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Marine/Estuarine Site Assessment for Florida


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A Framework for Site Prioritization
September 2005

Laura Geselbracht, Roberto Torres, Graeme S. Cumming, Ph.D., Dan Dorfman and Mike Beck, Ph.D.

Final Report for Florida's Wildlife Legacy Initiative
a program of the Florida Fish and Wildlife Conservation Commission

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Table of Contents

Tables

Figures

Table of Contents, continued

Appendices

Introduction

This document presents the Marine/Estuarine Site Prioritization Framework for Florida which was developed as a supplemental component of the Florida Comprehensive Wildlife Strategy. The prioritization of sites on which to focus resource management and conservation actions, has been used extensively in conservation for decades and likely much longer. Efforts to prioritize sites for these purposes in marine and estuarine systems is a younger science, with perhaps 30 years of experience, beginning in the U.S. with the establishment of the National Marine Sanctuaries Program mandated by Title III of the Marine Protection, Research and Sanctuaries Act of 1972. In 1975, the Aquatic Preserve Act was passed in Florida, which initiated the creation of a network of coastal aquatic preserves. While the criteria used to establish national marine sanctuaries and Florida's aquatic preserves likely took into account the major habitat types present in other sites within their respective networks, the framework described in this document explicitly recognizes the major habitat types present in network sites by utilizing objective criteria to identify a set of network sites that represent the major marine and estuarine habitat types statewide. This approach of utilizing objective criteria to ensure representation of major habitat types within a defined planning area has been employed for both terrestrial-based and marine conservation planning for several years (Ball, 2000; Possingham et al., 2000; Airame et al., 2003; Beck, 2003; Day and Roff, 2000; Leslie et al., 2002; Margules and Pressey, 2000).

The framework presented in this document is not intended to replace site-based studies which will, by their very nature, be much more detailed and likely to rely on a larger suite of site specific resource information. The site based studies that have been completed in the state for marine and estuarine sites (e.g., the national marine sanctuary, national estuary program sites, national estuarine research reserves and state aquatic preserves) have not as yet been examined as part of a larger state-wide system. The framework described here is a comprehensive statewide view that relies on the best available broad-scale information and a smaller collection of finer-scale information (unfortunately, not all datasets are available on a statewide or regional basis yet). Effective conservation planning demands the assessment of conservation goals and targets across multiple scales (Peterson 2000, Poiani et al, 2001). This framework and the analyses that it supports are intended to provide the broad-scale base of the pyramid of marine and estuarine resource information for Florida. The goal of the framework and representative analyses presented here is to provide resource managers, marine scientists, conservation practitioners and other stakeholders with a tool to aid in the identification of a suite of areas that can serve as focal points for statewide marine and estuarine resource management and conservation.

Site prioritization analyses used in conjunction with the other elements of the Florida Comprehensive Wildlife Conservation Strategy (threat assessment, strategy development and measures), provide resource managers, conservation practitioners, researchers and other interested individuals/groups with a set of focal areas for achieving greater resource protection, management and restoration. While some threat abatement strategies will best be achieved at a statewide level (e.g., through improved legislation), other strategies may best be developed and applied locally (with successful strategies being exported to other sites in need where appropriate).

The framework presented in this document represents the culmination of a 2-year process, originally started by The Nature Conservancy as a Central and South Florida (aka NOAA's West Indian Province) marine ecoregional assessment that was initiated concurrently with a Mid/South Atlantic (aka NOAA's Carolinian Province) marine ecoregional plan. A number of expert workshops were held as part of these processes to provide guidance and select criteria for the framework. About halfway through the Central and South Florida marine ecoregional assessment, the opportunity arose through the Florida's Comprehensive Wildlife Conservation Strategy process to expand the Marine Site Prioritization Assessment to a statewide assessment and to develop a more extensive framework. Florida is one of a few states that has included a marine component in it's CWCS process.

Since the initiation of Florida's CWCS process, 5 workshops have been held to solicit guidance and feedback on framework development. The first of these workshops was a Northern Gulf Coast scoping meeting held in Tallahassee on October 19, 2004 (a participant list for all of the workshops held to assist with site prioritization framework development can be found in Appendix A). The intent of the first meeting was to solicit input on habitat and species targets to include in the analysis, as well as agreeing on a process for the analysis. The next three workshops, which were of similar content, were intended to solicit input from marine resource experts around the state (St. Petersburg, Tallahassee and Dania Beach). These expert workshops were titled "Site Prioritization and Threat Assessment Expert Workshops". During this set of 2-day workshops, most of the first day was devoted to the site prioritization framework, while the second day focused on threat assessment (i.e., description of problems). The purpose of the last workshop, the Florida Marine Site Prioritization Framework Expert Review Workshop, was to evaluate draft results of several analysis scenarios to solicit feedback on analysis inputs and process. This final meeting was held on June 16th, 2005 in St. Petersburg. Another set of three workshops was held as part of the larger marine CWCS component, but since these were concerned exclusively with threat abatement and strategy development (CWCS element #4), they are not covered in this document. An Interim Report that was prepared for this project (Geselbracht and Torres, 2005) provides a brief overview of the site prioritization process, describes inputs, and presents some early draft results.

The analyses and results presented in this document, i.e., the draft scenarios depicting potential priority areas, are intended to be a first step in the process of identifying priority marine and estuarine sites for further or more intensive resource management and conservation action. The analyses are not intended to replace expert knowledge of marine and estuarine systems and species, but to serve as a tool to help objectively evaluate and fine-tune expert knowledge. The framework is based on a site prioritization process that uses a site optimization algorithm known as Marxan. Marxan was developed by Ian Ball and Hugh Possingham at the University of Adelaide (Ball, 2000; Possingham et al 2000) and a set of collaborators that included The Nature Conservancy and other conservation groups. As in any planning exercise, the validity of the results is only as good as the data inputs. As available data improve, the results can be further refined, indeed, one of the benefits of this exercise has been to identify gaps in our current knowledge. In the development of this framework, we have used the best available statewide data relating to marine and estuarine ecosystems. Although the outer planning area boundary established for this framework extends to the 500 meter isobath, very limited data were included beyond state waters in this iteration of the framework. It will be possible to readily add datasets to future iterations; these results should be seen as the beginning of a process, rather than the end.

Site Prioritization Process

Overview

This section provides a description of the site prioritization framework. First, an overview is provided of a key component of the framework, the Marxan site optimization model which is used to identify potential priority sites. Next, a description is provided of the Marxan inputs and how we derived the information to create each of these inputs. The final portion of this section provides some draft application of this site prioritization framework using several different scenarios.

The Marxan site optimization algorithm identifies priority areas which are defined as a set of areas that efficiently represent the selected amount of each target at the scale of analysis. To use this decision support tool, we selected a planning area, stratified it into subregions, selected planning units appropriate for the scale of the analysis, identified resource targets (habitats, species and phenomena) to use in the analysis together with data describing their distributions and the levels at which to represent these targets in the model results, and chose an appropriate level of site cohesiveness. Expert consultation was solicited and obtained at each step of the process, which is described in more detail below.

