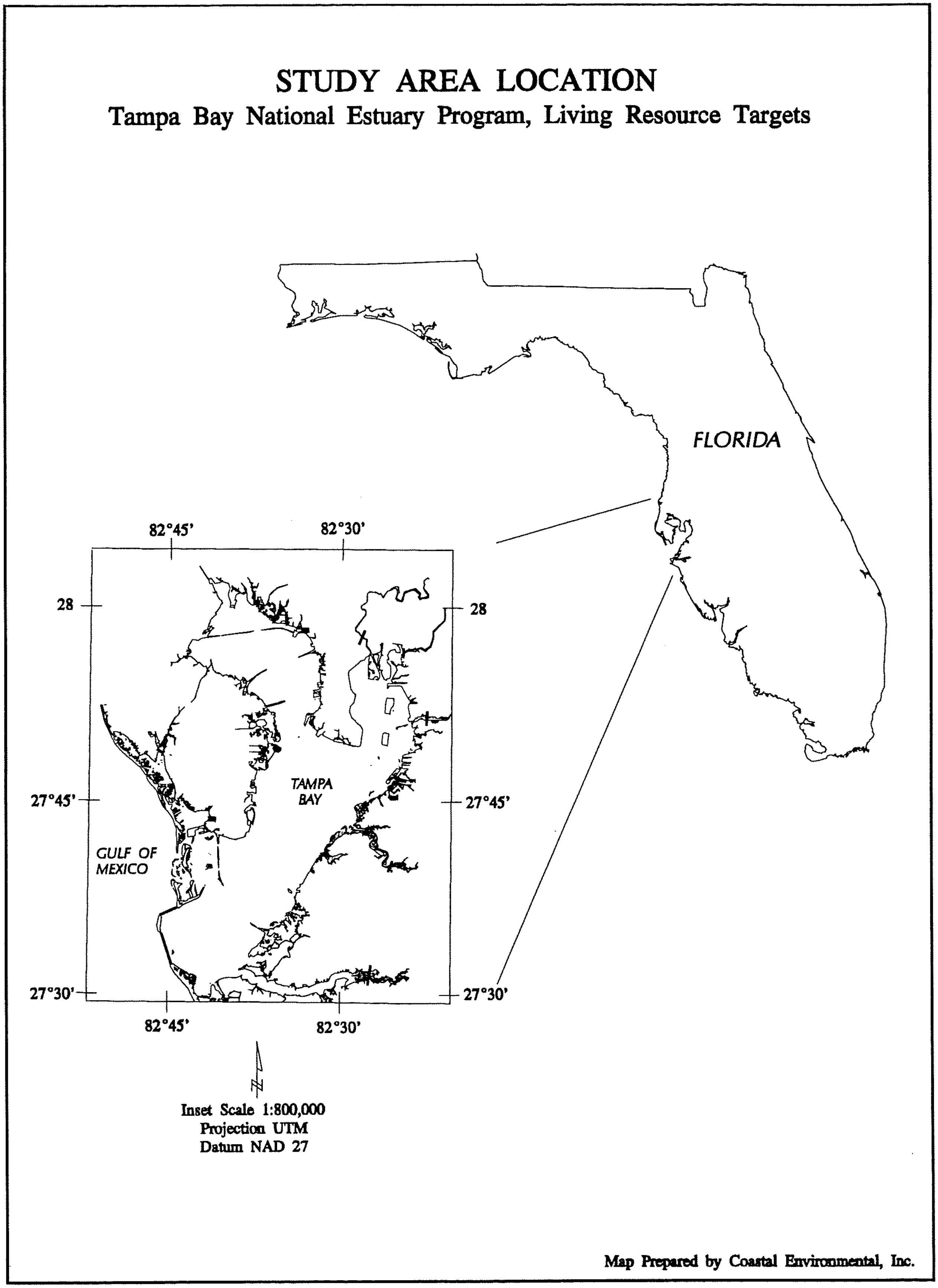

Figure 1.1 Location and limits of Living Resource Target Mapping Project study area.

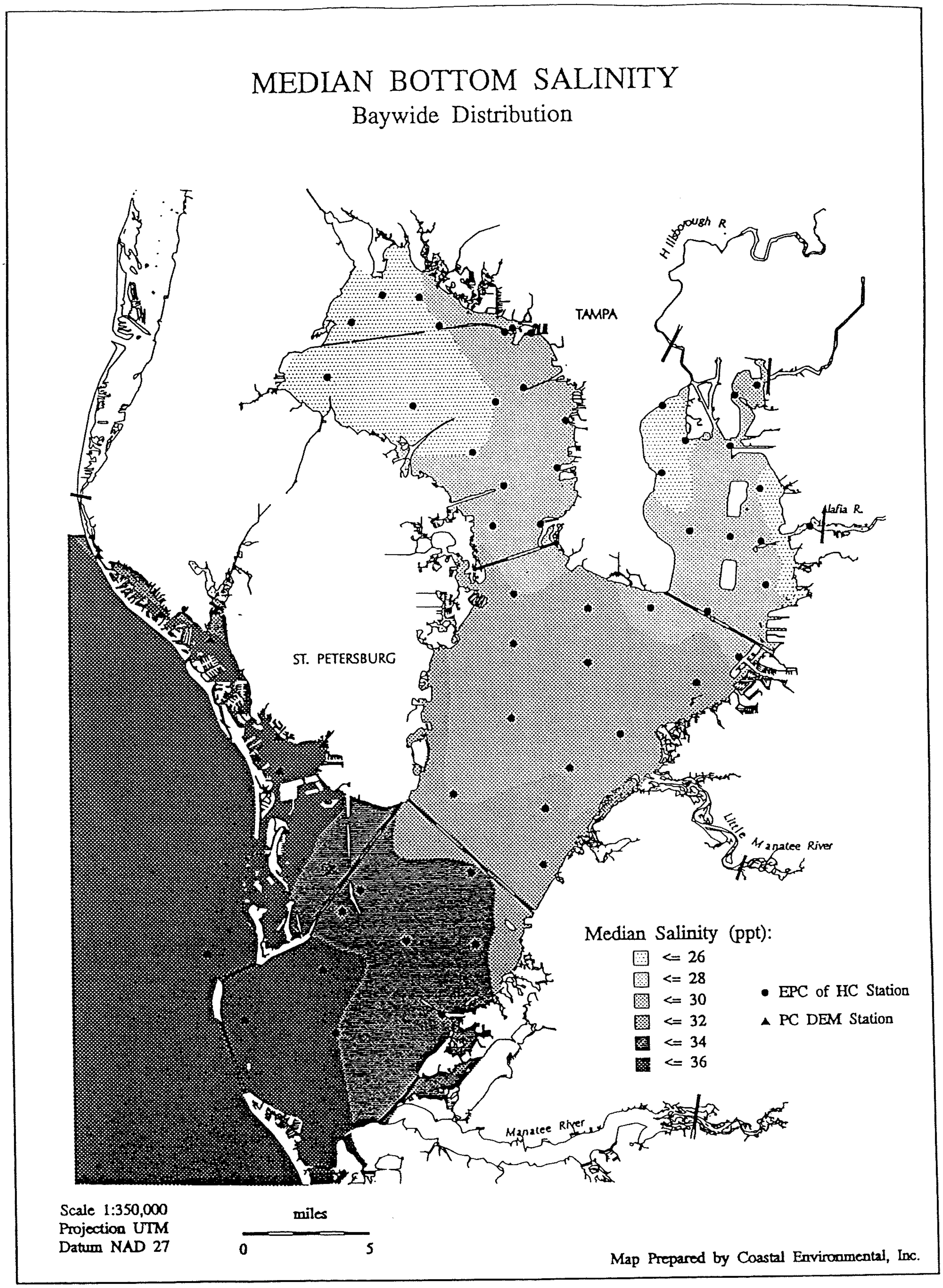

Figure 1.2 Distribution of Median Bottom Salinities in Tampa Bay. Data summarized from EPC of Hillsborough Co. (1974 to 1990) and Pinellas Co. DEM (1990 to 1991).

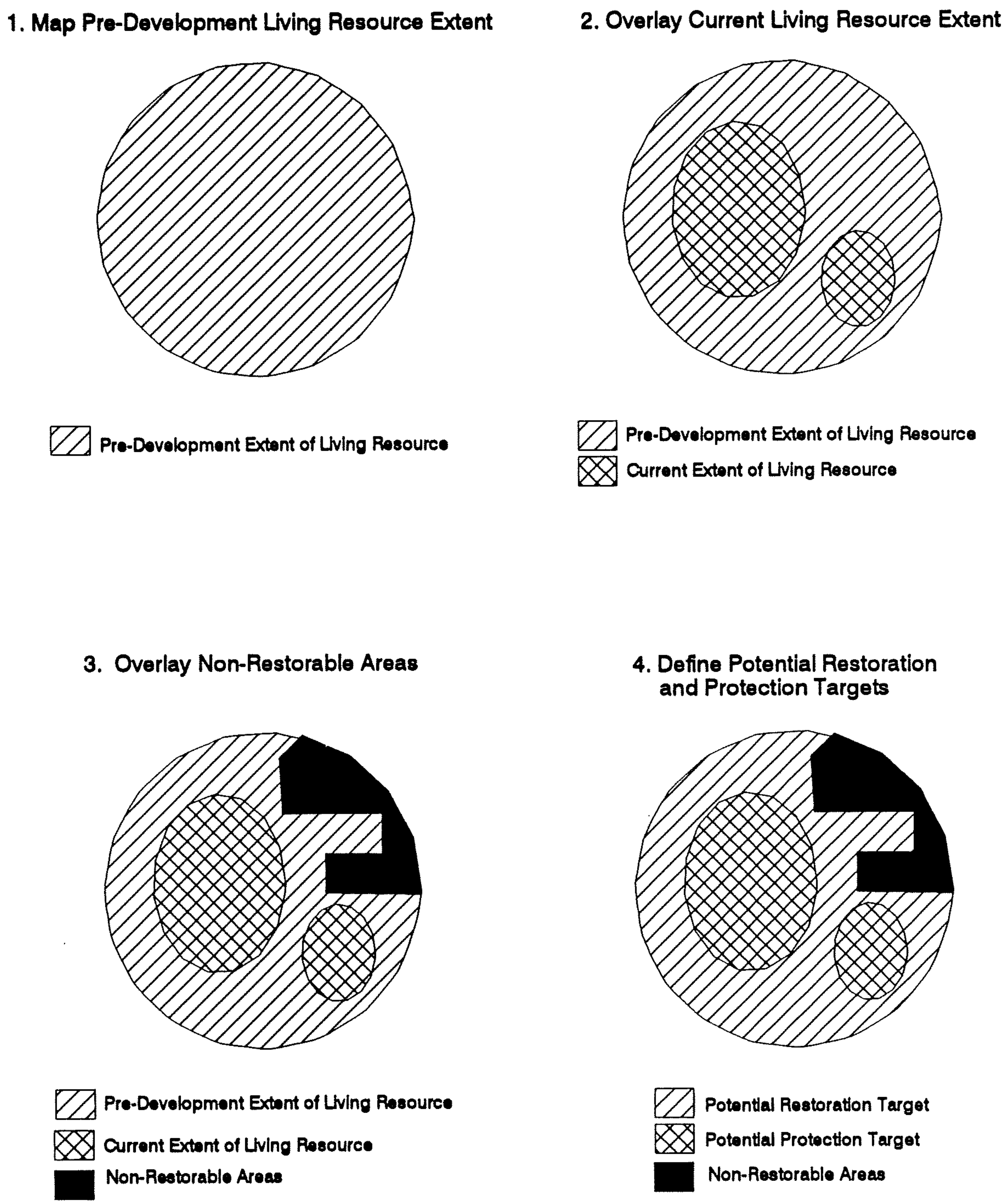

Figure 1.3 Conceptual approach to setting living resource targets for Tampa Bay.

2.0 PROJECT OBJECTIVES

The Living Resource Target Mapping Project initially focused solely on categories which included mangroves, seagrasses, tidal marshes, benthic habitats, low salinity habitats, and bay scallops. At the first Living Resources subcommittee meeting held to discuss this project, in September of 1992, it became clear that these living resource categories were a mix of habitats and animals, and therefore, they were not appropriate categories for comparison. At that meeting a list of seven habitats was proposed and ultimately selected to be the focus of this project. Each of these habitat categories represented a definable physical environment in Tampa Bay. These categories included the following:

- seagrasses and other SAV;
- mangrove forests;
- tidal marshes;
- non-vegetated subtidal;
- non-vegetated intertidal;
- salt barren/high marsh; and
- pelagic (water column).

It was recognized that restoration or protection would only be successful if viable communities of plants and animals actually inhabited these targeted physical environments. As a result, representative species that have at least a portion of their life cycle that uses the identified habitats were identified. Furthermore, it was agreed that these identified species, or "target" species, had to have well defined and reasonably well known environmental requirements for their survival and, if applicable, reproduction. As a result of these discussions, the literature was researched and several local experts in the Tampa Bay area were also contacted to develop a list of "target" species for each identified living resource habitat. Each of the listed "target" species had documented information concerning their environmental requirements.

The list of living resource habitats and the associated "target" species were presented to the full TBNEP Technical Advisory Commitee (TAC) on November 6, 1992. On December 8, 1992, the Living Resource subcommittee, after much discussion, agreed that the present approach using the above described "target" species would not appropriately fulfill the original objective of the project. A great deal of concern was voiced regarding the choice of species. Apparently, many of the important inhabitants of the selected habitats do not have well documented environmental requirements. The subcommittee recommended that the habitat mapping be continued, but that the approach of defining environmental requirements of "target" species be discontinued for this project. Additional living resource targets will be defined through TBNEP projects scheduled for 1994 and 1995, and included as elements in the CCMP.

It was agreed that, in lieu of defining environmental requirements, a list of desirable organisms that comprise a viable community should be compiled for each identified habitat. Successful restoration, therefore, would only be accomplished if all or part of the identified viable community exists. Recommendations as to how these habitats could be monitored to evaluate the success of the restoration program were also desired. It was recognized that the habitat monitoring program should assess habitat variables which may help explain why or why not there has been successful restoration of the habitat.

Therefore, the work plan and objectives of this project, as revised, entailed the following tasks:

1. Map the benchmark and current habitat coverages, and physically altered areas, for the purposes of developing areal targets for habitat restoration and/or protection.

2. Identify areas in the bay which are currently recognized as having environmental conditions sufficiently degraded as to make any restoration/protection actions problematical without improvement in these conditions.

3. Develop quantitative protection and restoration targets for emergent tidal wetlands and seagrasses.

4. Provide recommendations regarding monitoring programs to assess the success or failure of restoration/protection actions taken to address the targets developed under task 1 above.

5. Identify the biotic components of a viable community for each of the specified habitat types and salinity regimes.

This work plan was presented and approved at a full TAC meeting on January 7, 1993. Tasks 1 and 2 are addressed in detail throughout the following sections of this report. Recommendations regarding monitoring programs to address the success of protection/restoration actions are provided in the discussion. Finally, the list of desirable organisms that comprise a viable community, compiled for each identified key habitat, is provided as Appendix 1 of this report.

3.0 METHODS

The general approach to this project was to overlay mapped historic and existing distributions of living resources in Tampa Bay in order to develop quantitative acreage targets for resource protection and restoration. This work was completed in five distinct steps:

1. Map the historical living resource distributions for a benchmark time period.

2. Map the existing living resource distributions for 1990.

3. Overlay the historical and existing resource distributions to define candidate restoration and protection targets.

4. Subtract the physically altered, non-restorable areas from restoration targets.

5. Rank the relative restoration potential of the seagrass restoration areas.

This methods section describes the data sources and methods used to develop the restoration and protection goals.

3.1 Study Area

The specific area of interest for this project was presented in Figure 1.1. In order to provide more flexible management approaches, it was the desire of the TBNEP to establish living resource targets on a bay segment by segment basis. For scientific and management purposes, Tampa Bay was divided into seven geographic segments (Figure 3.1). These segments are based on those developed by Lewis and Whitman (1985), and vary in terms of surface water hydrology, salinity regime, living resource distribution, living resources, and patterns of anthropogenic impacts.

3.2 Selection of Benchmark Time Period and Level of Resolution

The circa 1950 time period was selected as the benchmark period for the establishment of restoration targets. This period was selected due to the availability of a consistent, comprehensive ca 1950 habitat data set. This data set was developed for a Florida Department of Natural Resources (FDNR) and U.S. Fish and Wildlife Service cooperative study, and is summarized in a Tampa Bay Regional

Planning Council (TBRPC) trend analysis report (NUS, 1986) and a TBRPC restoration plan report (TBRPC, 1986).

During the 1950's some development had already displaced and degraded some of the original habitat in the bay, but the USFWS/FDNR land use data for this period provides a single source, bay wide picture of the historical distribution of much of the original habitat of the bay. The period of major physical alteration of Tampa Bay had begun in the 1930's. The Gandy Bridge causeways, Port Tampa, Port facilities in Hillsborough Bay, Davis Islands filled areas, and St. Petersburg waterfront areas had been developed prior to 1950 (TBNEP, 1994a), and during the 1950's major circulation patterns of Boca Ciega Bay and Old Tampa Bay had been altered by the construction of additional causeways such as the Courtney Cambell Causeway (Goodwin, 1987 and 1989). However, much of the original seagrass meadows and emergent vegetative habitats were still intact during this period. The major physical alterations associated with Hooker's Point, Hillsborough spoil islands 2D and 3D, Boca Ciega Bay, Anna Maria Island, Pinellas Bayway, Skyway, and the Howard Franklin Bridge had not been completed during the 1950's.

The level of resolution provided by this project was limited by the level of detail introduced by the input data sets. As will be discussed in the following methods, many of these data were developed to a relatively high level of detail. The existing land use and bathymetry data are especially detailed. However, Tampa Bay is a dynamic system. Human activities, climatic and biological trends, and the natural shifting of sediments within the estuary limit the resolution to which precise locations of restoration targets can be delineated. Differences in photographic interpretation methods further limit the level of detail in comparing the 1950 and 1990 habitat data. The intent of this project was to establish bay segment scale acreage targets of habitats to be restored and protected, and to present the patterns of habitat loss throughout the bay. The locations of restoration and protection areas were mapped to the highest level of detail allowed by the original data. However, the level of resolution in these data should not be used to investigate the detailed history of habitat trends within specific areas such as one of the smaller tributaries, or a specific port development site.

3.3 Shoreline and Bathymetry

3.3.1 1950 Time Period

The historical shoreline for Tampa Bay was derived from the ca 1950 FDNR/USFWS digital land cover data. Each land cover polygon from the source data set was classified as either land or estuarine water, and the shoreline was assigned to the boundary between these two classes.

Bathymetric data for the ca 1950 time period were digitized from a historical National Oceanographic and Atmospheric Administration (NOAA) navigational chart obtained from the NOAA, National Ocean Survey Topographic and Bathymetric Survey Vault in Rockville, Maryland. The source chart was a 1951 revision of chart number 1257, and was printed at a scale of 1:80,000.

3.3.2 1990 Time Period

The existing digital shoreline for Tampa Bay was based on data collected for the 1990 seagrass survey conducted by the Southwest Florida Water Management District, SWIM Program. This shoreline was selected as the standard shoreline datum for the TBNEP. These data were photo-interpreted from 1:24,000 scale color photographs made in December of 1990.

A detailed GIS bathymetric model was produced for the existing time period. Mean low water depth was interpolated from point soundings and the existing shoreline data set. Digital hydrographic soundings data were obtained from the NOAA National Geophysical Data Center for 357,130 points within the Tampa Bay vicinity. These mean low water data were recorded in a comprehensive survey during 1947 to 1958, and were corrected for tide or water level, vessel draft, and sound velocity. A subset of these data are represented as soundings and bathymetry contours on the current NOAA navigational charts (e.g. 1991 NOAA chart number 1257). The vertical datum for these data was the Gulf Coast low water datum, and the horizontal datum was the NAD 1927 datum.

Using Triangular Irregular Network (TIN) interpolation software (ESRI, 1993), the point soundings and the shoreline delineation were used to interpolate a bathymetric model of the bay at a horizontal resolution of 25 meters and a vertical resolution of 0.5 meters. This model was carefully compared to the bathymetric contours presented on the 1991 NOAA navigational charts. An area east of and adjacent to Cat's Point in Boca Ciega Bay was updated with the 1991 information from the charts. A summary of the completed bathymetric model is presented in Figure 3.2.

3.4 Seagrass Meadows

3.4.1 1950 Time Period

The first step in developing the seagrass restoration and protection goals was to map the historic distribution of seagrass meadows for the benchmark 1950 time period. The objective of this step was to compile historical GIS data layers in a format that could be geographically combined with mapped distribution data for the existing time period.

The data source for the ca 1950 seagrass meadow coverage was the FDNR/USFWS 1950 historical data set. This seagrass meadows mapped by this data set were interpreted from 1:24,000 scale, color photographs, and a comparative summary of the data were presented in a report produced by the Tampa Bay Regional Planning Council (TBRPC, 1986). These data were obtained in digital form from the FDNR Marine Research Institute in St. Petersburg, Florida, converted from raster to vector format, and horizontally rectified to geographically coincide with mapped data for the existing time period. Three seagrass categories were included in the source data. These categories ("moderate/dense seagrass", "patchy seagrass", "sparse seagrass") were combined into a single class for this study.

3.4.2 1990 Time Period

The existing seagrass distribution data were obtained in a GIS format from the 1990 Seagrass Survey conducted by the SWFWMD Surface Water Improvement and Management (SWIM) Program. These data were photo-interpreted from 1:24,000 scale natural color photographs made in December 1990. Two categories of seagrass coverage (continuous and patchy) were combined into a single seagrass presence coverage.

3.4.3 Overlay of Data from the 1950 and 1990 Time Periods

The mapped historic and existing seagrass data layers were overlayed by using a geometric union operation of the Arc/Info GIS software package (ESRI, 1993). Areas which, in 1990, supported a seagrass meadow were identified as resource protection areas for that resource. Areas which historically supported seagrass in 1950 and did not support seagrass in 1990 were identified as potential restoration areas.

3.4.4 Non-Restorable Areas

Areas of Tampa Bay which have been physically altered to the extent that they have no reasonable possibility of supporting seagrass meadows were mapped and subtracted from the potential restoration targets. Mapped physically altered areas from the TBNEP Physical Impacts Project (TBNEP, 1994a) were used to delineate non-restorable areas for this project. These digitally mapped data sets for channels, spoil and borrow areas, filled areas, and modified shorelines are shown in Figure 3.3.

Existing and historical maps and documents were used to define the major physical impacts which have occurred in Tampa Bay. Existing navigational channels, dredge spoil areas, and borrow areas were delineated from current 1991 NOAA 1:40,000 scale navigational charts. A series of historical NOAA navigational charts (1877 to present) and USGS quadrangles (1950's to present) was obtained from the National Archives in Washington, D.C. Information from these sources was used to interpret and delineate areas of Tampa Bay which have been filled and shorelines which have been modified. The historical materials were arranged in chronological order, and the patterns of development and physical impacts to bay habitat through the decades were examined. The impacted areas were then delineated on the digital shoreline from the SFWFMD 1990 seagrass survey. This shoreline, as stated previously, was selected as the standard shoreline datum for all TBNEP projects.

3.5 Emergent Vegetative Habitat

3.5.1 1950 Time Period

The historical estuarine emergent vegetation data were a subset of the previously described ca 1950 digital land cover data base. Classes used for this study were mangrove, saltmarsh, and an intermediate mangrove/saltmarsh class. For purposes of setting restoration targets, the mangrove, marsh, and mangrove/marsh data categories were combined into a single estuarine emergent vegetation category. The 1950 data were of sufficient detail to map restoration targets for salt barren/high marsh habitat, and all areas of this habitat existing in 1990 were classified as protection targets.

3.5.2 1990 Time Period

Existing estuarine emergent vegetation data for mangroves and marshes were obtained in a GIS format from the 1990 Land Use / Land Cover Survey conducted by the Southwest Florida Water Management District. These data were photo-interpreted from 1:24,000 scale color infrared photographs made in December of 1990. Land cover was identified using the Florida Department of Transportation - Florida Land Use, Cover, and Forms Classification System (FLUCCS), and wetlands were identified following this protocol to FLUCCS level III (FDOT, 1985).

Existing data for saltern (salt barren / salt marsh) was delineated specifically for this project from the original SWFWMD 1:24,000 scale color photography used for the 1990 seagrass survey. Qualitative field reconnaissance was conducted in February of 1993 to assist with interpretation of the saltern photographic signatures.

3.5.3 Overlay of Data from the 1950 and 1990 Time Periods

The mapped historic and existing emergent vegetative habitat data layers were overlayed by using a geometric union operation of the Arc/Info GIS software package (ESRI, 1993). Areas which, in 1990, supported emergent vegetation were identified as resource protection areas. Areas which historically supported emergent vegetation in 1950 and did not in 1990 were identified as potential restoration areas for emergent vegetation. All existing saltern areas were identified as resource protection areas.

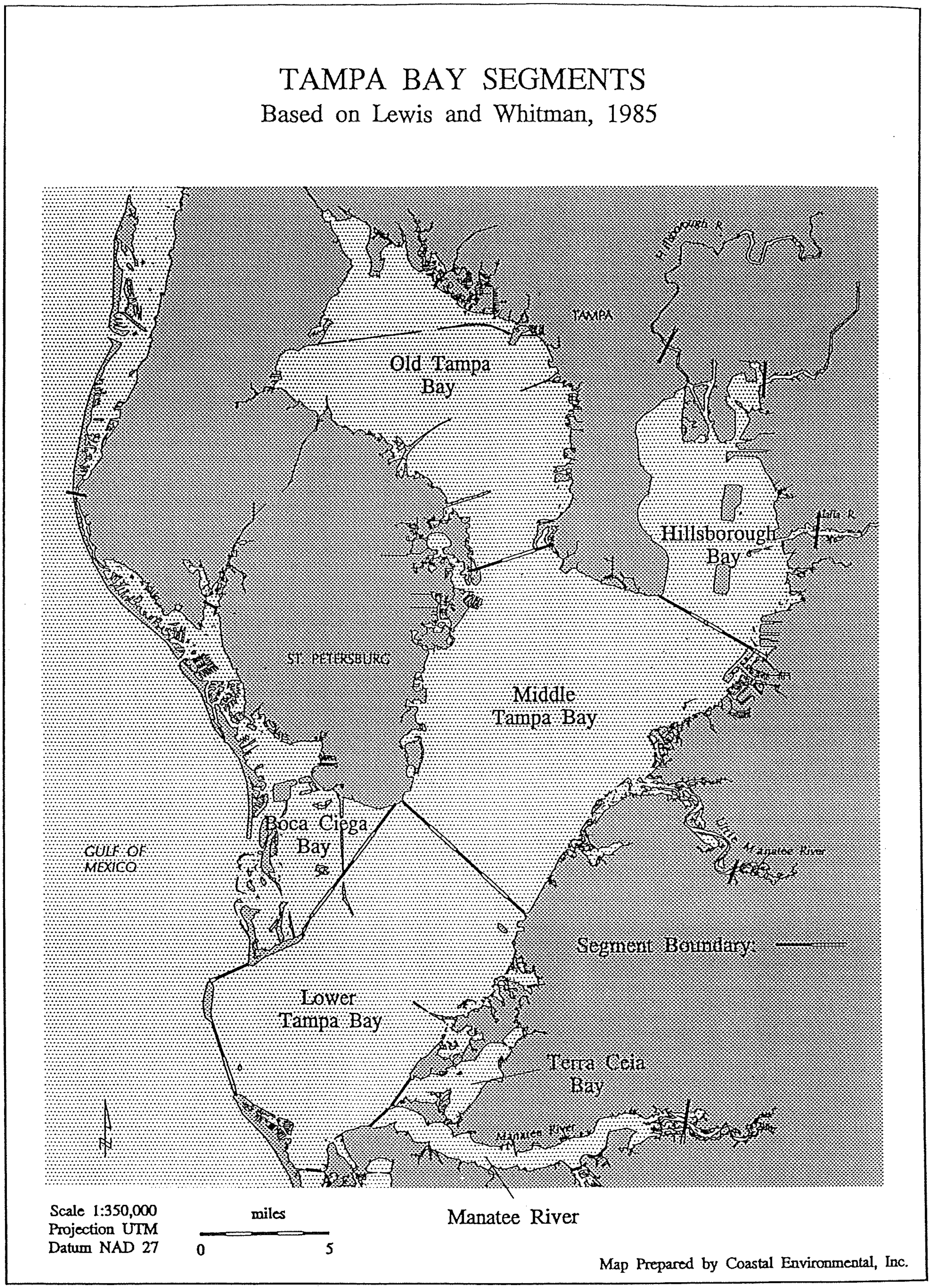

Figure 3.1 Segmentation Scheme for Tampa Bay.

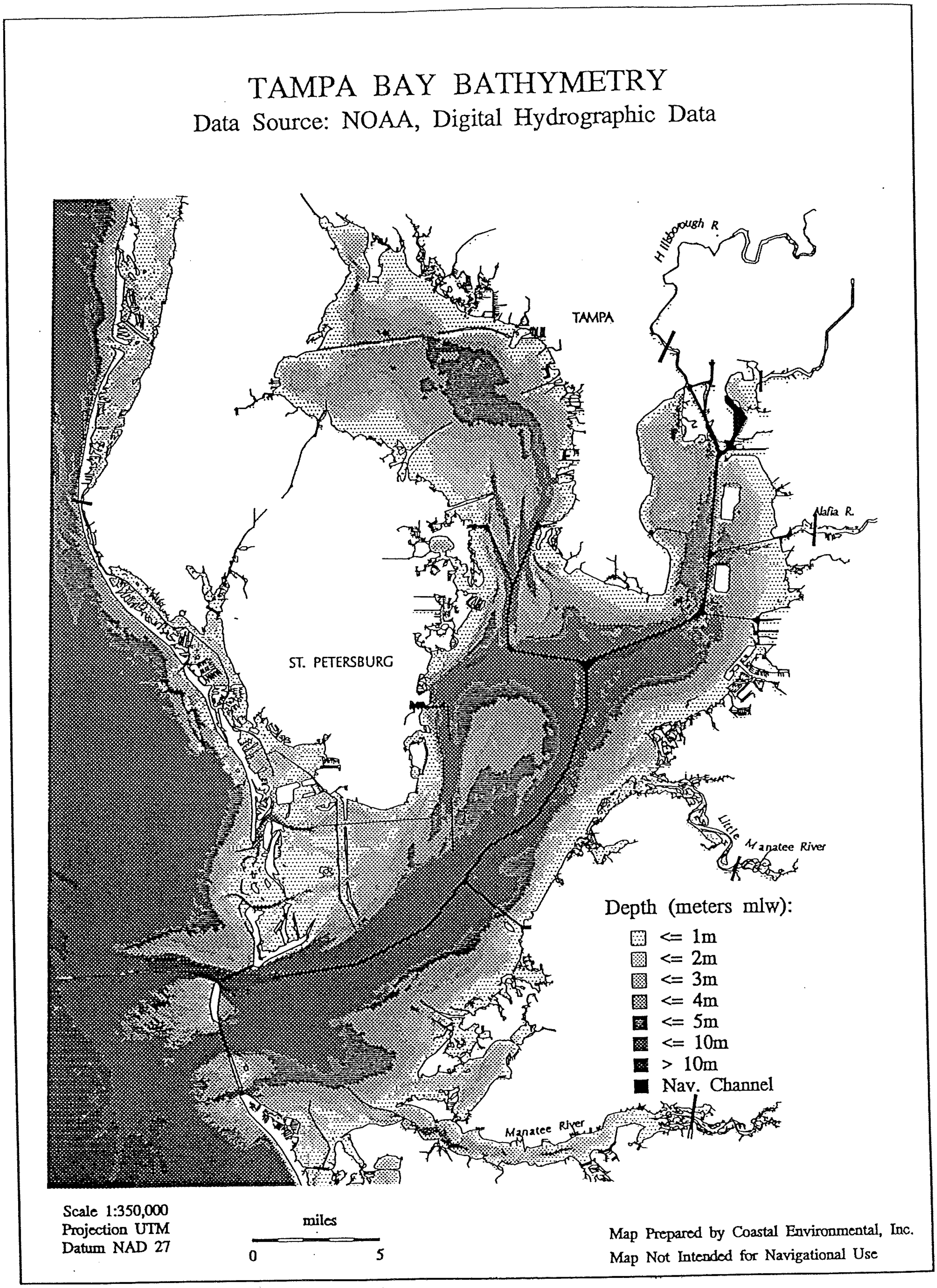

Figure 3.2 Tampa Bay Bathymetry. Data source: NOAA soundings, SWFWMD 1990 shoreline.

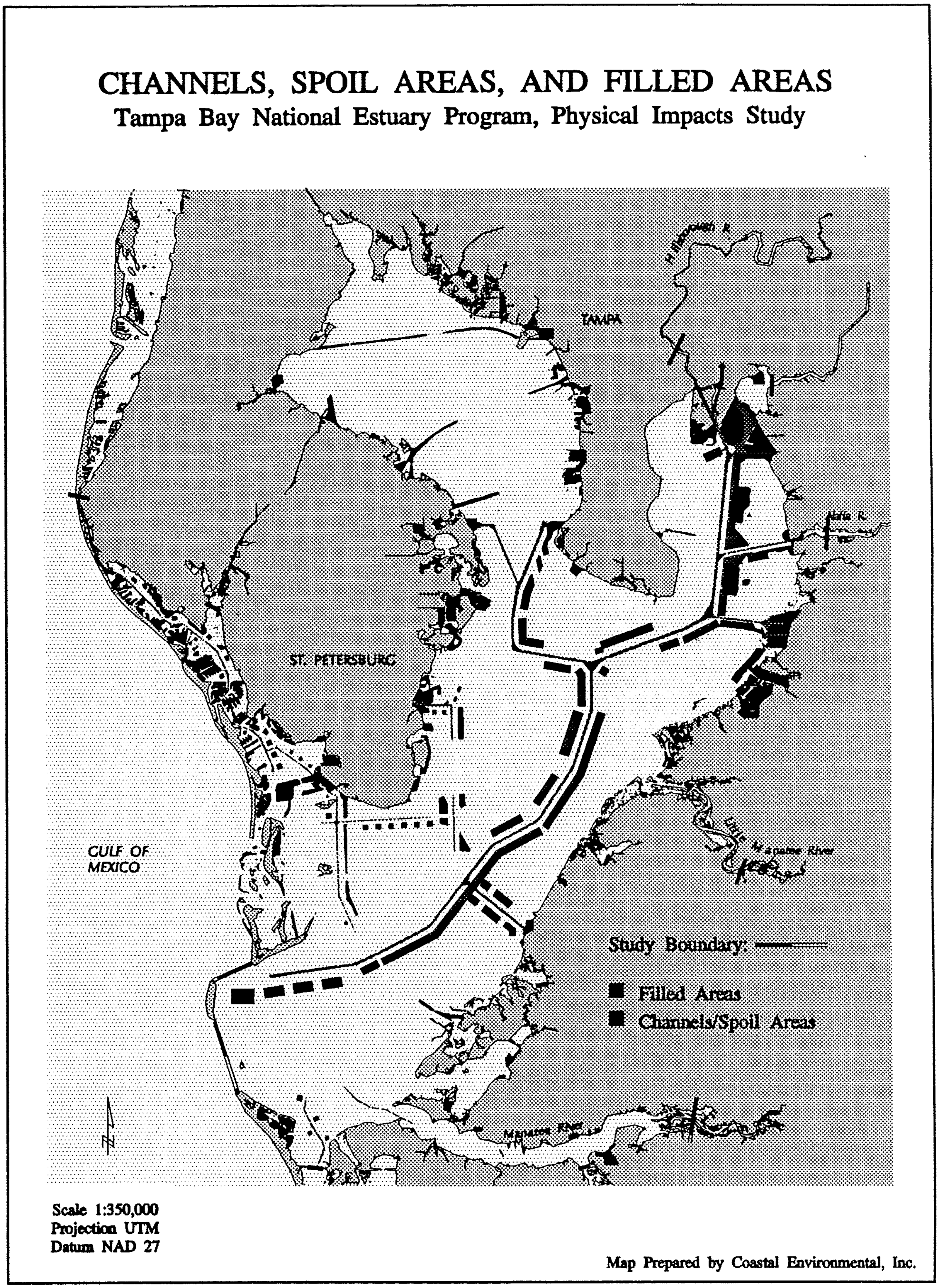

Figure 3.3 Non-restorable areas of Tampa Bay. Data source: TBNEP Physical Impacts Study,

4.0 RESULTS

Mapped results of the historical living resource distributions, existing living resource distributions, non-restorable areas, and restoration and protection targets are presented in the following section. As discussed in the previous methods section, the level of spatial resolution provided by this project is limited by the level of detail introduced by the input data sets. The locations of restoration and protection areas were mapped to the highest level of detail allowed by the original data. However, the level of resolution in these data should not be used to investigate detailed habitat trends within specific areas such as one of the smaller tributaries or a specific port development site.

For convenience to the reader, areal estimates were provided to the nearest 100 acres throughout this results section. The lack of a probability based sampling design for the historical and 1990 habitat data sets precludes the formulation of unbiased estimates of accuracy or precision in the areal estimates. However, the patterns of habitat loss between the two time periods are broadly distributed and unequivocal, and the restoration and protection acreages expressed in 100 acre increments will provide clear and useful management targets for restoration and protection. Due to the relatively smaller size of Hillsborough Bay, areal estimates for Hillsborough Bay were presented to the nearest acre.

4.1 Seagrass Meadows

4.1.1 1950 Time Period

Figure 4.1 presents the 1950 bay-wide seagrass distribution, as documented in the FDNR - USFWS cooperative study. The estimated area of bay-wide seagrass coverage in this period was 40,400 acres. It was also estimated that shallow areas without seagrass comprised approximately 49,600 acres in the benchmark period. Shallow areas were defined as having less than 2 meters of water at mean low water. Table 4.1 presents the estimated areas of seagrass and shallow areas without seagrass in the 1950 time period.

Figures 4.2 through 4.7 present the 1950 seagrass distribution by bay segment. In Old Tampa Bay and Boca Ciega Bay, it was estimated that nearly 10,800 acres of seagrass existed in each of these segments in the benchmark period. The seagrass coverage in these two bay segments accounted for over 50% of the total bay coverage in this period. Middle Tampa Bay (9,600 acres) and Lower Tampa Bay (ca. 6,100 acres) also contained significant seagrass coverage in the benchmark period. In each of these four bay segments (i.e., Old Tampa, Middle Tampa, Lower Tampa, and Boca Ciega bays) approximately 50% of the shallow areas were covered by seagrasses. In contrast, seagrasses covered somewhat less than 20% of the shallow areas in Hillsborough bay, and only about 5% in the Manatee River.

Figure 4.8 presents the relationship between seagrass coverage and depth in Hillsborough Bay, Old Tampa Bay, Middle Tampa Bay, and Lower Tampa Bay. These data suggest that seagrasses covered from 30% (in Hillsborough Bay) to nearly 60% (in both Middle and Lower Tampa bays) of the area between 0 and 0.5 meters in the benchmark period. Clearly, the proportion of the area that is covered by seagrass declines with depth. With the exception of one point for Old Tampa Bay, there is good agreement in this relationship among Old, Middle, and Lower Tampa bays. This may suggest that light conditions in these segments were more similar to each other than they were relative to Hillsborough Bay, where the lower proportion of the shallow area that is covered by seagrass may have been due to greater light attenuation.

4.1.2 1990 Time Period

Figure 4.9 presents the 1990 bay-wide seagrass distribution from the SWFWMD SWIM Seagrass Survey. The estimated area of bay-wide seagrass coverage in 1990 was 25,200 acres. It was also estimated that the 1990 shallow area without seagrass comprised approximately 39,600 acres. Shallow areas were defined as having less than 2 meters of water at mean low water. Table 4.2 presents the estimated areas of seagrass and shallow areas without seagrass in the 1990 time period. Perhaps, the most striking feature of the baywide 1990 seagrass map for Tampa Bay is that seagrasses were almost completely absent from Hillsborough Bay, and are no longer prevalent in the deeper portions of the shallow shelf rimming Old Tampa Bay. An important change which is less evident at this map scale is the loss of seagrass meadows from the now developed portions of Boca Ciega Bay.

Figures 4.10 through 4.15 provide a more detailed presentation of the 1990 seagrass coverage. The shores of Old Tampa Bay have now been developed to a large extent, and navigational channels can be seen bisecting the remaining shallow seagrass meadows. In 1990, new seagrass meadows can also be seen along the fringes of the transportation causeways built across the previously deep areas of the bay. With the exception of patches of seagrass, the 1990 data indicate that Hillsborough Bay and the northern half of Boca Ciega Bay had no remaining seagrass meadows. The distribution of seagrasses in the Manatee River appears to extend further upstream than indicated by the 1950 data.

Figure 4.16 presents the relationship between seagrass coverage and depth in Hillsborough Bay, Old Tampa Bay, Middle Tampa Bay, and Lower Tampa Bay. As was indicated by the 1950 data, the proportion of the area that is covered by seagrass declines with depth. The data indicate a trend in seagrass coverage which parallels the knowledge of water quality and light penetration in Tampa Bay. The Environmental Protection Commission of Hillsborough County (EPC) conducts monthly monitoring at fixed water quality stations throughout the bay, and the data indicate that the order of bay segments from relatively greater to lesser light penetration is Lower Tampa Bay, Middle Tampa Bay, Old Tampa Bay, and Hillsborough Bay (EPCHC, 1990). The EPC mean secchi disk depth for each of the bay segments is superimposed on the seagrass coverage by depth curves in Figure 4.17. These data indicate that little seagrass growth occurs in Tampa Bay below the secchi disk depth, and that there is a strong relationship between light penetration and seagrass coverage by depth.

4.1.3 Non-Restorable Areas

Many areas of Tampa Bay have been physically altered to such an extent that they are unlikely to support seagrass meadows in the future. As discussed in the methods section, these non-restorable areas were identified and mapped through the TBNEP Physical Impacts Project (TBNEP, 1994a). The baywide distribution of these non-restorable areas was presented in Figure 3.3. The amount of non-restorable area existing in what was once shallow water (depth less than 2 meters MLW) was estimated as 12,800 acres baywide. Large areas of Boca Ciega Bay have been filled for residential and commercial development (5,100 acres, 26% of the total shallow water area). Large areas of the shallows in Old Tampa Bay (2,800 acres, 9%) and Hillsborough Bay (1,900 acres, 24%) have been filled and channelized for urban and port development. Relatively fewer non-restorable areas were estimated in Middle Tampa Bay (800 acres, 7%), Boca Ciega Bay (200 acres, 4%), and the Manatee River (less than 100 acres, 1%).

4.1.4 Seagrass Targets and Shallow Habitat Protection Areas

Seagrass restoration and protection targets were developed by overlaying the 1950, 1990, and non-restorable data sets. All areas which had seagrass in 1990 were identified as seagrass protection areas. All areas which had seagrass coverage in the 1950's, did not have seagrass coverage in 1990, and were not classified as non-restorable were identified as seagrass restoration areas. The baywide distribution of the seagrass restoration and protection areas is presented in Figure 4.18. This map indicates that the major seagrass restoration areas are located in the northern portions of the bay. Table 4.3 and Figure 4.19 present the acreage targets for protection and restoration of seagrasses. The total seagrass restoration target was estimated as 14,800 acres, and the total seagrass protection target was estimated as 25,200 acres.

Figures 4.20 through 4.25 present the distribution of seagrass restoration and protection targets for each bay segment. These figures provide a view of the large areas targeted for seagrass restoration in Old Tampa Bay, Hillsborough Bay, and along the Eastern shoreline of Middle Tampa Bay. In the lower portions of the bay seagrass loss has been patchy, and the data suggest that it has occurred along the deeper edges of shallow vegetated areas.

All shallow areas (2 meters or less at mean low water) that did not have seagrass in either 1950 or 1990, and that were not classified as non-restorable, were identified as shallow non-seagrass protection areas. The baywide distribution of these shallow habitat protection areas is shown with the non-restorable areas in Figure 4.26. In Figure 4.26, the seagrass protection and restoration targets have been shaded as shallow also in order to make the map more easily understood. The total area of the shallow protection target is 39,600 acres, and a column presenting the targets by bay segment is included in Table 4.3. Figures 4.27 through 4.32 present the shallow habitat areas and non-restorable areas for each bay segment.

4.2 Emergent Vegetative Habitat

4.2.1 1950 Time Period

Figure 4.33 presents the 1950 bay-wide distribution of mangrove and saltmarsh habitat, as documented in the FDNR - USFWS cooperative study. The estimated area of mangrove and saltmarsh for this period was 22,500 acres. Mangrove habitat comprised 15,900 acres of this total, the combined saltmarsh/mangrove category comprised 2,700 acres, and saltmarsh comprised 3,900 acres. Table 4.4 presents the estimated areas of mangrove and saltmarsh for the 1950 time period.

Figures 4.34 through 4.39 present the 1950 emergent vegetative habitat distribution by bay segment. The north and south shores of Old Tampa Bay and the eastern shores of Middle and Lower Tampa Bay had the largest areas of estuarine emergent vegetation in the 1950 period. The estuarine emergent vegetation of Old and Middle Tampa Bay alone accounted for over 50% of the total bay coverage in this period (12,400 acres). Mangroves and salt marshes were distributed along the shores of essentially all of the bay segments in the historical time period. Although, they were already conspicuously absent from the developed shores of Tampa, the lower Manatee River, and the southern portions of St. Petersburg. Several large contiguous areas of saltmarsh vegetation were identified in the 1950 data base. These areas were located directly along the northeastern shoreline of Old Tampa Bay and inland of two large contiguous stands of mangroves on the eastern shore of Middle Tampa Bay. The Alafia, Little Manatee, and Manatee Rivers all had broad coverages of saltmarsh vegetation extending inland from the bay.

4.2.2 1990 Time Period

Figure 4.40 presents the 1990 bay-wide distribution of mangrove and saltmarsh habitat, as documented in the SWFWMD 1990 land cover data. The estimated area of mangrove and saltmarsh habitat for 1990 was 17,900 acres. Mangrove comprised 13,800 acres of this total, and saltmarsh comprised 4,100 acres. In addition, new mapping of salt barren and high marsh areas indicated that approximately 900 acres of this habitat existed in 1990. Table 4.5 presents the estimated areas of mangroves, saltmarshes, and salt barren/high marshes for the 1990 time period. The scale of the bay wide plot of mangroves and salt marshes presents a less detailed overview of the current extent of emergent vegetation. Notable features in this plot are the large contiguous marsh/mangrove areas which remain in Old Tampa Bay and along the eastern shore of Tampa Bay between the Alafia and Manatee Rivers.

Figures 4.41 through 4.46 present more detailed views of the 1990 distribution of mangrove and saltmarsh habitat for each bay segment. It is evident from these data that most of the mangrove and marsh areas have been bisected by channels, transportation causeways, and filling associated with urban development.

4.2.3 Protection Targets

The combined 1950 and 1990 emergent vegetative habitat acreages are presented in Figure 4.47. All 1990 areas of estuarine emergent vegetation were identified as living resource protection targets, and a breakdown of these targets by bay segment is presented in Table 4.6. Based upon these data, a protection target of 18,800 acres can be established for saltmarsh, mangrove, and high marsh/salt barren habitat in Tampa Bay. The largest contiguous portion of this target is contained in the combined total of 8,600 acres of mangrove forest located in Old Tampa Bay and Middle Tampa Bay.

