Reference Document and Guide to the Evaluation of Permitted Coastal Construction Activities That Affect Coral Reef and Coastal Resources in Southeast Florida

Southeast Florida Coral Reef Initiative
Maritime Industry and Coastal Construction Impacts
Local Action Strategy Project 7 & 11

Southeast Florida Coral Reef Initiative

Acting above to protect what's below.

Reference Document and Guide to the Evaluation of Permitted Coastal Construction Activities That Affect Coral Reef and Coastal Resources in Southeast Florida

Reference Document

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1. Introduction

1.1. Project Goals, Objectives, and Constraints

In support of its primary goal to improve the protection of coral reefs and associated resources and to encourage coastal construction project applicants to consider avoidance and minimization of impacts to coral resources from the project planning stage through construction, the Maritime Industry and Coastal Construction Impacts (MICCI) Project 7 & 11 addressed two, related objectives:

- Create an electronic database that will serve as the primary source of information on regulatory coordination, past and current resource impacts, impact assessment, and examples of permit requirements and regulatory restrictions for permitted coastal construction activities in and around the southeast Florida region (Miami-Dade, Broward, Palm Beach, and Martin counties).
- Develop a resource reference document for planners, reviewers, and permitters of large-scale coastal construction projects that contains important references, a history of past permitted projects, and a comprehensive view of major coastal construction permitted projects from 1995 onwards.

The database and reference document cover coastal construction permits issued from 1995 through 2008; both products represent a data snapshot. While this document addresses historical changes in coastal construction, neither the document, nor the database cover historical (i.e., pre-1995) permits. The database and this document are not intended to be static reference tools; therefore, periodic future updates will be needed as more is learned about projects, opportunities, and useful resources. Future additional funding may be required to maintain and update the database and document.

MICCI Project 7 & 11 represented a continuation of the overall MICCI Local Action Strategy, in that the project goals and objectives used the results from the other proposed and ongoing MICCI projects to complement the results of this project. The following are examples of such projects:

MICCI Project 3 (Tetra Tech EC Inc., 2007) concerned emerging innovative coastal construction technologies, practices, and procedures, provided important information on the various coastal construction threats and their impacts on southeast Florida coral reefs. It also presented existing and emerging technologies that mitigate impacts, or have been used in other regions to reduce impacts or costs to implement mitigation measures. Best management practices (BMPs) and other measures developed during the coastal construction planning phase, and improvement to enforcement and monitoring approaches, were also considered. In describing the various impacts associated with coastal construction and the measures that can be taken to reduce these impacts, Project 3 provided essential background and baseline information that was used in Project 7 & 11 to identify impact categories for the project database and to describe resource impacts in the reference document.

MICCI Project 6 (PBS&J, 2008), focused on the development of BMPs as a guidance tool by which to manage, monitor, and minimize coral reef impacts resulting from coastal construction. This project also provided important background information for Project 7 & 11, especially as related to coastal construction activities, methods, and impacts (Chapter 2), and permitting related to southeast Florida coastal construction (Chapter 4). The discussion on permitting served to identify the permit types to be included in the Project 7 & 11 database and reference document.

MICCI Project 26 (FCES/FAU, 2007), involved the development of a 'tool' by which to evaluate cumulative impacts to the southeast Florida region's coral reef resources. The intent of the 'tool' is to use it during project permit applications and environmental impact assessment preparation. This project served as a background document from which to develop the Project 7 & 11 database and as a template for the evaluation of cumulative impacts on a case study permit in this document (Appendix 1).

Finally, it should be noted that while a majority of the permits entered and evaluated for this project did not directly reference the region's coral reefs, the permits held the potential to impact coral reefs and associated resources, including the nearshore seagrass communities, mangrove stands and forests, and other coastal habitats. The Florida Coastal Management Program identifies the entire Florida peninsula as part of the coastal zone (DCA, 1998), and inland and coastal construction activities separately and synergistically affect the region's coastal resources. Furthermore, there are well-established linkages across coral reefs and other habitats, where the latter serve multiple functions that affect the health of the coral reefs (McCook et al., 2009). This includes mangroves and other estuarine habitats providing nursery grounds for a number of important commercial and keystone species, serving as feeding grounds for species that move between coral reefs and mangroves, and providing nutrients to adjacent habitats, among others. Similarly, seagrass beds provide shelter for many important species, of which several feed in the seagrasses and transfer nutrients to coral reefs. Other nearshore environments may yield related benefits such as larval transfer, as well as providing a physical buffer to prevent the flow of runoff (and pollution) that may result in turbidity or smothering of coral reef and nearshore hardbottom resources. Thus, the permitted activities evaluated in this project are considered in terms of their overall impacts to the region's coastal zone.

1.2. Project Tasks

1.2.1. Development of a Geo-Referenced Database of Permitted Coastal Construction Activities

The first project task was the development of a permit database that could document all past and ongoing project impacts and related information from the various permits issued by local, state, and federal regulatory agencies. Although many of the regulatory agencies have internal permit tracking databases, there has never been, until now, a single source geo-referenced database that contained coastal construction permits from all agencies. The following coastal construction activities were targeted during permit data mining:

- *Navigation*
  Projects under navigation were further divided into: 1) new navigation projects (e.g. creation of navigational channels), 2) expansion projects (e.g. port expansion projects), and 3) maintenance navigation projects (e.g. Atlantic Intracoastal Waterway (ICW) and inlet bypass maintenance and dredging).

- *Beach nourishment and shoreline erosion abatement*
  These projects included soft stabilization projects such as (re) nourishment and hard stabilization projects such as jetty, breakwater, and seawall construction and maintenance.

- *Coastal development*
  Coastal development encompassed a variety of categories including estuarine and wetland fill, all development seaward (in this case, generally eastward) of the Coastal Construction Control Line (CCCL), and estuarine dredging and filling, as exemplified by marina, airport, and commercial dock construction and expansion, as well as residential and commercial new construction and expansion/redevelopment. This category did not include small-scale (e.g. single family residential) docks, which are too numerous to be included in the study.

- *Energy*
  Projects under the energy category considered those that were inshore, such as power plants (in terms of siting and expansion), transmission lines, and those that were offshore, primarily pipelines.

- *Communications*
  Communications generally referred to those projects that involved telecommunication infrastructure, such as fiber-optic cables and related support systems, which were placed or buried below the mean high water line (MHWL).

The first task also called for the development of Geographic Information System (GIS) layers for each of the permit types in the geo-referenced database in support of spatial and temporal analysis of past and current projects. The GIS layers are linked to the permit database so that permits can be identified on digital maps. These maps can be analyzed for the extent of permitting activity (by type and over time) in a given area.

Permit Types
Project permits fell into categories of coastal construction activities in the State of Florida that require one or more permits from a local, state, or federal agency. Agencies may partner to permit certain activities that require multi-jurisdictional permits; whereas, other agencies may delegate permits for application at regional or local levels. Each permit type considered for the project is described in further detail.

Local (i.e. County) Level Permits
Although coastal construction permitting is generally administered at the state and federal levels, especially those activities that occur seaward of the CCCL, counties also participate in the permitting of such activities, via delegated permits (as in Broward and Miami-Dade counties) and authority of local activities that do not trigger state or federal permits.

The Martin County Environmental Division in the county's Department of Growth Management requires permitting for certain coastal activities such as shoreline stabilization, but it defers to the state for docking and other water-based activities related to coastal construction (Martin County, 2010). Similarly, Palm Beach County's Planning, Zoning, and Building Department issues a series of permits (Types 3-8), including Type 8 permits for all marine structures, which oversee docks, seawalls, boatlifts, dune walkways, etc., and which require that applicants meet all state and federal requirements (Palm Beach County, 2010).

Both Broward and Miami-Dade counties also have permitting systems for local activities that do not trigger the need for state or federal level permits, such as the Broward County Environmental Resource License (Broward County, 2010) and Miami-Dade County's Class I Permit (Miami-Dade County, 2010). These two counties also have agreements with the Florida Department of Environmental

Protection (FDEP) to oversee and permit certain activities. Broward County entered into the delegation agreement with FDEP and the South Florida Water Management District (SFWMD) in 2001, whereby the county's Environmental Protection and Growth Management Department would be authorized to issue Environmental Resource Permits (ERP) that do not conflict with those reserved for FDEP and SFWMD (itemized in section 10 of the Delegation Agreement)[1]. Miami-Dade County signed a memorandum of agreement with FDEP in 1996 that the County's Department of Environmental Resource Management (DERM) would permit minor projects related to small dock installations and repairs, seawall and bulkhead repairs and replacements, and minor dredging operations, among other minor activities, that would be exempt under FDEP requirements[2]. Finally, both counties have also been delegated to issue mangrove trimming permits, required under the 1996 Florida Mangrove Trimming Act [Section 403.9321-403.9333, Florida Statutes (F.S)] that are otherwise be permitted by FDEP.

State Level Permits

The State of Florida administers three main permit types related to coastal construction: Coastal Construction Control Line (CCCL) permits, Environmental Resource Permits (ERPs), and Joint Coastal Permits (JCPs). FDEP manages all three permitting programs[3]. The FDEP Bureau of Beaches and Coastal Systems (BBCS) manages the CCCL and JCP programs, although the latter is administered through the Environmental Permitting Section. The Office of Submerged Lands and Environmental Resources manages the ERP program, with two exceptions:

- FDEP entered into an agreement with the SFWMD in 1982 that divided the permitting responsibilities between the agencies based on the nature and location in relation to the CCCL of the permitted activities; and

[1] The delegation agreement can be read at: http://www.dep.state.fl.us/water/wetlands/docs/erp/BrowardCoDeleg.pdf.

[2] The Memorandum of Agreement can be read at: http://www.dep.state.fl.us/water/wetlands/docs/erp/DadeCoDeleg.pdf.

[3] The 1993 Florida Environmental Reorganization Act merged the Departments of Environmental Resources (DER) and Natural Resources (DNR) into FDEP in a landmark reorganization of the State of Florida's environmental management and permitting system (Fumero, 1994). The act consolidated wetland resource, surface water management, and mangrove alteration permits into a single approval called an ERP and led to the joint processing CCCL permits and ERPs, creating the JCP. The ERP and JCP programs commenced in October 1995.

- The JCP program regulates ERPs related to navigational dredging of deepwater ports and inlets.

CCCL Permits

The CCCL is a line defined by §161.053 F.S. as the landward limit of FDEP's authority to regulate construction. Demarcated as the boundary that significant damage can occur to inland structures form water forces resulting from a one-hundred year storm, the CCCL program requires the structures built seaward of the CCCL be designed to withstand these forces. The program also requires that construction seaward of the CCCL be sited and designed to minimize adverse impacts to the beach and dune system and associated resources. The seaward limit of CCCL permitting is the MHWL.

ERP

The ERP program regulates all wetlands and surface waters, including dredge and fill activities, storm water runoff quantity and quality, construction in wetlands, state waters, or over sovereign submerged lands of the state, and alteration of surface water flow, as well as mangrove trimming and alteration in those counties that do not have delegated authority (FDEP, 2007). Also, since 1997, the US Army Corps of Engineers (USACE) has issued an expanded State Programmatic General Permit (SPGP), which has delegated the USACE's authority to the state ERP program to issue federal dredge and fill permits under section 404 of the Clean Water Act for activities such as those activities that qualify for exemptions or general permits.

JCP

The JCP program regulates coastal construction that, prior to its implementation in October 1995, were issued by a variety of state agencies, allowing for the concurrent processing of applications for coastal construction, environmental resource, and wetland resource permits, as well as sovereign submerged lands authorizations (FDEP, 2007). In the case where a federal dredge and fill permit is required, the JCP application is forwarded to the USACE for processing. To qualify for a JCP, activities must meet all of the following criteria:

- The activity must be located on Florida's natural sandy beaches;
- The activity must extend seaward of the MHWL and into sovereign submerged lands; and
- Activities must be likely to impact sand distribution on the beach.

<u>Federal Level Permits</u>

The USACE leads federal agency permitting in coastal construction in the State of Florida, and the agency issues two main types of permits:

- Permits issued under Section 10 of the Rivers and Harbors Act of 1899; and
- Permits issued under Section 404 of the Clean Water Act.

Activities involving coastal construction are reviewed under Section 10 of the Rivers and Harbor Act to ensure that the activities do not present a barrier or obstruction to navigation and do not impede the public interest (PBS&J, 2008). Activities that result in deposition of dredge and fill material seaward of the MHWL require a permit under Section 404 of the Clean Water Act. Additionally, the USACE issues Nationwide Permits (NWP) for a variety of approved minor impact activities in order to reduce the often time consuming review process.

Finally, at the federal level, the National Environmental Policy Act (NEPA) requires all federal agencies to evaluate the environmental impacts of proposed actions and consider reasonable alternatives. Coastal construction activities that are considered major federal actions are required to be evaluated, and the lead agency is to conduct detailed environmental analyses in a tiered process that could trigger the development of environmental assessments and environmental impact statements.

1.2.2. Development of a Reference Document on Permitting Coastal Construction Activities

This reference document, along with the permit database, was developed to provide permitters with a consistent level of baseline information in determining if a new activity should be authorized and, if so, the needed permit conditions to protect coral resources during coastal construction projects. This document focuses on the following:

- A historical review of 1950-1995 development trends in the southeast Florida region (Section 3);
- An analysis of how permitted impacts have been mitigated since 1995 through federal and state permits (Section 3);
- An evaluation of the strengths and weaknesses of the prevailing permitting practices for coastal construction activities in the southeast Florida region (Section 4); and,
- Recommendations to sustain the strengths and improve the weaknesses in the permitting process (Section 4).

2. Methods

2.1. Selection of Coastal Construction Permit Types and Evaluation Period (1995 -2008)

The method employed to select both the types of coastal construction permits and the time period over which the permits would be evaluated, was chosen to maximize the amount of information that could be obtained from the permits (i.e. data richness) and permit availability (i.e. data accessibility). Permit information that could otherwise not meet the criteria of richness and completeness, or accessibility, was captured in the form of a historical review that assessed major coastal construction trends on a decadal scale from the mid-20th century to the commencement of the permit evaluation period.

The permit types considered for evaluation were those defined as representing activities that occur in the "coastal" portion of southeast Florida and those which could be mined for a continuous period. The implementation of the JCP program in October 1995 represented the best starting point, and the inclusion of CCCL permits, ERPs (including SFWMD delegated permits), and JCPs represented the most relevant permit types because they met the criteria of data richness and data accessibility[4].

Due to the need for boundaries on the project scope, it was determined that minor projects[5], modifications, and exempt projects would not be included at this time. Thus, single-family residential family docks covered under ERPs were not included, nor were other, smaller-scale permits. Also, CCCL field permits which are issued where FDEP considers the construction as "minor structures and activities" and where it "determines the activity has minor impacts" [Chapter 62B-33.008 (10), Florida Administrative Code (F.A.C.)] were also not included.

[4] This focused approach allowed for the comparison of effects for all permitted project types from 1995 – 2008, and provided more detailed information on cumulative impacts than would a sample of permits over a longer period. Experienced regulatory personnel agreed that detailed data from recent permits is more comprehensive than that available in historic authorizations (MacLeod, personal communication; Smith, personal communication; Teich, personal communication). Although the historical permit data is valuable, a direct comparison of cumulative impacts would require either weighting or more detailed data mining. Additionally, older permits are not readily available for data mining. While this was mainly a logistical challenge, it further reinforced the accepted approach. As a result of data mining and interviews with various program personnel, it was determined that the October 1995 control date was the most defensible, both from a data quality assurance and a data analysis framework standpoint.

[5] Minor projects are a designation within the ERP system and are identified as such; these permits generally do not require additional information as needed to populate the project database.

Although cumulatively these types of activities may have a significant impact, the number of activities were too numerous for inclusion in the project. Ideally, small-scale permits that were excluded will eventually be added to the database when more project funding is available.

Once the various types of projects were identified, permits for each project type were identified and obtained. Only final permits and final orders for which data were available in digital format were entered in the project database. The FDEP BBCS provided digital files for all CCCL permit final orders (1997-2008)[6], final order database, and JCP files (1996-2008) and permit database. The FDEP Southeast District (SED) office provided digital files for all ERP permits (1996-2008) and a permit database containing information on all ERP permits, including those that were exempt. Spatial information on the different permit files was provided as layer files from the FDEP BBCS office.

Database files containing information on the CCCL permits, ERPs, and JCPs were summarized, and data available for annual permits, permit subtypes, and regional distribution of permits, and other relevant data were analyzed[7]. The information available in the final orders and permits and their accompanying documentation (e.g. impacts, impact mitigation, and monitoring reports) was standardized and entered into the permit database. Each project was classified with a project identification (PID), and the project attributes (e.g. project description, location, anticipated impacts, and expected mitigation), as well as all associated permits (since there can be multiple permits per project) were entered so that the database would allow for a cumulative impact analysis via comparing project types, area, years, types of impacts, etc.

2.2. Review and Analysis of Coastal Construction Activities

Three approaches were adopted in the review and analysis of coastal construction activities in support of the completion of this reference document:

1. *Review and analysis of impacts of coastal construction activities based on existing data from past Environmental Impact Statements (EISs), Environmental Assessments (EAs), available grey literature pertaining to southeast Florida*

[6] Information on CCCL final orders related to project scope, duration, and completion was obtained from the summary documents downloaded from the FDEP BBCS website.

[7] Although not yet completed, it is expected that the final geo-referenced database of permitted coastal construction activities will contain summary information on all permits, including those permits for which only summary information could be obtained from their respective FDEP databases.

resources, information from previous MICCI projects, and supporting information.

The time period for this approach was set from 1950-1995, such that major coastal construction activities in the decades following World War II up through the implementation of the JCP program could be evaluated. These included a review of US Census data on population and housing trends in the four counties, determination of major port construction and operations at the Port of Miami, Port Everglades, and the Port of Palm Beach, as well as beach nourishment events, inlet dredging operations, and other major activities. A wide series of documents were accessed to complete this review, including several EISs, EAs, and other literature related to southeast Florida resources (in particular, beach nourishment and port expansion, maintenance, and dredging projects).

2. *Review of literature related to permit-independent assessments of major ecosystem status and trends.*

This approach focused on historical data and analysis related to permit-independent assessments of major resources, habitats, and ecosystems related to coastal construction activities in southeast Florida. These included trends on nourishment and landscape changes and resource conditions, including coverage and distribution of major and associated ecosystems.

3. *Review and analysis of the agency permit databases and geo-referenced database to determine activities and impacts over the evaluation period by permit type and by geographical area.*

This approach focused primarily on the complete databases provided by the agencies and the geo-referenced database, evaluating activities and impacts by the major permit type (CCCL permit, ERP, and JCP), over the time period of the database (1995-2008), and across counties.

With information obtained from the approaches, as well as the data mining and entry process in support of the development of the geo-referenced database, several conclusions and recommendations were developed in relation to information gaps, cumulative impact analysis, and future efforts.

3. Results

The results presented below were determined using the approaches described in Section 2.2. Historical major coastal construction activity results were obtained from conducting an extensive literature review of trends in population growth and coastal construction from 1990 to 1995 (hereafter titled the pre-JCP era). Similarly, the literature review provided the data required to present changes in resource and ecosystem conditions in southeast Florida over the time period of the analysis (1950-2008). Finally, the third approach relied almost exclusively on the complete agency databases and geo-referenced permit database to discuss coastal construction activities from 1995 to 1998.

3.1. Trends in Coastal Construction in the Southeast Florida Region: 1950 – 1995

Coastal construction in the pre-JCP era effectively created the current urbanized landscape and resulted in a multitude of impacts. To best understand both how permitting operated in the JCP era (as determined in this study) and the effects that prior activities had on current development trends and resource conditions, the reference document presents a historical review on the changes in housing and development in the region and trends in major coastal construction activities. The start date selected for the historical review is 1950, which marks the first full decade following World War II and which sets up the region for the population and coastal construction explosion of the next six decades.

Although development and construction did occur directly over coral reefs for a majority of activities over the 55 years considered in the trend, the impacts created at the land-sea interface or via increased population pressure from inland development both had profound effects on the quality of the region's coral reefs and associated resources.

3.1.1. Population Growth in the Southeast Florida Region: 1950 – 2008[8]

Population growth in the four county region over the past six decades is a useful indicator for coastal development, especially for those coastal communities that experienced the most rapid and dense growth over the period.

Miami-Dade County[9]

Miami-Dade County provides a rich and complex history on immigration from 1950 onwards, punctuated by seminal events such as the Cuban Revolution (1959) and Mariel Boatlift (1980)[10], which increased the county's population and

[8] Information for this section, unless stated otherwise, is from the US Census. Source: www.census.gov.

[9] Miami-Dade County is referred to as Dade County for the period from 1950-1997. In November 1997, voters approved changing the name to Miami-Dade County (Finefrock, 1997).

[10] From the time of the Cuban Revolution to 1962, and then again from 1965 to 1973, over 460,000 Cubans entered the US via boat or airlifts (Perez, 1992). Following a period of relatively low

accelerated an already frenetic demographic influx (see Figure 1 for population growth in Miami-Dade County). In 1950, the then Dade County was already the largest county in Florida, both in terms of overall area and total population. The county's 495,084 residents lived mainly in the cities of Miami and Miami Beach, both of which were largely coastal in location. The former included settlements such as Coconut Grove, Key Biscayne and Virginia Key, Miami Shores, and North Miami Beach, as well as other waterfront communities. Miami Beach, which had been founded in 1915 on a mangrove fringed, barrier island, was wholly a coastal settlement. A total of 352,758 of the county's residents lived in the city of Miami, and 49,312 lived in Miami Beach. Thus, from its origins, the county developed along mainly the coastal ridge, with its growing population exerting direct effects on the coastal resources, such as mangroves, seagrasses, and hardbottom communities, including corals.

Miami-Dade County had very few communities and persons who resided in inland areas, with the cities of Coral Gables and Hialeah, both established in 1925, being exceptions and which housed around 20,000 residents each. Smaller settlements also developed inland, such as Miami Springs, South Miami, Sweetwater, and West Miami, as well as the farming communities in southern Miami-Dade County, notably Florida City, Homestead, and Perrine, but none of these settlements had more than 5,000 residents. In 1950, in fact, almost 80 percent (%) of the total county population resided in or near coastal areas.

migration, the Mariel Boatlift started in April 1980, when Cuban President Fidel Castro allowed Cubans to immigrate to the US from the port of Mariel. Over the next few months, an estimated 175,000 Cubans arrived in South Florida and the Florida Keys.

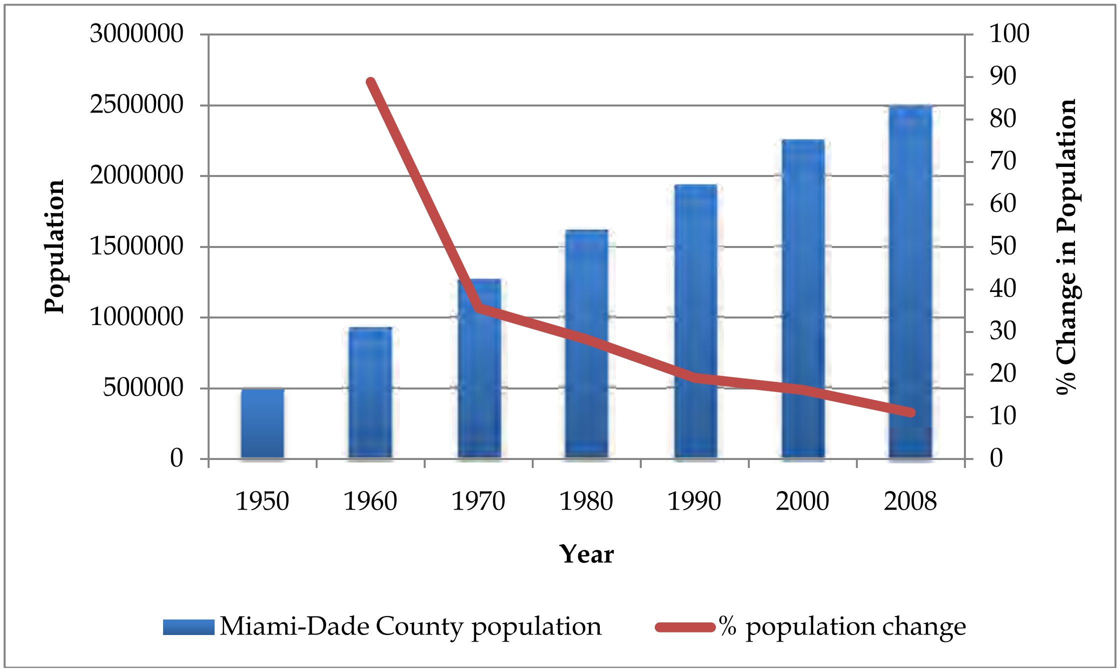


Figure 1: Miami-Dade County population growth: 1950 - 2008.

Miami-Dade County experienced an 89% population growth increase from 1950 to 1960, and the county's population effectively doubled from 495,084 residents in 1950 to 935,047 residents in 1960. While growth remained robust in the coastal settlements, with cities like Miami Beach increasing by 47.5%, from 49,312 residents in 1950 to 72,757 residents in 1960, inland communities also increased their overall share of the county's population. Hialeah added over 47,000 persons, Coral Gables doubled in size, and western suburbs in primarily southern Miami-Dade County (but also Northwest Miami-Dade County) increased the county's overall population. Unlike as observed in the pre-World War II era, when the major centers of population in Miami-Dade County were completely or partially coastal, the 1950s saw the first signs of a western shift in immigration, most likely to accommodate the large numbers of incoming residents.

By 1970, the trend to the western suburbs had been established and was growing in Miami-Dade County. With the population having reach 1.27 million residents, Miami-Dade County became the first county in the State of Florida to have exceeded a million inhabitants. Assisted by the Cuban Diaspora after the Cuban Revolution (1959), many Cubans migrated to Miami-Dade County and settled in parts of the city of Miami, namely Little Havana, Hialeah, and other western suburbs. This is best illustrated by comparing the rates of growth for different

Census Community Divisions (CCDs), or subdivisions (Figure 5)[11], in the 1970 Census (Figure 6). While established population centers like the city of Miami and Miami Beach did increase in population and contained a plurality of the county's population, at 46.5%, inland settlements such as the Hialeah and Northwest CCDs also experienced robust growth rates (see Figures 6-9).

From the 1980s onward, inland (and mainly southern) suburbs dominated population growth in Miami-Dade County. Population followed development and more affordable housing in the increasingly accessible inland communities. Roadways were constructed to provide motor vehicle access to the western suburbs, and housing and population growth followed. In 1980, Miami-Dade County's population reached 1.63 million, and while the city of Miami and Miami Beach CCDs accounted for 55% of that total, western suburbs such as Kendale Lakes-Lindgren Acres and Kendall-Perrine CCDs accounted for a larger percentage of the total population than in previous decades. Also, other established inland communities such as Hialeah, Homestead, and Princeton-Goulds CCDs significantly increased their population totals.

In 1990, as Miami-Dade County's population neared two million inhabitants, inland subdivisions emerged as the county's future development centers, accounting for over a million of the county's residents, or 51.7% of the total. The inland growth trend continued into 2000, when 1.27 million (or 56.2%) of Miami-Dade County's 2.25 million residents were located inland. Population growth continued to occur along the coast, but it was minor compared to inland population growth. Miami Beach CCD, for instance, grew by 1.7%, and the city of Miami CCD increased by 5.8%; however, Kendale Lakes-Lindgren Acres CCD grew by 65% over the same period (adding over 123,000 residents), Hialeah CCD by 33.5% (adding 70,000 residents), and North Westside CCD by 33.4% (adding almost 25,000 residents). While the city of Miami CCD contained the largest number of residents, at 850,725 inhabitants, it was clear that from the 1990 period onwards, population growth in Miami-Dade County had been dominated by inland, and not coastal, communities.

The inland communities that fueled the county's growth, especially from the 1990s onward, had effects on the region's coastal resources. Demand for associated infrastructure (ex. roads, highways, sewage facilities, etc.) and coastal recreation, among other stressors, impacted the coastal resources via activities such as fishing, diving and related uses, increased the volume of treated sewage

[11] See Figure 5 for the identification and location of all Census Community Divisions (CCDs) and in reference to Figures 6-9 (population) and 14-16 (housing).

in outfall facilities, and exacerbated nonpoint sources of pollution.

Broward County

Broward County, like the southern Miami-Dade County, is a major population center (see Figure 2 for population growth in Broward County). It has grown considerably since 1950, but unlike its neighboring counties, population growth in Broward County has been limited by both its relative size compared to Miami-Dade and Palm Beach counties and the boundary of two Water Conservation Areas 2 and 3 along the county's western suburbs that comprises 65% of the county's total land area (1,196.9 square miles) (Broward County, 2003). This boundary has affected the amount of inland population growth that Broward County has been able to accommodate, thereby limiting inland communities to those located along its southern boundary. The net result has been a comparatively larger population in a smaller area, creating the highest population density among the four southeast Florida counties and the second highest population density in the entire State of Florida (US Census, 2000).

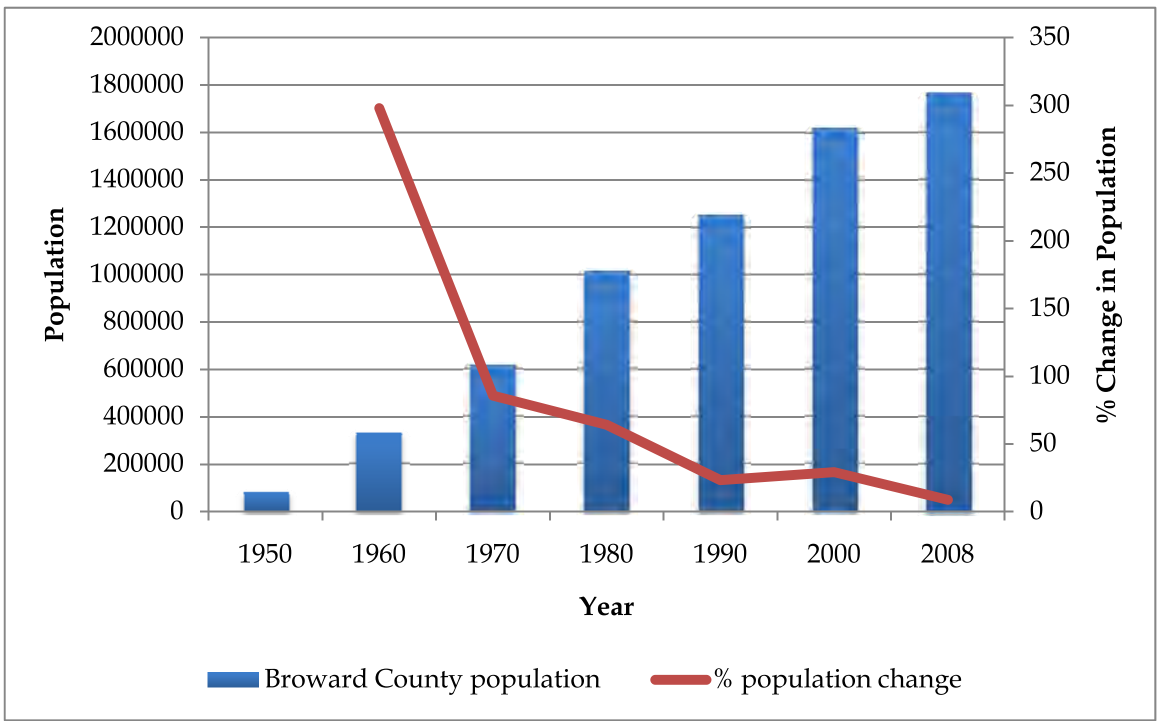


Figure 2: Broward County population growth: 1950 - 2008.

In 1950, Broward County's population stood at only 83,933 inhabitants. Most of these individuals were located in the now Fort Lauderdale and Hollywood subdivisions, as well as smaller settlements in Deerfield Beach and Pompano Beach. Thus, the county's population was almost wholly coastal, and few people lived in the western parts of the county. For instance, less than 3,000 residents lived in the now Miramar-Pembroke Pines CCD, then known as West Hollywood. Also, it should be noted that, relative to the almost half a million residents of Miami-Dade County to the south, Broward County was even smaller in population than Palm Beach County. Indeed, it would be the subsequent decades that would witness the population explosion that would make Broward County the second largest in the state.

Much of the initial population growth in Broward County occurred during the 1950s. By 1960, the population increased by 280%, as an additional 250,000 persons were added to Broward County's 83,933 inhabitants from 1950. The growth was mostly in the coastal communities, with the Fort Lauderdale CCD increasing by more than 60,000 residents and effectively tripling in size; in fact, the 98,782 persons living in the CCD exceeded the county's total 1950 population. Similarly, Hollywood CCD almost doubled in population, with 42,302 inhabitants in 1960 from 23,710 in 1950. The northern settlement of Deerfield Beach experienced the most explosive growth, such that the subdivision increased from less than 2,500 individuals in 1950 to 31,039 in 1960. Smaller towns, such as Pompano Beach and Hallandale, also increased their population totals, and had 16,000 and 11,000 residents in 1960, respectively. Together, these coastal towns and cities represented 56% of the county's population; however, it is likely that a much larger percentage lived in and around the county's coastal areas. Conversely, the emerging subdivisions from inland portions, consisting of the Davie, Margate, the aforementioned Miramar-Pembroke Pines, and Plantation CCDs, accounted for only 4.5% of the county's population (see Figures 6-9).

By 1970, the population of Broward County had almost doubled from the previous decade. While growth in terms of percentage increases was not as high as witnessed over the 1950s, the county added almost 300,000 individuals to its 1960 population of 333,946, ending up at 620,100 individuals in the 1970 Census. Persons again mostly resided in coastal areas, with the Fort Lauderdale and Hollywood CCDs both more than doubling in population size. Together, these subdivisions represented more than half (217,112 individuals in the Fort Lauderdale CCD and 115,886 individuals in the Hollywood CCD) of the county's population. The other three coastal CCDs, Deerfield Beach, Hallandale, and Pompano Beach, contributed almost 130,000 individuals. But, the 1970 Census also demonstrated the rise of the inland suburbs and especially Plantation CCD (which increased from 4,904 residents in 1960 to 45,440 residents in 1970) and Miramar-Pembroke Pines CCD (which increased from 6,914 individuals in 1960 to 39,493 individuals in 1970). As growth would stabilize in the saturating coastal communities, the inland CCDs would shoulder the population growth in subsequent decades.

Broward County became the second Florida county, after Miami-Dade County in 1970, to exceed a million inhabitants in 1980. The 1.02 million individuals who lived in Broward County that year were increasingly concentrated in inland communities, which had augmented their relative share of the county's total population. While just under two thirds still lived in the coastal CCDs, 385,476 residents, or 37.8%, lived in one of the four inland CCDs. Thus, while Fort Lauderdale and Hollywood CCDs remained the largest settlements, Plantation CCD was now the third largest subdivision in the county. Relative rates of increase had shifted in favor of inland growth as well. While the coastal CCDs grew at rate of 37.4% from 1970 to 1980, the inland CCDs almost tripled in size, growing at a rate of 267% over the same time period.

In 1990, Broward County's population reached 1.26 million, representing a significant decline over the past few decades. That is, while almost a quarter million new inhabitants were added to the county, the growth rate (23.3%) was lower than in previous Census counts. Importantly, growth in the coastal CCDs was largely relegated to Deerfield Beach and Pompano Beach subdivisions, and the Fort Lauderdale and Hollywood CCDs' populations did not increase considerably. As in 1980, the inland subdivisions accounted for a majority of the growth, such that the populations of the four inland CCDs represented 46% of the county's total population. Plantation CCD, which had consisted of less than 5,000 inhabitants in 1960, was the second largest subdivision after Fort Lauderdale CCD in 1990. In fact, all four inland subdivisions had more than 100,000 inhabitants, with the Plantation CCD leading all inland areas with 211,297 residents.

By 2000, the population in Broward County had passed 1.62 million inhabitants, keeping pace with Miami-Dade County's 2.25 million and ahead of Palm Beach County's 1.13 million inhabitants. Broward County added more persons than any other Florida county in the 1990s, growing by 29% over the decade. All CCDs grew in population size, but growth rates were now wholly dominated by inland subdivisions (with the exception of Deerfield Beach CCD, which grew by 50% over the 1990s). For the first time in Broward County history, the 857,279 residents of the inland CCDs now represented the majority, or 52.3%, of the county's population; three of the four subdivisions had populations of 200,000 or more residents, with Plantation CCD having 258,184 persons. Growth was particularly high in the Miramar-Pembroke Pines CCD, which increased from 111,749 residents in 1990 to 217,611 residents in 2000, a growth rate of 94.7%. Hurricane Andrew, which struck southern Miami-Dade County in 1992 led to a migration of displaced communities to Broward County's western suburbs and, most notably, to the city of Pembroke Pines (which grew from 65,323 residents in

1990 to 136,860 residents in 2000).

Impacts following the inland subdivision growth now included increased nonpoint sources of pollution resulting from increased vehicles and infrastructure development, and higher demand for coastal resources – including beaches, fisheries, and diving (see Johns et al, 2001, for a study of reef uses in southeast Florida; see Murley et al., 2003, for an analysis of beach visitation in southeast Florida). All of these changes had effects on the county's and region's coastal ecosystems, including coral reefs.

Palm Beach County

Palm Beach County is the second largest county in terms of area, next to Miami-Dade County (see Figure 3 for population growth in Palm Beach County). Similar to Broward and Miami-Dade, population growth (in now what is the third most populous Florida county) occurred along the region's coastal areas. However, unlike the southern counties, which did have agricultural interests but were limited by suitable soil, Palm Beach County developed an extensive agricultural economy that supported a large population in the western, or Glades, sector of the county. Additionally, like both southern counties, Palm Beach County was limited in terms of its westward development, as it contains Water Conservation Area 1 (Loxahatchee National Wildlife Refuge) and part of Water Conservation Area 2 (FWC, 2010). Also, much of the 700,000 acre Everglades Agricultural Area is located in western Palm Beach County and does not permit urban development and is instead designated for agricultural production (mainly sugarcane and winter vegetables) (DOI, 1994).

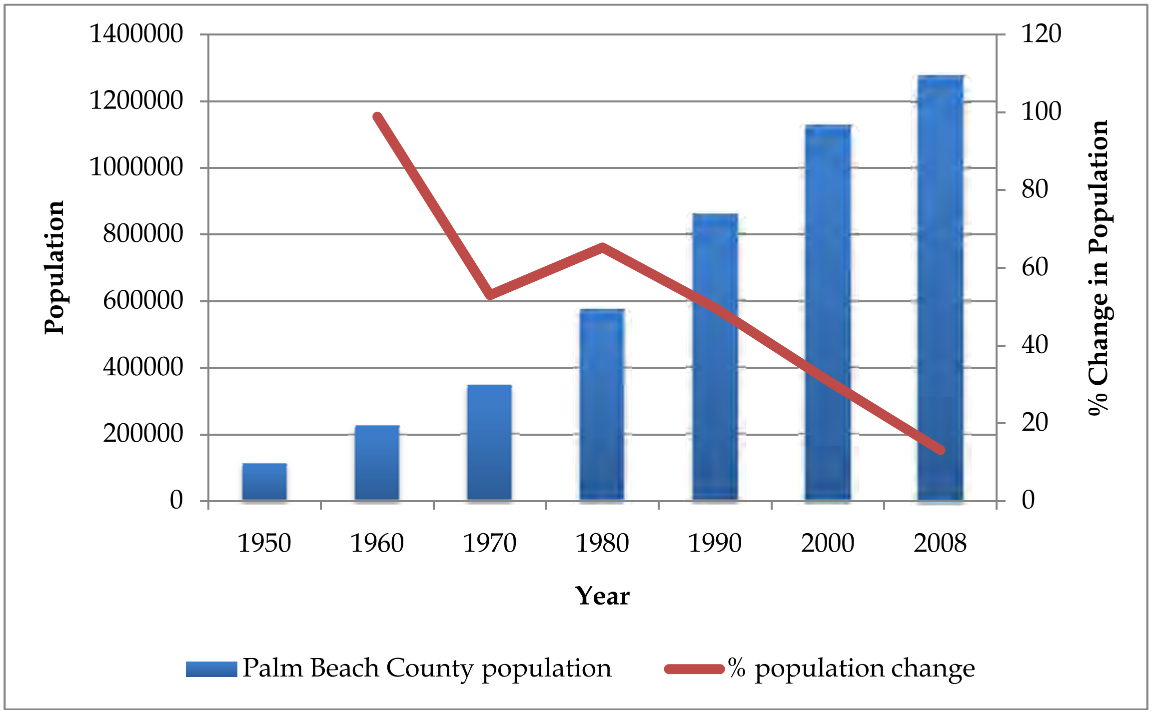


Figure 3: Palm Beach County population growth: 1950 - 2008.

In 1950, Palm Beach County consisted of 114,688 inhabitants, and a majority of these residents lived in and around six settlements that would later become the county's coastal CCDs. Of these settlements, the city of West Palm Beach contained almost half of the county's population, at 43,164 individuals, and the city of Lake Worth accounted for another 17,277 inhabitants. Smaller, coastal settlements in Boynton Beach and Delray Beach had 9,190 residents. The other, major population center in the county was located westward in the agricultural region next to Lake Okeechobee. Consisting of settlements such as Belle Glade, Canal Point, and Pahokee, this subdivision had 15% (17,133 individuals) of the county's total population.

During the 1950s, the population of Palm Beach County doubled, ending up at 228,106 residents by 1960. Of this total, the growth was almost all within coastal communities, with places like West Palm Beach adding 20,000 persons, Boynton Beach and Delray Beach adding almost 20,000 persons, and Lake Worth adding almost 10,000 persons. Even smaller coastal settlements like Riviera Beach and Boca Raton, which had 4,065 and 992 inhabitants in 1950, respectively, grew considerably. Riviera Beach increased its population to 20,204, and Boca Raton grew to include 7,026 inhabitants.

By 1970, Palm Beach County had increased its population again, to 348,993 persons. Unlike the huge growth that took place in Broward and Miami-Dade counties, CCDs in Palm Beach County grew more modestly (see Figures 6-9). Growth along the southern boundary, in Boca Raton, was robust, as the area gained 22,000 residents over the previous decade. Also, Boynton Beach and Delray Beach increased in size, with the settlements adding almost 20,000 residents in the 1960s. The western, agricultural section of the county reported a modest increase as well, as the population there increased from 19,271 in 1960 to 26,462 in 1970.

From 1980 onwards, Palm Beach County commenced on a strong population growth trend, adding over 200,000 residents from 1970. Three coastal subdivisions – Boynton Beach-Delray Beach CCD, Lake Worth CCD, and West Palm Beach CCD – had populations of over 100,000 individuals; in fact, Boynton Beach-Delray Beach led all CCDs for the first time in overall population (120,631 residents). Also, by 1980, three inland subdivisions had grown to a point where their total population, 39,957 individuals, represented 6.9% of the county's population. The inland CCDs, (Glades, Royal Palm Beach-West Jupiter, and Sunshine Parkway), were located westward of the established coastal settlements and abutted the county's protected lands to the west.

In 1990, Palm Beach County had 863,503 inhabitants, an increase of 49% from the previous Census count. Almost all CCDs reported considerable growth, with the exception of West Palm Beach and Riviera Beach CCDs, which increased less than 10% each. Other coastal CCDs, however, added 173,000 residents to the 315,665 residents that they had in 1980, increasing their totals by 54.8% over the decade. Inland areas also grew robustly, with Royal Palm Beach-West Jupiter CCD and Sunshine Parkway CCD increasing by 269% and adding just over 100,000 residents. While inland areas were not as populated relative to coastal areas as similar areas were in the southern counties, the three inland subdivisions represented 16.2% (or 16.2% if the agricultural, Belle Glade-Pahokee CCD is included) of the county's population.

By 2000, the population of Palm Beach County exceeded one million inhabitants, making it the third most populous county behind Miami-Dade and Broward counties. The population, set at 1.13 million in the 2000 Census, represented a 31% increase from 1990, and it was distributed across most of the county's CCDs. That is, while inland CCDs did grow at faster rates than coastal CCDs, both types of CCDs increased their respective populations considerably. For example, all coastal CCDs, with the exception of West Palm Beach CCD, increased their 1990 populations by at least 18%. In some cases, such as Boynton Beach-Delray Beach CCD, the increase was 44.8%. Growth rates were even higher within inland CCDs, of which the Sunshine Parkway CCD surged ahead of coastal CCDs like West Palm Beach, Boca Raton, Riviera Beach, and Jupiter; the population for

Sunshine Parkway CCD increased from 88,312 in 1990 to 137,521 in 2000, representing a percentage increase of 55%. The other inland CCDs, Royal Palm Beach-West Jupiter and Glades, also increased their respective populations. Overall, inland communities now represented 20.4% (or 23.1% if the agricultural, Belle Glade-Pahokee CCD is included) of the county's population, an increase of 4.2% over the 1990 Census. However, unlike in both Broward and Miami-Dade counties, where inland populations had effectively achieved majority status over coastal populations, Palm Beach County in 2000 remained predominantly a region dominated by coastal subdivisions. This was due in part to the slower pace at which the county had increased its population relative to the southern counties and as a result of open waterfront space (as well as limited development potential in westward protected areas), population growth had continued at high rates (ex. 15-20 percent) within coastal subdivisions. Unless that growth was further shifted to inland subdivisions, coastal construction activities (and impacts) resulting from high coastal population growth would persist.