The Marxan model seeks to minimize the following objective function:

$$Total\ Cost = \sum_i Cost\ site\, i \quad + \quad \sum_j Penalty\ \cos t\ \ for\ element\ j \quad + \quad w_b \sum boundary\ length$$

Marxan begins by selecting a random set of planning units, then iteratively explores improvements to this portfolio of sites by randomly adding or subtracting planning units. At each iteration, the new portfolio is compared with the previous portfolio and the better one is selected. Marxan uses a method called simulated annealing to reject sub-optimal portfolios, thus greatly increasing the probability of converging on the most efficient portfolio. In our draft analyses presented later in this document, the algorithm was run for 10 million iterations.

Marxan and the related models, SPEXAN and SITES, have been used for a variety of marine applications. The Ecology Centre at the University of Queensland hosts a website on MARXAN and its known applications. The site (http://www.ecology.uq.edu.au/index.html?page=27710) lists these known applications in a table. An abbreviated form of this table is recreated below.

Table 1. Some Marine Applications of the Marxan, Spexan and Sites Site Selection Models

Place of Application, Report/Publication Date & Contact Information	Program Used and Summary of Application
Florida Keys, 2003 Heather Leslie, Department of Ecology and Evolutionary Biology Princeton University	SPEXAN 3.1/Sites: This was the first marine application of the simulated annealing algorithm, which is part of the SPEXAN/Sites/MARXAN packages.
Channel Islands, 2003 Satie Airame, Marine Policy Coordinator for PISCO (The Partnership for Interdisciplinary Studies of Coastal Oceans) at the University of California, Santa Barbara	SITES: A working group of stakeholders used the siting tool to design a network of fully protected marine reserves for the National Marine Sanctuary.
Australia - Great Barrier Reef Marine Park, 2003 Suzanne Slegers, GIS Officer, GBRMPA	MARXAN: This effort evaluated the existing zoning scheme in the GBRMP to meet biodiversity conservation objectives.
Northern Gulf of Mexico, 2001 Mike Beck, Senior Scientist, Marine Initiative The Nature Conservancy	SITES: This was the first non-governmental application of the tool to be publishes in the peer-reviewed literature.
Gulf of California, 2002 Enric Sala, Center for Marine Biodiversity and Conservation	SITES: This collaborative effort between marine scientists at Scripps Institution of Oceanography (USA) and World Wildlife Fund yielded possible marine reserve network configurations for the Gulf of California.
Willamette Valley-Puget Trough-Georgia Basin (USA/Canada), 2002 Zach Ferdana, GIS Analyst, The Nature Conservancy of Washington	SITES: Conservation planners are using both biological community and species-based conservation targets to draft a network of priority areas for conservation action in the Pacific Northwest (USA).
Galapagos Islands (Ecuador), 2000 Rodrigo H. Bustamante, CSIRO Marine Research	MARXAN: The siting tool is being used to further the implementation of the Galapagos Marine Reserve and the associated zoning initiative, and to monitor its performance.
Northwest Atlantic (USA/Canada), *unknown* Hussein Alidina, Sr. MaHunager GIS/Conservation Planning	MARXAN: WWF Canada and The Conservation Law Foundation (Boston, MA, USA) are collaborating on this initiative to designate areas of high conservation value in the Gulf of Maine/Bay of Fundy/Scotian Shelf/Georges Bank/Offshore waters. It is in the early stages.
South Australia, 2002 Romola Stewart The Ecology Centre, The University of Qld	MARXAN: Marine reserve systems are configured using MARXAN to compare solutions that retain South Australia's existing marine reserves with reserve systems that are free to either ignore or incorporate them.
British Columbia, 2002 Jeff Ardron, Living Oceans Society, British Columbia	MARXAN: Staff at this grassroots non-governmental organisation have used the siting tool to explore the possible configurations of a system of marine protected areas, including fully protected marine reserves, for the British Columbia Central Coast.
Connecticut/New York, *unknown* Amanda E. Wheeler, University of New Haven	MPA designs for Estuary of Long Island Sound – Connecticut/New York were created using MARXAN. Amanda has written an excellent MPA Design Tutorial, available in .PDF format ("Download), with details on file creation, step by step methods for using MARXAN to design MPAs, and an abstract describing her work.

Planning Area, Subregions and Planning Units

Planning Area: Although the Florida CWCS is intended to be a state plan, and this framework was developed as a component of it, a considerable amount of interest was expressed in marine areas beyond state waters during workshops. We thus, decided to structure this framework using the more liberal 500 meter isobath as our outer boundary. Even so, due to data availability and scope of this project, the results within state waters should be given much greater weight than those outside state waters, as more comprehensive and detailed coarse and fine filter target datasets were available for state waters. We set the inner planning boundary at the inland extent of the National Wetlands Inventory marine and estuarine habitat categories, which for the most part captures the extent of ocean derived saltwater influence.

Subregion Stratification: Marine habitats and species change gradually with latitude. To capture these regional differences, we stratified the planning area into eight regions based on expert knowledge of coastal geomorphology and faunal assemblages. The eight selected subregions are illustrated in Figure 1 and described below.

- Northeast Florida**:** From the border with Georgia on Florida's northeast coast south to Cape Canaveral, the Florida coast is characterized by a moderately broad and gently sloping continental shelf. This stretch of coastline forms the southern portion of the Georgia Bight. Coastal geomorphology has been shaped by a mixed regime of wave and tidal energies. In the northern portion of this area, coastal geomorphology is typical of a mixed energy environment. Tidal inlets are wide and deep, tidal flats and marshes are relatively extensive, and barrier islands are relatively short. South of Matanzas Inlet, the only inlet along this stretch of coast free of jetties and other stabilizing structures, the barrier island-inlet system displays wave dominated characteristics. The barrier islands along this portion of the coast are relatively long, the dunes relatively high, and a prominent longshore bar and trough system is mostly present. Beaches range from narrow and steep to wide and gently sloping. Due to the widely spaced inlets in this area and attenuation of tides with distance from the inlets, the areas behind the dunes most distant from the inlets are essentially fresh. The majority of the Northeast Florida coastline is comprised of Holocene quartz-sand barrier islands, while about 20% is Pleistocene and includes Anastasia limerock in beach and shallow nearshore areas (Davis, 1997).

- East-Central Florida: From Cape Canaveral south to the Jupiter Inlet, the East-Central Florida Coast has a sandy beach/narrow barrier island morphology similar to the Southeast Coast except that the continental shelf becomes progressively broader at the northern end of this subregion towards Cape Canaveral. A key feature of this portion of the coastline is the Indian River Lagoon, actually an estuary, that has been characterized as the most biologically diverse in North America due to it straddling of both subtropical and temperate zones. Benthic habitat types common in this region include patch coral reef, shallow Sabellariid worm reef, hard bottom and deep oculina banks. A major point source of freshwater discharge into this region of coast is from Lake Okeechobee through the St. Lucie Canal.