4.2.4 Restoration Targets

Several large areas of lost habitat are visible at the baywide map scale. These areas are located along the eastern shoreline of the bay from the Hillsborough River in the north to an area south of the Little Manatee River. Table 4.7 presents a breakdown of land cover in areas which were previously classified as marsh and mangrove in 1950.

A segment by segment breakdown of the 1950 to 1990 comparison is mapped in Figures 4.48 through 4.53. These figures indicate that most of the loss of emergent vegetative habitat between the two time periods is associated with areas of shoreline filling for urban development. The mangrove and saltmarsh habitat of Old Tampa Bay includes a large continuous tract of mangroves along the western shoreline which has been bisected by causeway and port development. A total of 1,600 acres of marsh and mangrove habitat has been lost in Old Tampa Bay between the two time periods. The shoreline of Hillsborough Bay was extensively developed both before and after 1950. The bay segment plot of 1950 and 1990 emergent vegetation for Hillsborough Bay (Figure 4.49) illustrates the loss of emergent wetlands in areas of urban and port development along the eastern shoreline. Likewise, the map for Middle Tampa Bay (Figure 4.50) indicates a similar pattern.

These data indicate that a total of approximately 9,700 acres of what was mangrove and saltmarsh habitat have been lost from Tampa Bay since 1950. These same data, however, also indicate that approximately 5,900 acres of saltmarsh and mangrove vegetation occurred in areas in 1990 where it did not occur in 1950. An analysis of this conversion reveals that of the 5,900 acres approximately 35% (2,065 acres) was converted from upland/range/urban land use categories; 30% (1,770 acres) was converted from other intertidal wetland habitat (e.g. flats/beaches); 26.7% (1,575 acres) was converted from open water and subtidal habitat (e.g. patchy and sparse seagrass); and 8.3% (490 acres) was converted from freshwater wetlands. An operational definition of "new" emergent tidal wetlands would include the conversion of upland, subtidal and freshwater wetland cover types to emergent tidal wetlands; but would exclude the conversion of other types of non-vegetated intertidal wetlands (e.g. flat/beaches). Therefore, based upon this analysis it can be argued that approximately 4,100 acres of new emergent tidal wetlands were established in the bay between 1950 and 1990 (e.g. 5,900 - 1,770 rounded to the nearest hundred).

Given the sources of error in the available data sets, it may not be possible to accurately determine the net loss of marsh/mangrove habitat in Tampa Bay since the 1950 benchmark period. Differences in photographic interpretation between the 1950 and 1990 data sets have likely resulted in some marsh areas being correctly classified in 1990, but which were misclassified as uplands in 1950. Errors in the classification system used in the 1950 USFWS data set have been noted by Haddad (1989), especially as they relate to the misclassification of marsh and high marsh areas. In addition, it is known that the 1990 SWFWMD data set has misclassified some fringe upland areas with brazilian pepper coverage as mangrove forest (Reis, personal communication). Nonetheless, assuming that the 4,100 acres calculated above represents the highest reasonable estimate of new marsh/mangrove growth since 1950, then it can be concluded that a minimum net loss of marsh/mangrove habitat of 5,600 acres has occurred between 1950 and 1990.

Based on this analysis, defensible restoration targets for emergent vegetative habitat of either 9,700 acres or 5,600 acres could be established for Tampa Bay depending upon the preferred philosophical approach. The former figure represents the total acreage of emergent vegetation lost or converted since 1950, whereas the latter represents a minimal estimate of the baywide net loss of emergent vegetation inclusive of potential new growth since 1950. It is recommended that the TBNEP consider the relative technical merits and feasibility of both alternatives before establishing a final restoration target.

Table 4.1 Estimated extent of seagrass coverage and shallow areas without seagrass in 1950 (rounded to nearest 100 acres, Hillsborough Bay areas rounded to nearest acre). Data source: FDNR and USFWS cooperative study.

Bay Segment	Seagrass Coverage (Acres)	Shallow Areas without Seagrass (Acres)
Old Tampa Bay	10,700	10,800
Hillsborough Bay	2,321	9,702
Middle Tampa Bay	9,600	8,300
Lower Tampa Bay	6,100	5,500
Boca Ciega Bay	10,800	9,000
Terra Ceia Bay	700	2,100
Manatee River	200	4,300
Bay-wide Total	40,400	50,900

Table 4.2 Estimated extent of seagrass coverage and shallow areas without seagrass in 1990 (rounded to nearest 100 acres, Hillsborough Bay areas rounded to nearest acre). Data source: 1990 SWFWMD, SWIM Seagrass Survey.

Bay Segment	Seagrass Coverage (Acres)	Shallow Areas without Seagrass (Acres)
Old Tampa Bay	5,600	9,800
Hillsborough Bay	44	6,710
Middle Tampa Bay	5,300	7,000
Lower Tampa Bay	6,200	3,800
Boca Ciega Bay	6,800	6,500
Terra Ceia Bay	1,000	1,500
Manatee River	400	4,100
Bay-wide Total	25,200	39,500

Table 4.3 Acreage targets for protection and restoration of seagrasses (rounded to nearest 100 acres, Hillsborough Bay areas rounded to nearest acre).

Bay Segment	Seagrass Restoration Target (Acres)	Seagrass Protection Target (Acres)	Shallow Non-seagrass Protection Target (Acres)	Non-Restorable Area (Acres)
Old Tampa Bay	5,500	5,600	9,800	1,900
Hillsborough Bay	1,767	44	6,710	2,800
Middle Tampa Bay	4,100	5,300	7,000	1,900
Lower Tampa Bay	1,300	6,200	3,800	800
Boca Ciega Bay	2,000	6,800	6,500	5,100
Terra Ceia Bay	100	1,000	1,500	200
Manatee River	< 50	400	4,100	< 50
Bay-wide Total	14,800	25,200	39,500	12,800

Table 4.4 Estimated extent of mangroves and saltmarshes for the 1950 time period (rounded to the nearest 100 acres). Data source: FDNR and USFWS cooperative study.

Bay Segment	Mangrove Coverage (Acres)	Mangrove/Marsh Coverage (Acres)	Saltmarsh coverage (Acres)
Old Tampa Bay	3,300	900	500
Hillsborough Bay	1,100	400	200
Middle Tampa Bay	5,200	600	1,500
Lower Tampa Bay	2,600	200	400
Boca Ciega Bay	2,100	200	< 50
Terra Ceia Bay	900	< 50	< 50
Manatee River	600	300	1,300
Bay-wide Total	15,900	2,700	3,900

Table 4.5 Estimated extent of mangroves, saltmarshes, and salt barren/high marshes for the 1990 time period (rounded to nearest 100 acres). Data Source: 1990 SWFWMD land cover data, TBNEP 1990 salt barren/ high marsh delineation.

Bay Segment	Mangrove (Acres)	Saltmarsh (Acres)	Salt Barren/ High Marsh (Acres)
Old Tampa Bay	3,500	1,200	100
Hillsborough Bay	800	500	< 50
Middle Tampa Bay	5,100	900	500
Lower Tampa Bay	2,200	200	200
Boca Ciega Bay	1,100	100	< 50
Terra Ceia Bay	700	< 50	< 50
Manatee River	500	1,300	< 50
Bay-wide Total	13,800	4,100	900

Table 4.6 Emergent vegetative habitat by bay segment and time period (rounded to nearest 100 acres).

Bay Segment	1950 Period (Acres)	1990 Period (Acres)	Present in 1950 Not Present in 1990	Present in 1990 Not Present in 1950
Old Tampa Bay	4,800	4,700	1,600	1,600
Hillsborough Bay	1,700	1,300	1,100	700
Middle Tampa Bay	7,600	6,500	2,700	1,600
Lower Tampa Bay	2,900	2,600	1,100	700
Boca Ciega Bay	2,400	1,200	1,700	500
Terra Ceia Bay	1,000	700	400	200
Manatee River	2,200	1,700	1,100	700
Bay-wide Total	22,500	18,800	9,700	5,900

Table 4.7 Summary of 1990 land cover in areas which were previously classified as marsh and mangrove in 1950 (rounded to nearest 100 acres). Data Source: Land cover summarized from SWFWMD 1990 land cover data.

1990 Land Cover	Old Tampa Bay	Hillsb-borough Bay	Middle Tampa Bay	Lower Tampa Bay	Boca Ciega Bay	Terra Ceia Bay	Manatee River	Bay-wide Total
Agriculture	< 50	< 50	< 50	< 50	< 50	< 50	< 50	100
Barren Land	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Freshwater Wetland	300	100	400	400	100	100	300	1,700
Open Water	600	200	200	400	400	200	500	3,200
Rangeland	< 50	< 50	< 50	< 50	< 50	< 50	< 50	100
Submerged Estuarine Vegetation	< 50	< 50	< 50	< 50	< 50	< 50	< 50	200
Transportation and Utilities	200	200	< 50	100	100	< 50	< 50	600
Upland Forest	100	100	100	< 50	100	< 50	< 50	400
Urban and Built Up	400	500	1,000	200	1,100	100	200	3,500

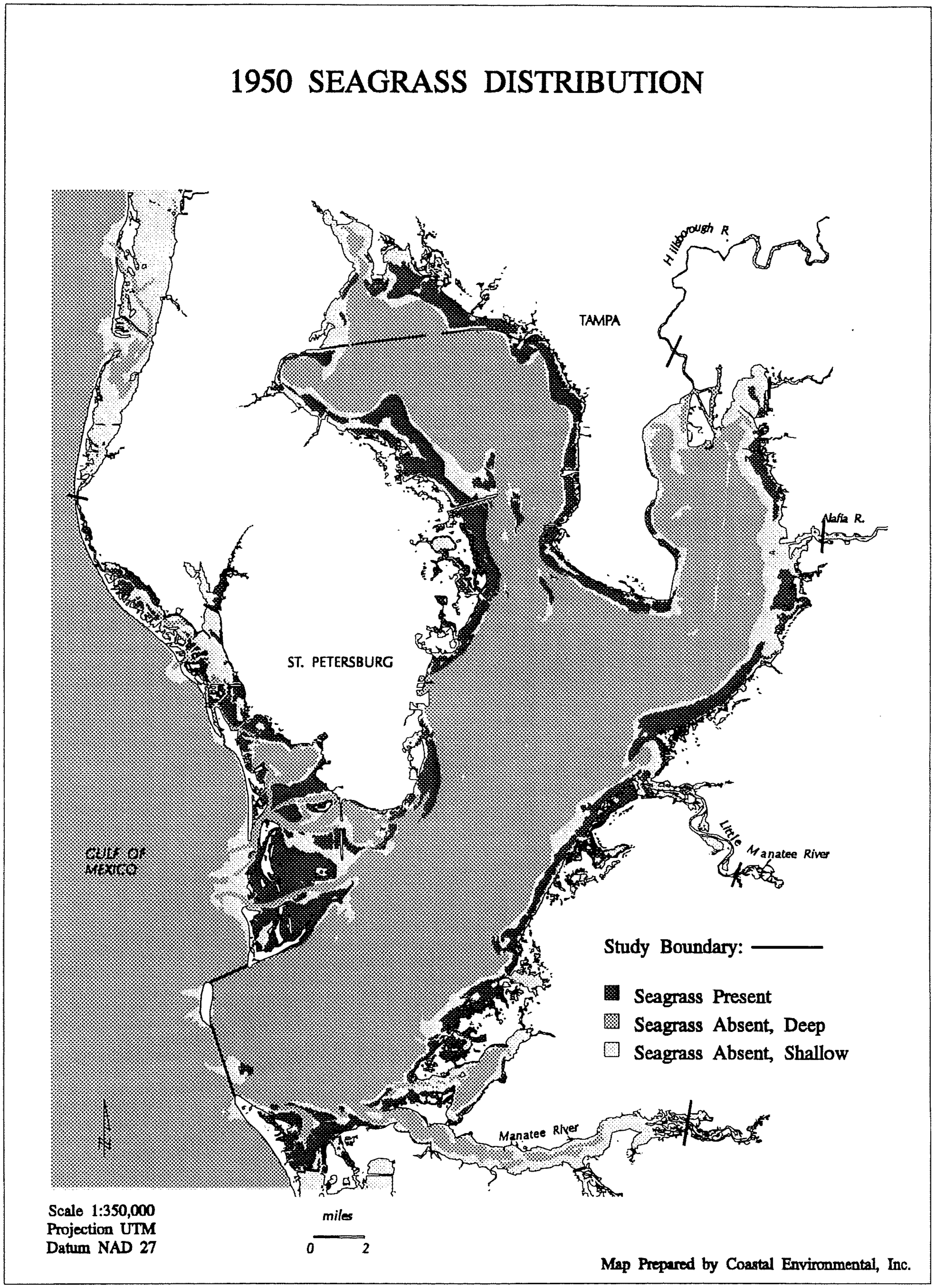

Figure 4.1 1950 Seagrass distribution in Tampa Bay. Data source: FDNR and USFWS cooperative study.

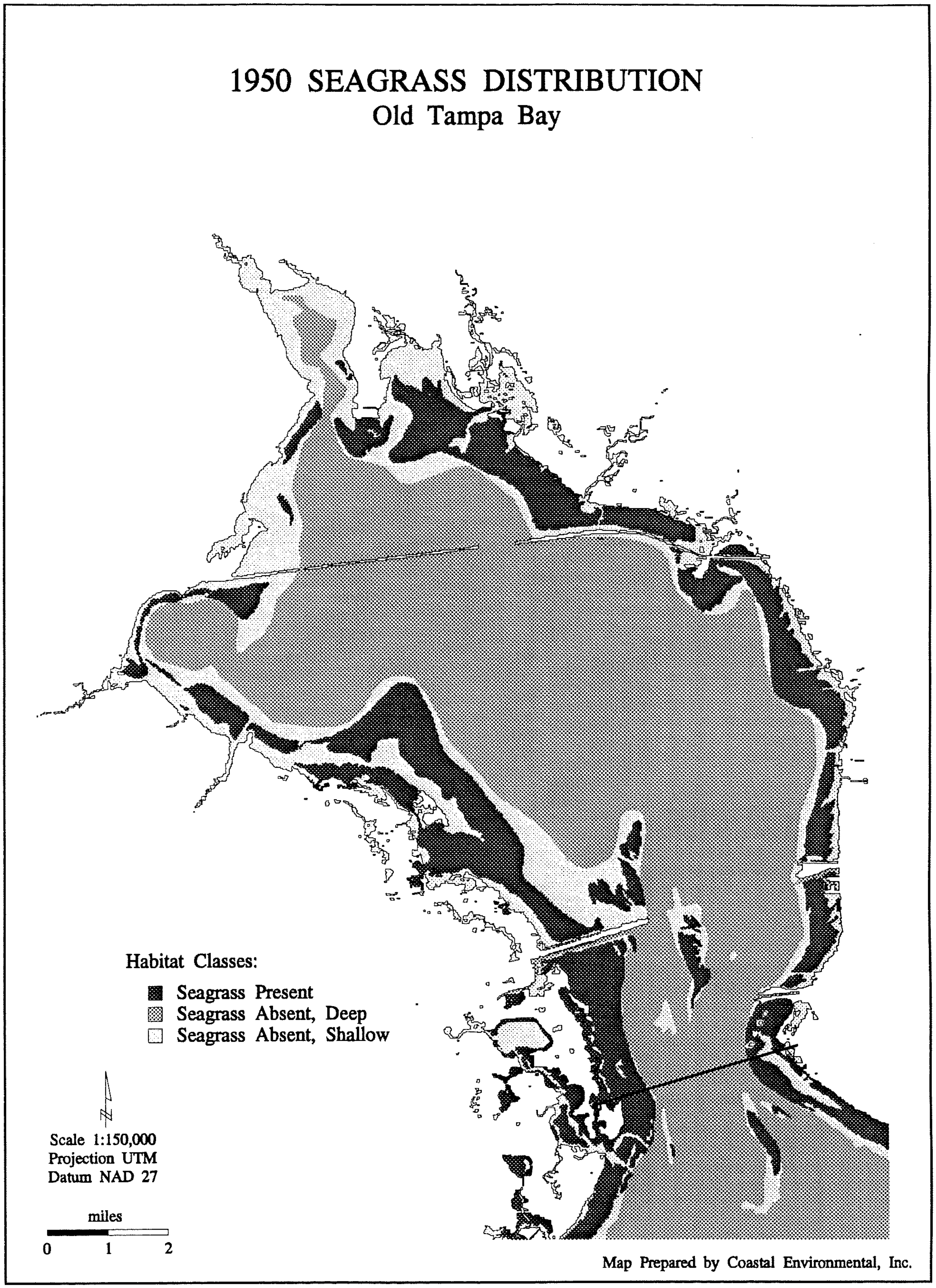

Figure 4.2 1950 Seagrass distribution in Old Tampa Bay. Data source: FDNR and USFWS cooperative study.

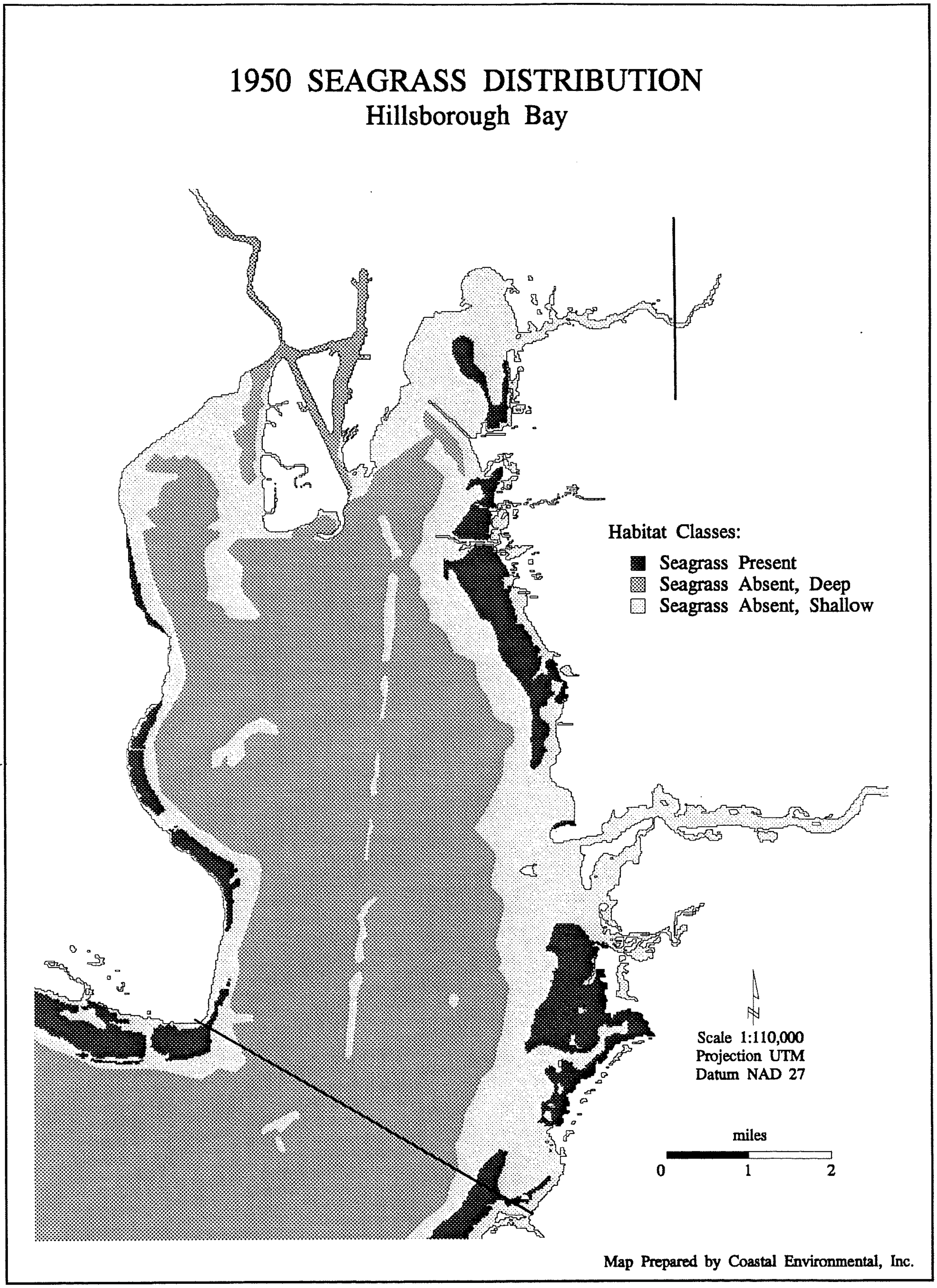

Figure 4.3 1950 Seagrass distribution in Hillsborough Bay. Data source: FDNR and USFWS cooperative study.

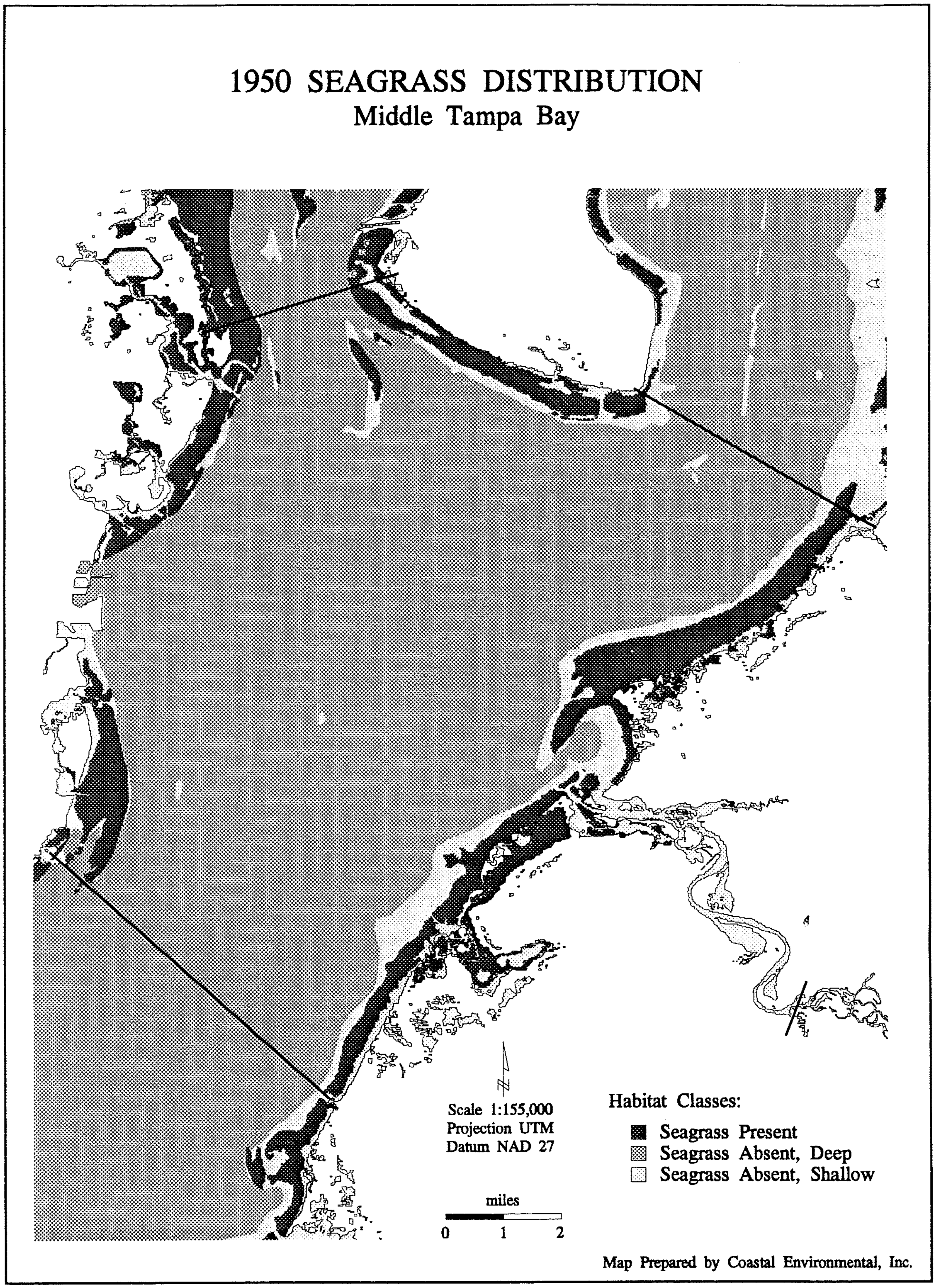

Figure 4.4 1950 Seagrass distribution in Middle Tampa Bay. Data source: FDNR and USFWS cooperative study.

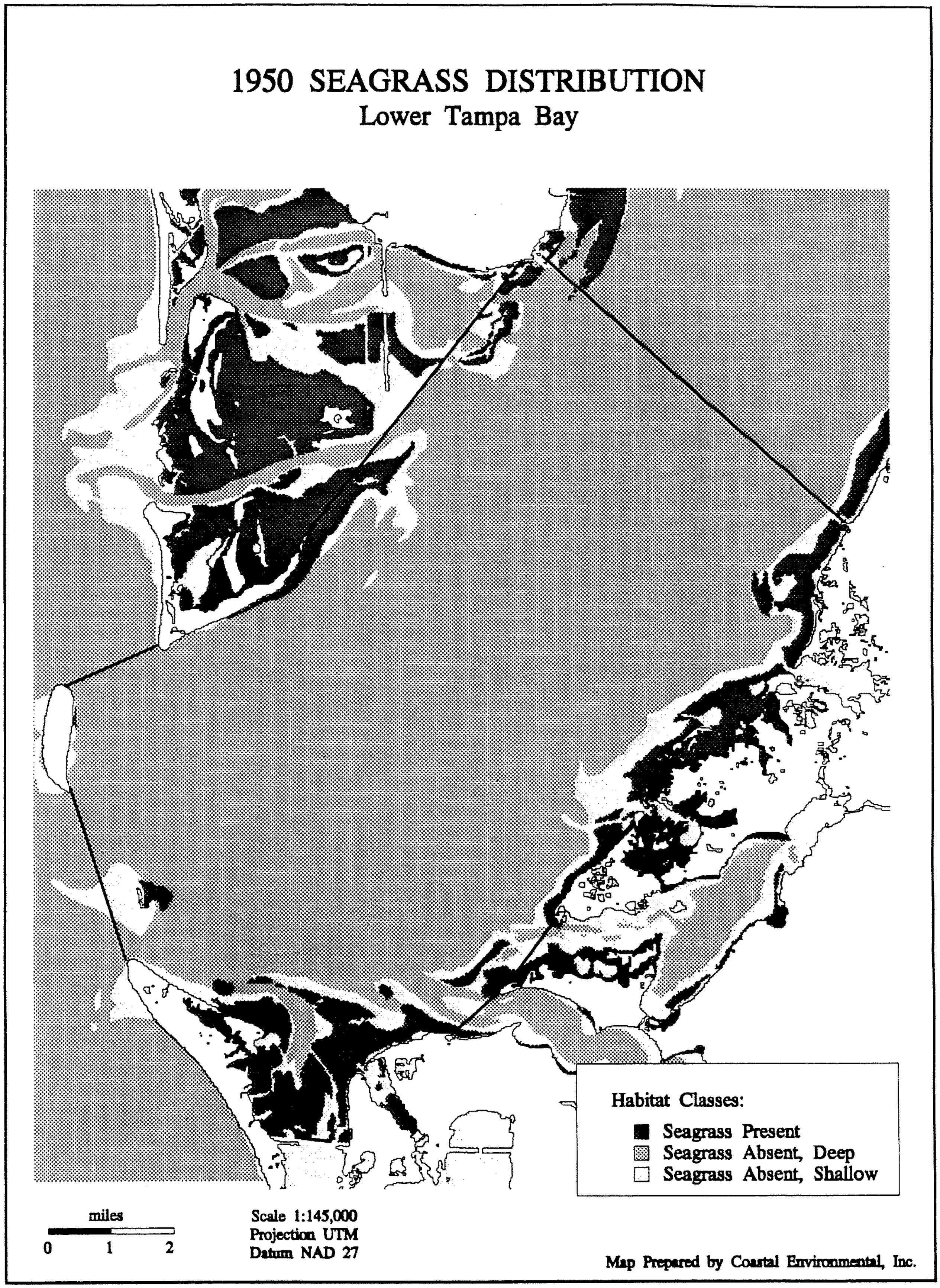

Figure 4.5 1950 Seagrass distribution in Lower Tampa Bay. Data source: FDNR and USFWS cooperative study.

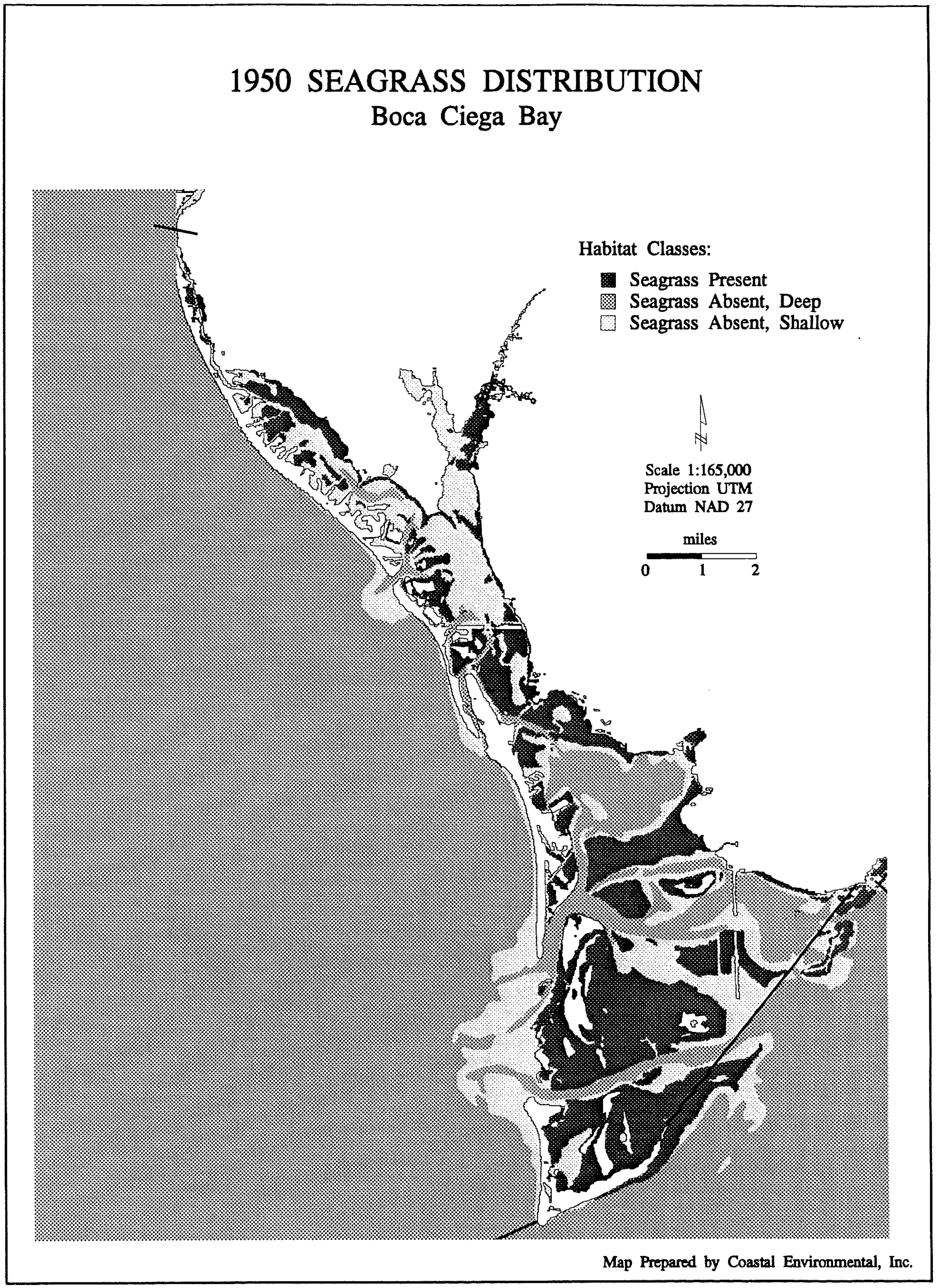

Figure 4.6 1950 Seagrass distribution in Boca Ciega Bay. Data source: FDNR and USFWS cooperative study.

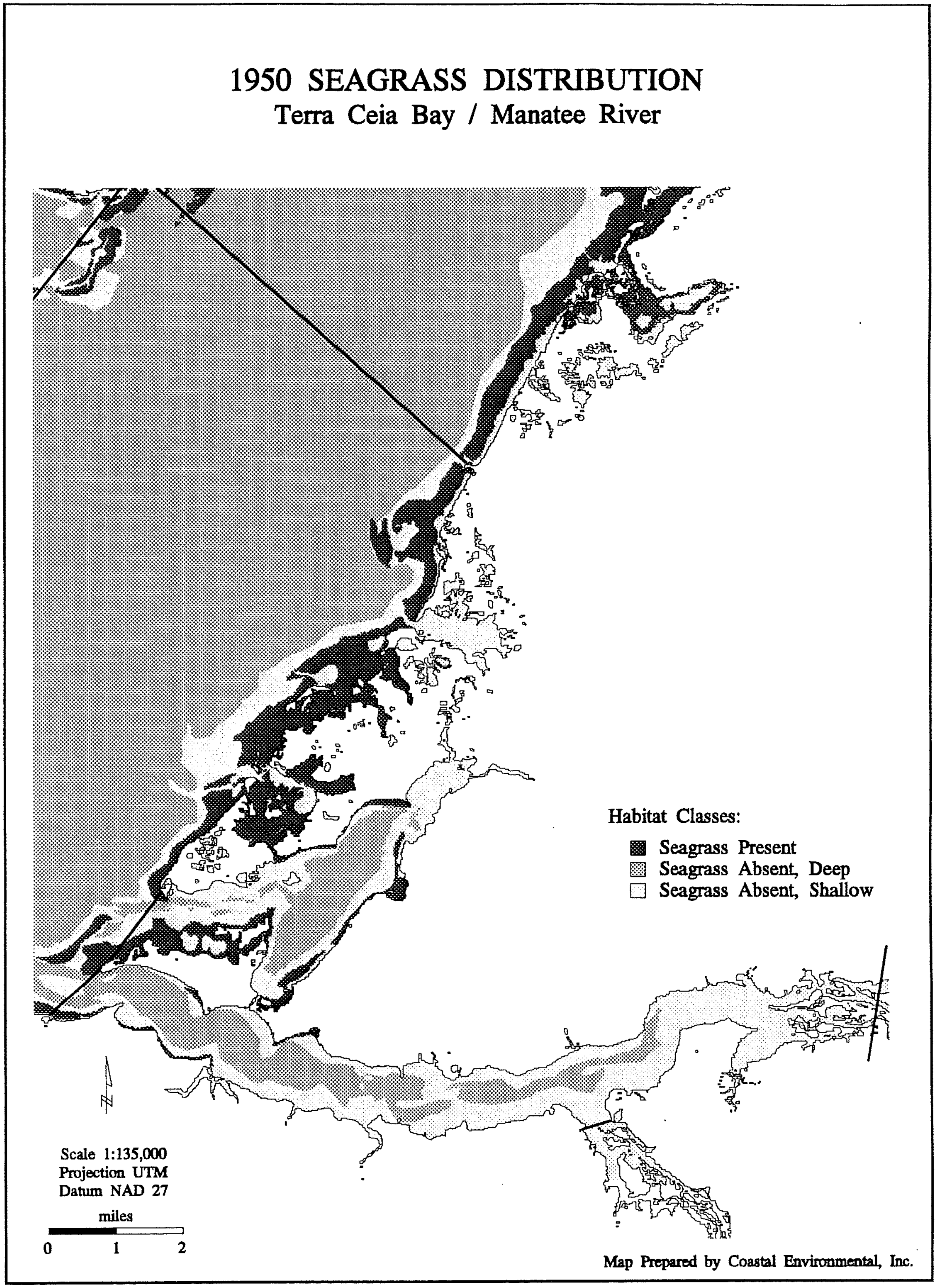

Figure 4.7 1950 Seagrass distribution in Terra Ceia Bay and the Manatee River. Data source: FDNR and USFWS cooperative study.

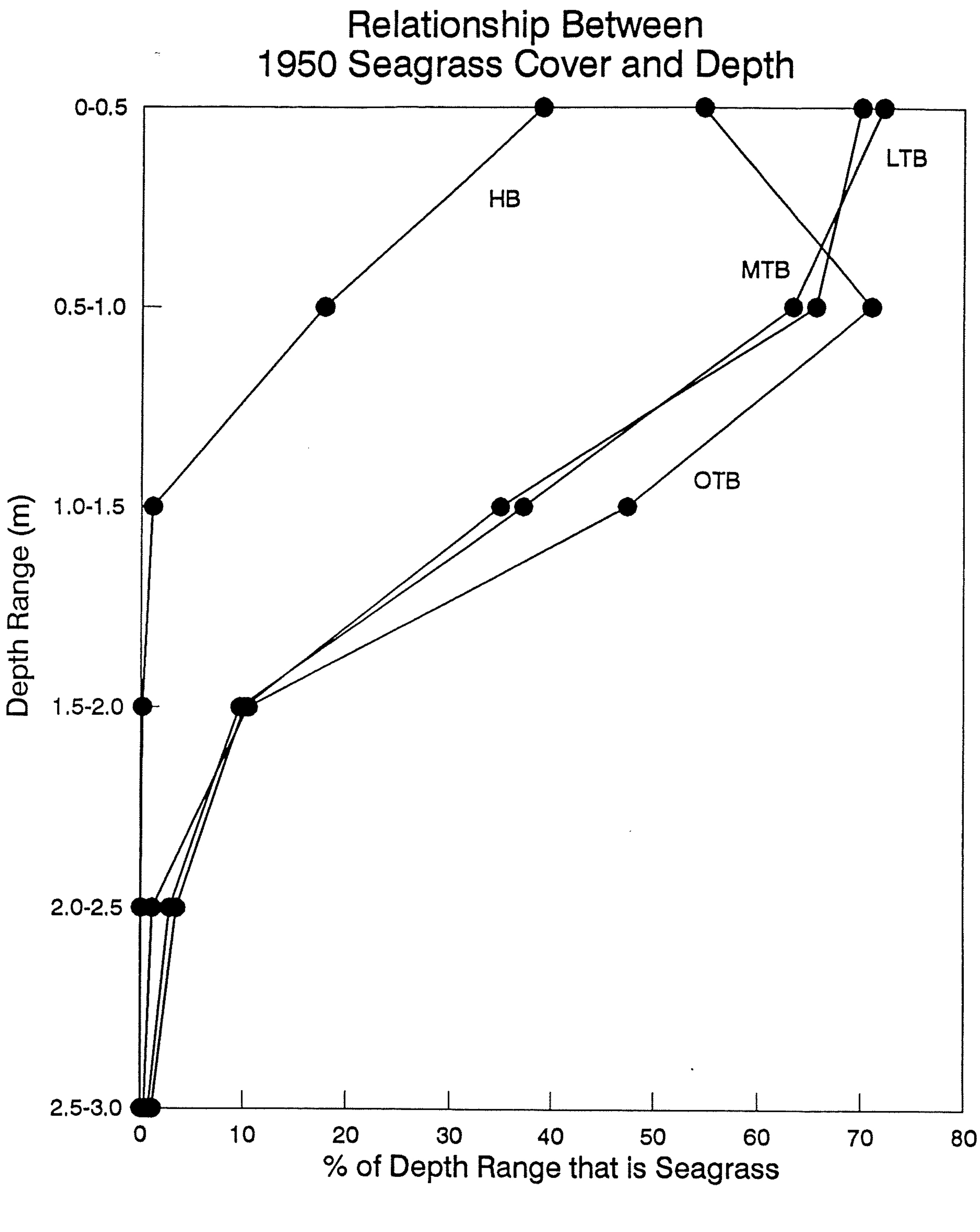

Figure 4.8 1950 Seagrass coverage of shallow areas by depth and bay segment.

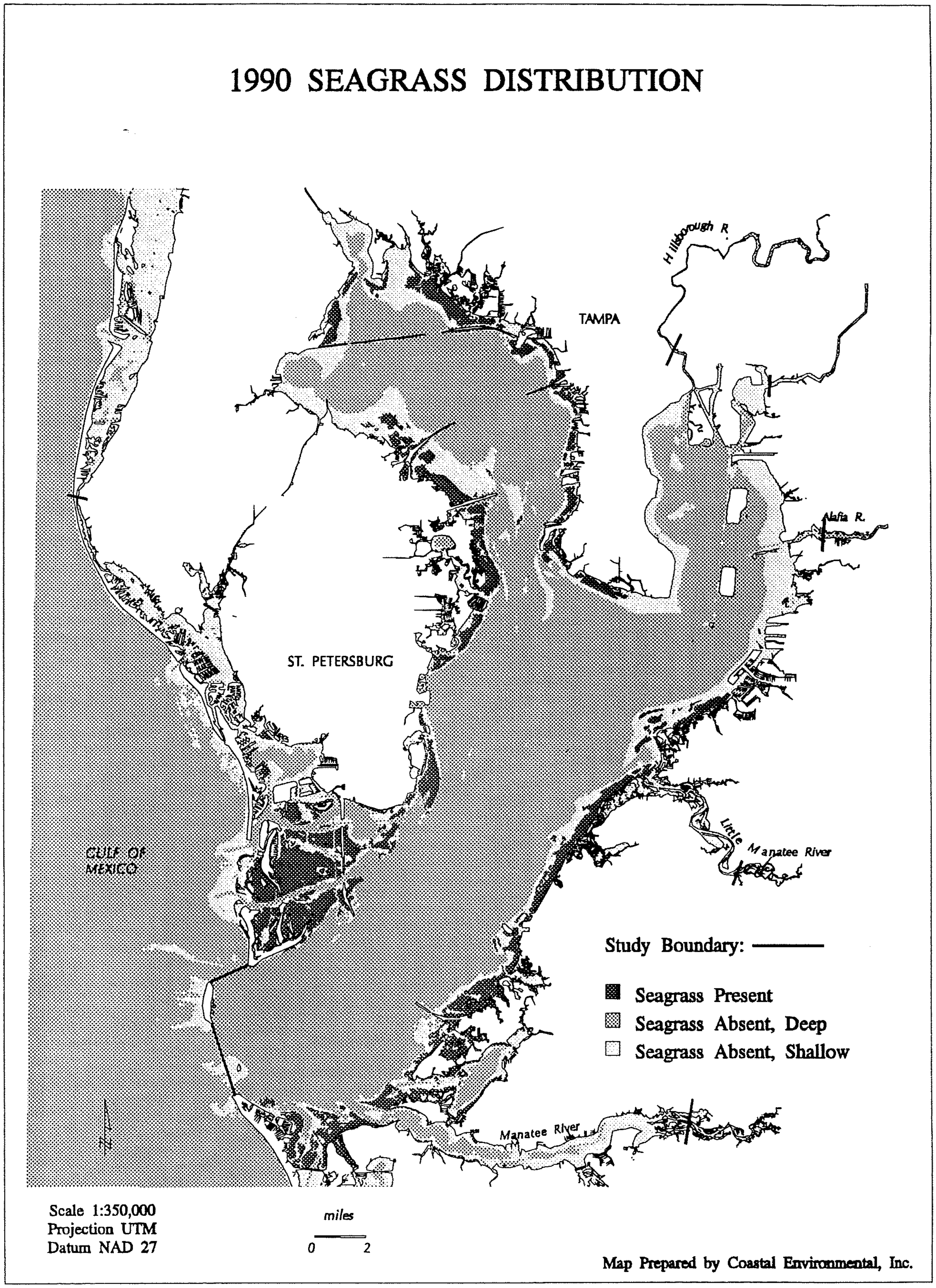

Figure 4.9 1990 Seagrass distribution in Tampa Bay. Data source: SWFWMD SWIM Program.

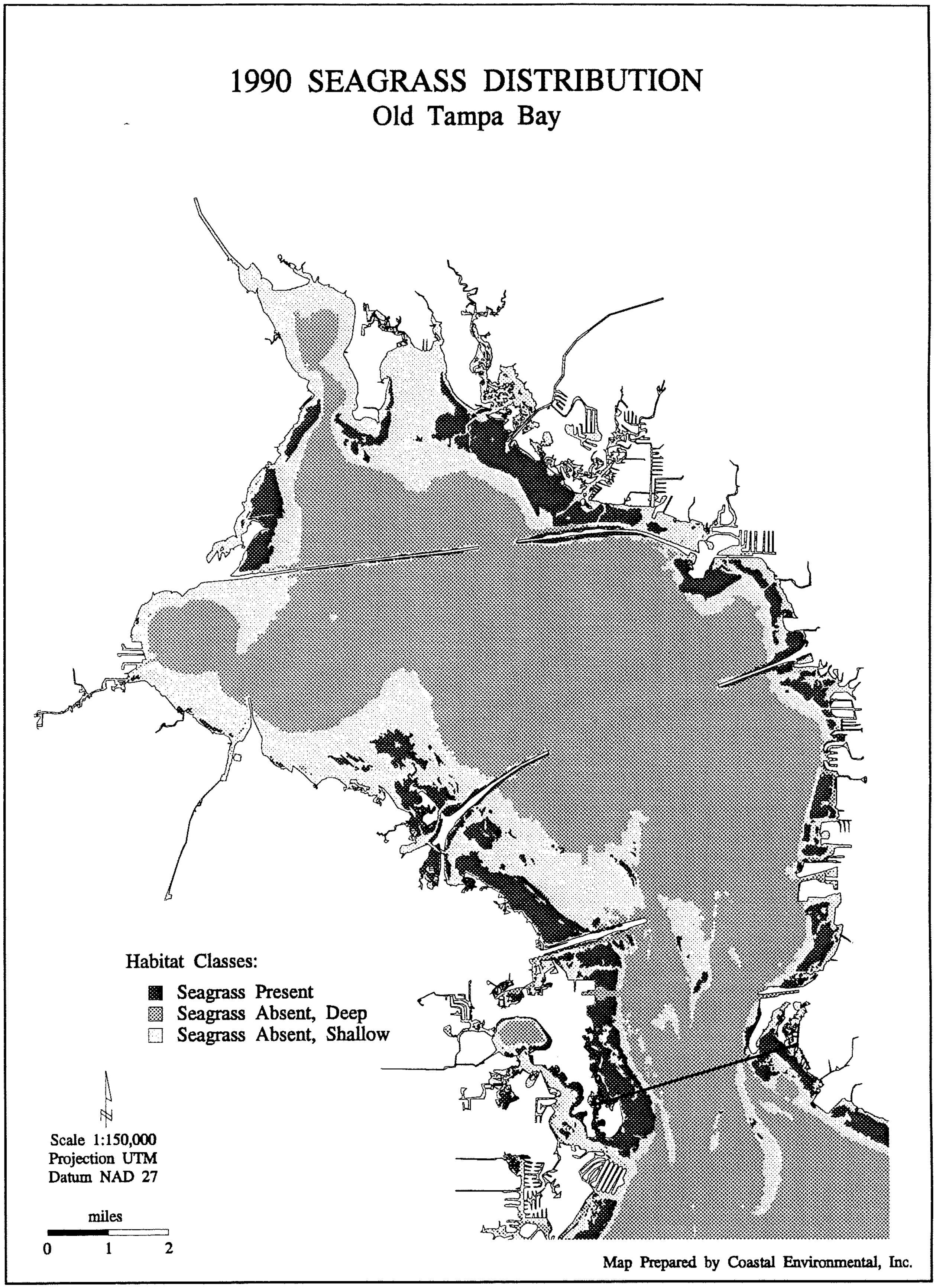

Figure 4.10 1990 Seagrass distribution in Old Tampa Bay. Data source: SWFWMD SWIM Program.