Martin County

Martin County is the smallest and least populated of the four counties discussed (see Figure 4). Representing the northernmost county off the Florida Reef Tract, the county has had a diverse history of slow coastal development and inland agricultural operations. Also, the county does not possess a large population center such as Miami, Fort Lauderdale, or West Palm Beach, and its growth has been largely fueled by migrants wanting to relocate to the more intimate environs of coastal communities such as Stuart and, later, Hobe Sound and Jensen Beach. Thus, population growth has been largely coastal, with the exception of Indiantown, a largely agricultural subdivision located next to the St. Lucie Canal in inland Martin County.

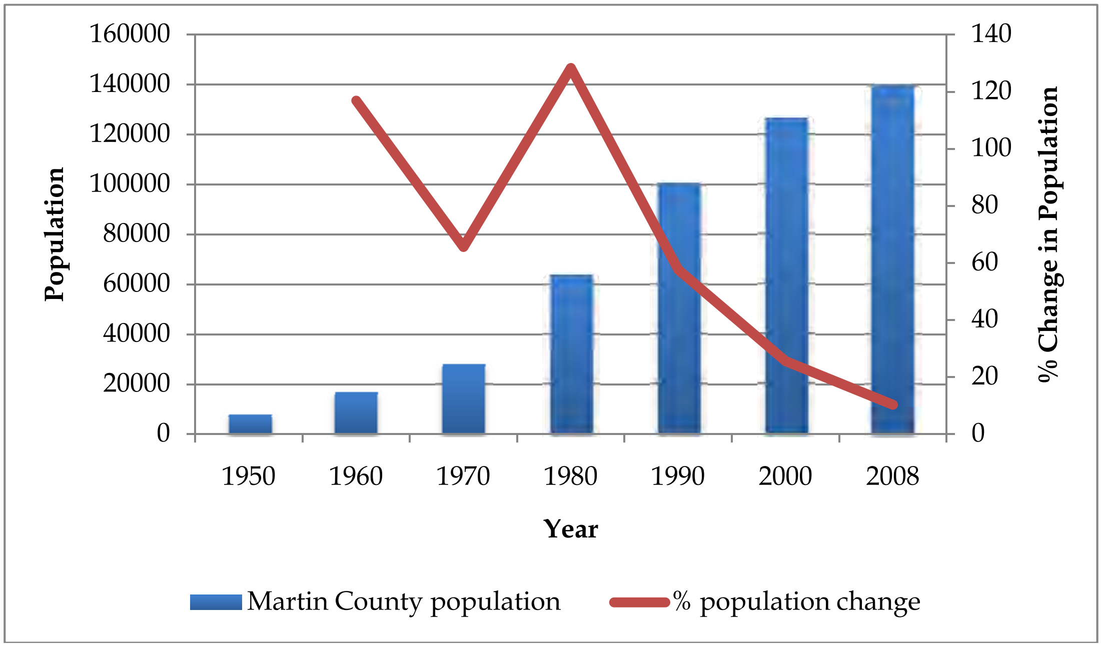


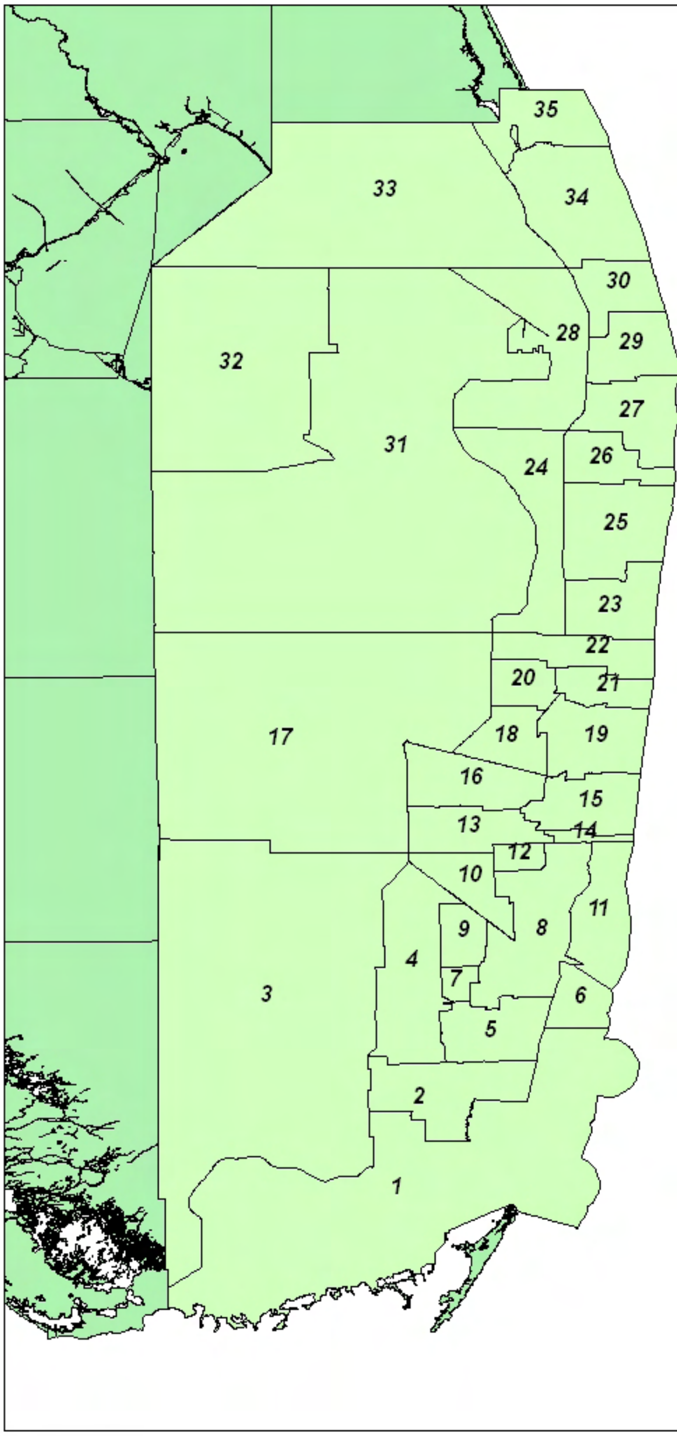
Figure 4: Martin County population growth: 1950 - 2008.

In 1950, Martin County had a population of 7,807 inhabitants, and most were listed as living in the city of Stuart, which had a population of 2,192 residents. A total of 1,298 inhabitants were counted in the region that today includes the western portion of Martin County and Indiantown. Another small, mainly coastal settlement of 854 persons was recorded along the southern border, adjacent to Jupiter in northern Palm Beach County. By 1960, the county's population more than doubled to 16,932 residents, with most (4,942) living in the Stuart CCD. Another 1,500 or fewer persons lived in the Indiantown and Port Salerno-Hobe Sound CCDs. The 1960s did not lead to much population growth, especially as compared to the southern three counties, and Martin County added only another 11,000 inhabitants. While the Port Salerno-Hobe Sound CCD increased by more than 100%, growth in the other CCDs was modest.

From the 1970s onward, Martin County grew at a much faster rate than in the previous two decades (see Figures 6-9). By 1980, the county's population had increased from 28,035 in the previous Census to 64,104, a percentage increase of 128%. Also, the Port Salerno-Hobe Sound and Stuart CCDs had grown from settlements of 5,800 or fewer residents to towns of 23,542 and 32,002 residents, respectively. As the county experienced more immigration, settlement was predominantly coastal. For instance, Indiantown CCD over the same period grew from 2,283 to 2,470 residents. The 1990 Census determined that Martin County's population had exceeded 100,000 persons, with most of the growth being divided between Port Salerno-Hobe Sound (46,396 residents) and Stuart (42,497) residents. Indiantown CCD again lagged at 12,007 residents. Finally, in

2000, the county's population increased by 25%, after two decades of 128% and 57% growth. As in 1990, the county's population was largely divided between the two coastal subdivisions, with Port Salerno-Hobe Sound CCD (55,884 residents) edging out Stuart CCD (55,347 resident) as the most populous subdivision in the county.

Due to Martin County's predominantly coastal population and its potential for population growth (both within its coastal corridor and inland areas), impacts on coastal communities – including the county's coral reefs and associated resources – could follow the trend of the southern counties. That is, growth would increase the demand for infrastructure, as well as lead to higher rates of coastal resource use.



CCD	Code
Conservation	17
David	16
Deerfield Beach	22
Fort Lauderdale	19
Hallandale	14
Hollywood	15
Margate	20
Mirama-Pembroke Pines	13
Plantation	18
Pompano Beach	21
Indiantown	33
Port Salerno	34
Stuart	35
Everglades	3
Hialeah	10
Homestead	1
Kendale lakes - Lindren Acres	4
Kendall-Perrine	5
Key Biscayne	6
Miami	8
Northwest Dade	12
Miami Beach	8
Nowth Westside	9
Princeton-Goulds	2
South Westside	7
Glades	31
Jupiter	30
Belle-Glade-Pahokee	32
Boca Raton	23
Boynton Beach-Delray Beach	25
Lake Worth	26
Riviera Beach	29
Royal Palm Beach-West Jupiter	28
Sunshine Parkway	24
West Palm Beach	27

Figure 5: Southeast Florida Census County Divisions.

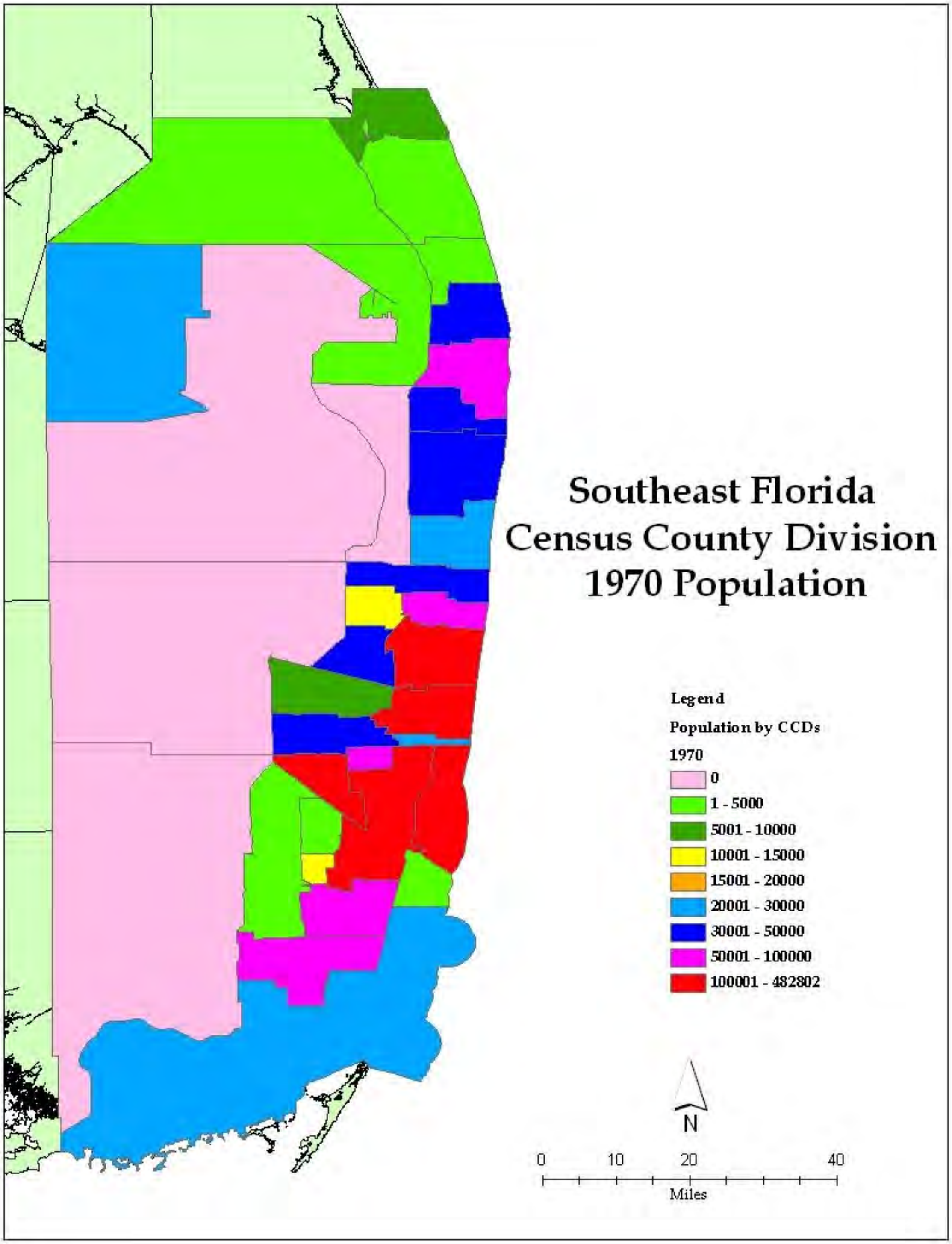


Figure 6: Southeast Florida Census County Division population: 1970.

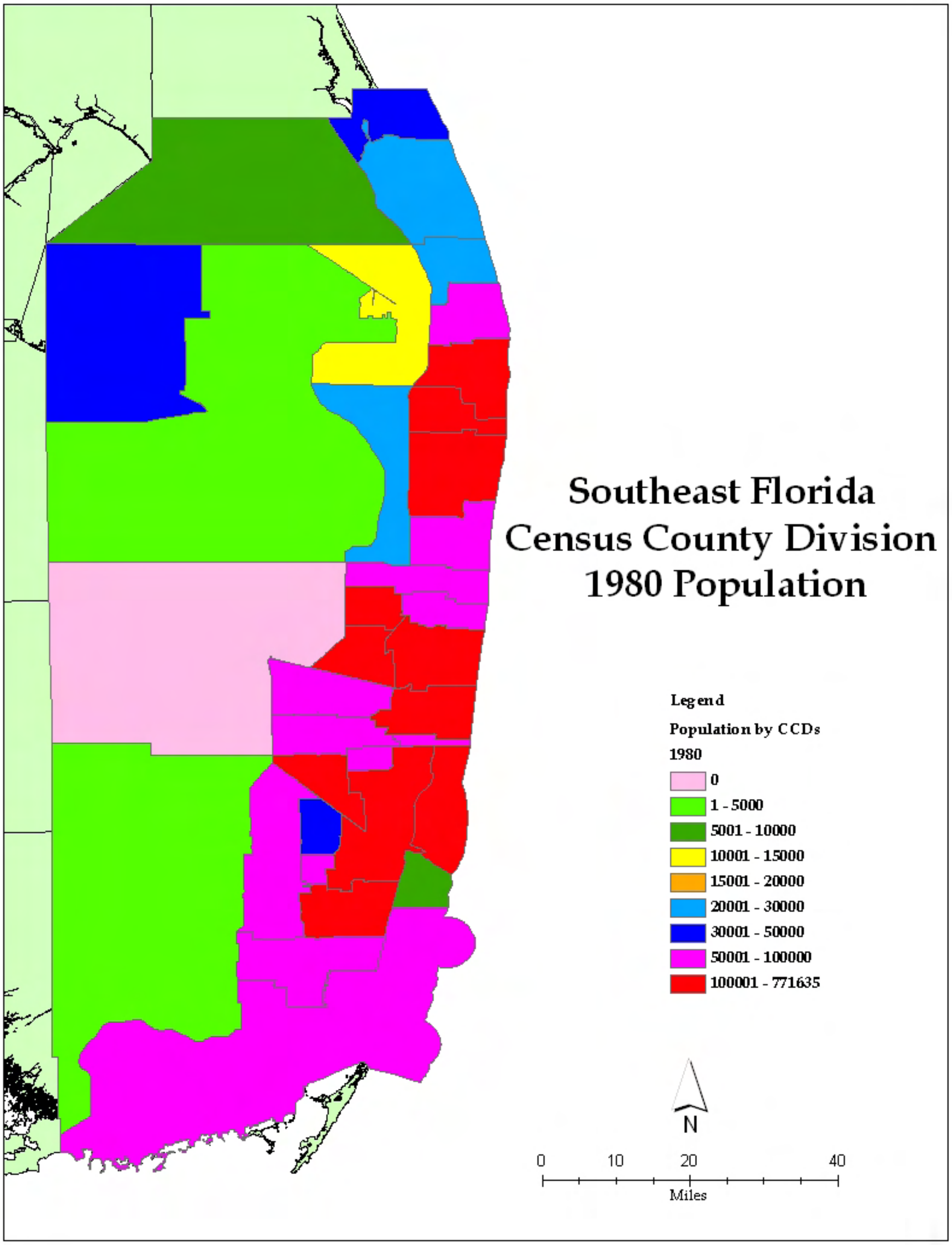


Figure 7: Southeast Florida Census County Division population: 1980.

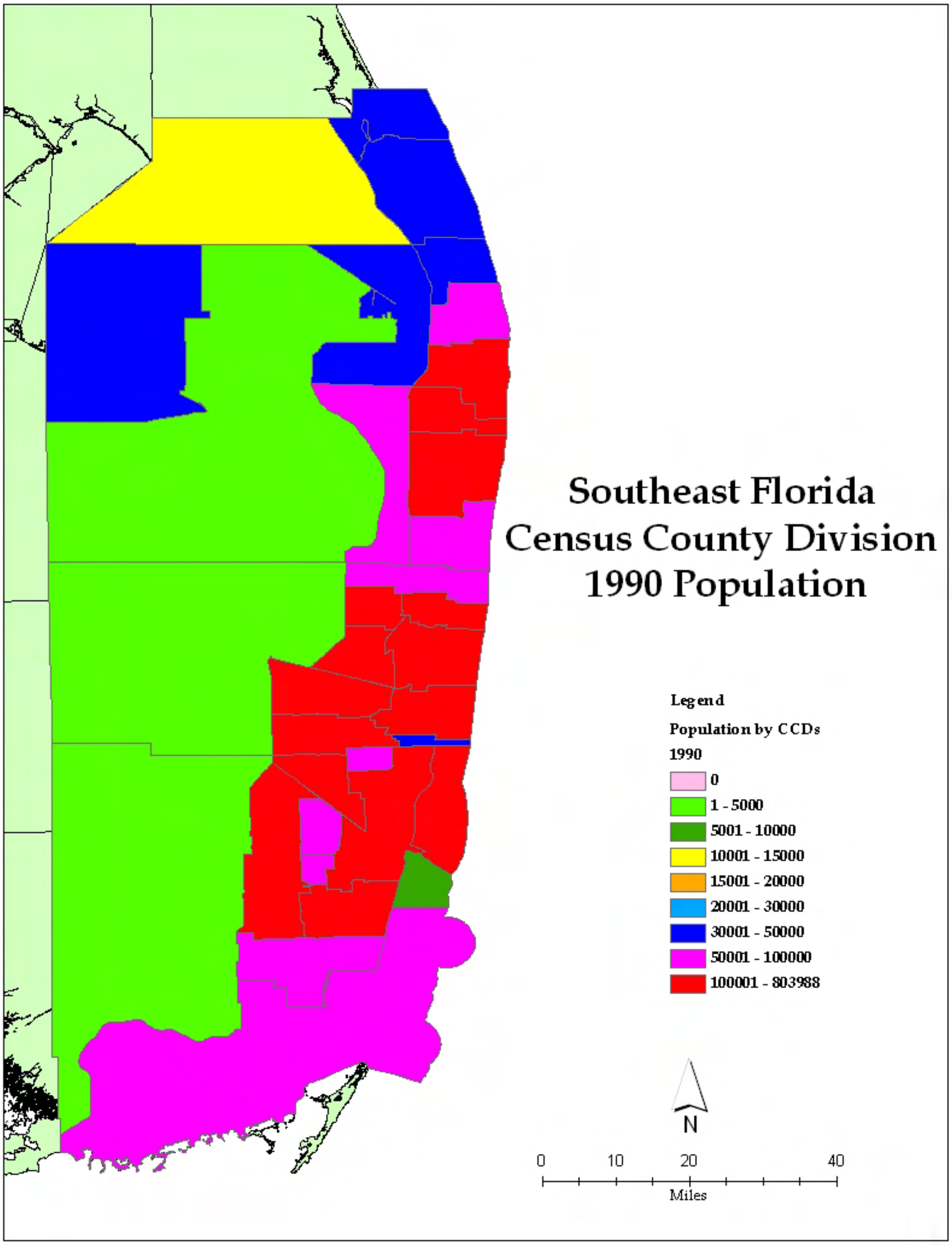


Figure 8: Southeast Florida Census County Division population: 1990.

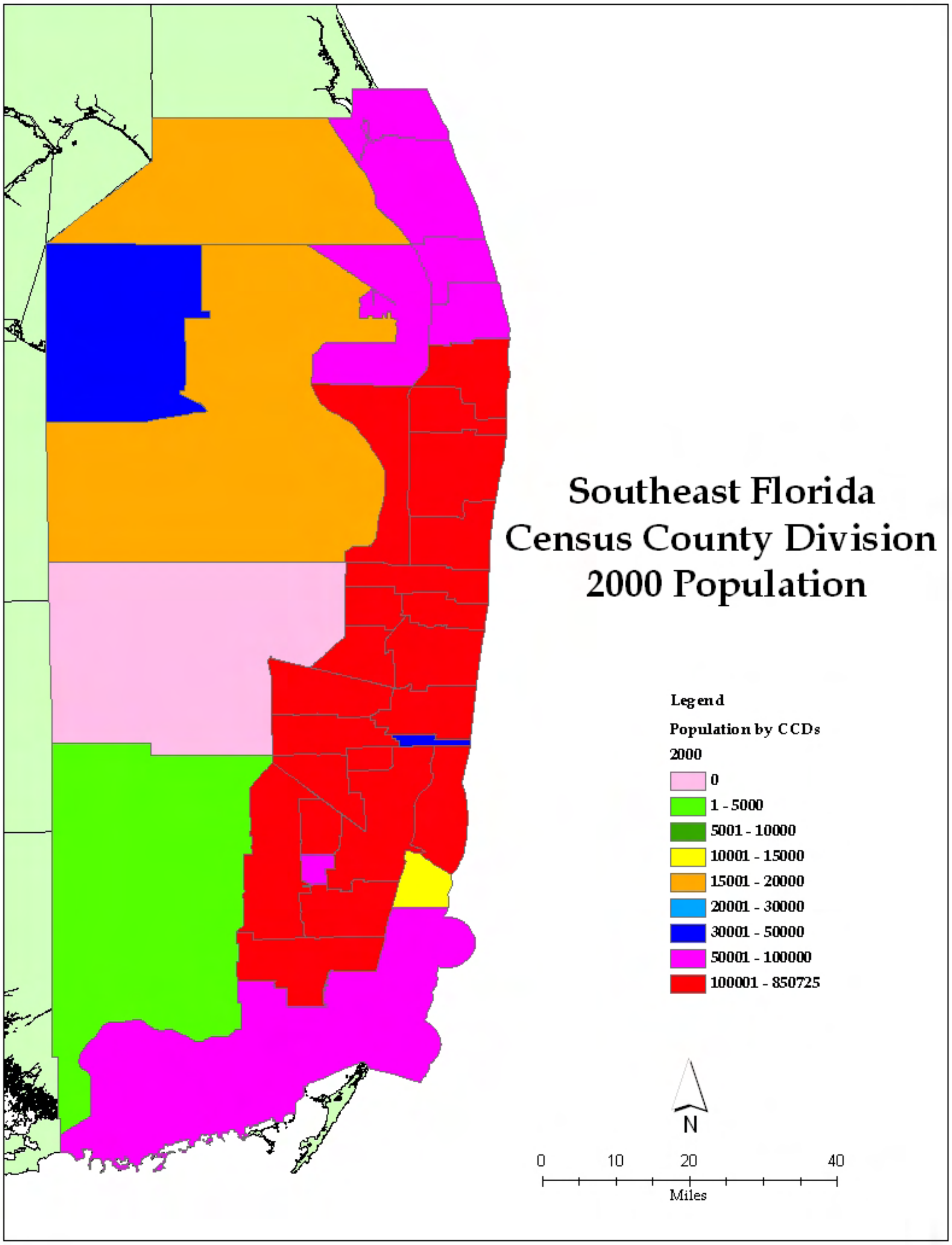


Figure 9: Southeast Florida Census County Division population: 2000.

3.1.2. Housing Growth in the Southeast Florida Region: 1950 - 2008

Housing growth in the southeast Florida region, as measured in the US census, demonstrated that there was a strong link between the number of residents and the total number of housing units, but that certain areas actually grew in terms of the number of units even when population totals declined. Also, housing in the coastal segments, especially the southern two counties, had been largely built out by the 1990s; thus, much of the coastal construction impacts in Miami-Dade and Broward counties were those related to the re-configuration of existing stock or the redevelopment of individual units (see section on CCCL permits in this report). As with population, the pressures on coastal resources were not related to housing growth occurring on top of or adjacent to coral reefs and associated resources, but from the effects of inland development.

In 1950, there were 266,840 housing units in the four-county region (see Figures 10-13 for housing growth in each of the four counties from 1950-2008). Of that total, Miami-Dade County led with almost half of all units (180,658), compared to 46,502 units in Palm Beach County, 36,284 units in Broward County, and 3,396 units in Martin County. For those places for which there are records for housing units, the city of Miami had 87,532 units, Miami Beach had 21,838 units, the city of Fort Lauderdale had 16,969 units, and the city of West Palm Beach had 16,454 units. Smaller subdivisions like Coral Gables, Hialeah, Hollywood, and Lake Worth had 8,000 or fewer units. As determined for the population, the housing unit distribution suggests that most construction in 1950 was coastal, and that inland settlements did not have much housing infrastructure.

By 1960, following a decade of considerable growth, especially in Miami-Dade County, the housing stock more than doubled to 574,374 units. Of these units, just fewer than 350,000 were in Miami-Dade County, followed by 128,559 units in Broward County, 89,396 units in Palm Beach County, and 7,473 units in Martin County. As in 1950, development in Miami was concentrated in coastal areas, especially in the city of Miami (120,017 units) and Miami Beach (38,608 units). Together, the two subdivisions accounted for 45.4% of Miami-Dade County housing units and 27.6% of the entire inventory for the four-county region. In Broward County, as in 1950, the cities of Fort Lauderdale (34,984 units) and Hollywood (15,409 units) led all subdivisions.

Over the 1960s, southeast Florida was built out further to accommodate the region's burgeoning population, which exceeded 2.26 million inhabitants in 1970. The 860,994 units in the four counties were again disproportionately distributed, with Miami-Dade County having over half the units (453,908 units), Broward County (253,320 units) now firmly ahead of Palm Beach County (141,363 units), and Martin County with 12,403 units. In Miami-Dade County, the city of Miami added fewer units than in the past, growing only by 5,000 houses, whereas Miami Beach increased its units by 13,248, or 34.3%, to end up with 51,856 units. Inland cities, such as Hialeah and Coral Gables, increased housing units as well, with the former growing to 31,727 units and the latter to 15,026 units. Also, Miami-Dade County suburbs such as Kendall (10,740 units) began to grow as part of larger expansion to the west. To a lesser extent, inland settlements also were built over the decade in Broward County, most notably in Miramar (7,987) in the southwest and Plantation (6,584) in the midwest parts of the county. However, coastal subdivisions like Fort Lauderdale (63,488), Hollywood (44,108), and Pompano Beach (16,844) still dominated the overall housing stock, with units having doubled in Fort Lauderdale and Pompano Beach and tripled in Hollywood over the decade. Housing growth in Palm Beach County, where the number of units increased by 58.1%, was mostly within coastal subdivisions, and it consisted of the rapid growth of a new subdivision called Boca Raton that almost tripled to 12,207 units, 84.5% increase in Boynton Beach to 7,568 units, 62.6% increase in Delray Beach to 7,854 units, and a 27.6% increase in Lake Worth to 12,637 units. In Martin County, where the housing units increased by almost 5,000 units to 12,403 units in 1970, most of the development was in and around the coastal towns of Stuart (2,065 units) and Hobe Sound (710 units), followed by the inland settlement of Indiantown (658 units).

From the 1980 Census onwards, the Census Bureau implemented the aforementioned CCD system in various states, including Florida, to identify geographical clusters. The CCD system could be used to determine housing unit densities by subdivision (rather than having to rely on previous subdivisions or areas that met a size criterion), and the system allowed for a direct comparison between CCDs in the four counties over the past three Census counts (1980-2000) (see Figures 14-16). In 1980, the housing stock increased considerably for the entire region, from 860,994 units in 1970 to 1.48 million in 1980, representing a percentage increase of 72% (Figure 14). Unlike in previous decades, when Miami-Dade County led other counties in the total number of housing units added, Broward County led the region in the 1970s by adding 232,841 units, greater than Miami-Dade County's contribution of 211,374 units and Palm Beach County's contribution of 154,175 units. Martin County added 21,599 units over the same period.

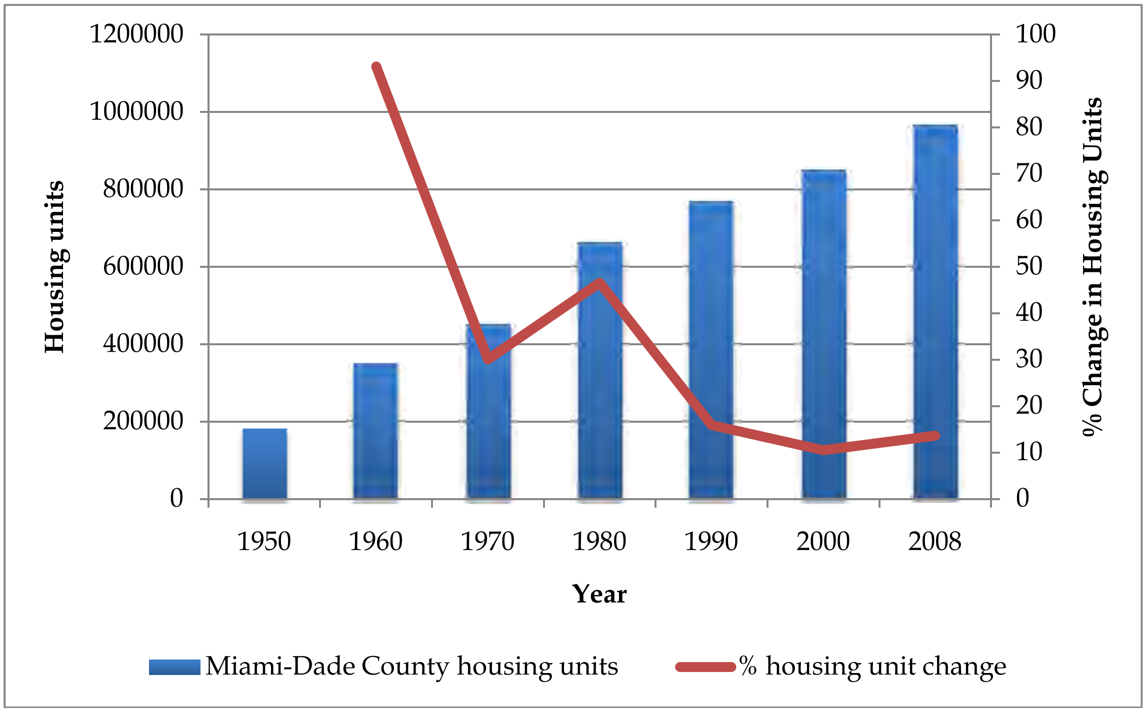


Figure 10: Housing unit growth in Miami-Dade County: 1950 - 2008.

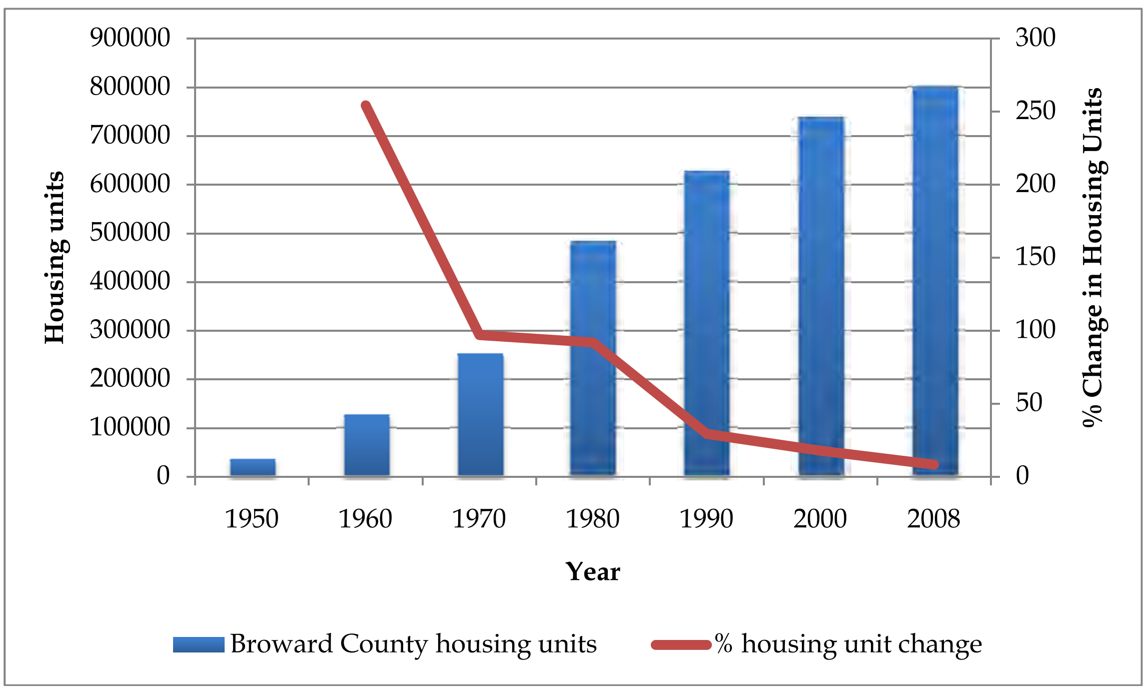


Figure 11: Housing unit growth in Broward County: 1950 - 2008.

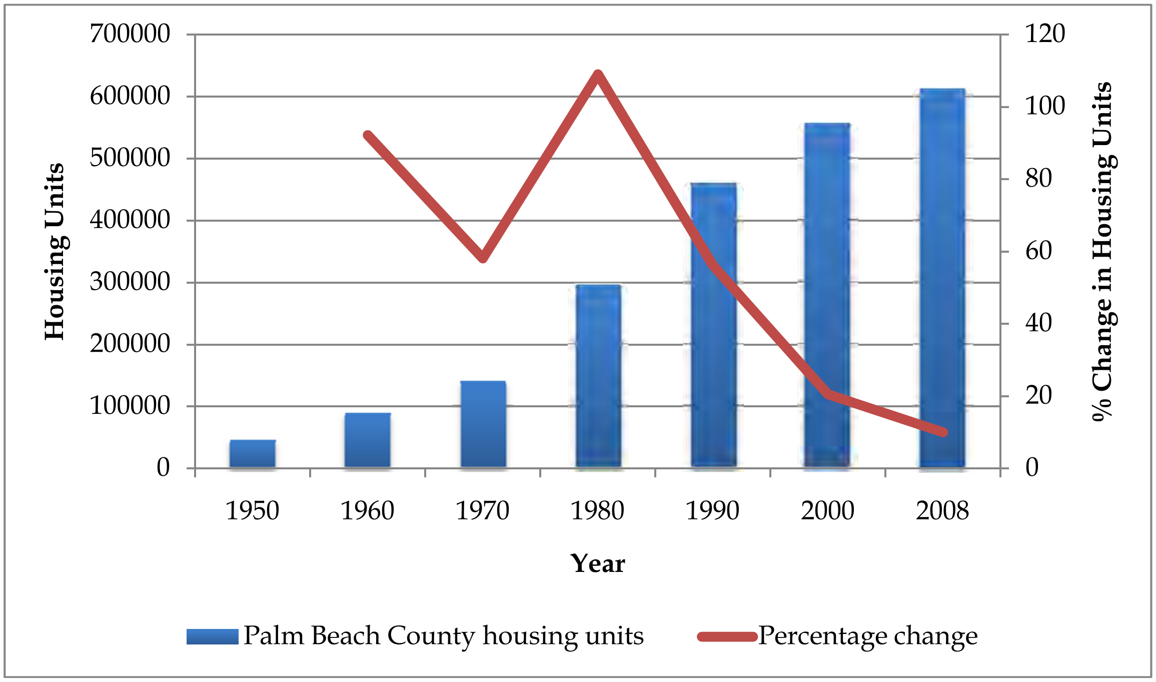


Figure 12: Housing unit growth in Palm Beach County: 1950 - 2008.

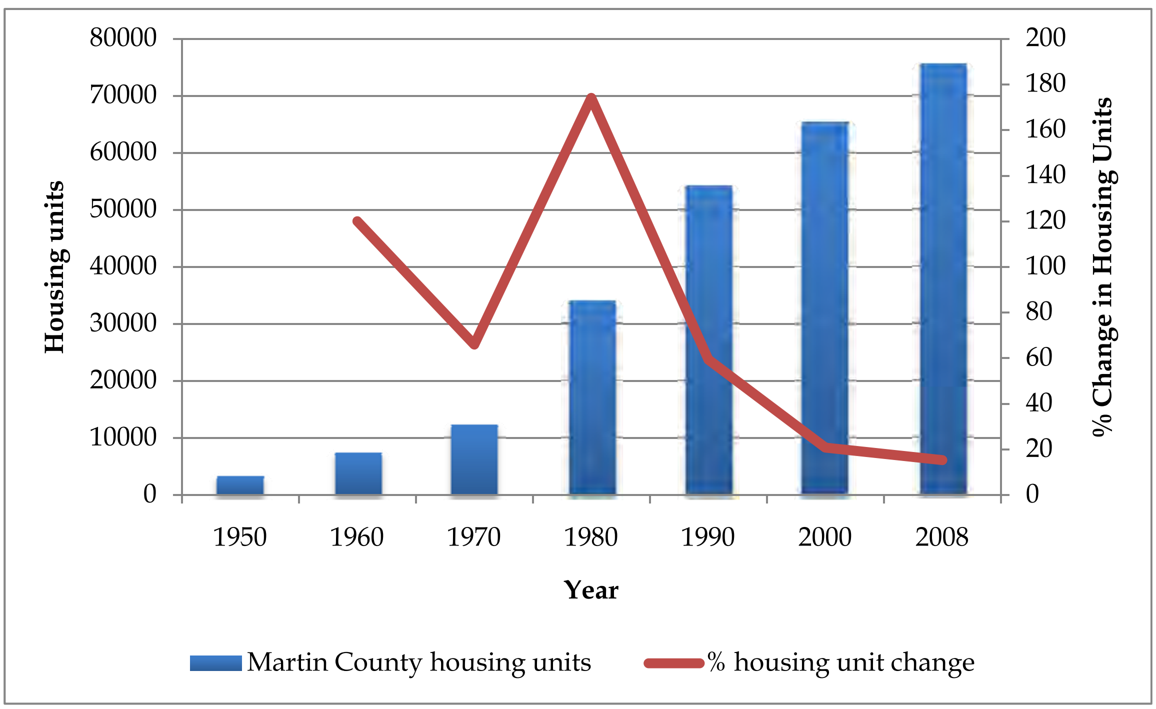


Figure 13: Housing unit growth in Martin County: 1950 - 2008.

Miami-Dade County's three coastal CCDs – Key Biscayne, city of Miami, and Miami Beach – accounted for 441,341 of the 665,282 housing units, or 66.3%, of the county's housing stock. Among inland CCDs, Hialeah and Kendall-Perrine CCDs (which includes the city of Coral Gables) both had 50,000 or more housing units (Figure 14). Other, emerging inland subdivisions were still developing and had 29,000 or fewer units. Within Broward County, inland settlements such as Davie, Margate, Miramar-Pembroke Pines, and Plantation CCDs were relatively recent developments, and these subdivisions contained 33% of the county's total housing stock (almost identical to the proportion of inland housing units in Miami-Dade County). By contrast, two of the largest CCDs, Fort Lauderdale and Hollywood CCDs, held 42.7% of the county's housing units. Thus, while the inland areas were developing in Broward County, most of the coastal construction still occurred along the county's coast in the 1970s. Among Palm Beach County's 295,536 housing units, most (89.5%) were located in coastal CCDs. Among these, Boynton Beach-Delray Beach CCD held the most units (68,885), followed by Lake Worth CCD (58,162), West Palm Beach CCD (55,129), Riviera Beach CCD (36,621), and Boca Raton CCD (33,403). Among inland communities, Sunshine Parkway led all others with 13,489 units. Of the three Martin County CCDs, the Stuart subdivision accounted for most housing units (18,619), which represented 54.8% of the total housing stock for the county. Another coastal CCD, Port Salerno-Hobe Sound CCD, accounted for another 37.1% of the county's housing units. The inland CCD, Indiantown CCD, had 2,753 housing units in 1980, which represented just over 8% of the total housing units.

The 1990 Census determined that there were almost 1.92 million housing units in the four county region, increasing by 29.4% from 1980. Growth in Broward County slowed from the previous two decades, as the county added 142,520 housing units, representing an increase of 29.3%. Miami-Dade County added 106,006 units, increasing the county total by 15.9%. Growth was more robust in housing units in Palm Beach County, where the addition of 94,803 units represented a 56.2% increase from 1980. Similarly, Martin County increased its housing stock by 59.4%, adding 11,272 housing unit over the 1980s.

Miami-Dade County increased its inland share of housing units as CCDs such as Hialeah, Kendale Lakes-Lindgren Acres, Kendall-Perrine, North Westside, and Princeton-Goulds grew from 182,043 units in 1980 to 271,180 units in 1990, representing a 49% increase (Figure 15). Conversely, the coastal CCDs, comprised of Key Biscayne, city of Miami, and Miami Beach, only grew from 411,341 units to 419,866 units over the decade, resulting in a 2.1% increase. While 54.4% of the county's housing units remained within coastal CCDs, recent growth trends suggested that the inland housing stock may soon exceed the coastal stock. With Broward County, the growing western suburbs of Plantation (102,050 units), Margate (70,706 units), Miramar-Pembroke Pines (46,826 units), and Davie (43,544) CCDs accounted for 41.9% of the total housing units in the county. Overall, the housing units in the inland communities increased by almost 62% during the decade. By contrast, the coastal CCDs units increased by 13% from 1980 to 1990, adding 41,917 units over the decade. In Palm Beach County, a majority of housing units added from 1980 to 1990 were from coastal CCDs. Boca Raton CCD increased its housing units by 73.8%, adding 24,668 units to the 33,403 units it had in 1980. Similarly, Boynton Beach-Delray Beach CCD added 24,433 units to its 68,885 units, resulting in a 58.5% from 1980 to 1990. Lake Worth CCD also grew considerably over the 1980s, adding 24,443 units to grow by 42%. Together, the coastal CCDs in Palm Beach County represented 83.2% of the county's housing stock. Within Martin County, the main shift within the CCDs occurred between Port Salerno-Hobe Sound CCD and Stuart CCD, where the former more than doubled over the 1980s to rank as the CCD holding the highest percentage of housing units in the county (47.3%). Stuart CCD trailed only slightly, holding a total of 24,481, which represented 45.2% of the county's housing units. Inland areas, such as Indiantown CCD, accounted for only 7.5% of the county's housing units although the subdivision did grow by 47%, from 2,753 units in 1980 to 4,038 units in 1990.

By 2000, the number of housing units in the four counties had grown almost to 2.22 million, from 1.92 million in the previous decade. This 15.6% increase, representing an addition of almost 300,000 units, over the 1990s was unevenly distributed as some counties grew more than others. However, in terms of growth rates, all counties represented a significant decline in the overall percentage of increases over previous decades. Thus, Palm Beach and Martin counties increased their housing units by almost 21% each, compared to Broward County's housing stock which grew by 17.8% and Miami-Dade County's housing stock which grew by 10.5%.

Within both Broward and Miami-Dade counties, housing units grew most rapidly in inland CCDs. In Miami-Dade County, the housing units increased from 771,288 in 1990 to 852,278 in 2000 (Figure 16). The coastal CCDs of Key Biscayne, city of Miami, and Miami Beach did not grow much from 1990 to 2000, adding only 13,000 units and growing by 3.2%, but the subdivisions nevertheless represented just over half (50.8%) of the county's housing units; by contrast, the inland CCDs grew by almost 69,000 units over the same time period, which represented a percentage increase of 19.7%. In Broward County, the coastal CCDs represented 52.8% of all units, but the inland communities of Davie, Margate, Miramar-Pembroke Pines, and Plantation CCD added the most units. In fact, Miramar-Pembroke Pines CCD increased from 46,826 units in 1990 to 84,120 units in 2000, resulting in an increase of 79.6% over the decade. In Palm Beach County, inland subdivisions did grow to an extent that coastal CCDs accounted for 74.5% for housing units, down from 83.2% in 1990, but growth in coastal subdivisions still dominated home construction in Palm Beach County. Finally, growth in Martin County was also dominated by coastal construction in the coastal CCDs over the 1990s. While the Indiantown CCD had the highest percentage growth in the number of units added from 1990 to 2000, at 29.9%, the coastal subdivisions of Port Salerno-Hobe Sound and Stuart CCDs also added units, increasing by 16.4% and 24%, respectively. Overall, the coastal subdivisions accounted for 62,266 housing units in the county, representing 92% of the housing stock. Thus, as determined for Palm Beach County, construction in coastal CCDs remained an important activity in Martin County through the 1990s.