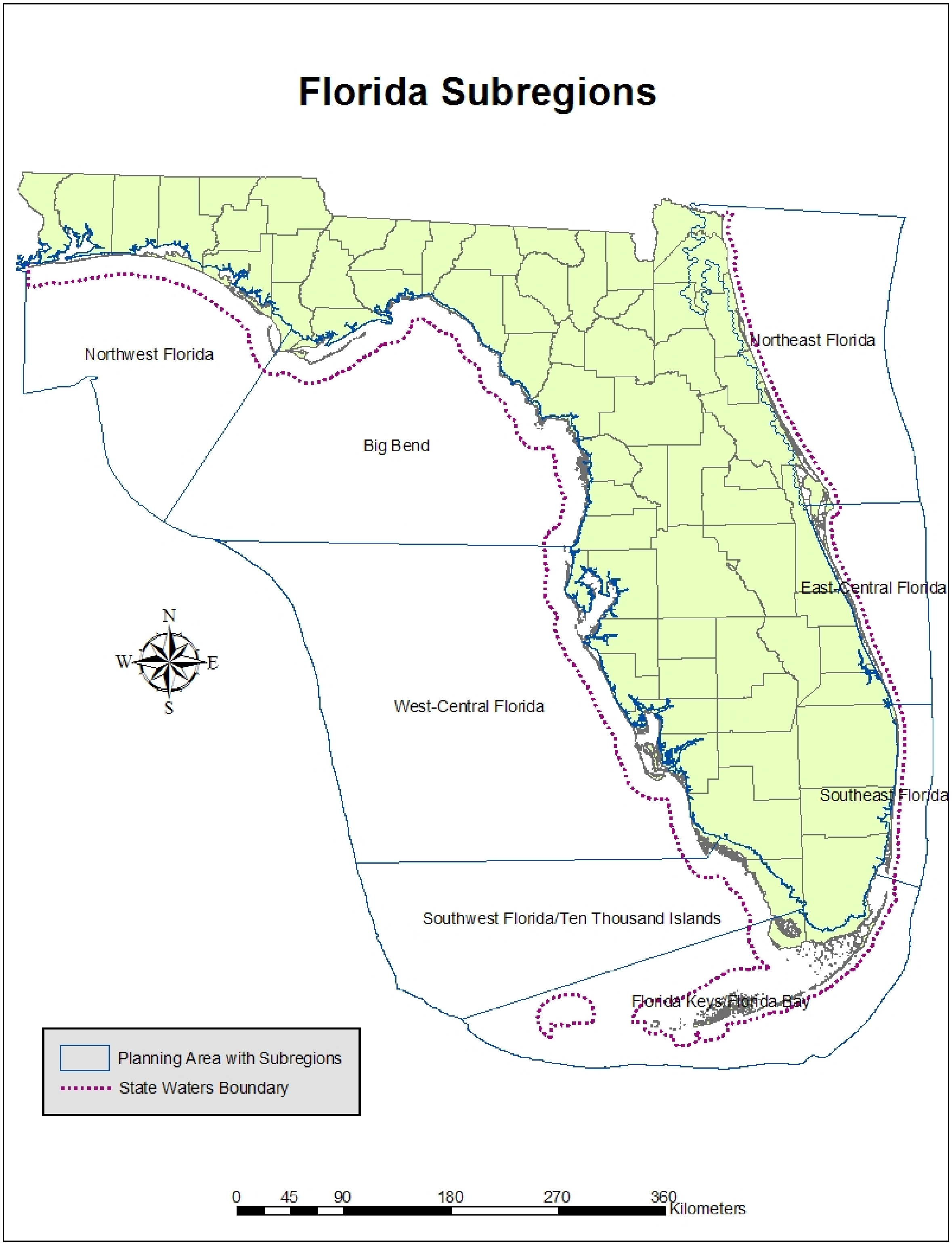
- Southeast Florida: The Southeast Coast of Florida from Jupiter Inlet south to Fowey Rocks (north end of the Florida Keys) is primarily characterized by sandy beaches, narrow barrier islands, a narrow continental shelf and reef terraces (approximately three) that run parallel to the beach. These reef terraces are dominated by octocorals and sponges rather than stony corals (Gilliam, 2004). Reef terraces along this stretch of coastline diminish north of approximately West Palm Beach making way for patch reefs. This region also includes the more impacted northern portion of Biscayne Bay which is surrounded by urbanized Miami-Dade County.

- Florida Keys/Florida Bay: The Florida Keys/Florida Bay region at the southern tip of Florida is characterized by a low lying string of oolitic-limestone islands that trend southwest from Key Biscayne off Miami to the Dry Tortugas more than 330 kilometers away (Randazzo and Halley, 1997). The southern side of the Florida Keys is bounded by the world's third largest fringing barrier reef, approximately 10 kilometers offshore. The continental shelf in this area is relatively shallow and makes way for the Florida Straits that separate the Florida Keys from Cuba. Florida Bay forms the large shallow water body between the Florida mainland and Florida Keys. Florida Bay is actually a patchwork of deeper "lakes" separated by shallow mud banks that in some areas support mangrove islands (Lodge, 1998). Southern Biscayne Bay is included in the northern portion of this region. This relatively undisturbed portion of the bay is a national park (Biscayne National Park).

- Southwest Florida/Ten Thousand Islands: The Ten Thousand Islands area extends from Cape Sable north to Cape Romano harbors one of the world's largest contiguous mangrove areas (more than 830 square kilometers) and is still growing seaward despite slowly rising sea level. The area is characterized by vast mangrove forests, mangrove islets, tidal channels, small embayments and abundant oyster and sabellarid worm reefs (Davis, 1997). The unique formation of mangrove islets in the Ten Thousand Islands area has been made possible by southbound longshore currents that carry sand and shells to the region allowing oysters to become established. In turn, oyster bars provide the substrate for mangroves to take hold (Lodge, 1998). In the Cape Sable area, it appears that vermetid gastropod reefs provided the substrate for mangrove islands to become established (Davis, 1997). These gastropod reefs are now relicts that no longer harbor living reef building gastropods.

- West Central Florida: The area from Cape Romano north to Anclote Key is characterized by the world's most morphologically diverse barrier island system with its 29 barrier islands and 30 inlets (Davis, 1997). This section of the Florida coast has a wide continental shelf extending more than 160 kilometers out into the Gulf of Mexico and both large and small embayments. The largest estuaries in this area, Tampa Bay and Charlotte Harbor, have tremendous tidal prisms. One of the largest freshwater sources into this portion of the coast, besides subsurface and sheet flow, is the Caloosahatchee River, which was artificially connected to Lake Okeechobee decades ago.