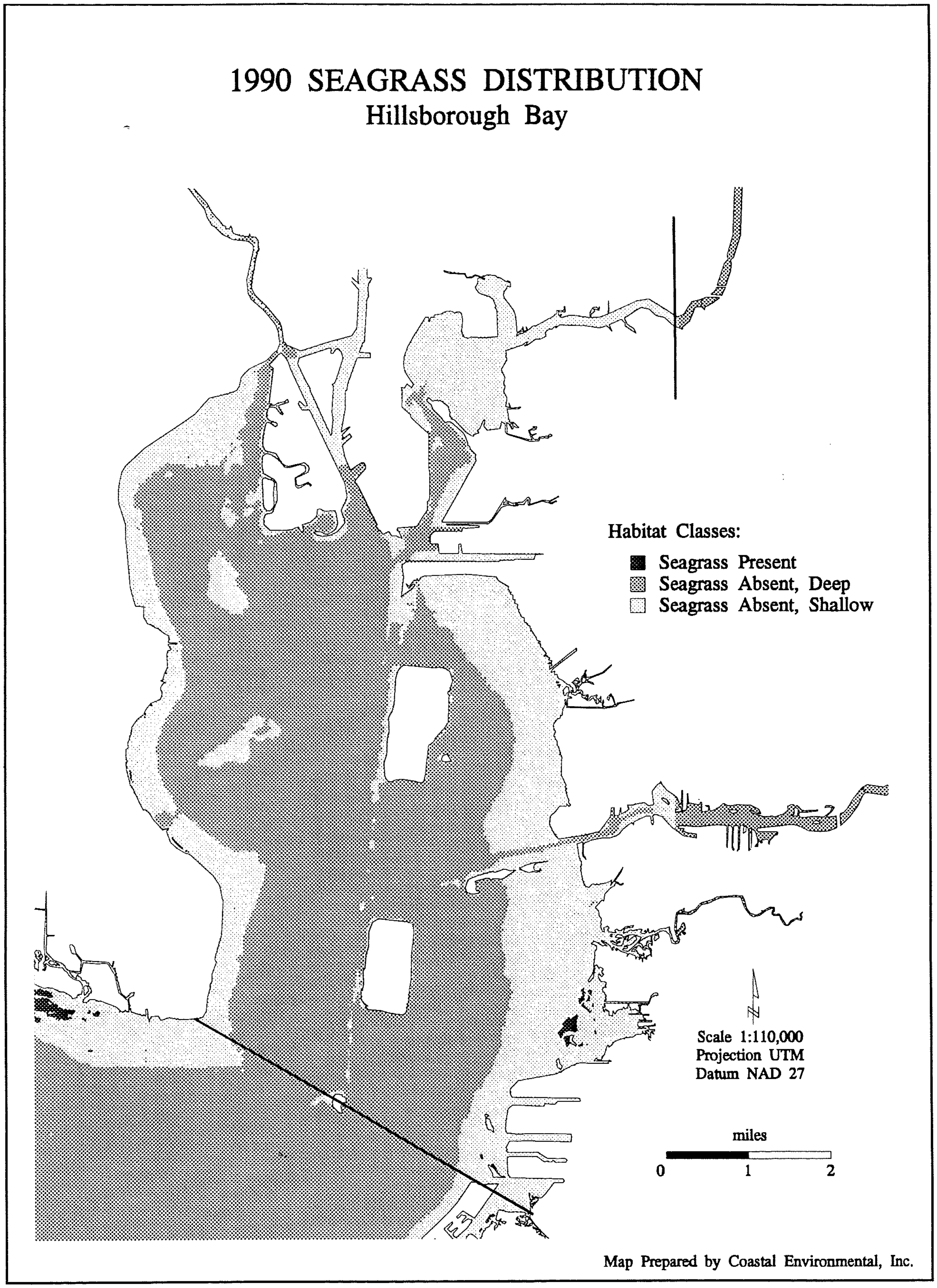

Figure 4.11 1990 Seagrass distribution in Hillsborough Bay. Data source: SWFWMD SWIM Program.

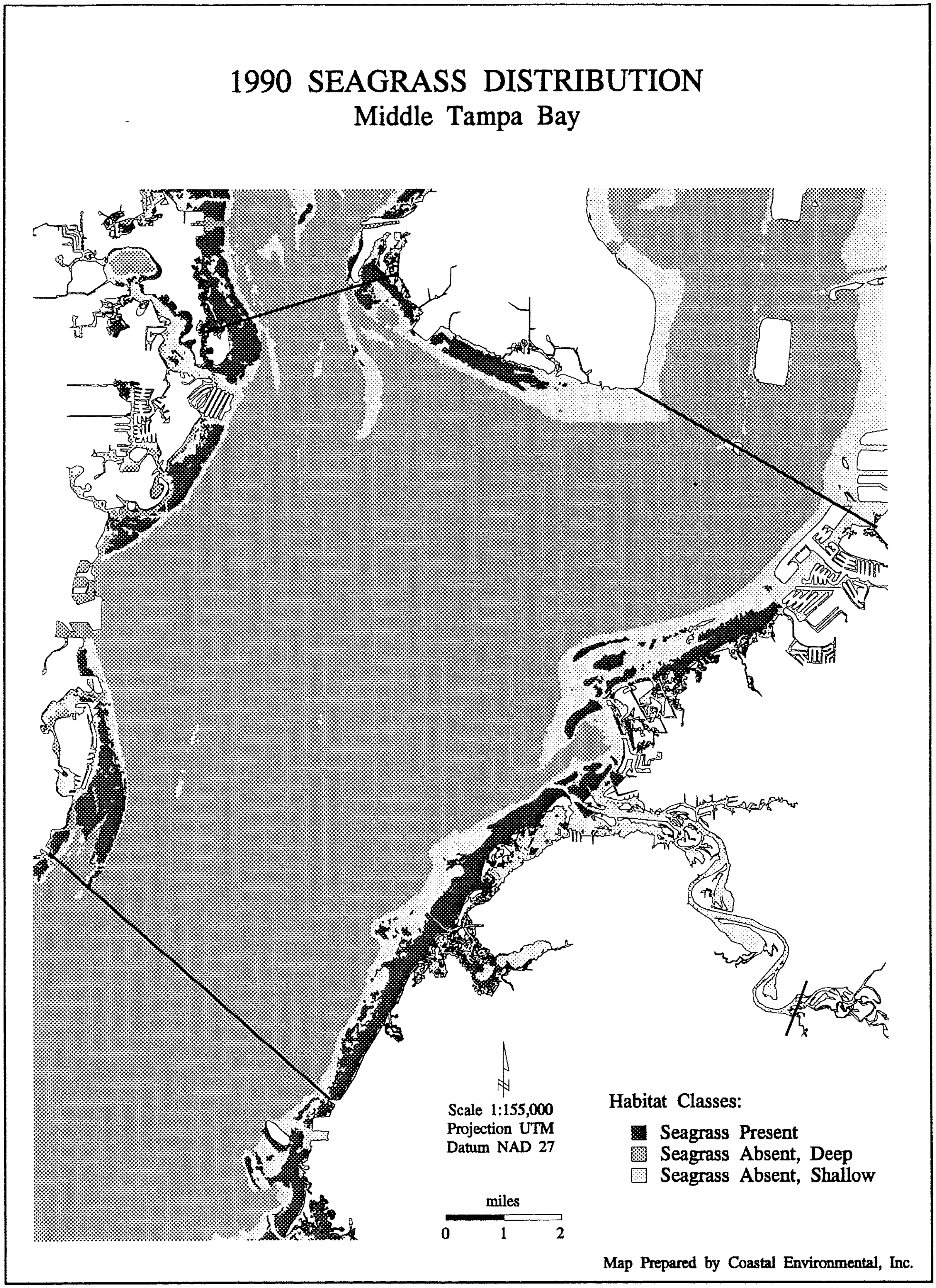

Figure 4.12 1990 Seagrass distribution in Middle Tampa Bay. Data source: SWFWMD SWIM Program.

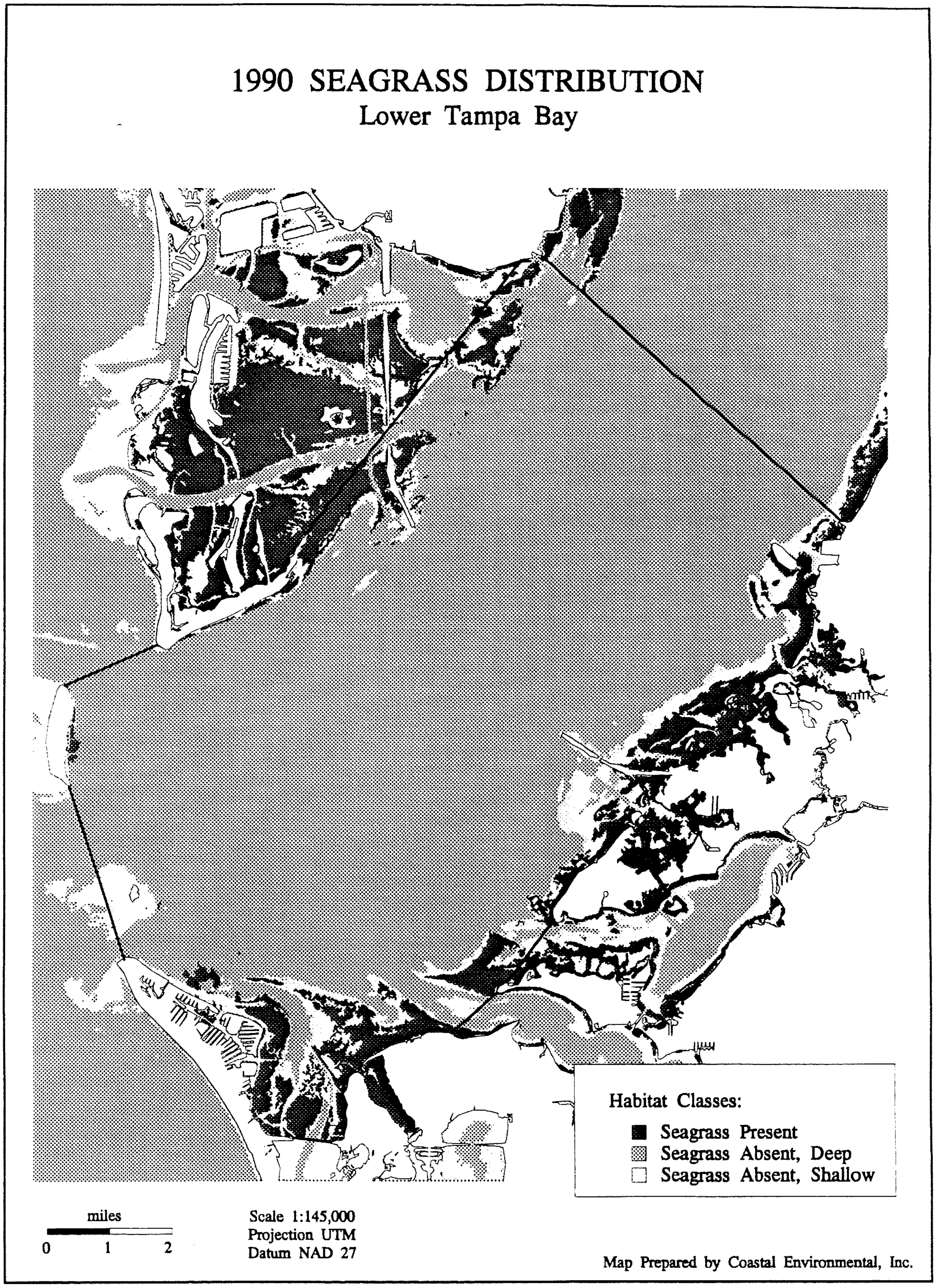

Figure 4.13 1990 Seagrass distribution in Lower Tampa Bay. Data source: SWFWMD SWIM Program.

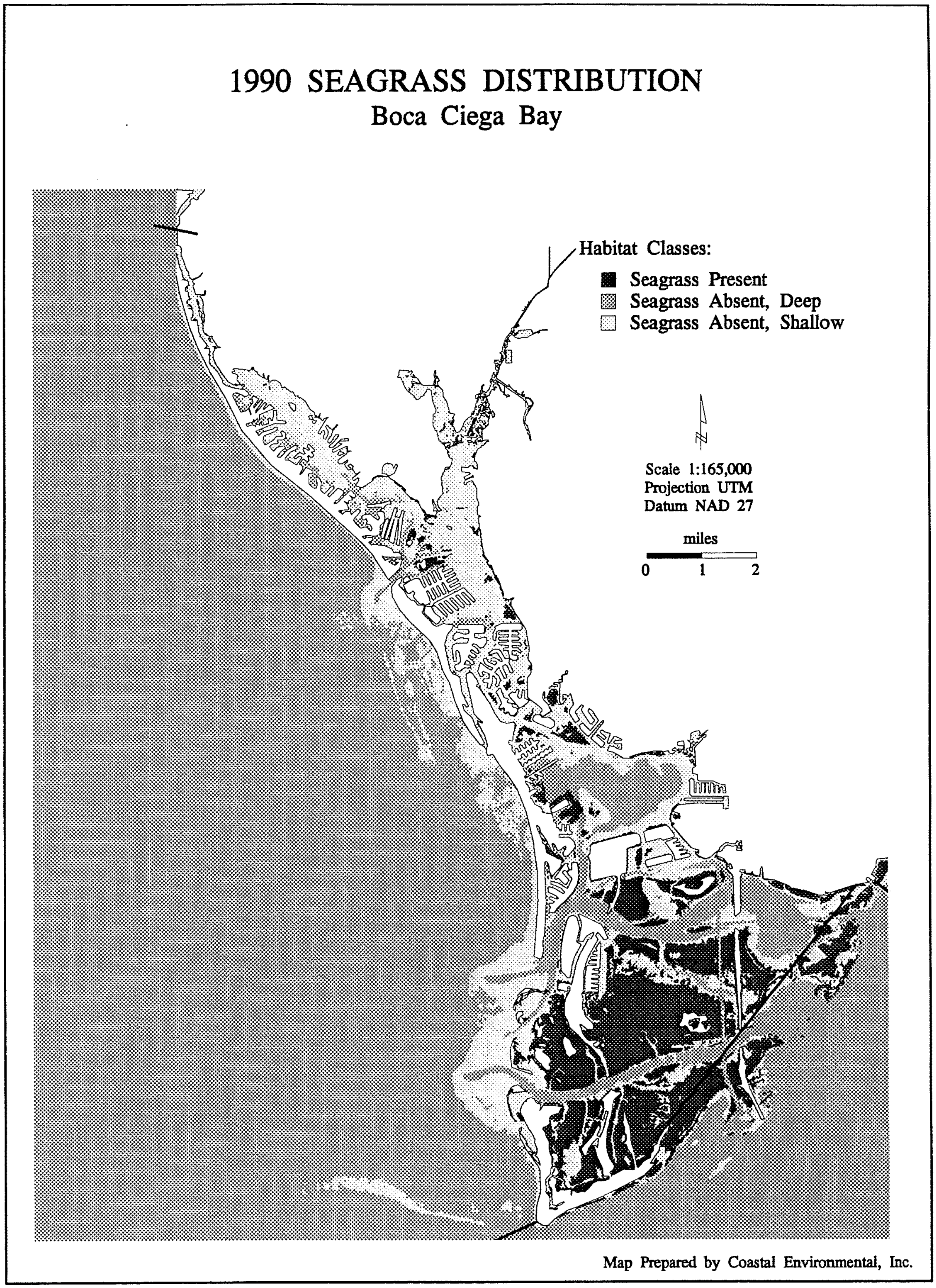

Figure 4.14 1990 Seagrass distribution in Boca Ciega Bay. Data source: SWFWMD SWIM Program.

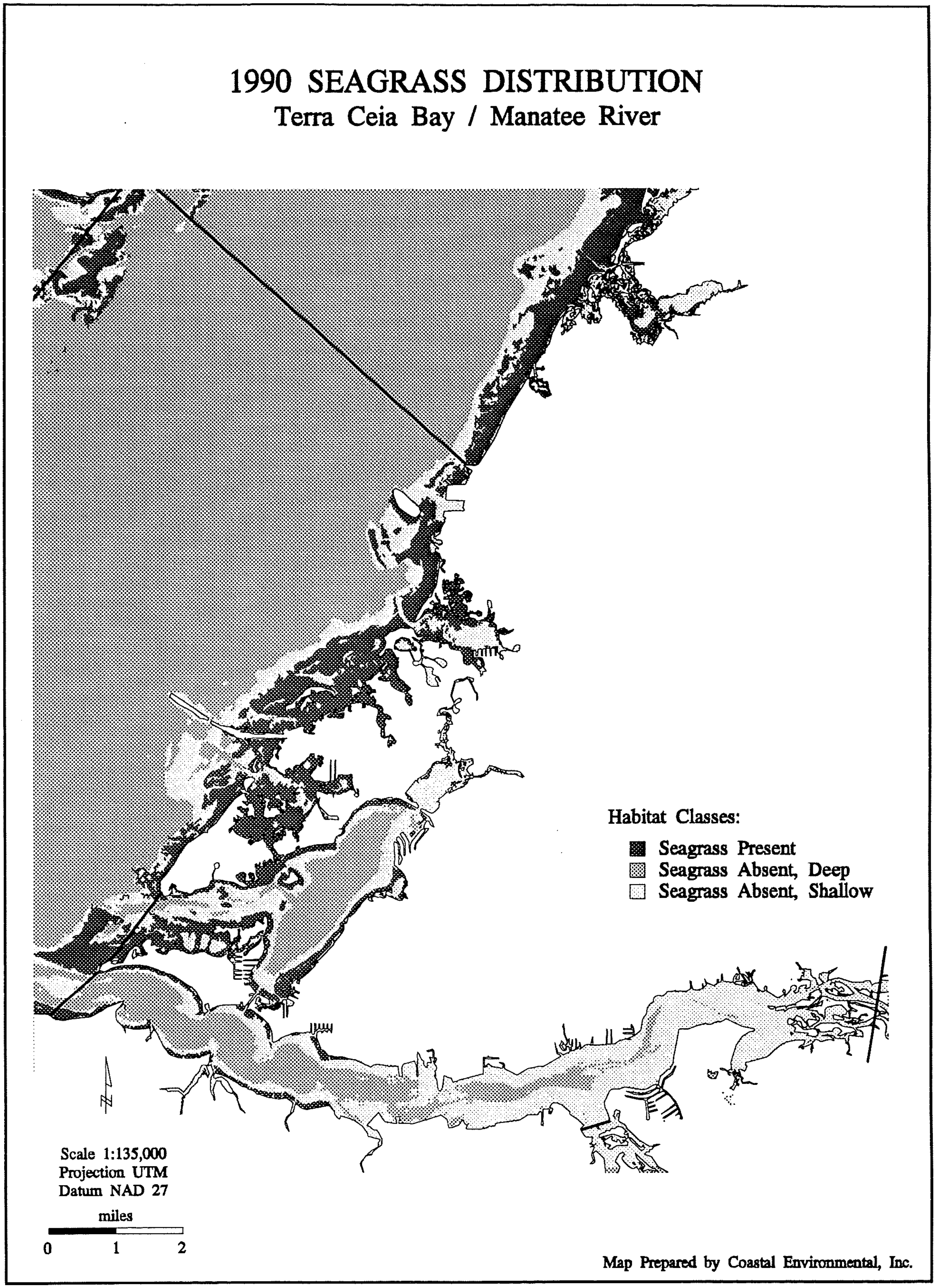

Figure 4.15 1990 Seagrass distribution in Terra Ceia Bay and the Manatee River. Data source: SWFWMD SWIM Program.

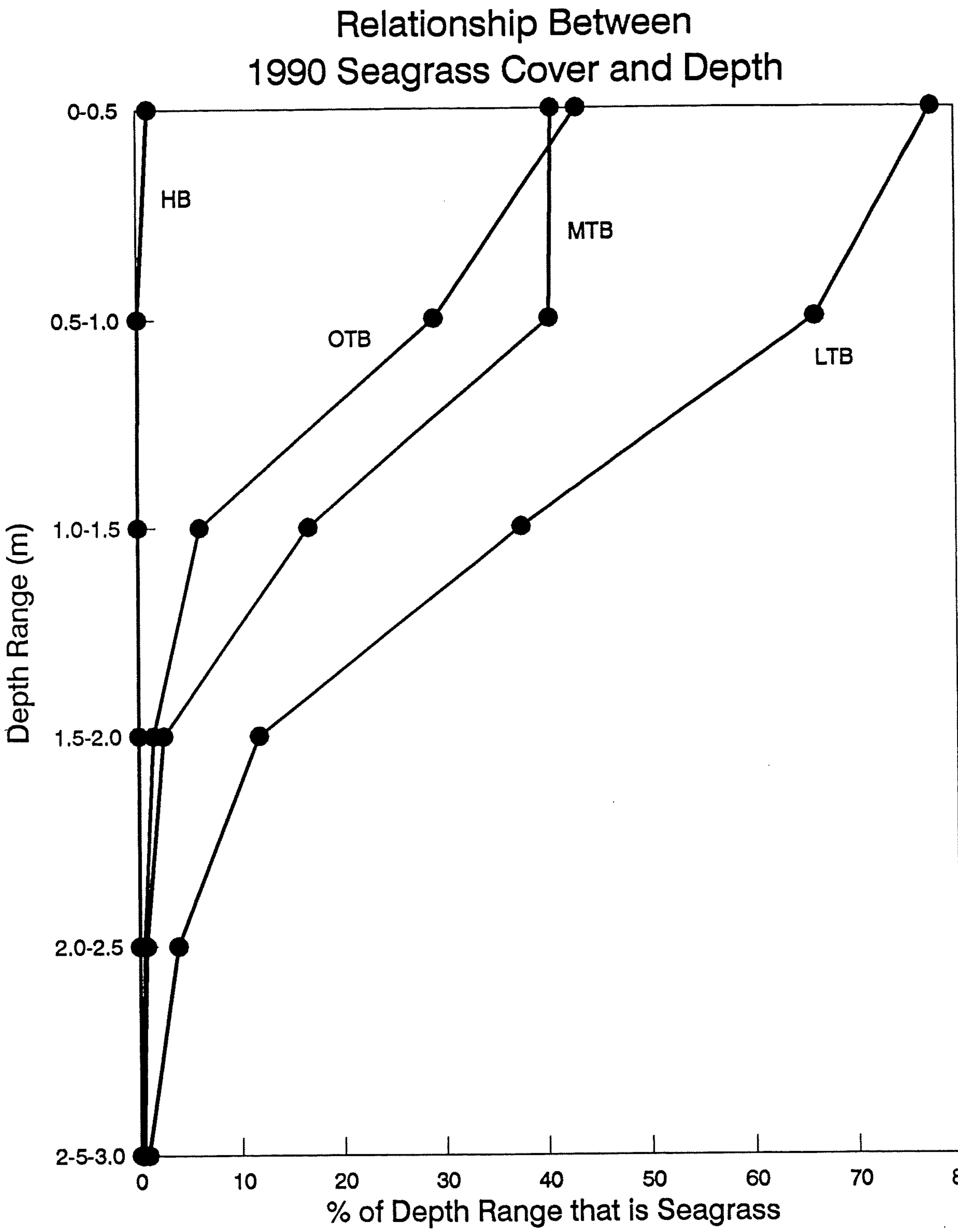

Figure 4.16 1990 Seagrass coverage of shallow areas by depth and bay segment.

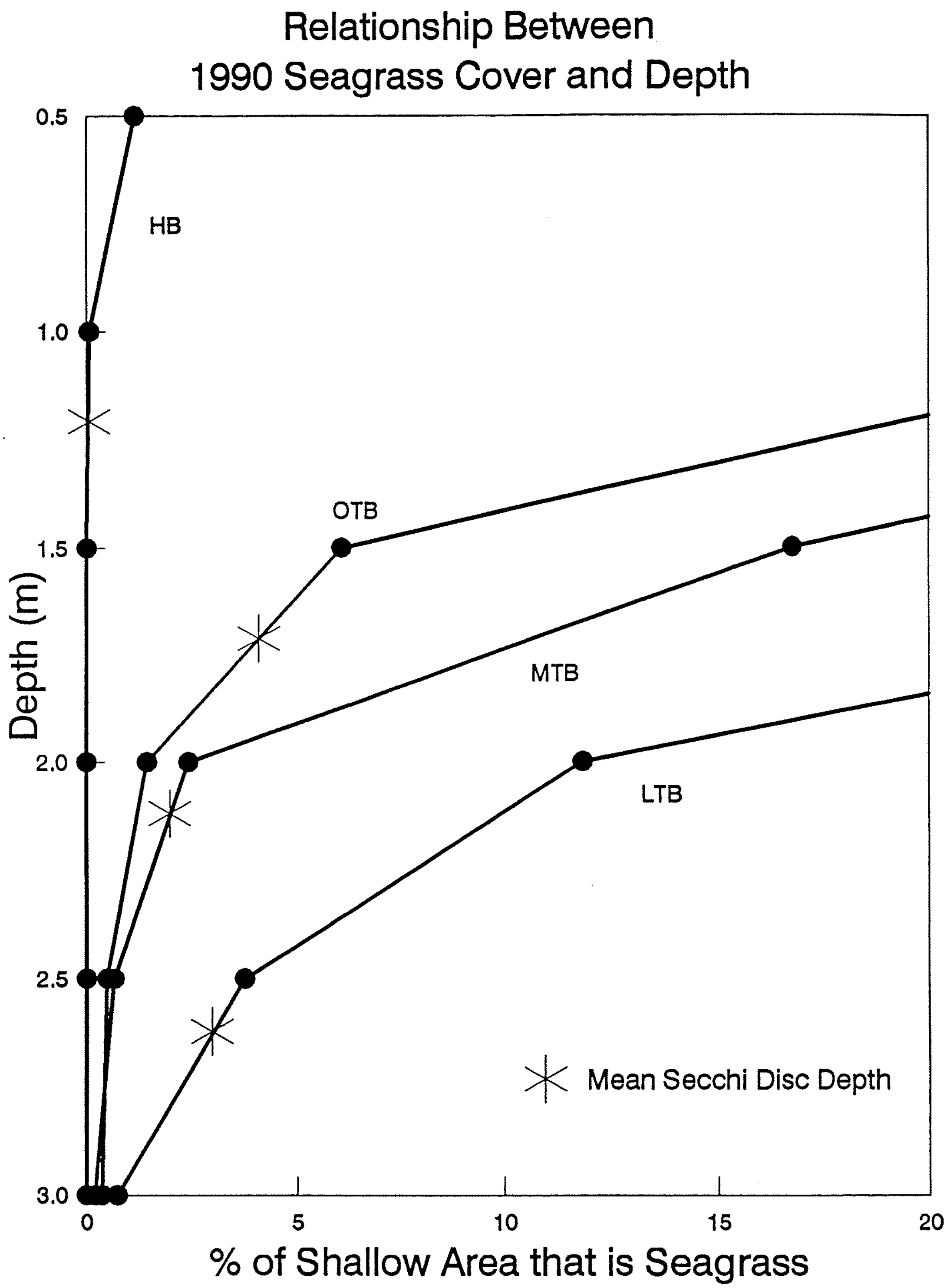

Figure 4.17 1990 seagrass coverage of shallow areas by depth and bay segment plotted with EPC of Hillsborough County light penetration data.

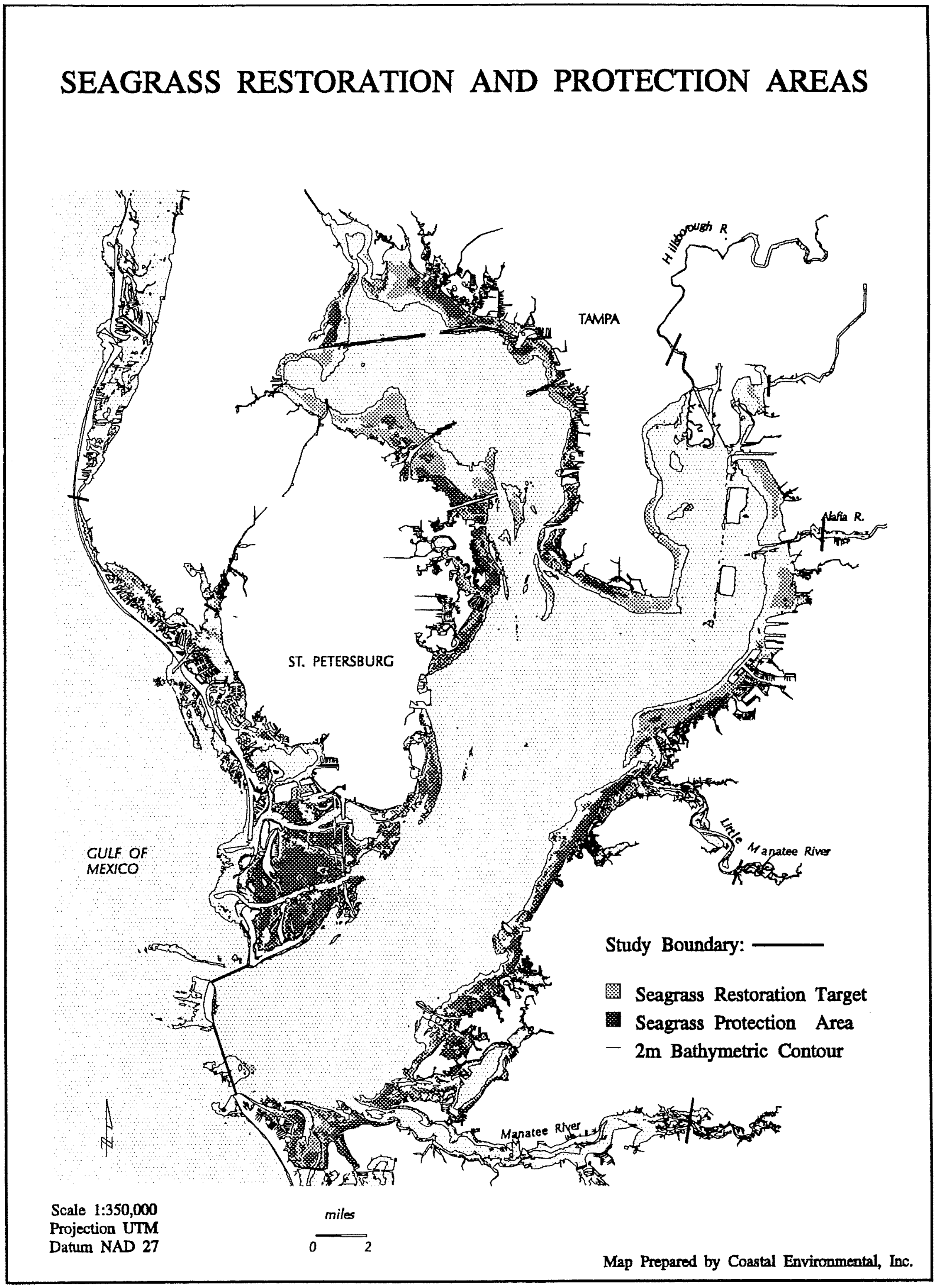

Figure 4.18 Seagrass restoration and protection targets in Tampa Bay.

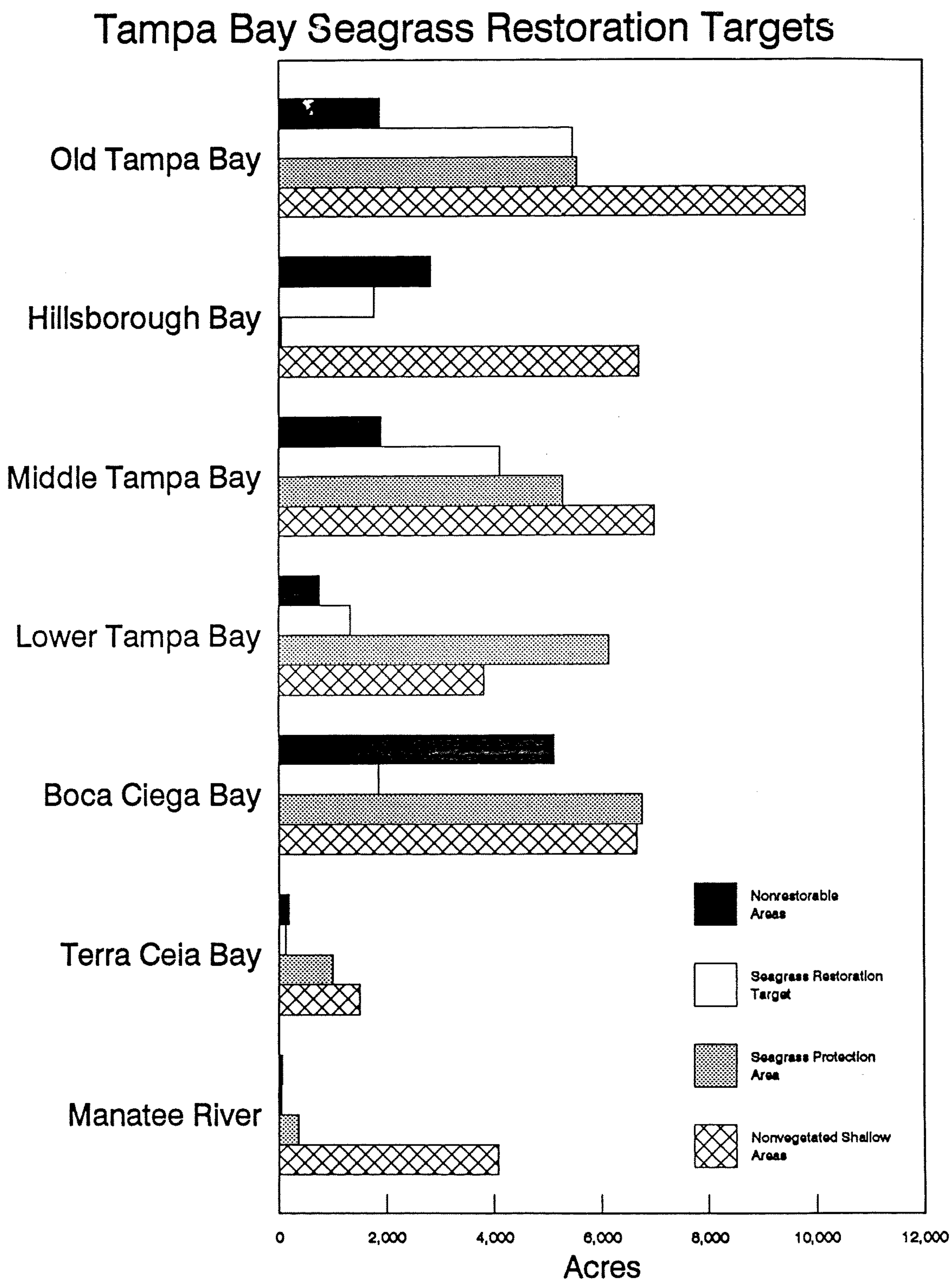

Figure 4.19 Seagrass restoration and protection targets in Tampa Bay.

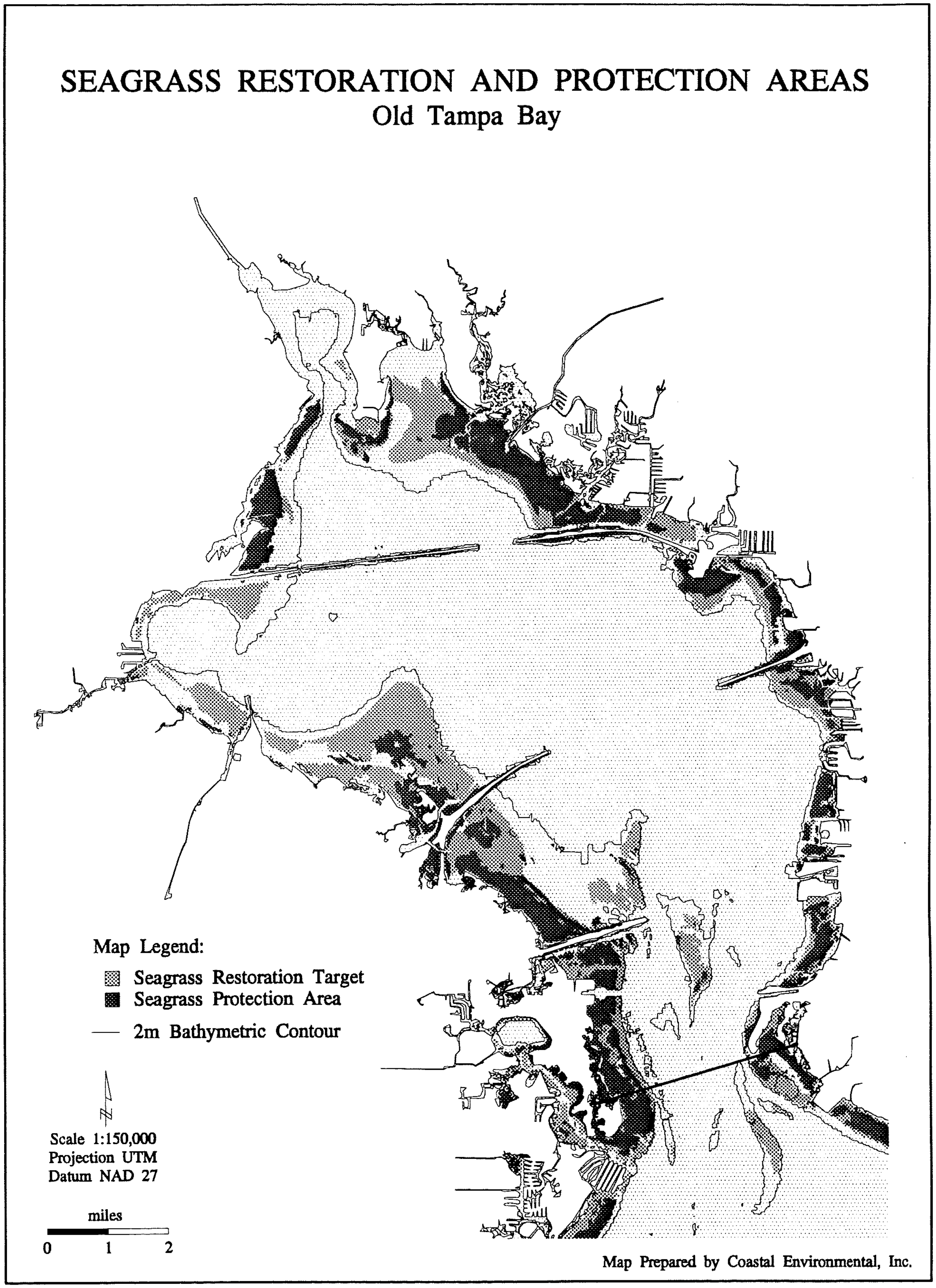

Figure 4.20 Seagrass restoration and protection targets in Old Tampa Bay.

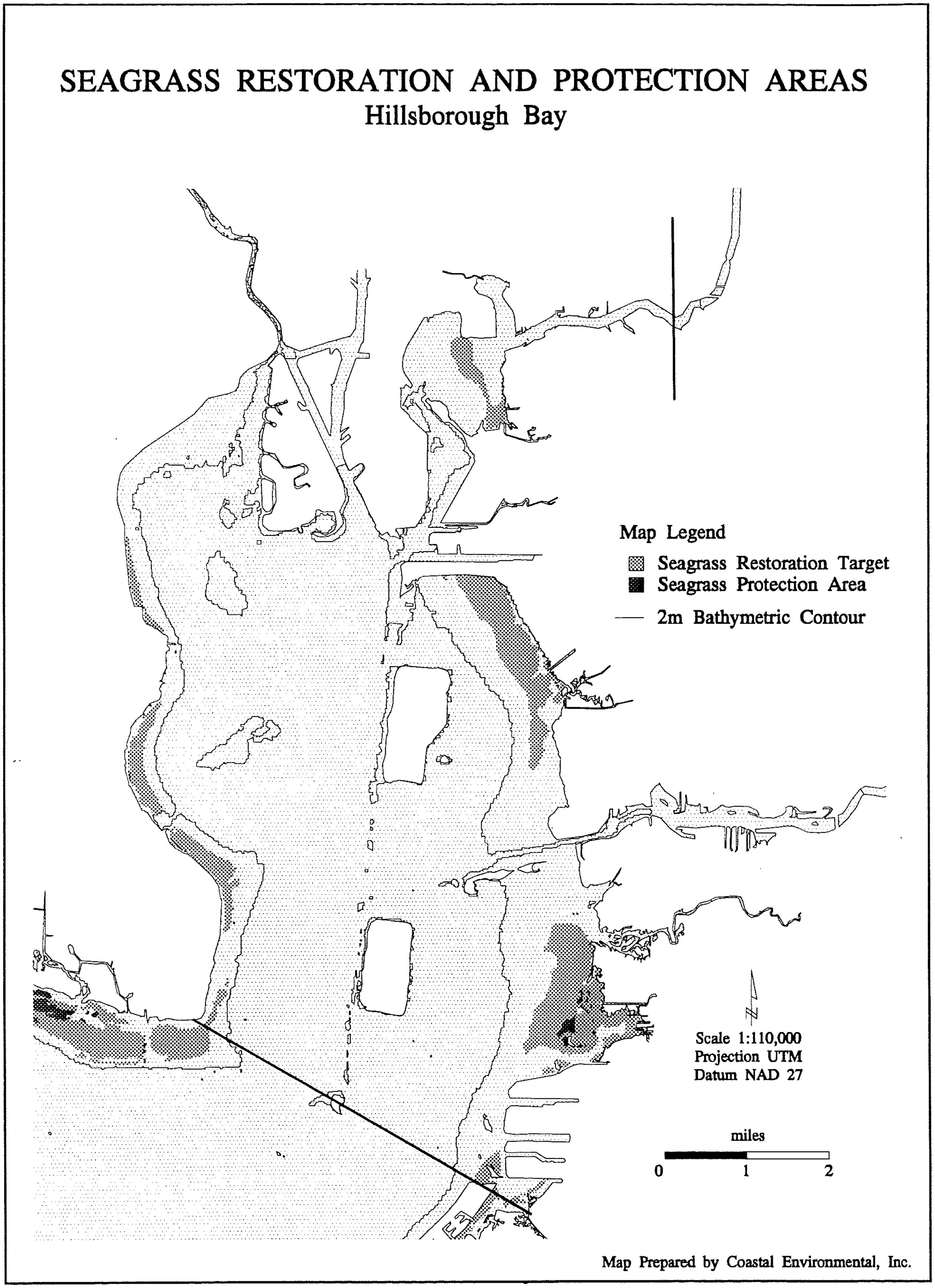

Figure 4.21 Seagrass restoration and protection targets in Hillsborough Bay.

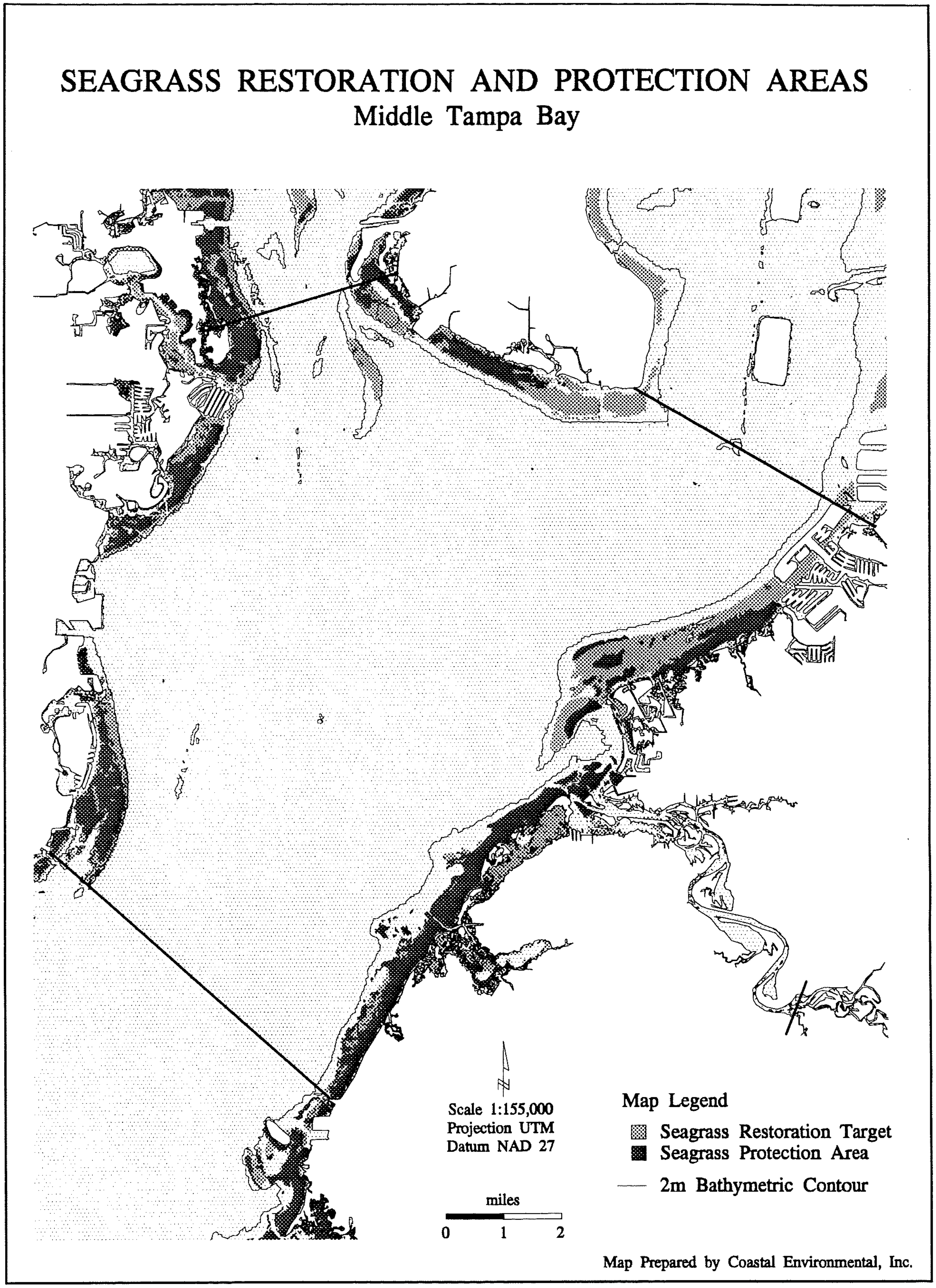

Figure 4.22 Seagrass restoration and protection targets in Middle Tampa Bay.