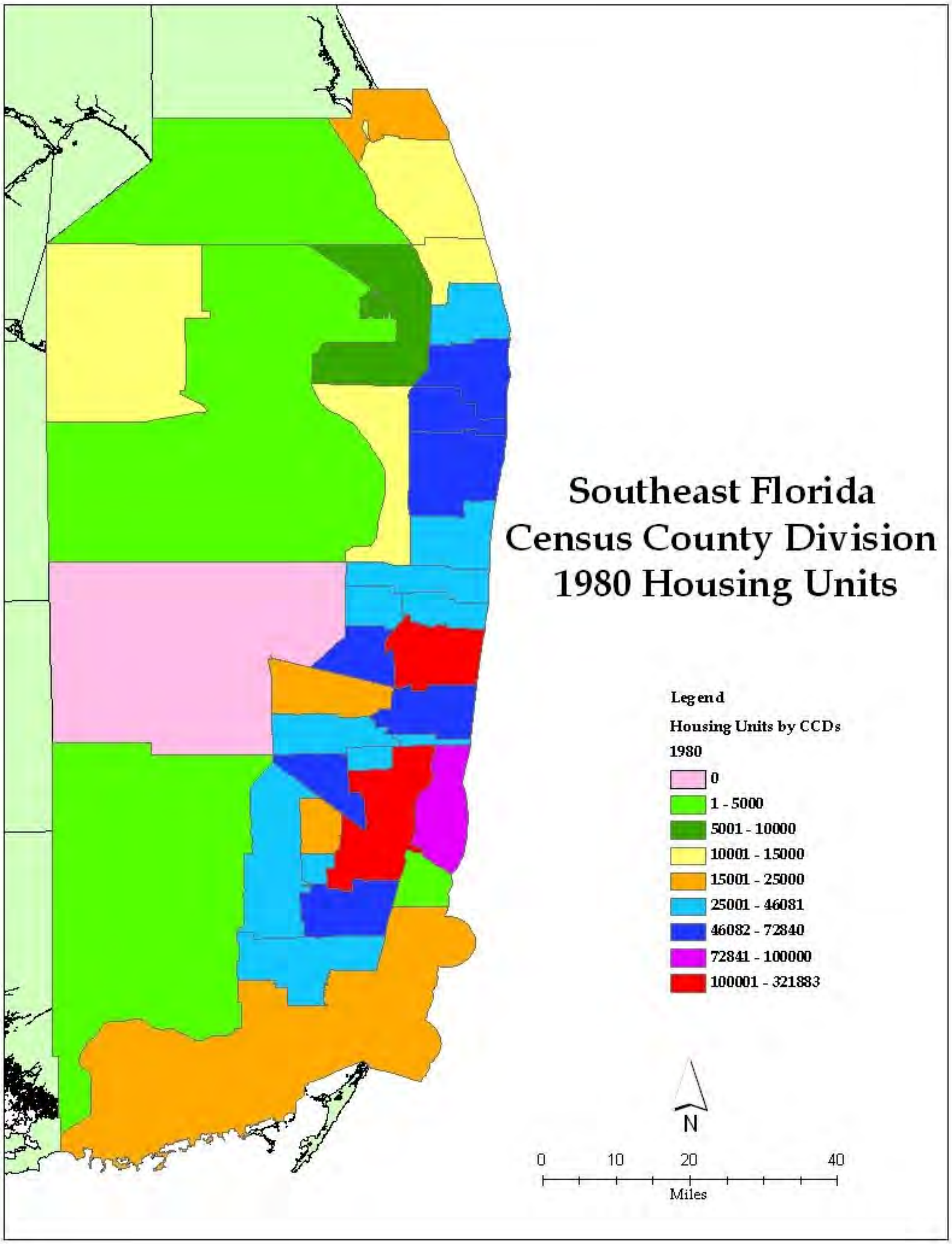


Figure 14: Southeast Florida Census County Division housing units: 1980.

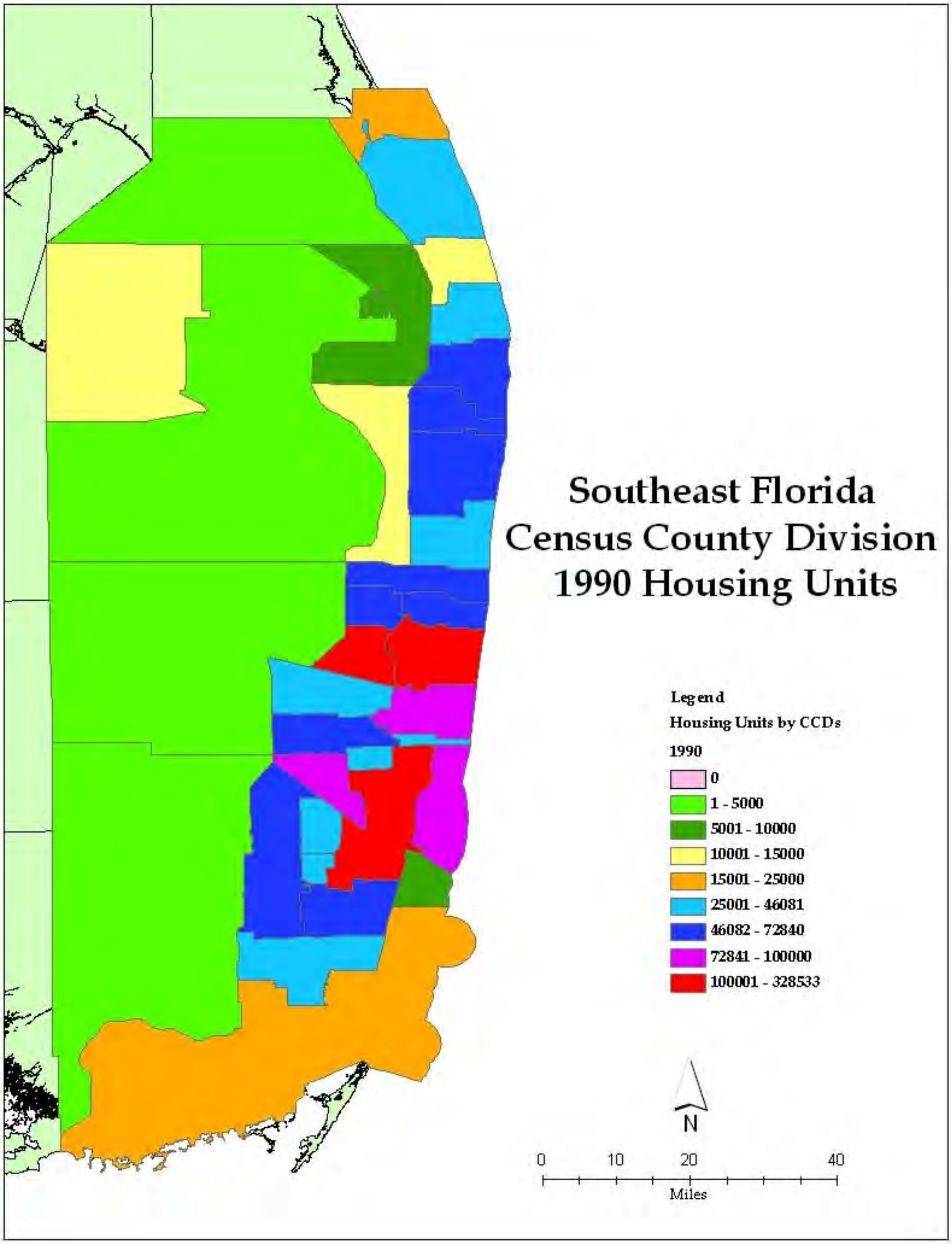


Figure 15: Southeast Florida Census County Division housing units: 1990.

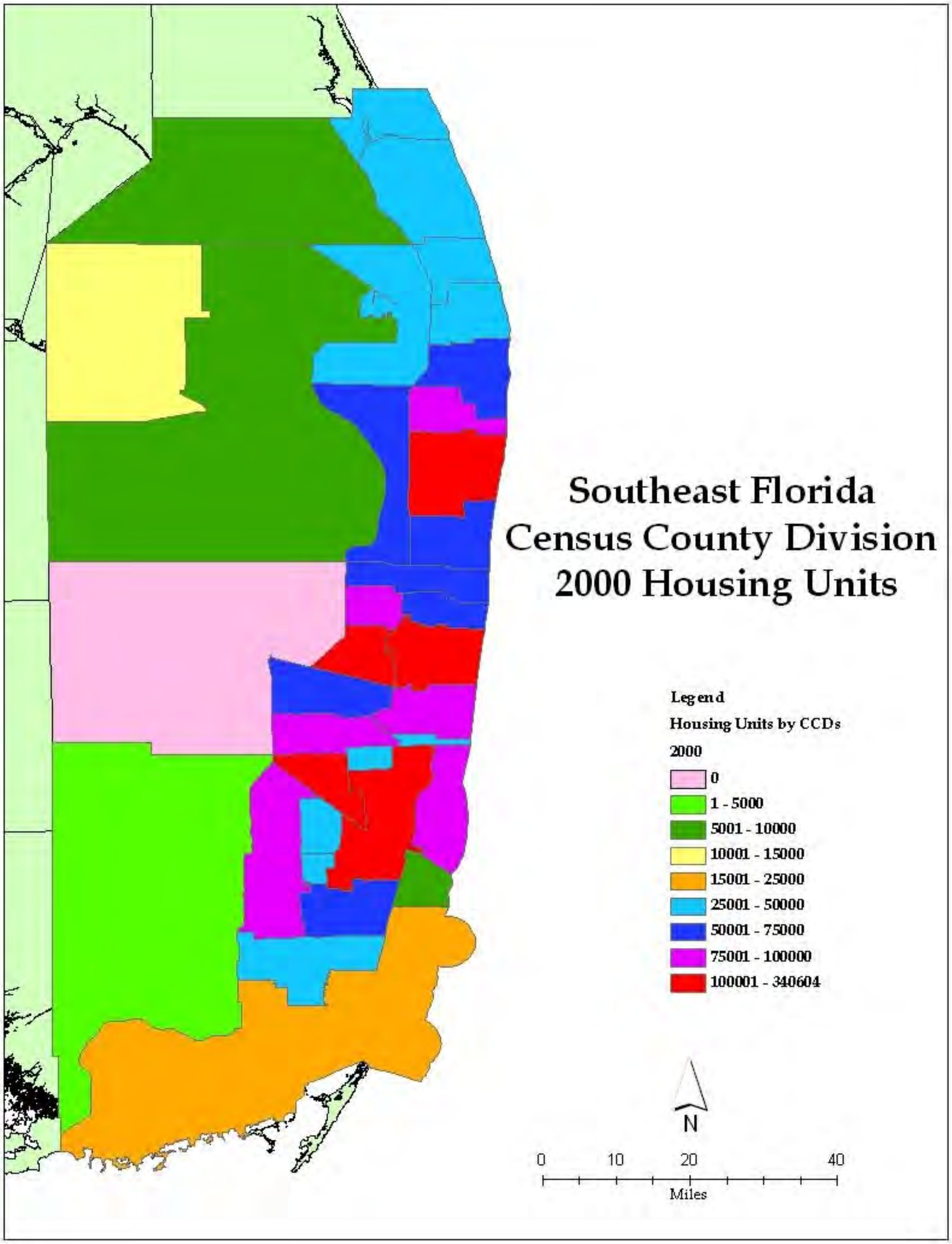


Figure 16: Southeast Florida Census County Division housing units: 2000.

3.1.3. Coastal Construction in the Southeast Florida Region: 1950 – 1995

As discussed in the previous two sections, coastal population growth, which dominated overall population growth in southeast Florida from 1950 to 1990 in most regions, had a profound effect on coastal construction in the region. As a crude measure, the saturation of coastal housing units promoted the growth on inland communities whose residents could not access the coastal subdivisions due to the reduced growth potential (as determined by the lower percentage of coastal housing growth in later decades) and resulting scarcity (leading to higher housing values). Related in part to the increasing demand for infrastructure and amenities, (in the case of inlet management, for example) coastal construction activities from the 1950s through the mid-1990s (and to the present day, in fact) transformed the coastal landscape. However, in doing so, coastal construction also generated impacts that resulted in the wholesale destruction of coastal habitats, including coral reefs and associated resources, and the interruption of dynamic coastal processes (CSA International, 2009; Peterson and Bishop, 2005).

The creation and expansion of ports and port facilities to meet local economic demands and increase the counties' leverage in the regional economy led to the dredging and filling of millions of cubic yards (cy) of spoil, creating in some cases large spoil islands while destroying benthic habitats, consisting in many instances of hardbottom communities containing corals. The interruption of longshore transport via port operations, residential and commercial hard structure development, such as breakwaters, jetties, and seawalls, and inlet dredging severely eroded certain beaches and overloaded shallow inlets. Beach nourishment activities approved for eroded beaches, or areas where there was a demand for beaches, used offshore sand borrow sites that were often not evaluated for their ecological values. In cases where sand could not be compacted properly on the beach or if incompatible beach fill was used, nourishment led to a smothering of nearshore benthic resources and permanent increased turbidity. Finally, historical records show that early residential extensions in some cases interrupted longshore sediment flow, increased shading (e.g., via docks), and promoted turbidity, the cumulative impact of which left coastal ecosystems increasingly fragmented and less resilient (Palm Beach County, 2003).

Ports and port expansions

There are three major ports in the southeast Florida region: the Port of Miami in central Miami-Dade County; Port Everglades in southern Broward County; and the Port of Palm Beach in south central Palm Beach County. Each port has expanded its operations significantly since its creation (all three ports were created in the early part of the 20th century), and each port has required extensive improvements related to maintenance and expansion-related dredging.

Port of Miami

The Port of Miami, which was initially constructed when a channel was dredged from the mouth of the Miami River to the Atlantic Ocean in 1896, underwent expansion in the early 1900s with the dredging of Government Cut in 1903 and Government Channel in 1916. This was followed by two additional deepenings, in 1929 and 1935, respectively (USACE, 1989). The port has undertaken several significant construction activities since 1950. In 1960, the port enlarged its turning basin to 300 feet (ft) and dredged a 39 acre, 30 ft depth turning basin along the north side of Fisher Island (USACE, 2003). In 1968, the port enlarged its entrance channel to a depth of 38 ft and a width of 500 ft. The port also widened three cuts (Outer Bar Cut, Bar Cut, and Government Cut) to a depth of 44 ft, widened Fishermen's Channel to a depth of 42 ft and a width of 400 ft, and constructed a 1,600 ft diameter turning basin near Lummus Island to a depth of 42 ft in 1990. From 1957 to 1995, the Port of Miami completed seven maintenance dredging operations, ranging from 247,000 cy dredged in 1993 to 3,000 cy dredged in 1995 (USACE, 2003). The average maintenance dredge operation led to the removal of 126,427 cy per operation. Apart from maintenance dredging, the port also conducted 18 major dredging activities involved in port construction, in 1904, 1927, 1937-38, 1964, 1980, and 1991. The construction activities between 1904 and 1968 dredged a total of 10.6 million cy, of which 90% were used to expand various islands around the port, including Lummus, Dodge, and Fisher Islands, and Virginia Key (USACE, 2003). Detailed information on the impacts of port operations was best captured by a series of expansions that occurred in the NEPA era (or from 1969 onwards).

The process for the expansions commenced following the 1979 adoption of the Port of Miami's Master Development Plan and extended through channel deepening projects in 1991 and in the early 2000s (USACE, 2004a). The impacts of the port expansion project led to the destruction of unspecified totals of hardbottom, seagrass, and unvegetated bottom, all of which was to be mitigated by planting acres of seagrasses. When this mitigation project failed, the port was required to plant 15 acres of mangroves as habitat restoration and performed an unspecified amount of habitat creation via artificial reefs and on spoil islands (USACE, 2004a). The channel deepening project of 1991 called for the deepening of the Fisher Island Turning Basin to 42 ft and the deepening of the entrance channel and three cuts to 44 ft. The project impacted 4.92 acres of hardbottom habitat and 94 acres of rock habitat, but it also led to damage of seagrass communities located outside the permitted dredge area. To offset the predicted and unexpected impacts, the port was required to create 15.91 acres of artificial reef, 94.0 acres of rock and rubble habitat, and unspecified amounts of mangrove wetland restoration. They also were required to complete a mitigation project in Oleta River State Park in North Miami involving the restoration of 42.5 acres of red mangrove habitat, enhancement of 20 acres of red mangrove habitat, and the creation of bilingual educational signage in the park.

Port Everglades

Port Everglades has been in existence since its official dedication in 1929 (Port Everglades, 2010). It grew considerably from the 1960s onwards and its harbor was dredged nine times between 1953 and 1984; four of the dredging operations were related to maintenance and five concerned port construction and related new work (USACE, 2004b). Overall, dredging resulted in the removal of 6.2 million cy or an average of 564,000 cy per dredging operation. Much of the compatible dredge spoil was placed in a county owned beach south of the port from 1961 to 1965 by USACE, which deposited an estimated 729,000 cy on the then Broward Beach State Park (BCECQB, 1987).

Five main projects took place in Port Everglades Harbor in the 1980s (USACE, 2004b). The first of these was the 1983 Berth 29 Bulkhead and Channel project that resulted in the dredging of 311,000 cy of material from unvegetated bottom for berth deepening. The port created 0.4 acres of mangrove habitat as mitigation. In 1984, the port dredged a channel as part of its Pier 7 Channel Dredging project, which led to the dredging of 242,222 cy of unvegetated bottom and did not require mitigation. Also, in 1984, the port dredged its outer entrance channel, removing 46 acres of unvegetated bottom as a channel improvement project and filling 4.73 acres of unvegetated bottom. In 1987, the port constructed a turning notch as part of an expansion to facilitate the dockage of larger vessels. The project resulted in the removal of 18.27 acres of mangrove wetlands, which the port mitigated for by creating 45 acres of mangroves in John U. Lloyd State Park located south of Port Everglades and preserving 48 acres of mangroves and creating a manatee refuge on-site. Finally, in 1989, the port expanded again by constructing a new berth which resulted in the removal of two acres of mangrove wetlands which were mitigated for by the creation of 4.5 acres of mangroves.

Port of Palm Beach

The Port of Palm Beach is the northernmost of the three ports in the southeast Florida region, and it is located within Lake Worth Inlet. Since 1915, the port has depended on maintenance dredging to keep the inlet and channel depths such that vessels can enter the port (CH2M Hill et al., 2006). The inlet was dredged to a depth of 35 ft to accommodate larger vessels in 1948 and again in 1967, and maintenance dredging has kept the depth at that level (Palm Beach County, 2003). The port estimated that the USACE and the port dredge between 75,000-100,000 cy in the federal portions of the port and the port berth areas every year for maintenance dredging purposes (CH2M Hill et al., 2006). Beach compatible material is deposited in a location on the northern end of the Town of Palm Beach, and the rest is placed on the southern part of Peanut Island, located in Lake Worth[12].

Inlets and inlet management

Inlets have played a major role in coastal construction in southeast Florida. Periodic maintenance is necessary to keep the inlets open to vessel traffic, i.e., to counter the effects of shoaling, and to reduce the impacts on adjacent beaches that often suffer increased rates of erosion due to trapped longshore sediment that would otherwise naturally nourish the downstream beaches. Thus, inlet management has also involved sand transfer, either via sand transfer plants or through nourishment.

Baker's Haulover Inlet is the southernmost maintained, artificial inlet in the southeast Florida region. Located in northern Miami-Dade County, the inlet has connected Biscayne Bay with the Atlantic Ocean since its construction in 1925 (FDEP, 1997a). Several improvements followed, including the reconstruction of the north jetty in 1963, the relocation and reinforcement of the south jetty in 1964, and tightening of the jetty in 1986, along with maintenance dredging to keep the inlet open at 400 ft wide and 14 ft deep. However, these improvements greatly affected longshore sand transport, affecting downdrift beaches. The net effect of the inlet was that 26,700 cy of sand per year needs to be bypassed to mitigate the impacts of the inlet.

Port Everglades is an important inlet in southern Broward County that serves as the major entry point for the county's commercial and cruise passenger port. Since 1962, when dredging was sidecast north of the inlet and a north jetty was constructed, the inlet has created a fillet that impounds/traps sediments that would otherwise have replenished beaches to the south of the inlet. It is estimated that these actions have disrupted deposition equivalent to 44,000 cy per year, which have required two major nourishment projects, in 1976 and 1989 (FDEP, 1999a). Hillsboro Inlet, also in Broward County, was improved in 1930 when a 200 ft jetty was constructed on its northern side (FDEP, 1997b). In 1952, another, 500 ft jetty was constructed on the inlet's southern side. The southern jetty was reinforced in 1964, along with the construction of a 225 ft breakwater extension. As part of the same project, the inlet channel was widened to 175 ft and deepened to 10 ft. Because of the sand trap created by the jetties, it is

[12] An underwater disposal site has been used since 2005 such that above land disposal is no longer conducted (T. Jordan, personal communication).

estimated that the inlet disrupts the passage of 120,000 cy per year (FDEP, 1999a).

In southern Palm Beach County, Boca Raton Inlet is estimated to bypass an average of 35,100 cy to downdrift beaches due to the construction of jetties to maintain an inlet opening in 1931 (FDEP, 1997c). The inlet was widened in 1956, and the channel was deepened to 10 ft. Over the years, various maintenance dredging operations were conducted to open the inlet that would otherwise shoal and close. The City of Boca Raton, which was deeded the inlet and the jetties in 1972, bought its own dredge and commenced maintenance dredging on a regular basis (Palm Beach County, 2003). After improvements in the late 1970s and 1980 to facilitate sand flow to downdrift beaches, dredging operations in 1985 placed 297,000 cy on the south beach. Since 1980, the City of Boca Raton has transferred an average of 55,000 cy per year to the downdrift beaches; however, it is estimated that there is a need to bypass 71,300 cy to offset the effects of the inlet (FDEP, 1997c).

Lake Worth and South Lake Worth Inlets are two important inlets in Palm Beach County. South Lake Worth Inlet is located off Boynton Beach, and it is a tidal inlet connecting Lake Worth to the Atlantic Ocean. Completed in 1927 to address water quality and vessel traffic, the inlet quickly closed due to a large shoal (Palm Beach County, 2003). As a result of sand becoming trapped at the mouth of the inlet, the downdrift beaches quickly eroded. Following the development of a sand transfer plant in 1937, the plant pumped 55 cy of sand per hour (or 50,400 cy per year) out of the inlet (Palm Beach County, 2003). The plant was upgraded in the late 1940s, and while it continued to transfer sand, interior shoaling in the inlet created the need in 1953 for the construction of a training wall along the northern side of the inlet. Dredging was also employed to remove sediment from interior shoals, averaging 42,600 cy per year from 1961-1969. Additional improvement to the sand transfer plant in 1967 and modifications to the inlet improved conditions such that an average of 70,000 cy of sand were bypassed per year from the late 1960s onward. However beaches south of the inlet did suffer, and in 1998, a beach nourishment project at Ocean Ridge was performed to make up for the effects of the inlet (FDEP, 1999b).

Lake Worth Inlet is located next to the City of Riviera Beach in Palm Beach County, and it serves as the primary entry point for the Port of Palm Beach. Although the first inlet was constructed in 1877, a larger, more stable inlet was not completed until 1919 when the channel was widened to between 100 and 200 ft and the main channel was dredged to 10 ft (Palm Beach County, 2003). In 1935, the US government took over the maintenance of the inlet and deepened the channel to 20 ft, which was subsequently deepened to 27 ft in 1948. In the 1960s, the channel was deepened first to 33 ft and then to its present depth of 35 ft

(Palm Beach County, 2003). The stabilization of the inlet led to erosion in downdrift beaches for an 8.5 mile stretch south of the inlet. A sand transfer plant, completed in 1958, pumped sand south from the inlet onto a downdrift beach, with improvements in 1985 to tighten the south jetty to prevent the leakage of sand northward through the jetty back into the inlet. Notwithstanding the efforts to bypass sand to the south, it is estimated that the impacts of the inlet have resulted in the need for an annual bypass of 171,300 cy of sand and that the overall impact resulting from the stabilization of the inlet has been the loss of 12 million cy from the coastal system (FDEP, 1996).

Jupiter Inlet is the northernmost inlet in Palm Beach County. It has historically naturally opened and closed, as noted by visitors and residents from colonial to state history. Although several attempts were made to keep the inlet open, it was only after a dredging operation in 1948 that resulted in the removal of 37,000 cy of material that the inlet was opened at a depth of eight ft and 100 ft wide (Palm Beach County, 2003). Due to the reduced flow within the inlet following the creation of northern (St. Lucie Inlet) and southern (Lake Worth and South Lake Worth Inlets) inlets, the Jupiter Inlet required regular maintenance dredging to remain open. An estimated 1.5 million cy were dredged between 1952 and 1989 by the Jupiter Inland District, most of which was deposited on the shore south of the inlet (FDEP, 1997d).

The northernmost inlet located in the southeast Florida region is the St. Lucie Inlet in Martin County. Initially excavated in 1892, effort to stabilize the inlet in the late 1920s via the construction of a jetty on its northern end interrupted sand transport to southern beaches, especially on Jupiter Island (FDEP, 1995). By the 1990s, the situation had worsened such that 5.8 miles of the island were critically eroded[13] and were identified for a nourishment project.

Beach restoration

Beach restoration activities, comprised mainly of nourishment, re-nourishment, and stabilization, have dominated as shoreline protection measures since they were first implemented in the State of Florida. The main purpose of beach

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[13] The FDEP BBCS defines a critically eroded area as a: "segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that inland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost. Critically eroded areas may also include peripheral segments or gaps between identified critically eroded areas which, although they may be stable or slightly erosional now, their inclusion is necessary for continuity of management of the coastal system or for the design integrity of adjacent beach management projects" (FDEP, 2010).

restoration has been to protect shoreside infrastructure via storm damage reduction while providing ancillary recreational benefits. From the mid-20th century to 1995, beach fill comprised a total of 9.8 million cy in Martin County, 21.5 million cy in Palm Beach County, 8.6 million cy in Broward County, and 18 million cy in Miami-Dade County (Figures 17-21) (Western Carolina University, 2010).

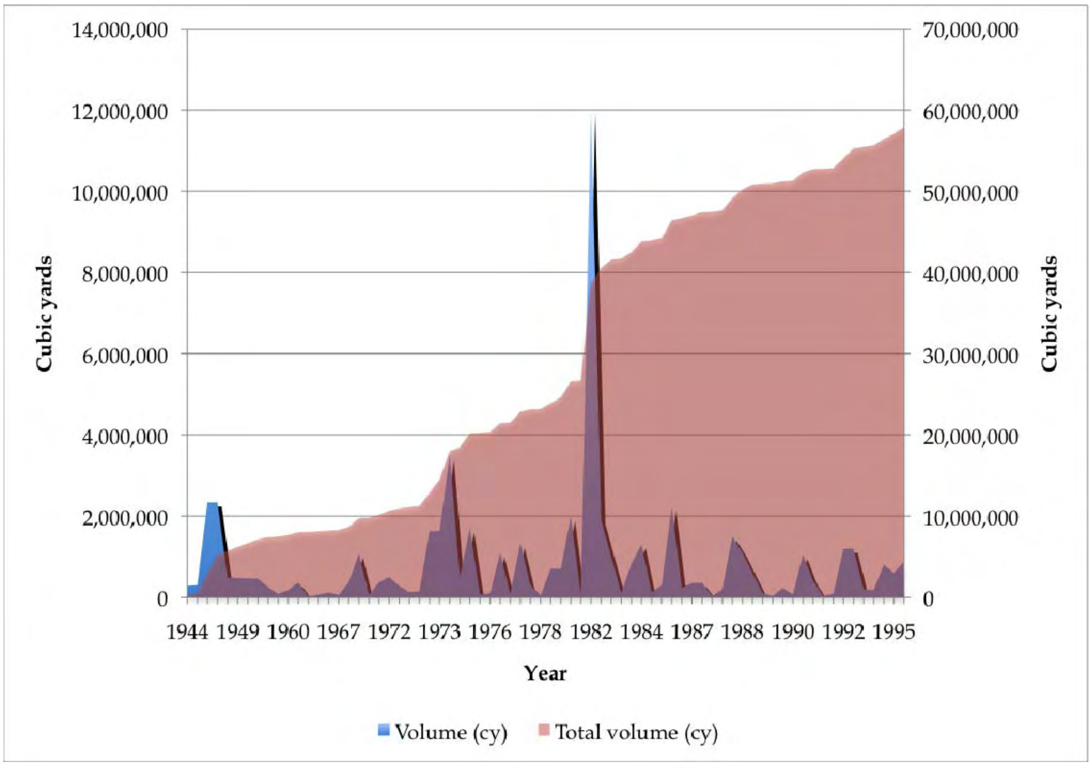


Figure 17: Beach nourishment in southeast Florida: 1944-1995 (Western Carolina University, 2010).

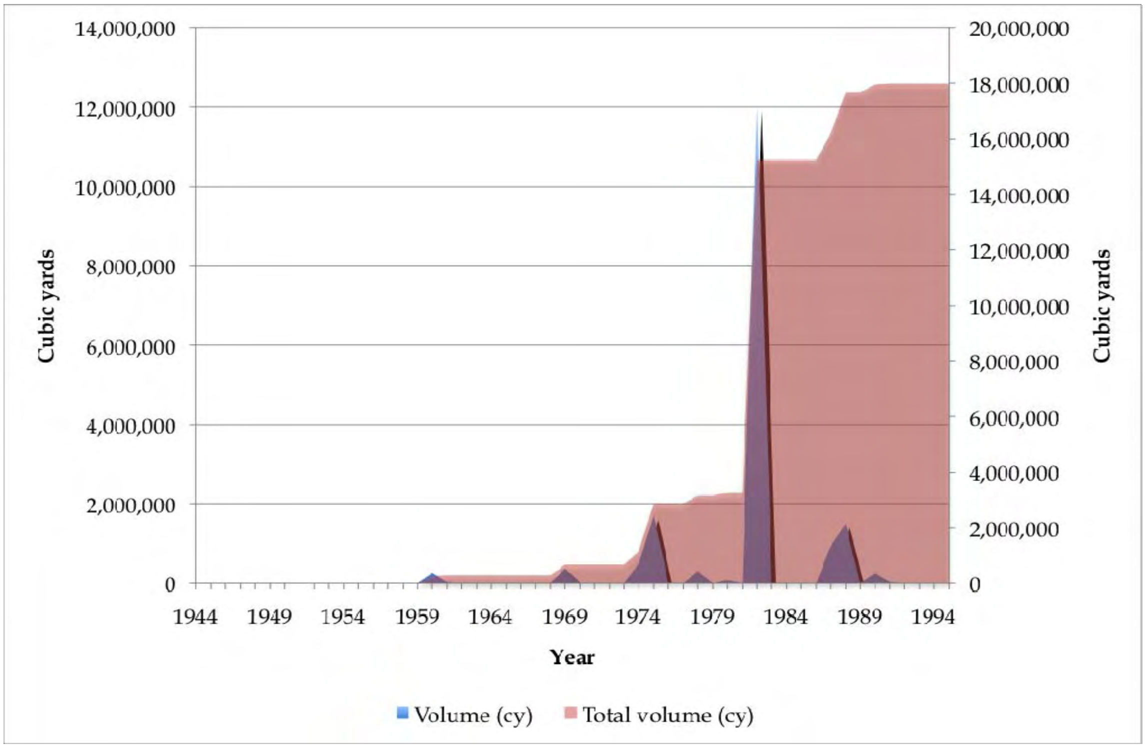


Figure 18: Beach nourishment in Miami-Dade County: 1944-1995 (Western Carolina University, 2010).

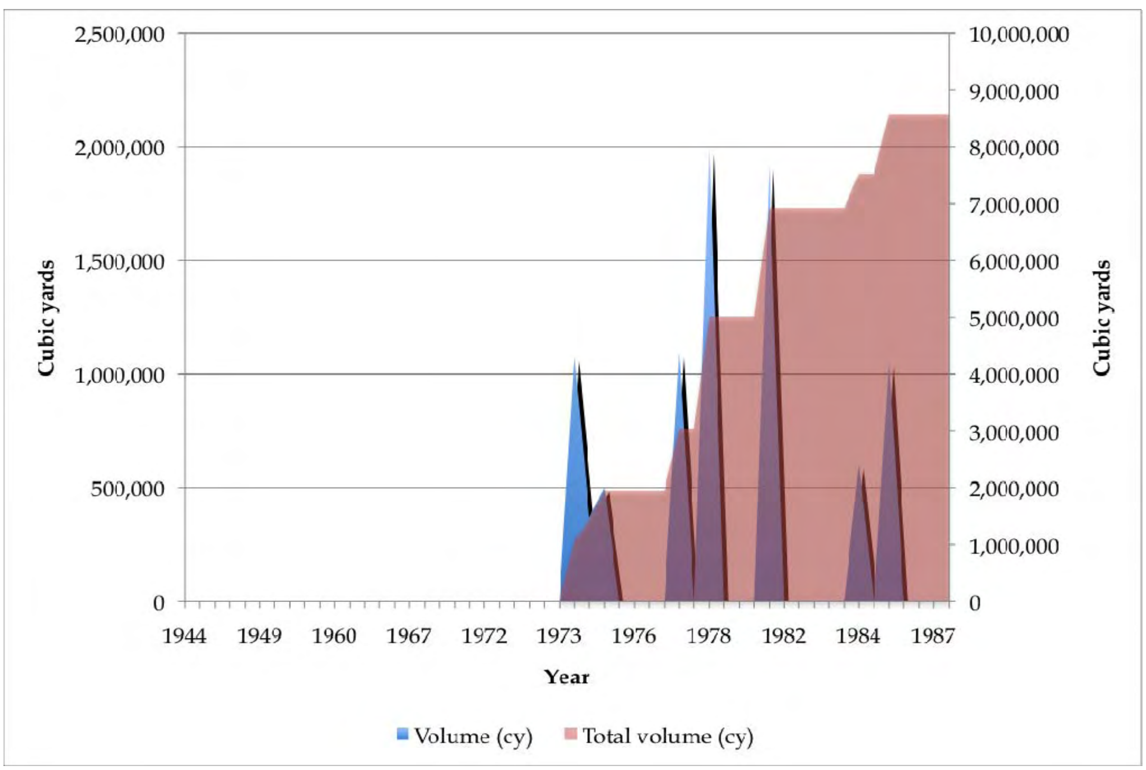


Figure 19: Beach nourishment in Broward County: 1944-1995 (Western Carolina University, 2010).

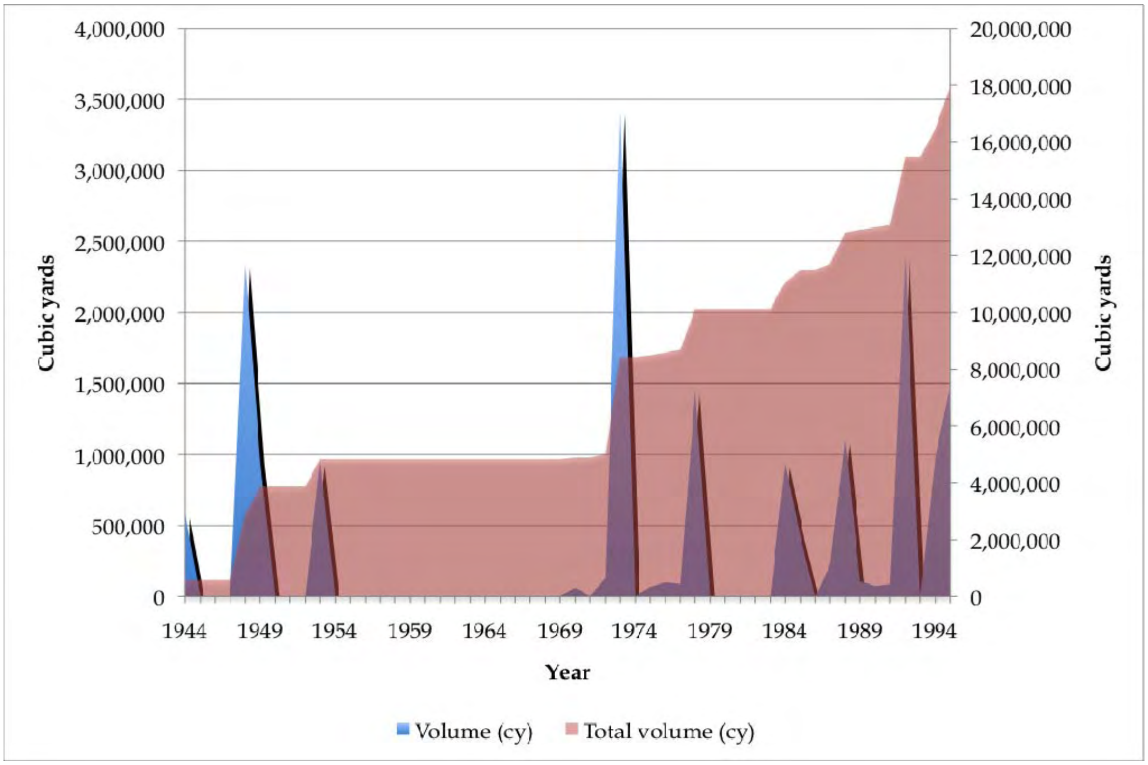


Figure 20: Beach nourishment in Palm Beach County: 1944-1995 (Western Carolina University, 2010).

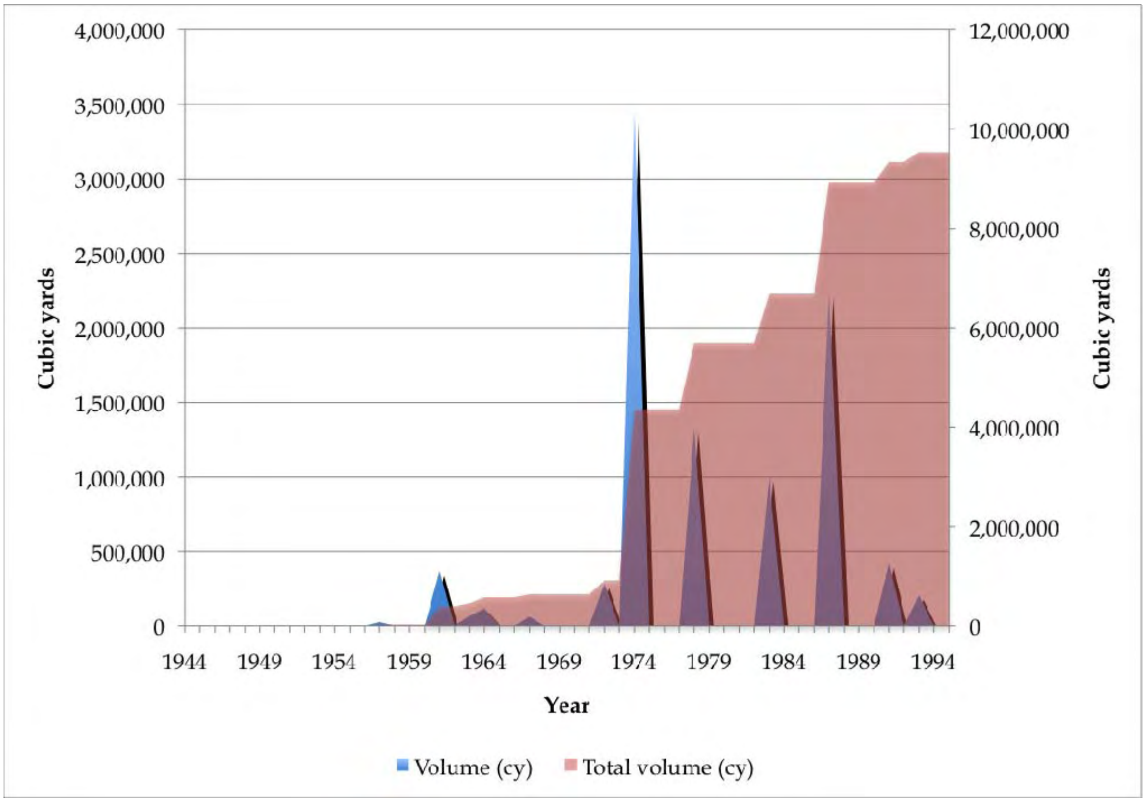


Figure 21: Beach nourishment in Martin County: 1944-1995 (Western Carolina University).

In Miami-Dade County, several beaches were nourished from 1960-1995 (Western Carolina University, 2010; FDEP, 2008). Bal Harbour, Haulover Park, and Sunny Isles were each nourished more than once from 1960 onwards for a total of 4.4 million cy (USACE, 1997). Miami Beach underwent two restoration projects, including a massive project completed in 1982 that placed 12 million cy of sand over 10 miles of Miami Beach, and again in 1985, that resulted in the placement of another 350,000 cy. Another 1.2 million cy were used in beach restoration projects between 1969 and 1987 in Virginia Key and Key Biscayne.

Broward County's southern beaches in Hollywood and Hallandale, including John U. Lloyd State Park, were nourished with 5.1 million cy of sand from the early 1970s onwards (Western Carolina University, 2010; FDEP, 2008). The problem facing these downdrift beaches was the expansion of Port Everglades, which interrupted longshore sand transport to the beaches and resulted in the need for re-nourishments (BCEQCB, 1987). One large project in 1979 required the deposition of almost two million cy over these southern beaches. Other beaches nourished in Broward County were Hillsboro Beach (500,000 cy in 1972), and Pompano Beach (almost three million cy over two nourishment projects in 1970 and 1983) (Western Carolina University, 2010).

Palm Beach's shorelines received the most sand, due to a combination of the four inlets located along the length of the county and shoreline activities (Western Carolina University, 2010; FDEP, 2008). Northern and southern Boca Raton beaches in the southern part of the county, which are located adjacent to the Boca Raton Inlet, were nourished in the 1980s, adding 1.4 million cy of sand. Delray Beach received 4.34 million cy over four projects from 1973 to 1992. The first and last projects required the installation of 1.63 million and 1.20 million cy, respectively. The Town of Palm Beach, located downdrift of the Lake Worth Inlet, nourished its beaches with 10.3 million cy of sand in 13 projects from 1944 onwards. The town in fact campaigned against the deepening of the inlet in 1965, as the residents feared that a deeper inlet would accelerate erosion along their shoreline (Palm Beach County, 2003). Similarly, the beach south of Lake Worth Inlet had to be nourished 16 times for a total of 4.89 million cy from as early as 1944 (Western Carlota University). Jupiter/Carlin Beach, which is located downdrift of Jupiter Inlet, was replenished in 1995 when 603,000 cy were deposited to both stabilize a larger beach segment (and to serve as a feeder beach to replenish more southern beaches) and to nourish the northern section closest to the inlet (Palm Beach County ERM, 1995).

In Martin County, Jupiter Island was the only site nourished; from 1957 onwards there have been 12 projects on the island (Western Carolina University, 2010; FDEP, 2008). The island's sandy beaches are a nesting habitat for loggerhead sea turtles. The issue facing Jupiter Island was its downdrift location from the St. Lucie Inlet. The construction of a jetty on Hutchinson Island in the 1920s to stabilize the inlet led to the accumulation of material that would otherwise have replenished Jupiter Island. Since the 1950s, the island has been nourished over periodic projects that have placed a total of 9.8 million cy of sand.

As shown in the figure below (Figure 22), a majority of the beaches in southeast Florida were critically eroded by the end of the 20th century (taken from FDEP, 2008). Overall, 78.0% of the 118.9 miles of beaches in the region were listed as critically eroded; however, 62.6% of the critically eroded beaches have been restored via shore stabilization projects. The most critically eroded beaches were located in Broward and Miami-Dade counties, where 92% of the 38.9 miles of beaches were critically eroded. Most of the shore stabilization projects (i.e., restoration), have taken place in those counties, and 77.7% of the critically eroded beaches have been restored. Conversely, the northernmost beaches in the region, majorities of which were also critically eroded, have not been comparably restored. Of the northern beaches, only the critically eroded southern Palm Beach County beaches have been restored. Overall, less than half (48% or fewer) of the critically eroded beaches from central Palm Beach County to the Treasure Coast (St. Lucie and Martin counties) have been restored.