Figure 1. Subregions selected for Florida Marine/Estuarine Site Prioritization Analysis



- Big Bend: The Big Bend coastline extends from Anclote Key at the south to Cape San Blas at the North. The continental shelf in this subregion is extremely wide at more than 150 kilometers, and the seaward gradient extremely shallow resulting in a low wave energy environment (Davis, 1997). This coastal area is characterized by extensive seagrass and salt marsh communities that extend for approximately 350 kilometers along the coast and a single circulation cell is present in the area. Other prominent features of this subregion include actively discharging freshwater springs, large oyster reefs and a delta area formed by the Suwannee River. Other rivers discharging into this area are relatively minor as they are short and spring fed. Notably absent from this stretch of coastline is quartz sand.

- Northwest Florida: The Northwest Coast of Florida, or Panhandle Coast, has a wave dominated energy regime with barrier islands, well developed beaches and foredunes, and widely spaced inlets (Davis, 1997). The Apalachicola River, which drains much of Georgia and Alabama, ends in a large fluvial delta. Off this delta, the gradient into deep waters is shallow, approximately 1:1,800. Further to the west in this subregion, the offshore gradient is relatively steep, about 1:60 out to a depth of 20 m. Littoral drift from the Apalachicola Delta is westwardly oriented and has been estimated at 200,000 cubic meters annually.

Planning Units: To run Marxan, the ecoregion was divided into 18,943 1500-hectare hexagons. The hexagon shape was chosen for the planning units because more natural appearing clumps are formed as sites are selected based on the amount of boundary (six sides) shared among individual units. The size of the planning unit was selected to provide fine enough detail for statewide analysis while not overwhelming processing capabilities with excessive units that may add little to analytical resolution.

Marine and Estuarine Resource Targets & Data Sources

In completing the CWCS process for Florida, the Florida Fish and Wildlife Conservation Commission (FWC) made the decision to use a habitat-based approach. A complete description of the decisions that the FWC has made regarding how the state will approach development of its CWCS is provided on Florida's Wildlife Legacy Initiative website (http://myfwc.com/wildlifelegacy/). Under this approach, habitats are used to represent the species that are associated with them. In the case of Florida's CWCS, this will be the selected species of greatest conservation need (SGCN). A complete listing of these 900+ species can be found in the Comprehensive Wildlife Conservation Strategy and on the above listed website. The targets that we selected for the analyses that are presented in the main body of this document are the marine and estuarine habitats found in the states coastal waters and intertidal areas. The habitats are also referred to as coarse filter targets and should be as comprehensive as possible to fully represent the state's marine and estuarine systems.

Coarse Filter (Habitat) Targets: We used the FWC/FWRI document "Development of a System for Classification of Habitats in Estuarine and Marine Environments (SCHEME) for Florida" (Madley et al., 2002) as a guide to characterizing the habitat categories and assembling data. We assembled as comprehensive a set as possible of geospatial maps depicting marine and estuarine habitats in Florida. In assembling the data for this project, we relied on information existing at the time of project initiation (June 2004) and took into account the state-wide nature of the CWCS analysis and the timeframe available for completing it. Where insufficient data or processing time were available to characterize a particular habitat, it was eliminated from this iteration of the framework. Habitat types eliminated from further consideration in this version of the site prioritization analysis include intertidal rock, subtidal unconsolidated sediments and pelagic. The site prioritization framework presented here will, however, allow for additional habitat categories to be added as new information becomes available or sufficiently processed to fit into the framework. The FWC provided geospatial maps for the following marine/estuarine habitat categories:

- mangrove forest
- salt marsh
- submerged aquatic vegetation
- tide flats
- marine hardbottom; and
- artificial structures.

The Nature Conservancy assembled habitat maps for the following habitat categories using FWC spatial information as well as information from other sources (see Table 2 for specifics):

- coral reefs,
- beach/surf zone;
- coastal tidal river or stream.

Distribution maps for the following additional habitat targets were assembled exclusively by the Conservancy from a variety of data sources: bivalve reef (oyster reefs), annelid (worm) reefs and inlets. Table 2 lists the data sources for each selected marine/estuarine coarse filter target and describes any additional processing of the dataset conducted by The Nature Conservancy or project partners. Table 3 identifies the subregions in which specific coarse filter target data was utilized for the site selection modeling process.

Figure 2 depicts the number or density of coarse filter data surveys used in the site prioritization analysis. We created this map by overlaying our planning area with all of the coarse filter target datasets used in the analysis. Planning units were given a score based on the number of data surveys/groups occurring within each planning unit. Each data survey/group as listed in Table 4 was given a score of 1. The number of data surveys/groups represented in each planning unit varied from 0 to 14. Figures 3 through 13, illustrate the distribution of the coarse filter targets included in the site prioritization analysis. Lack of coarse filter data utilized in a specific subregion may reflect target distribution limits (e.g., coral reef, mangrove forest), lack of data of sufficient quality (e.g., oyster reefs), or other factors. The target ocean inlets and passes was not utilized as target in Subregion 5, Southwest Florida/Ten Thousand Islands, due to the exceedingly large number of small islands, and consequently passes, in the area.

Where benthic habitat maps were not available, benthic habitat type was predicted using an ArcInfo GIS model developed by Duke University Marine Geospatial Ecology Laboratory (2005) based on bathymetry data (90-meter grid scale) and using four geophysical features (depth, topographic variety, amplitude of topographic change and substrate type). The rationale for this approach was that there is often a strong correlation between benthic complexity and biological diversity. Topographic variety was classified as flat, slope, ridge and canyon. Sediment classes were extrapolated from data in the ASMFC SEAMAP Project and the USGS usSEABED Project. Application of the resulting model predicted a full range of potential benthic habitat types. The site prioritization analyses presented in the body of this report were conducted without considering the benthic complexity and hardbottom targets primarily because concerns were expressed during the expert review workshop that these datasets were based on incomplete information and that their inclusion would likely bias the results towards areas where more information was available. These datasets are, however, included in the framework, so that they may be used in future analyses where deemed helpful. Maps depicting the benthic data layers are contained in Appendix B.

Fine Filter (Species) Targets: Fine filter or species targets may be included in site prioritization analyses to represent ecologically important areas that are not likely to be adequately represented by coarse filter (habitat) targets alone. Inclusion is typically reserved for the most imperiled and/or rare species so as not to allow the fine filter information to "overwhelm" coarse filter targets in the prioritization analysis. We did not, however, include fine filter targets in the analyses we present in the body of this report so as to remain consistent with the FWC goal of using a habitat based approach for the Florida CWCS process. It would also have been impractical to include the dozens of marine species identified as species of greatest conservation need (SGCN) through the CWCS process in this analysis because the variation in available distribution information is such that it would be impossible not to bias the analysis towards species where distribution information has been more widely collected.

For those interested in other applications of this site prioritization framework beyond the CWCS process, we identified, selected and assembled distribution information on the most ecologically imperiled species for which there was appropriately scaled data. This information is presented in Appendix C along with data sources, rationales for inclusion, distribution maps and sample model output when fine filter targets are included.