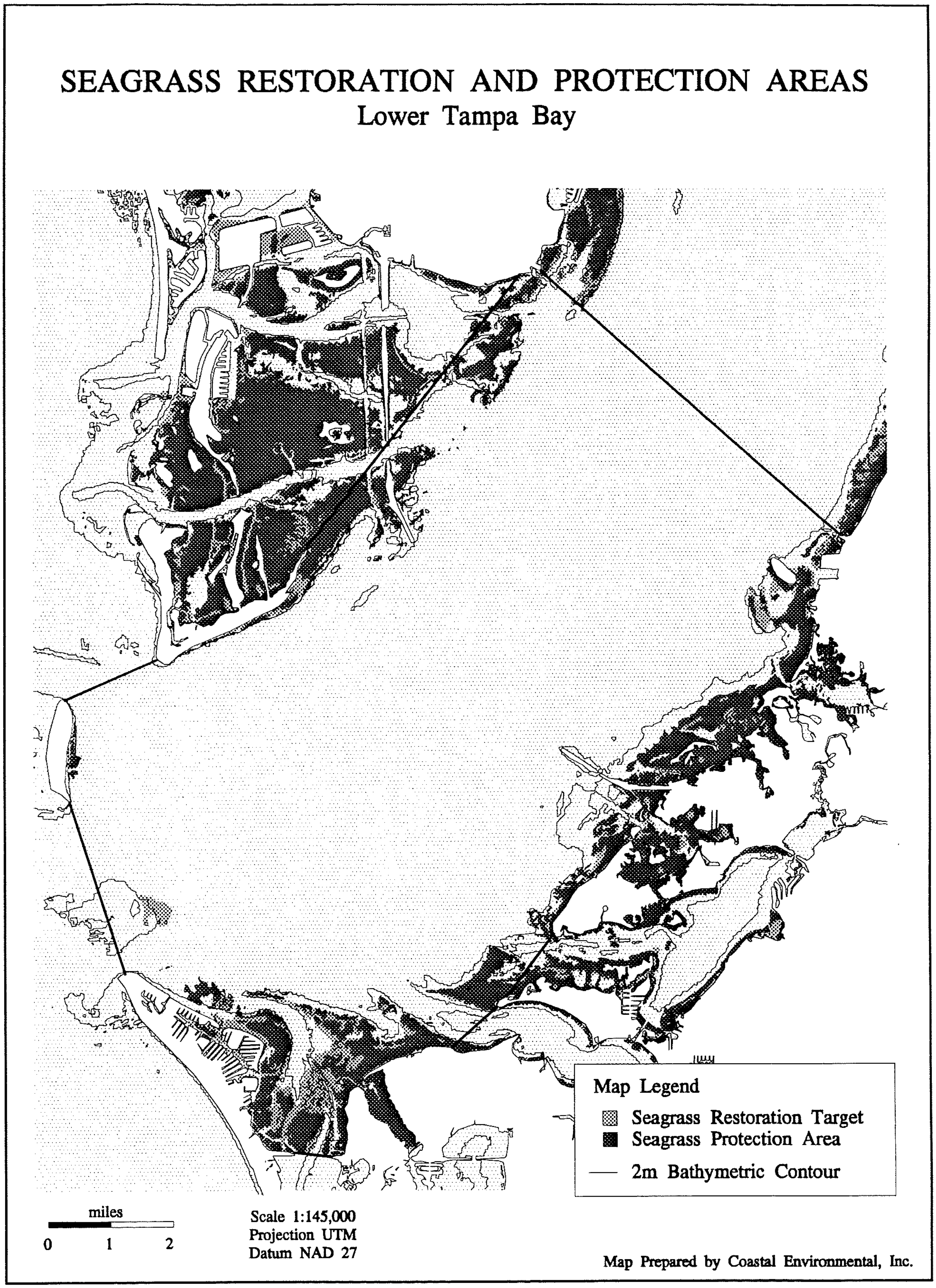

Figure 4.23 Seagrass restoration and protection targets in Lower Tampa Bay.

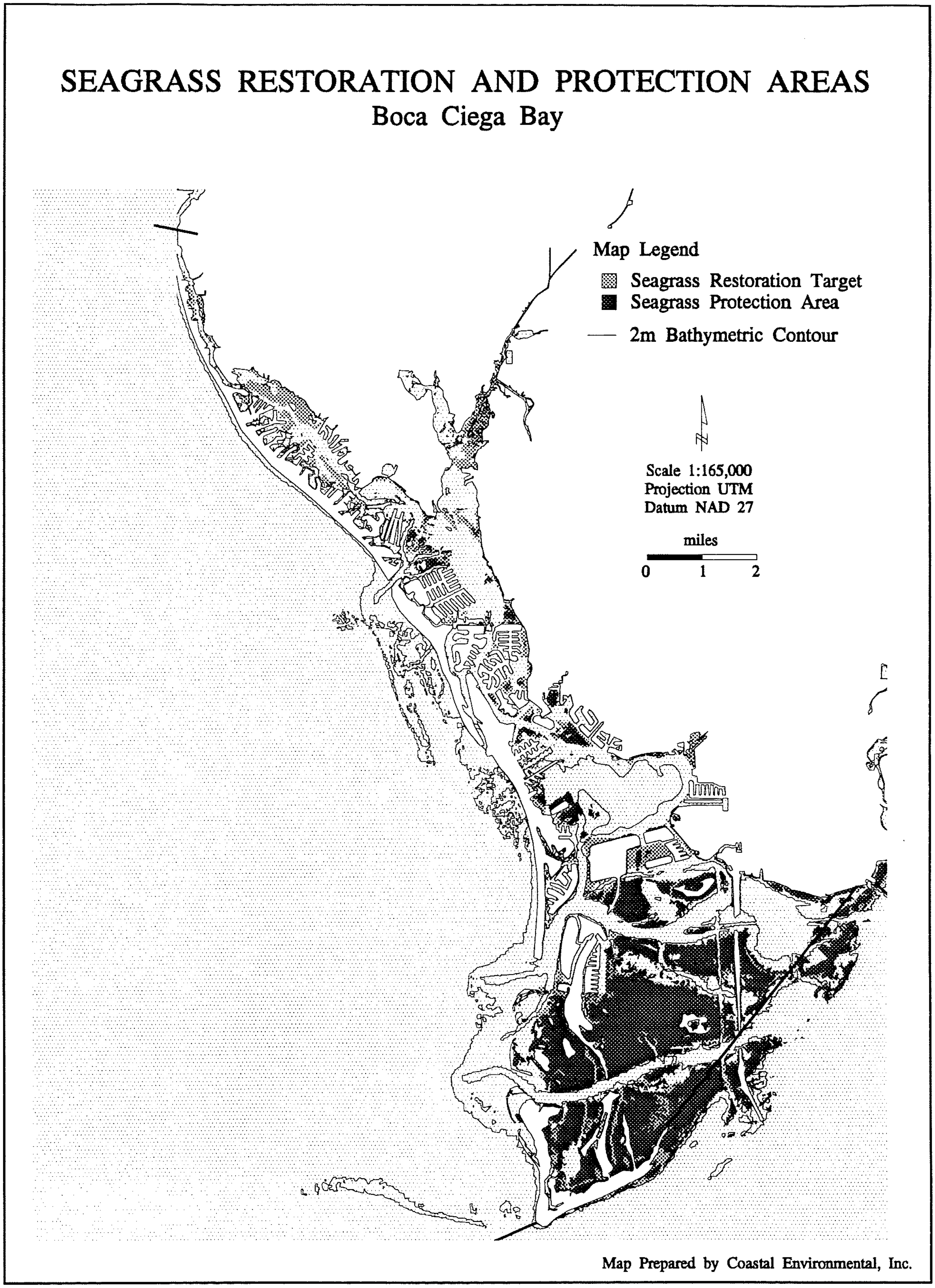

Figure 4.24 Seagrass restoration and protection targets in Boca Ciega Bay.

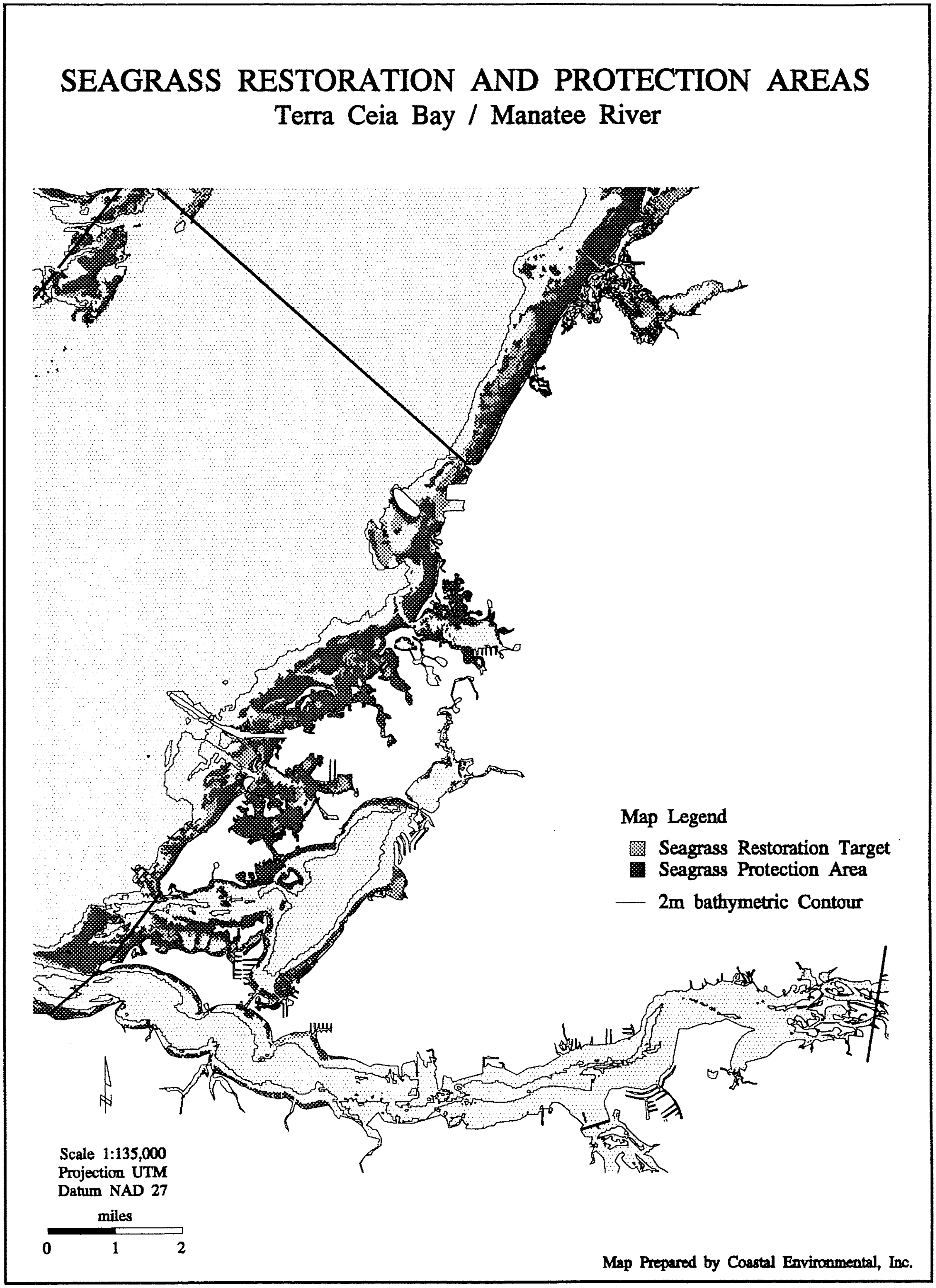

Figure 4.25 Seagrass restoration and protection targets in Terra Ceia Bay and the Manatee River.

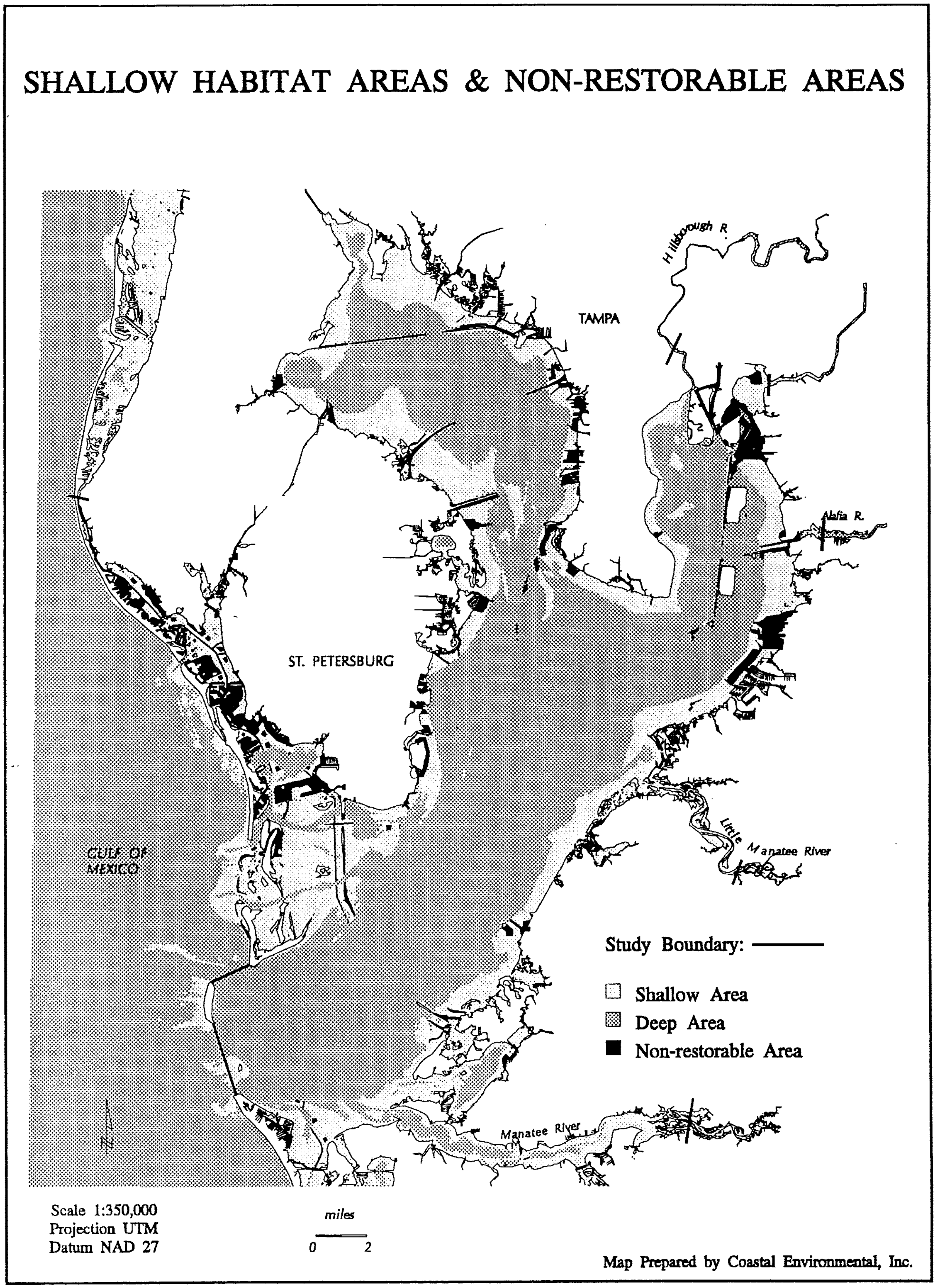

Figure 4.26 Areas less than 2 meters deep at mean low water and non-restorable areas in Tampa Bay.

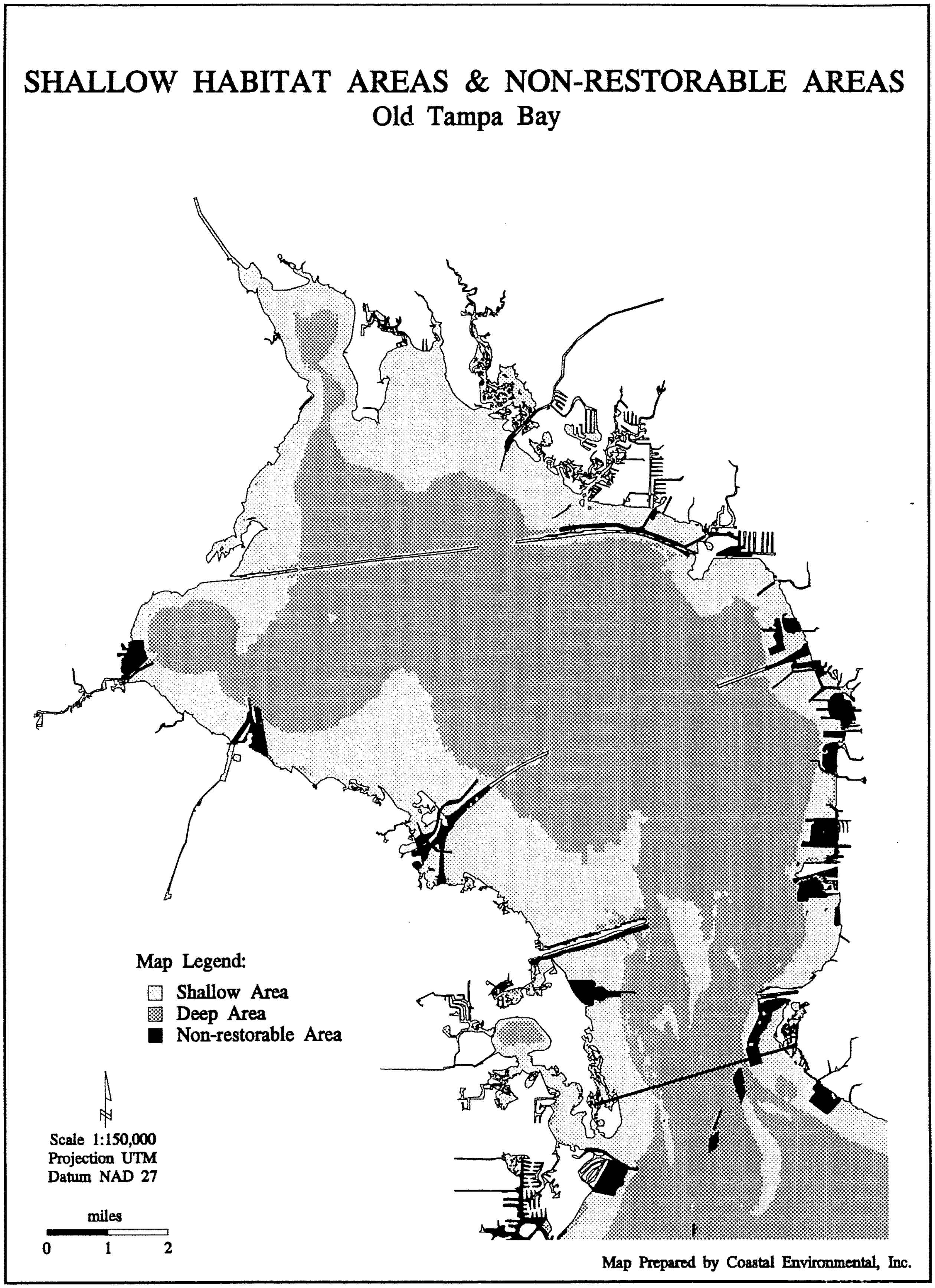

Figure 4.27 Areas less than 2 meters deep at mean low water and non-restorable areas in Old Tampa Bay.

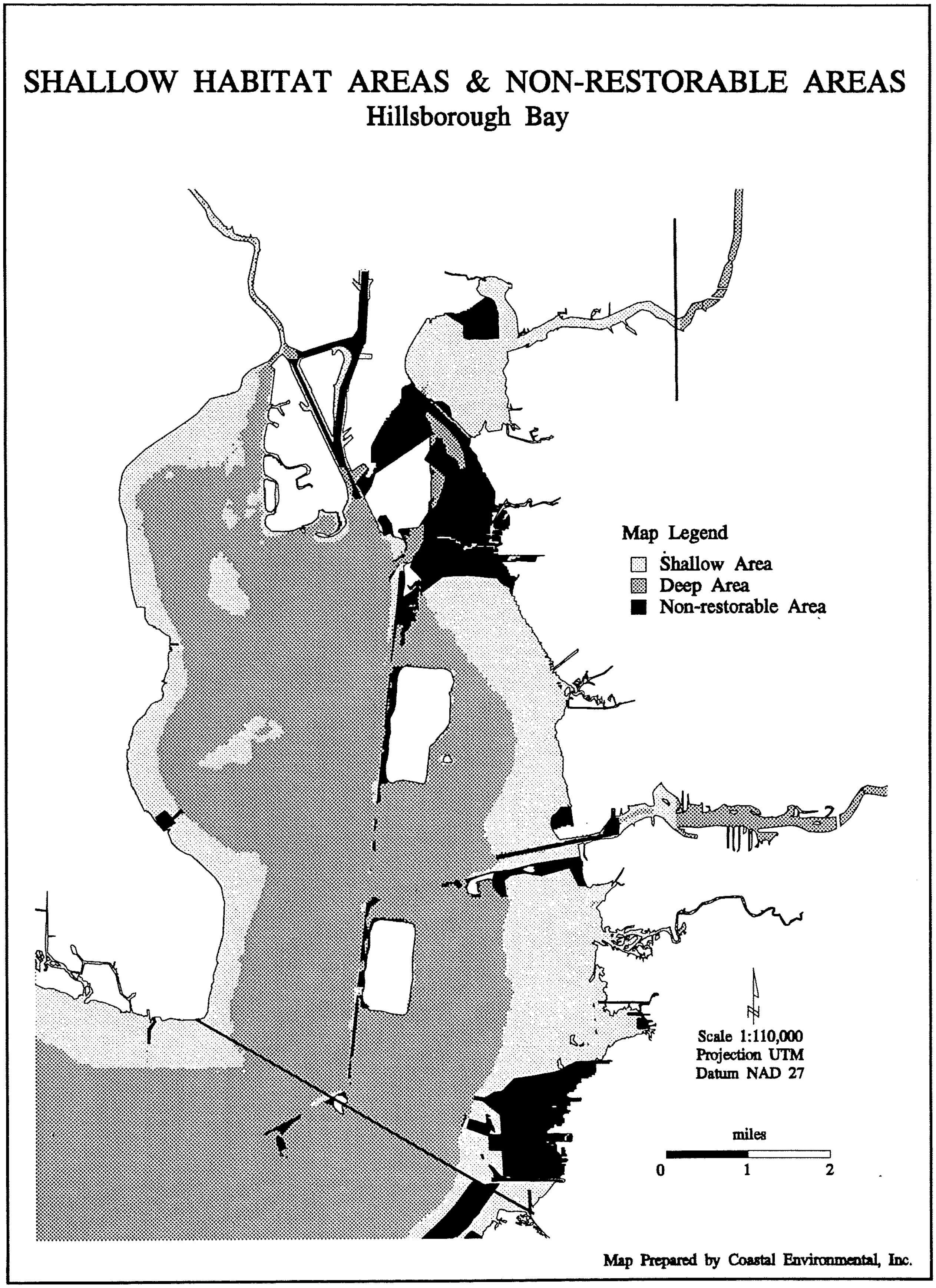

Figure 4.28 Areas less than 2 meters deep at mean low water and non-restorable areas in Hillsborough Bay.

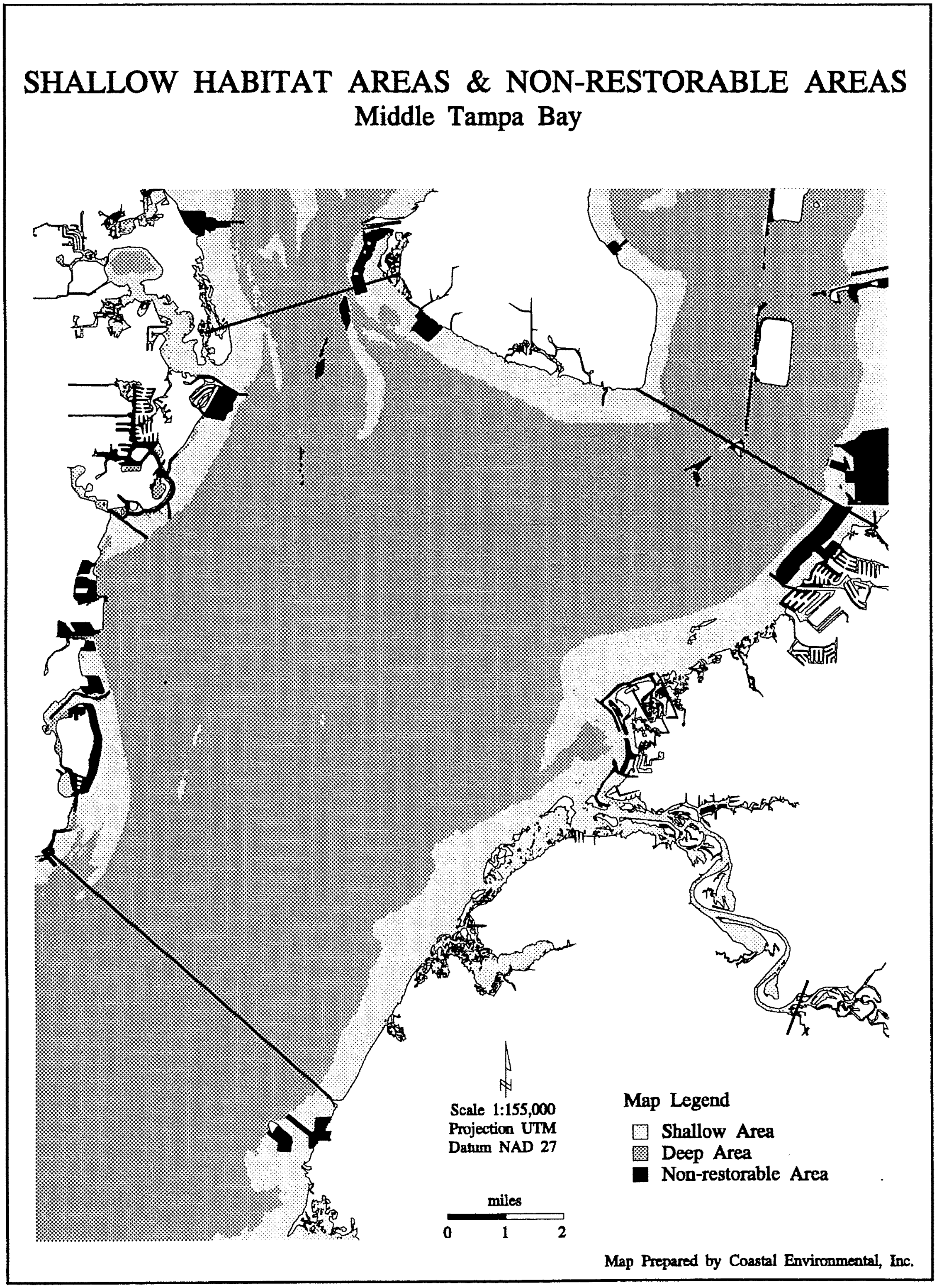

Figure 4.29 Areas less than 2 meters deep at mean low water and non-restorable areas in Middle Tampa Bay.

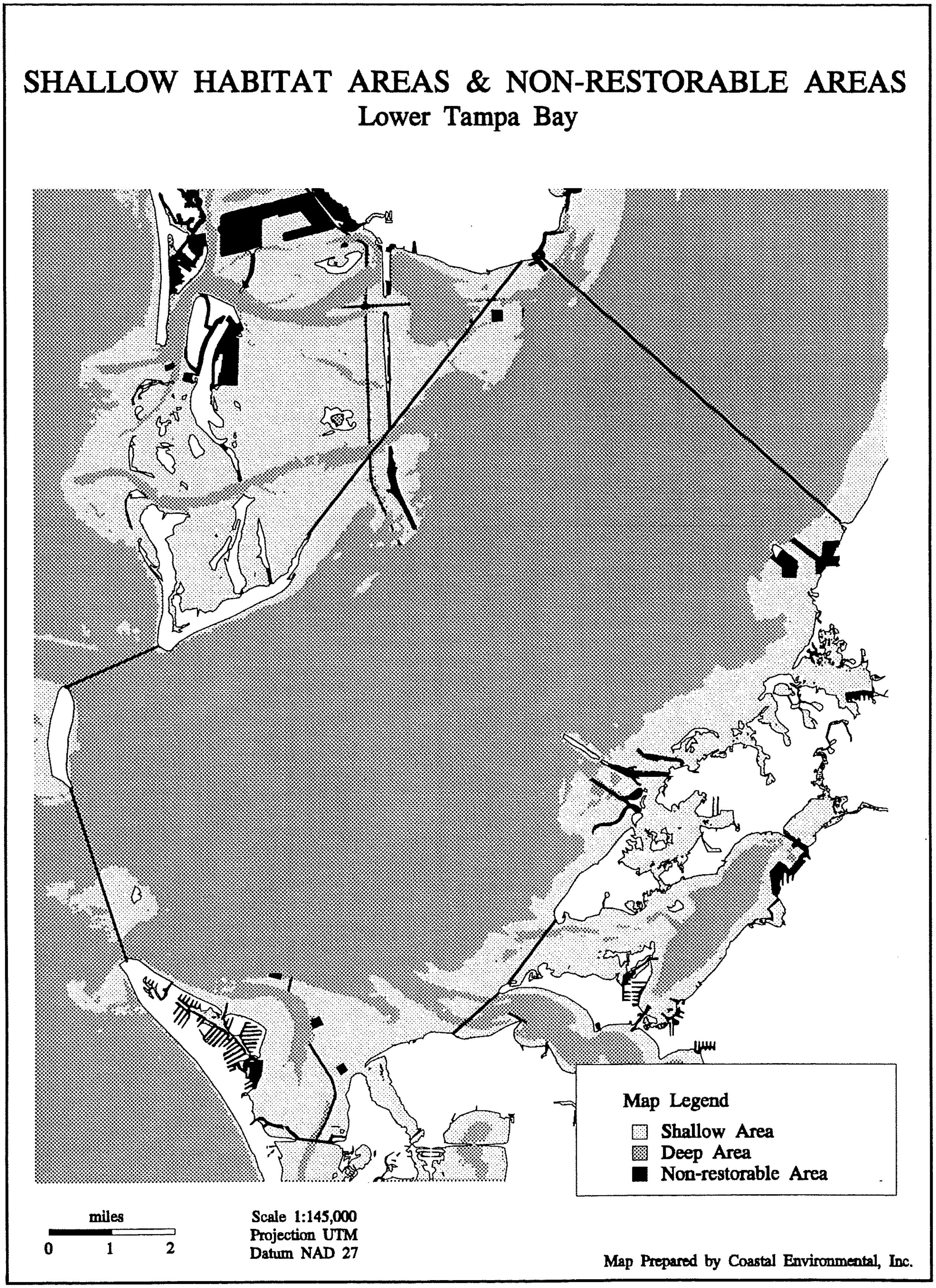

Figure 4.30 Areas less than 2 meters deep at mean low water and non-restorable areas in Lower Tampa Bay.

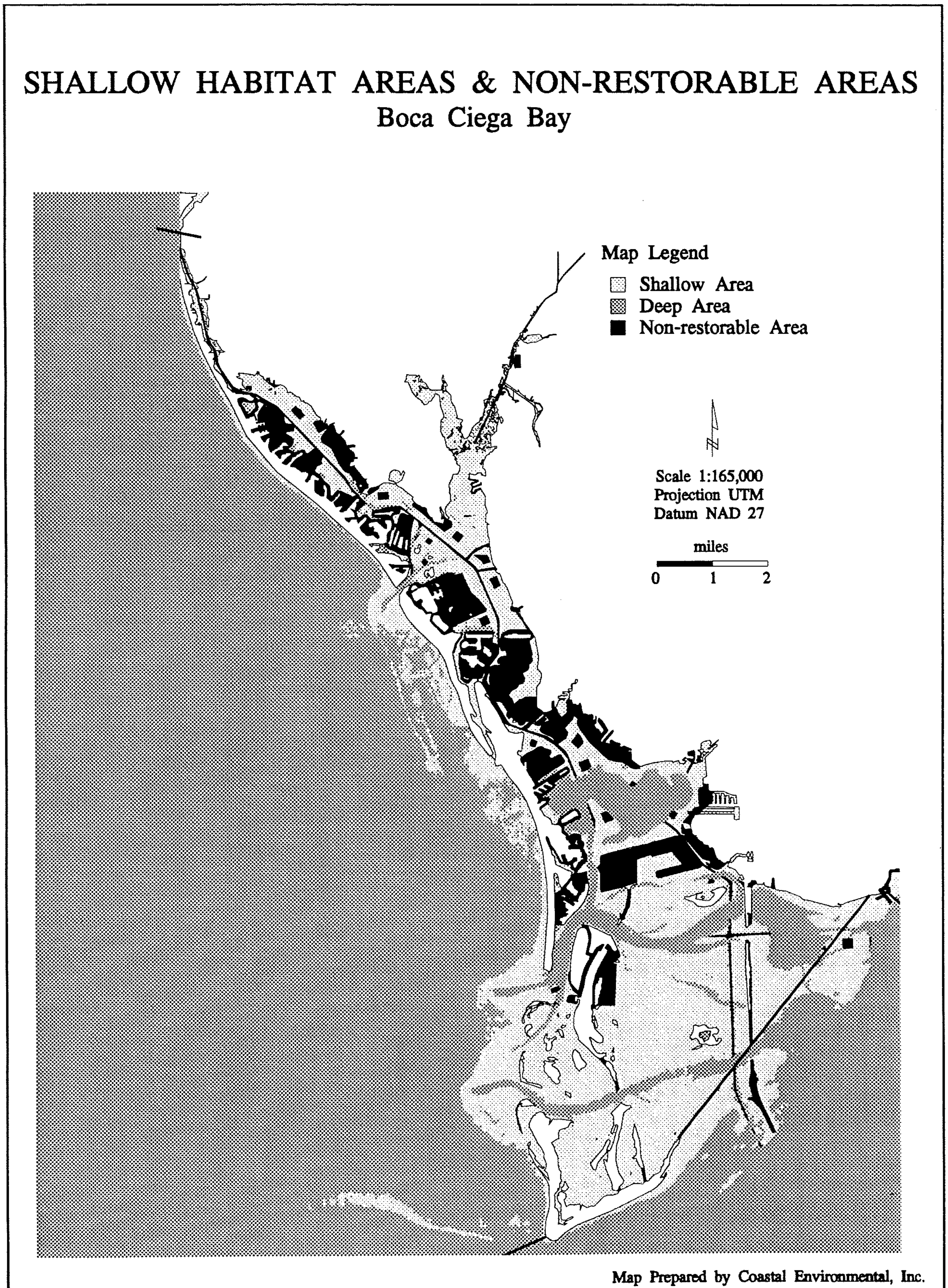

Figure 4.31 Areas less than 2 meters deep at mean low water and non-restorable areas in Boca Ciega Bay.

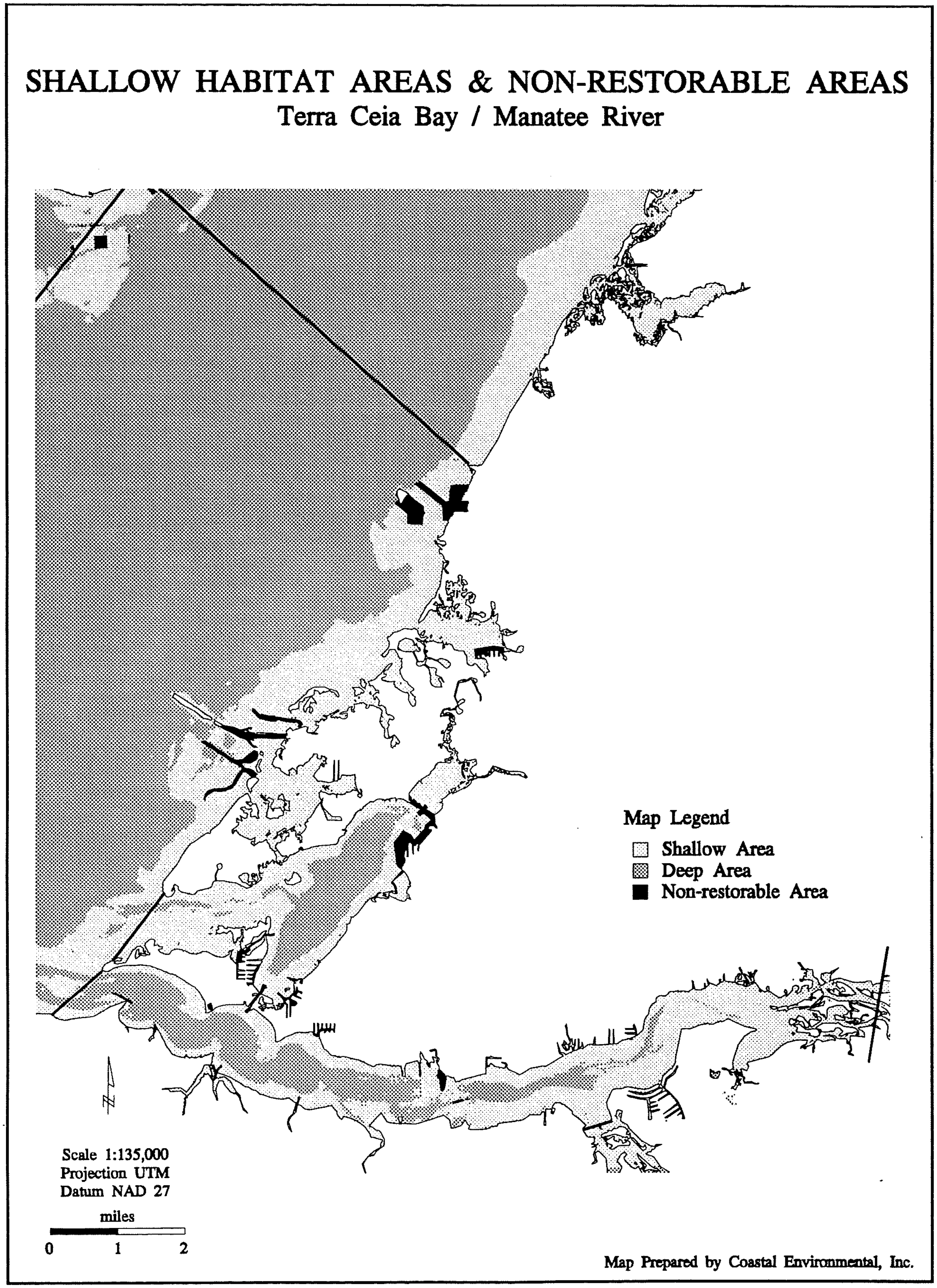

Figure 4.32 Areas less than 2 meters deep at mean low water and non-restorable areas in Terra Ceia Bay and the Manatee River.

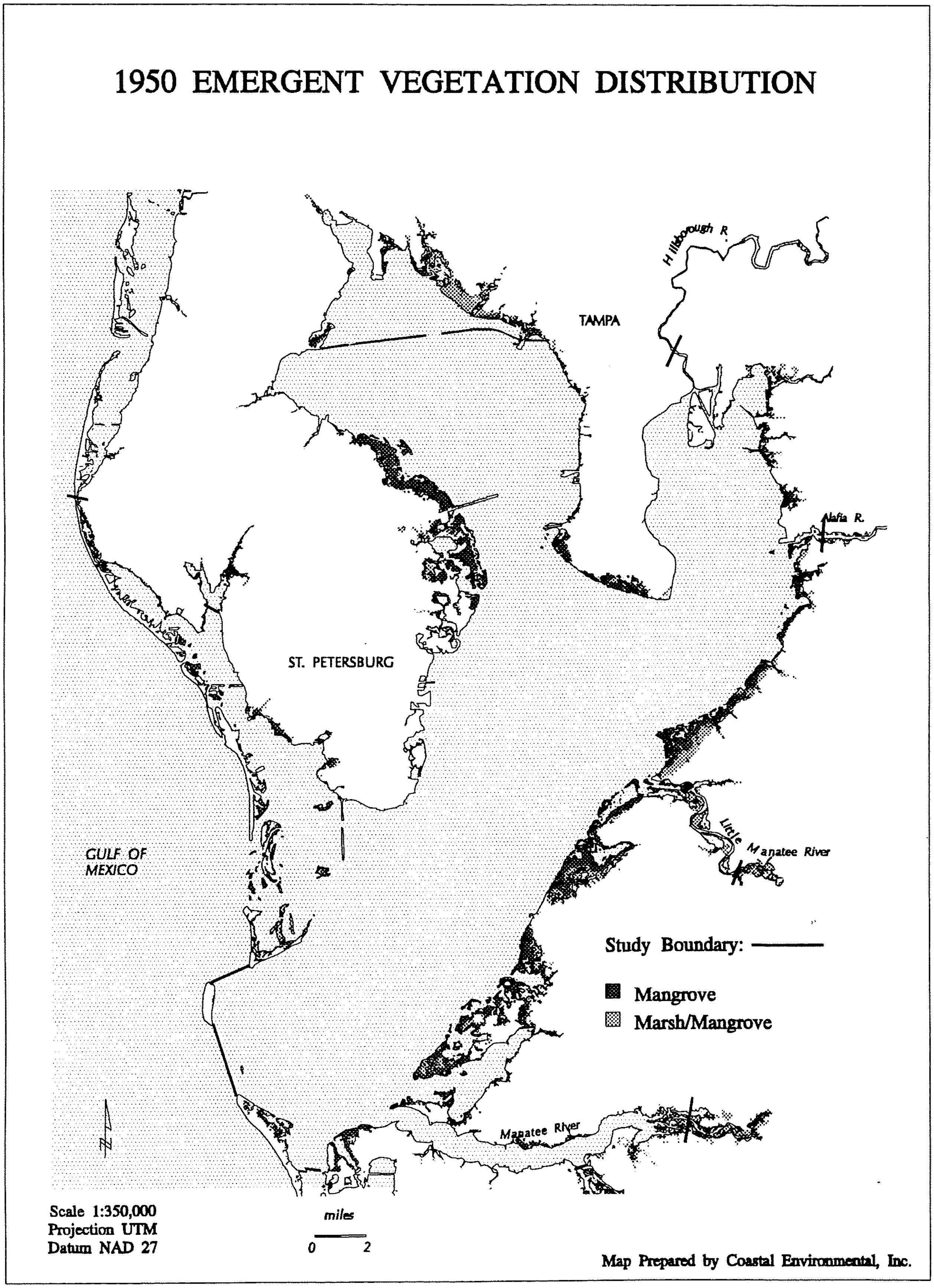

Figure 4.33 1950 Emergent estuarine vegetation distribution in Tampa Bay. Data source: FDNR and USFWS cooperative study.

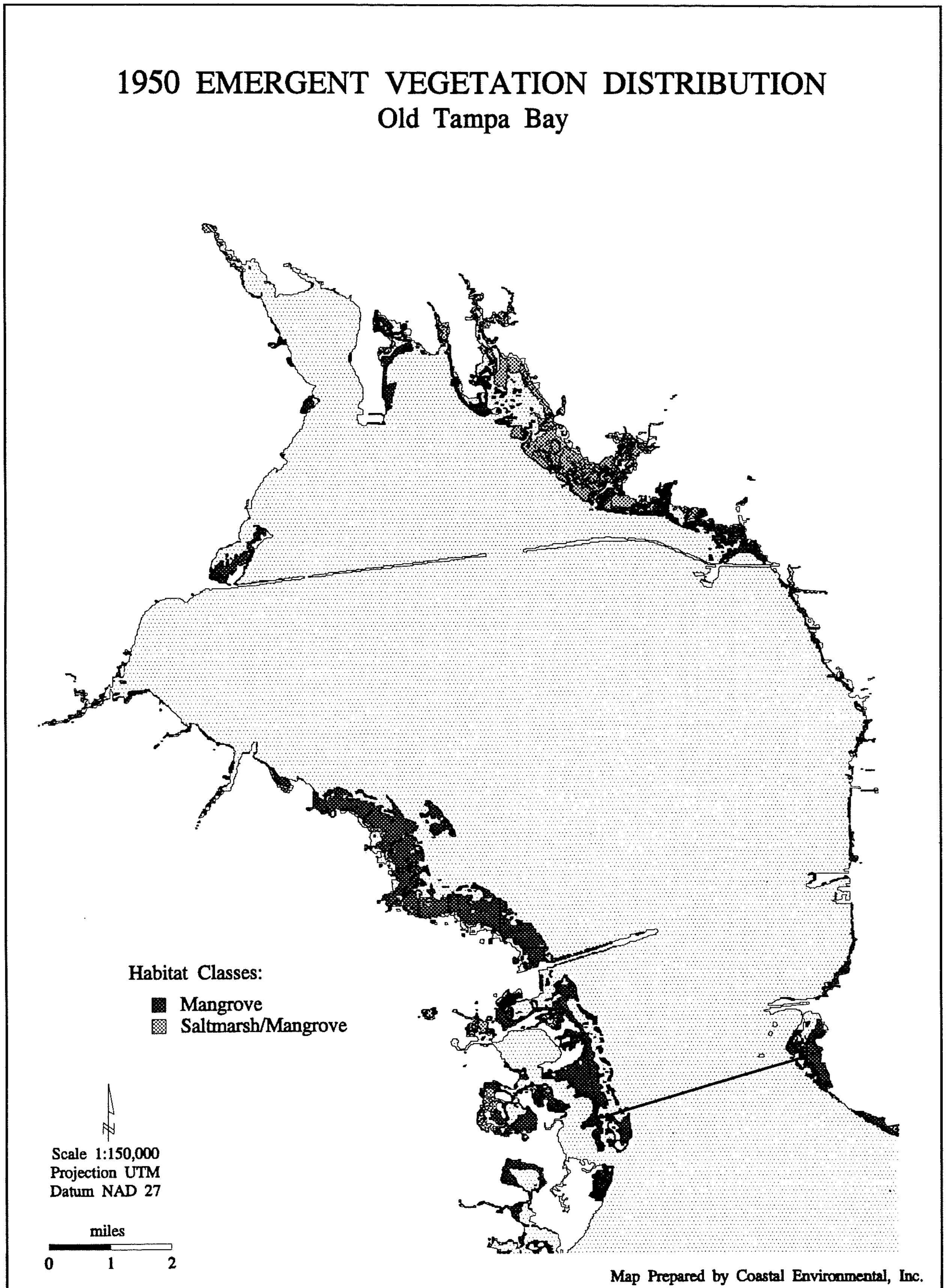

Figure 4.34 1950 Emergent estuarine vegetation distribution in Old Tampa Bay. Data source: FDNR and USFWS cooperative study.