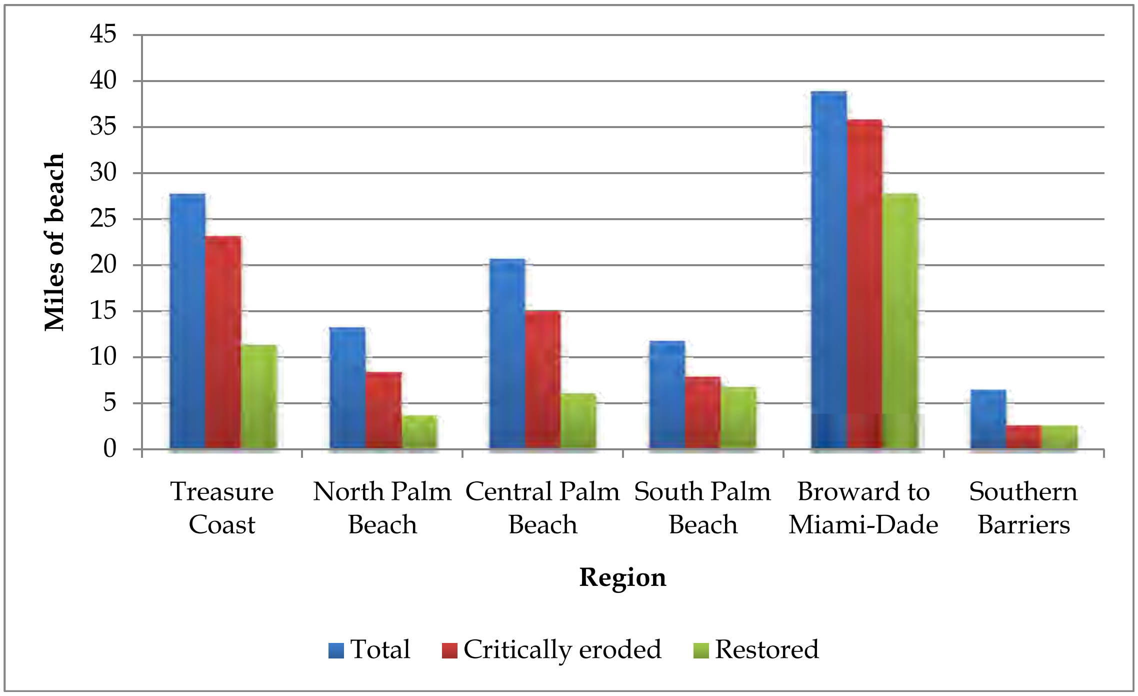


Figure 22: Critically eroded and restored beaches in southeast Florida, 2008 (FDEP, 2008)[14]

3.2. Review of Permitting-Independent Data

Independent assessments of resources, ecosystems, and human communities were used to broadly validate the trends derived from the permitting data. Significant challenges exist in these broad comparisons such as differences in spatial and temporal scales, which may be resolved at some broad geographic boundaries and medium-term time scales.

3.2.1. Status of Southeast Florida Beaches

This brief assessment complements the comments made on beach nourishment in previous sections of this document. It focuses mainly on the current status of beach ecosystems from the standpoint of sand quantity (erosivity) and sand quality, and future projections of these. The ecosystem impacts of beach nourishment on coral reefs are discussed in the section on status of coral reefs.

To analyze the status of beach systems on the Atlantic coast of Florida, Montague (2008) uses the conceptual framework of the sand-sharing system (Figure 23). Energy carried by waves from the northeast is stronger than that carried by

[14] The "Southern Barriers" refer to the barrier islands in Miami-Dade County and are comprised of Miami Beach, Key Biscayne, and Virginia Key.

waves approaching from the southeast. Along the way, sand is exchanged dynamically within a sand sharing system that links the beach with adjacent depositional and erosional sand features. Using this conceptual framework, Montague (2008) analyzed a database compiled by Duke University which detailed beach fill disposal of dredged material by both locally and federally funded dredge and fill projects alongside the inlet and harbor dredging records archived by USACE. The two databases provided a basis for estimating long-term net transport of beach fill in the Atlantic coast of the state.

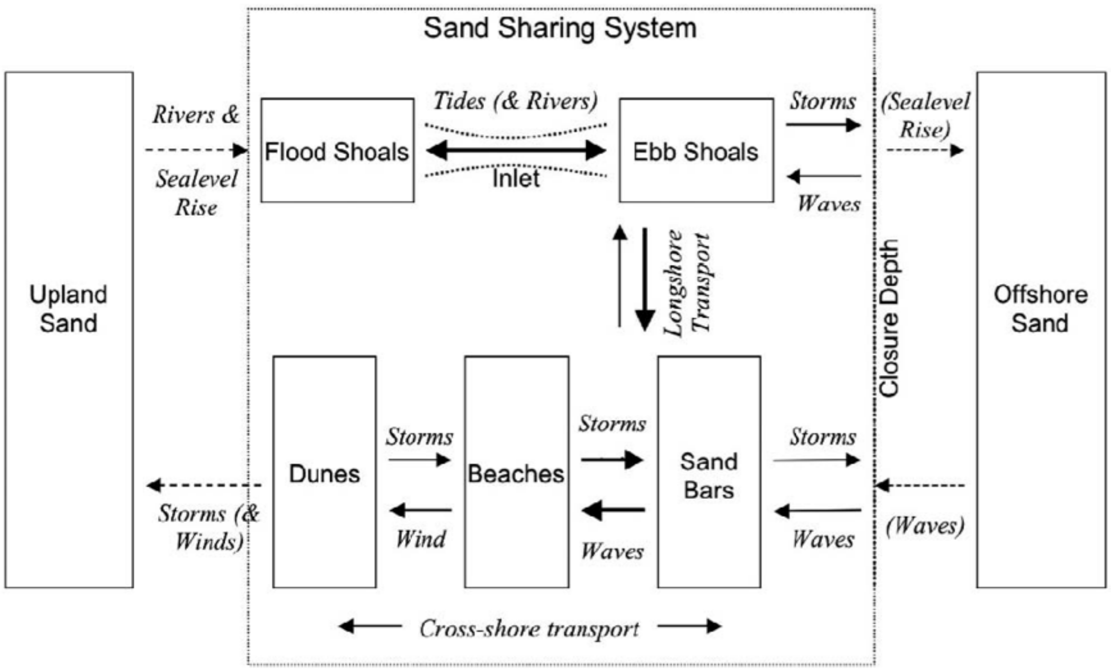


Figure 23: The sand sharing system (Montague, 2008).

The trends shown in Figure 24 indicate that after World War II and prior to 1970, most of the dredged material from navigation projects was removed from the sand sharing system and placed in offshore disposal sites. After 1970, dredged material was disposed of in greater quantities as beach fill or as nearshore placement. The analysis using the merged USACE-Duke database indicated an annual net cumulative sand deficit of between 74 X 10^6 cubic meters (m^3) and 104 X 10^6 m^3 from 1903 to 2003. This independent study shows that eastern Florida beaches have been steadily eroding. These cumulative rates translate to an annual net deficit rate ranging from 1.0 X 10^6 m^3 to as high as 1.7 X 10^6 m^3 for the period from 1948 to present.

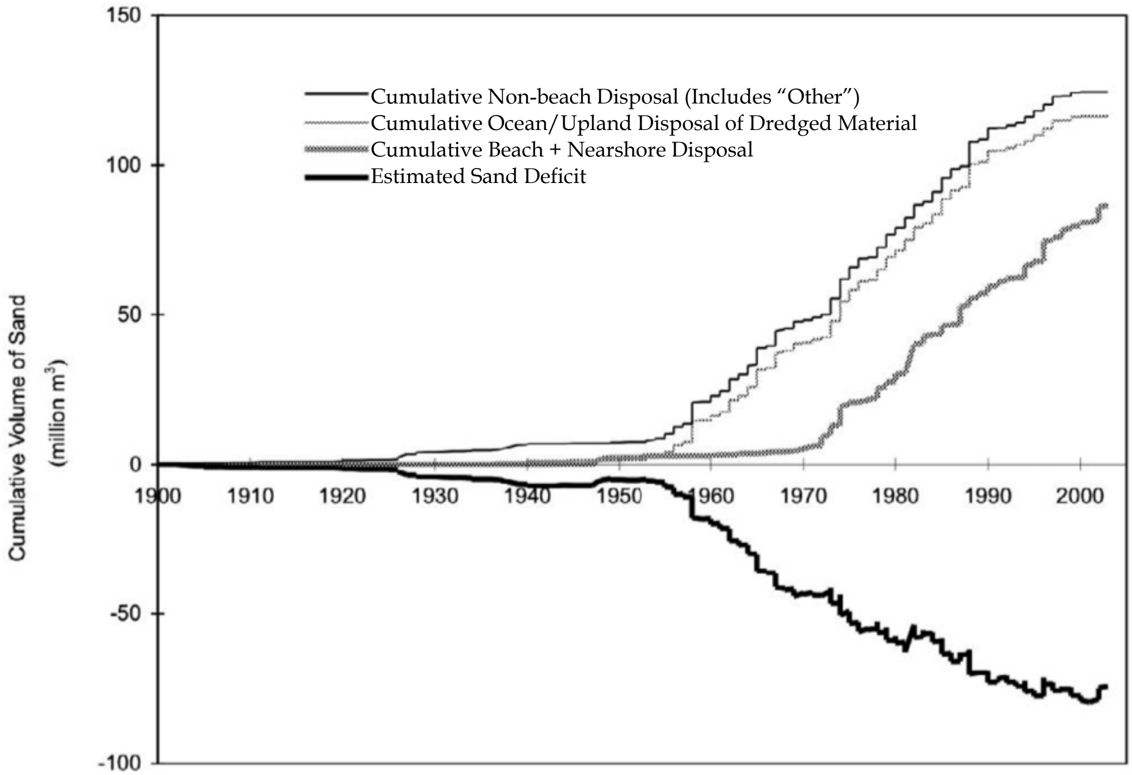


Figure 24: Estimated cumulative net sand deficit in east Florida based on disposal site of dredged sand and that placed as beach fill (Montague, 2008).

The volumes of dredge and fill over time and corresponding source and destination only partially explain net sand transport. The nature of sand particles of beach fill – size, density, shape, and durability – has to be taken into account as well (Wanless and Maier 2007; Wanless, 2009). Wanless and Maier (2007) tested natural beach, nourished beach, and borrow site sand samples for all four sand grain characteristics.

Natural beach sand in southeast Florida is quartz-carbonate mixture with 90% of particles falling in the size range between 250-1000 micrometer (µm) and none finer than 125 µm. The carbonate grains are solid, durable shell fragments round to semi-round in shape and are derived mostly from mollusk and Pleistocene carbonate fragments. Natural sand subjected to one week of tumbling with glass sphere abrasive produced less than 0.1% particles finer than 125 µm. In contrast, 1-3% of the borrow area sand was abraded to sizes less than 125 µm after one week of tumbling, a rate 10-30 times that of natural sand. About 8-10% of nourished beach sand fragmented into particles too fine to remain on the beach after a month of tumbling.

Using his personal observations over a 36-year experience, Wanless (2009) states that nearly all beach fill projects use sand from the offshore marine environment where the sediments are less than 200 μm in grain size, are platy and of porous skeletal calcium carbonate fragments, with only a small portion of quartz material. This material is not able to withstand wave abrasion and will further fragment to smaller particles such as fine silt and clay that remain in suspension in nearshore waters to increase turbidity and reduce light penetration. These stress and smother benthic communities at chronic concentrations. Long-term series data through sustained and operational compliance monitoring are needed to further validate these observations.

Looking forward 50 years from present, USACE (2009) examines the sustainability of southeast Florida beaches. Broward, Miami-Dade, and Martin counties show decreasing amounts of sand deficit for the period 2009 – 2059 (Figure 25). The analyses indicate the need for using geologically appropriate and non-domestic sources such as Bahamian aragonite. However, the sourcing of sand indicated in this analysis must take into account the fundamentals of appropriate sand grain characteristics, and the sediment sources that provide these.

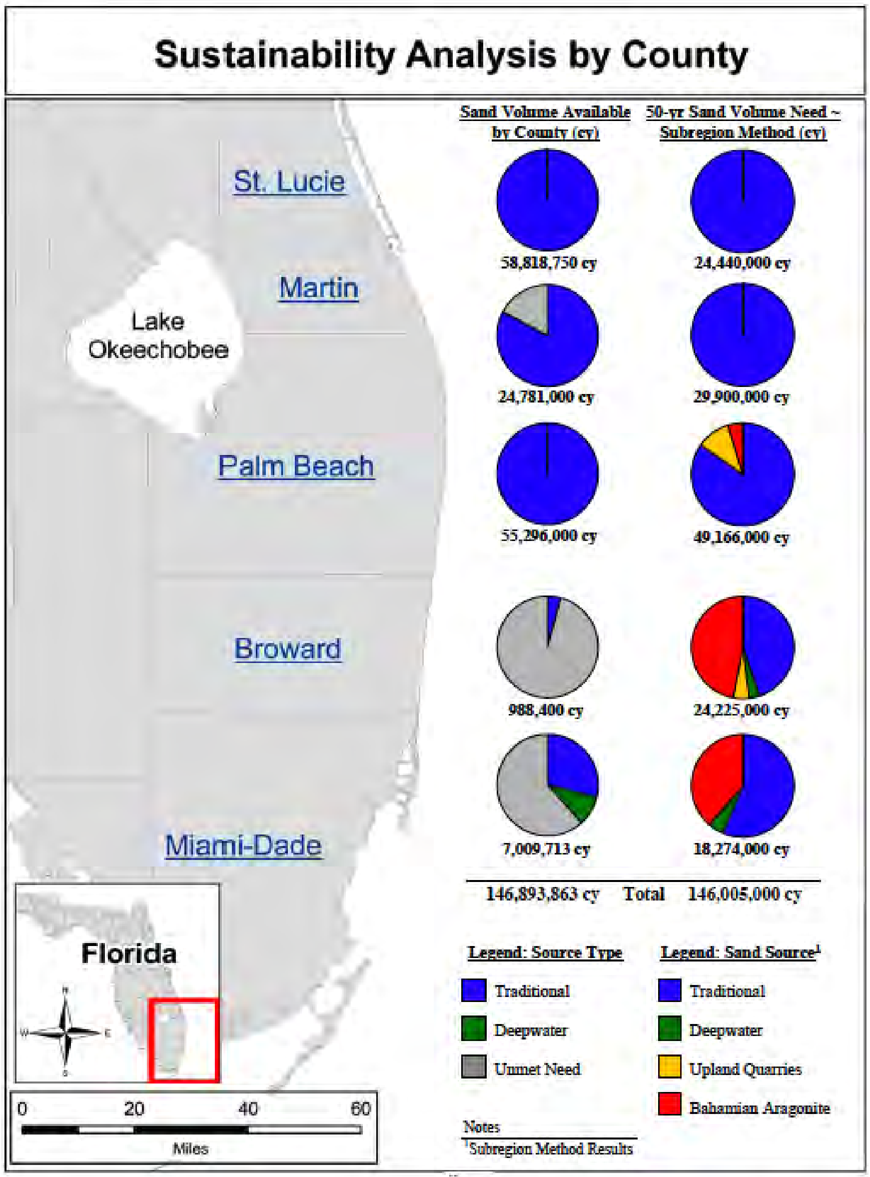


Figure 25: Sustainability analysis of beach sand in southeast Florida for the period 2009-2059 (USACE 2009).

3.2.2. Status of Southeast Florida Wetlands and Their Connectivity to the Southeast Florida Ecosystem

The southeast Florida region represents a continuous and connected coastal zone. Inland and coastal wetlands are an important component of the coastal zone, providing nutrients, shelter, and nursery habitats, among other benefits, to other ecosystems, including the region's coral reefs. The status of associated wetlands is discussed with a view to show that the historical development of the Everglades wetlands into reclaimed agricultural, industrial, and residential zones subsequent to statehood, has profoundly influenced contemporaneous conditions of coral reefs in southeast Florida. Here, the appropriate geographic scale is that of the South Florida environment, which consists of the headwaters of Kissimmee River-Lake Okeechobee, the Everglades and associated freshwater and coastal ecosystems. For consistency, wetlands within the jurisdiction of the four southeast Florida counties are highlighted where data is available while remaining cognizant of their connectivity with the larger coastal and offshore ecosystems.

Physiography and natural setting

South Florida's physiography is one dominated by wetlands. It features the Lake Wales Ridge west of the Kissimmee Lakes and River system, the Flatwoods, the Atlantic Coastal Ridge, the Big Cypress Swamp, the Everglades, the Mangrove and Coastal Glades, and the Florida Keys (McPherson and Halley 1996) (Figure 26). The Everglades in its pristine state was estimated to cover an area of about 3,860 mi^2 and has an indiscernible slope to the south, averaging less than 2 inches per mile) (Renken et al., 2005). Prior to drainage and canal building, overspill from Lake Okeechobee fed the Everglades so that water coursed slowly by sheetflow, forming a 30-mile wide (at its widest) and 250-mile long "river of grass" as it drained south to Florida Bay and the Gulf of Mexico (Figure 27A). During periods of high flow, waters also drained into the Atlantic Ocean through small rivers and seeped into Biscayne Bay.

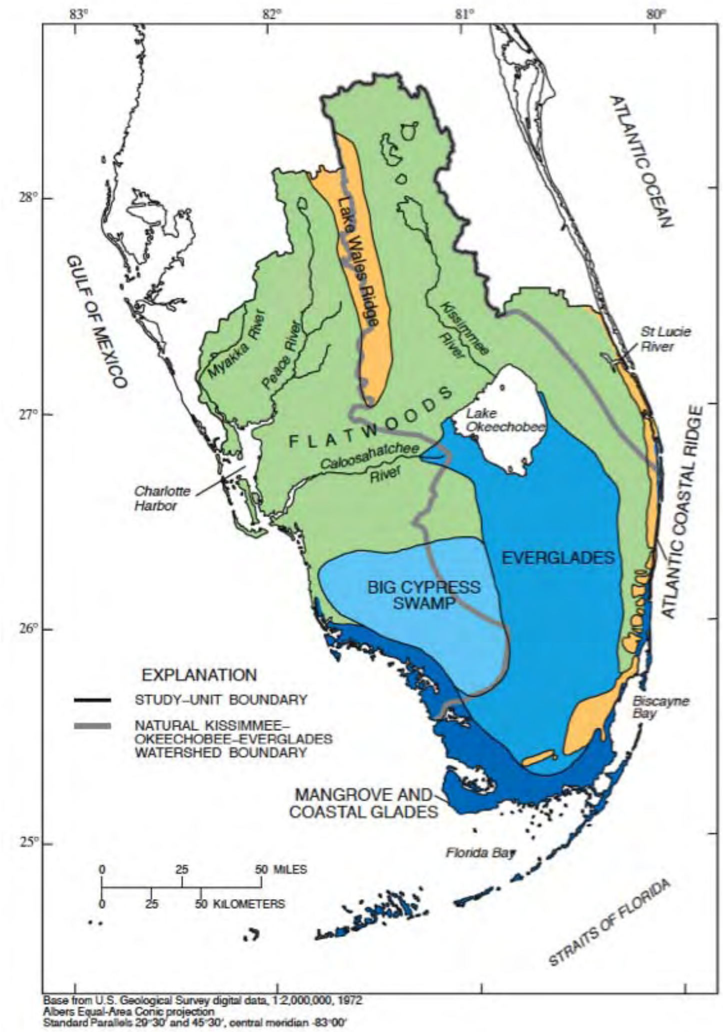


Figure 26: Physiography of the South Florida environment (McPherson and Halley, 1996).

Drying the wetlands

The current state of wetlands in southeast Florida is the cumulative effect of human-environment interactions in the South Florida environment. Controlling the flow of water through the vast expanse of the Everglades and developing the land it overlain for land-based economic activities seemed the logical way to conquer this wet frontier. Since statehood in 1845, political, economic, and social developments have shaped the region's ecology with far-ranging consequences. By 1850, the US Congress transferred all swamp and wetlands to the State, which, shortly thereafter, granted land leases to private citizens who undertook the drainage of wetlands. Thus, began the period of channelization of the Kissimmee-Okeechobee-Everglades watershed. The prospect of transforming an enormous wetland into productive farmland was a dream that fueled many prospectors to invest in drainage projects as capital investment for real estate business mainly for the farming sector.

Meanwhile, Henry Flagler pursued his vision to connect South Florida with his railroad network and to provide accommodations for the tourists he brought. With the completion of the Miami railroad in 1896, he seeded the development of a new economic base to the region – tourism – which became a significant driving force in urbanizing the southeast coast of Florida.

Efforts to drain Lake Okeechobee by the state during the turn of the century significantly contributed to the water deficit of the Everglades (Dovell, 1947). The construction of the North New River Canal (1906-1912), South New River canal (1906-1913), Miami Canal (1910-1913), Hillsboro Canal (1910-1915), West Palm Beach Canal (1913-1920), St. Lucie Canal (1916-1926), Lake Okeechobee South Shore Levee (1921-1926), Lake Okeechobee Levee (1932-1938), and the Tamiami Trail & Canal (1916-1928) all but isolated Lake Okeechobee from the northern Everglades. The Tamiami Trail further subdivided the Everglades into a north and south partitions, while connecting Miami with the Gulf of Mexico (Sklar et al., 1999).

When major flood events occurred after the wake of tropical storms in the 1920s, the state asked for federal assistance to control flooding. By 1930, the south shore of Lake Okeechobee was reinforced by the Hoover Dike. Massive inundation occurred again in the 1940s, and it became evident that a substantial initiative to control flows was necessary. The USACE was mobilized to undertake the Central and Southern Florida Project for Flood Control and Other Purposes (C&SFP). The systematic building of a network of canals, gates, water control structures and pumping stations, intended to partially divert the Everglades sheetflow to reclaim wetlands, control flooding and manage water for agriculture, began. From 1952 to 1973, the USACE built 720 miles of levees, 1000 miles of canals, 200 gates, and 16 pumping stations throughout the region (Walker and Solecki, 2004) (Figure 27B, Figure 28). The infrastructure built by C&SFP established six primary hydrologic units: Big Cypress, Lake Okeechobee, Water Conservation Area (WCA) 1, WCA-2, WCA-3, and the Everglades National Park (Sklar et al., 1999).

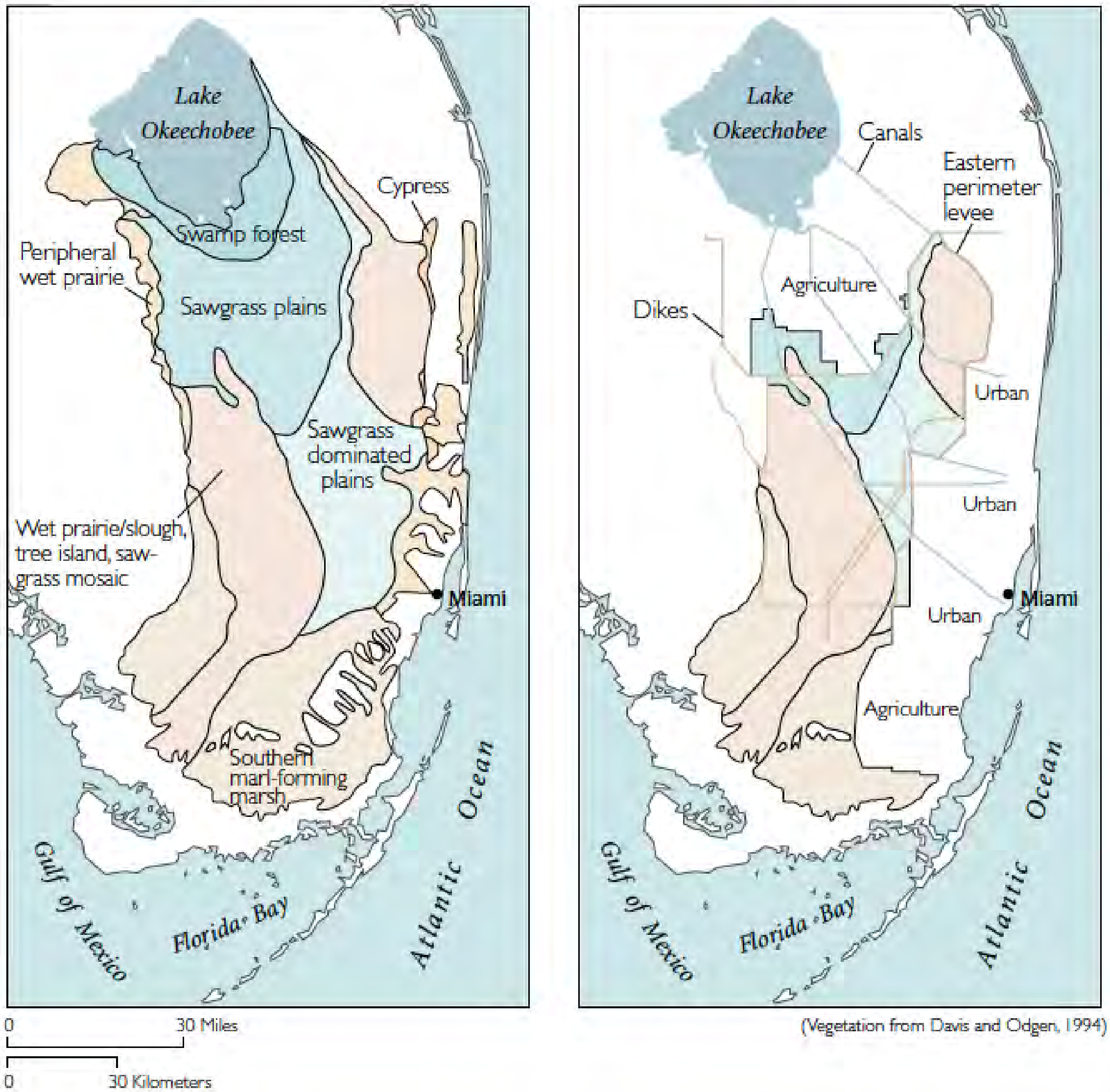


Figure 27: A) Vegetation pre-development (ca. 1900); B) Current Everglades vegetation (ca. 1990) (Ingerbritsen et al. 1999).

Between 1952 and 1973, the population in South Florida tripled from 800,000 to 2.5 million. Production of winter vegetables for domestic export grew. Sugar became a major crop. The federal government imposed a trade embargo on Cuba, which previously enjoyed a sugar trade quota with the US. Tourism was developing in parallel and became a driving force in urbanizing areas around the periphery of cosmopolitan Miami.

Today, the combined agricultural and urban corridor dominates the contemporaneous land and waterscapes of the region (Figure 27B) (Renken et al., 2005). Spatially, the partially reclaimed Everglades wetland system encapsulates the cumulative and dynamic anthropogenic forces that define the present-day ecological functionality of this wetland system.

Renken et al., 2005 and Walker (Solecki (2004) provide integrated biophysical and socioeconomic narratives, respectively, of changes in land use and their impacts on water and wetlands in the last century. Conversion of wetlands in the tri-county area peaked during 1953-1973, when slightly over 600,000 acres of natural areas became cropland (Table 1). From 1973-1988, the conversion of both natural and agricultural land to residential and commercial use actually outstripped that for tillage. By 1995, about 1.7 million acres of natural land was lost to agriculture and urbanization. Walker and Solecki (2004) surmise that the land use for 1988-1995 may have achieved a certain degree of stasis relative to the land use changes in the early 1900's. The future trajectory of South Florida land use will be determined by the need to generate economic revenues (especially in the midst of the 2007-08 recession), and the growing awareness and concern for ecosystems that provide invaluable goods and services to society (especially in the wake of a changing climate regime).

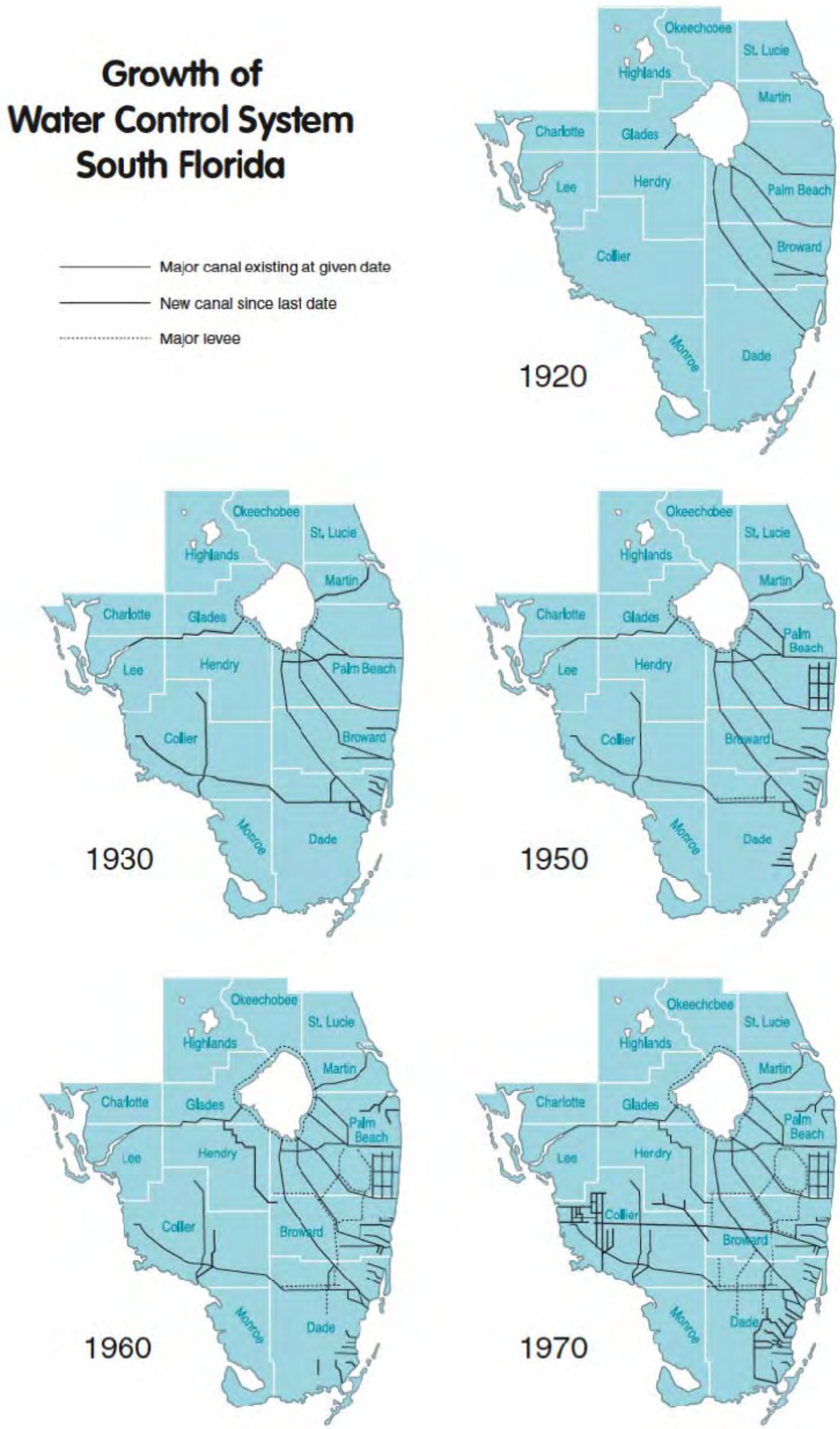


Figure 28: Development of the water control system in South Florida (Purdum, 2002).

Impacts of altered hydrology

The immediate hydrological impacts of the C&SFP were dramatic. About 890,000 acres of wetlands were converted to dry lands (Table 1). About 2.2 million acre feet of freshwater was channeled to the Atlantic Ocean or Gulf of Mexico, modifying the salinity regimes of receiving estuaries and resulting in diminished fisheries production, as well as reducing inflow contribution to the Biscayne Aquifer (DOI 1994). More significantly, the drainage works had disrupted the Everglades sheetflow and hydroperiod. Florida Bay, to the south, has become impoverished of freshwater and is negatively impacted by hypersalinity events.

Table 1. Land use changes in southeast Florida tri-county area (Palm Beach, Broward, and Miami-Dade counties), 1900 to 1995 (data from Walker and Solecki, 2004). Land cover conversions: Natural to Agriculture (N -> A), Natural to Urban (N -> U), Agriculture to Urban (A -> U) (in acres).

Land Use Changes	1900-1953	1953-1973	1973-1988	1988-1995	NET CHANGE 1900-1995
N -> A	375,106	602,937	112,433	41,514	Natural: - 1,678,341
N -> U	142,333	215,476	147,522	41,020	Agriculture: + 886,368
A -> U	0	56,340	144,062	45,220	Urban: + 791,973

<u>Reduced flows and diminished water quality</u>

Figure 29 compares pre-drainage flows with present-day flow patters (Ingerbritsen et al 1999). The compartmentalization of the Lake Okeechobee-Everglades wetland system virtually erased the regional scale sheetflow in the northern Everglades and greatly reduced the same in current location of the Everglades National Park (ENP). Pre-drainage estimated flow of the Everglades was about 2.3 million (M) acre ft. Water flow to the ENP for 2009 (a heavy rain year) is about 1.4 M acre ft, a 40% reduction of flow volume (Figure 30A) (SFWMD, 2010). During drought years such as in 2008, flow to the ENP was as low as 0.34 M acre ft, a mere 14% of pre-drainage flow.

The engineering of the Okeechobee-Everglades ecosystem altered not just flow volumes but water quality because of the land use change that prompted wetland drainage in the first place – conversion of wetland to farmland. Water of the natural wetland system had very low phosphorus content. With the establishment of the Everglades Agricultural Area south of Lake Okeechobee, which had the thickest peat soil enriched organically for highly productive agriculture, the enrichment of the once oligotrophic water began and persists today. Figure 30B shows inflow and interior mean P concentrations for 2009. Compared to natural flow concentrations of 5-10 ppb total phosphorus (TP), the load of the inflows into water conservation areas are 2.5X pre-development loads. The ENP has close to natural concentrations and pass the TP criterion of 10 ppb set for the Everglades Protected Area by Chapter 62-302.540 F.A.C. (SFWMD, 2010). The SFWMD predicts that enriched soils within the impacted areas of the Water Conservation Areas (WCA's) will affect water quality for decades, making the restoration of water quality a daunting challenge (SFWMD, 2010).

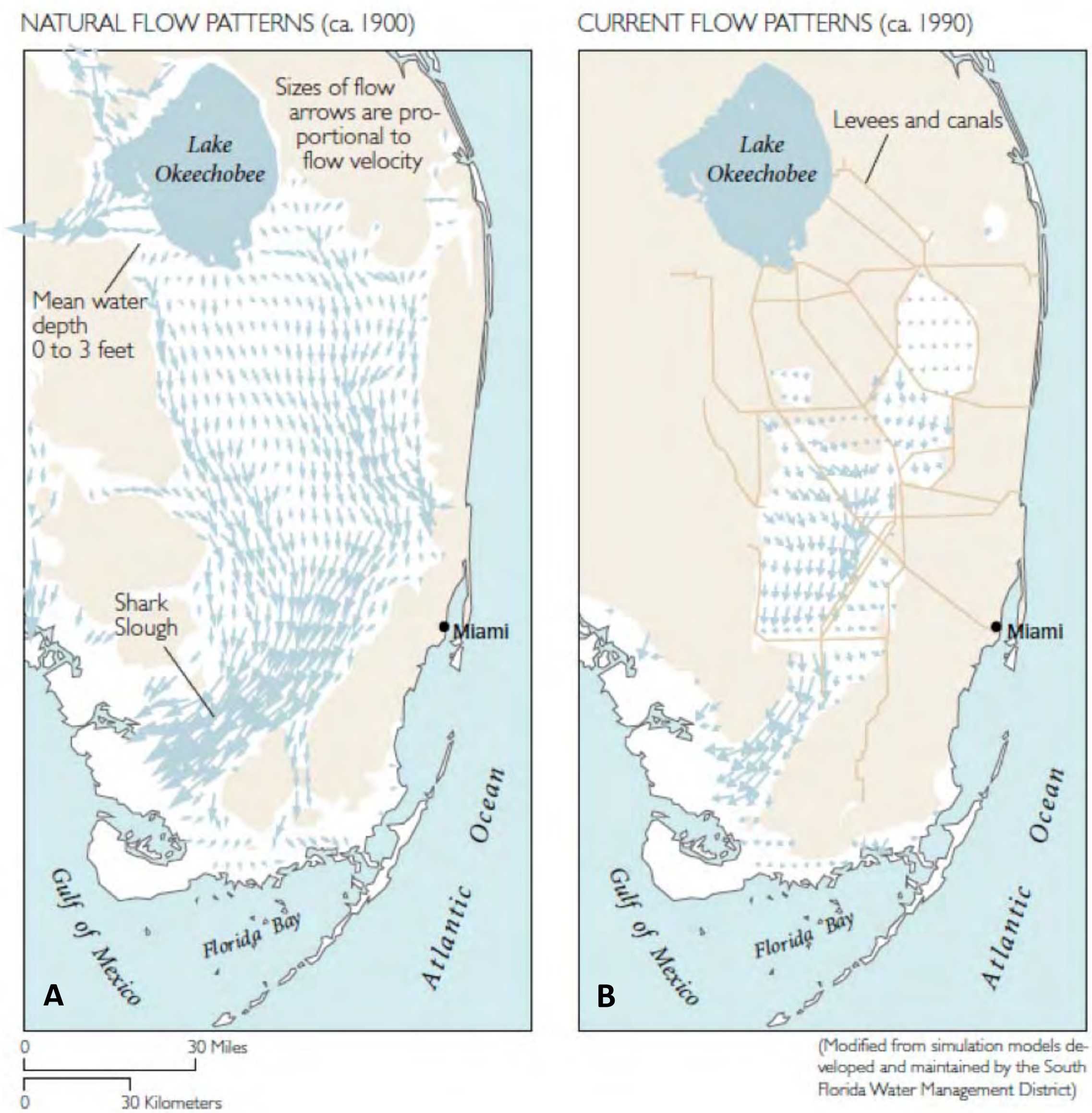


Figure 29: A) Natural flow patterns (ca. 1900). B) Current flow patterns (ca. 1990) (Ingerbritsen et al., 1999).

WATER FLOW (ACRE-FEET IN THOUSANDS)

	Water Year 2009*	Water Year 2008
1. Lake Kissimmee Outflows	495	302
2. Lake Istokpoga Outflows	289	31
3. Lake Okeechobee Inflows	2,091	1,013
4. Lake Okeechobee Outflows	1,141	177
5. St. Lucie Canal Inflows	173	14
6. St. Lucie Canal Outflows	165	0
7. Caloosahatchee Inflows	376	42
8. Caloosahatchee Outflows	1,016	87
9. Water Conservation Area 1 Inflows	336	243
10. Water Conservation Area 1 Outflows	335	214
11. Water Conservation Area 2 Inflows	906	488
12. Water Conservation Area 2 Outflows	737	512
13. Water Conservation Area 3 Inflows	1,212	798
14. Water Conservation Area 3 Outflows	1,556	246
15. Everglades National Park Inflows	1,393	343

* Water Year 2009 flows are reflected on map

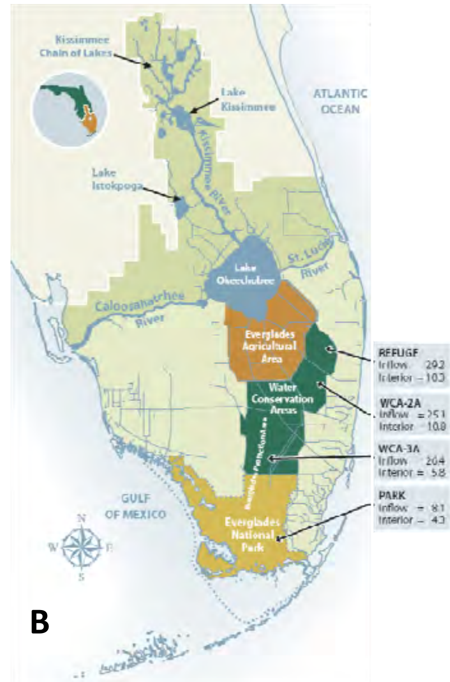


Figure 30: A) Year 2009 water flows (1000 acre-feet) along the Kissimmee-Okeechobee-Everglades watershed. B) Water year 2009 mean phosphorus concentrations (ppb) (inflows are flow-weighted mean concentrations, interiors are geometric mean concentrations) (SFWMD, 2010).

<u>Pollutants</u>

Pesticides from agriculture and polychlorinated biphenyls from industrial use remain as environmental concerns in the modern-day wetland system. A recent addition is mercury, which was first reported to be present in elevated concentrations in ENP biota (Ogden, 1974). The highly bioaccumulative form of mercury is methylmercury, a neurotoxic compound which threatens humans and wildlife that consume Everglade fish. Sulfur, in the form of sulfate, hastens the methylation of mercury; as sulfate or sulfite it affects the cycling of a number of elements including phosphorus; and as sulfide is toxic to aquatic biota (Gabriel et al., 2010).

Mercury concentrations in lower trophic level fish species inhabiting the WCAs has decreased substantially from high levels in the late 1980s to the early 1990s. However, this is not the case for largemouth bass, mercury level for which remain above the proposed US Environmental Protection Agency (EPA) human health criterion for fish consumption for methyl mercury of 0.3 micrograms per gram.

The source and transformations of mercury remain to be elucidated. Accumulation of mercury in sediments indicates a five-fold increase since 1900 through atmospheric deposition (Rood et al., 1995). Fish-eating freshwater fish, alligators, wading birds, and panthers have all been found to bioaccumulate mercury in their tissues (USFWS, 1999). The 50-yr decline in the numbers of wading birds may be a result of mercury poisoning (USFWS, 1999).

Implications to present-day wetland permitting in southeast Florida

The analysis above indicates that drastic ecological changes for wetlands were driven by turn of the 20th century drainage for agriculture, and mid-20th century actions to further develop marshes to productive land uses as necessary to induce human migration. Walker and Solecki (2004) indicate that conversion rates may have stabilized for the period 1988-1995. Brody et al. (2008) update this trend in their analysis of federal wetland permitting in Florida and Texas for the period 1991 to 2003. Within this period, they show the most intense wetland development took place between 1994 and 1997. For Florida, the federal wetland alteration permits were concentrated in coastal urban areas, particularly in southeast Florida from West Palm Beach to Miami-Dade, as well as the Florida Keys. About half of the permits issued in Florida were located within the 100-year floodplain.

In Florida, an average of 2,111 federal permits were granted per year for the 13-year period of study, mostly in coastal urban areas of southeast Florida. The study could not ascertain the total number of wetlands impacted, but the Individual Permit type alone accounts for conversion of 2,000 acres. Under federal guidelines, contemporary wetland alteration should include compensatory mitigation at a ratio of at least 2:1. However, there is mounting evidence that created wetlands do not necessarily function the way natural wetlands do, so that they do not replace the functionality of destroyed natural wetlands. Often, compensatory mitigation only takes into account acreage and does not stipulate for the monitoring of created wetland functionality over time as a permit compliance condition. Kentula et al. (1992) provides strong evidence that less functional wetlands such as depression wetlands were being created to mitigate the loss of ecologically complex wetland types. In addition, the hydrological disconnect between impact and compensatory mitigation sites is not seriously considered in setting mitigation conditions for permitting. A final point is the high density of permits granted within the 100-year floodplain that would result in the increase of built-up surfaces, further exacerbating flood damage because of a diminished ability of the impervious grounds to absorb and store water runoff. The current analysis of state issued environmental permits on wetland alteration shows an added overlay of anthropogenic pressure. The unabsorbed runoff over built up surfaces contributes to nutrient and sediment loading of adjacent coastal systems such as estuaries, seagrass beds, and coral reefs. The current permitting system must be cognizant of the critical need to protect remaining natural wetlands, and where possible impose stringent mitigation conditions to minimize further attrition of their cover.

The historical legacy of wetland modification and hydrological alteration in south Florida to favor land use for agriculture, industry, and human habitation, continues to put in jeopardy the surrounding coastal ecosystem including coral reefs. The estuarine areas such as Biscayne Bay and Florida Bay suffer from degraded water quality and grossly altered salinity regimes. Remaining fragmented wetlands inefficiently filters nutrients and pollutants. In addition to those conveyed directly through sewage outfalls (see below), eutrophication poses real threats to corals reefs.

3.2.3. Status of Southeast Florida Coral Reefs

Geomorphological setting

Coral reefs in the southeast Florida region are the northern extension of the Florida Reef Tract, spanning the distance from Monroe County to Martin County as parallel and discontinuous reefs (Collier et al., 2008) (Figure 31A, B). In general, these high-latitude reefs are structured as three shore-parallel tracts: the inner reef crests at 3-4 m depth, the middle reef at 6-8 m, and the outer reef at 15-21 m. Inshore of the inner reef consists of a series of shallow, discontinuous ridges, hardbottom areas, patch reefs, and worm reefs (*Phragmatopoma* spp.), known as the Inner Ridge Complex.

The reefs and hardbottom areas in this region support a rich and diverse biological community including abundant octocoral, macroalgae, zoanthid, stony coral, and sponge assemblages (Collier et al., 2008). The southeast Florida coral reefs are subject to many anthropogenic stressors due to their proximity to major urban centers, coastal development, and land-based pollution, as well as from commercial and recreational activities.

<u>Coastal Construction Related Threats</u>

<u>Nutrient loading</u>

As discussed in the preceding section, drainage canals built in the early 20th century, including those that empty into the Atlantic coast, continue to transport nutrient-enriched water as it flows through the Everglades Agricultural Area. In addition, runoff from coastal urban settlements on the floodplains, laced with unabsorbed fertilizer from manicured lawns and golf courses, provide nonpoint sources of nutrients. This runoff impacts coastal ecosystems including seagrasses and coral reefs.