Table 2. Coarse Filter (Habitat) Source Data Used in Site Prioritization Analysis

TARGET	DATA TYPE	DATA SOURCE(s)	SOURCE DATASET NAME(s)	PROJECT DATA PROCESSING	DATASET EXTENT	PROJECT DATASET NAME(s)
Coral Reef	Polygon	FWC-FWRI	sf_benthic_97.shp	Isolated patch & platform margin reefs attributes;	SE Florida & Florida Keys	sf_benthic_97.shp
		Palm Beach County	palm beach 2003_reef_OFFSHORE.shp	Used as is;		palm beach 2003_reef_OFFSHORE.shp
			and LADS data	Created reef shapefile from LADs data;		palm beach reefs.shp
		Miami Dade County	LADS data	Created reef shapefile from LADs data;		miami dade reefs.shp
		Broward County	broward reefs.shp	Used as is.		broward reefs.shp
Oculina		NURC/UNCW	oculina.shp			oculina.shp
				------------------------- For all coral reef datasets, we identified patch (discrete reef patches, mostly shallow at 0-15 meters deep), shallow bank (0-10 meters deep), deep bank (10-30 meters deep), and deep reef resources (30-200 meters deep).		
Mangrove Forest	Polygon	FWC (FL GAP)	fl_veg03.shp	Isolated mangrove forest & scrub mangrove attributes; Converted raster data to shapefile.	Statewide	fl_veg03_mangroves.shp
Beach/Surf Zone	Polygon	FWC (FL GAP)	beach_surf_zone.shp	Used as is (missing SE Florida beaches)	Statewide, incomplete;	beach_surf_zone.shp;
		SFWMD	beaches_wmd.shp	Used as is. These 2 datasets complement each other to fill gaps in each.	Statewide, incomplete	beaches_wmd.shp
Salt Marsh	Polygon	FWC (FL GAP)	fl_veg03.shp	Isolated salt marsh attribute; Created shapefile from raster data.	Statewide	flveg03saltmarsh
Submerged Aquatic Vegetation	Polygon	FWC-FWRI	seagrass_fl_1987to1999_poly.shp	Used as is.	Statewide	seagrass_fl_1987to1999_poly.shp

TARGET	DATA TYPE	DATA SOURCE(s)	SOURCE DATASET(s)	PROJECT DATA PROCESSING	DATASET EXTENT	PROJECT DATASET NAME(s)
Coastal Tidal River or Stream	Line	FWC-FWRI	Florida coastline and tidal rivers	Overlaid “Florida coastline and tidal rivers” with NHD stream reaches	Statewide	coastal_rivers2d.shp
		USGS	National Hydrography Dataset (NHD)			
Tide Flats	Polygon	FWC (FL GAP)	fl_veg03.shp	Isolated tide flats attribute in fl_veg03 and combined with FWC/FWRI's tide flats layer.	Statewide	fl_veg03_and_FWRI_tidalflats.shp
		FWC-FWRI	tidefl.shp			
Marine Hardbottom[1]	Polygons	SEAMAP, 1997	seamap.shp	Selected hardbottom and potential hardbottom attributes, and joined the two resulting files.	Florida Atlantic Coast with some gaps	HardbottomC.shp
		FWC-FWRI	sf_benthic_97.shp			
Bivalve Reef (Oyster)	Polygon	Grizzel et al. 2002	Canaveral_Seashore_allreef-final.shp	Used as is;	East-Central Florida	Canaveral_Seashore_allreef-final.shp
		USFWS	national_wtlds_inventory_areas.shp	Isolated intertidal mollusk reef in NWI;	Statewide	nwi_est_intrtdl_moll_reefs.shp
		ANERR	Oyster_Bars_ANERR.shp	Used as is;	Apalachicola NERR	Oyster_Bars_ANERR.shp
		A. Volety	Oysters bar aerials, SW FL	Created shapefile from aerial images for SW FL;	SW Florida	oysterssw.shp
		SFWMD	SLO2003beds.shp	Used as-is;	St. Lucie Estuary	SLO2003beds.shp
		SRWMD	oyster_bigbend.shp	Used as is;	Big Bend	oyster_bigbend.shp
		SRWMD/ USGS-NWRC	oyster_nw_92.shp	Used as is.	Panhandle	oyster_nw_92.shp
Annelid Worm Reef[2] (Sabellariidae)	Polygon	D. McCarthy D. Kirtley & W. Tanner D. Stauble & D. McNeill	N/A	Created shapefile using graphics and text descriptions with reference points; in some cases located reefs mentioned in text above using FGDL – Digital Orthophoto Quarter Quad 3 Meter aerial images; some coordinates also used	Southeast & East Central Florida	wormreefs.shp

TARGET	DATA TYPE	DATA SOURCE(s)	SOURCE DATASET(s)	PROJECT DATA PROCESSING	DATASET EXTENT	PROJECT DATASET NAME(s)
Ocean Inlets and passes	Polygon	Univ. of FL Geoplan Center & USGS	Aerial photos (digital orthoquads, DOQQs)	Used Geoplan & USGS county aerials to ID locations; Solicited expert input re: polygon size.	Statewide	inlets_poly_statewideWkeys.shp
Artificial Structures	Point	FWC-FWRI FWC-FWRI	Artreef_new.shp ESI.shp	Used as is; Isolated solid man-made structures attribute in Environmental Sensitivity Index shapefile.	Statewide Statewide	artreef_new.shp solidstr.shp
Benthic Complexity[2]	Polygon	National Geophysical Data Center	90 meter bathymetry data	Model derived by Duke University Marine Geospatial Ecology Laboratory (DUGAP 2005); Gulf Coast dataset produced by G. Cumming	Statewide with some gaps	bc2-poly.shp

[1]*Based on input received at expert workshops, the marine hardbottom and benthic complexity targets were left out of the draft result scenarios presented in the body of this report.*

[2]*Survey information for sabellarid worm reefs in Florida was only available for the sabellarid, Phragmatopoma lapidosa, which occurs in east-central and southeast Florida coastal areas.*

Table 3. Subregions with Coarse Filter Target Datasets Included in Report Analysis

	Subregions							
Coarse Filter Target	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Coral Reef		x	x					
Mangrove Forest	x	x	x	x	x	x	x	
Beach/Surf Zone	x	x	x	x	x	x	x	x
Salt Marsh	x	x	x	x	x	x	x	x
Submerged Aquatic Vegetation	x	x	x	x	x	x	x	x
Coastal Tidal River or Stream	x	x	x	x	x	x	x	x
Tide Flats	x	x	x	x	x	x	x	x
Bivalve Reef (Oyster)	x	x			x	x	x	
Annelid Worm Reef (Sabellariidae)		x	x					
Ocean Inlets and passes	x	x	x	x		x	x	x
Artificial Structures	x	x	x	x	x	x	x	x

Figure 2. Density of the data used in the site prioritization analysis.