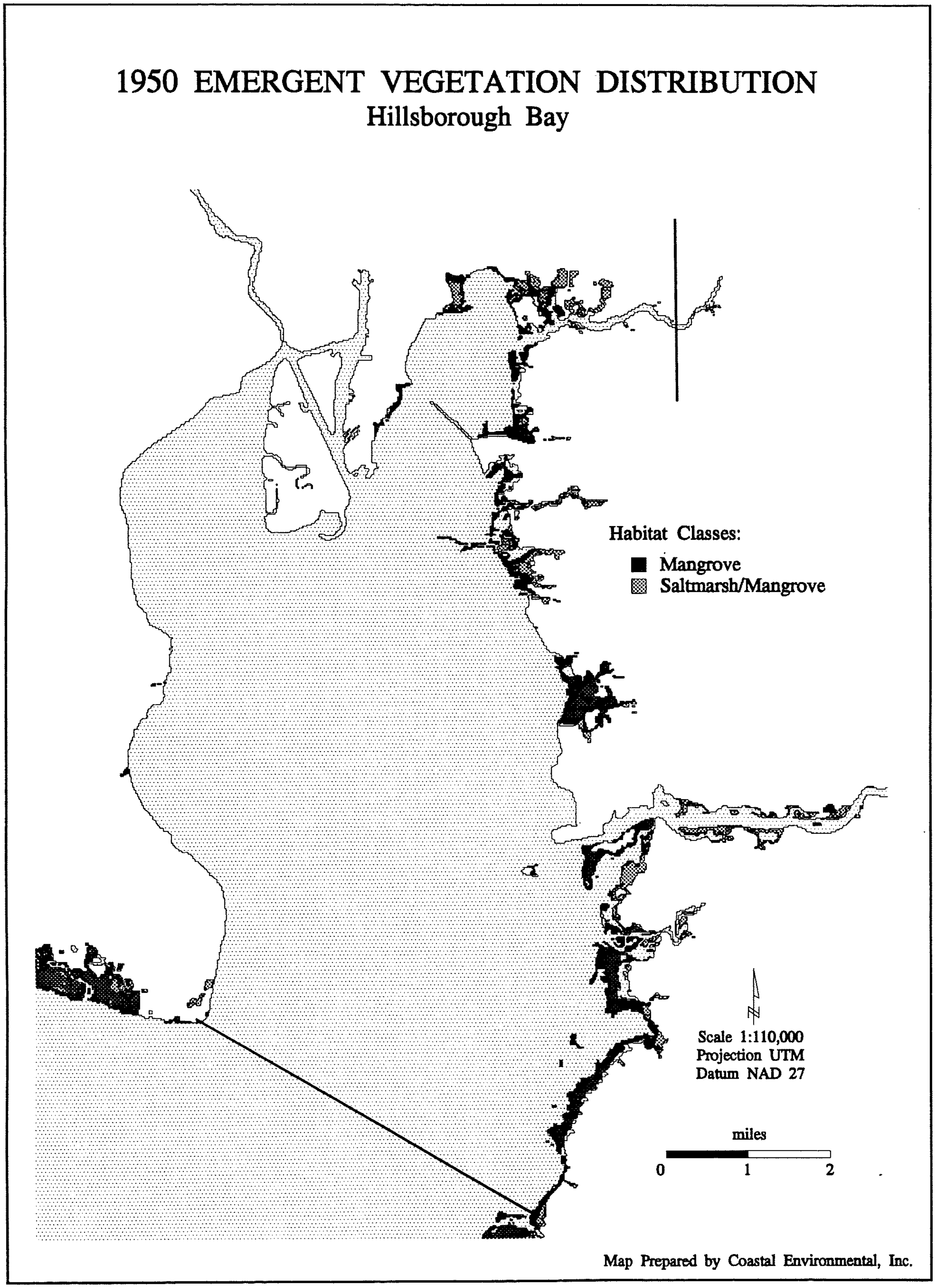

Figure 4.35 1950 Emergent estuarine vegetation distribution in Hillsborough Bay. Data source: FDNR and USFWS cooperative study.

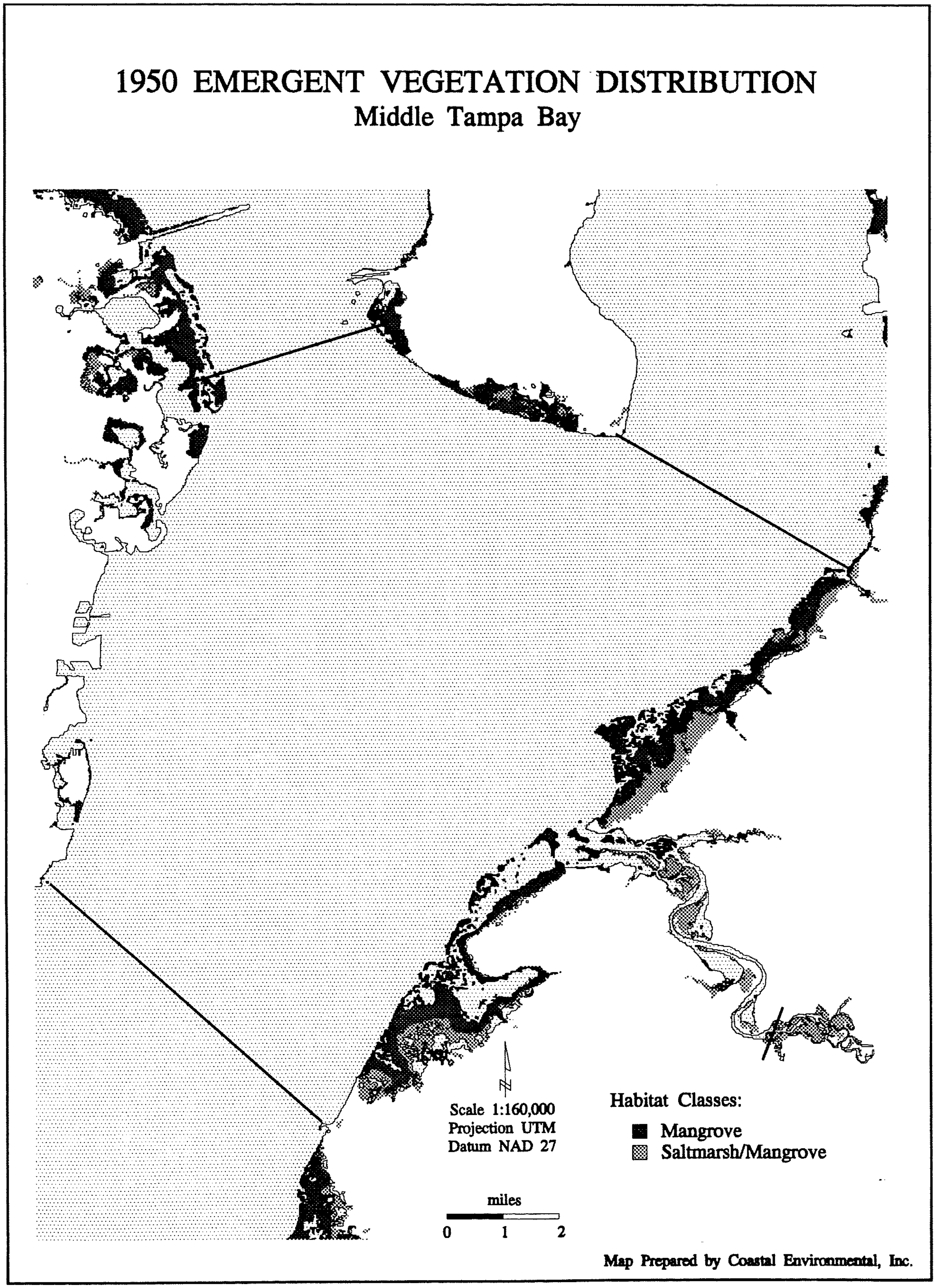

Figure 4.36 1950 Emergent estuarine vegetation distribution in Middle Tampa Bay. Data source: FDNR and USFWS cooperative study.

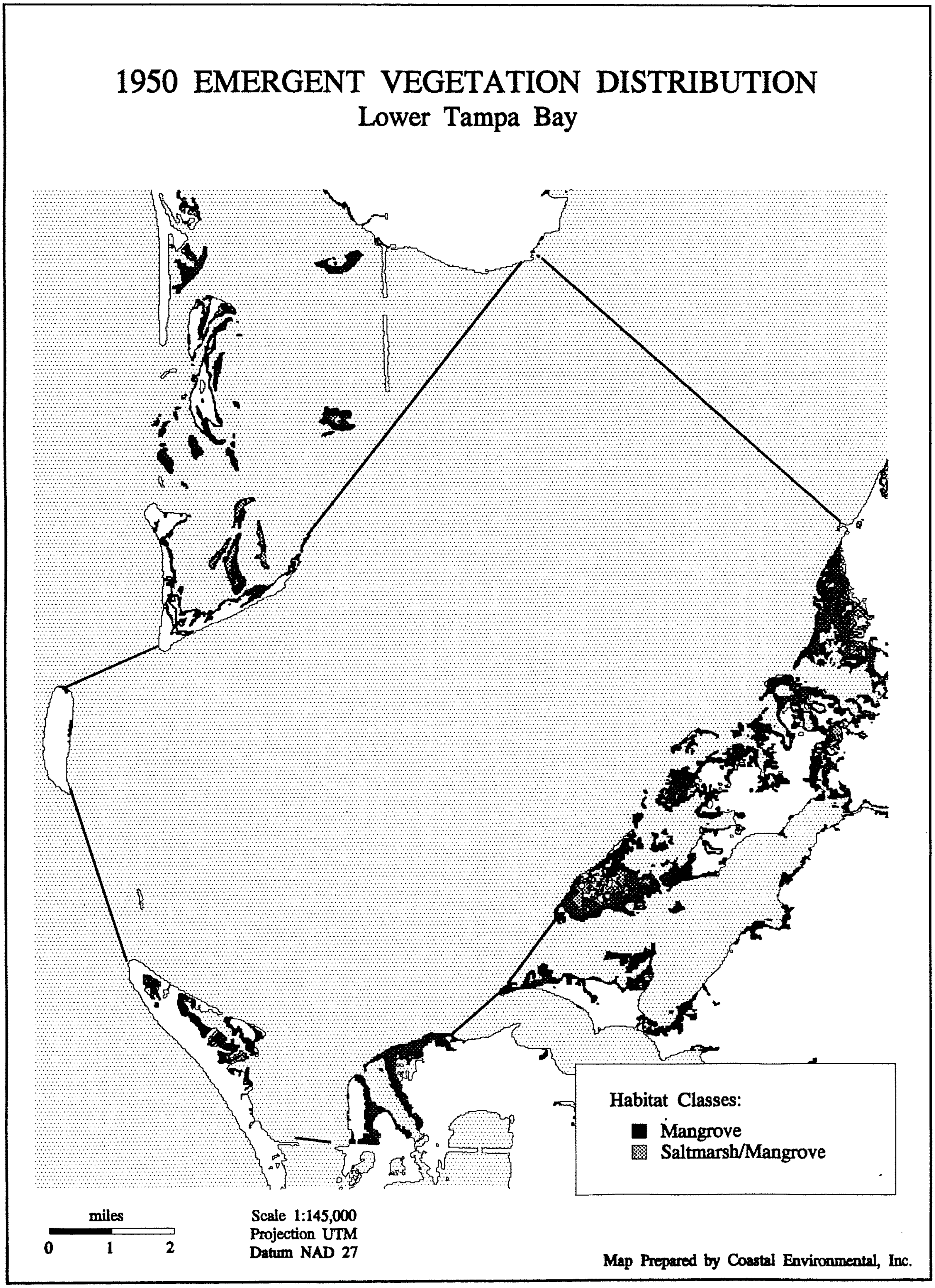

Figure 4.37 1950 Emergent estuarine vegetation distribution in Lower Tampa Bay. Data source: FDNR and USFWS cooperative study.

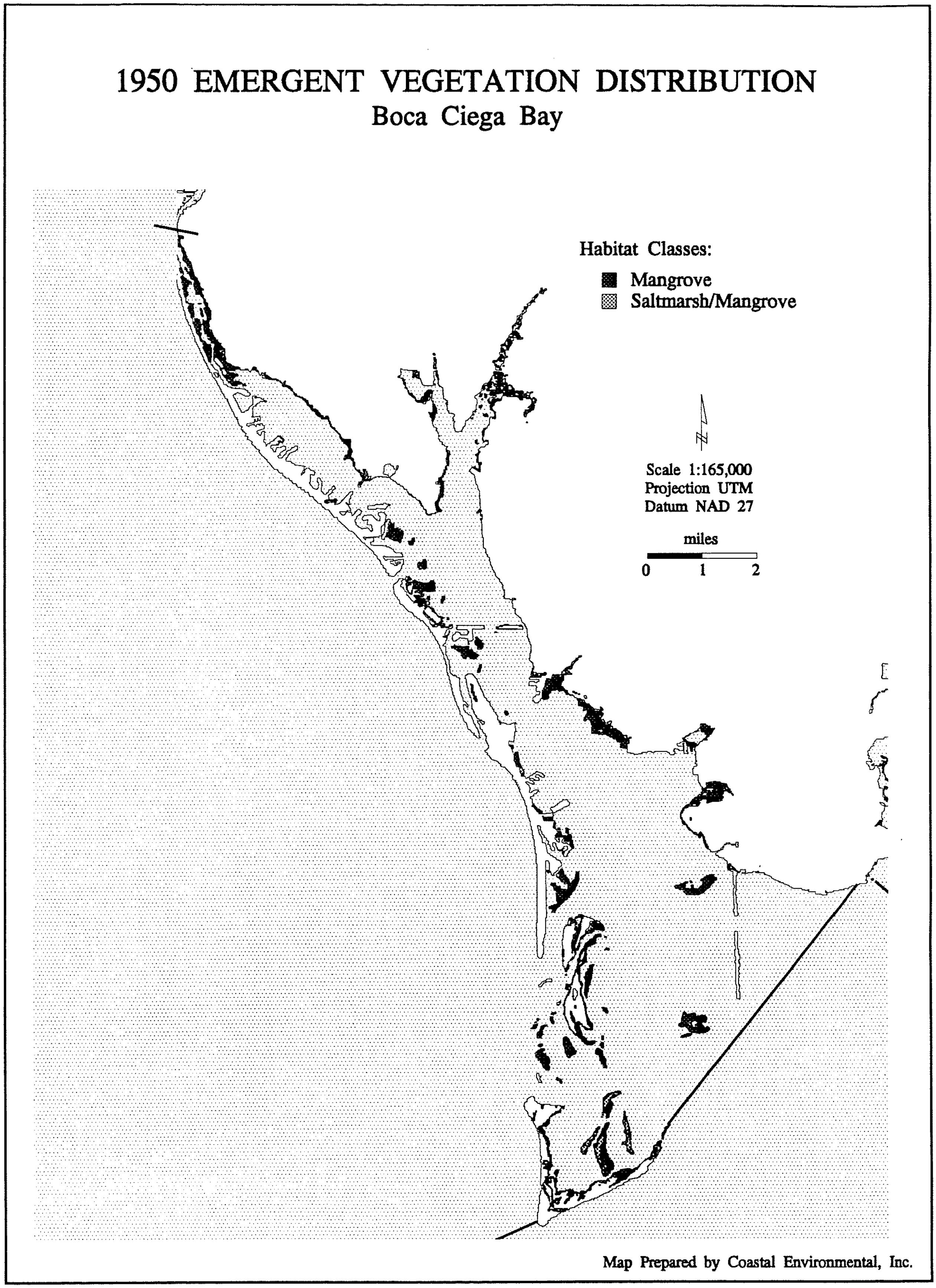

Figure 4.38 1950 Emergent estuarine vegetation distribution in Boca Ciega Bay. Data source: FDNR and USFWS cooperative study.

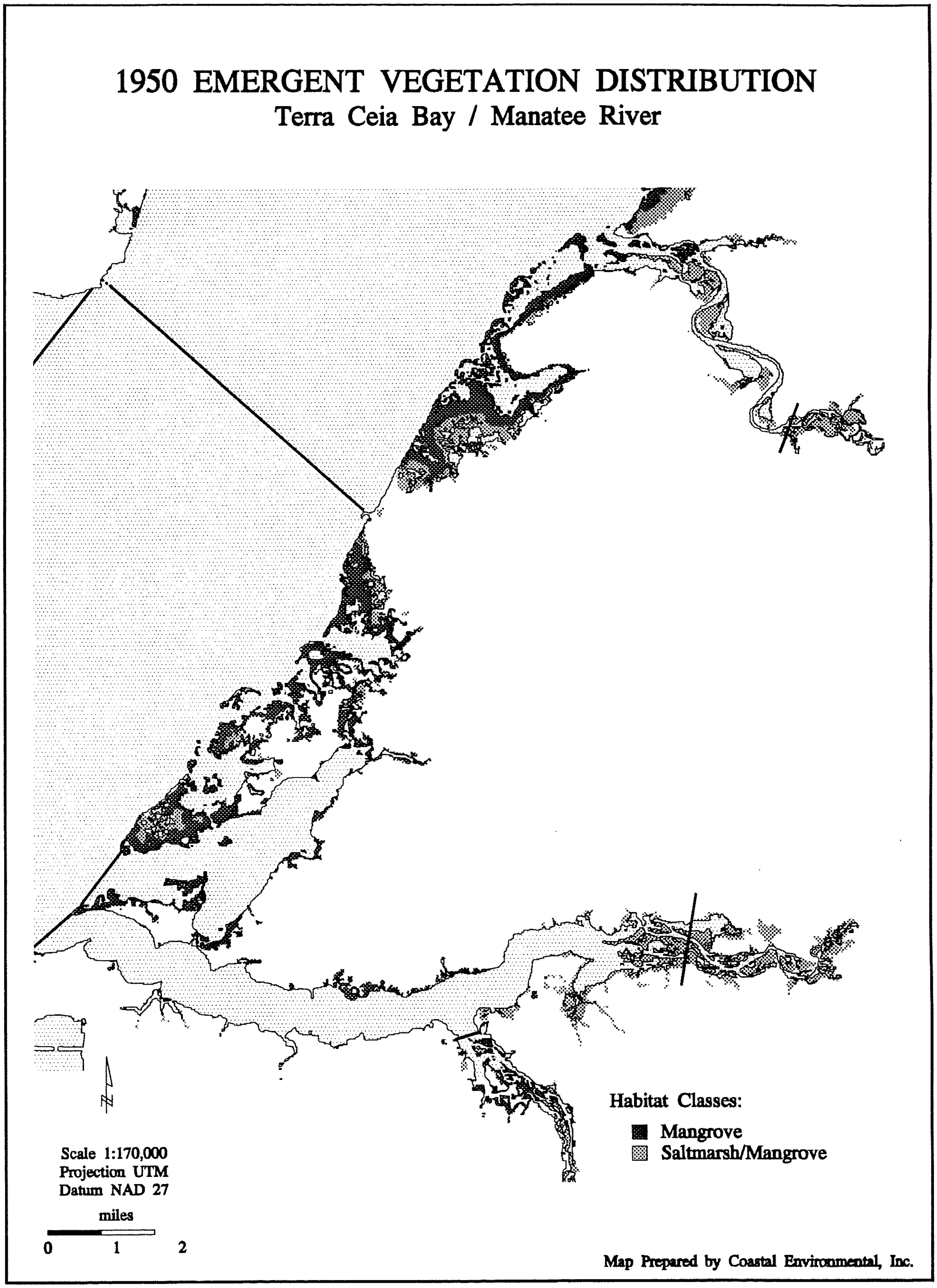

Figure 4.39 1950 Emergent estuarine vegetation distribution in Terra Ceia Bay and the Manatee River. Data source: FDNR and USFWS cooperative study.

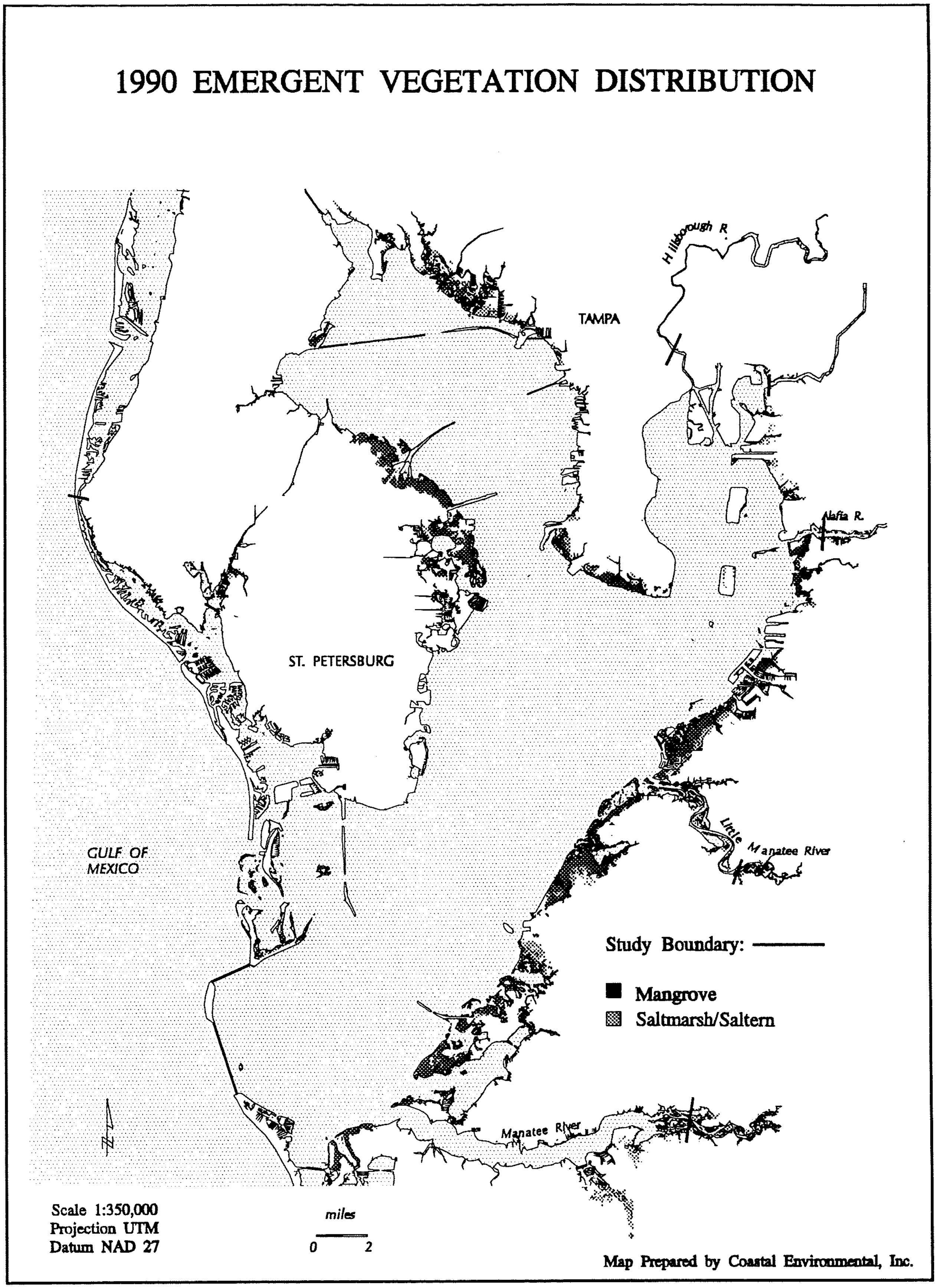

Figure 4.40 1990 Emergent estuarine vegetation distribution in Tampa Bay. Data source: SWFWMD.

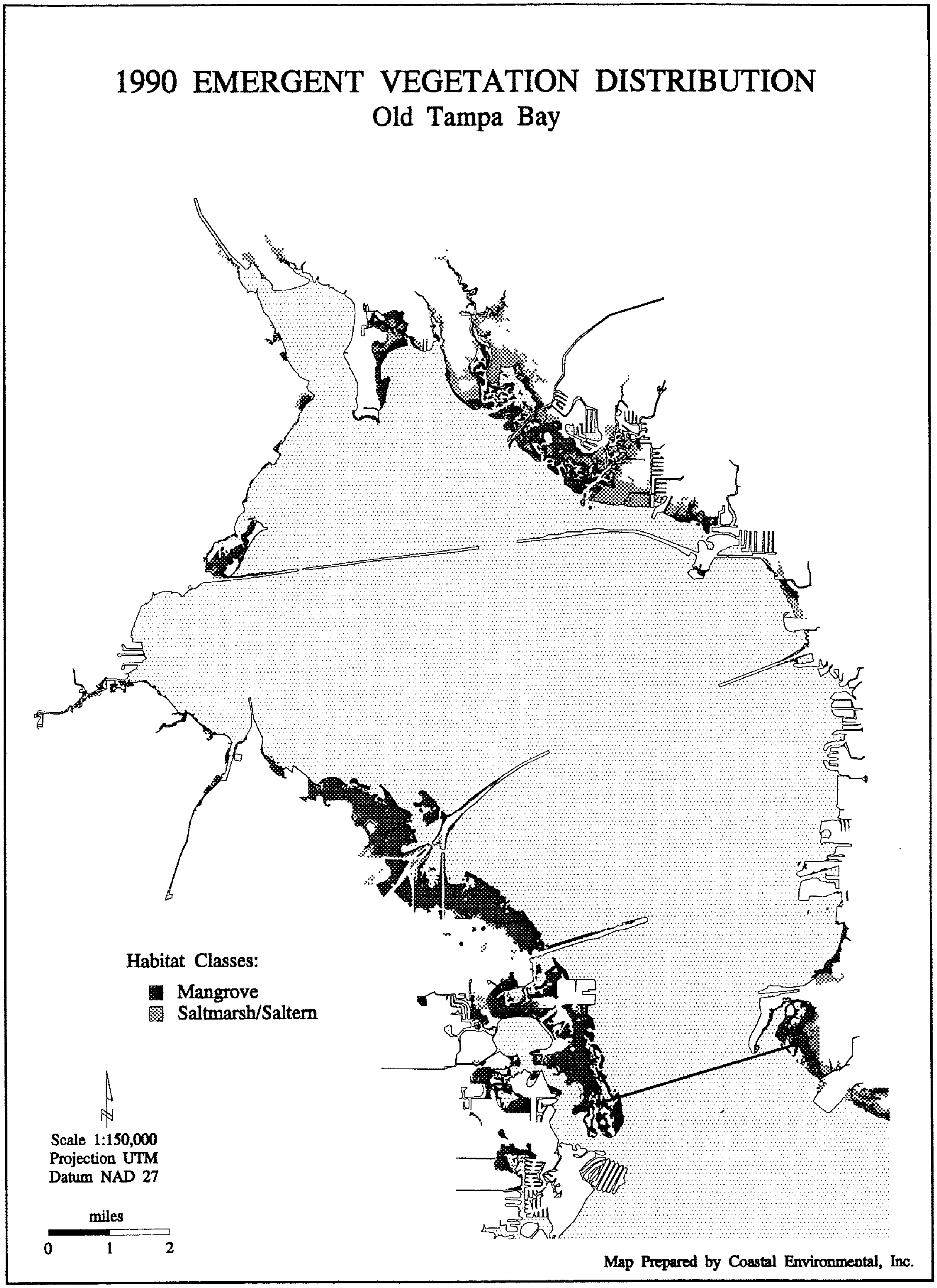

Figure 4.41 1990 Emergent estuarine vegetation distribution in Old Tampa Bay. Data source: SWFWMD.

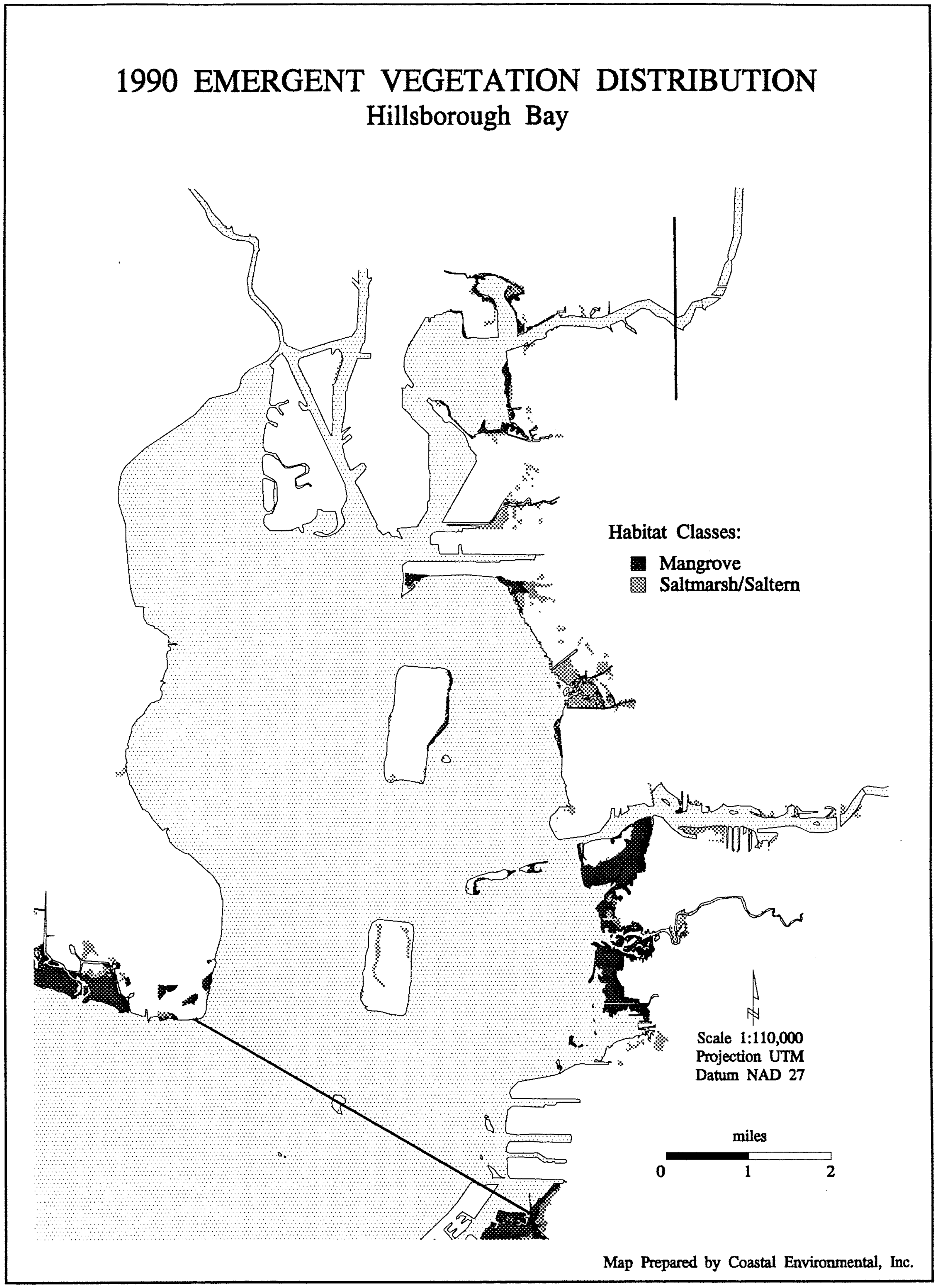

Figure 4.42 1950 Emergent estuarine vegetation distribution in Hillsborough Bay. Data source: SWFWMD.

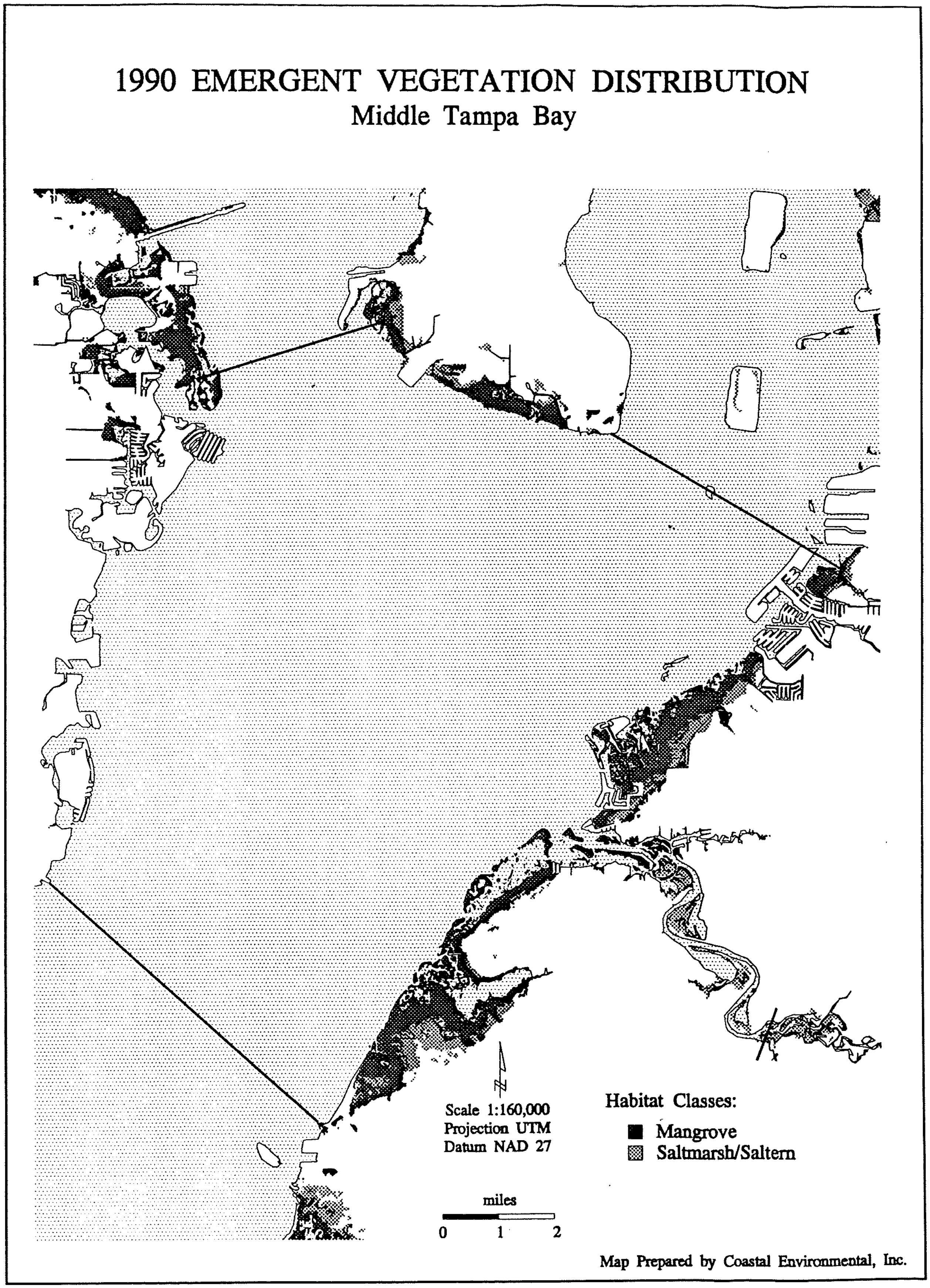

Figure 4.43 1950 Emergent estuarine vegetation distribution in Middle Tampa Bay. Data source: SWFWMD.

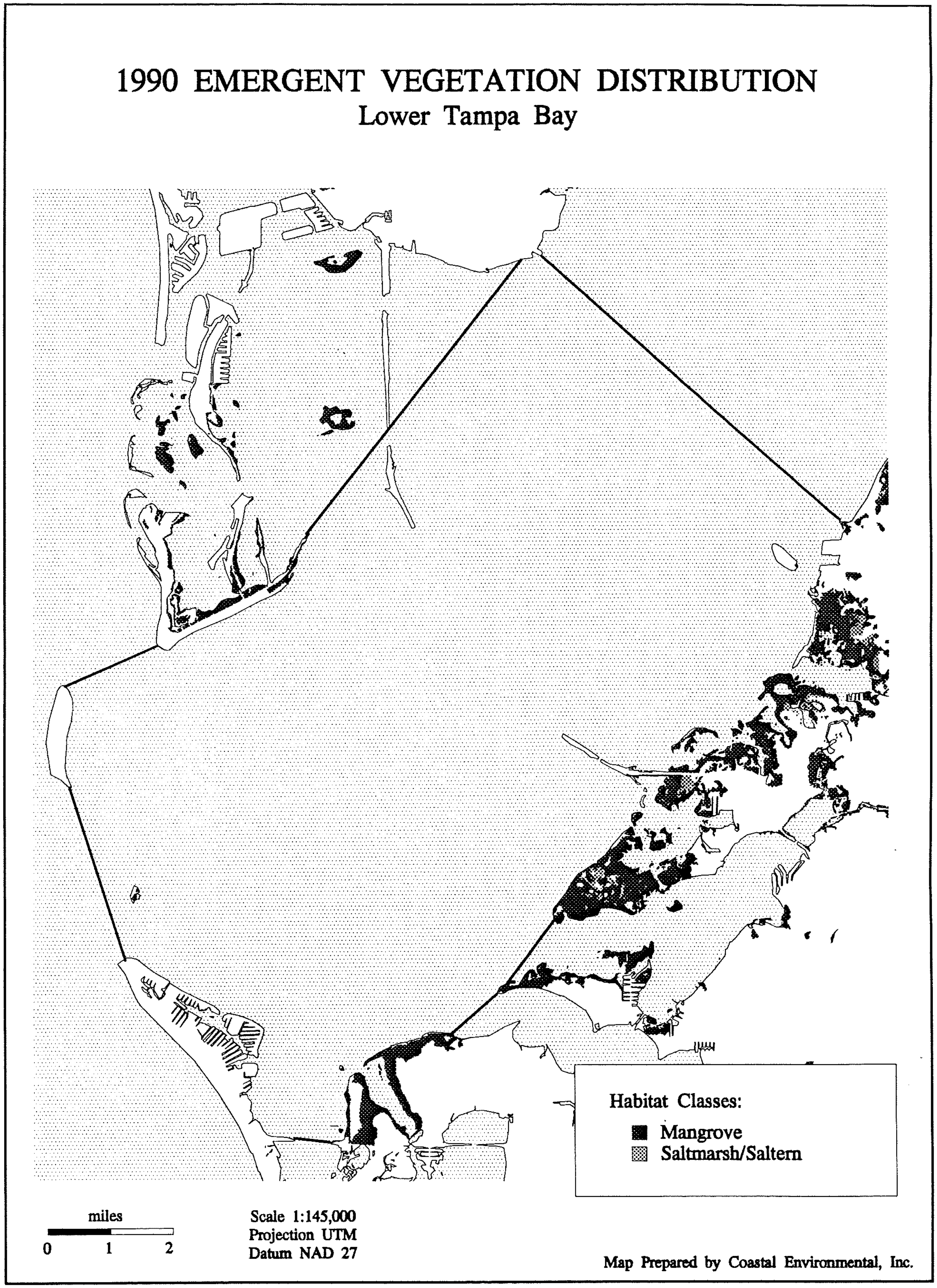

Figure 4.44 1990 Emergent estuarine vegetation distribution in Lower Tampa Bay. Data source: SWFWMD.

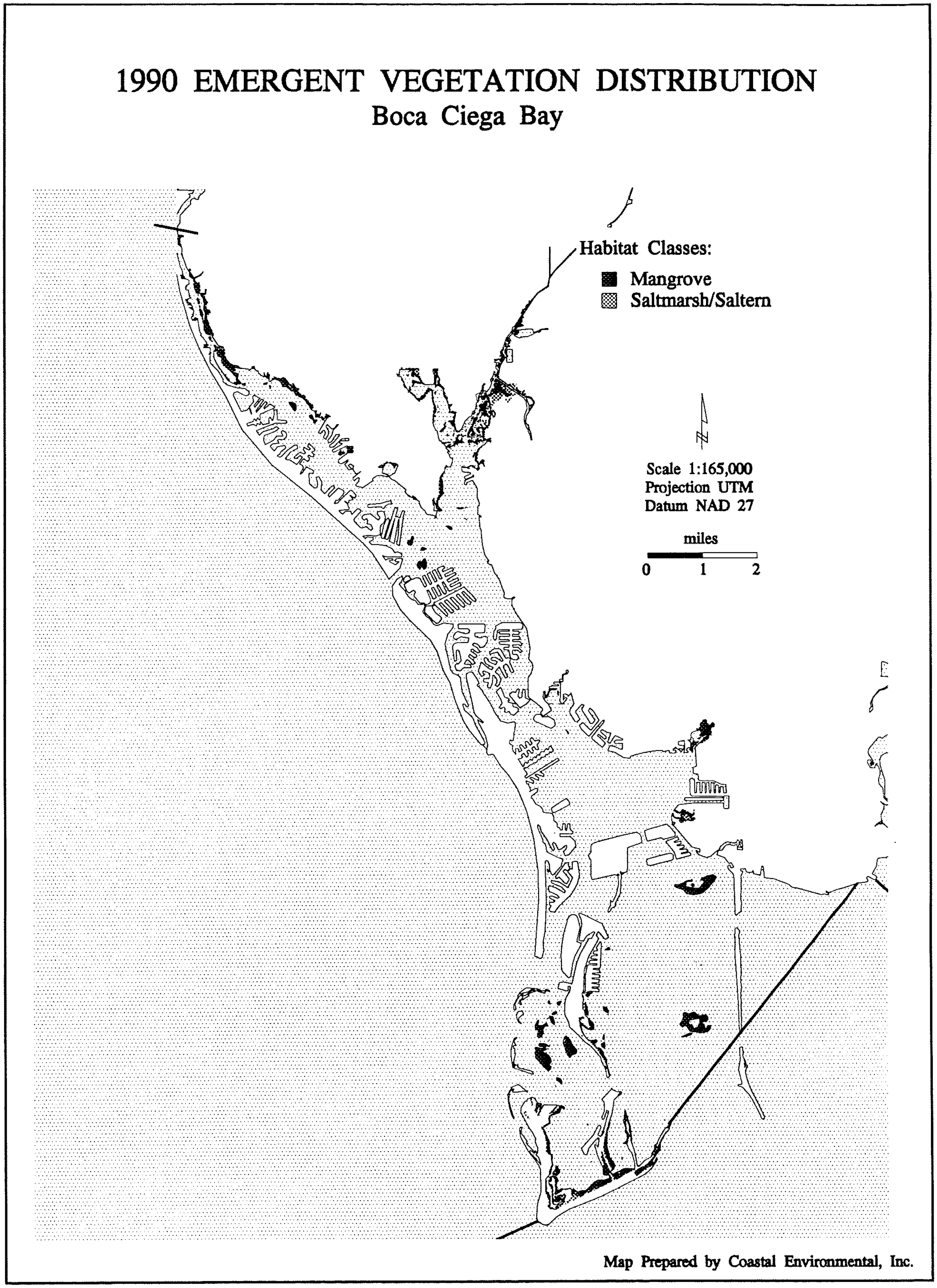

Figure 4.45 1990 Emergent estuarine vegetation distribution in Boca Ciega Bay. Data source: SWFWMD.

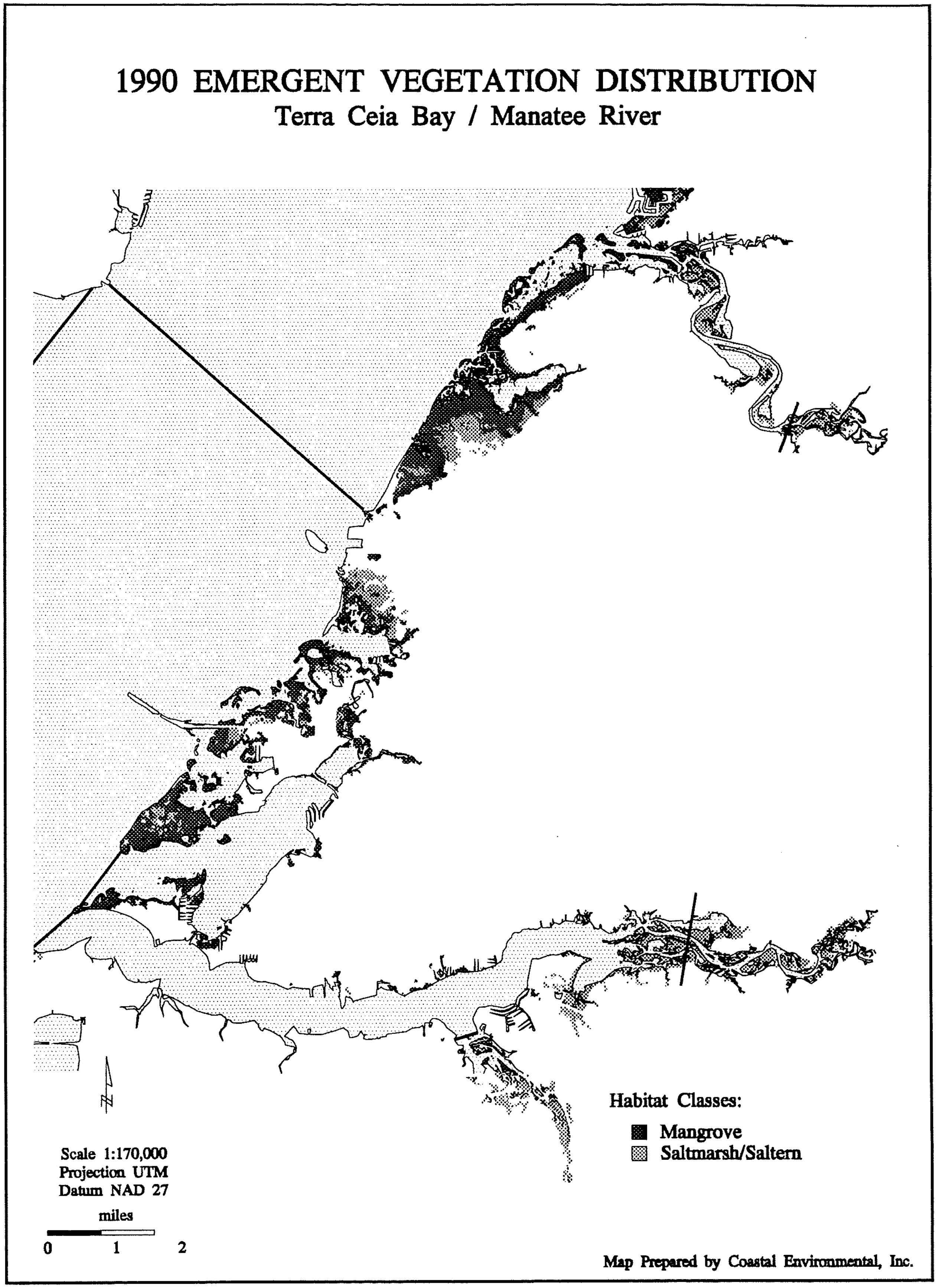

Figure 4.46 1990 Emergent estuarine vegetation distribution in Terra Ceia Bay and the Manatee River. Data source: SWFWMD.

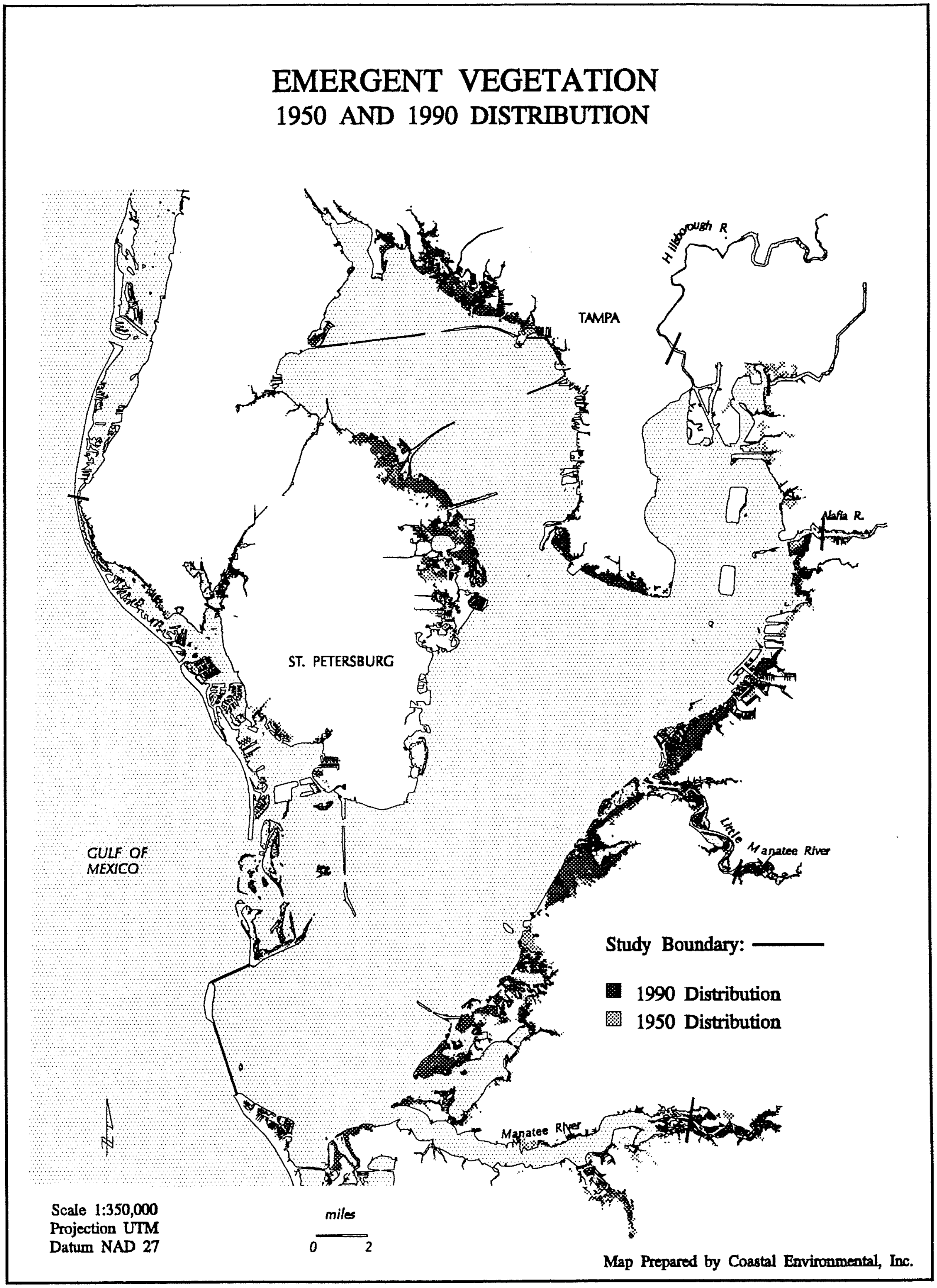

Figure 4.47 Loss of emergent vegetation in Tampa Bay.