Until 2009, no long-term water quality monitoring programs existed in the southeast Florida region. Despite this, significant studies provide unequivocal evidence of the role of manmade sources degrading southeast Florida reefs. Lapointe et al. (2005a, 2005b) showed that macroalgal blooms of *Codium isthmocladium,* evident since the early 1990s, occurred in response to persistent nutrient enrichment in various sites in the southeast Florida region. Examining elemental ratios in *C. isthmocladium* tissues, they found southeast Florida populations to be nitrogen (N) limited compared to the other populations in the Caribbean (Figure 32). As such, low-level enrichment of ammonia from secondarily treated effluents can trigger bloom responses. Using $\delta^{15}N$ signature in macroalgal tissues, Lapointe et al. (2005b) demonstrated that macroalgae, some of which were invasive species, were assimilating sewage nitrogen from point sources such as ocean outfalls and injection wells, as well as nonpoint sources such as sewage leachates flowing through submarine groundwater discharges. The authors point to six ocean outfalls (Delray Beach, Boca Raton, North Broward, Hollywood, North Dade, and Central Dade) that supply 1.5 billion liters per day of ammonia-enriched (approx. 900 μM) secondarily treated effluents into the region's coastal waters. On April 30, 2008, the state legislature passed the Wastewater Disposal Bill (HR 7139 and SB 1302), which stipulates that wastewater should meet higher standard requirements of Advanced Wastewater Treatment by 2018 and to recycle at least 60% of wastewater by 2025. The law also stipulates that new ocean outfalls will not be built, nor old ones expanded, after the 2025 date. Use of the Delray Beach sewage outfall ceased on March 31, 2009.

A

B

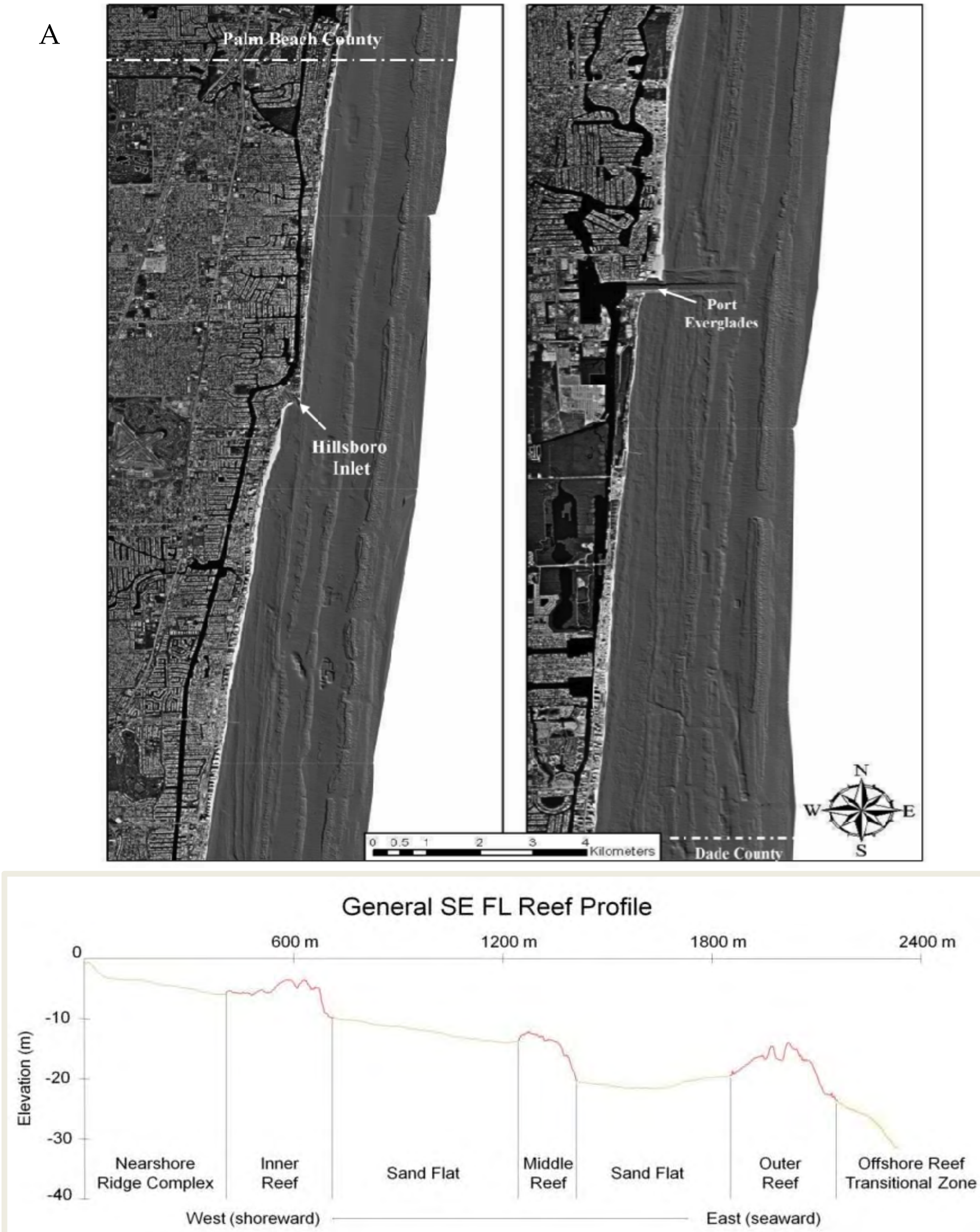


Figure 31: (A) The coral reefs off southeast Florida consist of three linear shore-parallel tracts with an inshore series of shallow, discontinuous ridges, shown here in a laser airborne depth sounding map of Broward County (map from Ferro et al. 2005). (B) A cross section of the Florida Reef Tract off central Broward County (R. Dodge in Andrews et al., 2005).

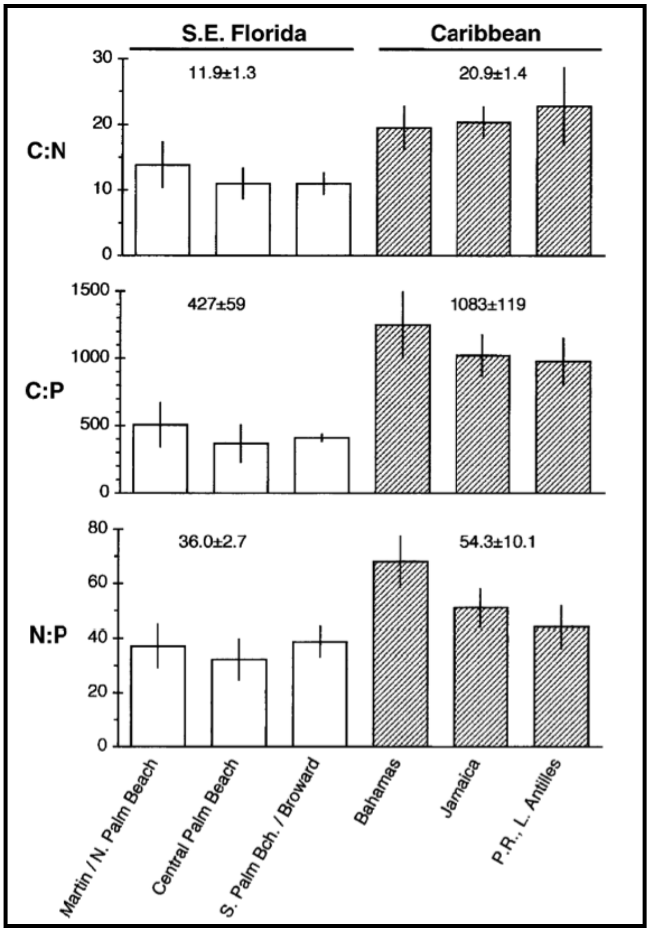


Figure 32: Tissue elemental ratios of *Codium isthmocladium*, a macroalgae that grows in reef areas in the Caribbean (n = 3-12). In comparison to populations in the wider Caribbean, those in southeast Florida are N-limited, and would bloom under conditions of continued exposure to enriched-N sewage effluents (Lapointe et al., 2005).

Given the rapidly increasing population of the region, the volume of sewage production will only increase and major changes in treatment and disposal sites will have to be made to reverse current trends. This, in addition to commercially and recreationally overexploited resources, natural nutrient inputs from upwelling and tidal bores (Leichter et al., 2003), and coastal development, results in the degradation of the southeast Florida coral reef ecosystems.

<u>Sedimentation from beach fill</u>

Beaches in southeast Florida are critical assets for the region's tourism industry. The beaches are periodically re-nourished because of chronic erosion and, while permits have been granted for these projects, their cumulative environmental impacts remain poorly studied and documented in the peer-reviewed scientific literature. Erosion from beach fill activity has long been suspected to contribute significant sediment load to coastal waters in the southeast region, threatening benthic communities including coral reefs. Jordan et al. (2010) detail sedimentation patterns before, during, and after the implementation of a large-scale beach nourishment project in Broward County. The nourishment project was conducted from May 14, 2005 to February 8 2006. A total of 1,837,600 cy of sand obtained from offshore sand borrow areas of Broward County was placed on four major county beaches (205,200 cy on Hallandale Beach, 999,700 cy on Hollywood Beach, 87,7000 on Dania Beach, and 545,000 cy on the beach at John U. Lloyd State Park). The study shows that significantly elevated sediment collection rates were obtained during construction activity that lasted for 10 months (Figure 33). A comparison of pre-, during-, and post-construction sediment collecting rates by benthic community (nearshore hardbottom, middle and outer reef) shows the elevated sediment collection rates during construction (Figure 33). The sediment collection rates appear to persist post-construction in the middle and outer reefs as shown in Figure 34. Only medium-term to long-term monitoring studies might be able to resolve the question of whether the degree of exposure to elevated sediment load from sediment activities during beach nourishment presents a threat to coral reefs. More importantly, the nature of the fill sediments may be a potential threat. Inferior sediment fill that easily erodes with wave turbulence fragments to fine silt that can smother sensitive filter feeders including corals (Wanless and Maier, 2007). Given the huge volume of fill used in the project, the amount of fine sediments that could be generated is sufficient to bury nearshore hardbottom communities and smother those in the outer reefs.

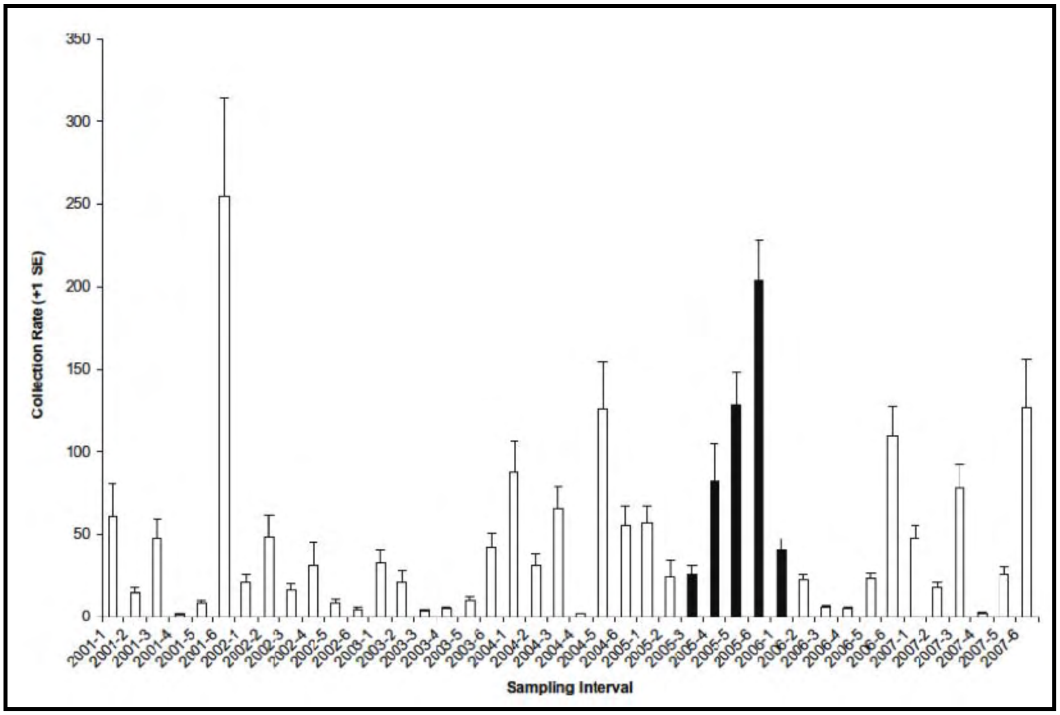


Figure 33: Mean collection rate (mg/cm2/day) for each sampling interval (pooling all sites). Black bars indicate during-construction intervals (Jordan et al., 2010).

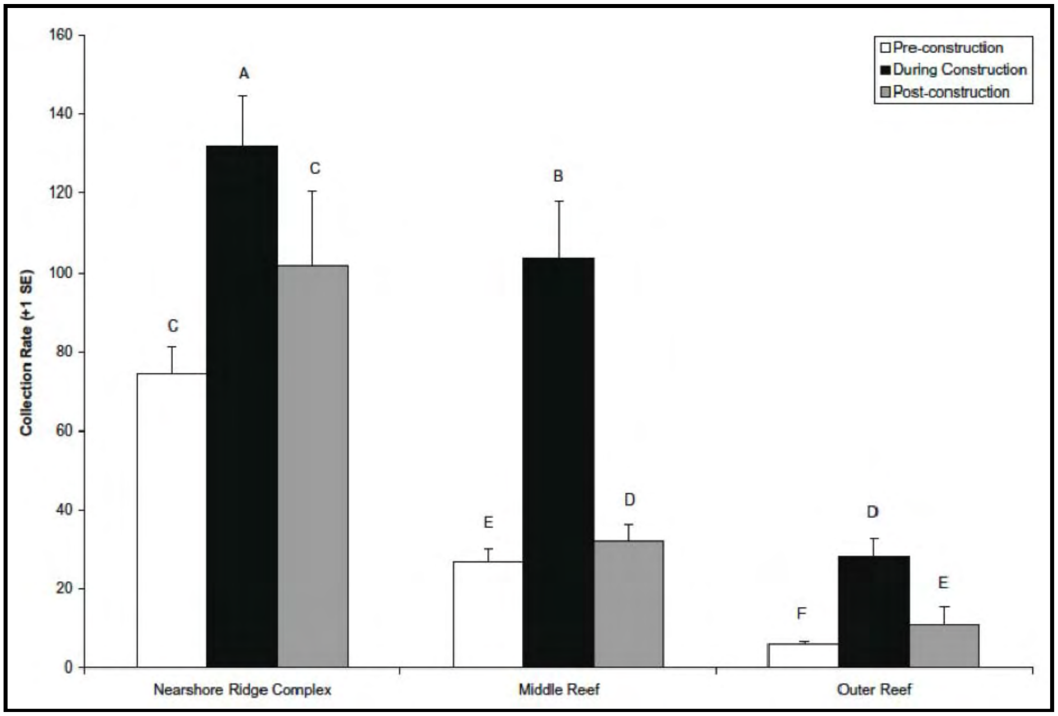


Figure 34: Comparison of collection rate (mg/cm2/day) for pre-, during- and post-construction times. Different letters indicate significant difference ($p < 0.05$ using Tukey HSD) (Jordan et al., 2010).

Lindeman and Snyder (1999) document the impacts of beach fill that buried nearshore hardbottom communities in Carlin Park during a beach restoration that occurred during the period March-April 1995, about 10 months into their 27-month study in Jupiter, Palm Beach County. Using mean number of individuals and average number of species per transect as metrics, they compared nearshore hardbottom fishes in a control site (Coral Cove) and the impact site in Carlin Park. The mean numbers of species decreased from 7.2 to less than 1 species per transect, and from 38 individuals to less than 1 individual per transect after burial event (Figure 35). Lindeman and Snyder (1999) documented that the majority of fish displaced by burial are early life stages of exploited and ecologically important species, which become vulnerable to predators when remaining unsettled in proximity to buried habitats. Because of behavioral fidelity to natal sites, these are prone to high predation levels.

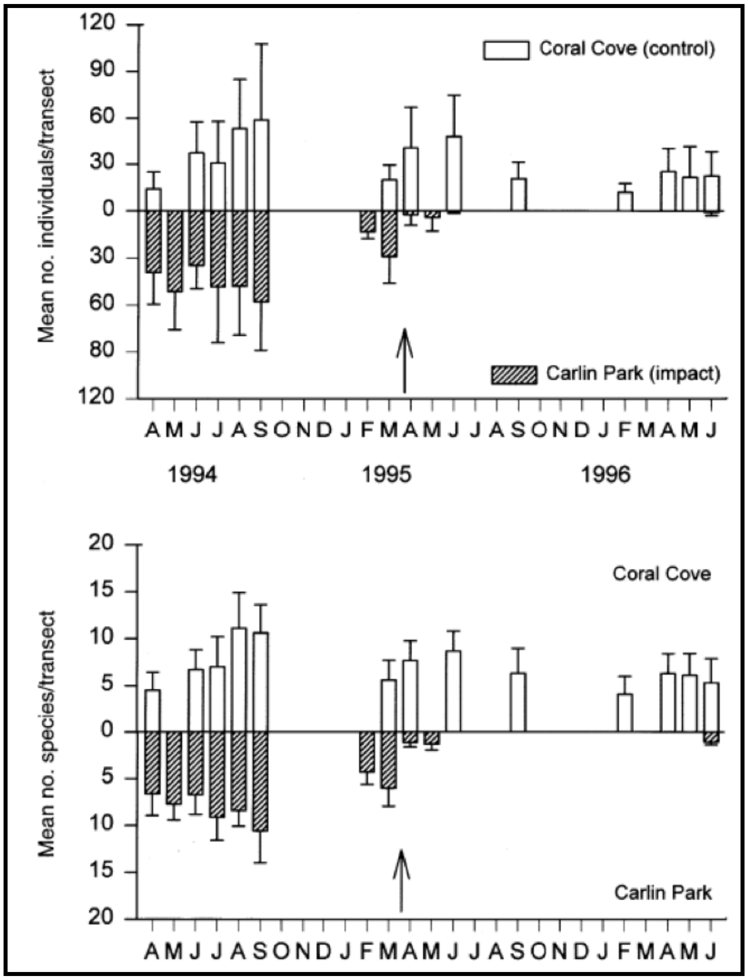


Figure 35: Mean numbers of individuals and species at control and impact sites in Jupiter, Palm Beach County, FL. Arrows show the timing of burial of hardbottom reef (Lindeman and Snyder, 1999).

Prognosis

The coral reefs of southeast Florida represent the northern most extension of coral reef development in the continental US. These are also immediately adjacent to a rapidly urbanizing region that is generating massive pressure on its coastal ecosystems. The major challenge is that there are insufficient baseline studies against which to measure short and long-term effects of indirect, direct, and cumulative impacts. The FDEP Coral Reef Conservation Program and the Southeast Florida Coral Reef Initiative (SEFCRI) are working to increase the knowledge of the region's coral reef ecosystems, but the current state of information is still inadequate, and the pressures are, by all indications, increasing at an accelerated rate. Both historical and contemporaneous coastal development continues to unload residuals on coastal waters including sediments, nutrients, and pollutants that threaten coastal ecosystems including coral reefs.

3.3. Trends Derived from Agency and Geo-Referenced Permit Databases

Trends were derived from two main sources: 1) agency databases for each of the major permit types (FDEP, BBCS, and FDEP SED provided for the CCCL permit, and JCP programs, and the ERP program, respectively), which provided summary and permit sub-type data and frequency of permit activity; and 2) the project, geo-referenced permit database from this project, which provides detailed data on permit types and sub-types, permitted impacts and mitigation, and differences between permitted activities across counties. For each permit type considered (i.e., CCCL, ERP, and JCP), summary trends were first derived from the agency database and detailed trends were then derived from the geo-referenced permit database.

The following figures (Figures 36-39) show the distribution of all permits (CCCL, ERP, and JCP) in each of the four counties. As should be expected, the distribution demonstrates the waterfront or coastal nature of CCCL and JCP projects; by contrast, ERP projects were located both along the coastlines and uplands within each county. In certain counties, ERP projects formed clusters as a result of planned development. For example, Jupiter Farms, a planned community in northwestern Palm Beach County, created an ERP cluster. In other regions, such Martin County, ERP distribution was almost wholly coastal or in close proximity to water bodies; by contrast, ERP distribution included more inland projects in the lower three counties.

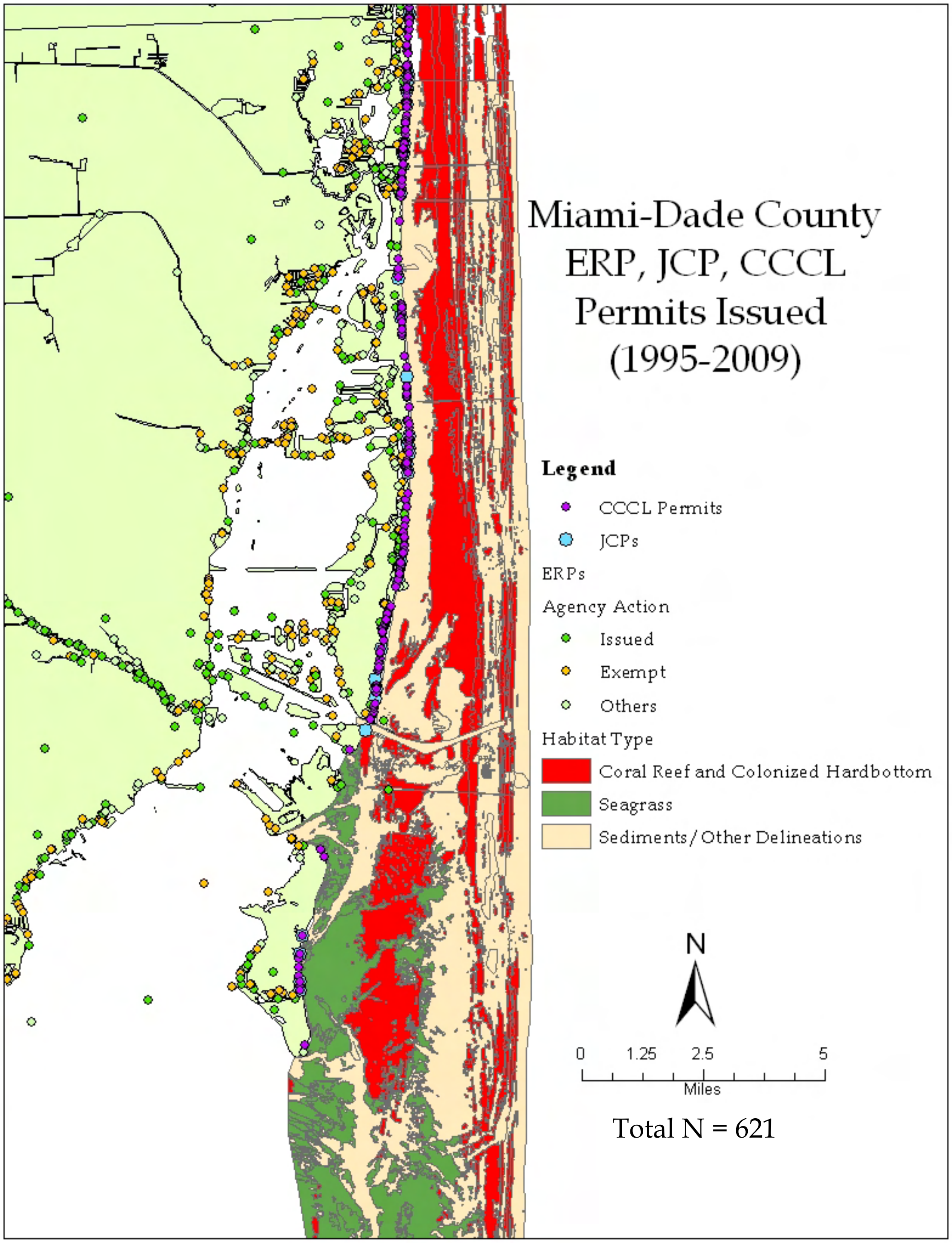


Figure 36: Miami-Dade County total permits issued from 1995-2008.

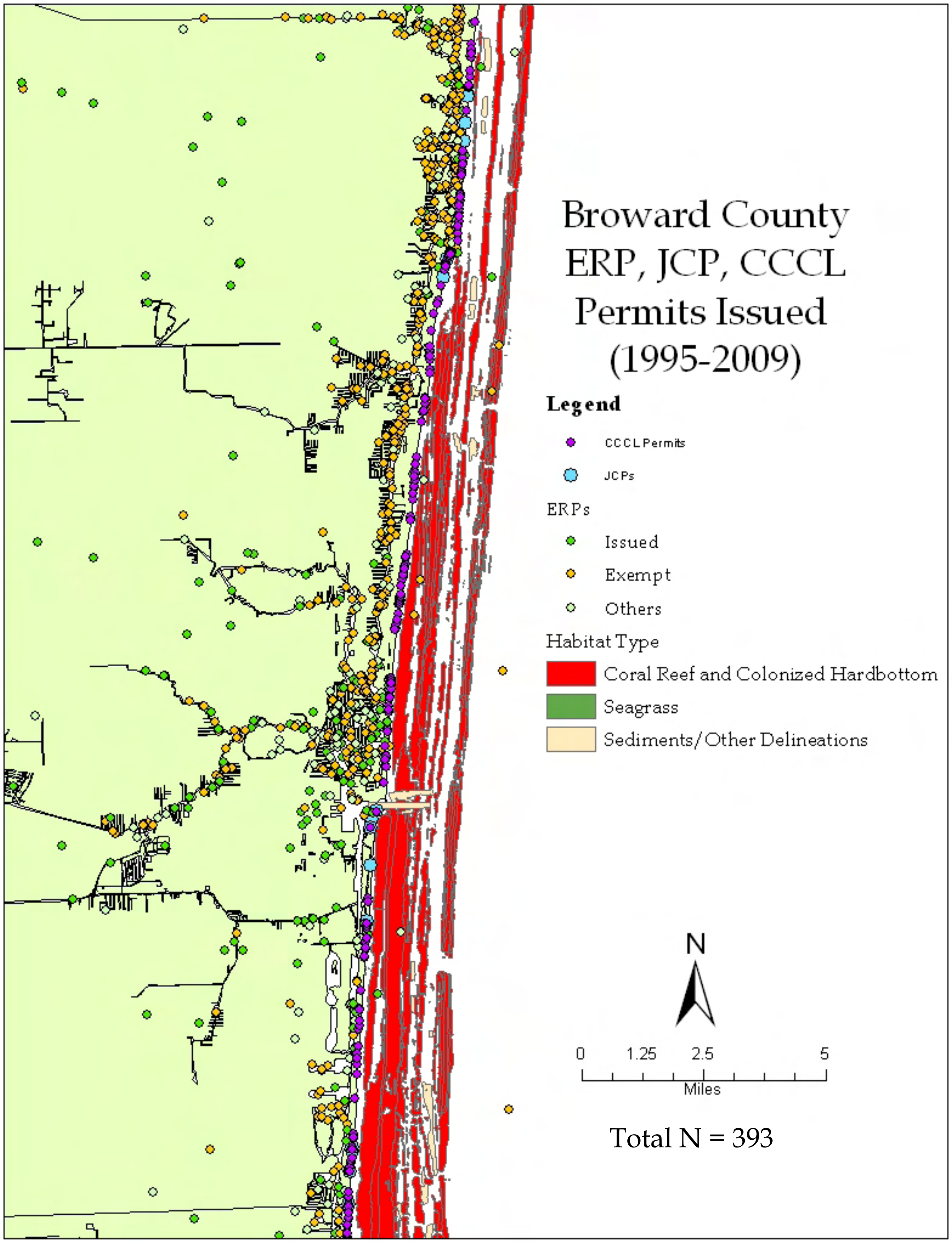


Figure 37: Broward County total permits issued from 1995-2008.

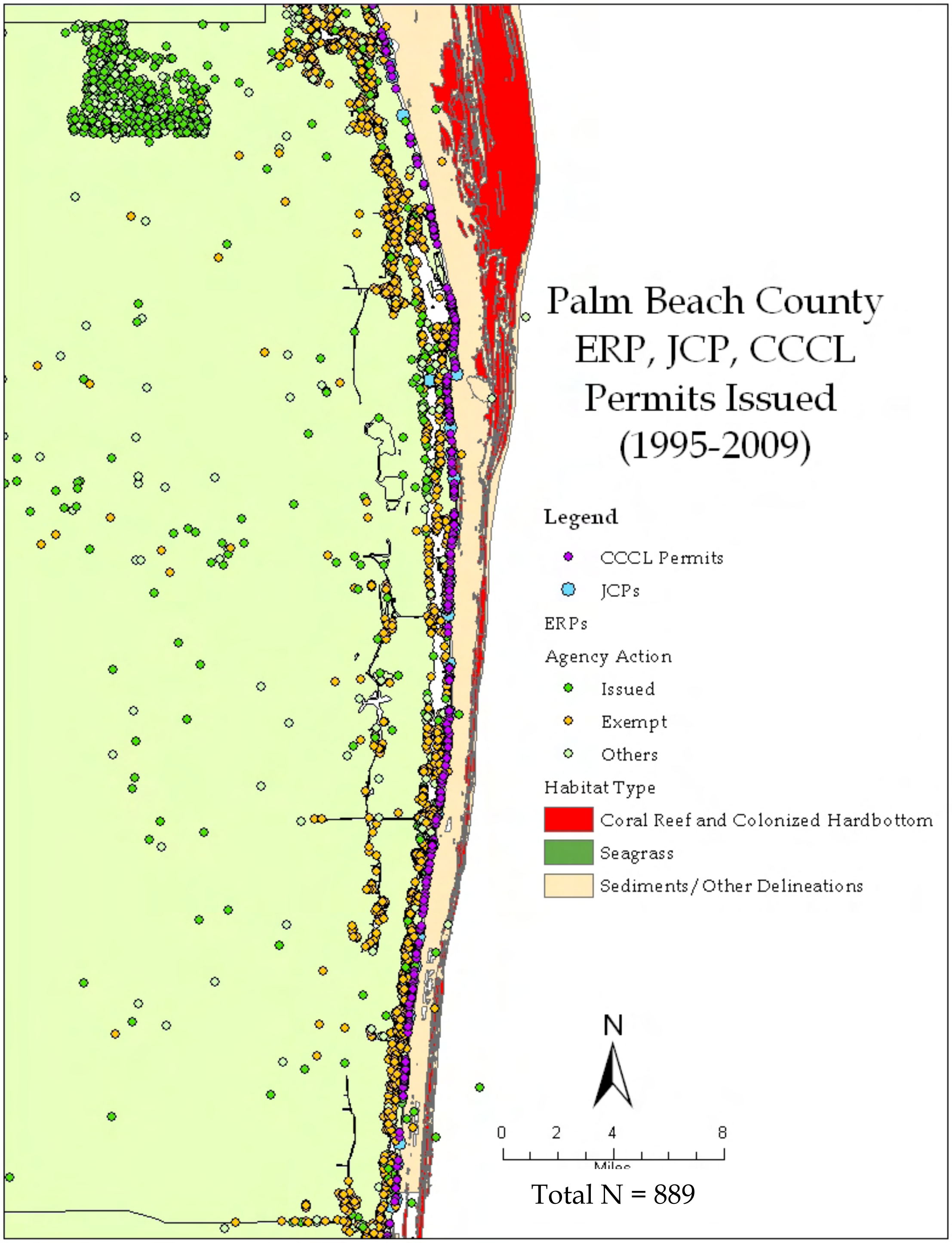


Figure 38: Palm Beach County total permits issued from 1995-2008.

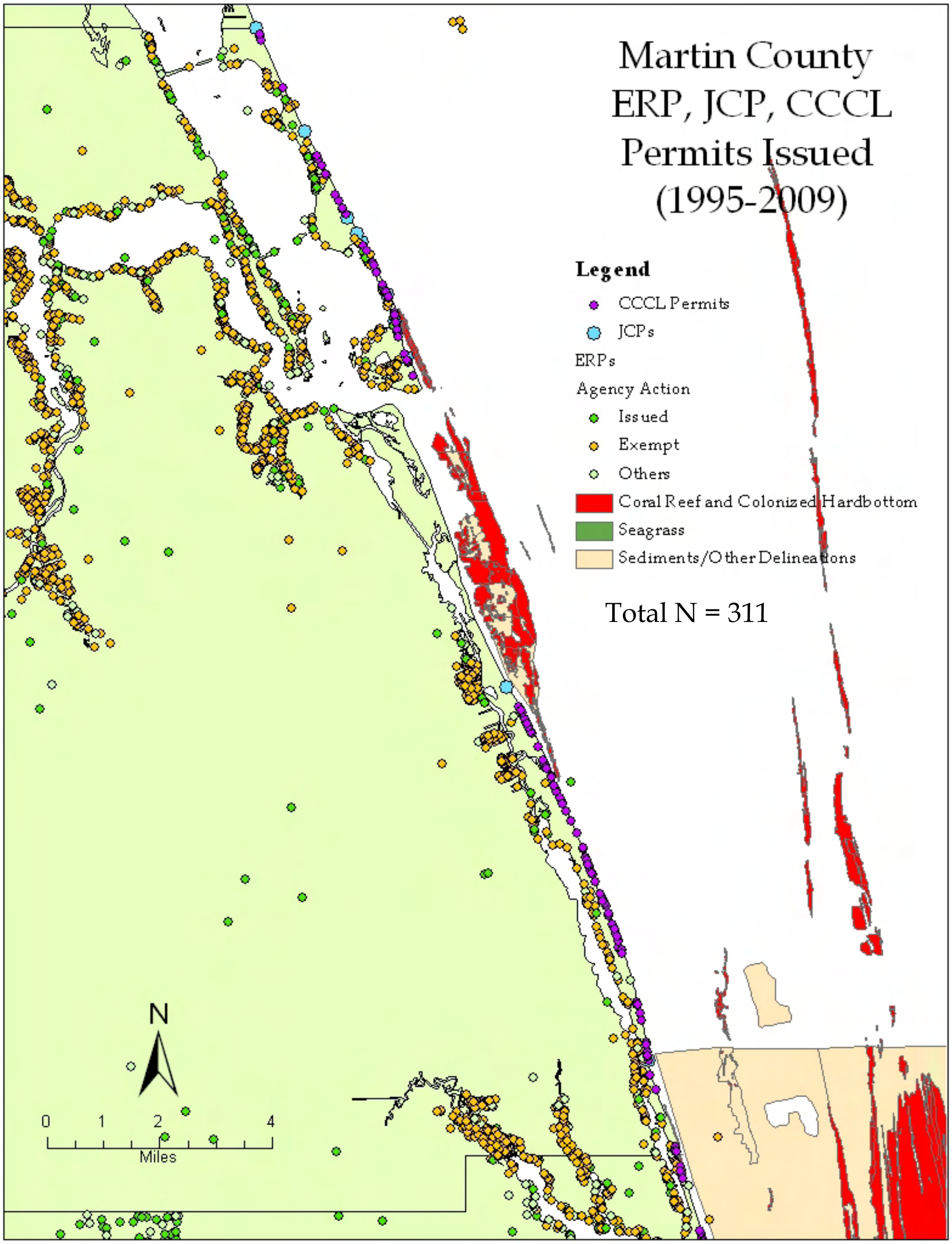


Figure 39: Martin County total permits issued from 1995-2008.

When considered by FDEP range monument distribution, The total number of permits showed discrete monuments in which permits were more frequently issued than in others (Figure 40). This was again due mostly to the high concentration of ERPs in northern Palm Beach County and a cluster of ERPs in and around downtown Miami in Miami-Dade County. Coastal development seaward of the CCCL was more evenly distributed across monuments, with certain ranges containing coastal protected areas (ex. Hobe Sound National Wildlife Refuge) containing little to no CCCL permit activity (Figure 41).Parts of central Martin County also had high concentrations of total permits, due to the large number of ERPs issued there (Figure 42). The highest concentration of CCCL permits was located within the southern three counties and especially in northern and central Miami-Dade County along the barrier islands. Finally, JCPs were the least frequently issued of the three permit types and thus were the least concentrated across the region (Figure 43). Figures 44-47 show the locations of range monuments within the area.

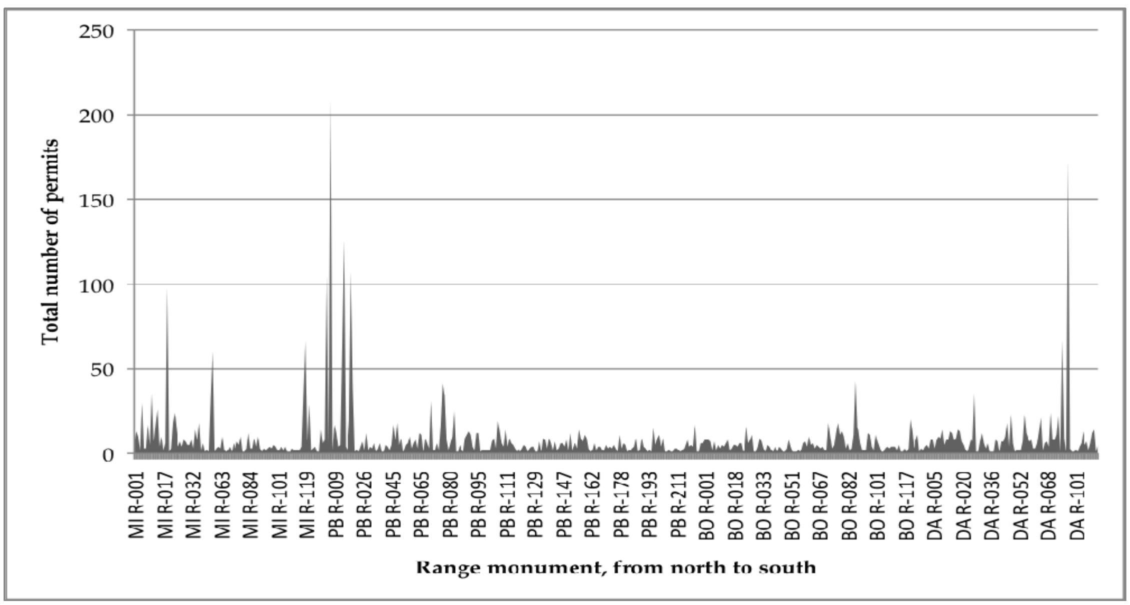


Figure 40: Total permits issued from 1995-2008, by range monument from north to south.

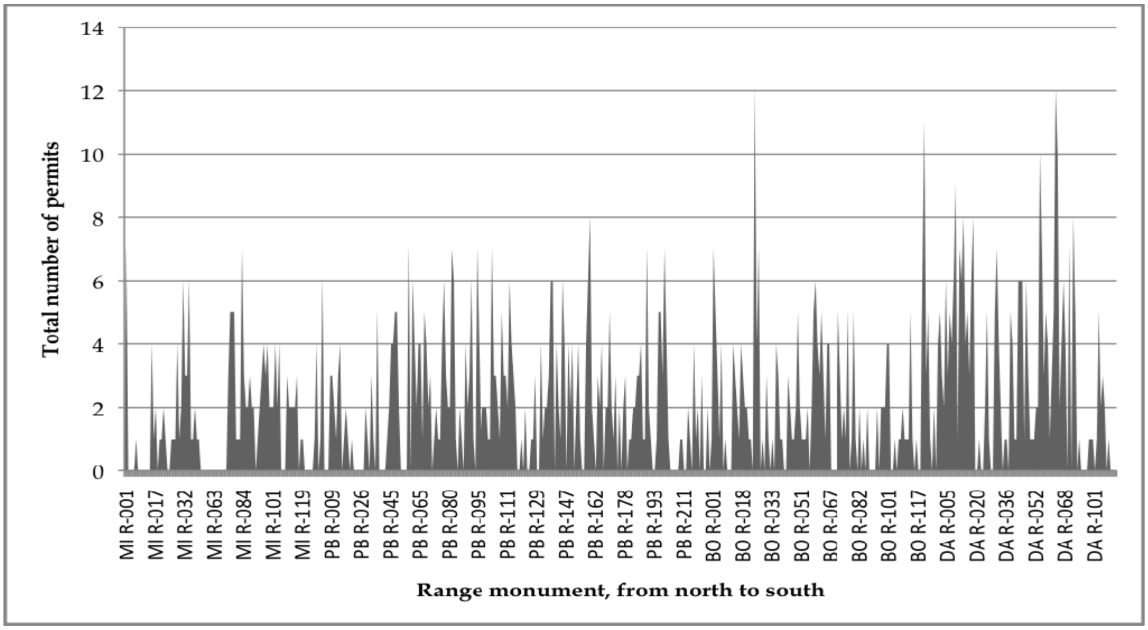


Figure 41: Total CCCL permits issued from 1995-2008, by range monument from north to south.

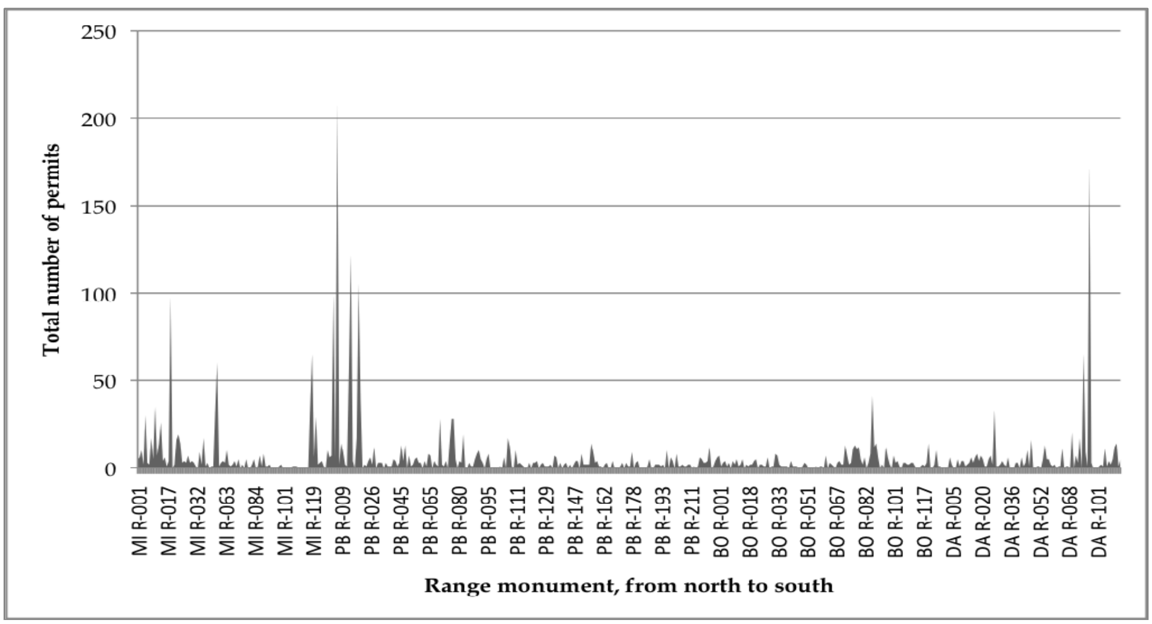


Figure 42: Total ERPs issued from 1995-2008, by range monument from north to south.