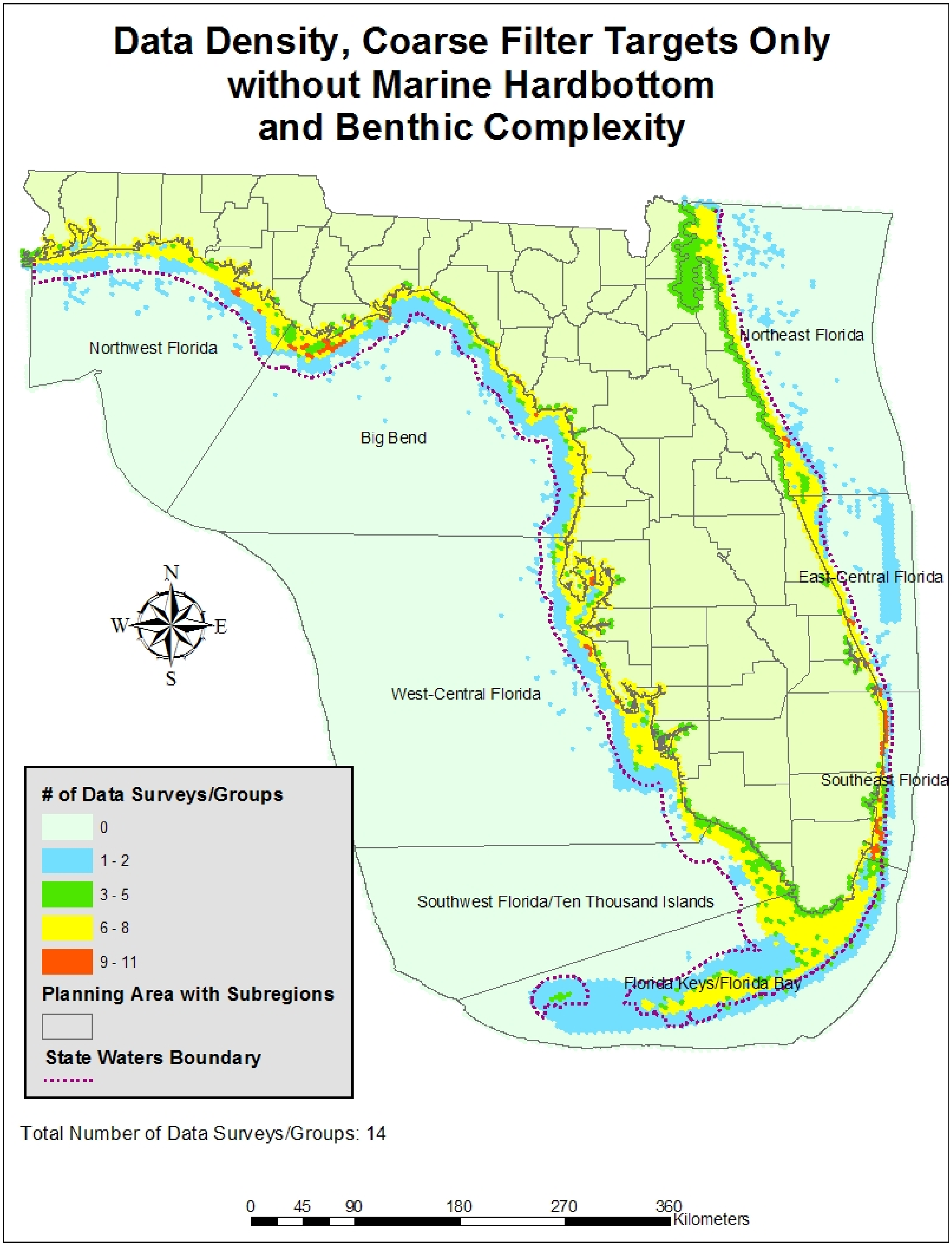


Table 4. Coarse filter data surveys used to determine data density.

Refer to Table 2 for additional information on the datasets/data groups listed below.

	DATA SURVEY/GROUP NAME
1	Coral Reef, LADS surveys conducted for Miami-Dade, Broward and Palm Beach counties.
2	South Florida Benthic (sf_benthic_97.shp): Used for coral reef and hardbottom targets.
3	Coral Reef, Oculina (oculina.shp)
4	fl_veg03.shp (dataset includes the following targets: mangrove swamp, salt marsh and a portion of tidal flats and beaches)
5	Tidal Flats: FWRI dataset, tidefl.shp
6	beaches_wmd.shp (extracted from SFWMD Land Use 1995)
7	Submerged Aquatic Vegetation (seagrass_fl_187to1999_poly.shp)
8	Coastal Tidal Rivers or Stream (coastal_rivers2d.shp)
9	Bivalve reef, oysters (includes the 7 sources of data listed in Table 1).
10	National Wetlands Inventory
11	Aerial photos, digital orthoquads: Used for ocean inlets and passes target.
12	Environmental Sensitivity Index: Used for artificial structure, hardened shoreline target
13	Annelid worm reefs (wormreefs.shp): Surveys conducted by several individuals; May overlap, but only counted as one data survey/group.
14	Artificial Structure, artificial reef (artreef_new.shp)

Figure 3. Coarse filter target – coral reef.