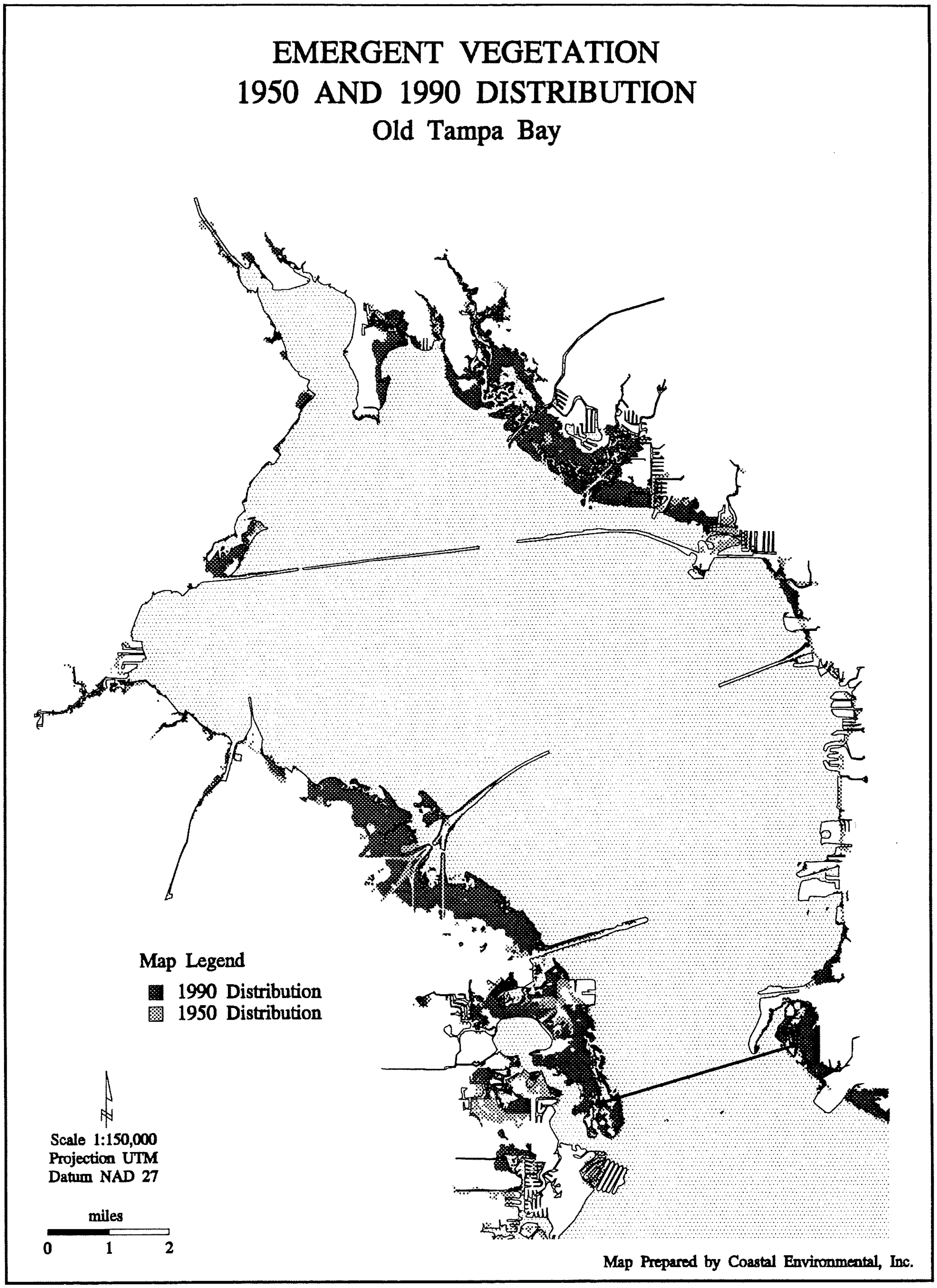

Figure 4.48 Loss of emergent vegetation in Old Tampa Bay.

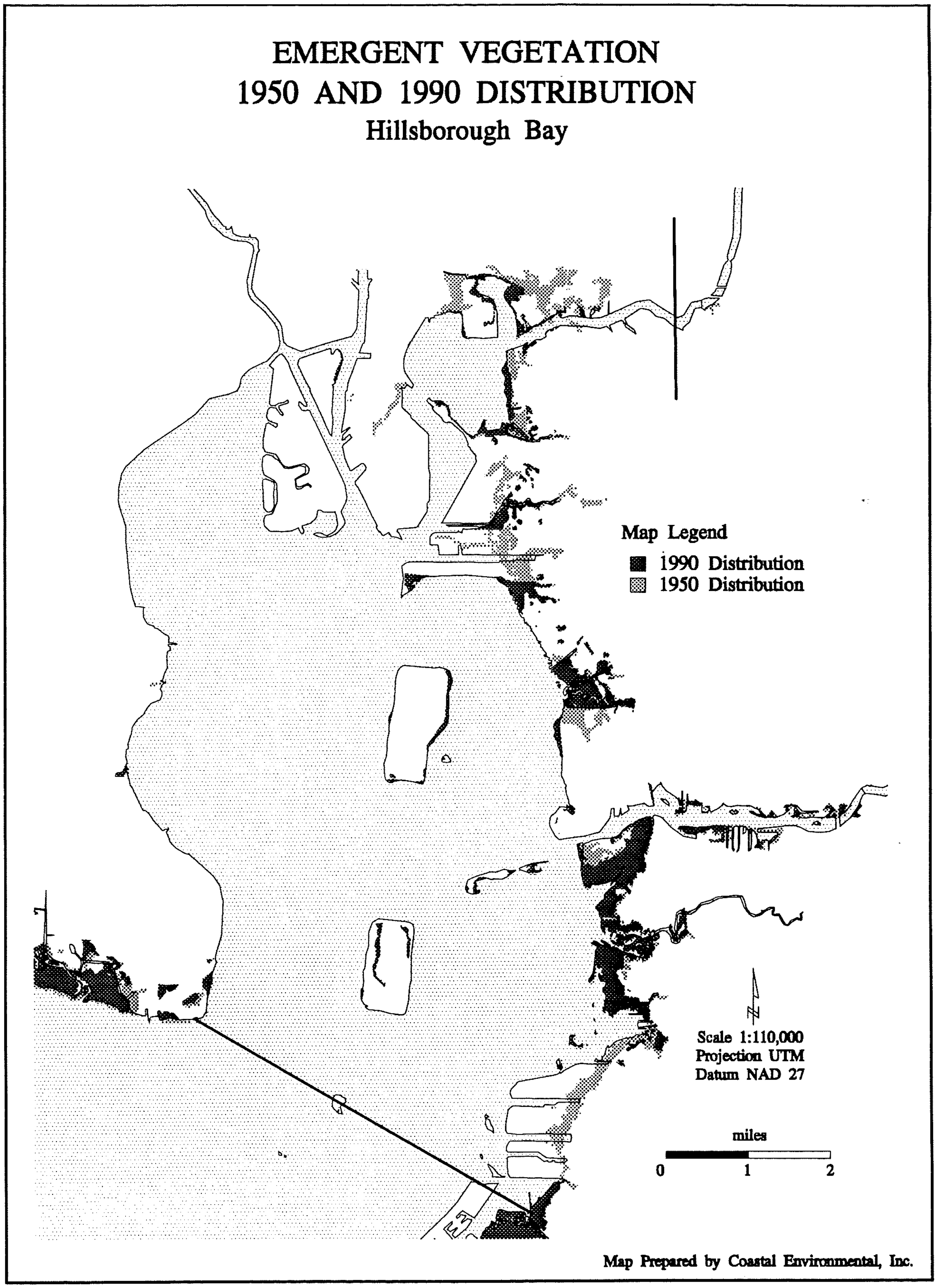

Figure 4.49 Loss of emergent vegetation in Hillsborough Bay.

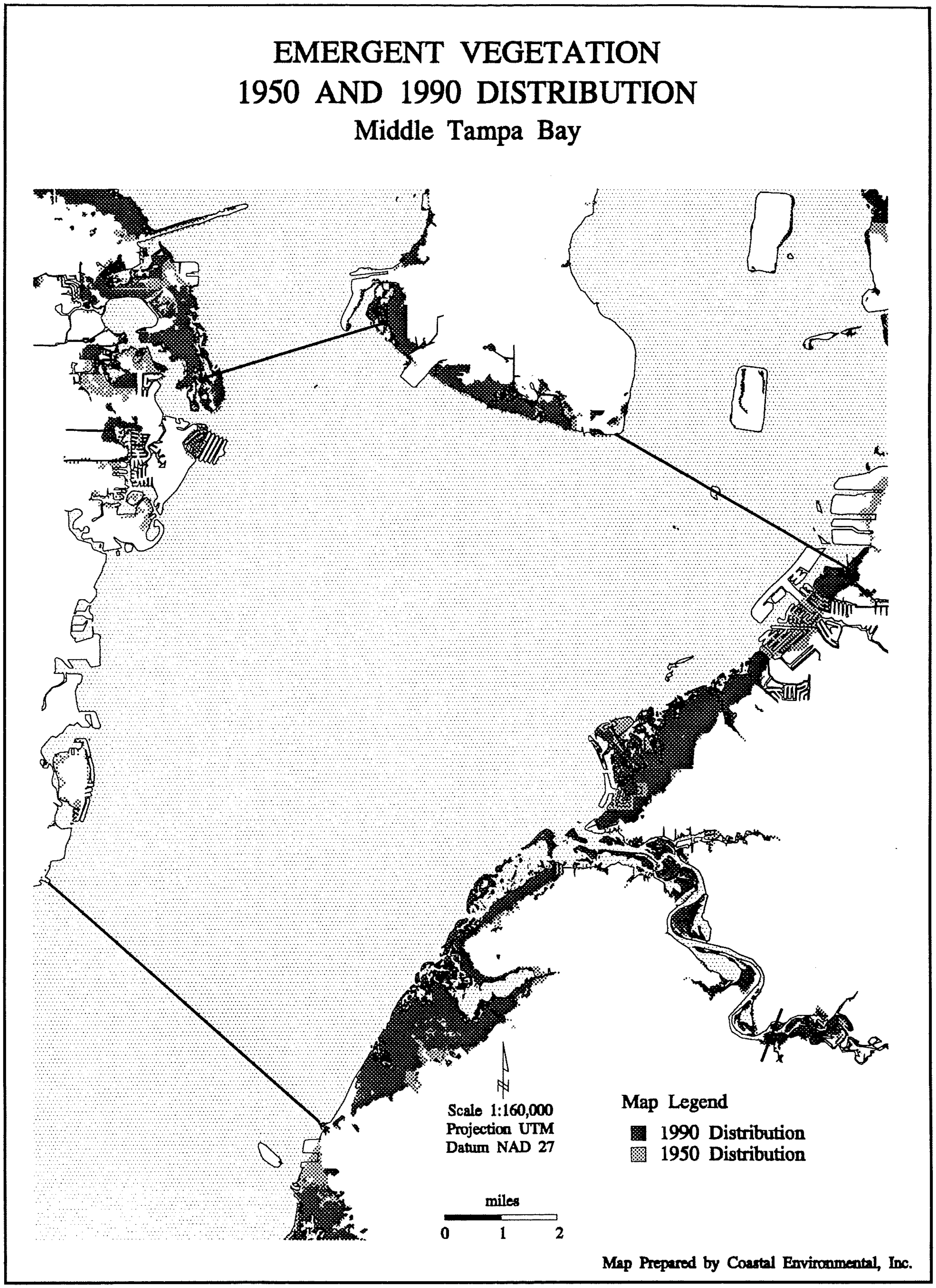

Figure 4.50 Loss of emergent vegetation in Middle Tampa Bay.

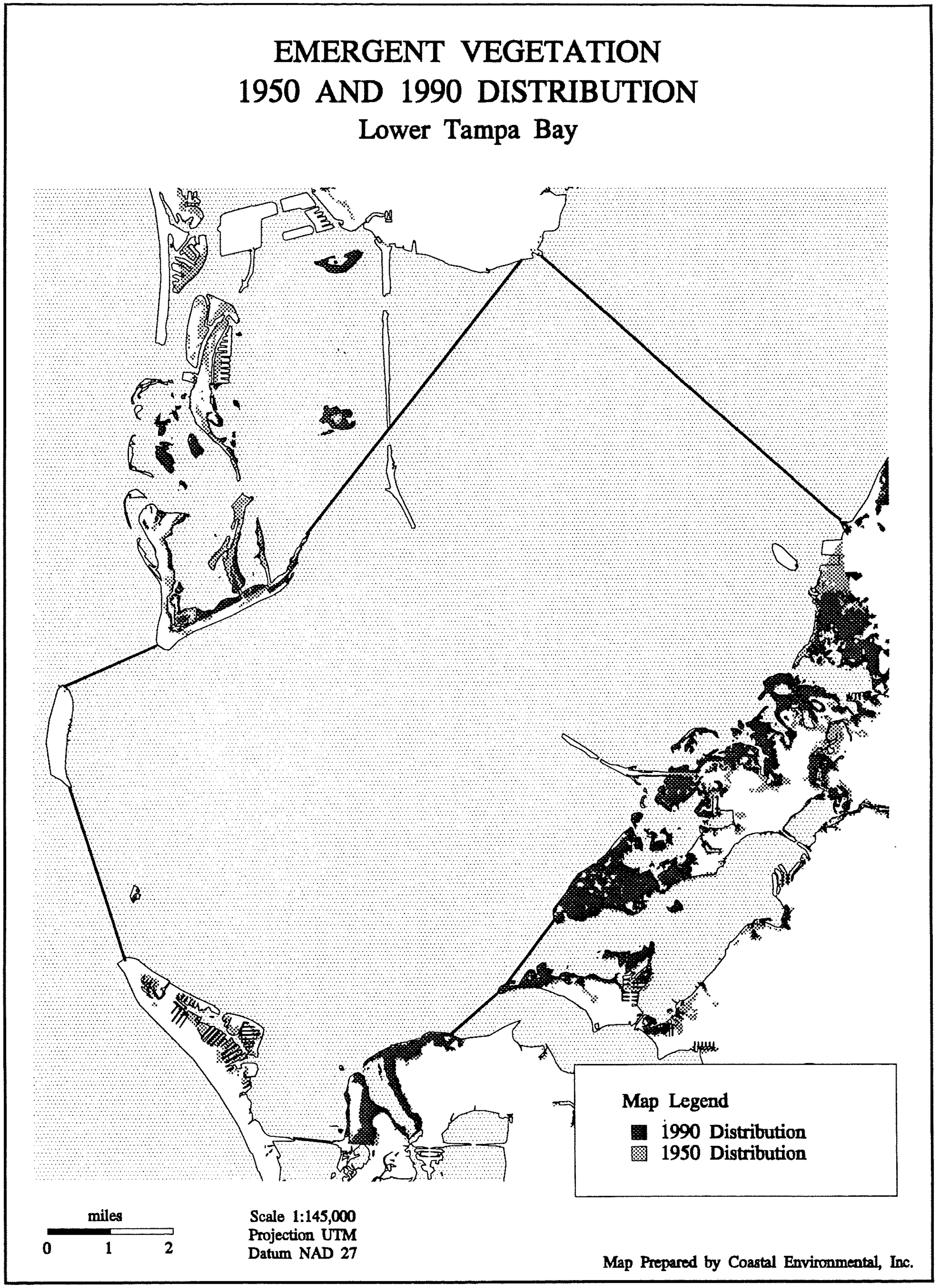

Figure 4.51 Loss of emergent vegetation in Lower Tampa Bay.

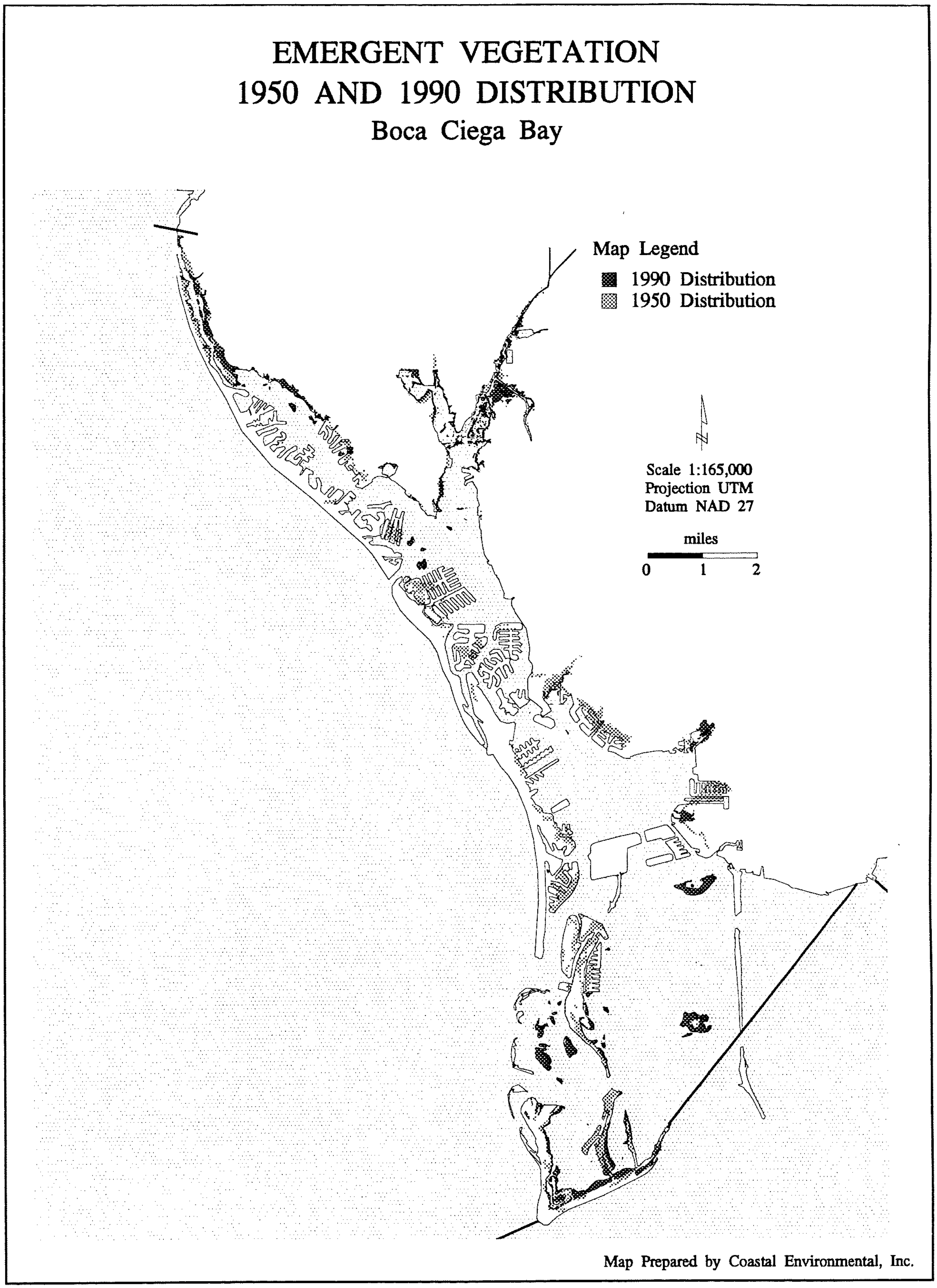

Figure 4.52 Loss of emergent vegetation in Boca Ciega Bay.

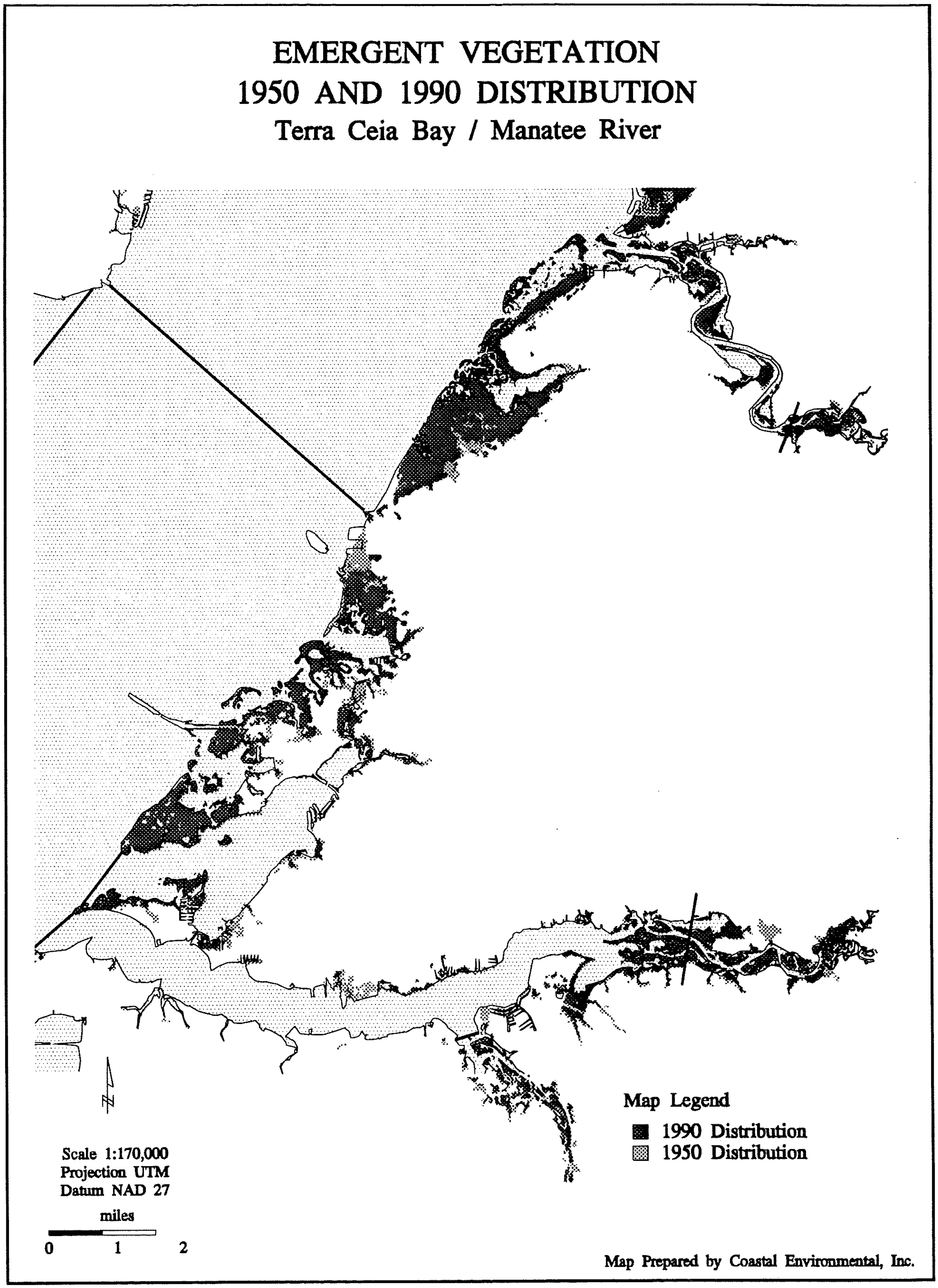

Figure 4.53 Loss of emergent vegetation in Terra Ceia Bay and the Manatee River.

5.0 DISCUSSION

The results of this project provide the necessary data to establish scientifically defensible quantitative habitat restoration and protection targets for Tampa Bay. The results are presented on a bay segment scale. As discussed in the methods section of this report, the level of detail provided by this project was limited by the level of detail introduced by the input data sets. For convenience to the reader, acreage estimates were rounded to the nearest 100 acres. The lack of a probability based sampling design for the benchmark and 1990 habitat data sets precludes the formulation of unbiased estimates of accuracy or precision in the areal estimates. However, the patterns of habitat loss between 1950 and 1990 are broadly distributed and unequivocal. The resulting habitat restoration targets will provide the basis and justification for management actions developed to address the restoration and protection of estuarine habitat in Tampa Bay.

The location of potential restoration and protection areas were mapped to the highest level of detail allowed by the original data. Some of the input data were developed to a higher level of detail than others. The existing land use and bathymetry data are especially detailed. However, caution should be used in interpreting fine scale features with these data sets. Tampa Bay is a dynamic system. Human activities, climatic and biological trends, and the natural shifting of sediments within the estuary limit the resolution to which precise locations of restoration targets can be delineated. Differences in photographic interpretation methods between the two time periods further limit the level of scrutiny which should be used in comparing the 1950 and 1990 habitat data. The level of detail and dynamic nature of the bay should be considered when attempting to use these data to investigate habitat trends within specific areas such as one of the smaller tributaries or a specific port development site.

As discussed in the introduction of this report, seagrass meadows and emergent vegetative habitats are members of a larger set of vital habitats in Tampa Bay. The existing extent of the other habitats identified as critical by the TBNEP - including non-vegetated subtidal, non-vegetated intertidal, and pelagic habitats - were recommended as the protection targets for those habitats. It was also recognized that the importance of protecting and restoring all of the vital habitats could not be seperated from the maintainence of viable populations of organisms which use the habitats. Hence, species lists for viable communities were compiled under this project, and are presented in Appendix 1 of this report.

A multi-faceted monitoring plan has been developed to collect information on short and long term trends in the coverage and viability of critical habitats in Tampa Bay (TBNEP, 1994b). The monitoring program design addressed objectives associated with ambient water quality, fish communities, seagrasses, benthic communities, and bay scallops. Statistical methods were developed to extrapolate the ambient water quality, fish community abundance, seagrass coverage and quality, and scallop abundance to allow for the reporting of regional and bay-wide estimates. A benthic community survey was also designed which has resulted in the completion of a benthic synoptic survey of Tampa Bay in 1993. If fully funded in the future, the multi-faceted monitoring program will provide information suitable for hypothesis testing regarding the long-term success of habitat protection and restoration resulting from management actions implemented in Tampa Bay.

Protection and Restoration of Seagrass

The seagrass management targets for Tampa Bay are to protect the existing 25,200 acres of seagrass meadows, and to restore an additional 14,800 acres of seagrass meadows to the bay. The TBNEP is currently developing specific management actions which can be implemented to achieve these goals. These seagrass protection and restoration management actions will likely include: the expanded posting of seagrass protection zones and the restriction of motorized watercraft use within these zones; setting seagrass based water quality improvement goals; minimizing further development and channelization of seagrass meadow areas; and possible pilot plantings of seagrasses in shallow areas which historically supported seagrass growth. If these management actions are successful the benefits likely to be gained by the public include: improved water quality, increased stabilization of near shore sediments; improved fishing conditions; and improved wildlife habitat.

The seagrass restoration targets have been defined in terms of restoring seagrass meadows at the locations where they previously existed in the benchmark period. This approach did not involve setting targets based solely on depth such as restoring seagrass meadows to all areas less than 2 meters deep. This is because some areas which are greater than two meters deep may be restorable, and some areas which are less than 2 meters deep may not be. The results of this project indicate that previously existing seagrass meadows in areas of the bay currently greater than 2 meters in depth may be restorable. A notable example of this type of restoration potential is the large borrow pit which was excavated to build the MacDill Air Force Base runway on the Interbay Peninsula. Although this pit is currently too deep to support seagrass restoration attempts, previously developed restoration plans have proposed that the pit be refilled with suitable sediment material and revegetated (TBRPC, 1986).

It is likely that not all areas less than 2 meters deep were covered by seagrass meadows in pre-development times. When future environmental conditions have been restored to levels required for seagrass growth within the restoration areas, it is likely that some shallow areas in Tampa Bay will continue to persist without seagrass coverage. Naturally drifting sand deposits, tidal currents, and violent storms will likely destroy seagrass beds in localized areas on a periodic basis. Black and white aerial photographs of Tampa Bay area were made in 1938 for the Soil Conservation Service (SCS), and these photographs were examined by Coastal at the federal National Archives repository in Washington, D.C. These photos indicate that as early as the 1938 time period, bare sandy areas were common in locations otherwise likely to be an appropriate depth for seagrass meadows. In a dynamic estuary such as Tampa Bay, it is likely that shallow areas lacking in seagrass coverage will continue to exist under conditions of restored water quality and light penetration.

The data used to set the restoration targets also indicate that seagrass coverage is not likely to be complete to depths of 2 meters. Figure 5.1 presents a combination of histograms for the 1950 and 1990 seagrass coverages by depth (Figures 4.8 and 4.23). Several of the bay segment maps of seagrass in the historical and existing time periods indicated widespread coverage of seagrass meadows. These segments were Old Tampa Bay in 1950, Middle Tampa Bay in 1950, and Lower Tampa Bay in both the 1950 and 1990 time periods. It is interesting to note that the percent seagrass coverage-by-depth histograms presented in the results section indicate a very similar pattern for these segments and time periods. The data for each of these cases indicate a 70 % to 80 % coverage at a depth of 0 to 0.5 meters, a 35 % to 45 % coverage at a depth of 1 to 1.5 meters, and a 10 % coverage at a depth of 1.5 to 2 meters. These data suggest that this is the restoration coverage that can be reasonably expected for Tampa Bay under ideal conditions. It is possible that water quality had been significantly degraded during the times in which the historical photographs were made (1950 and 1938 periods). However, it is more likely that some shallow areas lacking in seagrass coverage will continue exist in the bay even under conditions of restored water quality and light penetration.

The purpose of this project was to set numerical targets for the restoration of living resources. The restoration areas as mapped by this project represent areas where seagrasses were lost between the 1950 and 1990 time periods. The likelihood of sucessful seagrass restoration within these areas varies throughout the bay due to local environmental conditions such as water clarity, depth, substrate characteristics, pollutant concentrations, and wave energy. The likelihood of successful seagrass restoration based on expected light penetration in the water column is presented in Figures 5.2 through 5.7. These figures do not represent areas recommended for the planting of seagrasses, but represent the areas most likely to be revegetated under improved water quality conditions.

The expected availability of light for each restoration area was based on expected patterns of light penetration (EPCHC, 1991; PCDEM, 1991) and depth. For presentation purposes, light penetration was classified from deepest (Class 1) to shallowest (Class 3) following the classification pattern presented in Table 5.1. The resolution of this analysis does not account for fine scale patterns in light penetration. This is particularly true for the tributaries where likelihood of sucess may be overestimated due to local patterns of decreased light penetration and channelization.

In addition, it should be recognized that very little information exists regarding light conditions in shallow areas of Tampa Bay. This lack of information will likely limit the value of predicting areas of expected seagrass growth.

Current water quality conditions in Tampa bay suggest that much seagrass growth now should be possible in the mapped restoration areas, and the most recent seagrass trend analysis data indicate that this in fact is occurring (Reis, personal communication). Tampa Bay should not be thought of as a static system, and time lags between water quality improvements and seagrass recovery should be recognized in the process of adjusting restoration targets in the future.

Protection and Restoration of Emergent Vegetation

The protection target for mangrove, saltmarsh, and salt barren/high marsh habitats, as recommended by this study, is the existing 18,800 acres of these habitats. During the preparation of the CCMP, the TBNEP will develop a set of management actions aimed to achieve this target. These management actions will likely include: minimizing further dredge and fill destruction of tidal wetlands; protecting or restoring the hydrologic regimes in tidal wetlands; examining existing mangrove pruning regulations; and minimizing physical impacts to intertidal zones from vehicular and pedestrian traffic. The benefits to be gained by protecting these saltwater wetlands are: stabilization of shorelines and nearshore sediments; the maintenance of fishing and recreation areas; and the protection of important fish and shellfish nursery areas.

The results of this project indicate that 9,700 acres of what was mangrove and salt marsh habitat have been lost from Tampa Bay since 1950. However, mangrove and saltmarsh vegetation has naturally established, or has been planted, along new shorelines associated with urban filling and causeway construction throughout the bay during the same time period. Some areas indicated as new wetlands by these data are likely the result of differences in photographic interpretation between the 1950 and 1990 data sets. In addition, exotic vegetation such as brazilian pepper (*Schinus terebinthifolius*) has invaded the edges of existing mangrove forests in the bay, and has likely been classified as mangroves in the 1990 SWFWMD data set. Nonetheless, given these sources of error, the total new estuarine emergent vegetation since 1950 is estimated to be approximately 5,900 acres.

The TBNEP will develop management actions for the restoration of estuarine emergent vegetation in Tampa Bay as part of the CCMP. The restoration management actions will likely include recommendations to create new wetlands and to minimize disturbance of naturally established wetlands in created intertidal areas such as along the causeways. Estuarine emergent plants such as the red mangrove (*Rhizophora mangle*) are adept at colonizing new areas where depth and wave action conditions are suitable. However, many of the shorelines suitable for the recolonization of mangroves are now hardened by vertical seawalls. It is likely that many waterfront residents discourage the establishment of mangrove seedlings along the seawalls on their property. This may be a result of the misinterpretation of state regulations regarding the pruning of mangroves. A better management balance can be reached between protecting waterfront views and permitting the managed establishment of emergent vegetation in urban areas.

Relationship to Ongoing Restoration and Protection Efforts.

The TBNEP is developing living resource restoration and protection goals in concert with preexisting and ongoing restoration and protection efforts. Seagrass restoration target development is an active area of resource management throughout the nation. Efforts similar to those underway in Tampa Bay have recently been documented by the Indian River Lagoon National Estuary Program (Morris and Tomasko, 1993) and the Chesapeake Bay Program (Batiuk et al., 1992). Locally, many of the management agencies of Tampa Bay have been undertaking aggressive efforts to restore and protect the living resources of the bay. Some of the recent efforts by the SWFWMD SWIM department, the City of Tampa's Bay Study Group, The Hillsborough County Environmental Lands Acquisition Program, the Cockroach Bay Restoration Alliance, and Pinellas County are discussed in the 1993 Tampa Bay Status and Trends Report (TBNEP, 1993). The TBNEP, working with these and other agencies, citizens groups, and industries will use the information provided by this study to establish the restoration and protection targets, the management actions needed to meet the targets, and the time periods over which the targets will be met. Ultimately, the TBNEP will provide a management framework in the form of the Tampa Bay Comprehensive Conservation and Management Plan.

Table 5.1 Classification pattern used to summarize likely light penetration and water depth conditions for potential seagrass restoration areas.

Water Depth (MLW)	Secchi Disk (m) > 2.8 m	Secchi Disk 2.8-2.3 m	Secchi Disk 2.3-1.8 m	Secchi Disk 1.8-1.3 m	Secchi Disk < 1.3 m
< 0.5 m	1	1	2	2	3
0.0 - 1.0 m	1	2	2	3	3
1.0 - 1.5 m	2	2	3	3	3
1.5 - 2.0 m	2	3	3	3	3
2.0 - 2.5 m	3	3	3	3	3
> 2.5 m	3	3	3	3	3

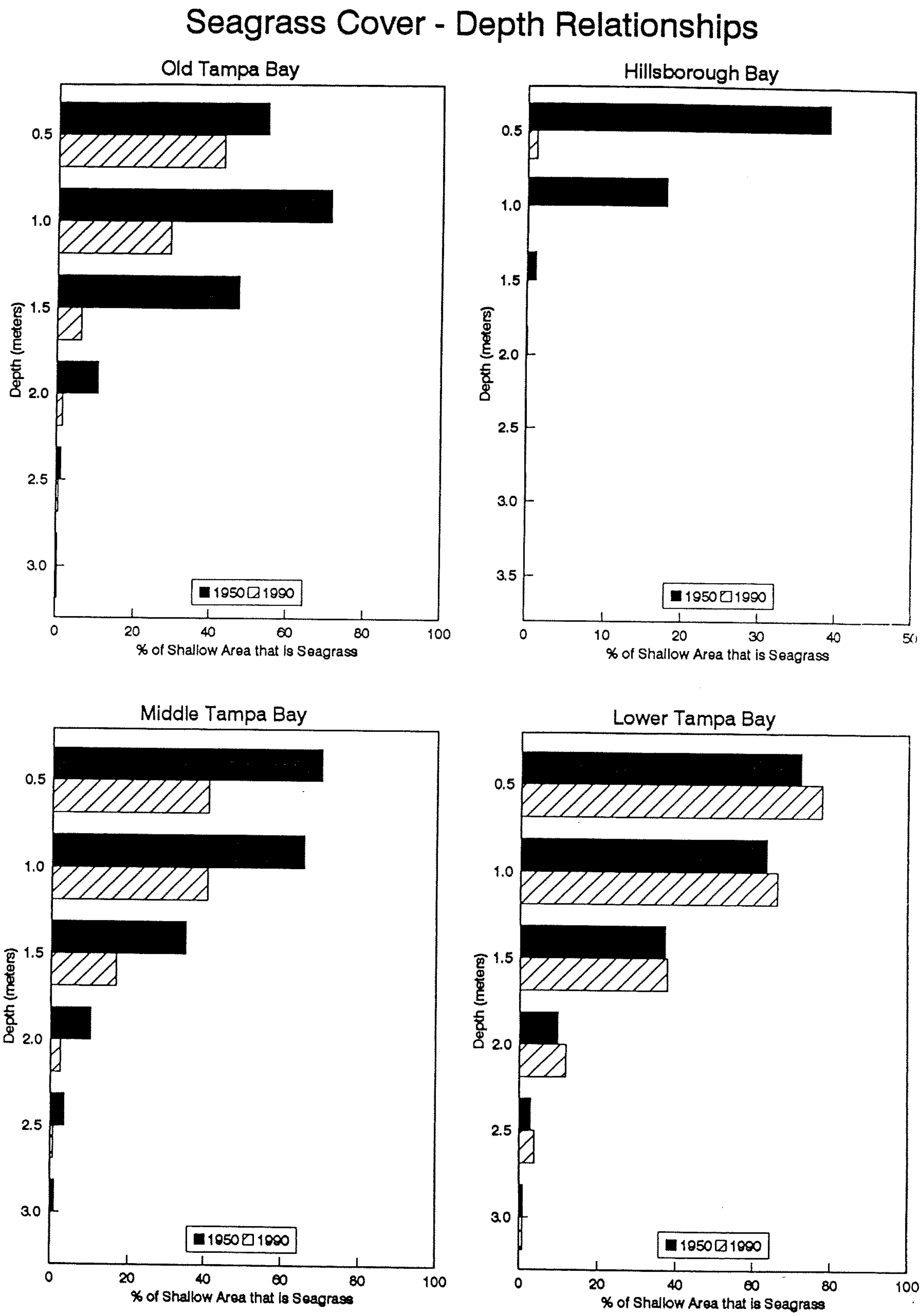

Figure 5.1 Comparative summary of seagrass cover by depth and bay segment for historical and current time periods.

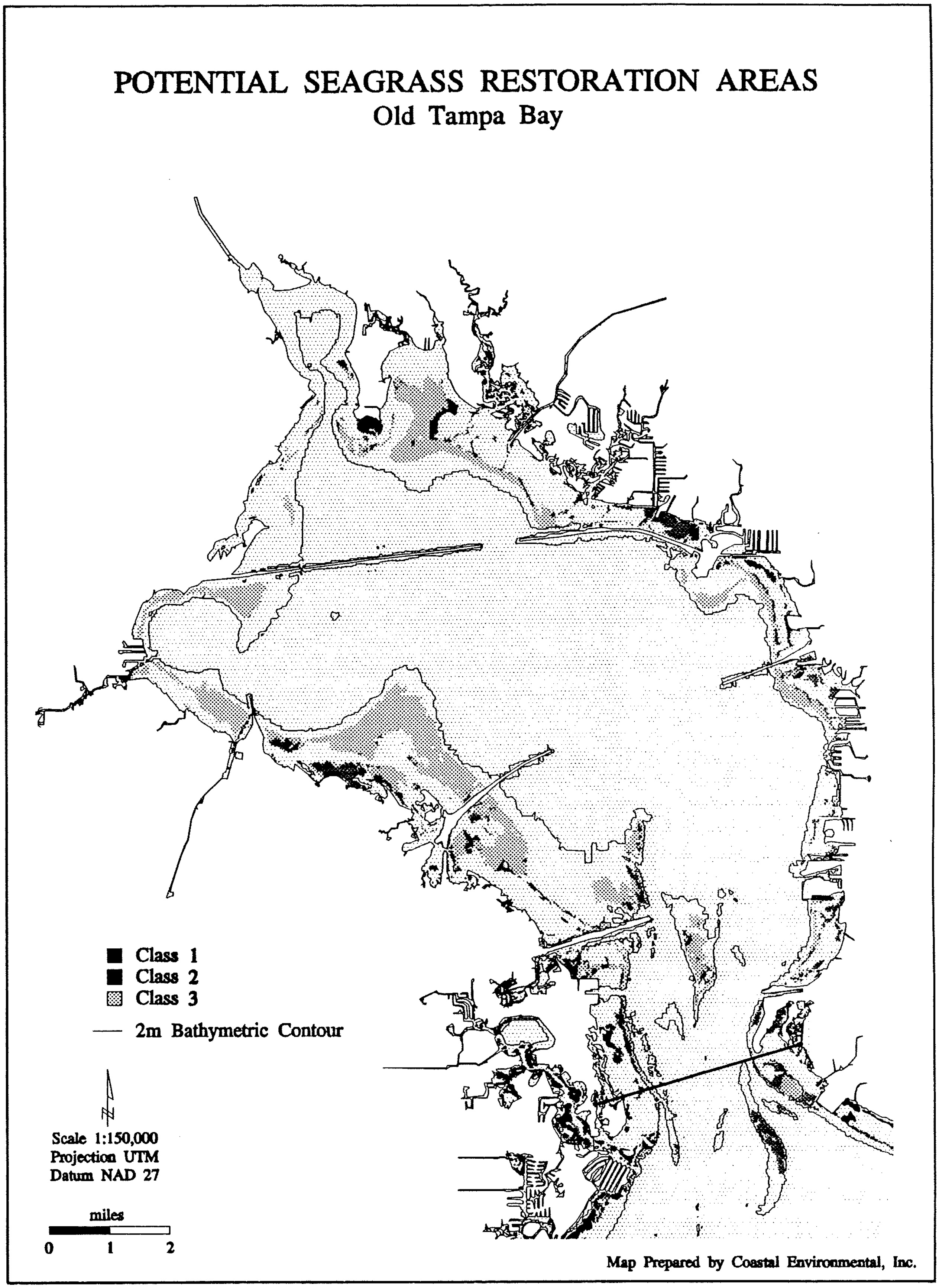

Figure 5.2 Potential seagrass restoration areas in Old Tampa Bay classified by Secchi depth and water depth (Class 1 represents areas with the greatest light penetration and shallowest depth).

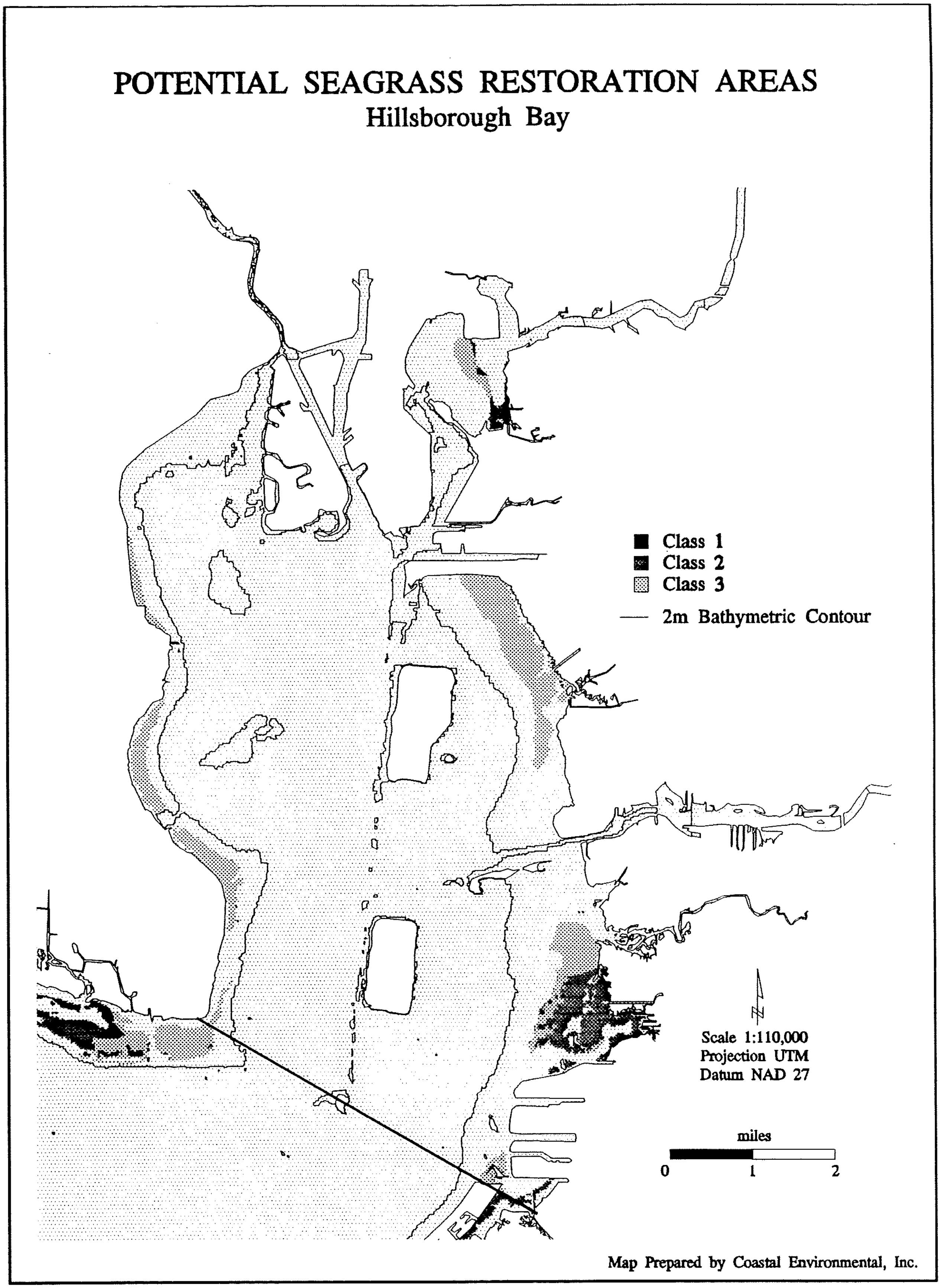

Figure 5.3 Potential seagrass restoration areas in Hillsborough Bay classified by Secchi depth and water depth (Class 1 represents areas with the greatest light penetration and shallowest depth).