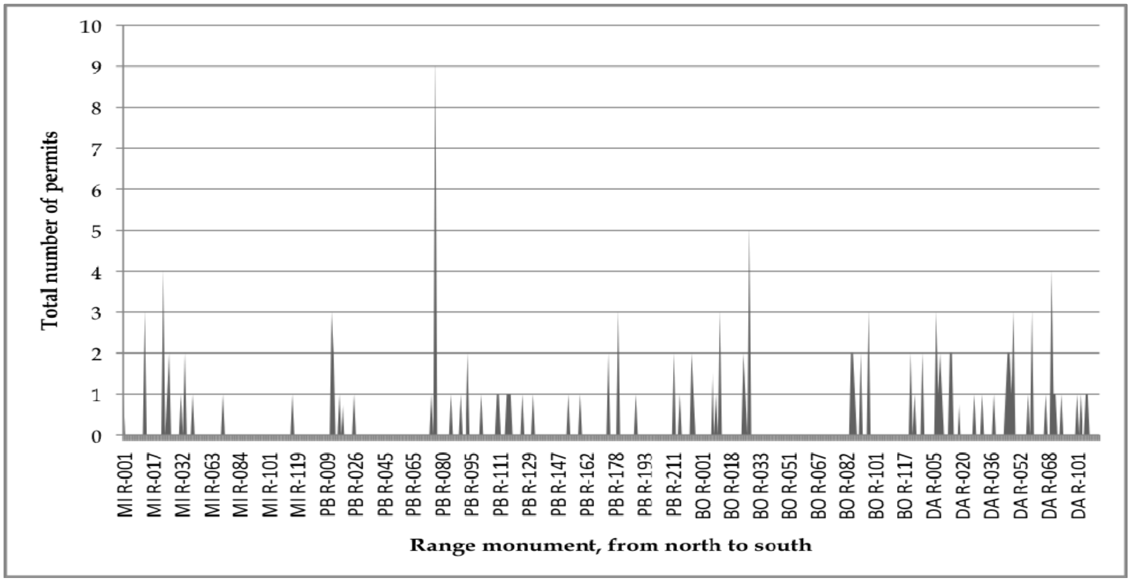
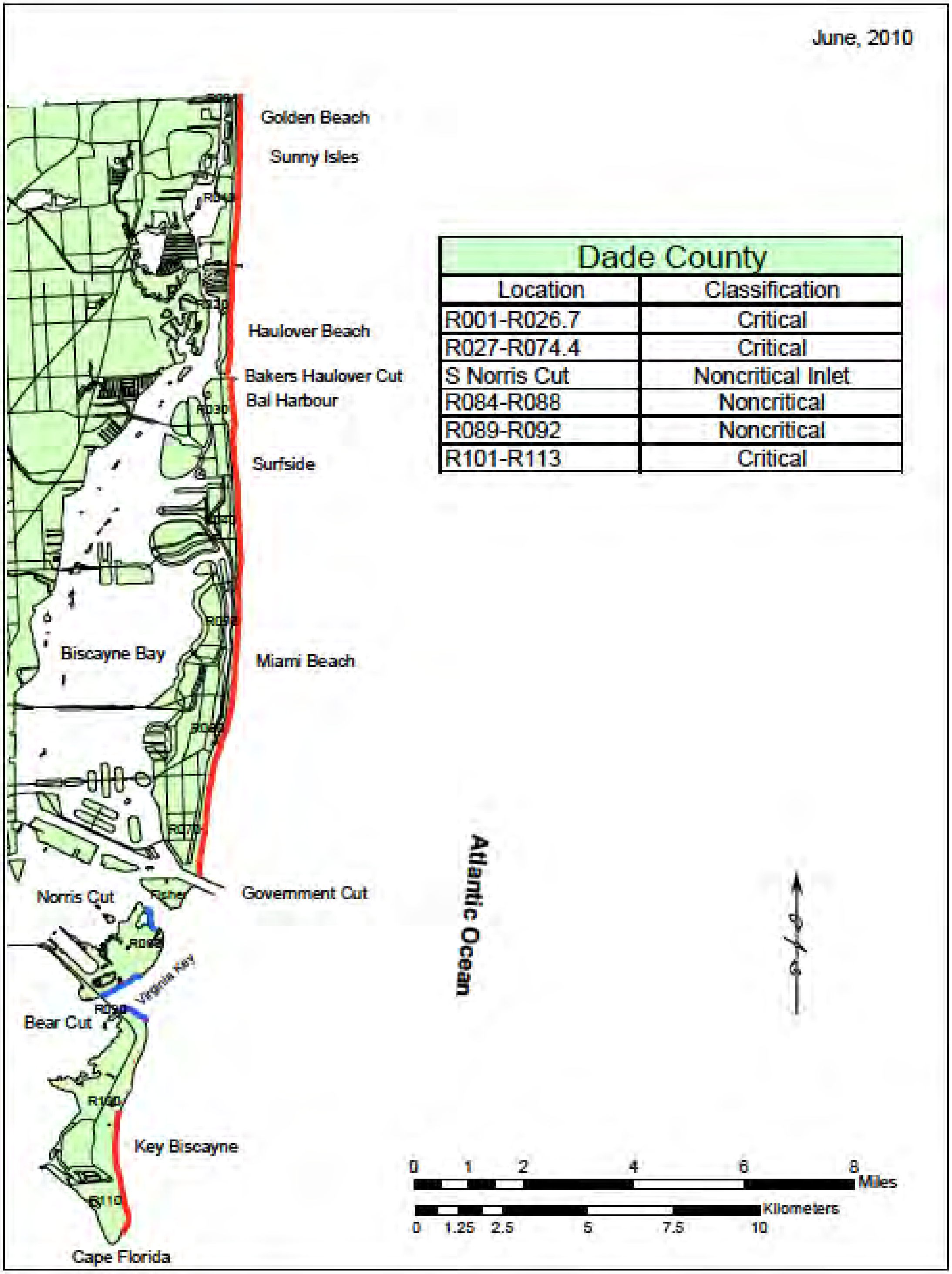
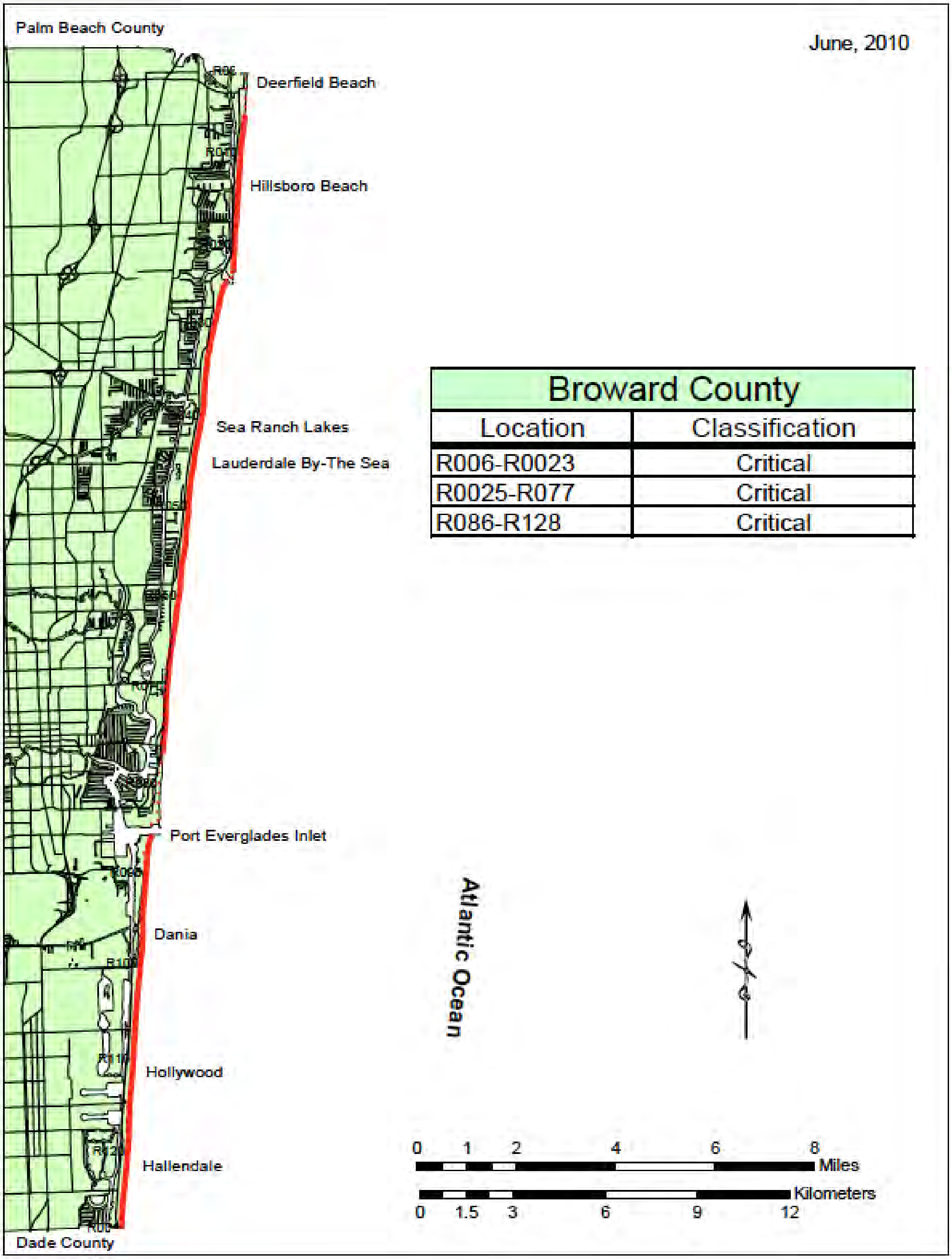


Figure 43: Total JCPs issued from 1995-2008, by range monument from north to south.



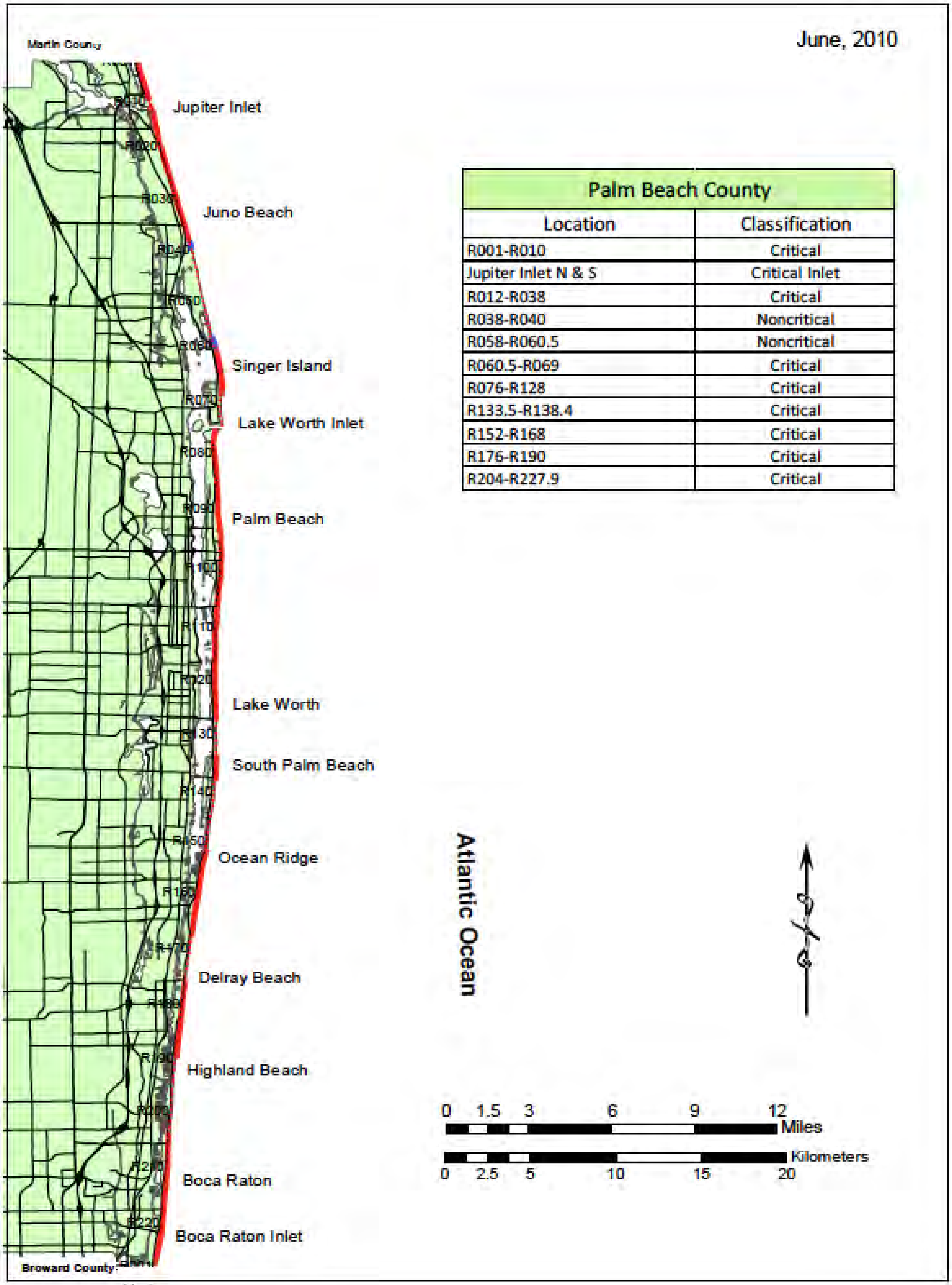
Dade County	
Location	Classification
R001-R026.7	Critical
R027-R074.4	Critical
S Norris Cut	Noncritical Inlet
R084-R088	Noncritical
R089-R092	Noncritical
R101-R113	Critical

Figure 44: Miami-Dade County range monuments (FDEP, 2010).



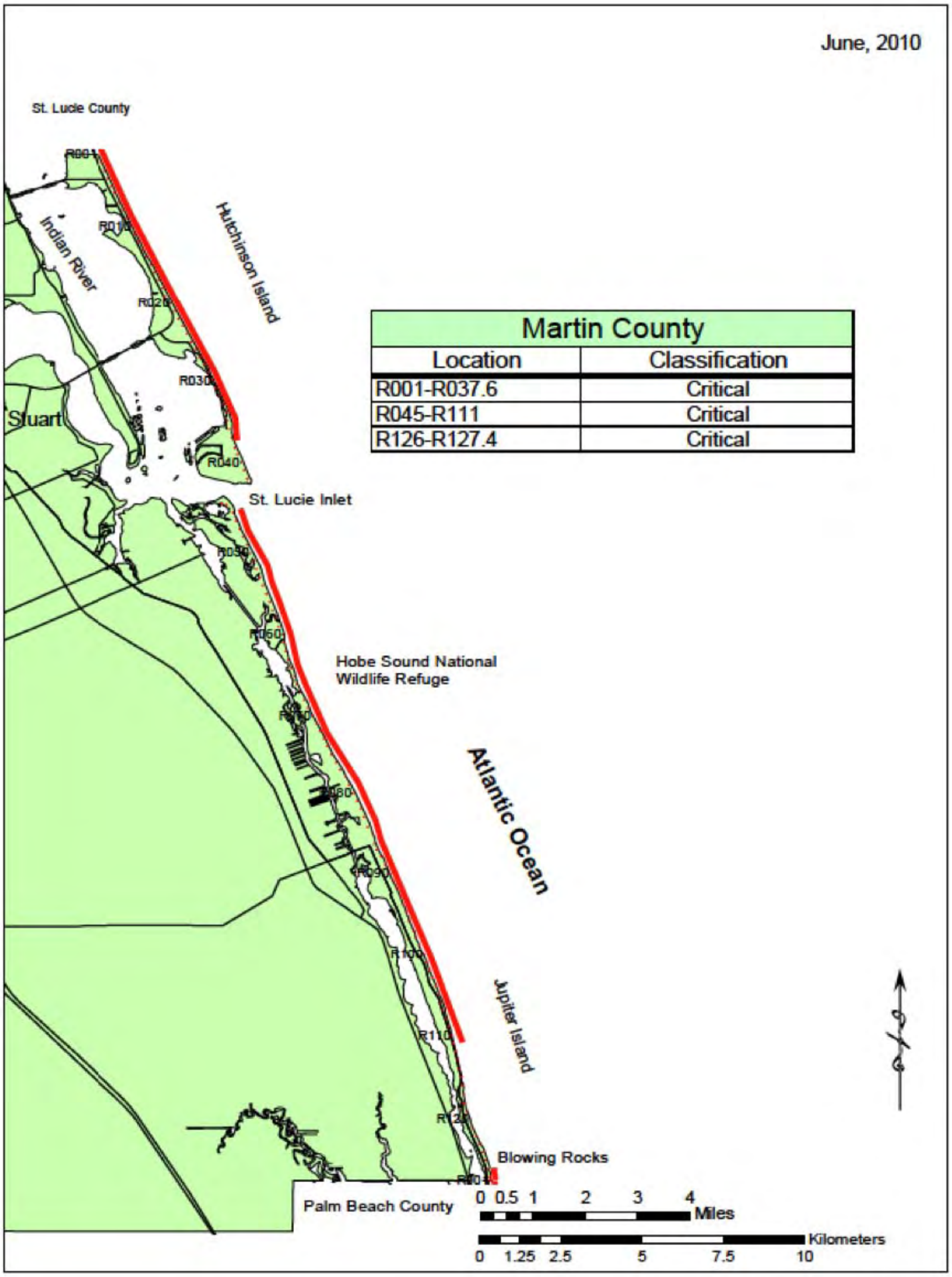
Broward County	
Location	Classification
R006-R0023	Critical
R0025-R077	Critical
R086-R128	Critical

Figure 45: Broward County range monuments (FDEP, 2010).



Palm Beach County	
Location	Classification
R001-R010	Critical
Jupiter Inlet N & S	Critical Inlet
R012-R038	Critical
R038-R040	Noncritical
R058-R060.5	Noncritical
R060.5-R069	Critical
R076-R128	Critical
R133.5-R138.4	Critical
R152-R168	Critical
R176-R190	Critical
R204-R227.9	Critical

Figure 46: Palm Beach County range monuments (FDEP, 2010).



Martin County	
Location	Classification
R001-R037.6	Critical
R045-R111	Critical
R126-R127.4	Critical

Figure 47: Martin County range monuments (FDEP, 2010).

FDEP BBCS CCCL permit database

The CCCL permit database provided by the FDEP BBCS covered the January 1997-June 2009 time period, although FDEP BBCS maintains database records for CCCL permits into the mid-1980s. However, for the geo-referenced permit database, the 1997-2009 time period was selected for data entry and analysis[15].

From January 1997 to June 2009, FDEP BBCS received a total of 1,141 permit applications, of which 441, or 38.6%, were from Palm Beach County, 298, or 26.1%, were from Miami-Dade County, 247, or 21.6%, were from Broward County, and 155, or 13.6%, were from Martin County[16]. Altogether, 35 applications were denied, representing a denial rate of 3.1%.

All projects covered under CCCL permits were, by the nature of the permit type, located seaward of the Coastal Construction Control Line in a beach and dune system. Such projects were not, however, permitted to be located across the land-sea interface (defined as seaward of the mean high tide line). Nevertheless, due to the potential erosion impacts that poorly built structures could have and which would extend into marine habitats and the sundry effects that construction would have on existing habitat, CCCL permitted activities could

[15] The narrow (1997-2009) database time period was selected for two reasons: maintaining consistency across permit types, and maximizing data mining operations. In terms of maintaining consistency, an analysis of the ERP permit database (please see below for a detailed description of the ERP permit database) provided by FDEP SED demonstrated that the program commenced issuing 150 or more permits based on 500 or more permit applications only in 1997, the second full year of the program. Thus, it was decided that all permit types would be mined from the mid-1990s onward. The second reason, that of maximizing data mining operations, was agreed upon based on permit and data availability. FDEP BBCS maintains a digital archive of CCCL permit final orders that extend back to approximately 1998 (although some counties have final orders that extend back to part of 1997). The final orders and all other documentation for older CCCL permits can only be retrieved via microfiche. It was decided that in order to maximize data mining operations, a control date of 1997 would be established for CCCL permits, and that all permits not available in digital format that could be accessed would be retrieved via microfiche and photocopied. An additional decision that affected data collection for CCCL permits was the use of the map viewing webpage that FDEP BBCS maintains on its website (FDEP BBCS Interactive Web Mapping website: http://ca.dep.state.fl.us/imf/?focus=beaches). The webpage allows users to find particular permits, including CCCL permits, for which the webpage generates a PDF summary document containing summary information on the project.

[16] FDEP BBCS also issued a total of 2,761 field permits from 1997 to mid-2009. Over 40% of these, or 1,121 field permits, were issued in Palm Beach County, followed by Broward County at 28.5% (786 permits), Miami-Dade County at 19.1% (526 permits), and Martin County at 11.9% (328 permits).

profoundly affect the region's coral reefs and associated resources.

In terms of the types of projects that the CCCL permits addressed, 80.9% (n = 4948) of all activities listed for a project were coded as 'new', which meant that most permits focused on new construction. Just over 6% (n = 382) of the activities involved a 'removal', 3.3% (n = 204) concerned a design change, and both additions and repairs accounted for 2.9% (n = 178) of all activities. It should be noted that most permits listed several objectives but most were involved with new construction (or construction on an older structure). Among project description categories, 501 permits listed a swimming pool, making it the most frequently cited project description (8.2%). This was followed by landscaping at 8.1% (n = 496), walkways at 7.5% (n = 461), single family dwelling at 7.3% (n = 446), fill at 7.1% (n = 433) which was often an activity related to swimming pool construction, decks and other extensions attached to the major structure at 6.2% (n = 378), other minor activities at 6.0% (n = 366), and excavation at 5.3% (n = 322), another activity often related to swimming pool construction.

New construction dominated all four counties' CCCL permits, with 83.7 of all Martin County CCCL permit codes listing it as an activity (n = 758), compared to 81.5% of Palm Beach County codes (n = 1,701), 80.1% of Miami-Dade County codes (n = 1,625), and 77.8% of Broward County codes (n = 864). There were no major differences in project types across counties, except that both Martin and Palm Beach counties had additions listed as 4% of construction, compared to 2% or less in Broward and Miami-Dade counties.

In terms of major activities, there were considerable differences between counties in the activities that their projects most frequently completed. For example, in comparing the five most highly ranked activities, Miami-Dade permit activities were ranked in the order of the highest to lowest in the top five activities as walkways, landscaping, swimming pools, decks and other structures, and other minor activities. Broward County activities that ranked highest (in order) were swimming pools, landscaping, other minor activities and deck and other structures (tie), and walkways. By contrast, Martin County activities that ranked highest (in order) were single-family dwellings, swimming pools, fill, landscaping, and deck and other structures. Similarly, the ranking for Palm Beach activities was single-family dwellings, swimming pools, fill, landscaping, and walkways. The upper two counties' permits had more single-family dwellings and related projects than did the lower two counties, where multi-family dwellings and commercial establishments (ex. hotels) were more important.

With respect to impacts and impact minimization or mitigation, only 2.2% of the total codes (132 out of 6,119) were related to restorative activities such as dune construction or reconstruction or native vegetation planting. If fill were considered as a mitigation or minimization measure, then 9.2% of the codes were related to an environmental response (although, as stated earlier, fill was generally used in projects to offset excavated material resulting from parking garage, swimming pool, and other subterranean construction. It should be noted that these codes in the CCCL permit database referred to major activities and were thus only partly indicative of the overall action required to mitigate against impacts; the special conditions listed in each permit final order addressed the impacts directly and were not available in the database provided by FDEP BBCS.

Geo-referenced CCCL permit database

Of the 1,106 CCCL permits identified in the FDEP BBCS CCCL permit database, a subsample of 778 CCCL permits final orders and summary documents could be accessed, and these were entered into the geo-referenced permit database (Figure 44). Of the 778 permits, 36.1% (281 permits) were from Palm Beach County, 30.3% (236 permits) were from Miami-Dade County, 20.2% (157 permits) were from Broward County, and 13.3% (104 permits) were from Martin County. The major difference between the FDEP BBCS CCCL permit database and the geo-referenced permit database was that Miami-Dade County was oversampled and Palm Beach County was undersampled, relative to the counties' permit percentages in the former database[17].

[17] Undersampling was a result of the total number of digital files available from FDEP BBCS, such that there were fewer Palm Beach County CCCL files available in digital format relative to Miami-Dade County CCCL files.

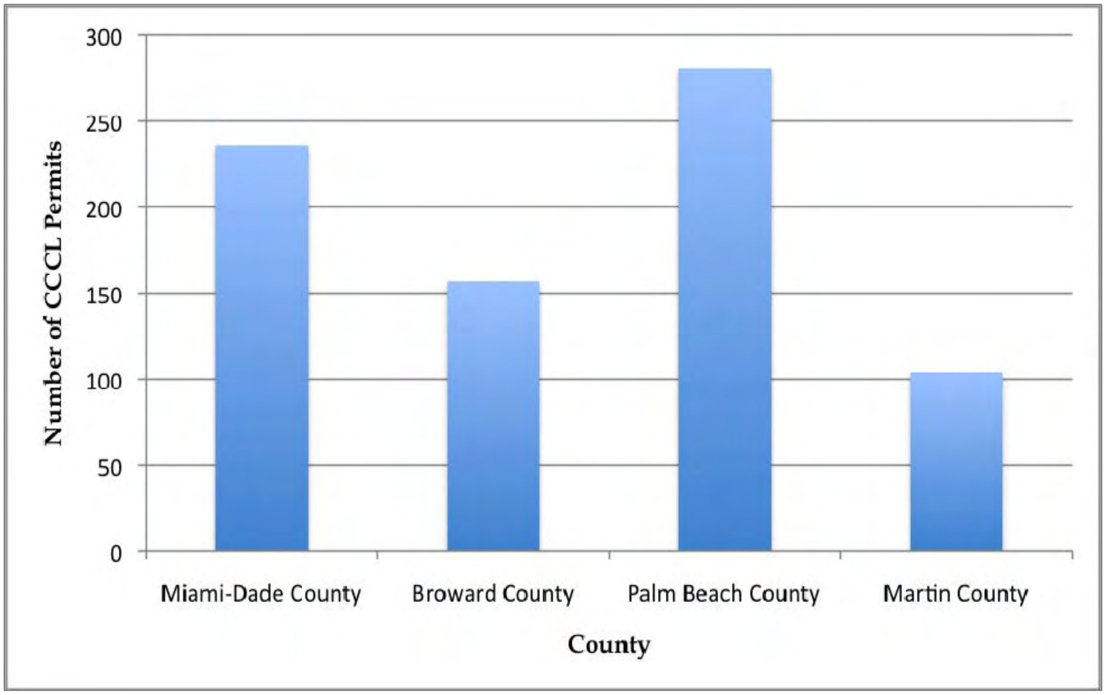


Figure 48: CCCL permits by county: 1997 - 2009.

The geo-referenced permit database used the following codes for the major project types for each permit type (Table 2).

Table 2. Geo-referenced permit database project types and codes.

Major Project Type Code	Major Project Type Code Explanation
NI	Navigation - New
N2	Navigation - Expansion
N3	Navigation - Maintenance
B1	Beach nourishment & shoreline erosion abatement using soft stabilization
B2	Beach nourishment & shoreline erosion abatement using hard stabilization
D1	Coastal development – estuarine/wetland fill
D2	Coastal development – seaward of the CCCL
D3	Coastal development - estuarine dredging
E1	Energy projects inshore
E2	Energy projects offshore
E3	Alternative energy project
C1	Telecommunications
C2	Other telecommunications project
MT	Mangrove trimming

The coastal construction project types targeted in this project included navigation, beach nourishment stabilization, coastal development, energy projects, and telecommunication projects (including underwater cables). Navigation activities related primarily to projects involving dredging, including dredging to create new navigational channels (N1), expansion of existing access and port expansion (N2), and maintenance dredging, including ICW and inlet bypass maintenance (N3). Beach nourishment activities were divided into two sub-categories, such that B1 concerned mainly beach nourishment and related restoration measures (or soft stabilization), and B2 referred to all other beach-related projects that involved hard stabilization, such as riprap, seawall, groins, etc. Coastal development activities were divided into three sub-categories, where D1 related to estuarine or wetland excavation and fill projects located landward of the CCCL, D2 related to any type of coastal development located seaward of the CCCL, and D3 related to all forms of estuarine dredging. Energy and energy-related projects concerned all activities that affected power plants, transmission lines, sub-stations, deepwater ports and offshore offloading facilities, etc., and these projects were divided into those that occurred inshore (within and/or inside the ICW, including coastal projects) and those that occurred offshore (within and/or beyond the ICW seaward). Communications projects included those related to fiber optic cable placement on or in the seabed and related activities, where C1 referred to all telecommunication projects, and C2 covered all other communications activities. Finally, mangrove trimming projects (MT) were added as a separate category, as these activities were identified as ERP permits (in Martin and West Palm Beach counties).

All projects permitted under the CCCL program were labeled as coastal development projects located seaward of the control line (D2, Table 1), and because of the difference in goals between CCCL and ERP/JCP permits, a new category of goals on the type of construction project was developed as follows:

- C = commercial;
- G = governmental;
- M = multi-family; and
- R = residential, single-family.

The most frequently permitted CCCL projects, at 49.0%, were related to residential, single-family dwellings, followed by multi-family developments (22.6%), commercial constructions (16.5%), and governmental projects (11.5%) (Figure 49). Less than 0.4% of CCCL projects were related to temporary structures. However, there were considerable differences in project types by county. Residential or single-family home construction, for example, comprised 90.3% and 67.7% of all CCCL permits in Martin and Palm Beach counties, respectively, but only 14.3% of Miami-Dade CCCL permits. Broward County single-family home construction made up 39.5% of all the county's CCCL permits. By contrast, multi-family home development, which mostly involved condominium construction, made up 45.1% of Miami-Dade County CCCL permits and 24.8% of Broward County CCCL permits, but such high density development projects were less common in Palm Beach (10.7%) and Martin (1.0%) counties, due most likely to a combination of coastal land scarcity and prices. Also, commercial developments, such as hotels, restaurants, and other commercial establishments, were more frequently built in Miami-Dade (27.8% of all permits) and Broward (22.9% of all permits) counties than in Palm Beach (8.6% of all permits) and Martin (2.9% of all permits) counties.

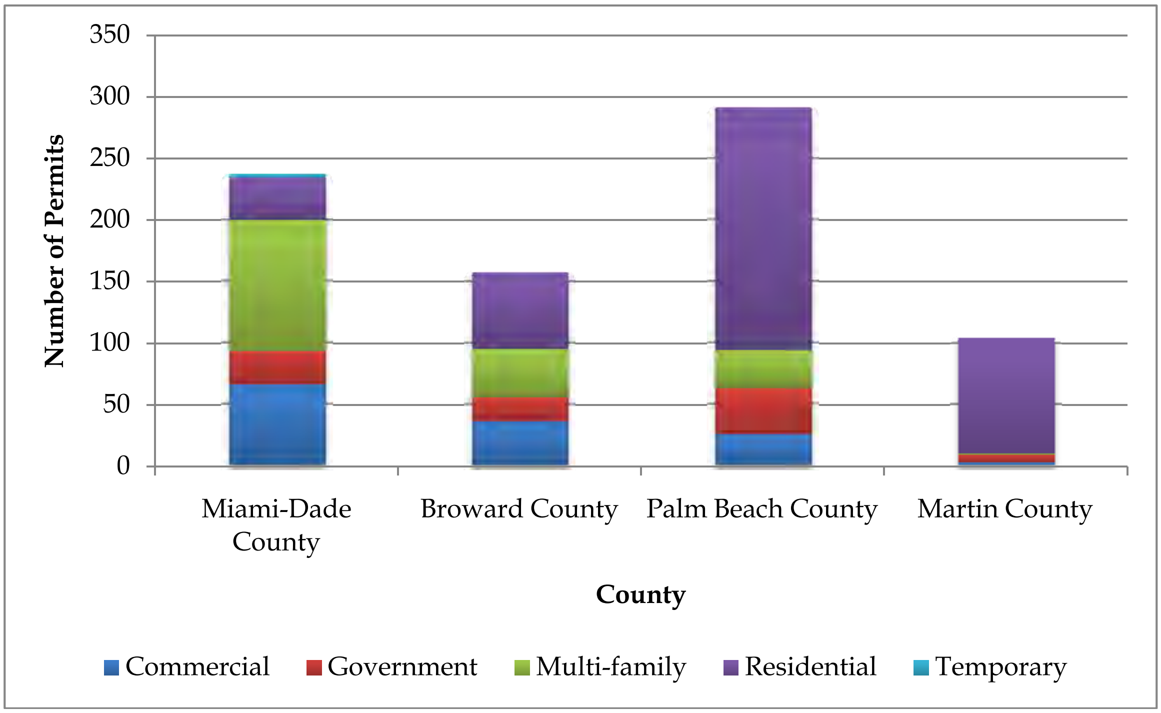


Figure 49: CCCL permits by type of project: 1997 - 2009.

Of the various impacts identified, three main categories were defined and recorded in the geo-referenced permit database: biological impacts; physical impacts; and water quality impacts. Biological impacts refer to effects on the biota within the environs of the permitted site resulting from coastal construction activities. Biological impacts resulted from activities that affected coastal or marine flora and fauna, either by directly altering habitats or by altering the functionality of habitats (i.e., decreased resilience). Biological impact categories included impacts on flora, such as dune vegetation, other native coastal vegetation, mangroves, and seagrasses, and impacts on fauna, such as construction impacts on endangered and threatened species (ex., Florida manatee, sea turtles, *Acropora* spp. corals, etc.), fish, and invertebrates. Physical impacts refer to the class of impacts that directly or indirectly damage or alter part of a permit area or alter the physical environment in the project area. Physical impacts were often correlated with biological impacts, where physical alterations had impacts on the prevailing flora and fauna within the permit site. Activities such as dune alteration, wetland excavation and fill, debris, and dredging, among others, were among the impact categories identified as physical impacts. Finally, water quality impacts refer to the class of impacts that directly or indirectly affect water clarity and (to a lesser extent) toxicity, related mostly with sedimentation and turbidity resulting from shore-sea interface and in-water activities. As with physical impacts, water quality impacts were often identified in tandem with biological impacts such that construction activities that resulted in turbidity and sedimentation had indirect impacts on fauna (e.g. toxicity, lowered visibility, etc.) and fauna (e.g. decreased sunlight penetration, smothering, etc.).

Impacts by category within CCCL permits were heavily skewed toward physical impacts, which made up over two thirds of the total impacts (64.8%) (Figure 50). Biological impacts made up most of the rest of the impacts, at 34.5%, and only 9.7% of the impacts were related to water quality. Physical impacts were most often associated with impacts to the beach and dune system, excavations, fills, sand placement, and other related coastal construction impacts. By contrast, biological and water quality impacts almost invariably focused on sea turtle nesting habitat protection and storm water discharges. It should be noted however that several of the impacts that were listed as physical impacts were those associated with using dune vegetation to stabilize dunes, and these could have also been categorized as biological impacts.

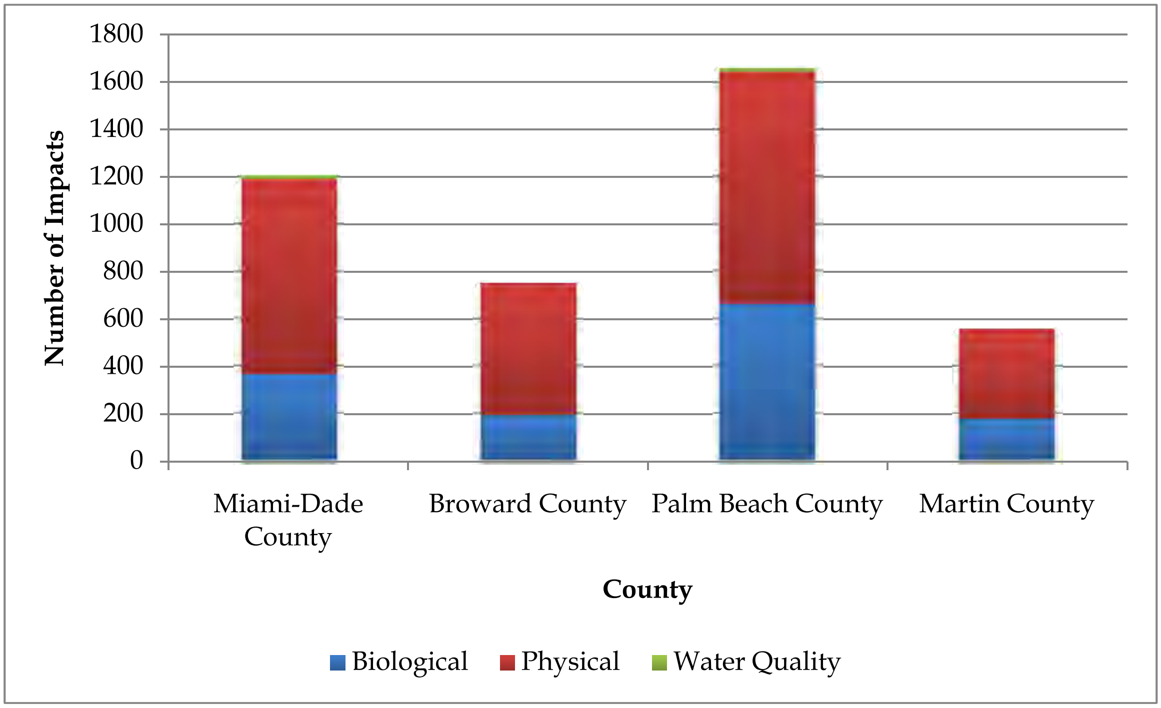


Figure 50: CCCL permits by impact category: 1997 - 2009.

In terms of impacts by resource type, 62% of all impacts listed in the CCCL permits were related to physical impacts on the beach, especially as related to physical impacts to the beach and dune system (Figure 51). While these impacts were primarily related to landside effects on the beach system, a secondary important concern was often increased turbidity in marine habitats resulting from construction activities. Another 26.1% of the impacts concerned biological impacts on sea turtles resulting (mainly) from lighting systems and (less so) from changes to the beach and dune system. Fewer impacts were related to dune vegetation (7%), erosion (2.2%), and exotic and invasive species management (1.5%). The main activities under impacts that were quantified were the cubic yards of excavation and fill associated with each project that involved such activities (most commonly for subsurface construction of structures, garages, swimming pools, etc.). Of the 437 projects that involved excavation activities, the average amount of all material (including beach quality sand) that was excavated was 1,412 cy (SD = 2,639.3), with considerable variation between projects. By comparison, 449 project permits listed fill activities which also involved all material (but from which only beach quality sand could be placed seaward of the control line), and this material averaged 2,079 cy (SD = 3,722.6) per project, also with considerable variations between projects. Nevertheless, it was determined that CCCL projects as permitted filled, on average, almost 700 cy more material than the projects excavated.

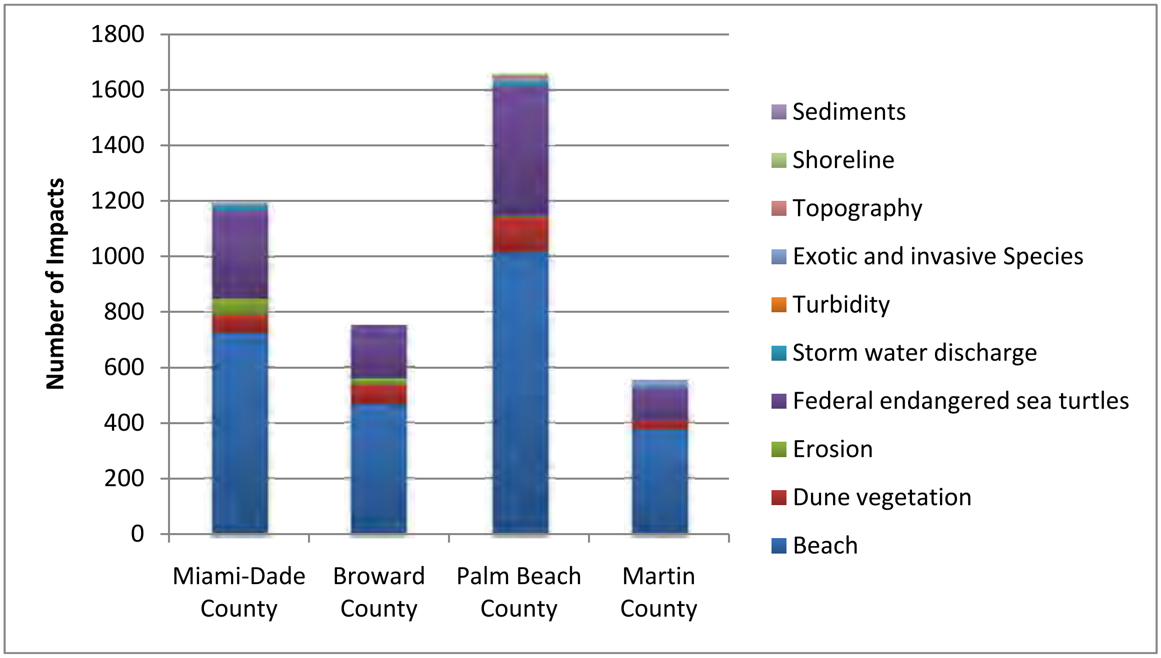


Figure 51: CCCL permit impacts by resource type: 1997 - 2009.

Most impacts described in the database were related to mitigation (i.e. impacts that were avoided, minimized, or offset through mitigation), such that while direct impacts comprised 10.1% of impacts (of which most were related to excavation activities), mitigation measures accounted for the remainder, or 89.9%, of impacts[18] (Figure 52). The CCCL permits reviewed did not include compensatory mitigation as an option, and the most common type of mitigation measure was compensatory mitigation (44.2%), followed by minimization (41.4%), and avoidance (14.4%). Compensatory mitigation was most frequently used in Palm Beach County CCCL permits, where it made up 54.5% of all mitigation measures; by contrast, Martin County used mitigation least frequently, at 17.4%, relying more on minimization (52.1%) and avoidance (30.5%). Both Miami-Dade and Broward counties preferred minimization (47%) over mitigation (28%) or avoidance (15%).

[18] The impact level section of the geo-referenced database contained three categories that could be used to describe an impact type: Direct impacts; indirect impacts; and mitigation. These were listed together to demonstrate whether a direct or indirect impact resulting from a project had an associated mitigation activity. Mitigation was divided into the following three activities: avoidance, which was practiced as a form of not allowing certain activities that would have an unacceptable impact; minimization, where only less than a threshold amount or extent of activities would be allowed that would not trigger an unacceptable impact, and; compensatory mitigation, where activities would result in an unacceptable impact and would need some form of remediation, either on or off site.

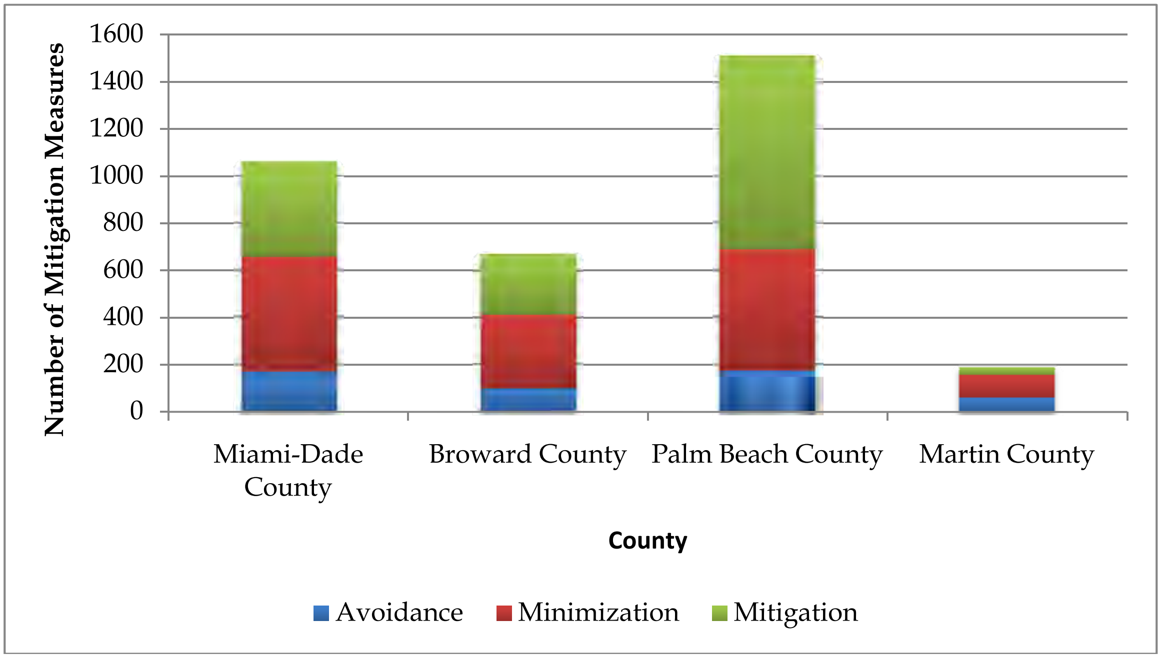


Figure 52: CCCL permit impact mitigation measures: 1997 - 2009.

CCCL permitted projects, being entirely coastal, were located along the control lines of each of the four counties. Almost all of the permits, with the exception of particular governmental projects that may have involved walkways, were single locations, and the maps show the central location of each project (Figures 53-56).