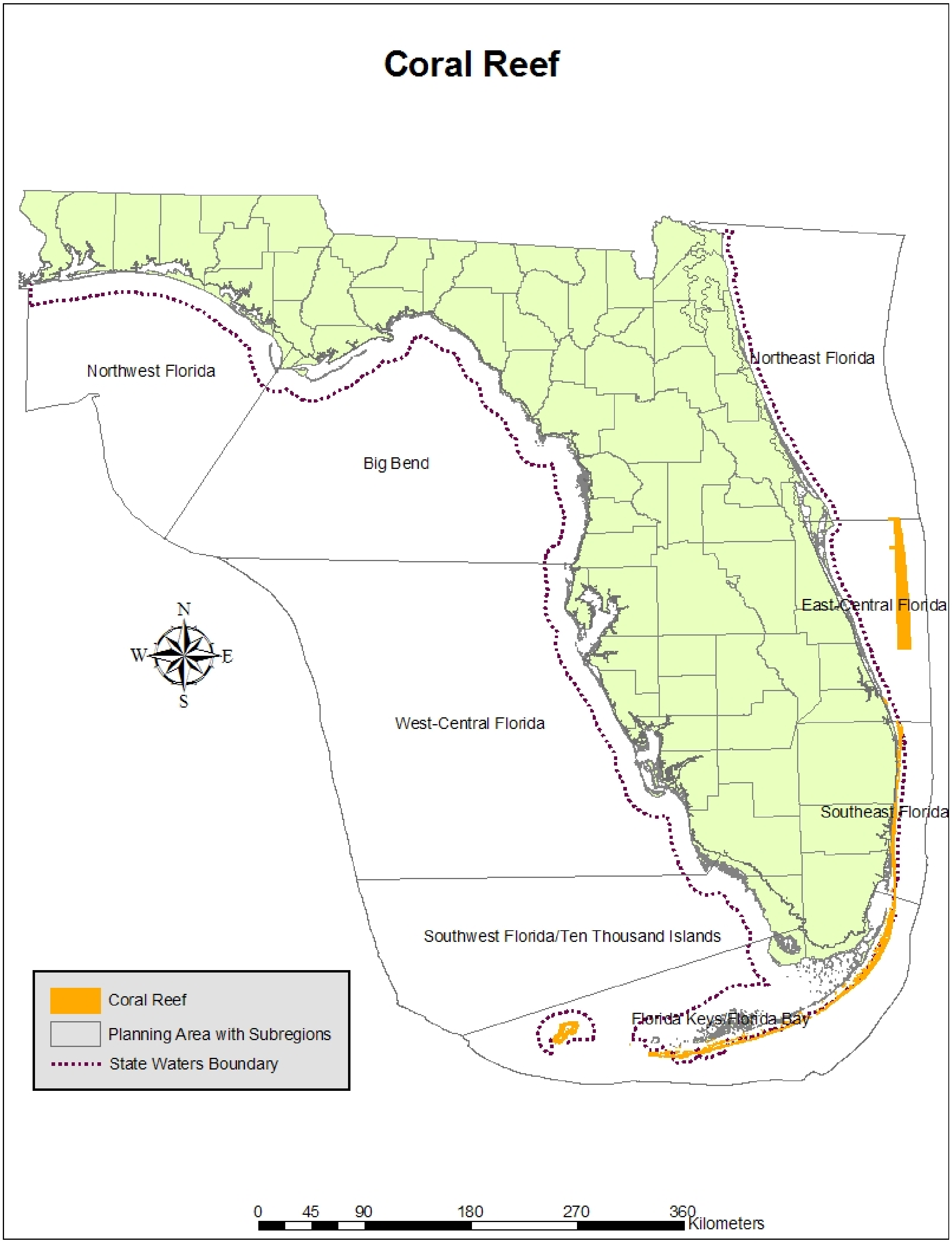


Figure 4. Coarse filter target – mangrove forest.

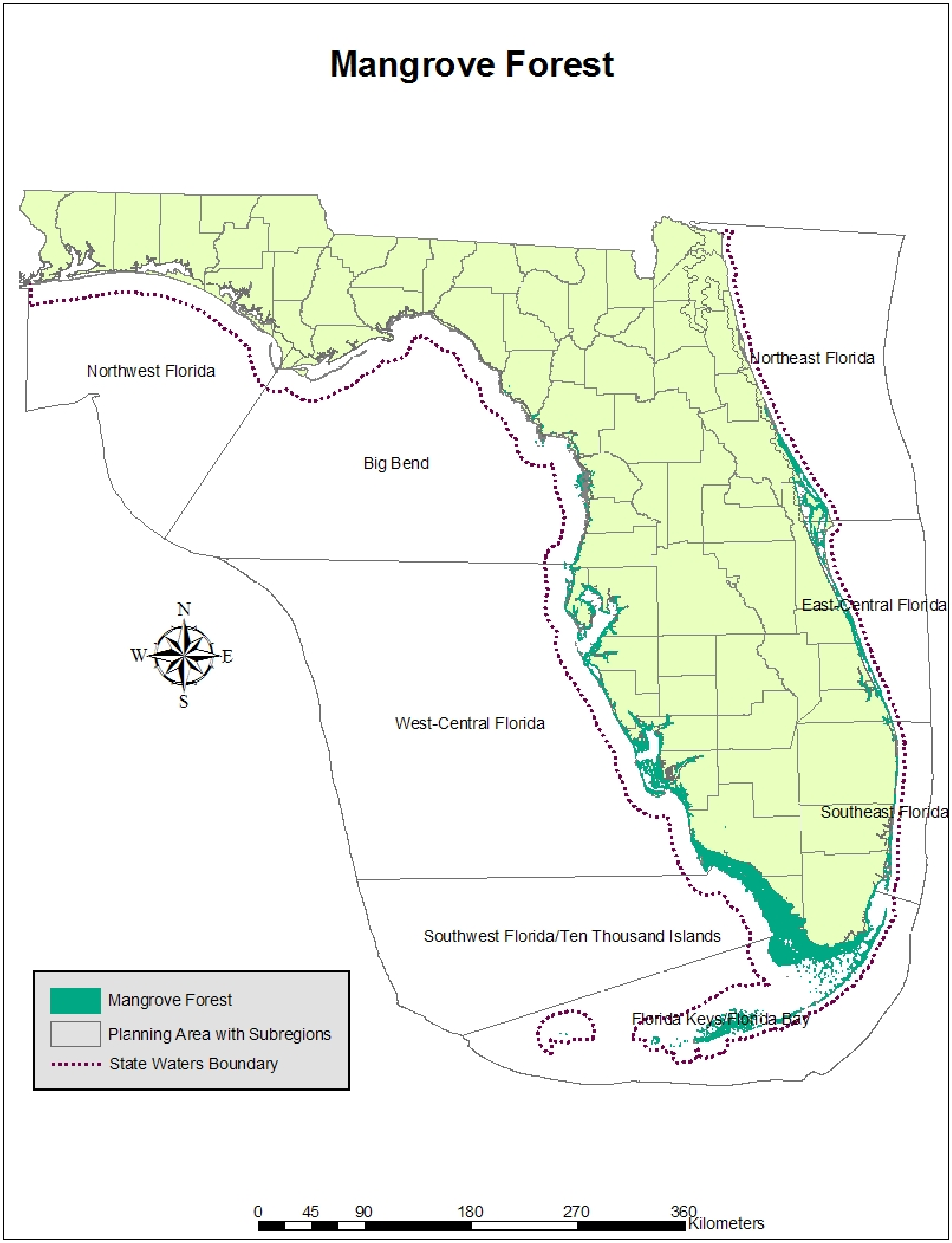


Figure 5. Coarse filter target – beach/surf zone.