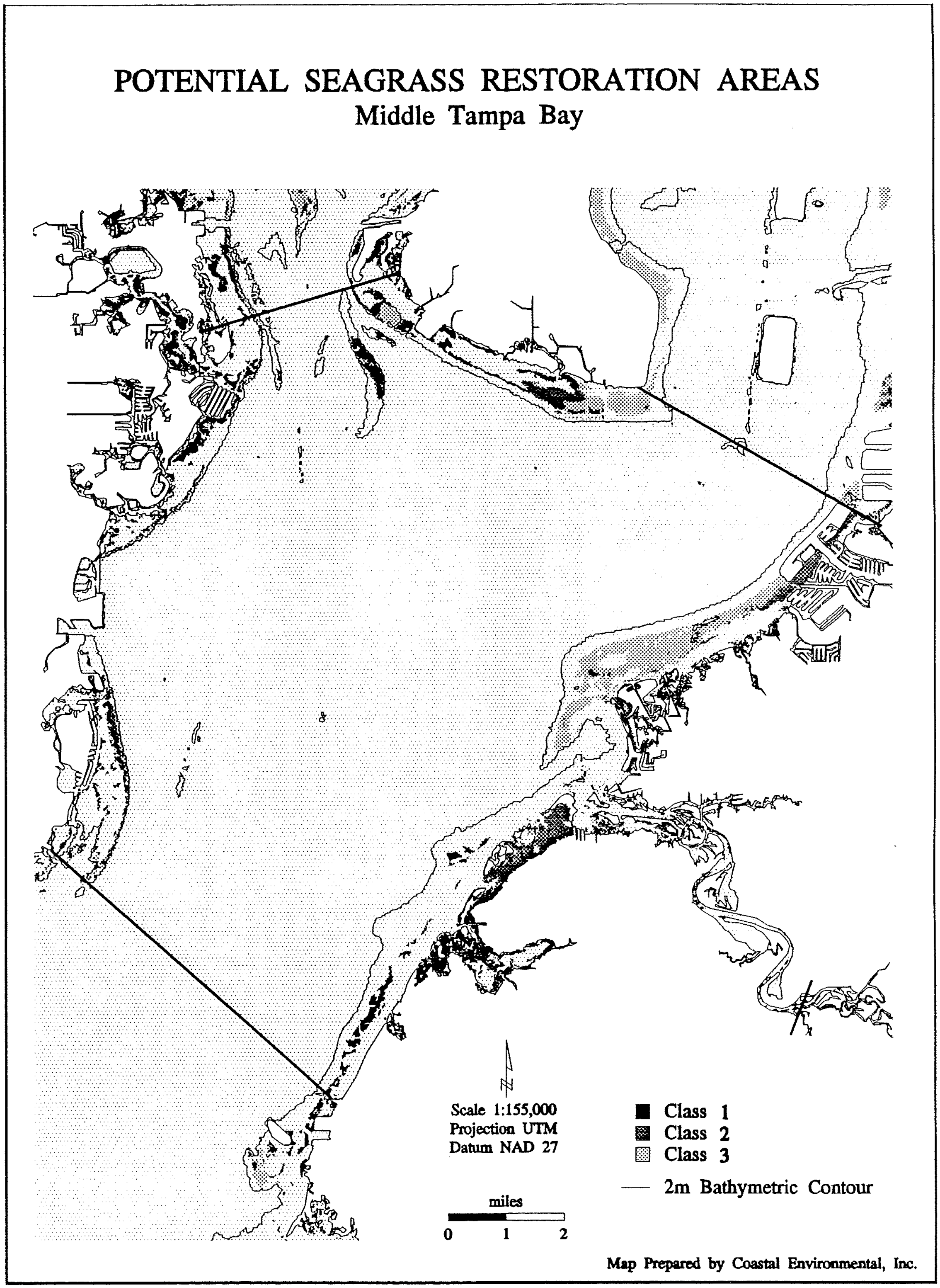

Figure 5.4 Potential seagrass restoration areas in Middle Tampa Bay classified by Secchi depth and water depth (Class 1 represents areas with the greatest light penetration and shallowest depth).

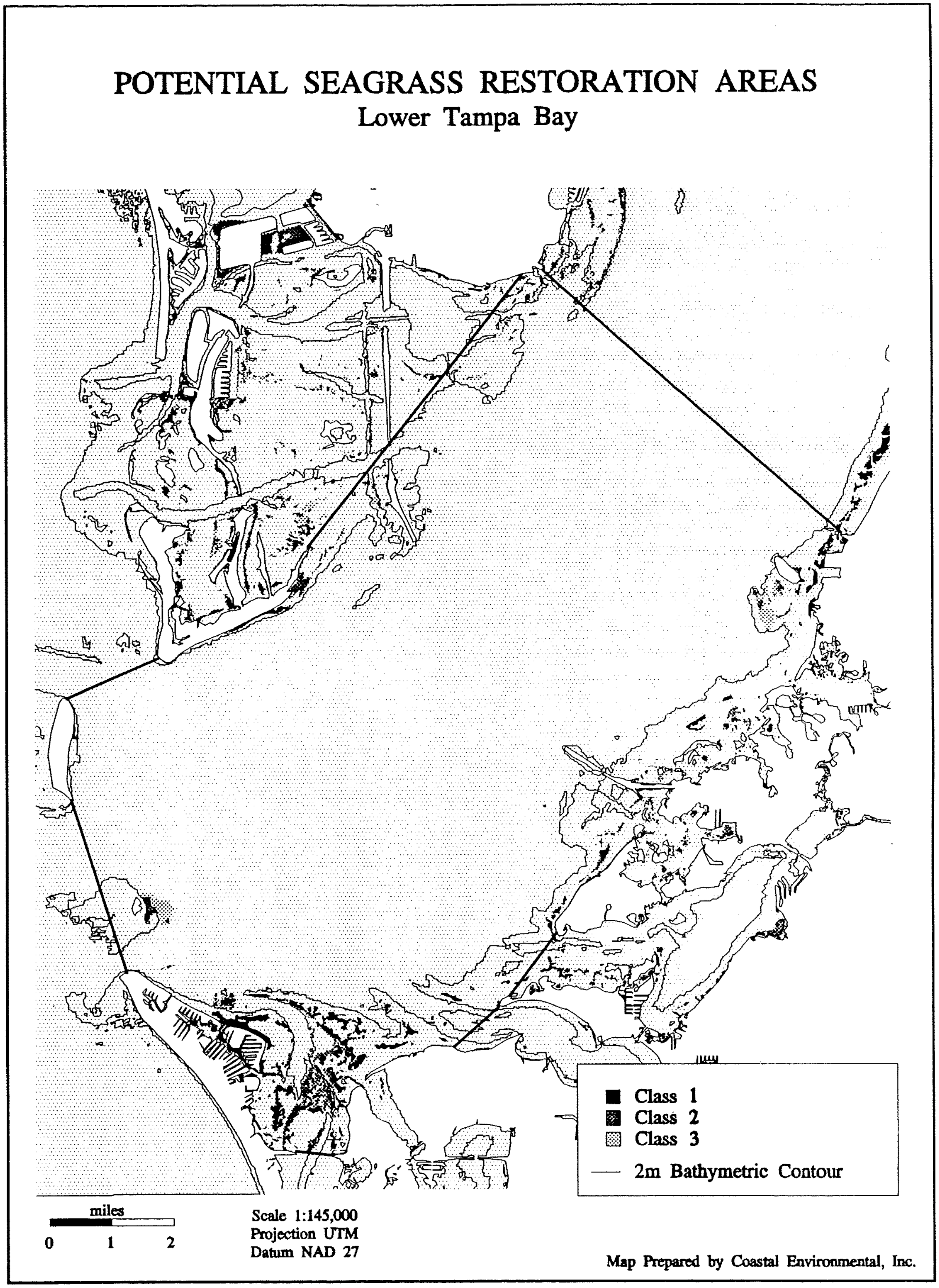

Figure 5.5 Potential seagrass restoration areas in Lower Tampa Bay classified by Secchi depth and water depth (Class 1 represents areas with the greatest light penetration and shallowest depth).

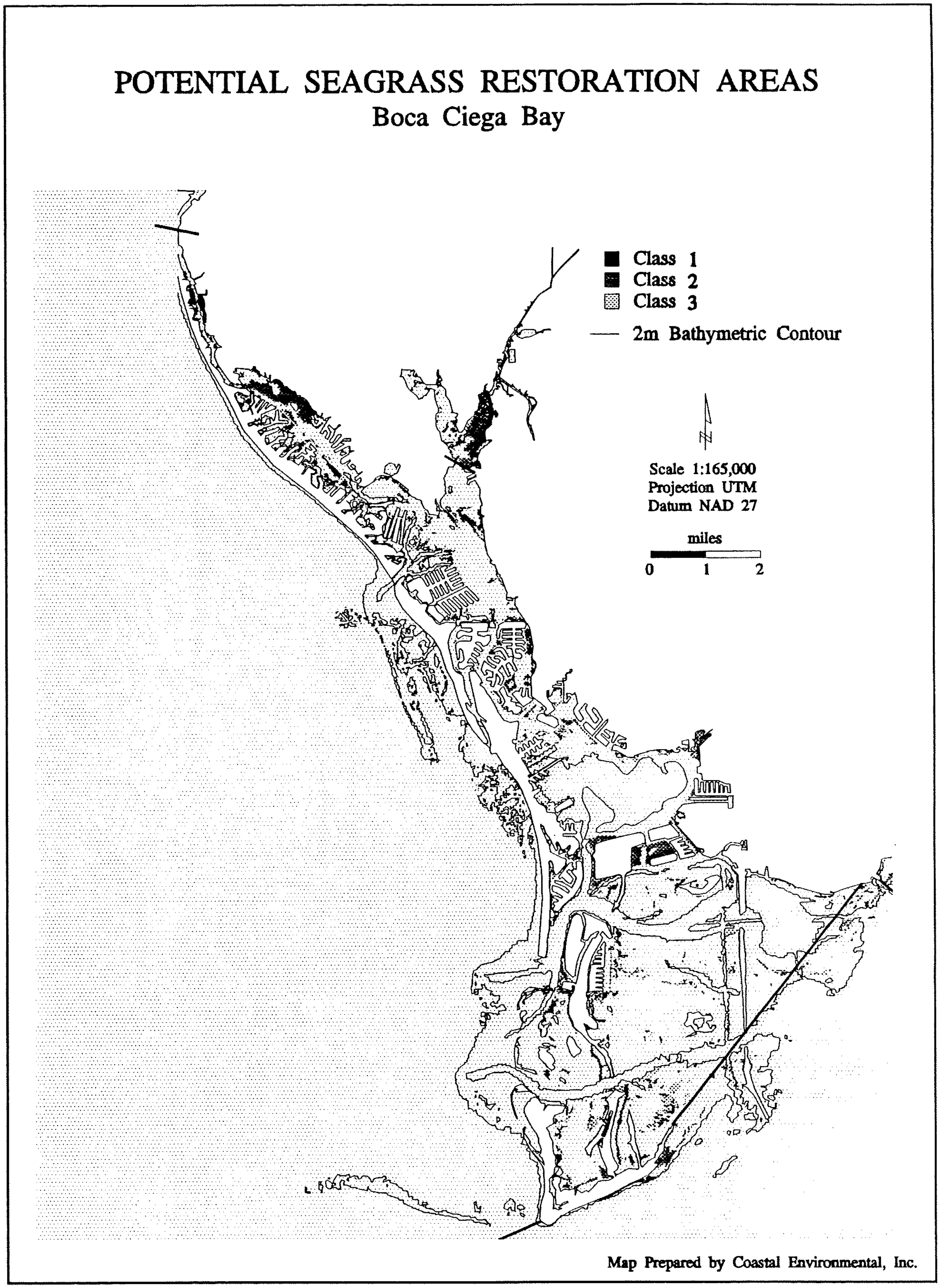

Figure 5.6 Potential seagrass restoration areas in Boca Ciega Bay classified by Secchi depth and water depth (Class 1 represents areas with the greatest light penetration and shallowest depth).

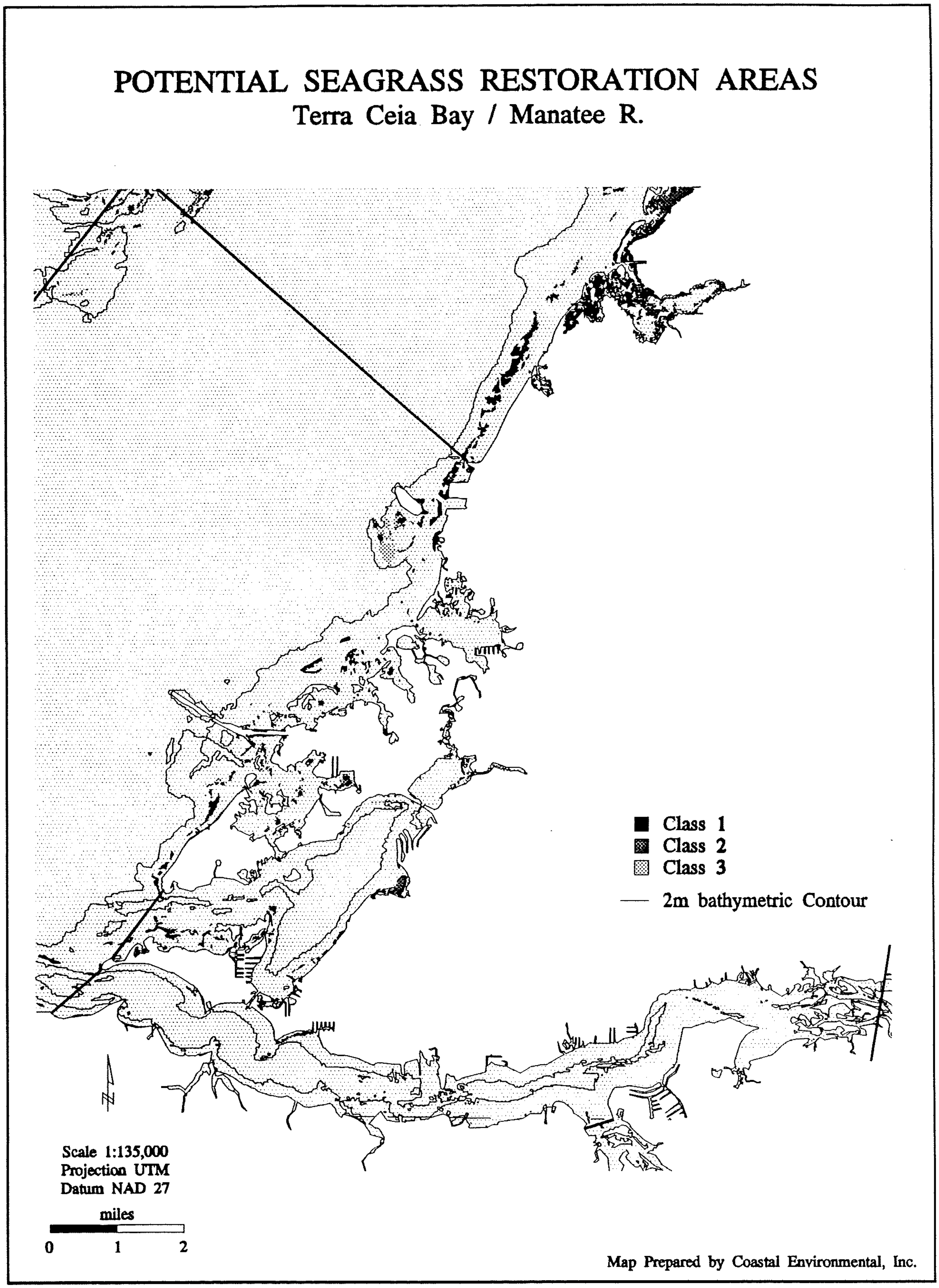

Figure 5.7 Potential seagrass restoration areas in Terra Ceia Bay and the Manatee River classified by Secchi depth and water depth (Class 1 represents areas with the greatest light penetration and shallowest depth).

6.0 LITERATURE CITED

Batiuk, R.A., R.J. Orth, K.A. Moore, W.C. Dennison, J.C. Stevenson, L.W. Staver, V. Carter, N.B. Rybicki, R.E. Hickman, S. Kollar, S. Bieber, and P. Heasly. 1992. Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: A Technical Synthesis. Chesapeake Bay Program, Annapolis Maryland. 186 p.

Brooks, G.R. and L.J. Doyle. 1991. Distribution of sediments and sedimentary contaminants in Tampa Bay. In Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida. pp. 399-414.

Carlton, J.M. 1975. A guide to common Florida salt marsh and mangrove vegetation. Florida Department of Natural Resources Marine Research Publication Number 6. FDNR Marine Research Laboratory, St. Petersburg Florida. 30 p.

Derrenbacker J.A. Jr., and R.R. Lewis III. 1985. Live bottom communities of Tampa Bay. In Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida. pp. 248-278. Tampa, FL. pp. 385-392.

Environmental Protection Commission of Hillsborough County (EPCHC). 1990. R. Boler ed. Surface water quality, Hillsborough County, Florida. EPCHC, Tampa, Florida.

Environmental Systems Research Institute, Inc. (ESRI). 1993. Arc/Info Geographic Information Systems Software Version 6.10. ESRI, Redlands, California.

Estevez, E.D. ed. 1989. Tampa and Sarasota Bays: Issues, Resources, Status, ad Management. NOAA Estuary-of-the-Month, Seminar Series No. 11. NOAA Washington, D.C., U.S. Government Printing Office: 1988 - 242-312/92627. 215 pp.

Estevez, E.D. and L. Mosura. 1985. Emergent vegetation. In Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida. pp. 248-278.

Florida Department of Transportation (FDOT). 1985. Florida land use, land cover and forms classification system: a technical manual. FDOT, Tallahassee, Florida. 66 p.

Goodwin, C.R. 1987. Tidal-flow, circulation, and flushing changes caused by dredge and fill in Tampa Bay, Florida. U.S. Geol. Surv. Water Supply Paper 2282. U.S. Geological Survey, Alexandria, Virginia.

Goodwin, C.R. 1989. Circulation of Tampa and Sarasota Bays. In E.D. Estevez, ed. Tampa and Sarasota Bays: Issues, Resources, Status, and Management. NOAA Estuary-of-the-Month Seminar Series No. 11. U.S. Dept. Commerc. Washington, D.C. pp.46-94.

Haddad, K. 1989. Habitat trends and fisheries in Tampa and Sarasota Bays. In E.D. Estevez, ed. Tampa and Sarasota Bays: Issues, Resources, Status, and Management. NOAA Estuary-of-the-Month Seminar Series No. 11. U.S. Dept. Commerce. Washington, D.C. pp. 113-128.

Lewis, R.R., III. 1977. Impacts of dredging in the Tampa Bay estuary, 1876-1976. In E.L. Pruitt, ed. Proceedings of the Second Annual Conference of the Coastal Society - time-stressed environments: assessments and future actions. Coastal Society, Arlington, VA. pp. 31-55.

Lewis, R.R., III. 1989. Biology and Eutrophication of Tampa Bay. In E.D. Estevez, ed. Tampa and Sarasota Bays: Issues, Resources, Status, and Management. NOAA Estuary-of-the-Month Seminar Series No. 11. U.S. Dept. Commerce. Washington, D.C. pp. 113-128.

Lewis R.R., III. and E.D. Estevez. 1988. The ecology of Tampa Bay, Florida: an estuarine profile. U.S. Fish and Wildlife Service Biological Report 85(7.18). U.S. Fish and Wildlife Service, Washington, D.C. 133 pp.

Lewis, R.R., III, and R.L. Whitman Jr. 1985. A new geographic description of the boundaries and subdivisions of Tampa Bay. In Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida. pp. 248-278.pp.

Lewis, R.R., III, M.J. Durako, M.D. Moffler, and R.C. Phillips. 1985a. Seagrass meadows of Tampa Bay: a review. In Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida. pp. 248-278.pp.

Lewis, R.R., III, R.G. Gilmore Jr., D.W. Crewz, and W.E. Odum. 1985b. Mangrove habitat and fishery resources of Florida. In Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida. pp. 248-278. Tampa, FL. pp. 281-336.

Lewis, R.R., III, K.D. Haddad, and J.O.R. Johansson. 1991. Recent areal expansion of seagrass meadows in Tampa Bay, Florida: real bay improvement or drought-induced? In Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida. pp. 248-278. pp. 189-192.

Morris, L.J. and D.A. Tomasko (eds). 1993. Proceedings and Conclusions of Workshops on: Submerged Aquatic Vegetation and Photosynthetically Active Radiation. Special Publication SJ93-SP13. Palatka, Florida: St. Johns River Water Management District.

NUS Corporation. 1986. Tampa Bay estuarine wetland trend analysis. Prepared for the Tampa Bay Regional Planning Council. St. Petersburg, Florida.

Schomer, N.S., R.D. Drew, and P. Johnson. 1990. Vegetation Communities. In Wolfe, S.H. and R.D. Drew, eds. 1990. An ecological characterization of the Tampa Bay watershed. U.S. Fish and Wildlife Service Biological Report 90(20). pp. 134-215.

Tampa Bay National Estuary Program (TBNEP). 1993. Tampa Bay status and trends. Printed by the Tampa Bay National Estuary Program, St. Petersburg Florida in cooperation with the U.S. Environmental Protection Agency, Region IV.

Tampa Bay National Estuary Program (TBNEP). 1994a. Physical impacts to bottom habitats in Tampa Bay. Prepared for the Tampa Bay National Estuary Program. Prepared by Coastal Environmental, Inc. TBNEP, St. Petersburg, Florida. 130 p.

Tampa Bay National Estuary Program (TBNEP). 1994b. A monitoring program to assess environmental changes in Tampa Bay, Florida. Prepared for the Tampa Bay National Estuary Program. Prepared by Coastal Environmental, Inc. TBNEP Technical Publication #02-93.

Tampa Bay National Estuary Program (TBNEP). In Review. Current and Historical Freshwater Inflow to Tampa Bay, Florida. Prepared for the Tampa Bay National Estuary Program. Prepared by Coastal Environmental, Inc. TBNEP, St. Petersburg, Florida.

Tampa Bay Regional Planning Council (TBRPC). 1986. Habitat restoration study for the Tampa Bay Region. Prepared by TBRPC, St. Petersburg, Florida. 283 p.

Treat, S.F. and P.A. Clark, eds. 1991. Proceedings of the Tampa Bay Area Scientific Information Symposium 2. February, 1991. Available from TEXT, Tampa Florida.

Treat, S.F., J.L. Simon, R.R. Lewis III, and R.L. Whitman Jr. 1985. Proceedings of the Tampa Bay area scientific information symposium, May 1982. Florida Sea Grant College Report Number 65. Bellwether Press, Tampa Florida.

Wolfe, S.H. and R.D. Drew, eds. 1990. An ecological characterization of the Tampa Bay watershed. U.S. Fish and Wildlife Service Biological Report 90(20). 334 p.

Zieman J.C. and R.T. Zieman. 1989. The ecology of the seagrass meadows of the west coast of Florida: a community profile. U.S. Fish and Wildlife Service Biological Report 85(7.25). 155 pp.

APPENDIX 1

IDENTIFICATION OF SPECIES THAT REFLECT THE VIABILITY OF IMPORTANT TAMPA BAY HABITATS

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INTRODUCTION

One of the Tampa Bay National Estuary Program's (TBNEP) major goals is to develop a Comprehensive Conservation and Management Plan (CCMP) for the Tampa Bay estuary and its surrounding waters. Living resources management and habitat protection plans will be two major components of the CCMP. Habitat resource "targets" identified by TBNEP will guide the development of the CCMP management strategies for Tampa Bay. These targets include critical habitats (e.g. mangroves, seagrasses) and biological resources (e.g. fish, bay scallops, benthos) that are considered valuable to the Tampa Bay Estuary by the TBNEP.

TBNEP is conducting a Habitat Resources Mapping Project to provide information that can be incorporated into the CCMP. The primary objectives of the Habitat Resource Mapping Project are to identify and map locations of seven critical habitats (seagrass, mangrove, coastal marsh, salt barren/high marsh (saltern), pelagic, non-vegetated subtidal, and non-vegetated intertidal) in Tampa Bay; identify those that might require protection, enhancement, or restoration; and provide recommendations regarding monitoring the effectiveness of restoration/protection actions. The Habitat Resource Mapping Project has four components. This document focuses on Task 2, which has undergone a series of transitions in scope since the inception of the project. Task 2 was developed to provide information that can be used to evaluate whether a habitat restoration or protection plan meets its goal.

Task 2 of the Habitat Resource Mapping Project originally was intended to identify one or two candidate indicator species for each habitat type that would aid in assessing whether a critical habitat was functioning adequately. Indicator species were to be selected to represent each of the habitats in two salinity regimes in the estuary: waters with salinities greater than or equal to 10 ppt (saline), and waters with salinities less than 10 ppt (oligohaline). Critical environmental requirements that determine the viability of the habitat for the chosen species were also to be identified.

Candidate indicator species were to be evaluated based on the following selection criteria:

- Ecologically/Economically significant
- Species are sensitive to environmental impacts
- Existing knowledge is available on resources and requirements
- Ability to measure their response to changing environmental conditions (e.g., status can be monitored).
- Effects of anthropogenic impacts can be measured
- Ability to determine historical distribution

After some debate, the Living Resource subcommittee agreed that the approach of selecting a very limited number of "target" species would not appropriately fulfill the original objective of the Living Resources Mapping Project. A great deal of concern also arose regarding the lack of well defined information on environmental requirements for many species; consequently the subcommittee recommended discontinuing the approach of defining environmental requirements for the "target" species.

The Living Resource Subcommittee agreed that the redefined approach to Task 2 would be to compile a list of organisms that constitute a viable community for each of the critical habitats and salinity ranges. This information could be used to assist in evaluating the effectiveness of habitat restoration and preservation efforts in the Tampa Bay Estuary. A restoration or preservation effort will be considered successful if all or part of the identified viable community exists within a particular habitat. Other tasks within the Habitat Resources Mapping Project will provide recommendations on how the communities selected in Task 2 should be monitored to provide information necessary to evaluate the success of a restoration or preservation program.

METHODS

Completing Task 2 required a thorough review of available information concerning biological resources in the Tampa Bay estuary. This review involved searching computerized data bases, reviewing published and unpublished literature, and corresponding with scientists who have conducted research in the estuary. A bibliographic data base of Tampa Bay references compiled by the Center for Nearshore Marine Science at University of South Florida was reviewed for pertinent information. Information obtained from two recent TBNEP publications was also helpful. These were "A Synthesis of Life Histories of Bay Species" (Killam et al. 1992) which provided information about critical habitats for important fish and wildlife species that are dependent on the estuary, and "Oligohaline Areas in Tampa Bay Tributaries: Spatial Extent and Species List" (Coastal Environmental Services 1992), which provided information on the extent of oligohaline areas in the four major tidal tributaries as well as species lists of plants, benthos, and fish and their distributions by salinity. Numerous other references obtained for the synthesis of life histories of Tampa Bay species, including published journal articles, grey literature, books, government documents and unpublished data sets were reviewed.

Scientists who conducted research on biological resources in the Tampa Bay estuary were contacted to solicit information on biological communities representative of the seven selected critical habitats and two salinity regions. A list of scientists who were contacted is shown in Table 1. These scientists provided additional information on published and unpublished data and ongoing research in the estuary. They were also asked to identify a variety of organisms that could be considered components of viable critical habitats including plants, phytoplankton, zooplankton, ichthyoplankton, benthos, fish, birds, reptiles and amphibians, and mammals.

Information obtained from the literature search and through correspondence with scientists was synthesized into tables of species (in some cases genera or families) that represent a viable community for each habitat. Species selected for each habitat were partitioned by salinity class.

It was difficult to select representative species of all communities for each critical habitat. For example, the phytoplankton and zooplankton communities are more influenced by physical or chemical conditions within the estuary (e.g. salinity) than by other features of a particular structural habitat. For these reasons, phytoplankton and zooplankton species, genera, or families were chosen to represent the saline and oligohaline portions of the pelagic habitat rather than assigning them to structural habitats such as seagrass or mangrove. No information was tabulated for SAV habitats in oligohaline waters. A list of possible SAV species that might be found in oligohaline waters of Tampa Bay was determined by King Engineering Associates, Inc. based on Traver et al. (1986); however, it would be inappropriate to assign any SAV species to the oligohaline areas of the Tampa Bay estuary until actual field surveys are conducted. The salt barren/high marsh habitat comprise areas which are unique to the higher salinity regions of the Tampa Bay Estuary; therefore, it would have been inappropriate to attempt to identify an oligohaline community associated with this habitat.

Species of commercial or recreational importance, those having rare, threatened or endangered status, and species whose life histories and environmental requirements were detailed in previous TBNEP publications are identified in this document to provide additional information on particular components of a viable community.

TABLE 1. LIST OF CONTACTS

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Don A. Wood
Fl. Game and Freshwater Fish Commission
Tallahassee, FL

Habitat: SEAGRASSES (>10 ppt)

	Scientific Name	Common Name
SEAGRASSES		
	Thalassia testudinum	turtle grass
	Syringodium filiforme	manatee grass
	Halodule wrightii	shoal grass
	Ruppia maritima	widgeon grass[4]
	Halophila engelmannii	star grass
ICHTHYOPLANKTON		
	Brevoortia spp.	menhaden[1]
	Opisthonema oglinum	Atl. thread herring
	Anchoa mitchilli	bay anchovy[1,3]
	Gobiesox strumosus	skilletfish
	Menidia spp.	silverside
	Bairdiella chrysoura	silver perch[3]
	Cynoscion nebulosus	spotted seatrout[1,3]
	Menticirrhus spp.	whiting[1]
	Sciaenops ocellatus	red drum[1,3]
	Chasmodes saburrae	Florida blenny
	Hypsoblennius hentzi	feather blenny
	Bathygobius soporator	frillfin goby
	Sygnathus louisianae	chain pipefish
	Sygnathus scovelli	Gulf pipefish
	Hippocampus zosterae	dwarf seahorse
	Oligoplites saurus	leatherjacket
	Eucinostomus spp.	mojarra
	Lagodon rhomboides	pinfish
	Archosargus probatocephalus	sheepshead[1]
	Gobiosoma bosci	naked goby
	Gobiosoma robustum	code goby
	Microgobius gulosus	clown goby[3]
	Microgobius thalassina	green goby
	Prionotus spp.	searobin
	Achirus lineatus	lined sole[3]
	Symphurus plagiusa	blackcheek tonguefish
BENTHOS		
Phylum Nemertea		
	Nemertea sp.	
Phylum Mollusca		
Class Gastropoda		
	Crepidula maculosa	
	Mitrella lunulata	
	Nassarius vibex	
	Gastropoda sp.	
	Anachis semiplicata	
	Diastoma varium	
Order Nudibranchia		
	Aplysia sp.	sea hare

Habitat: SEAGRASSES (>10 ppt)

Scientific Name	Common Name
Class Bivalvia	
Amygdalum papyrium	
Mysella planulata	
Lyonsia hyalina	
Argopectin irradians	bay scallop
Geukensia demissa	ribbed mussel
Phylum Annelidia	
Class Polychaeta	
Streblospio benedicti	
Kimbergonuphis simoni	
Axiothella mucosa	
Capitella capitata	
Tharyx dorsobranchialis	
Leitoscoloplos robustus	
Laeonereis culveri	
Heteromatus filiformis	
Arenicola cristata	
Brania wellfleetensis	
Prionospio heterobranchia	
Aricidea taylori	
A. philbinae	
Sphaerosyllis longicauda	
Polydora ligni	
Neanthes succinea	
Magelona pettiboneae	
Prionospio perkinsi	
Neanthes acuminata	
Nereidae sp.	
Eteone heteropoda	
Scolelepis texana	
Mediomastus ambiseta	
Pectinaria gouldii	
Brania clavata	
Diopatra cuprea	
Class Oligochaeta	
Enchytraeidae spp.	
Tubificidae spp.	
Phylum Arthropoda	
Class Crustacea	
Order Amphipoda	
Ampelisca holmesi	
Ampelisca vadorum	
Cymadusa compta	
Grandidierella bonnieroides	
Corophium sp.	
Order Tanaidacea	
Hargeria rapax	

Habitat: SEAGRASSES (>10 ppt)

Scientific Name	Common Name
Order Isopoda	
Erichsonella attenuata	
Order Thoracica	
Balanus sp.	barnacle
Order Decapoda	
Penaeus duorarum	pink shrimp[1,3]
Palaemonetes intermedius	cleaning shrimp[3]
Palaemonetes pugio	grass shrimp[3]
Periclimenes longicaudatus	cleaning shrimp
Tozeuma carolinense	arrow shrimp
Processa hemphilli	grass shrimp
Periclimenes americanus	grass shrimp
Alpheus normanni	green snapping shrimp
Hippolyte sp.	grass shrimp
Callinectes sapidus	blue crab[1,3]
Portunus gibbesii	portunid crab
Libinia dubia	spider crab
Neopanope sp.	mud crab
Limulus polyphemus	horseshoe crab
Order Teuthidida	
Lolliguncula brevis	brief squid
Phylum Chordata	
Branchiostoma floridae	lancelet
FISH	
Carcharhinus limbatus	blacktip shark[1]
Sphyrna tiburo	bonnethead shark
Elops saurus	ladyfish
Brevoortia spp.	menhaden[1]
Dorosoma petenense	threadfin shad
Harengula jaguana	scaled sardine
Opisthonema oglinum	Atl. thread herring
Anchoa mitchilli	bay anchovy[1,3]
Synodus foetens	inshore lizardfish
Arius felis	hardhead catfish
Bagre marinus	gafftopsail catfish
Gobiesox strumosus	skilletfish
Urophycis floridana	southern hake
Strongylura spp.	needlefish
Cyprinodon variegatus	sheepshead minnow
Floridichthys carpio	goldspot killifish
Fundulus grandis	Gulf killifish
Fundulus similis	longnose killifish
Lucania parva	rainwater killifish
Menidia spp.	silverside
Hippocampus erectus	lined seahorse
Hippocampus zosterae	dwarf seahorse
Syngnathus louisianae	chain pipefish
Syngnathus scovelli	Gulf pipefish

Habitat: SEAGRASSES (>10 ppt)

Scientific Name	Common Name
Centropristis striata	black sea bass[1]
Lutjanus griseus	grey snapper[1]
Eucinostomus gula	silver jenny
Eucinostomus harengulus	tidewater mojarra
Orthopristis chrysoptera	pigfish
Archosargus probatocephalus	sheepshead[1]
Diplodus holbrookie	spottail pinfish
Lagodon rhomboides	pinfish
Bairdiella chrysoura	silver perch
Cynoscion nebulosus	spotted seatrout[1,3]
Leiostomus xanthurus	spot[1,3]
Menticirrhus americanus	southern kingfish[1]
Menticirrhus saxatilis	northern kingfish[1]
Sciaenops ocellatus	red drum[1,3]
Mugil spp.	mullet[1,3]
Chasmodes saburrae	Florida blenny
Hypsoblennius hentzi	feather blenny
Gobionellus boleosoma	darter goby
Gobiosoma robustum	code goby
Microgobius gulosus	clown goby[3]
Prionotus scitulus	leopard searobin
Opsanus beta	Gulf toadfish
Citharichthys macrops	spotted whiff
Etropus crossotus	fringed flounder
Paralichthys albigutta	Gulf flounder[1]
Achirus lineatus	lined sole[3]
Symphurus plagiusa	blackcheek tonguefish
Monacanthus hispidus	planehead filefish
Lactophrys quadricornis	scrawled cowfish
Sphoeroides nephelus	southern puffer
Chilomycterus schoepfi	striped burrfish

MARINE MAMMAL

Trichechus manatus	Florida manatee[2,3]

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

[4] = Also present at salinities < 10 ppt.

Habitat: MANGROVES (>10 ppt)

	Scientific Name	Common Name
MANGROVES		
	Rhizophora mangle	red mangrove
	Avicennia germinans	black mangrove
	Laguncularia racemosa	white mangrove
	Conocarpus erecta	buttonwood
ICHTHYOPLANKTON	*Centropomus undecimalis*	common snook[1,2,3]

No studies dealt specifically with ichthyoplankton collected in the mangrove fringes (Primarily because of the difficulty in sampling these habitats). Snook larvae were observed while snorkeling around mangrove prop roots in high and low salinity regions of Tampa Bay (K. Peters, pers comm. 1992). It is likely that larvae of other fish species which are identified below in the FISH section also use the mangrove ecosystem.

	Scientific Name	Common Name
BENTHOS		
	Littorina irrorata	saltmarsh periwinkle
	Melampus coffeus	gastropod
	Cerithidea scalariformisit	gastropod
	Bulla spp.	gastropod
	Crassostrea virginica	American oyster[1,3]
	Brachidontes spp.	bivalve
	Nereis spp.	polychaete
	Balanus spp.	barnacle
	Ligea exotica	isopod
	Sphaeroma terebrans	isopod
	Aratus pisonii	mangrove tree crab
	Sesarma curacoaense	crab
	Penaeus duorarum	pink shrimp[1,3]
	Alpheus spp.	snapping shrimp
	Callinectes sapidus	blue crab[1,3]
	Libinia dubia	spider crab
	Neopanope texana	mud crab
	Menippe mercenaria	stone crab
	Ascidia niger	tunicate
FISH		
	Anchoa mitchilli	bay anchovy1,3
	Gobiesox strumosus	skilletfish
	Megalops atlanticus	Atl. tarpon[1,3]
	Adinia xenica	diamond killifish
	Cyprinodon variegatus	sheepshead minnow
	Floridichthys carpio	goldspot killifish
	Fundulus grandis	gulf killifish
	Fundulus similis	longnose killifish
	Lucania parva	rainwater killifish
	Poecilia latipinna	sailfin molly
	Menidia spp.	silverside
	Centropomus undecimalis	common snook[1,2,3]
	Eucinostomus gula	silver jenny
	Eucinostomus harengulus	tidewater mojorra
	Orthopristis chrysoptera	pigfish

Habitat: MANGROVES (>10 ppt)

	Scientific Name	Common Name
	Archosargus probatocephalus	sheepshead[1]
	Lagodon rhomboides	pinfish
	Cynoscion arenarius	white seatrout[1]
	Cynoscion nebulosus	spotted seatrout[1,3]
	Leiostomus xanthurus	spot[1,3]
	Menticirrhus americanus	southern kingfish[1]
	Menticirrhus saxatilis	northern kingfish[1]
	Sciaenops ocellatus	red drum[1,3]
	Mugil spp.	mullet[1,3]
	Gobionellus boleosoma	darter goby
	Gobiosoma robustum	code goby
	Microgobius gulosus	clown goby[3]
	Paralichthys albigutta	Gulf flounder[1]
	Achirus lineatus	lined sole[3]
	Sphoeroides nephelus	southern puffer
BIRDS		
	Pelecanus occidentalis	brown pelican[2]
	Pelecanus erythrorhynchos	white pelican
	Phalacrocorax auritus	double-crested cormorant
	Anhinga anhinga	anhinga
	Fregata magnificens	magnificant frigatebird
	Ardea herodias	great blue heron
	Casmerodius albus	great egret
	Egretta thula	snowy egret[2]
	Egretta tricolor	tricolored heron[2]
	Egretta rufescens	reddish egret[2]
	Nycticorax nycticorax	black-crowned night-heron
	Nyctanassa violacea	yellow-crowned night-heron
	Eudocimus albus	white ibis
	Plegadis falcinellus	glossy ibis
	Ajaia ajaja	roseate spoonbill[2]
	Mycteria americana	wood stork[2]
	Coragyps atratus	black vulture
	Cathartes aura	turkey vulture
	Circus cyaneus	northern harrier[2]
	Buteo jamaicensis	red-tailed hawk
	Falco peregrinus	peregrine falcon[2]
	Haliaeetus leucocephalus	bald eagle[2]
	Pandion haliaetus	osprey
	Rallus longirostris	clapper rail[2]
	Coccyzus minor	mangrove cuckoo
	Tyrannus dominicensis	gray kingbird
	Vireo altiloquus	black-whiskered vireo
	Dendroica discolor	prarie warbler
	D. palmarum	palm warbler
	Corvus ossifragus	fishcrow
REPTILES AND AMPHIBIANS		
	Eumeces inexpectatus	SE five-lined skink
	Nerodia fasciata taeniata	Atl. salt marsh snake[2]
	Drymarchon corais couperi	Eastern indigo snake[2]

Habitat: MANGROVES (>10 ppt)

	Scientific Name	Common Name
	Neroidia fasciata compressicauda	mangrove water snake
	Opheodrys aestivus	rough green snake
	Alligator mississippiensis	American alligator[2]
	Malaclemys terrapin	diamondback terrapin
MAMMALS		
	Procyon lotor	raccoon
	Mustela vison	mink[2]
	Lutra canadensis	river otter[2]
	Mephitis mephitis	striped skunk

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: MANGROVES (<10 ppt)

	Scientific Name	Common Name
MANGROVES		
	Rhizophora mangle	red mangrove
	Avicennia germinans	black mangrove
	Laguncularia racemosa	white mangrove
	Conocarpus erecta	buttonwood
ICHTHYOPLANKTON		
	Centropomus undecimalis	common snook[1,2,3]

No studies dealt specifically with ichthyoplankton collected in the mangrove fringes. Snook larvae were observed while snorkeling around mangrove prop roots in high and low salinity regions of Tampa Bay (K. Peters, pers comm. 1992). It is likely that larvae of other fish species which are identified below in the FISH section also use the mangroves.