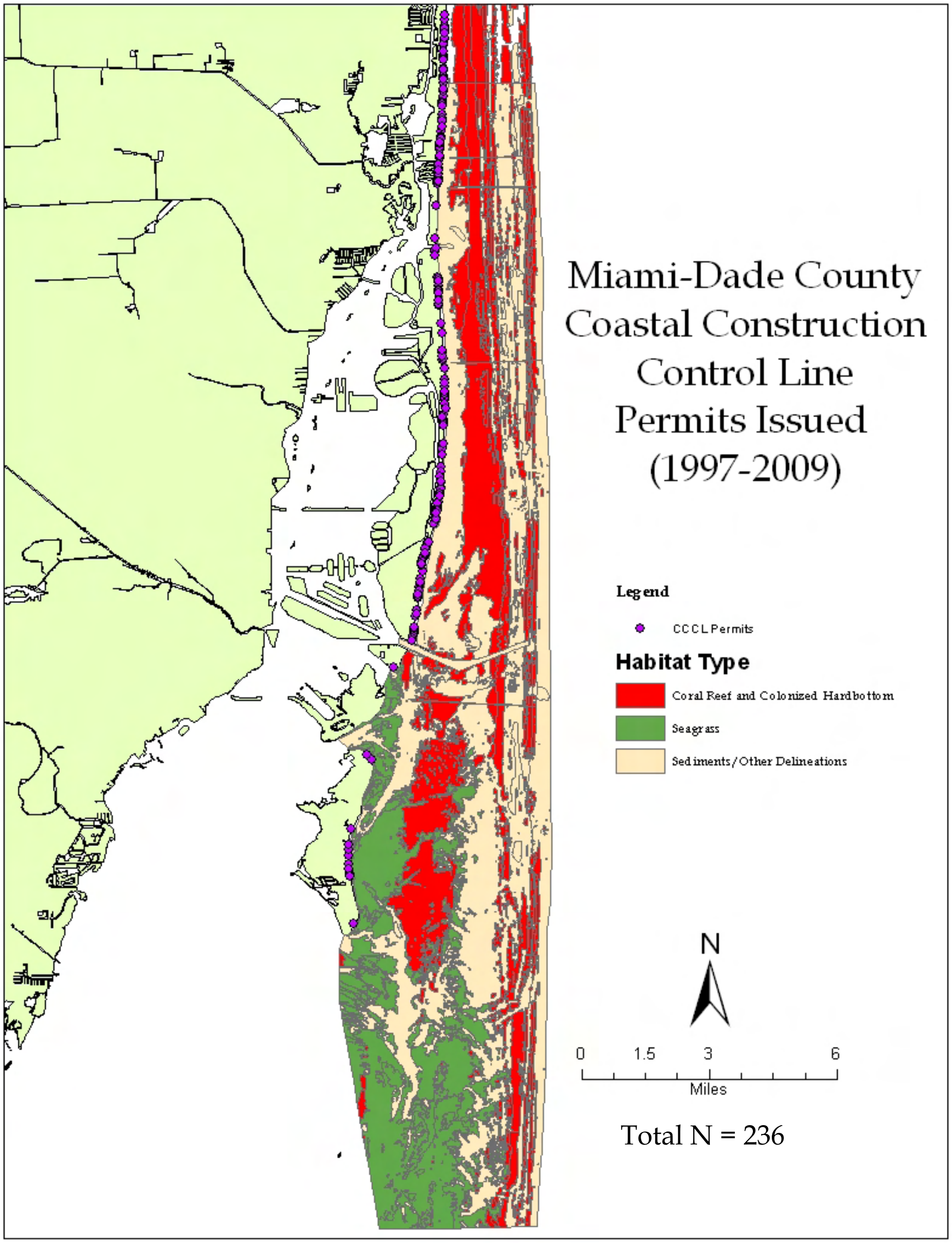


Figure 53: CCCL permits issued in Miami-Dade County: 1997 - 2009.

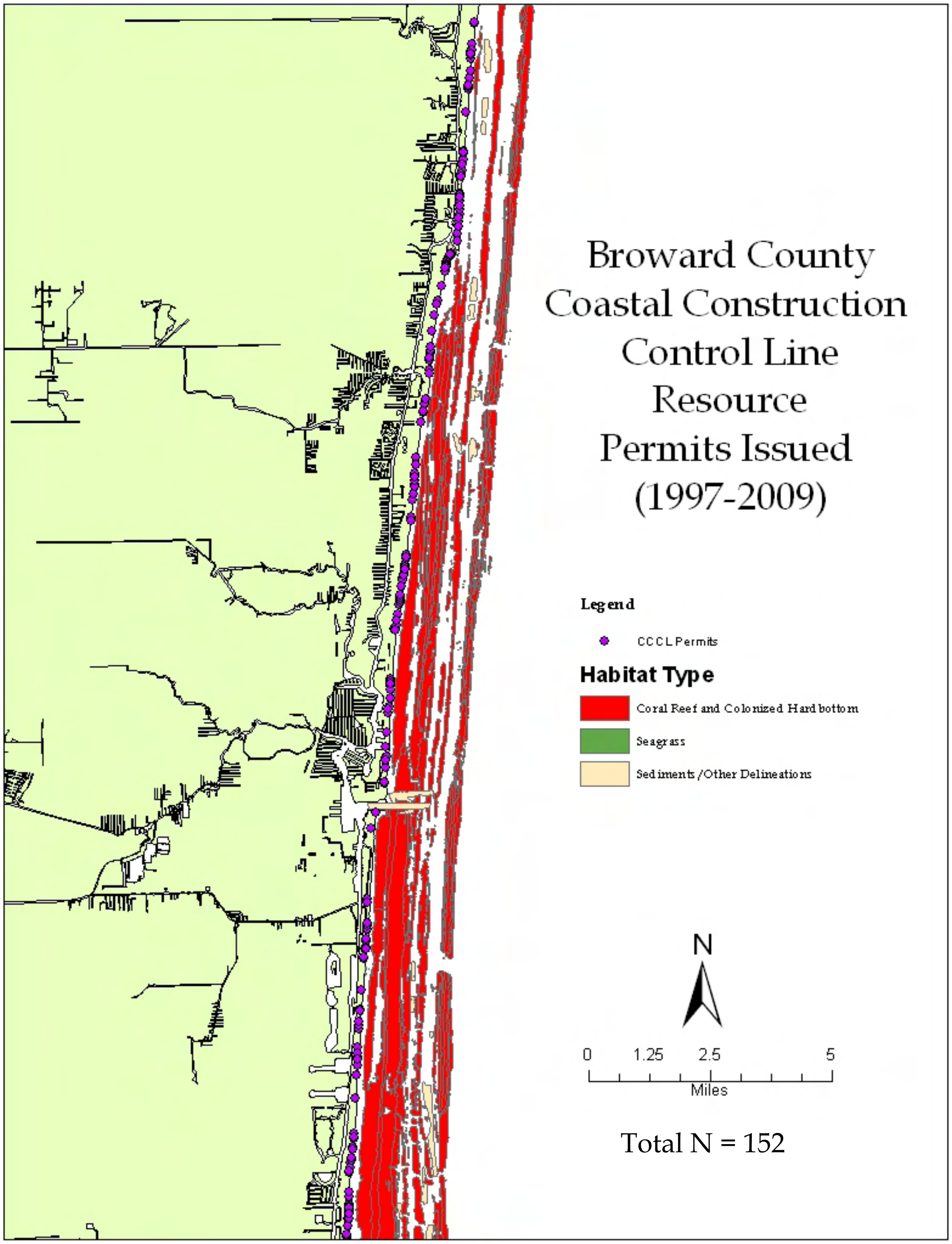


Figure 54: CCCL permits issued in Broward County: 1997 - 2009.

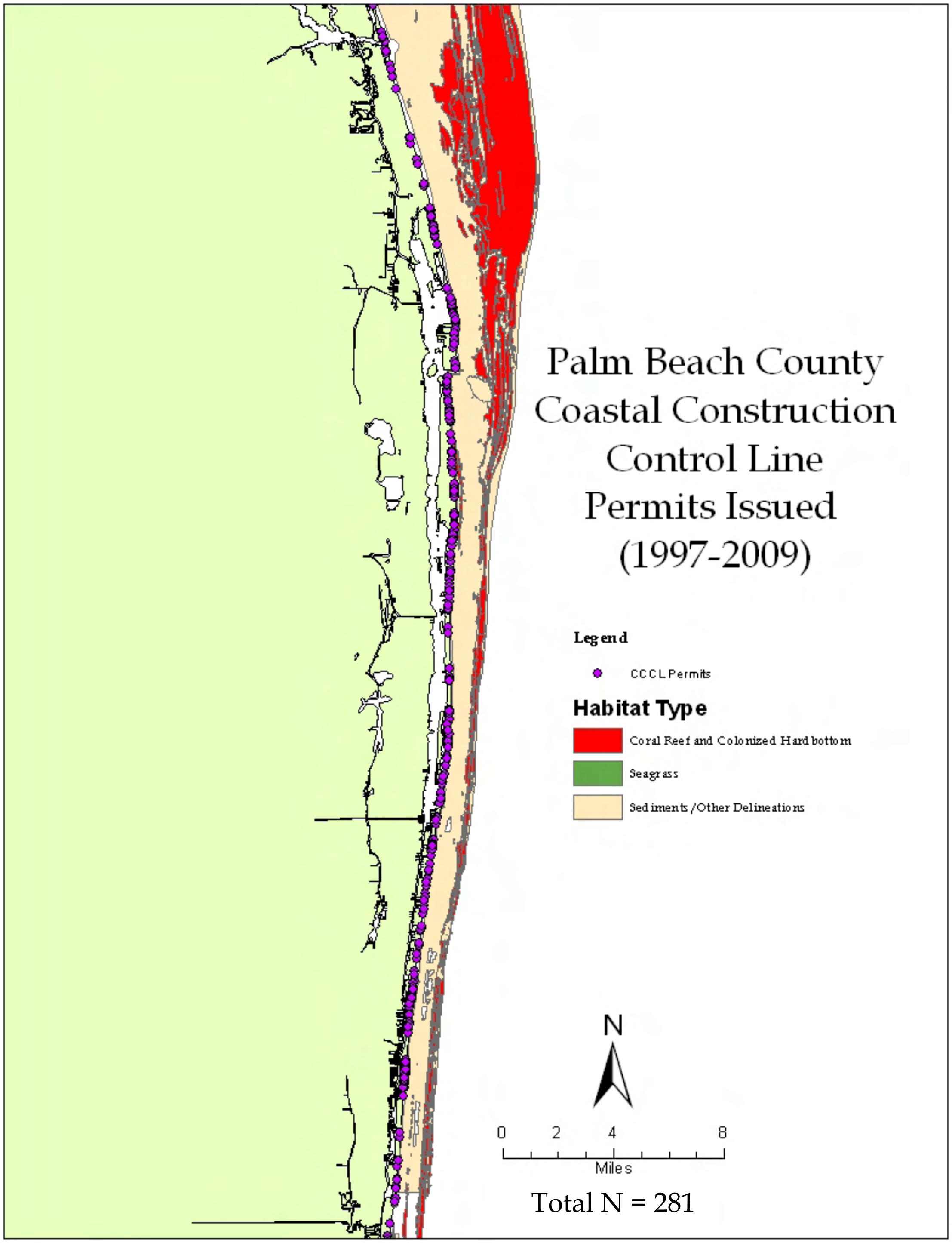


Figure 55: CCCL permits issued in Palm Beach County: 1997 - 2009.

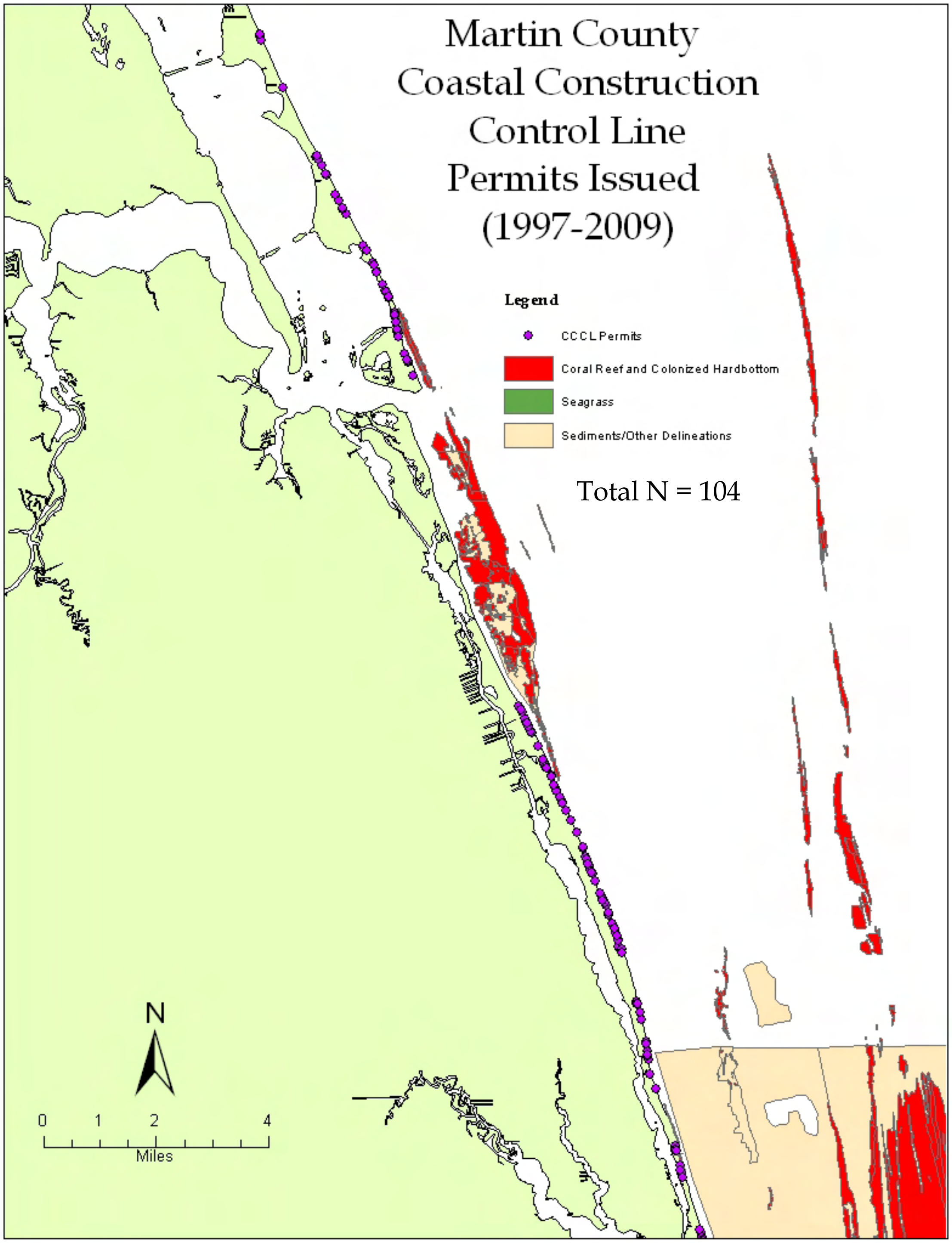


Figure 56: CCCL permits issued in Martin County: 1997 - 2009.

FDEP SED ERP database

The ERP database provided by the FDEP SED for the period of 1995-2008 contained 18,977 permits[19] (Figure 57). Of these permits, 46.8% (8,892 permits) were from Palm Beach County, followed by 26.1% (4,966 permits) from Martin County, 14.8% (2,808 permits) from Broward County, and 12.3% (2,231 permits) from Miami-Dade County.

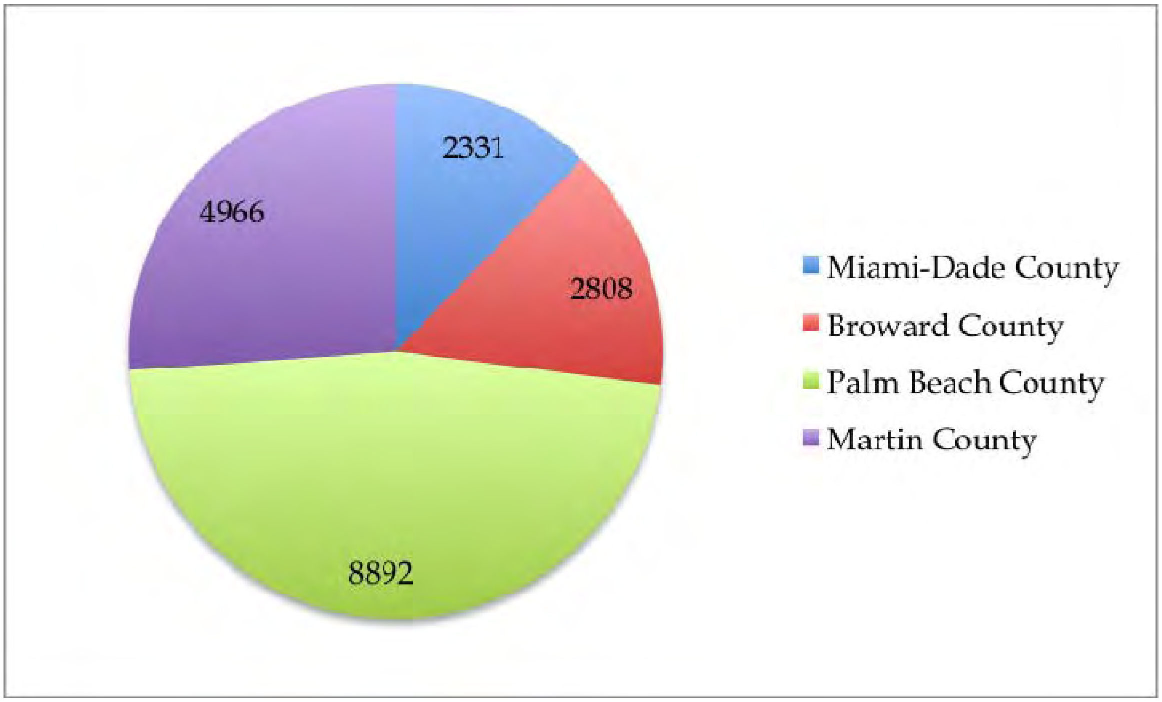


Figure 57: FDEP SED ERP database total permits: 1995 - 2008.

[19] FDEP SED provided a version of the full permit database in mid-2008, which was used to identify permit types and subtypes. Another version of the permit database was sent in April 2010, which was used to summarize the total permits applied for since the inception of the ERP program.

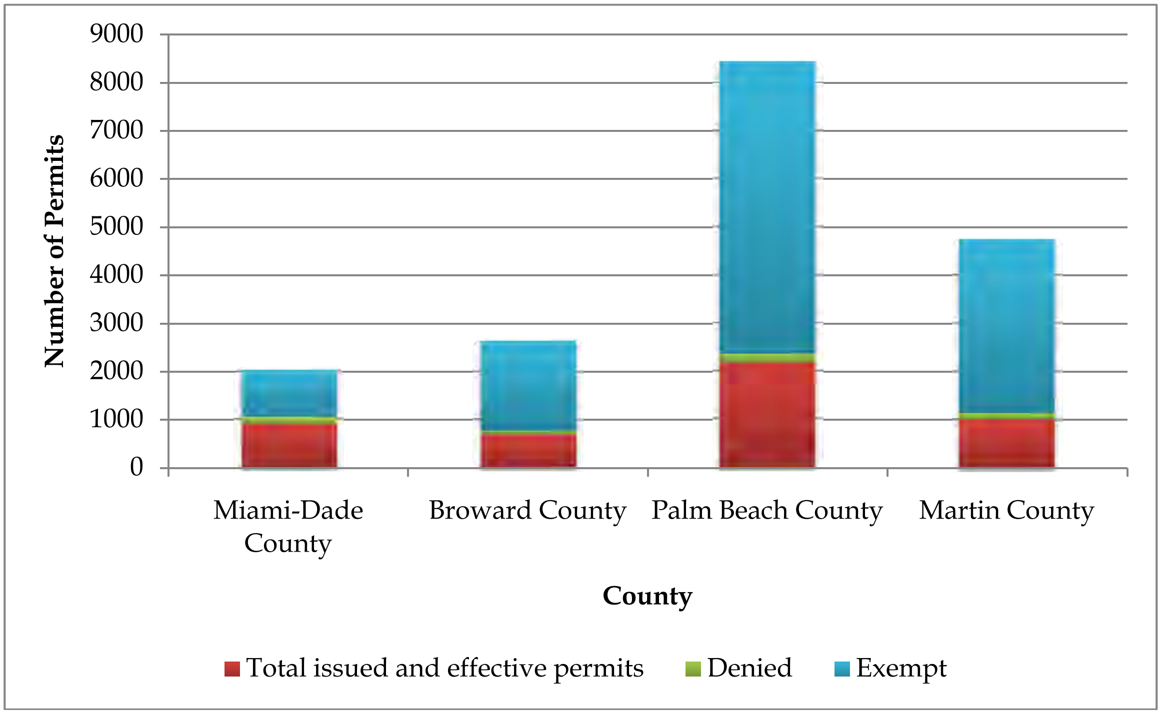


Figure 58: FDEP SED ERP permit decisions: 1995 - 2008.

Within the entire ERP database, 66.2% (12,579 permits) of all permits were related to exempt activities, 25.0% (4,756 permits) were issued or effective[20] permits, and 2.7% (512 permits) were denied (Figure 58). The remainder were either pending, withdrawn, or delegated. Within the counties, the issued and effective permit percentages varied. In Miami-Dade County for example, 38.1% of permits (888 permits) were issued or effective, compared to 20.3% of Martin County permits (1,009 permits). Conversely, while only an average of between 2.0 – 2.5% of permits were denied in the upper three counties, 6.4% of all Miami-Dade County applications (150 permit applications) were denied. Among exempt activities, Martin County led all counties with 72.6%, or 3,605 permits, being exempt, followed by Palm Beach County (68.5%, or 6,087 permits), Broward County (67%, or 1,880 permits), and Miami-Dade County (43.2%, or 1,007 permits)[21].

[20] Permits that do not require extensive overview, such as noticed general permits (NGP) and mangrove alterations, were designated as effective permits.

[21] One reason for the lower percentage of Miami-Dade County exemptions may be a result of the county's agreement with FDEP in 1996, which states that DERM would permit minor projects related to small dock installations and repairs, seawall and bulkhead repairs and replacements, and minor dredging operations, among other minor activities, that would be exempt under FDEP requirements.

When all denied, exempt, and pending files were excised from the database, a total of 4,756 permits were identified as having been issued or effective from 1995 to 2008. Of these, 46.5% (2,169 permits) pertained to Palm Beach County, 21.2% (1,009 permits) to Martin County, 18.7% (888 permits) to Miami-Dade County, and 14.5% (690 permits) to Broward County.

Table 3. Percentage of ERP permit types issued for each county by the FDEP SED: 1995 - 2008. Permit types are based on sub-types identified under the ERP program.

Type of ERP	Miami-Dade County	Broward County	Palm Beach County	Martin County
Dredge and Fill	1.60	0.43	0.70	0.30
ERP - Conceptual Approval	0.23	0.87	0.23	0.10
ERP Standard General Permit - Conceptual Approval	0.00	0.14	0.00	0.00
ERP Noticed General Permit	7.98	24.64	17.54	25.23
ERP Individual Permit	9.01	7.54	3.73	4.15
ERP Modification	26.68	23.62	16.14	17.33
ERP Standard General Permit	29.30	29.28	20.15	29.79
Dredge and Fill and ERP Variances	1.60	0.14	0.47	0.30
Formal Determination	0.68	0.14	28.17	12.66
Everglades and Lake Okeechobee	0.46	0.29	0.93	0.30
Mangrove Trimming and Alteration	0.68	0.00	4.01	6.08
Mitigation Banking	11.40	0.00	4.20	0.00
Mangrove Exemptions	0.00	0.00	0.51	1.42
Management and Storage of Surface Waters	0.46	0.00	0.09	0.10
ERP Individual Storm Water System Permit	9.92	12.75	3.13	2.23

As shown in Table 3, there were considerable differences in the types of ERPs for each county. The most common permit in Miami-Dade, Broward, and Martin counties was the ERP Standard General Permit. Just under 30% of all Broward and Martin County permits were comprised of this permit type. By contrast, Palm Beach County's most commonly obtained permit was a formal determination, which comprised over 28% of the county's total permits. Also, permit modifications comprised an important percentage of all counties' permits, with modifications accounting for a quarter of all permits in Miami-Dade and Broward counties, and 16.1% and 17.3% of Palm Beach County and Martin County total permits, respectively. Individual storm water system permits were more important in the lower two counties, whereas mangrove trimming and alteration – regulations for which were delegated to Miami-Dade and Broward counties – comprised approximately 5% of total permits in the upper two counties. Mitigation banking permits were only used in Miami-Dade and Palm Beach counties; in the case of the former county, the permits were related to the Everglades Mitigation Bank, whereas the latter county's mitigation banking was related to the Loxahatchee Mitigation Bank.

Table 3 also demonstrates the concentration of inland permits issued under the ERP program; this is primarily due to the fact that the other two permit types (at the state level) address most coastal construction permits (or those located seaward of the CCCL). Also, ERPs, as previously described, are related to both wetlands and surface waters, including dredge and fill activities; storm water runoff quantity and quality; construction in wetlands, state waters, or over sovereign submerged lands of the state; and alteration of surface water flow; as well as mangrove trimming and alteration in those counties that do not have delegation agreements. However, as discussed below, many ERPs listed in Table 4 likely had considerable impacts on coastal habitats which, because of their connectivity, affected the region's coral reefs. Thus, permits associated with mangrove trimming, docking facilities, riprap repair, and other coastal activities affected coastal resources that are connected to coral reefs. Other permits related to inland activities, such as dredge and fill permits for housing developments, had secondary effects on coastal habitats, by affecting population and housing growth and thereby increasing infrastructure and demand for coastal uses and visitation. Finally, the sheer number of activities related to ERP-related permits, including exempt permits, represented a large set of changes to the inland and coastal environment that collectively represented a wide swath of impacts in the coastal zone.

A breakdown of major permit types, including exempt permits, also showed different permit characteristics by county. In Miami-Dade County, exempt permits, which comprised 53.7% of all permits that were not denied or withdrawn, were largely made up of two permit subtypes: docking facilities and boat ramps (47.6%) and de minimis activities (25.3%) as defined under §373.406 F.S. (6). Seawalls and riprap repair, restoration, and construction made up 5.7% of all exempt activities. Exempt activities in Broward County were also dominated by docking facilities and boat ramps (57.8%), but seawalls and riprap repair, restoration, and construction comprised a larger percentage (19.1%) of

Broward County exempt activities than did Miami-Dade County. De minimis activities comprised a fifth (20.8%) of the exempt activities in Broward County. Palm Beach County exempt activities were similar to those in Broward County, with docking facilities and boat ramps (54.1%), seawalls and riprap repair, restoration, and construction (20.1%), and de minimis activities (18.6%) comprising a majority of exemptions. Finally, in Martin County, almost two thirds of all exempt activities, or 63%, were related to docking facilities and boat ramps. A further 16% of exempt permits concerned seawalls and riprap repair, restoration, and construction. By contrast, 7.6% of the activities fell into the de minimis category.

Within ERP Standard General Permits, 55.0% of all activities in Miami-Dade County under that permit type involved construction on less than one acre of wetlands. Another 23.3% involved construction on less than 40 acres. Fewer than 5% of the permits were related to the construction of 1-2 new boat slips on one acre of wetlands. In Broward County, 44.0% of ERP Standard General Permits were related to construction on less than one acre of wetlands, 24.2% were related to construction on less than 40 acres, and 17.0% were related to construction of 1-2 new boat slips on one acre of wetlands. In Palm Beach County, ERP Standard General Permits related to construction on either less than one acre of wetlands (43.2%) or less than 40 acres (42.4%) were almost equally permitted, whereas new slip construction of 1-2 boat slips on an acre of wetlands comprised only 8.1% of the total. In Martin County, over half of the ERP Standard General Permits were related to construction on less than one acre of wetlands, and only 17.7% of the permits concerned construction on less than 40 acres. The construction of 1-2 boat slips on an acre of wetlands comprised 17% of Martin County's ERP Standard General Permits.

Permit modifications were a significant component of the total permits, as shown in Table 3 above, and these concerned a variety of modification subtypes. For the entire region, permit modifications comprised 19.5% of all permits issued, but this varied considerably across counties. In Miami-Dade County, over a third of all modifications (34.2%) for a particular type of minor activity (M1, where the modification resulted in a cost of $300 or more); however, all minor activities, including permit transfers, comprised 75.2% of the subtypes. In Broward County, M1 modifications also led all permit types (23.3%), but minor activities were less important than in Miami-Dade County, making up 62.6% of the total modification permits. Major modifications comprised over a third of all Broward County modification permits (37.4%). Minor modification in Palm Beach County permits were also led by M1 permits, but these comprised less than a fifth (18.5%) of all modifications. But, as in Miami-Dade County, minor modifications in general, including permit transfers, comprised 76.0% of the Palm Beach

County modification permits. Martin County modifications were also dominated by minor activities, which made up 74.9% of all modifications in the county. While M1 modifications were important, they did not reach 30% of all modifications, as the permit subtype did in Miami-Dade and Palm Beach counties.

Noticed General Permits (NGPs) were least frequently issued in Miami-Dade County, where the permit type made up less than 8% of all permits, compared to between 17-25% of all permits in the other three counties. A fifth of the activities associated with Miami-Dade County Noticed General Permits concerned subaqueous utility crossings of artificial waterways, followed by installation, maintenance, repair, and removal of underground cable, conduit, or pipelines (18.6%), and other general activities (17.1%). In Broward County, where NGPs made up 24.6% of all permits, the main activities associated with NGPs were minor activities (45.9%), installation of riprap (15.3%), installation, maintenance, repair, and removal of underground cable, conduit, or pipelines (11.8%), and piers and associated structures (9.4%). In Palm Beach County, 28.2% of all NGP were minor activities, 21.0% were related to construction on the Jupiter Farms planned community of single family residences, 17.6% concerned piers and associated structures, and 8.5% involved riprap installation. Martin County NGPs comprised a quarter of all county permits, and most of these (50.2%) were associated with piers and associated structures, followed by minor activities (26.5%), and riprap installation (10.8%).

Individual ERPs were the least frequently issued of main permit types, representing between 4-9% of all permits. In Miami-Dade County, which led all counties in terms of individual ERPs issued (9%), the main activities associated with the permits were construction on 100 or more acres of wetlands (19.0%), 10-29 new boat slips on a less than 40 acres of wetlands (19.0%), and construction on between 2-5 acres of wetlands (15.2%). Broward County individual ERP projects comprised 7.5% of the county's total permits, and the most frequently permitted individual activities were those related to 10-29 new boat slips on less than 40 acres of wetlands (23.1%), construction on between 2-5 acres of wetlands (17.3%), construction on between 5-10 acres of wetlands (13.5%), and 30-49 new boat slips on less than 40 acres of wetlands (11.5%). In Palm Beach County, where only 3.7% of all permits were individual ERPs, 20.0% of the permits involved construction on between 1-2 acres of wetlands, 17.5% involved construction on between 50-100 acres of wetlands, 13.8% involved less than 10 new slips and construction on less than an acre of wetlands, and 11.3% involved construction on between 2-5 acres of wetlands. As in Palm Beach County, individual ERPs in Martin County accounted for a small percentage (4.2%) of total permits issued or effective in the county. Two permit types, construction on between 2-5 acres of wetlands and 10-29 new boat slips on less than 40 acres of wetlands, accounted for 14.6% of all individual ERPs in Martin County, followed by permits that involved construction on between 1-2 acres of wetlands and those that led to the installation of less than 10 new slips (12.2%) and construction on less than an acre of wetlands (12.2%).

Finally, formal determination permits were more frequently issued in Palm Beach and Martin counties than in Miami-Dade and Broward counties. Almost all of the formal determinations were related to a non-binding formal definition, through which a property owner determined whether the property contained wetlands and thus would require an ERP for any proposed activities. Many of the formal definitions in the upper two counties were related to single or multiple housing unit developments, which were less common in the lower two counties.

The number of permit applications received increased considerably from a few permits in 1995 and 1996 to over 500 permits in 1997[22] (Figure 59). From 1998 onwards, permit applications averaged 1,678 permits/year, peaking at 1,899 permit applications in 2001. The number of effective or issued permits, i.e. those permits associated with a project (including formal determinations and modifications, but excluding exemptions) increased from over 100 permits in 1997 to over 500 permits in 2001 and 2002 (Figure 60). Overall, the number of issued or active permits averaged 285 permits/year from 1997-2008 (or 408 permits/year if 1997 were not included).

[22] New permits under the ERP/JCP process that commenced in 2005 took up to four months to process and mostly fell into 1996 and onwards. In effect, 1996 was the first year the program was in place; thus, while the graphics show a large increase in the number of permits, it should be noted that the permits were a continuation of the previous trends.

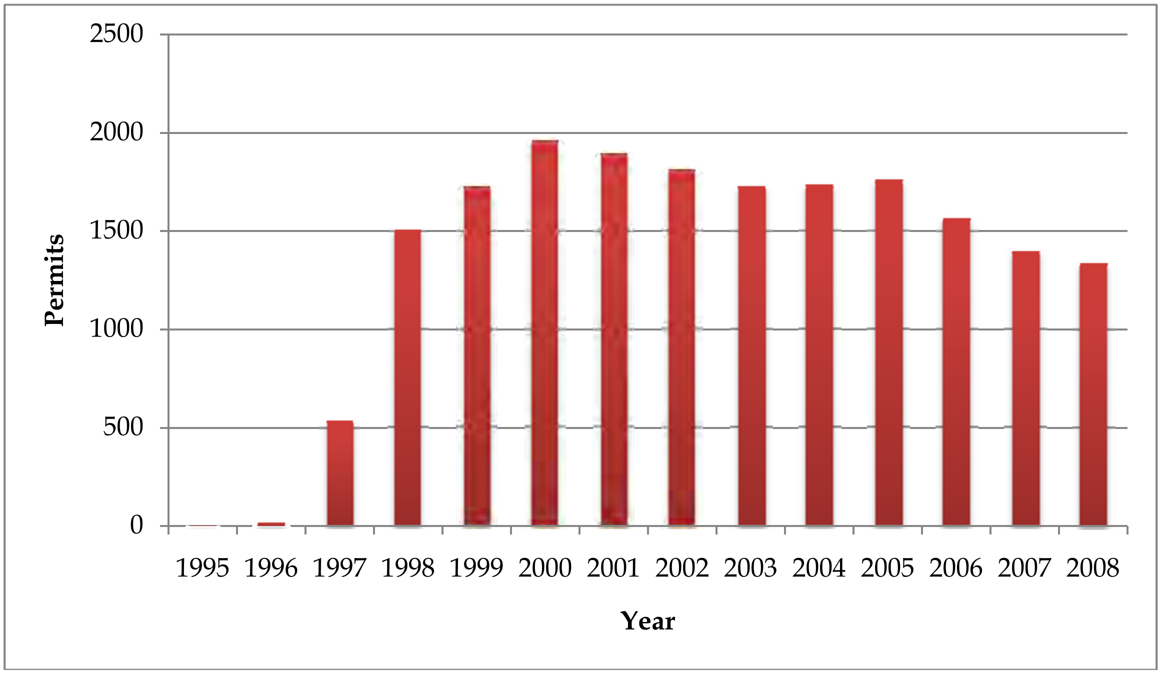


Figure 59: FDEP SED ERP permit applications received: 1995 - 2008[23].

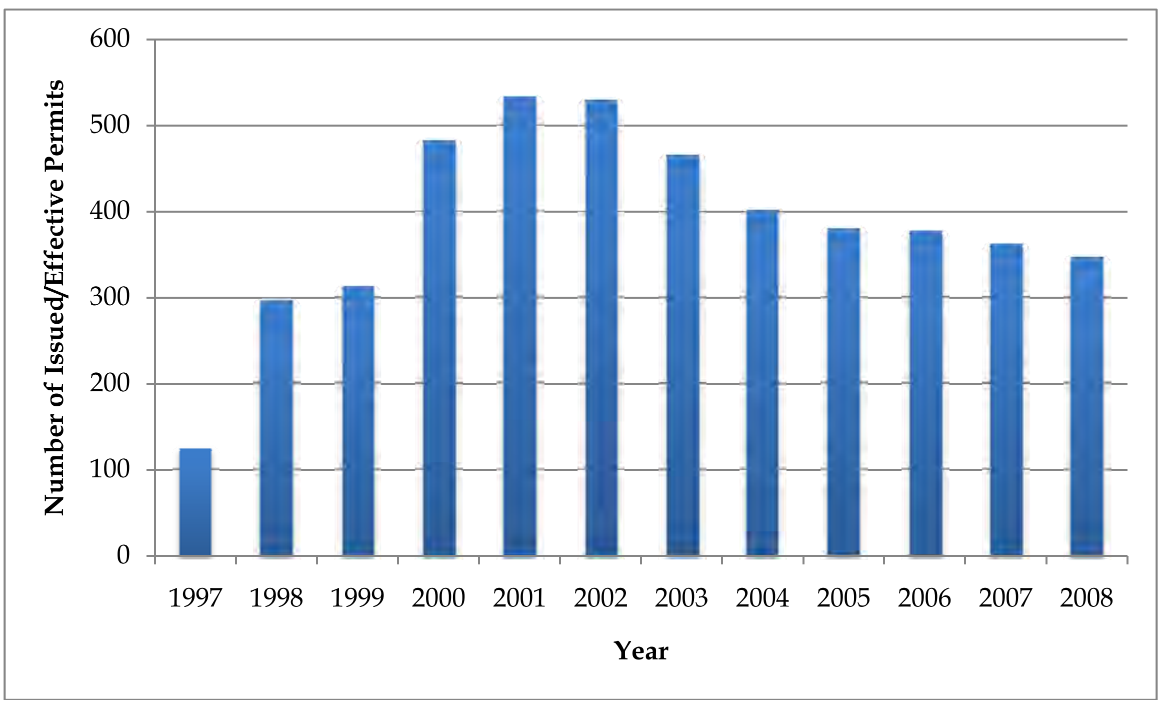


Figure 60: FDEP SED ERP issued/effective permits: 1997 - 2008[23].

The geo-referenced permit database of ERPs developed and populated from permit decision files provided by the FDEP SED office contained a subset of the permits described in the preceding paragraphs. Most notably, the SED office only contained a percentage of Martin County ERPs, of which the rest are housed in the SED Branch in Port St. Lucie and which could not be obtained for the project. Also, not all permits described above were available in digital format and thus could not be included at this time in the geo-referenced permit database, as the primary focus of the effort was on digital data mining and entry. Delegated ERPs to Broward County[23], and mangrove alteration and trimming permits delegated to Broward and Miami-Dade[24] counties were not available and thus could not be included in the geo-referenced permit database. ERP modifications were not included as separate permits in the geo-referenced database; instead, modifications were added to the permit activity section of the database that listed permit conditions.

Overall, the subsample of ERPs included in the geo-referenced database consisted of 1,059 ERPs[25], of which 344 permits pertained to Miami-Dade and Palm Beach County projects each, representing 32.5% of the database for each county. Almost a fifth of ERPs (18.7%, or 198 permits) were from Broward County, and 16.3% (173 permits) were from Martin County (Figure 61).

[23] From a Broward County delegated ERP database provided by FDEP SED that covered a seven year period (2001-2008), it was determined that 58.3% of the 276 delegated permits covered exempt activities, 83 permits (29.4%) were effective or issued, and 9 (3.2%) had been denied or withdrawn. Of the exempt permits, 79.5% involved docking facilities and boat ramps and 15.5% were de minimis activities. Within the various permit types, ERP Standard General Permits led all ERPs (56.6%), followed by modifications (22.1%), Individual Storm Water System ERPs (10.6%), Individual ERPs (.8.9%), and Noticed General Permits (1.1%). Within the Standard General Permit category, 37.5% concerned 1-2 new boat slips on an acre or less, and 26.6% were related to construction on between 0-1 acres of wetlands.

[24] Miami-Dade County DERM determined that since 1984, the county had issued 116 mangrove trimming permits, as well as eight mangrove removal permits since 1989 (Hill, personal communication). Similar information was not available for Broward County at the time of this report.

[25] Permit actions related to conceptual permits, formal definitions, and NGPs were entered in the geo-referenced database but were not considered in this analysis due to their minimal effects on impacts and mitigation.

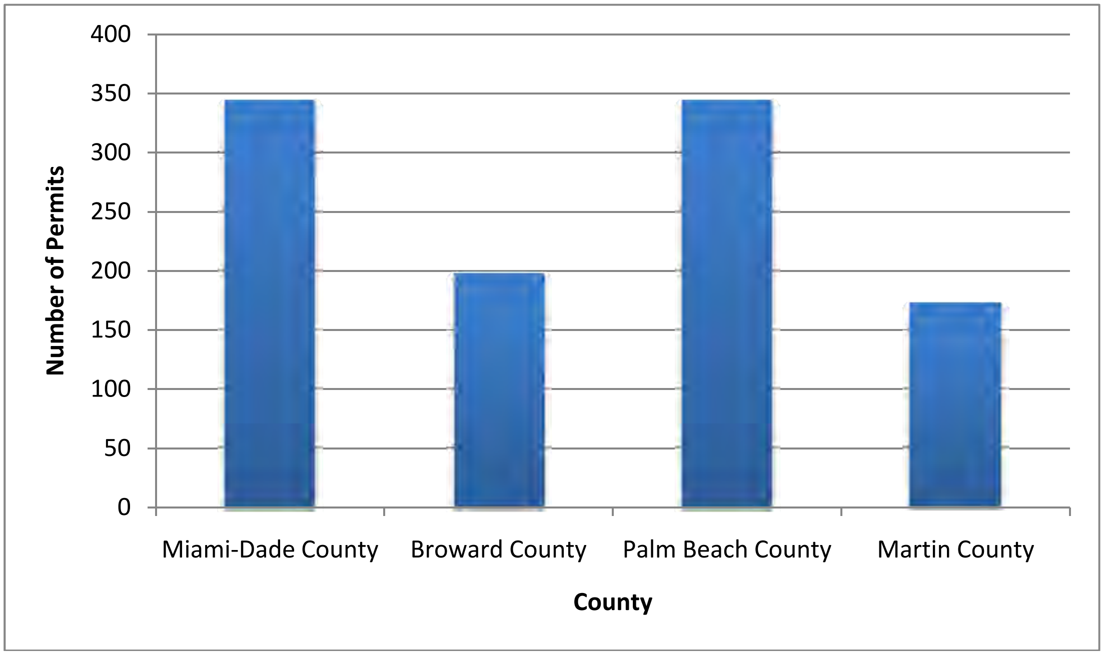


Figure 61: ERPs by county: 1995 - 2008.

With respect to project types (See Table 2), 25.7% of ERP projects were related to coastal construction involving estuarine or wetland fill (D1), followed by coastal construction seaward of the control line (D2) at 23.1% which did not involve a beach or dune system (otherwise, that sort of project would have triggered a CCCL permit), hard structural stabilization (B2) at 18.3%, new navigation dredging (N1) at 8.1%, coastal development involving estuarine dredging (D3) at 7.6%, and inshore energy projects (E1) at 5.7% (Figure 62). There were certain county-level differences, most notably related to mangrove alteration and trimming projects, which comprised 6.7% and 4.8% of Palm Beach and Martin County ERPs, respectively, but which were not issued for the lower two counties since those counties have delegated authority to issue their own mangrove permits. Also, coastal development projects that involved estuarine or wetland fill (D1) were less frequently issued in Miami-Dade and Martin counties (19%) than in Broward (33%) and Palm Beach counties (30%). Also, telecommunications projects (C1) were most often issued in Miami-Dade County, where 7.7% of all ERPs were related to telecommunications. Similar projects were less common in Broward (1.6%) and Palm Beach (1.3%) counties, and there were no telecommunications projects identified in Martin County.

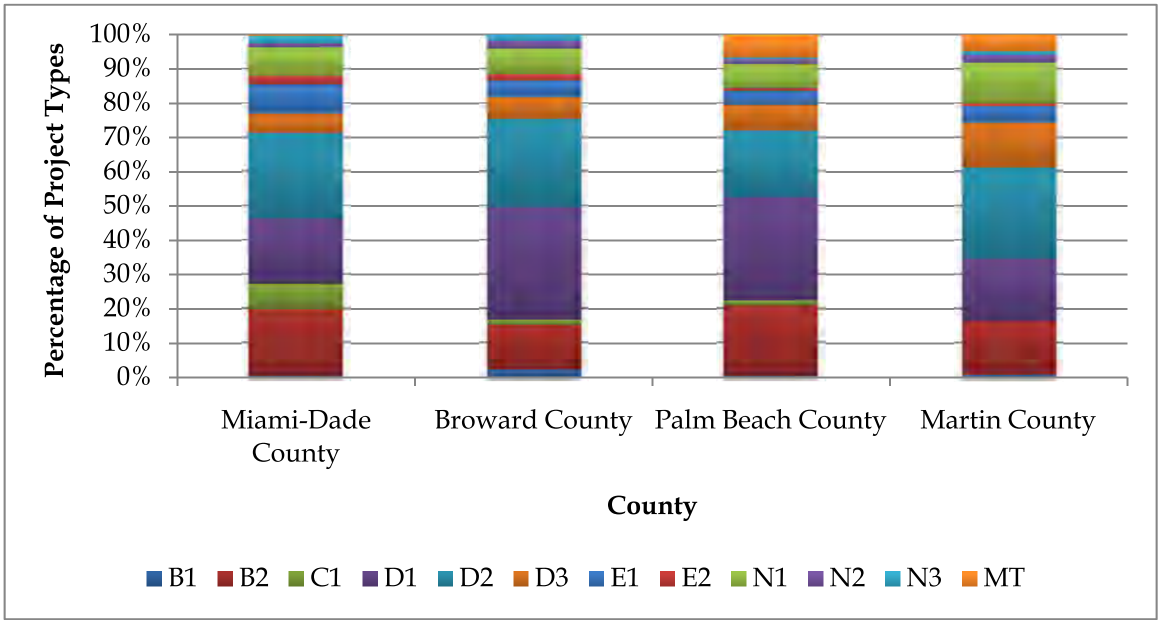


Figure 62: Percentage of ERPs by project type: 1995 – 2008 (see Table 3 for project type definitions and other details).