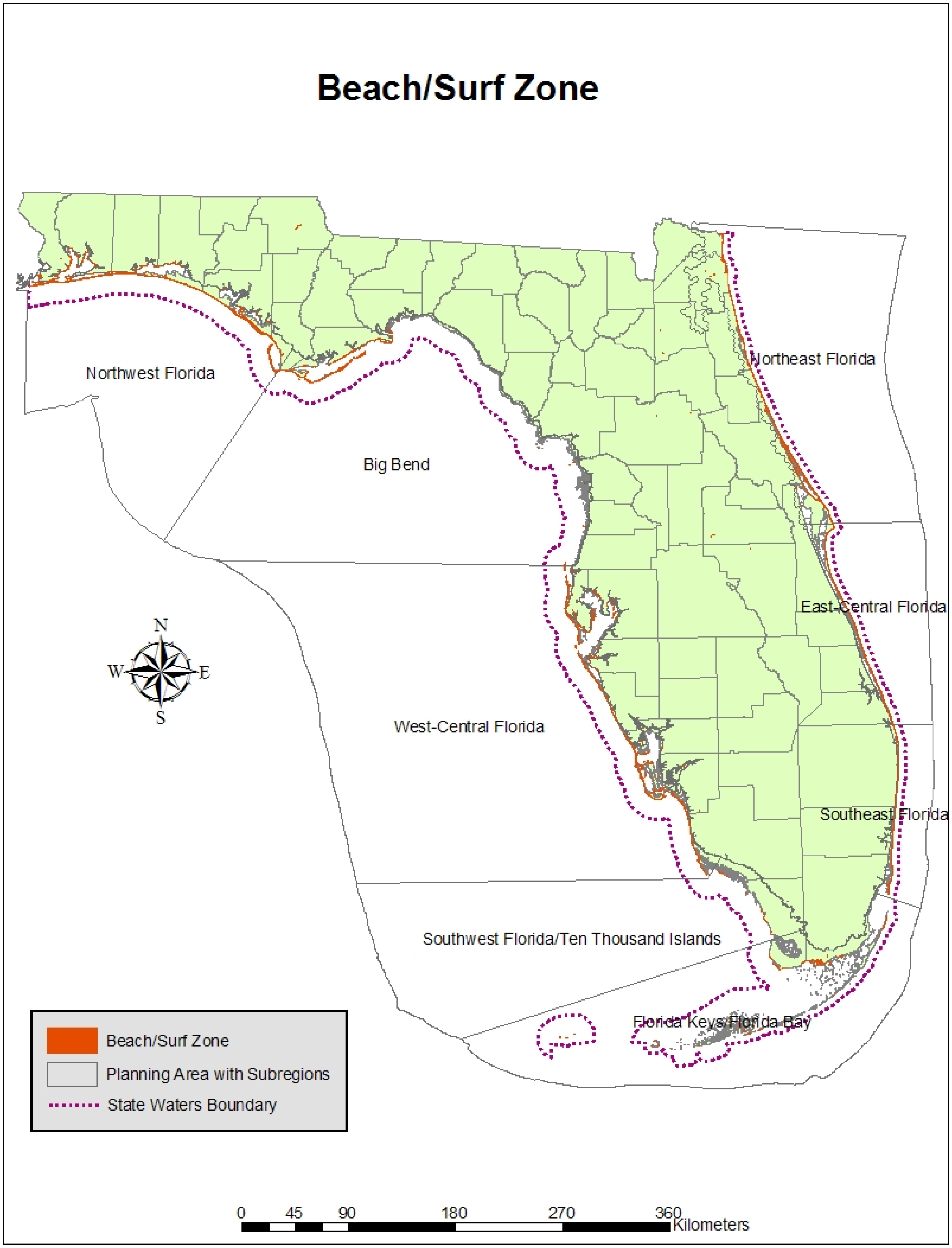


Figure 6. Coarse filter target – salt marsh.

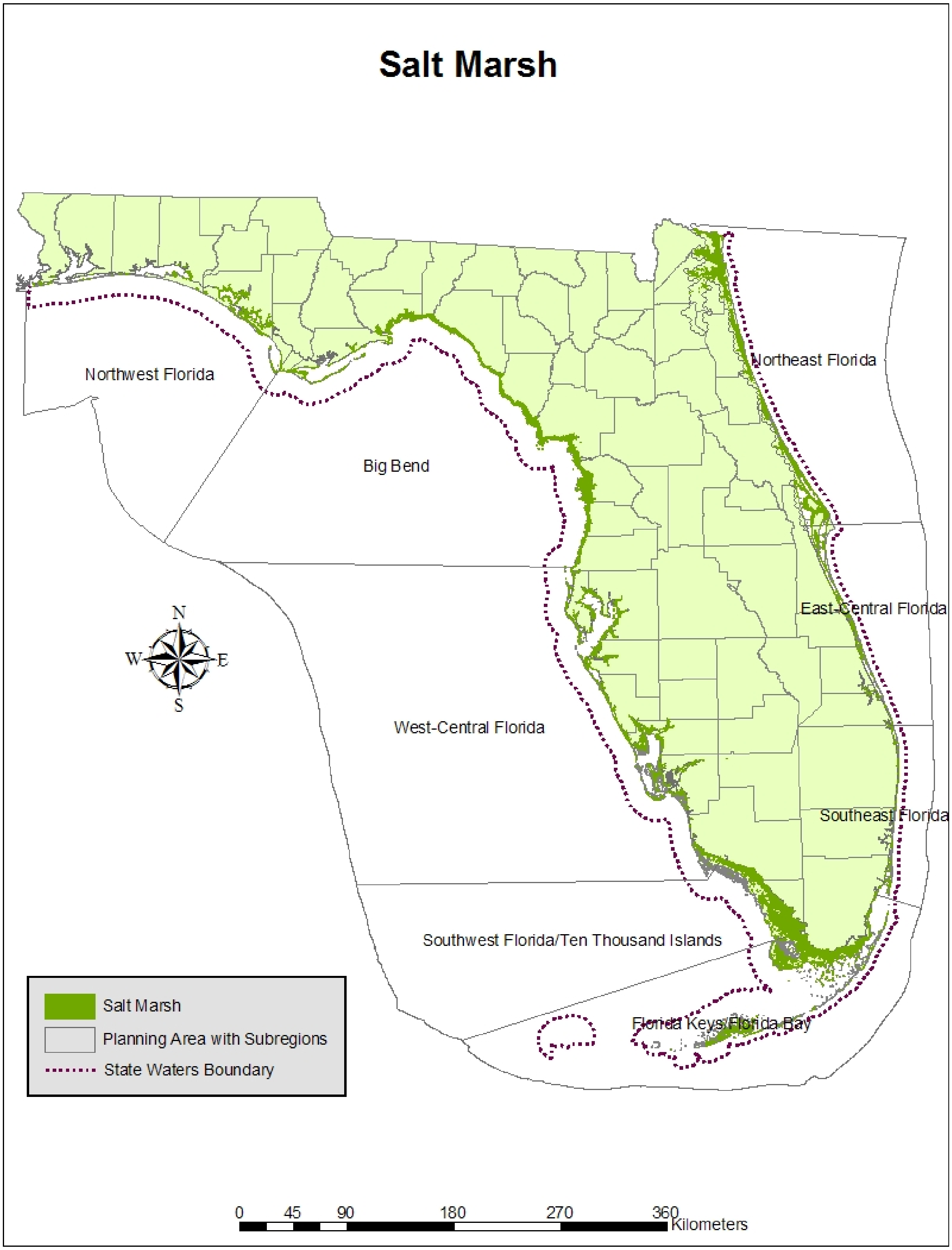


Figure 7. Coarse filter target – submerged aquatic vegetation.