	Scientific Name	Common Name
BENTHOS		
	Crassostrea virginica	American oyster[1,3]
	Aratus pisonii	mangrove tree crab
	Littorina irrorata	saltmarsh periwinkle
	Melampus coffeus	snail
	Sesarma curacoaense	crab
	Penaeus duorarum	pink shrimp[1,3]
	Callinectes sapidus	blue crab[1,3]
	Neopanope texana	mud crab
FISH		
	Anchoa mitchilli	bay anchovy[1,3]
	Brevoortia spp.	menhaden[1]
	Megalops atlanticus	Atl. tarpon[1,3]
	Adinia xenica	diamond killifish
	Fundulus grandis	gulf killifish
	Fundulus majalis	striped killifish
	Fundulus seminolis	seminole killifish
	Lucania goodei	bluefin killifish
	Fundulus confluentus	marsh killifish
	Lucania parva	rainwater killifish
	Rivulus marmoratus	rivulus[2]
	Gambusia affinis	mosquitofish
	Heterandria formosa	least killifish
	Poecilia latipinna	sailfin molly
	Labidesthes sicculus	brook silverside
	Menidia beryllina	tidewater silverside
	Centropomus undecimalis	common snook[1,2,3]
	Eucinostomus gula	silver jenny
	Eucinostomus harengulus	tidewater mojarra
	Diapterus plumieri	striped mojarra
	Lagodon rhomboides	pinfish
	Cynoscion arenarius	white seatrout[1]
	Cynoscion nebulosus	spotted seatrout[1,3]
	Leiostomus xanthurus	spot[1,3]
	Menticirrhus americanus	southern kingfish[1]

Habitat: MANGROVES (<10 ppt)

	Scientific Name	Common Name
	Menticirrhus saxatilis	northern kingfish[1]
	Sciaenops ocellatus	red drum[1,3]
	Mugil spp.	mullet[1,3]
	Gobiosoma bosci	naked goby
	Microgobius gulosus	clown goby[3]
	Trinectes maculatus	hogchoker[3]
BIRDS		
	Pelecanus occidentalis	brown pelican[2]
	Pelecanus erythrorhynchos	white pelican
	Phalacrocorax auritus	double-crested cormorant
	Anhinga anhinga	anhinga
	Fregata magnificens	magnificant frigatebird
	Ardea herodias	great blue heron
	Casmerodius albus	great egret
	Egretta thula	snowy egret[2]
	Egretta tricolor	tricolored heron[2]
	Egretta rufescens	reddish egret[2]
	Nycticorax nycticorax	black-crowned night-heron
	Nyctanassa violacea	yellow-crowned night-heron
	Eudocimus albus	white ibis
	Plegadis falcinellus	glossy ibis
	Ajaia ajaja	roseate spoonbill[2]
	Mycteria americana	wood stork[2]
	Coragyps atratus	black vulture
	Cathartes aura	turkey vulture
	Circus cyaneus	northern harrier[2]
	Buteo jamaicensis	red-tailed hawk
	Falco peregrinus	peregrine falcon[2]
	Haliaeetus leucocephalus	bald eagle[2]
	Pandion haliaetus	osprey
	Rallus longirostris	clapper rail[2]
	Coccyzus minor	mangrove cuckoo
	Tyrannus dominicensis	gray kingbird
	Vireo altiloquus	black-whiskered vireo
	Dendroica discolor	prarie warbler
	D. palmarum	palm warbler
	Corvus ossifragus	fishcrow
REPTILES AND AMPHIBIANS		
	Eumeces inexpectatus	SE five-lined skink
	Nerodia fasciata taeniata	Atl. salt marsh snake[2]
	Drymarchon corais couperi	Eastern indigo snake[2]
	Neroidia fasciata compressicauda	mangrove water snake
	Opheodrys aestivus	rough green snake
	Alligator mississippiensis	American alligator[2]
	Kinosternon bauri	striped mud turtle[2]
	Terrapene carolina	box turtle
	Malaclemys terrapin	diamondback terrapin
	Chrysemys nelsoni	Fl red-bellied turtle

Habitat: MANGROVES (<10 ppt)

	Scientific Name	Common Name
	Deirochelys reticularia	chicken turtle
	Trionx ferox	Fl softshell turtle
	Hyla cinerea	green tree frog
	Rana sphenocephala	southern leopard frog
MAMMALS		
	Procyon lotor	raccoon
	Mustela vison	mink[2]
	Lutra canadensis	river otter[2]
	Mephitis mephitis	striped skunk

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: TIDAL MARSH (>10 ppt)

	Scientific Name	Common Name
MARSH PLANTS		
	Juncus roemerianus	black needlerush
	Spartina alterniflora	smooth cordgrass
	Distichlis spicata	salt grass
	Eleocharis cellulosa	spike rush
	Salicornia spp.	glass wort
	Sesuvium portulacastrum	sea purslane
	Batis maritima	salt wort
	Borrichia frutescens	sea-oxeye
BENTHOS		
	Anthenaria sp.	anthozoa
	Melampus bidentatus	gastropod mollusc
	Melampus coffeus	gastropod mollusc
	Assiminea succinea	gastropod mollusc
	Littorina irrorata	saltmarsh periwinkle
	Cerithidea spp.	gastropod mollusc
	Geukensia demissa	ribbed mussel
	Polymesoda caroliniana	bivalve mollusc
	Cyrenoidea floridana	bivalve mollusc
	Crassostrea virginica	American oyster[1,3]
	Neanthes succinea	polychaete
	Scoloplos fragilis	polychaete
	Laeonereis culveri	polychaete
	Capitella capitata	polychaete
	Spirorbis spirillum	polychaete
	Enchytraeidae spp.	oligochaete
	Tubificidae spp.	oligochaete
	Cyathura polita	isopod
	Hargeria rapax	tanaid
	Balanus spp.	barnacle
	Gammarus mucronatus	amphipod
	Uca spp.	fiddler crab
	Penaeus duorarum	pink shrimp[1,3]
	Palaemonetes spp.	grass shrimp[3]
	Callinectes sapidus	blue crab[1,3]
FISH		
	Anchoa mitchilli	bay anchovy[1,3]
	Gobiesox strumosus	skilletfish
	Megalops atlanticus	Atl. tarpon[1,3]
	Adinia xenica	diamond killifish
	Cyprinodon variegatus	sheepshead minnow
	Floridichthys carpio	goldspot killifish
	Fundulus grandis	gulf killifish
	Fundulus similis	longnose killifish
	Lucania parva	rainwater killifish
	Poecilia latipinna	sailfin molly
	Menidia spp.	silverside
	Centropomus undecimalis	snook
	Eucinostomus gula	silver jenny
	Eucinostomus harengulus	tidewater mojarra
	Orthopristis chrysoptera	pigfish
	Archosargus probatocephalus	sheepshead[1]

Habitat: TIDAL MARSH (>10 ppt)

Scientific Name	Common Name
Lagodon rhomboides	pinfish
Cynoscion arenarius	white seatrout[1]
Cynoscion nebulosus	spotted seatrout[1,3]
Leiostomus xanthurus	spot[1,3]
Menticirrhus americanus	southern kingfish[1]
Menticirrhus saxatilis	northern kingfish[1]
Sciaenops ocellatus	red drum[1,3]
Mugil spp.	mullet[1,3]
Gobionellus boleosoma	darter goby
Gobiosoma robustum	code goby
Microgobius gulosus	clown goby[3]
Paralichthys albigutta	Gulf flounder[1]
Achirus lineatus	lined sole[3]
Sphoeroides nephelus	southern puffer

BIRDS

Scientific Name	Common Name
Egretta thula	snowy egret[2]
Casmerodius albus	great egret
Ardea herodias	great blue heron
Egretta tricolor	tricolor heron[2]
Butorides striatus	green-backed heron
Nycticorax nycticorax	black-crowned night-heron
Nyctanassa violacea	yellow-crowned night-heron
Eudocimus albus	white ibis
Plegadis falcinellus	glossy ibis
Mycteria americana	wood stork[2]
Ajaia ajaja	roseate spoonbill[2]
Accipiter cooperii	Coopers hawk
Accipiter striatus	sharp-shinned hawk
Buteo jamaicensis	red-tailed hawk
Falco peregrinus	peregrine falcon[2]
Circus cyaneus	northern harrier[2]
Haliaeetus leucocephalis	bald eagle[2]
Corvus ossifragus	fishcrow
Ammodramus maritimus	seaside sparrow
Rallus longirostris	clapper rail
Cistothorus palustris	marsh wren
Catoptrophorus semipalmatus	willet

REPTILES AND AMPHIBIANS

Scientific Name	Common Name
Malaclemys terrapin	diamondback terrapin
Chelydra serpentina	snapping turtle
Pseudemys floridana	cooter
Nerodia fasciata	water snake
Thamnnophis sirtalis	garter snake
T. sauritus	E. ribbon snake
Diadophus punctatus	ringneck snake
Coluber constrictor	racer
Elaphe obsoleta	rat snake
Crotalus adamanteus	E. diamondback rattlesnake
Alligator mississippiensis	American alligator[2]

Habitat: TIDAL MARSH (>10 ppt)

	Scientific Name	Common Name
MAMMALS		
	Procyon lotor	raccoon
	Mustela vison	mink[2]
	Lutra canadensis	river otter[2]
	Mephitis mephitis	striped skunk
	Oryzomys palustris	rice rat

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: TIDAL MARSH (<10 ppt)

	Scientific Name	Common Name
MARSH PLANTS		
	Juncus roemerianus	black needlerush
	Spartina alterniflora	smooth cordgrass
	Spartina bakeri	cordgrass
	Bacopa monnieri	water hysop
	Gratiola virginiana	hedge hysop
	Vigna luteola	cowpea
	Cladium jamaicense	sawgrass
	Typha domingensis	southern cattail
BENTHOS		
	Melampus bidentatus	gastropod mollusc
	Melampus coffeus	gastropod mollusc
	Littorina irrorata	saltmarsh periwinkle
	Cerithidea spp.	gastropod mollusc
	Geukensia demissa	ribbed mussel
	Polymesoda caroliniana	bivalve mollusc
	Cyrenoidea floridana	bivalve mollusc
	Crassostrea virginica	American oyster[1,3]
	Uca spp.	fiddler crab
	Penaeus duorarum	pink shrimp[1,3]
	Palaemonetes spp.	grass shrimp[3]
	Callinectes sapidus	blue crab[1,3]
FISH		
	Anchoa mitchilli	bay anchovy[1,3]
	Brevoortia spp.	menhaden[1]
	Megalops atlanticus	Atl. tarpon[1,3]
	Adinia xenica	diamond killifish
	Fundulus grandis	gulf killifish
	Fundulus majalis	striped killifish
	Fundulus seminolis	seminole killifish
	Lucania goodei	bluefin killifish
	Fundulus confluentus	marsh killifish
	Lucania parva	rainwater killifish
	Gambusia affinis	mosquitofish
	Heterandria formosa	least killifish
	Poecilia latipinna	sailfin molly
	Labidesthes sicculus	brook silverside
	Menidia beryllina	tidewater silverside
	Centropomus undecimalis	common snook[1,2,3]
	Eucinostomus gula	silver jenny
	Eucinostomus harengulus	tidewater mojarra
	Diapterus plumieri	striped mojarra
	Lagodon rhomboides	pinfish
	Cynoscion arenarius	white seatrout[1]
	Cynoscion nebulosus	spotted seatrout[1,3]
	Leiostomus xanthurus	spot[1,3]
	Menticirrhus americanus	southern kingfish[1]
	Menticirrhus saxatilis	northern kingfish[1]
	Sciaenops ocellatus	red drum[1,3]
	Mugil spp.	mullet[1,3]
	Gobiosoma bosci	naked goby

Habitat: TIDAL MARSH (<10 ppt)

	Scientific Name	Common Name
	Microgobius gulosus	clown goby[3]
	Trinectes maculatus	hogchoker[3]
BIRDS		
	Egretta thula	snowy egret[2]
	Casmerodius albus	great egret
	Ardea herodias	great blue heron
	Egretta tricolor	tricolor heron[2]
	Butorides striatus	green-backed heron
	Nycticorax nycticorax	black-crowned night-heron
	Nyctanassa violacea	yellow-crowned night-heron
	Eudocimus albus	white ibis
	Plegadis falcinellus	glossy ibis
	Mycteria americana	wood stork[2]
	Ajaia ajaja	roseate spoonbill[2]
	Accipiter cooperii	Coopers hawk
	Accipiter striatus	sharp-shinned hawk
	Buteo jamaicensis	red-tailed hawk
	Falco peregrinus	peregrine falcon[2]
	Circus cyaneus	northern harrier[2]
	Haliaeetus leucocephalis	bald eagle[2]
	Laterallus jamaicensis	black rail
	Rallus limicola	Virginia rail
	Porzana carolina	sora
	Rallus longirostris	clapper rail
	Corvus ossifragus	fishcrow
	Ammodramus maritimus	seaside sparrow
	Pooecetes gramineus	vesper sparrow
	Ammodramus caudacutus	sharp-tailed sparrow
	Cistothorus platensis	sedge wren
	Catoptrophorus semipalmatus	willet
REPTILES AND AMPHIBIANS		
	Malaclemys terrapin	diamondback terrapin
	Chelydra serpentina	snapping turtle
	Kinosternon bauri	striped mud turtle[2]
	Terrapene carolina	box turtle
	Pseudemys floridana	cooter
	Chrysemys nelsoni	Fl red-bellied turtle
	Nerodia fasciata	water snake
	Thamnnophis sirtalis	garter snake
	T. sauritus	E. ribbon snake
	Diadophus punctatus	ringneck snake
	Coluber constrictor	racer
	Elaphe obsoleta	rat snake
	Crotalus adamanteus	E. diamondback rattlesnake
	Alligator mississippiensis	American alligator[2]
MAMMALS		
	Procyon lotor	raccoon
	Mustela vison	mink[2]
	Lutra canadensis	river otter[2]

Habitat: TIDAL MARSH (<10 ppt)

Scientific Name	Common Name
Mephitis mephitis	striped skunk
Oryzomys palustris	rice rat

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: SALT BARREN/HIGH MARSH (>>10ppt)

	Scientific Name	Common Name
VEGETATION		
	Salicornia virginica	glasswort
	Batis maritima	saltwort
	Distichlis spicata	saltgrass
	Sporobolus virginicus	coastal dropseed
	Borrichia frutescens	sea oxeye
	Sesuvium portulacastrum	sea purslane
	Limonium carolinianum	sea lavender
	Monanthochloe littoralis	keygrass
	Aster tenuifolius	perennial saltmarsh aster
	Spartina patens	marsh hay
	Juncus roemarianus	black needlerush
	Avicennia germinans	black mangrove
	Laguncularia racemosa	white mangrove
	Conocarpus erecta	buttonwood mangrove
INVERTEBRATES		
	Littorina irrorata	saltmarsh periwinkle
	Cerithidea scoloriformis	horn snail
	Melampis coffeus	coffee snail
	Uca spp.	fiddler crab
	mosquito larvae	misc. insect larvae
BIRDS*		
	Accipiter cooperii	Coopers hawk
	Accipiter striatus	sharp-shinned hawk
	Charadrius wilsonia	Wilsons plover
	Charadrius vociferus	killdeer
	Himantopus mexicanus	black-necked stilt
	Sterna antillarum	least tern[2]
	Chordeiles minor	common nighthawk

*Numerous other bird species may use this habitat periodically when it is flooded with water, including members of the families Ardeidae (herons and egrets), and Laridae (gulls and terns).

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: PELAGIC (>10ppt)

Scientific Name	Common Name

PHYTOPLANKTON

Bacillariophyceae (Diatoms):

Skeletonema spp.
Thalassionema spp.
unidentified pennates
Leptocylindrus spp.
Nitzschia spp.
Chaetoceros spp.
Ceratulina spp.
Amphiprora spp.
Rhizosolenia spp.
Cyclotella spp.
Coscinodiscus spp.
Thalassiosira spp.
Biddulphia spp.
Asterionella spp.
Eucampia spp.
Bacteriastrum spp.
Corethron spp.
Crucigenia spp.
Fragilaria spp.
Grammatophora spp.
Guinardia spp.
Gyrosigma spp.
Lauderia spp.
Melosira spp.
Minutocellus spp.
Navicula spp.
Odontella spp.
Phaeodactylum spp.
Pleurosigma spp.

Dinophceae (Dinoflagellates)

Prorocentrum spp.
Gymnodinium spp.
Ceratium spp.
Dinophysis spp.
Glenodinium spp.
Goniaulax spp.
Noctiluca spp.
Oxytoxum spp.
Peridinium spp.
Ptychodiscus spp.

Myxophyceae (Blue-greens)

Anabaena spp.
Oscillatoria spp.
Scenedesmus spp.
Schizothrix spp.
Merismopedia spp.
Spirulina spp. (trichomes)
Nostoc spp. (trichomes)
Microcystis spp.

Habitat: PELAGIC (>10ppt)

	Scientific Name	Common Name
Chlorophytes (Greens)		
	Schroederia spp.	
	Scenedesmus spp.	
	Eutreptia spp.	
Chrysophyceae		
	Apedinella spp.	
	Mallomonopsis spp.	
	Calycomonas spp.	
Cryptophyceae		
	Cryptophyte spp.	
Prasinophyceae		
	Pyraminmonas spp.	
Haptophyceae		
	Hymenomas spp.	
	Isochrysis spp.	
Euglenophyceae		
	Eutreptia spp.	
	Euglena spp.	
ZOOPLANKTON		
Holoplankton		
Copepoda		
	Acartia tonsa	
	Oithona colcarva	
	Parvocalanus crassirostris	
	Oithona nana	
	Pseudodiaptomus coronatus	
	Oithona simplex	
	Euterpina acutifrons	
	Labidocera aestiva	
	Saphirella spp.	
	Eurytemora hirundoides	
Appendicularia		
	Oikopleura dieica	
	Appendicularia sicula	
	Oikopleura longicauda	
Cladocera		
	Evadne tergestina	
	Penilia avirostris	
	Podon polyphemoides	
Rotifera		
	Trichocerca spp.	
	Proales spp.	
	Keratella spp.	
	Brachionus spp.	

Habitat: PELAGIC (>10ppt)

	Scientific Name	Common Name
	Lecane spp.	
	Monostyla spp.	
	Platylas spp.	
Chaetognatha		
	Sagitta tenuls	
	Sagitta hispida	
Decapoda		
	Lucifer faxoni	
Ctenophora		
	Mnemiopsis sp.	
MEROPLANKTON		
	Cirripedia larvae	
	Decapoda larvae	
	Echinodermata larvae	
	Hemichordata (tornaria)	
	Hydromedusa	
	Nemertinea larvae	
	Pelecypoda larvae	
	Gastropoda larvae	
	Trochophore larvae	
	Polychaeta larvae	
	Bryozoa larvae	
	fish eggs	
	Hydrozoa larvae	
ICHTHYOPLANKTON		
	Brevoortia spp.	menhaden[1]
	Opisthonema oglinum	Atl. thread herring
	Anchoa mitchilli	bay anchovy[1,3]
	Anchoa hepsetus	striped anchovy[1]
	Menidia spp.	silverside
	Bairdiella chrysoura	silver perch[3]
	Cynoscion nebulosus	spotted seatrout[1,3]
	Cynoscion arenarius	white seatrout[1]
	Menticirrhus spp.	whiting[1]
	Sciaenops ocellatus	red drum[1,3]
	Leiostomus xanthurus	spot[1,3]
	Chasmodes saburrae	Florida blenny
	Gobiosoma robustum	code goby
	Eucinostomus spp.	mojarra
	Lagodon rhomboies	pinfish
	Archosargus probatocephalus	sheepshead[1]
	Microgobius gulosus	clown goby[3]
	Prionotus scitulus	leopard searobin
	Achirus lineatus	lined sole[3]
	Symphurus plagiusa	blackcheek tongue.
	Mugil cephalus	striped mullet[1,3]
	Chloroscombrus chrysurus	Atl. bumper
	Lactophrys quadricornis	scrawled cowfish

Habitat: PELAGIC (>10ppt)

	Scientific Name	Common Name
FISH		
	Carcharhinus limbatus	blacktip shark[1]
	Carcharhinus leucas	bull shark[1]
	Negaprion brevirostris	lemon shark[1]
	Carcharhinus acronotus	blacknose shark
	Megalops atlanticus	Atl. tarpon[1,3]
	Elops saurus	ladyfish[1]
	Brevoortia spp.	menhaden[1]
	Dorosoma petenense	threadfin shad
	Harengula jaguana	scaled sardine
	Opisthonema oglinum	Atl. thread herring
	Anchoa mitchilli	bay anchovy[1,3]
	Anchoa hepsetus	striped anchovy[1]
	Strongylura spp.	needlefish
	Menidia beryllina	tidewater silverside
	Membras martinica	rough silverside
	Echeneis naucrates	sharksucker
	Oligoplites saurus	leatherjacket
	Selene vomer	lookdown
	Chloroscombrus chrysurus	Atl. bumper
	Caranx hippos	crevalle jack
	Lobotes surinamensis	tripletail
	Scomberomorus maculatus	spanish mackerel[1]
	Scomberomorus cavalla	king mackerel[1]
	Rachycentron canadum	cobia[1]
REPTILES		
	Chelonia mydas mydas	Atl. green turtle[2]
	Caretta caretta caretta	Atl. loggerhead[2]
	Lepidochelys kempi	Kemp's ridley[2]
MARINE MAMMALS		
	Tursiops truncatus	Atl. bottlenose dolphin

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: PELAGIC (<10ppt)

Group	Scientific Name	Common Name
PHYTOPLANKTON		
Bacillariophyceae (Diatoms):	*Skeletonema spp.*	
	unidentified pennates	
	Leptocylindrus spp.	
	Nitzschia spp.	
	Chaetoceros spp.	
	Cyclotella spp.	
	Asterionella spp.	
Dinophceae (Dinoflagellates)	*Gymnodinium spp.*	
Myxophyceae (Blue-greens)	*Schizothrix spp.*	
	Merismopedia spp.	
	Nostoc spp. (trichomes)	
	Microcystis spp.	
Chlorophytes (Greens)	*Schroederia spp.*	
	Scenedesmus spp.	
	Eutreptia spp.	
ZOOPLANKTON		
Holoplankton		
Copepoda	*Eurytemora hirundoides*	
Rotifera	*Brachionus* spp.	
	Lecane spp.	
	Monostyla spp.	
	Platylas spp.	
ICHTHYOPLANKTON	*Leiostomus xanthurus*	spot[1,3]
	Chasmodes saburrae	Florida blenny
	Gobiosoma bosci	naked goby
	Adinia xenica	diamond killifish
	Fundulus seminolis	seminole killifish
	Lucania goodei	bluefin killifish
	Fundulus confluentus	marsh killifish
	Lucania parva	rainwater killifish
	Labidesthes sicculus	brook silverside
FISH	*Brevoortia spp.*	menhaden[1]
	Anchoa mitchilli	bay anchovy[1,3]
	Menidia beryllina	tidewater silverside
	Labidesthes sicculus	brook silverside

[1] = Commercial or recreational species
[2] = Endangered, threatened or species of special concern
[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: NON-VEGETATED SUBTIDAL (>10ppt)

Scientific Name	Common Name
BENTHOS	
Phylum Mollusca	
Class bivalvia	
Amygdalum papyrium	
Mulinia lateralis	
Mysella planulata	
Macoma tenta	
Tellina versicolor	
Sphenia antillensis	
Musculus sp.	
Tellina texana	
Corbicula maniliensis	
Mercenaria spp.	hard clam[1,3]
Crassostrea virginica	American oyster[1,3]
Class gastropoda	
Acetocina canaliculata	
Viviparidae	
Eulimastoma cf. weberi	
Acteon punctostriatus	
Cochiolepis sp.	
Haminoea succinea	
Nudibranchia	
Melongena corona	crown conch
Lolliguncula brevis	brief squid
Phylum platyhelminthes	
Order Polycladida	
Stylochus sp.	
Phylum Annelidia	
Class polychaeta	
Mediomastus ambiseta	
Paraprionospio pinnata	
Ampharetidae	
Amphioteis gunneri	
Brania wellfleetensis	
Laeonereis culveri	
Neanthes acuminata	
Parahesione luteola	
Pectinaria gouldii	
Pseudopolydora sp.	
Sphaerosyllis brevifrons	
Travisia hobsonae	
Cirrophorus americanus	
Exogone lourei	
Glycinde nordmanni	
Parapionosyllis longicirrata	
Streblospio benedicti	
Streptosyllis pettiboneae	
Tharyx annulosus	
Exogone dispar	
Nereis succinea	

Habitat: NON-VEGETATED SUBTIDAL (>10ppt)

Scientific Name	Common Name
Gyptis vittata	
Capitella capitata	
Eteone heteropoda	
Glycinde solitaria	
Parahesione luteola	
Minuspio cirrifera	
Mediomastus californiensis	
Melinna maculata	
Diopatra cuprea	
Polydora ligni	
Polydora socialis	
Pseudopolydora sp.	
Poecilochaetous johnstoni	
Schistomeringos rudolphi	
Onuphis sp.	
Glycera americana	
Phyllodoce arenae	
Syllis sp.	
Cistenides gouldii	
Glycera americana	
Stenoninereis martini	
Sthenelais boa	
Class Oligochaeta	
Aulodrilus piqueti	
Lumbricillus codensis	
Smithsondrilus marinus	
Phylum Arthropoda	
Class Crustacea	
Order Decapoda	
Penaeus duorarum	pink shrimp[1,3]
Palaemonetes intermedis	cleaning shrimp[1,3]
Palaemonetes pugio	grass shrimp[1,3]
Processa hemphilli	grass shrimp
Callinectes sapidus	blue crab[1,3]
Libinia dubia	spider crab
Neopanope sp.	mud crab
Order Cumecea	
Leucon acutirostris	
Cyclaspis sp.	
Oxyurostylis smithi	
Cyclaspis varians	
Order Amphipoda	
Ampelisca abdita	
Ampelisca verrilli	
Ampelisca vadorum	

Habitat: NON-VEGETATED SUBTIDAL (>10ppt)

Scientific Name	Common Name
Rudilemboides naglei	
Gitanopsis sp.	
Gammarus mucronatus	
Melita nitida	
Melita appendiculata	
Acanthohaustorius sp.	
Monoculodes spp.	
Order Podocopida	
Haplocytherida setipunctata	
Sarsiella sp.	
Order Mysidacea	
Mysidopsis almyra	
Mysidopsis bigelowi	
Order Copepoda	
Harpactacoida	
Phylum Chordata	
Branchiostoma floridae lancelet	
FISH	
Dasyatis americana	southern stingray
Dasyatis sabina	Atlantic stingray
Raja eglanteria	clearnose skate
Rhinoptera bonasus	cownose ray
Synodus foetens	inshore lizardfish
Arius felis	hardhead catfish
Bagre marinus	gafftopsail catfish
Gobiesox strumosus	skilletfish
Urophycis floridana	southern hake
Menidia spp.	silverside
Diplectrum formosum	sand perch
Centropristis striata	black sea bass[1]
Eucinostomus gula	silver jenny
Eucinostomus harengulus	tidewater mojarra
Orthopristis chrysoptera	pigfish
Archosargus probatocephalus	sheepshead[1]
Diplodus holbrooki	spottail pinfish
Lagadon rhomboides	pinfish
Bairdiella chrysoura	silver perch[3]
Cynoscion nebulosus	spotted seatrout[1,3]
Cynoscion arenarius	white seatrout[1]
Leiostomus xanthurus	spot[1,3]
Micropogon undulatus	Atl. croaker[1]
Menticirrhus americanus	southern kingfish[1]
Menticirrhus saxatilis	northern kingfish[1]
Sciaenops ocellatus	red drum[1,3]
Mugil spp.	mullet[1,3]
Gobionellus boleosoma	darter goby
Gobiosoma robustum	code goby
Microgobius gulosus	clown goby[3]

Habitat: NON-VEGETATED SUBTIDAL (>10ppt)

Scientific Name	Common Name
Prionotus scitulus	leopard searobin
Prionotus tribulus	bighead searobin
Centropomus undecimalis	common snook[1,2,3]
Citharichthys macrops	spotted whiff
Etropus crossotus	fringed flounder
Paralichthys albigutta	gulf flounder[1]
Achirus lineatus	lined sole[3]
Symphurus plagiusa	blackcheek tonguefish
Sphoeroides nephelus	southern puffer
Chilomycterus schoepfi	striped burrfish

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[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: NON-VEGETATED SUBTIDAL (<10ppt)

Scientific Name	Common Name
BENTHOS	
Phylum Cnidaria	
Class Hydrozoa	
Hydra sp.	
Phylum Mollusca	
Class Bivalvia	
Corbicula maniliensis	
Mulinia lateralis	
Pisidium puncteriferum	
Amygdalum papyrium	
Musculus sp.	
Tellina spp.	
Tellina texana	
Crassostrea virginica	American oyster[1,3]
Mercenaria spp.	Hard clam[1,3]
Phylum Annelidia	
Class Polychaeta	
Mediomastus ambiseta	
Paraprionospio pinnata	
Ampharetidae	
Amphioteis gunneri	
Brania wellfleetensis	
Laeonereis culveri	
Neanthes acuminata	
Parahesione luteola	
Pectinaria gouldii	
Pseudoployd ora sp.	
Sphaerosyllis brevifrons	
Travisia hobsonae	
Cirrophorus americanus	
Exogone lourei	
Glycinde nordmanni	
Parapionosyllis longicirrata	
Streblospio benedicti	
Streptosyllis pettiboneae	
Tharyx annulosus	
Class Oligochaeta	
Dero trifida	
Dero flabellinger	
Limnodrilus hoffmeisteri	
Pristima longiseta	
Aulodrilus piqueti	
Lumbricillus codensis	
Smithsondrilus marinus	
Phylum Arthropoda	
Class Crustacea	
Order Amphipoda	
Grandidierella bonnieroides	
Ampelisca vadorum	
Ampelisca abdita	

Habitat: NON-VEGETATED SUBTIDAL (<10ppt)

Scientific Name	Common Name
Order Mysidacea	
Mysidopsis almyra	
Mysidopsis bigelowi	
Order Isopoda	
Cyathura polita	
Xenanthura brevitelson	
Order Decapoda	
Penaeus duorarum	pink shrimp[1,3]
Palaemonetes intermedis	cleaning shrimp[3]
Palaemonetes pugio	grass shrimp[3]
P. paludosus	grass shrimp[3]
P. kadiakensis	grass shrimp[3]
Callinectes sapidus	blue crab[1,3]
Class Insecta	
Dubiraphia sp.	
Polypedilum sp.	
Coelotanypedini sp.	
Coelotanypus sp.	
Lepidoptera	
Marnischia	
Palpomyia tibialis	
Palpomyia sp.	
Stempellina sp.	
Tanytarsus sp.	
Isotomurus palustris	
Micropsecta sp.	
Procladius sp.	
Chironominae (pupae)	
Cladotanytarsus sp.	
Clinotanypus sp.	
Cryptochiromus sp.	
Stictechironomus sp.	
FISH	
Anchoa mitchilli	bay anchovy[1,3]
Brevoortia spp.	menhaden[1]
Fundulus seminolis	Seminole killifish
Lucania goodei	bluefin killifish
Fundulus confluentus	marsh killifish
Lucania parva	rainwater killifish
Gambusia affinis	mosquitofish
Heterandria formosa	least killifish
Poecilia latipinna	sailfin molly
Labidesthes sicculus	brook silverside
Menidia beryllina	tidewater silverside
Centropomus undecimalis	common snook[1,2,3]
Eucinostomus gula	silver jenny
Eucinostomus harengulus	tidewater mojarra
Diapterus plumieri	striped mojarra
Lagodon rhomboides	pinfish
Cynoscion arenarius	white seatrout[1]

Habitat: NON-VEGETATED SUBTIDAL (<10ppt)

Scientific Name	Common Name
Cynoscion nebulosus	spotted seatrout[1,3]
Leiostomus xanthurus	spot[1,3]
Menticirrhus americanus	southern kingfish[1]
Menticirrhus saxatilis	northern kingfish[1]
Sciaenops ocellatus	red drum[1,3]
Mugil spp.	mullet[1,3]
Gobiosoma bosci	naked goby
Microgobius gulosus	clown goby[3]
Trinectes maculatus	hogchoker[3]
Lepomis macrochirus	bluegill[1]
L. marginatus	dollar sunfish
L. punctatus	spotted sunfish
L. microlophis	redear sunfish
Micropterus salmoides	largemouth bass[1]
Lepisosteus osseus	longnose gar
L. platyrhincus	Florida gar
Amia calva	bowfin

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: NON-VEGETATED INTERTIDAL (>10ppt)

Scientific Name	Common Name
BENTHOS	
Phylum Mollusca	
Anachis avara	
Anadara transversa	
Bittium varium	
Diplodonta punctata	
Macrocallista nimbosa	
Ensis minor	
Macoma constricta	
Mercenaria sp.	hard clams[1,3]
Mulinia lateralis	
Musculus lateralis	
Mitrella sp.	
Nassarius ribex	
Olivella mutica	
Tagelus divisus	
Tellina tampaensis	
Crassostrea virginica	American oyster[1,3]
Phylum Annilidia	
Class Polychaeta	
Arabella iricolor	
Arenicola cristata	
Branchiosyhchus americana	
Clymenella mucosa	
Diopatra cuprea	
Glycera americans	
Magelona pettiboneae	
Apoprionospio pygmaea	
Travisia sp.	
Minuspio cirrifera	
Capitita ambiseta	
Nereis succinea	
Capitella capitata	
Paraprionospio pinnata	
Gyptis vittata	
Eteone heteropoda	
Polydora ligni	
Onuphis eremita oculata	
Pectinaria gouldii	
Scoloplos rubra	
Scoloplos robustus	
Travisia sp.	
Phylum Arthropoda	
Apanthura sp.	
Insect larvae	
Lepidopa websteri	
Pagurus annulipes	
Pinnixa spp.	

Habitat: NON-VEGETATED INTERTIDAL (>10ppt)

Scientific Name	Common Name
Class Crustacea	
Penaeus duorarum	pink shrimp[1,3]
Palaemonetes intermedis	cleaning shrimp[3]
Palaemonetes pugio	grass shrimp[3]
Callinectes sapidus	blue crab[1,3]
Phylum Echinodermata	
Ophiophragmus filograncus	
Leptosynapta sp.	
Phylum Chordata	
Branchiostoma floridae	lancelet
FISH	
Anchoa mitchilli	bay anchovy[1,3]
Anchoa hepsetus	striped anchovy[1]
Adinia xenica	diamond killifish
Cyprinodon variagatus	sheepshead minnow
Floridichthys carpio	goldspot killifish
Fundulus grandis	Gulf killifish
Fundulus similis	longnose killifish[3]
Lucania parva	rainwater killifish
Poecilia latipinna	sailfin molly
Menidia spp.	silverside
Eucinostomus gula	silver jenny
Eucinostomus harengulus	tidewater mojarra
Orthopristis chrysoptera	pigfish
Lagodon rhomboides	pinfish
Leiostomus xanthurus	spot[1,3]
Menticirrhus americanus	southern kingfish[1]
Menticirrhus saxatilis	northern kingfish[1]
Micropogon undulatus	Atl. croaker[1]
Sciaenops ocellatus	red drum[1,3]
Mugil spp.	mullet[1,3]
Gobionellus boleosoma	darter goby
Gobiosoma robustum	code goby
Microgobius gulosus	clown goby[3]
Achirus lineatus	lined sole[3]

BIRDS*

The intertidal areas of Tampa Bay are utilized by numerous members of the families listed for the mangrove and saltmarsh habitats including Ardeidae (Herons and Egrets), Threskiornithidae (Ibises and Spoonbills), and Phalacrocoracidae (Cormorants). Additionally, numerous members of Laridae (Gulls, terns and skimmers), Anatidae (Swans, ducks and geese), Charadriidae (plovers) and Scolopacidae (sandpipers) also use the intertidal areas. Some of the more common members of these families are listed below:

Larus atricilla	laughing gull
L. argentatus	herring gull
L. delawarensis	ring-billed gull
Sterna caspia	Caspian tern

Habitat: NON-VEGETATED INTERTIDAL (>10ppt)

Scientific Name	Common Name
S. maxima	royal tern
S. sandvicencis	sandwich tern
S. antillarum	least tern2
S. forsteri	Forster's tern
S. hirundo	common tern
S. nilotica	gull-billed tern
Rynchops niger	black skimmer
Aythya affinis	lesser scaup
Anas clypeata	northern shoveler
Anas crecca	green-winged teal
A. discors	blue-winged teal
Mergus serrator	red-breasted merganser
Calidris alpina	dunlin
Limnodromus griseus	short-billed dowitcher
Catoptrophorus semipalmatus	willet
Calitris mauri	western sandpiper
Tringa flavipes	lesser yellowlegs
Calidris canutus	red knot
Charadrius wilsonia	Wilson's plover
Pluvialis dominica	black-bellied plover

* A more comprehensive listing of bird species (e.g. rare and uncommon species, wintering vs. permenant residents) is presented in Schomer and Johnson (1990).

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

Habitat: NON-VEGETATED INTERTIDAL (<10ppt)

	Scientific Name	Common Name
BENTHOS		
	Penaeus duorarum	pink shrimp[1,3]
	Palaemonetes intermedis	cleaning shrimp[3]
	Palaemonetes pugio	grass shrimp[3]
	P. paludosus	grass shrimp[3]
	P. kadiakensis	grass shrimp[3]
	Callinectes sapidus	blue crab[1,3]
	Crassostrea virginica	American oyster[1,3]
FISH		
	Anchoa mitchilli	bay anchovy[1,3]
	Brevoortia spp.	menhaden[1]
	Adinia xenica	diamond killifish
	Fundulus grandis	Gulf killifish
	Fundulus majalis	striped killifish[3]
	Fundulus seminolis	seminole killifish
	Lucania goodei	bluefin killifish
	Fundulus confluentus	marsh killifish
	Lucania parva	rainwater killifish
	Gambusia affinis	mosquitofish
	Heterandria formosa	least killifish
	Poecilia latipinna	sailfin molly
	Labidesthes sicculus	brook silverside
	Menidia beryllina	tidewater silverside
	Eucinostomus argenteus	silver jenny
	Eucinostomus harengulus	tidewater mojarra
	Diapterus plumieri	striped mojarra
	Lagodon rhomboides	pinfish
	Cynoscion arenarius	white seatrout[1]
	Cynoscion nebulosus	spotted seatrout[1,3]
	Leiostomus xanthurus	spot[1,3]
	Menticirrhus americanus	southern kingfish[1]
	Menticirrhus saxatilis	northern kingfish[1]
	Sciaenops ocellatus	red drum[1,3]
	Mugil spp.	mullet[1,3]
	Gobiosoma bosci	naked goby
	Microgobius gulosus	clown goby[3]
	Trinectes maculatus	hogchoker[3]
	Tilapia spp.	tilapia
	Cyprinidae	shiner spp.

BIRDS

The intertidal areas of Tampa Bay are utilized by numerous members of the families listed for the mangrove and saltmarsh habitats including Ardeidae (Herons and Egrets), Threskiornithidae (Ibises and Spoonbills), and Phalacrocoracidae (Cormorants). Additionally, numerous members of Laridae (Gulls, terns and skimmers), Charadriidae (plovers) and Scolopacidae (sandpipers) also use the intertidal areas. Some of the more common members of these families which use oligohaline intertidal areas in Tampa Bay are listed below:

Rallus longirostris	clapper rail[**]
R. elegans	king rail[**]

Habitat: NON-VEGETATED INTERTIDAL (<10ppt)

Scientific Name	Common Name
Larus atricilla	laughing gull
L. argentatus	herring gull
L. delawarensis	ring-billed gull
Sterna caspia	Caspian tern
S. maxima	royal tern
S. sandvicencis	sandwich tern
S. antillarum	least tern2
S. forsteri	Forster's tern
S. hirundo	common tern
S. nilotica	gull-billed tern
Rynchops niger	black skimmer
Calidris alpina	dunlin
Limnodromus griseus	short-billed dowitcher
Catoptrophorus semipalmatus	willet
Calitris mauri	western sandpiper
Tringa flavipes	lesser yellowlegs
Calidris canutus	red knot
Charadrius wilsonia	Wilson's plover
Pluvialis dominica	black-bellied plover

* A more comprehensive listing of bird species (e.g. rare and uncommon species, wintering vs. permenant residents) is presented in Schomer and Johnson (1990).

** Clapper or king rails may be present if an adequate amount of vegetation cover is nearby.

[1] = Commercial or recreational species

[2] = Endangered, threatened or species of special concern

[3] = Detailed information on environmental requirements and life histories presented in Killam et al (1992).

REFERENCES

American Fisheries Society. 1991. Common and Scientific Names of Fishes from the United States and Canada. 5th Edition. Bethesda, MD. 183 p.

Beever, J.W. III. 1979. The ecology and biogeography of red mangrove arboreal folivores. Masters Thesis. University of South Florida. Tampa, Fl.

Bloom, S.A., J.L. Simon, and V.D. Hunter. 1972. Animal-sediment relations and community analyses of a Florida estuary. Mar. Biol. 13:43-56.

Coastal Environmental. 1992. Oligohaline Areas in Tampa Bay Tributaries: Spatial Extent and Species Lists. Final Report. Prepared for Tampa Bay National Estuary Program by Coastal Environmental Services, Inc. Technical Publication #04-92.

Comp, G.S. 1985. A survey of the distribution and migration of the fishes in Tampa Bay, pp. 393-425 IN: S.F. Treat, J.L. Simon, R.R. Lewis III, and R.L. Whitman, Jr. (eds.), Proceedings, Tampa Bay Area Scientific Information Symposium, Held May 1982, Bellwether Press.

Conservation Consultants, Inc. 1977. An analysis and summary on the effect of the cooling water system on aquatic fauna. A 316 Demonstration Biological Study.

Culter, J.K. 1986. Manual for identification of marine invertebrates. A Guide to Some Common Estuarine Macroinvertebrates of the Big Bend Region, Tampa Bay, Florida. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency. EPA/600/4-86/002.

Culter, J.K. and S. Mahadevan. 1982. Benthic studies of the lower Manatee River. Submitted to Manatee County Materials and Service Department by Mote Marine Lab, Sarasota, FL.

Culter, J.K., M.R. Milligan, J.R. Leverone, S. Mahadevan. 1991. Comparison of benthic macroinfauna among natural and planted *Spartina alterniflora* (Gramineae) and *Halodule wrightii* (Potamogetonacea) from Tampa Bay, pp. 193-215. IN: S.F. Treat, P.A. Clark (eds), Proceedings, Tampa Bay Area Scientific Information Symposium 2. 1991 February 27 - March 1; Tampa, Fla. 528 p. Avialable from TEXT, Tampa, Fla.

Dauer, D.M. and J.L. Simon. 1975. Lateral or along-shore distribution of the polychaetous annelids of an intertidal, sandy habitat. Marine Biology 31:363-370.

Durako, M.J., J.A. Browder, W.L. Kruczynski, C.B. Subrahmanyam, and R.E. Turner. 1985. Salt marsh habitat and fishery resources of Florida. IN: W. Seaman, Jr. (ed.) Florida Aquatic Habitat and Fishery Resources. Florida Chapter of the American Fisheries Society.

Dragovich, A. and J. A. Kelly, Jr. 1964. Ecological observations of macroinvertebrates in Tampa Bay, Florida, 1961-1962. Bull. Mar. Sci. of the Gulf and Caribbean: 14: 74-102.

Estevez, E.D. and E.L. Mosura. 1985. Emergent Vegetation, pp. 248-278. IN: S.F. Treat, J.L. Simon, R.R. Lewis III, and R.L. Whitman, Jr. (eds.), Proceedings, Tampa Bay Area Scientific Information Symposium, Held May 1982, Bellwether Press.

Florida Fisheries Independent Monitoring Program (FIMP). 1989 and 1990. Annual Reports. Compiled by the Florida Dept. of Nat. Res., Juvenile Fish Group, St. Petersburg, FL

Fonseca, M. 1992. Unpublished data. National Marine Fisheries Service, Beaufort, NC.

Godcharles, M.G. and W.C. Jaap. 1973. Exploratory clam survey of Florida nearshore and estuarine waters with commercial hydraulic dredging gear. Florida Dept. Nat. Res. Profess. Paper Ser. 21:1-77.

Gosner, K.L. 1971. Guide to Identification of Marine and Estuarine Invertebrates: Cape Hatteras to the Bay of Fundy. Wiley Interscience, New York, 693 p.

Haddad, K.D,. G.A. McGarry, R.E. Mathewson, Jr., D.A. Rydene, K.M. Peters, M. Durako, F.S. Sargent, P.F. Houhoulas, A.L. Petrei, S.D. Giordano, L.A. Houchin, and N.J. Berill. 1990. Marine Resources Geographic Information System and Fishery Resources. Final Report. FDNR-FMRI, St. Petersburg, FL.

Haddad, K.D,. G.A. McGarry, F.J. Sargent, R.E. Mathewson, Jr., D.A. Rydene, K.M. Peters, C.A. Friel, H. A. Norris, and T.J. Leary. 1992. Marine Resources Geographic Information System and Fishery Resources. Final Report. FDNR-FMRI, St. Petersburg, FL.

Hoese, H.D. and R.H. Moore. 1977. Fishes of the Gulf of Mexico: Texas, Louisiana, and Adjacent Waters. Texas A & M University Press. Texas. 327 p.

Hopkins, T.L. 1977. Zooplankton distribution in the surface waters of Tampa Bay, Florida. Bull. Mar. Res. 27:467-478.

Hsieh, H.-L. and J.L. Simon. 1991. Life history and population dynamics of *Kimbergonuphis simoni* (Polychaeta: Onuphidae). Marine Biology 110:117-125.

Johansson, J.O.R. Unpublished data. Personal communication, February 1993, City of Tampa, Bay Study Group, Tampa, FL.

Kale, H.W. II., and D.S. Maehr. 1990. Florida's Birds: A handbook and reference. Pineapple Press. Sarasota, FL.

Killam, K. A., R. J. Hochberg, and E. C. Rzemien. 1992. Synthesis of Basic Life Histories of Tampa Bay Species. Final Report. Prepared for Tampa Bay National Estuary Program by Versar Inc. Technical Publication #10-92.

Layne, J.N., J.A. Stallcup, G.E. Woolfenden, M.N. McCauley, and D.J. Worley. 1977. Fish and wildlife inventory of the seven county region included in the central Florida phosphate industry areawide environmental impact study. U.S. Fish and Wildlife Service. Wash. D.C. 3 Vols. Cited from Wolfe and Drew 1990.

Lewis, R.R. III, R. G. Gilmore, Jr., D.W. Crewz, and W. E. Odum. 1985. Mangrove habitat and fishery resources of Florida. IN: W. Seaman, Jr. (ed.) Florida Aquatic Habitat and Fishery Resources. Florida Chapter of the American Fisheries Society.

Lewis, R.R., III and E.D. Estevez. 1988. The ecology of Tampa Bay, Florida: An estuarine profile. U.S. Fish. Wildl. Serv. Biol. Rep. 85(7-18). 132 p.

Mitchell, M.E. 1989. A comparison of larval fish abundance between a vegetated and non-vegetated habitat with comments on ecological significance of notochord flexion in larval fish. Masters Thesis. Univ. of South Florida, Tampa, Fl.

Montague C.L. and R.G. Wiegert. 1990. Salt Marshes. IN: R.L. Myers and J.J. Ewel (eds.) Ecosystems of Florida. University of Central Florida Press. 765 p.

Mote Marine Laboratory. 1990. Marine Habitat Research and Restoration Program. Final Report to Florida Department of Natural Resources.

Myers, R.L. and J.J. Ewel. 1990. Ecosystems of Florida. University of Central Florida Press. Gainesville, FL.

Odum, W.E. and C.C. McIvor. 1990. Mangroves. IN: R.L. Myers and J.J. Ewel (eds.) Ecosystems of Florida. University of Central Florida Press. 765 p.

Odum, W.E. 1985. The Ecology of the Mangroves of South Florida: A Community Profile. U.S. Fish and Wildlife Service. FWS/OBS-81/24.

Paul, R.T. and G.E. Woolfenden. 1985. Current status and recent trends in bird populations of Tampa Bay, pp. 426-447. IN: S.F. Treat, J.L. Simon, R.R. Lewis III, and R.L. Whitman, Jr. (eds.), Proceedings, Tampa Bay Area Scientific Information Symposium, Held May 1982, Bellwether Press.

Peebles, E.B., M.S. Flannery, R.E. Matheson, Jr., and J.P. Rast. 1992. Fish nursery utilization of the Little Manatee River Estuary: Relationships to physiochemical gradients and the distribution of food resources, pp. 341-368. IN: S.F. Treat, P.A. Clark (eds), Proceedings, Tampa Bay Area Scientific Information Symposium 2. 1991 February 27 - March 1; Tampa, Fla. 528 p. Avialable from TEXT, Tampa, Fla.

Peters, K.M. and R.H. McMichael, Jr. 1987. Early life history of *Sciaenops ocellatus* (Pisces:Sciaenidae) in Tampa Bay, Fl. Estuaries 10:92-107.

Rast, J. and T.L. Hopkins. 1988. The zooplankton of the Little Manatee River Estuary, Florida. First Yearly Report: 1988. Prepared for the Southwest Florida Water Management District.

Reynolds, J.E., III, B.B. Ackerman, I.E. Beeler, B.L. Weigle, P.F. Houhoulis. 1992. Assessment and Management fo Manatees (*Trichechus manatus*) in Tampa Bay, pp. 289-309. IN: S.F. Treat, P.A. Clark (eds), Proceedings, Tampa Bay Area Scientific Information Symposium 2. 1991 February 27 - March 1; Tampa, Fla. 528 p. Avialable from TEXT, Tampa, Fla.

Robison, D.E. 1985. Variability in the vertical distribution of ichthyoplankton in lower Tampa Bay, pp. 359-383. IN: S.F. Treat, J.L. Simon, R.R. Lewis III, and R.L. Whitman, Jr. (eds.), Proceedings, Tampa Bay Area Scientific Information Symposium, Held May 1982, Bellwether Press.

Santos, S.L. and S.A. Bloom. 1983. Evaluation of succession in an estuarine macrobenthic soft-bottom community near Tampa, FL. Int. Revue ges. Hydrobiol. 68:617-632.

Santos, S.L. and J.L. Simon. 1980. Marine soft-bottom community establishment following annual defaunation: larval or adult recruitment? Marine Ecology-Progress Series. 2:235-241.

Schomer, N.S., R.D. Drew, and P. Johnson. 1990. Chapter 5. Vegetation Communities (Habitats). IN: Wolfe, S.H. and R.D. Drew, eds. An Ecological Characterization of the Tampa Bay Watershed. U.S. Fish and Wildlife Service, Biol. Rep. 90(20).

Schomer, N.S., and P. Johnson. 1990. Chapter 6. Fauna. IN: Wolfe, S.H. and R.D. Drew (eds.), An Ecological Characterization of the Tampa Bay Watershed. U.S. Fish and Wildlife Service, Biol. Rep. 90(20).

Simon, J.L. and D.M. Dauer. 1977. Reestablishment of a benthic community following natural defaunation. IN: Ecology of Marine Benthos, p 139-154. Univ. of South Carolina Press.

Squires, A.P. Unpublished data. Personal communication, February 1993, Coastal Environmental, Inc. St. Petersburg, FL.

Sykes, J.E. and J.R. Hall. 1970. Comparative distribution of mollusks in dredged and undredged portions of an estuary, with a systematic list of species. Fishery Bulletin 68:299-305.

Thoemke, K.W. 1979. The life histories and population dynamics of four subtidal amphipods from Tampa Bay, Florida. Masters Thesis. University of South Florida. Tampa, FL

Traver, D.P., J.A. Rodgers, M.J. Mahler, and R.L. Lazor. 1986. Aquatic and Wetland Plants of Florida. Bureau of Aquatic Plant Research and Control, FDNR, Tallahassee, FL. 127 p.

Turner, J.F., and T.L. Hopkins. 1974. Phytoplankton of the Tampa Bay system, Florida. Bull Mar. Sci. 24:101-121.

U.S. Fish and Wildlife Service. 1966-1969. Report of the Bureau of Commercial Fisheries. Biological Station, St. Petersburg Beach, Florida.

Vargo, G.A. 1990. Phytoplankton studies in the Little Manatee River: species composition, biomass, and nutrient effects on primary production. Prepared for the Southwest Florida Water Management District.

Weigle, B.L., J.E. Reynolds III, B.B. Ackerman, I.E. Beeler, P.L. Boland. 1991. Distrubution and abundance of bottlenose dolphins (*Tursiops truncatus*) in Tampa Bay, pp. 277-288. IN: S.F. Treat, P.A. Clark (eds), Proceedings, Tampa Bay Area Scientific Information Symposium 2. 1991 February 27 - March 1; Tampa, Fla. 528 p. Avialable from TEXT, Tampa, Fla.

Wolfe, S.H. and R.D. Drew, eds. 1990. An ecological characterization of the Tampa Bay Watershed. U.S. Fish and Wildlife Service, Biol. Rep. 90(20).

Wood, D.A. 1991. Offical Lists of Endangered and Potentially Endangered Fauna and Flora in Florida. Florida Game and Fresh Water Fish Commission. 1 April 1991.

Zieman, R.C. and R.T. Zieman. 1989. The Ecology of the Seagrass Meadows of the West Coast of Florida: A Community Profile. U.S. Fish and Wildlife Service. Biol. Rep. 85(7.25).