In terms of project goals, almost 77% of the permits concerned new projects, of which 59.6% did not include any other goals. Projects involving expansion comprised 11.0% of the permits and were most often identified in combination with other project goals (e.g., where a project involved expansion and another goal or goals). Similarly, while 20.3% of the ERPs included maintenance as a goal, it was most frequently identified in combination with other goals. Over 15% of the projects involved some type of reconfiguration, which, like the other goals, was most commonly part of a series of project goals. Finally, 14.3% of the ERPs had upgrades as part of their project goals in combination with one or more of the other goals.

Impact categories affecting ERPs were dominated by biological impacts (47.1%) and water quality impacts (40.1%) (Figure 63).Physical impacts were less important, at 12.4%. This finding was to be expected from the ERP program criteria, which consider biological impacts related to adverse effects on fish and wildlife and water quality impacts on surface water flow and quality as among the most important factors in making permitting decisions (ERP, 2009). There were no important differences in impact types across counties, although Palm Beach County permits did contain a slightly higher percentage of biological impacts (51.2%) and a lower percentage of water quality impacts (37.2%) compared to the rest of the region.

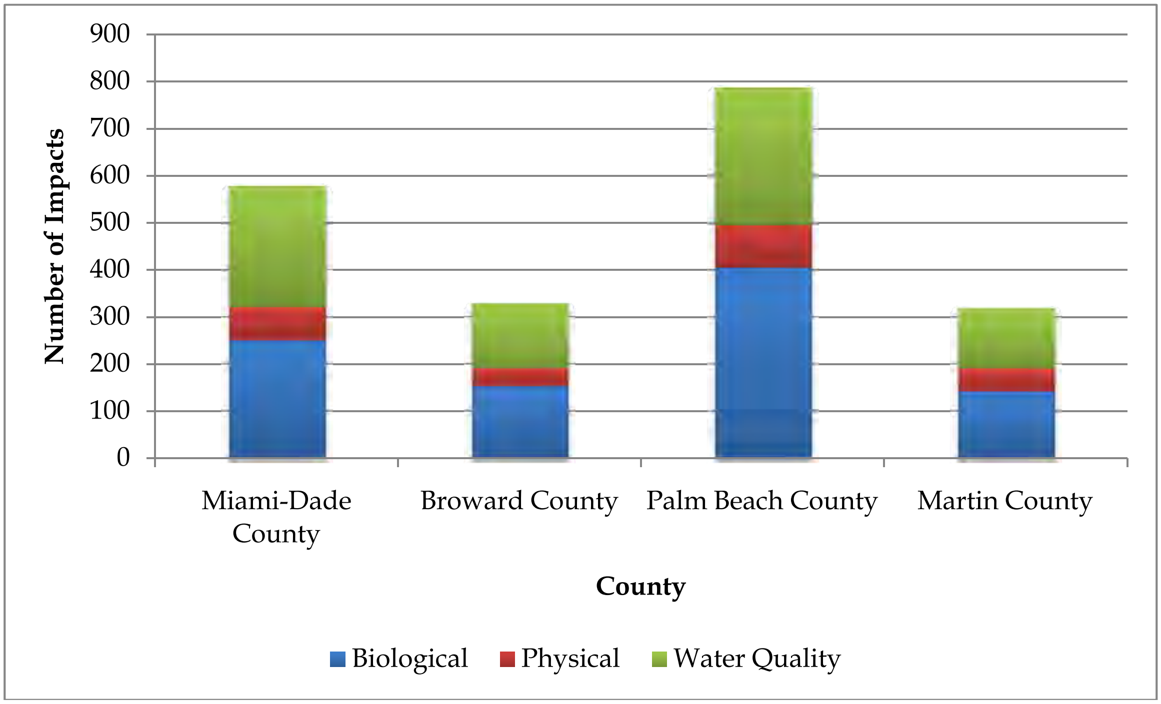


Figure 63: ERPs by impact category: 1995 - 2008.

The most frequently listed biological impacts were related to wetlands and wetland vegetation (18.9%), which were associated mostly with Palm Beach and Miami-Dade counties' projects, followed by construction or dredging activities related to manatees (13.9%), impacts to mangroves via trimming or alteration (6.0%), and impacts to seagrasses resulting from construction, vessel traffic, or dredging (3.0%). Coral reefs and hardbottom community impacts constituted only 0.5% of the listed impacts, as most ERPs did not directly affect coral reef environments. Turbidity (19.6%), pollution (6.3%), sedimentation (4.6%), and general water quality (4.0%) were the most frequently listed water quality impacts, with associated impacts such as light penetration (0.5%) and storm water discharge (0.2%) being less frequently identified. Among physical impacts, erosion (2.4%) and impacts to the shore, shoreline, and beach system (0.9%) being the most common impacts identified.

Finally, mitigation measures were an important component of ERP impact management. The most frequent approach to addressing impacts in ERP projects was minimization (48.9%), followed by avoidance (34.6%) (Figure 64). Where such approaches could not be employed, compensatory mitigation (12.7%) was most commonly used (both on-site and off-site measures were listed in the various mitigation projects mandated by the ERPs). Also, while not as common as the other measures, compensatory mitigation was also used to recover impact damages, and it represented 3.8% of all mitigation measures. Palm Beach County mostly relied on active forms of mitigation (i.e., using mitigation and compensatory mitigation) where these forms of mitigation measures made up 17.5% of all measures. Conversely, Broward County relied more on avoidance and minimization, as its active mitigation measures accounted for 12.1% of all measures.

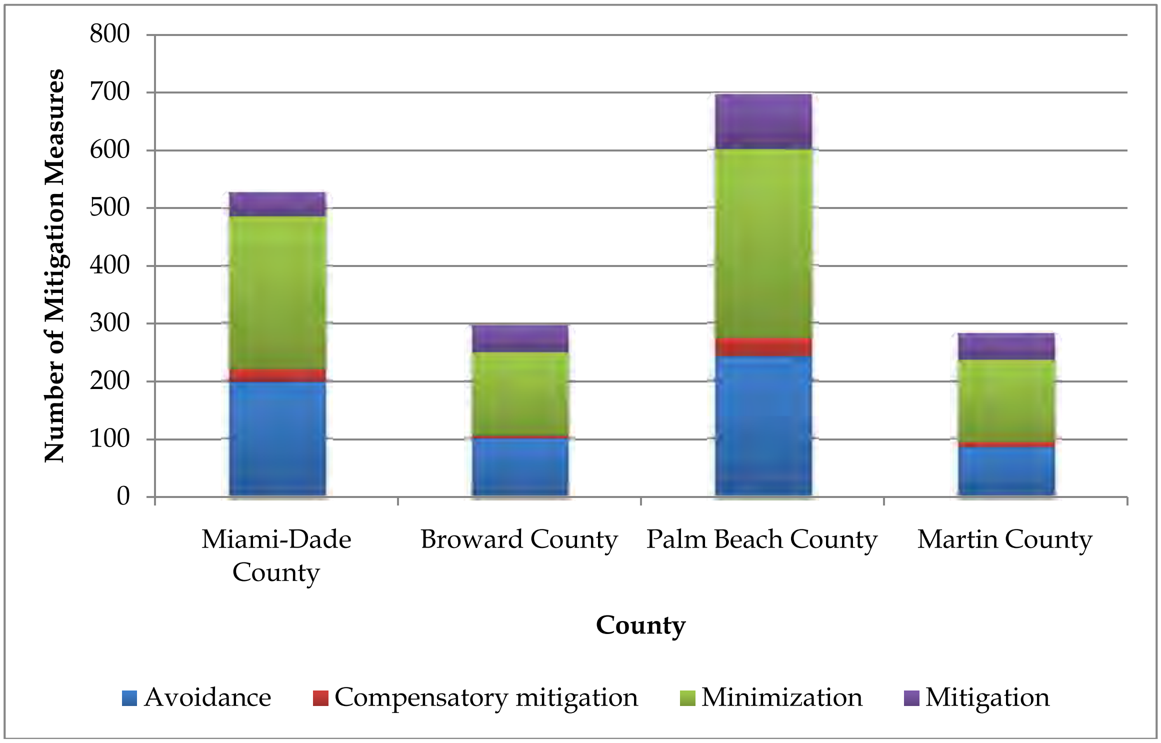


Figure 64: ERPs by impact mitigation measure: 1995 - 2008.

GIS maps were created using the geo-referenced database of ERP projects which identified the various projects across the four counties (Figures 65-68). The projects were spread all over the counties and included many inland projects. However, ERPs in general were located along surface water and coastal regions.

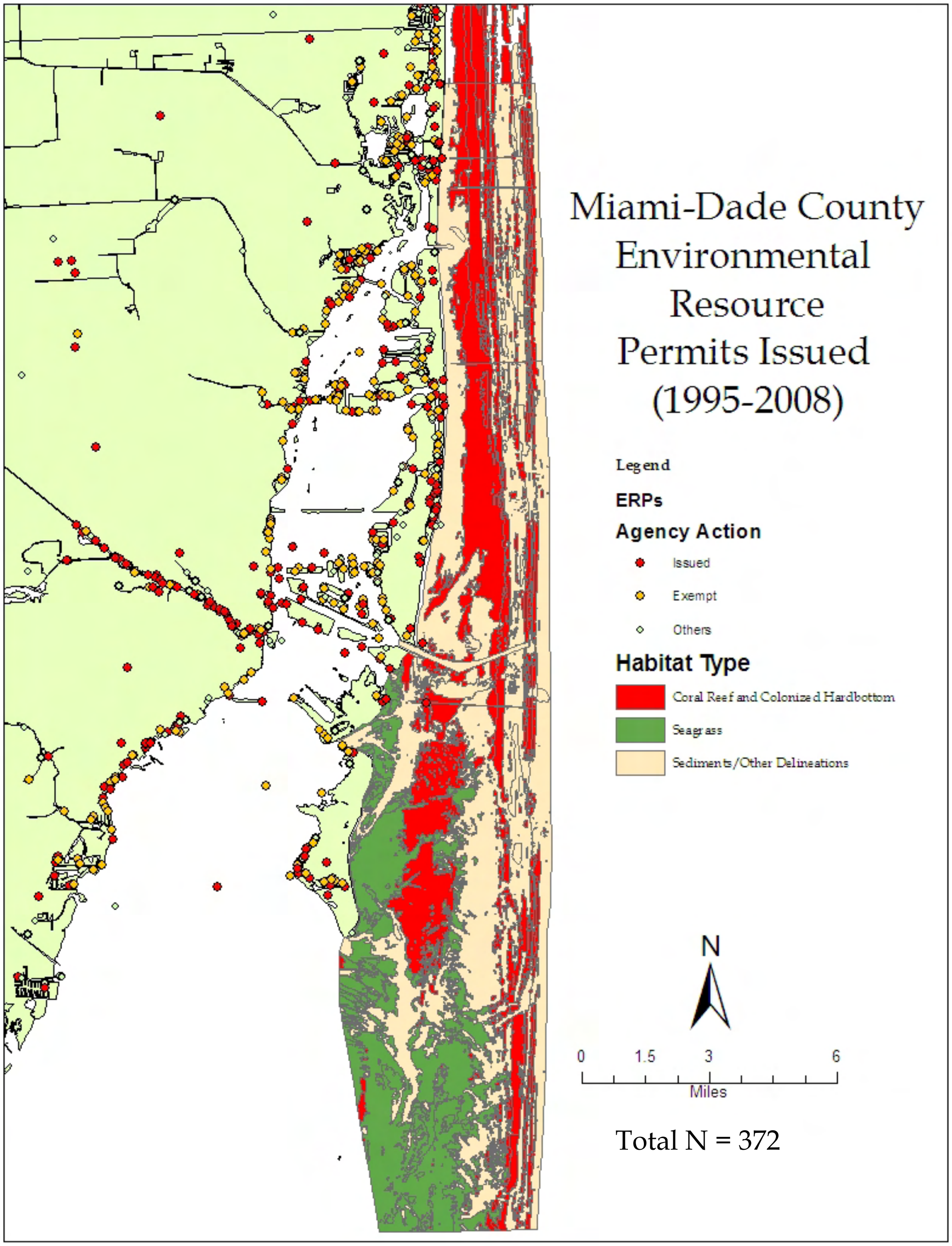


Figure 65: All issued and exempt ERPs in Miami-Dade County: 1995 - 2008.

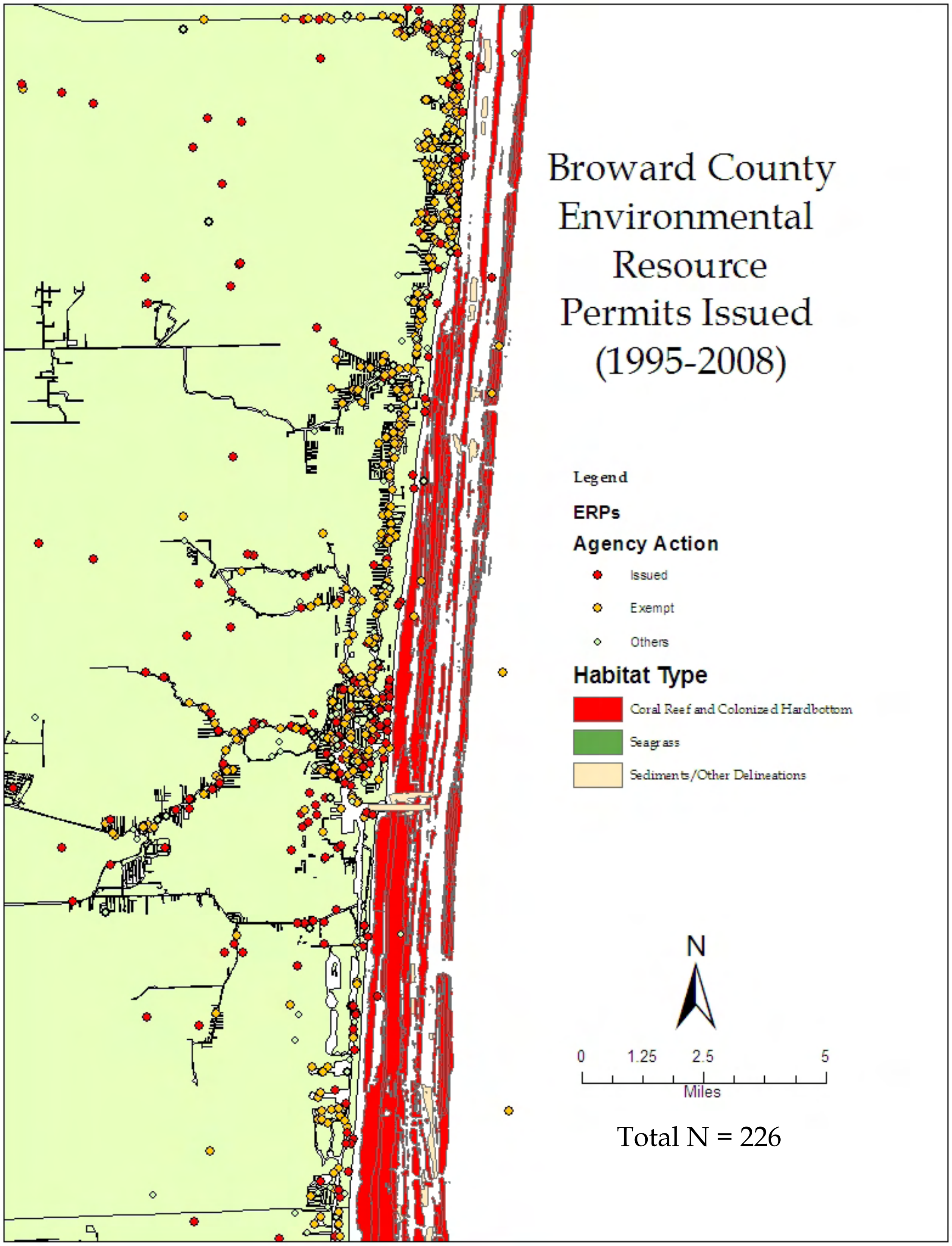


Figure 66: All issued and exempt ERPs in Broward County: 1995 - 2008.

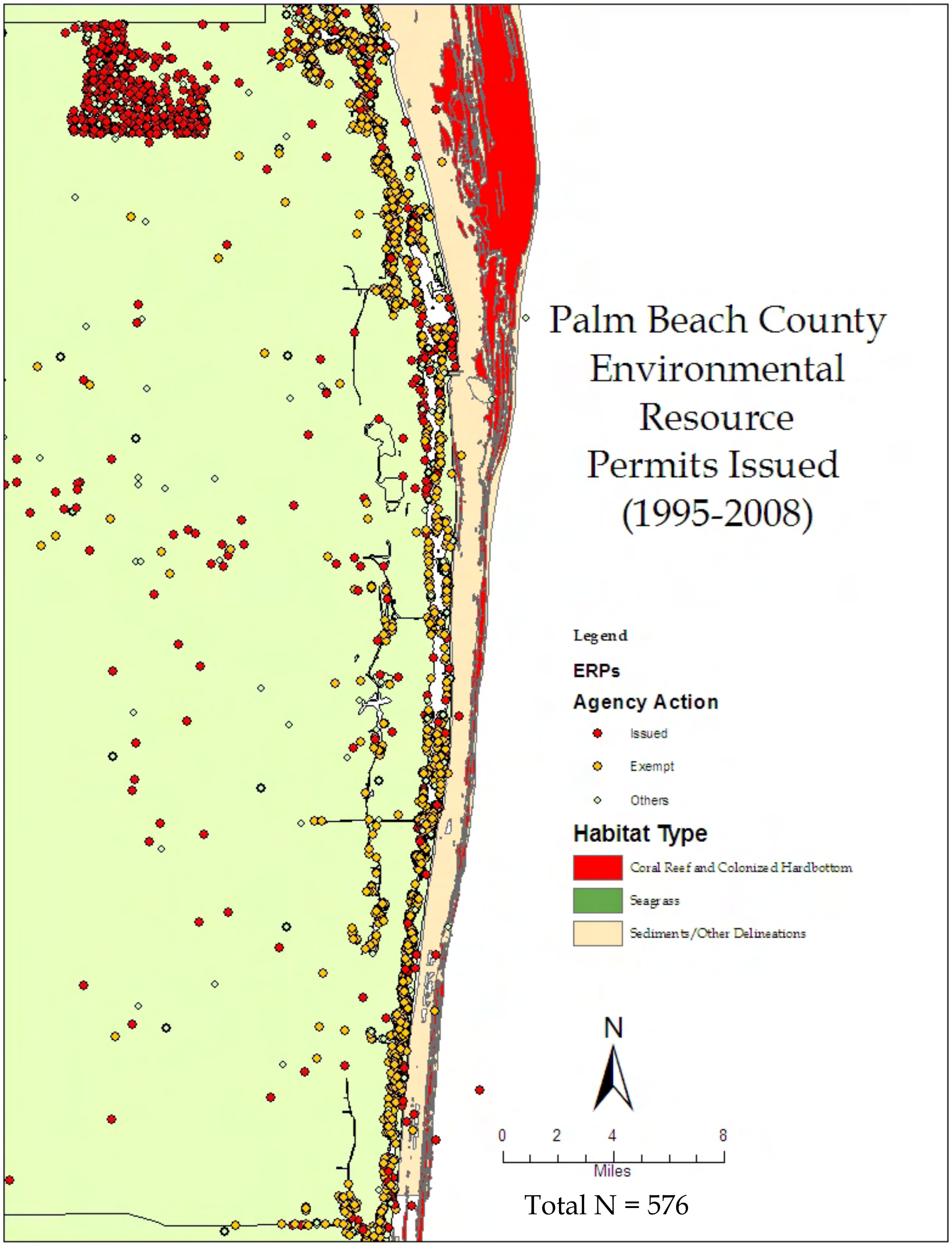


Figure 67: All issued and exempt ERPs in Palm Beach County: 1995 - 2008.

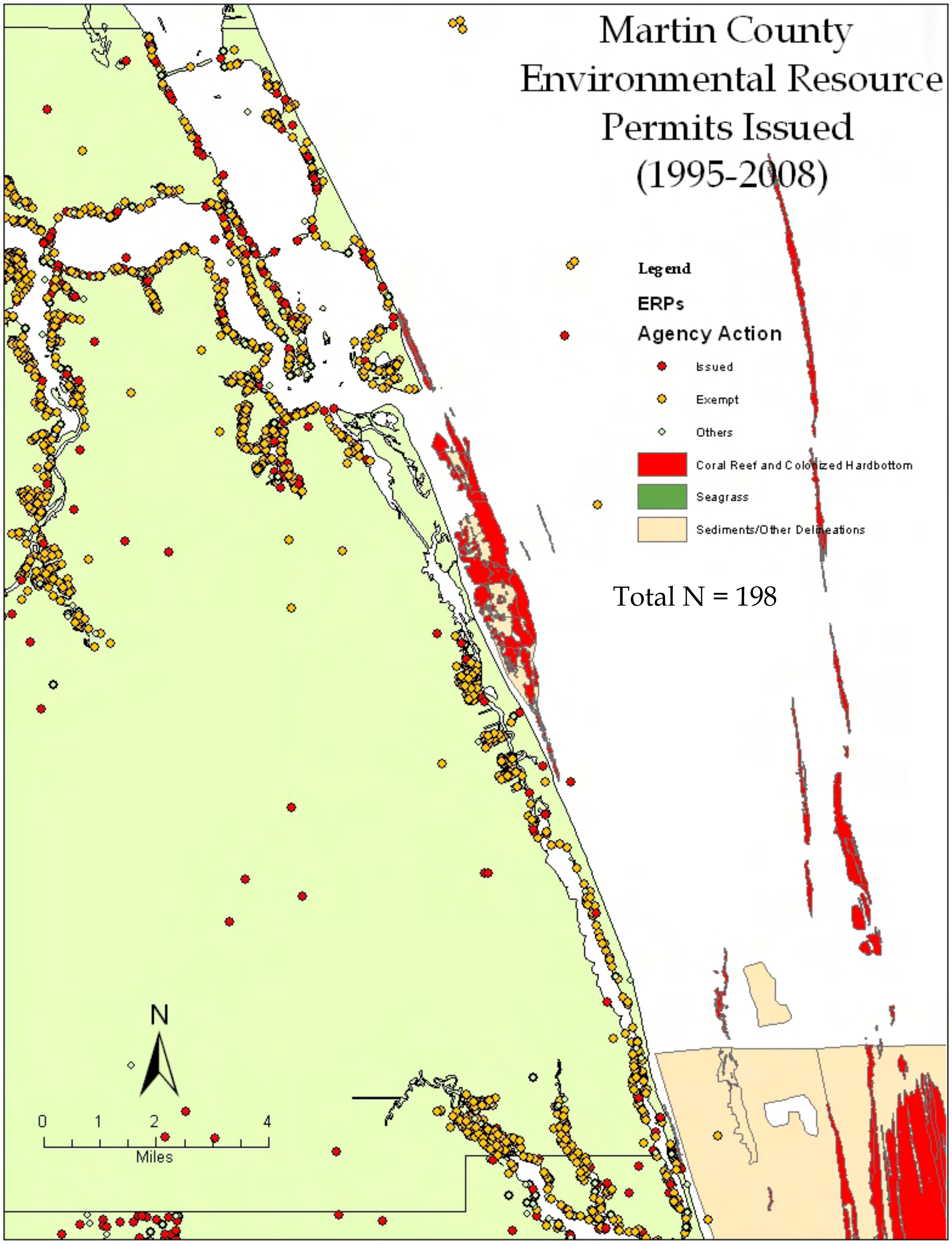


Figure 68: All issued and exempt ERPs in Martin County: 1995 - 2008.

JCP database

FDEP BBCS provided a JCP database that was used to identify JCP projects for the 1995-2008 period. Consisting of 216 entries, the database provided contained summary permit information, including the project title, permit type and subtype, and permit status. Over 37%, or 80 entries, were from Palm Beach County, compared to 32.9% (71 entries) from Miami-Dade County, 19.0% (41 entries) from Broward County, and 11.1% (24 entries) from Martin County.

A majority of the issued permits; however, concerned variances and modifications, and the final list of permits used for the geo-referenced database contained 69 permits. Of these permits, 39.0% (27 permits) were issued in Palm Beach County, 26.0% (18 permits) were issued in Broward County, 20.3% (14 permits) were issued in Miami-Dade County, and 14.5% (10 permits) were issued in Martin County (Figure 69).

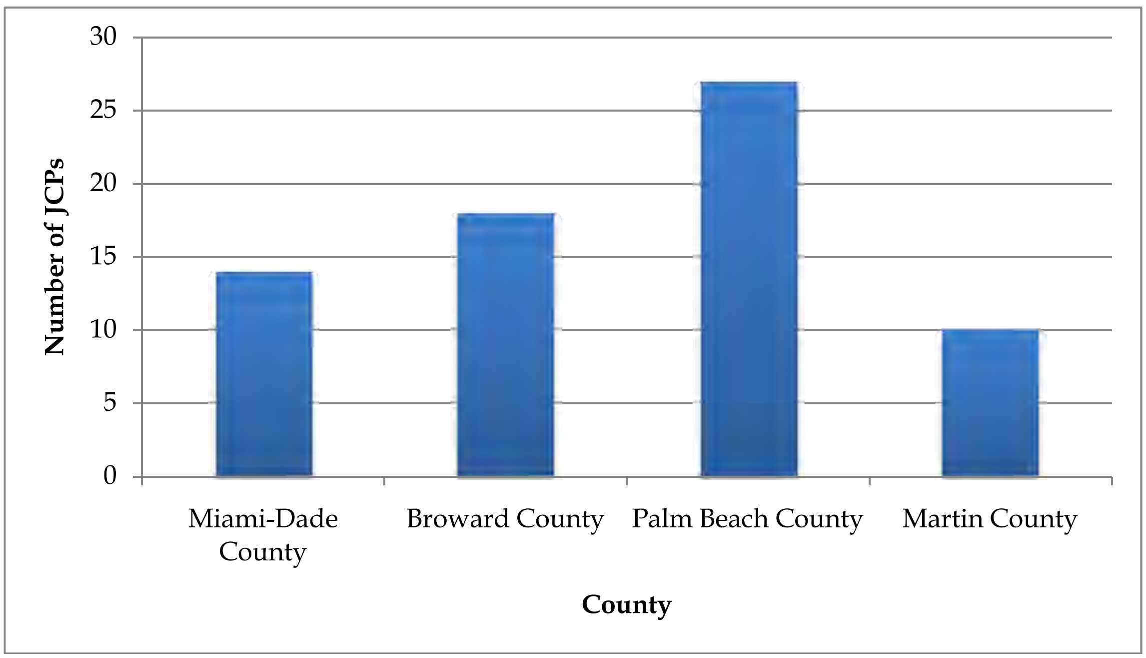


Figure 69: Number of JCPs by county: 1995 - 2008.

Permit types varied somewhat across counties, but B1 project types – related to beach nourishment and other soft stabilization projects – dominated JCPs in all four counties, accounting for between 23.5% of all JCP projects in Broward County to 57.7% of all JCP projects in Palm Beach County. Soft stabilization was the most frequently undertaken JCP project type, with 45.1% of all projects in the region involving soft sand stabilization (Figure 70). Hard stabilization projects (B2), which made up 13.0% of all JCP projects, were used in the lower three counties and represented almost a fifth of all Miami-Dade County projects, but hard stabilization was not used in Martin County. Over 19% of Palm Beach

County projects and approximately 10% of Broward and Miami-Dade County projects involved maintenance dredging (N3); whereas expansion dredging (N2) was the primary objective of a quarter of Broward and Martin County's projects. Dredging activities of all kinds represented 25.8% of the JCP projects. Finally, less frequent JCPs included energy related projects (E1), of which there was one example in Miami-Dade County, three estuarine or wetland fill projects (D1) in Broward and Miami-Dade counties, and two communications projects (C1) in Broward and Palm Beach counties. Unlike the wholly coastal CCCL permits and the mainly coastal and inland ERPs, JCPs were all related to activities permitted in marine habitats and thus were most likely to directly impact corals reefs and related habitats. While direct impacts were least likely from beach nourishment projects, the most frequently issued JCP project type, these projects were invariably planned to address and minimize secondary impacts from sand placement, especially sedimentation and turbidity resulting from placement and erosion. Other, wholly in-water projects, such as dredging operations, were more likely to have direct impacts with marine habitats, including corals.

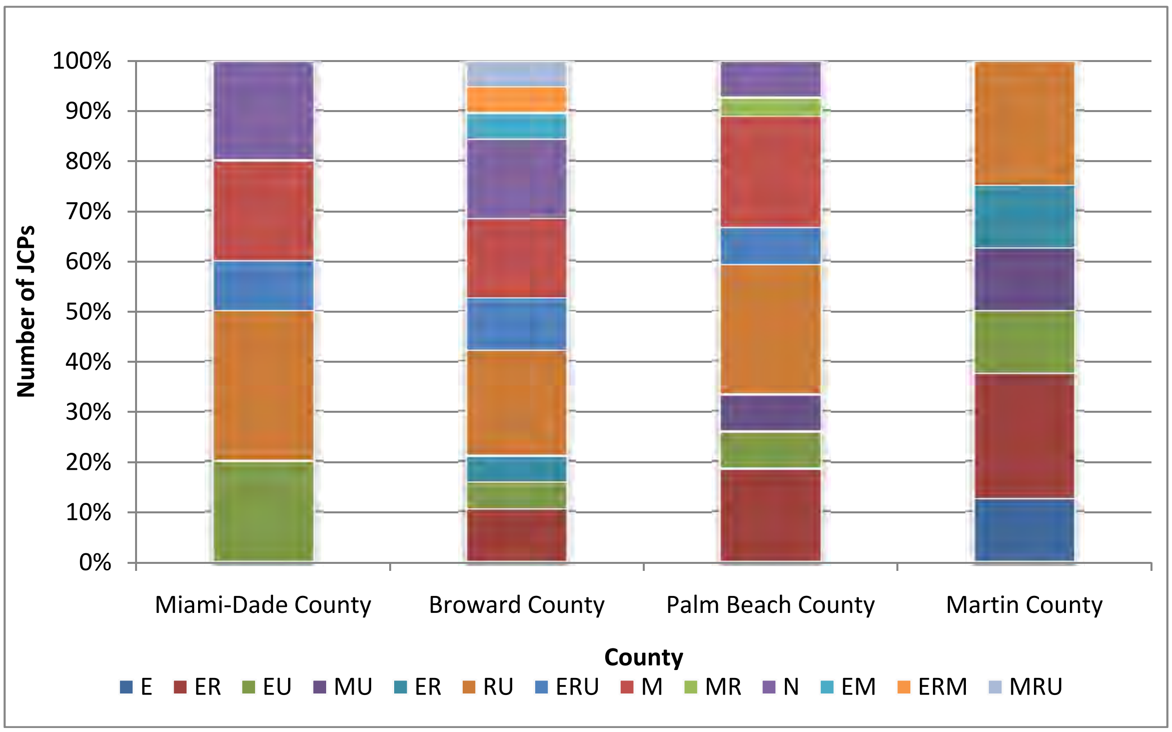


Figure 70: Percentage of JCPs by project type: 1995 - 2008.

In comparing the frequency of JCP projects based on the nature of project goals that each represented (E = expansion; M = maintenance; N = new; R = reconfiguration; U = upgrade, and combinations of each project type), it was determined that 54.7% of all JCPs involved reconfigurations and that 48.4%

involved upgrade activities (Figures 70 and 71). Over 40% of the projects were related to expansion, and 28% included some form of maintenance.

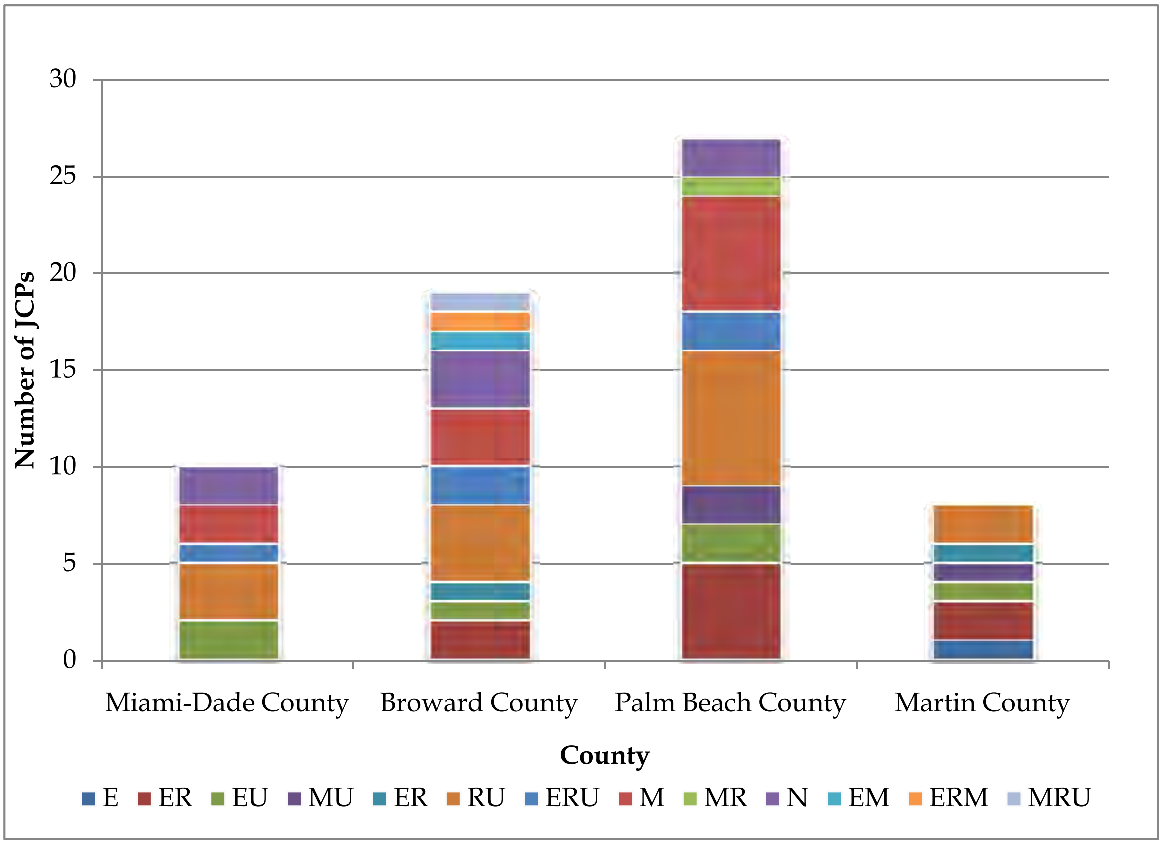


Figure 71: JCPs by project category: 1995 - 2008.

In terms of overall impacts, biological impacts exceeded all other categories of impacts, comprising 74.8% of all impacts identified in the project description and other documentation of all JCPs (Figure 72). Water quality impacts accounted for 16.6% of all impacts associated with JCPs, followed by physical impacts (8.6%). The most frequently cited impact was sea turtle impacts resulting from sand placement, dredging, and cable placement operations, among others (21.7%), followed by manatee impacts from dredging and other vessel-based, in-water activities (17.1%), increased turbidity (14.4%), and mechanical or sediment-related seagrass impacts (9.5%). Coral reefs, including areas with the threatened *Acropora* species, and hardbottom communities made up 7.1% of all listed impacts, and these were related mainly to physical damage from dredging and related operations, sedimentation and smothering from beach placement projects, and cable placement over coralline habitats.

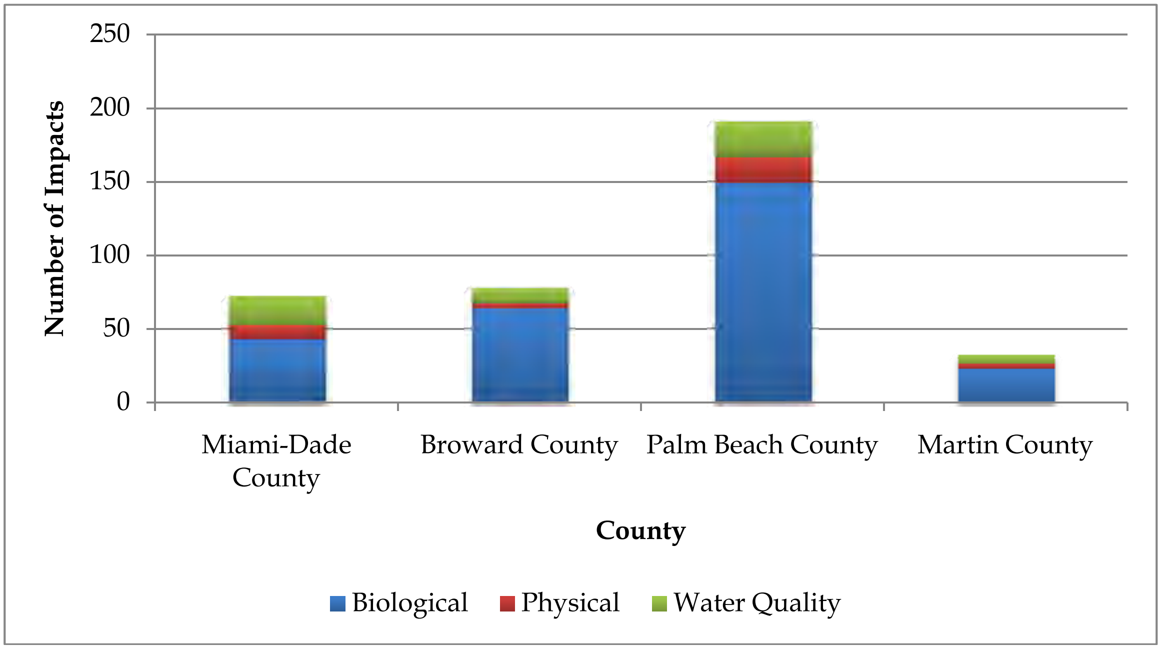


Figure 72: Number of JCP permitted impacts by category: 1995 - 2008.

Mitigation measures taken to offset the impacts resulting from JCP activities varied somewhat across counties, but all counties relied on avoidance, which comprised almost 30% or more of the mitigation measures taken in each county (Figure 73). Overall, avoidance represented 38.0% of all mitigation measures. Mitigation was also a popular option representing a quarter of all mitigation measures, and especially so in Martin County where it made up more than half of the mitigation measures and in Broward County where mitigation comprised 42.0% of the mitigation measures. Finally, compensatory mitigation, which was used only in 14.4% of all JCPs, was most frequently used in Palm Beach County, where 17.2% of the mitigation measures involved compensatory mitigation.

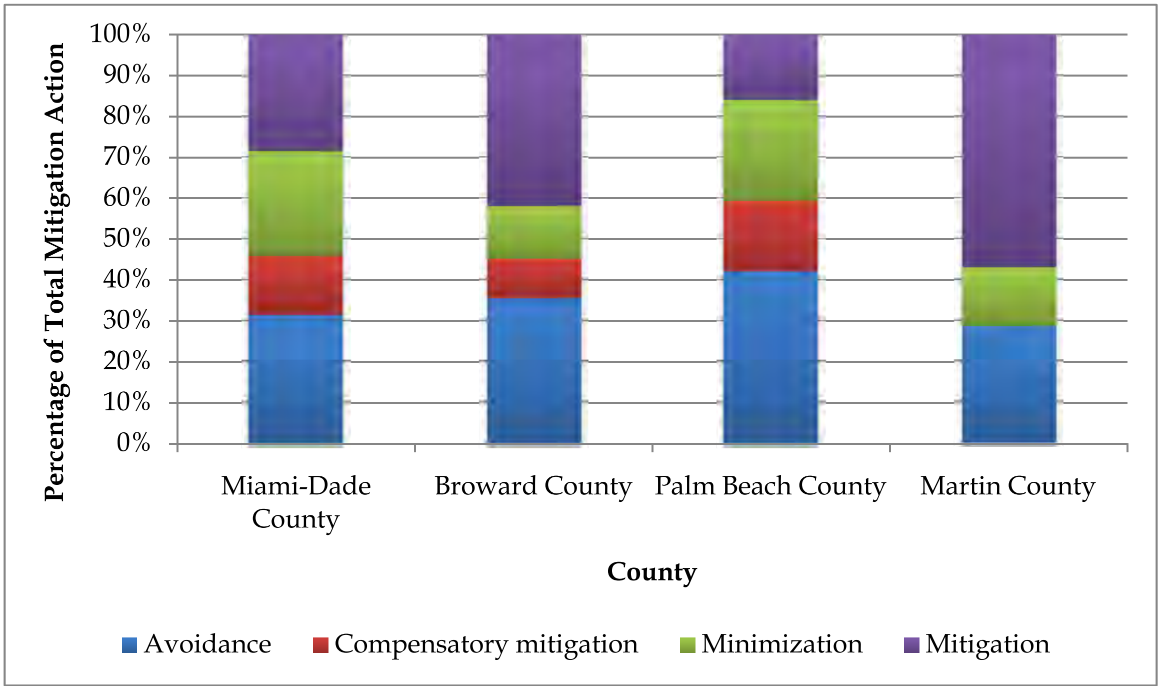


Figure 73: Percentage of JCP impact mitigation measures by county: 1995 – 2008 (see Table 2 for project type definitions and other details).

JCP projects in the four county region were spread across the counties' coastlines (Figures 74-77). While the location as shown in the maps for each project is the central point of each JCP, it should be noted that JCP projects were among the most extensive projects covered in the geo-referenced database and often extended for several kilometers along the coastline (e.g., beach nourishment projects).

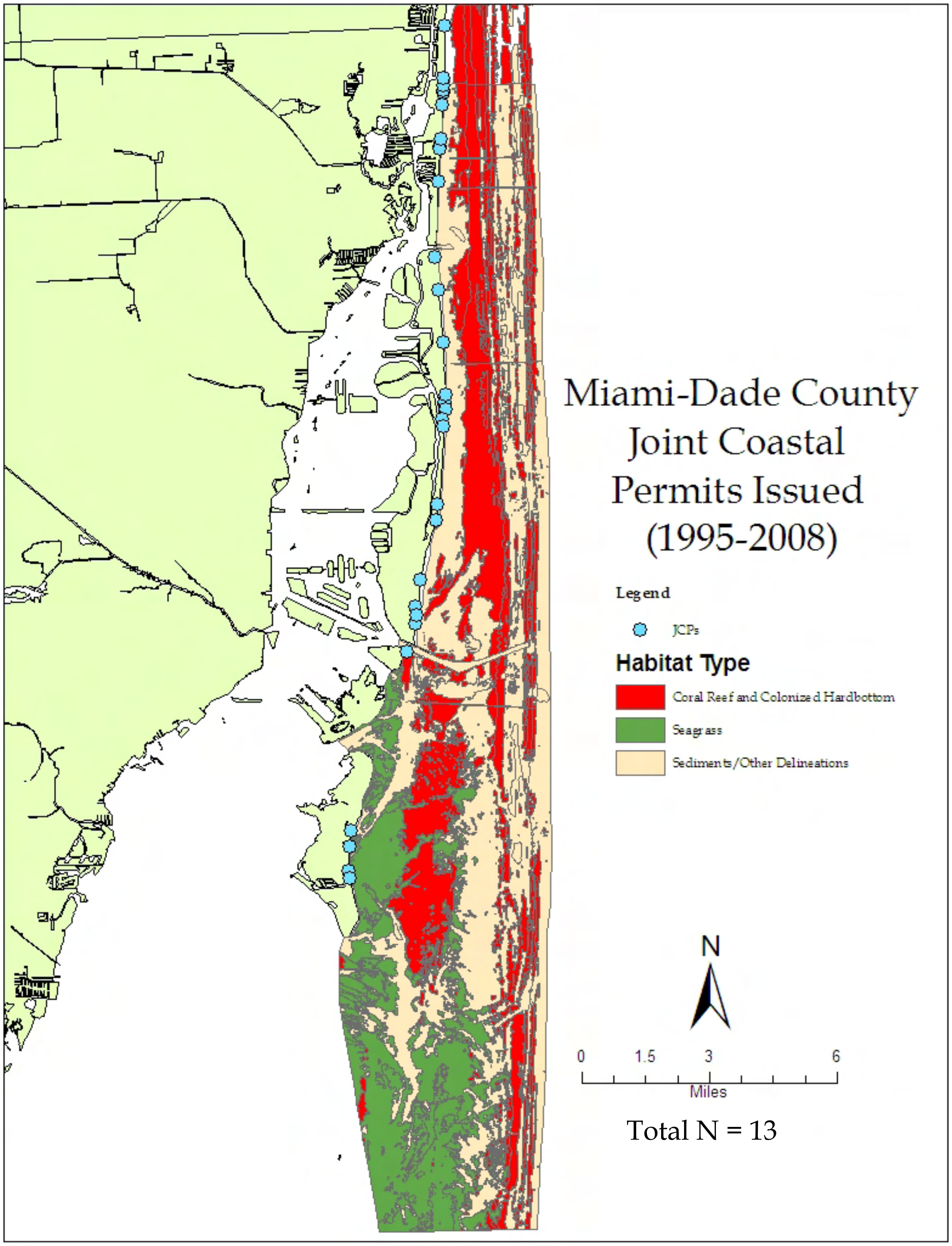


Figure 74: JCPs issued in Miami-Dade County: 1995 - 2008. Points represent general location of impact, therefore, one permit (N) may contain multiple points.

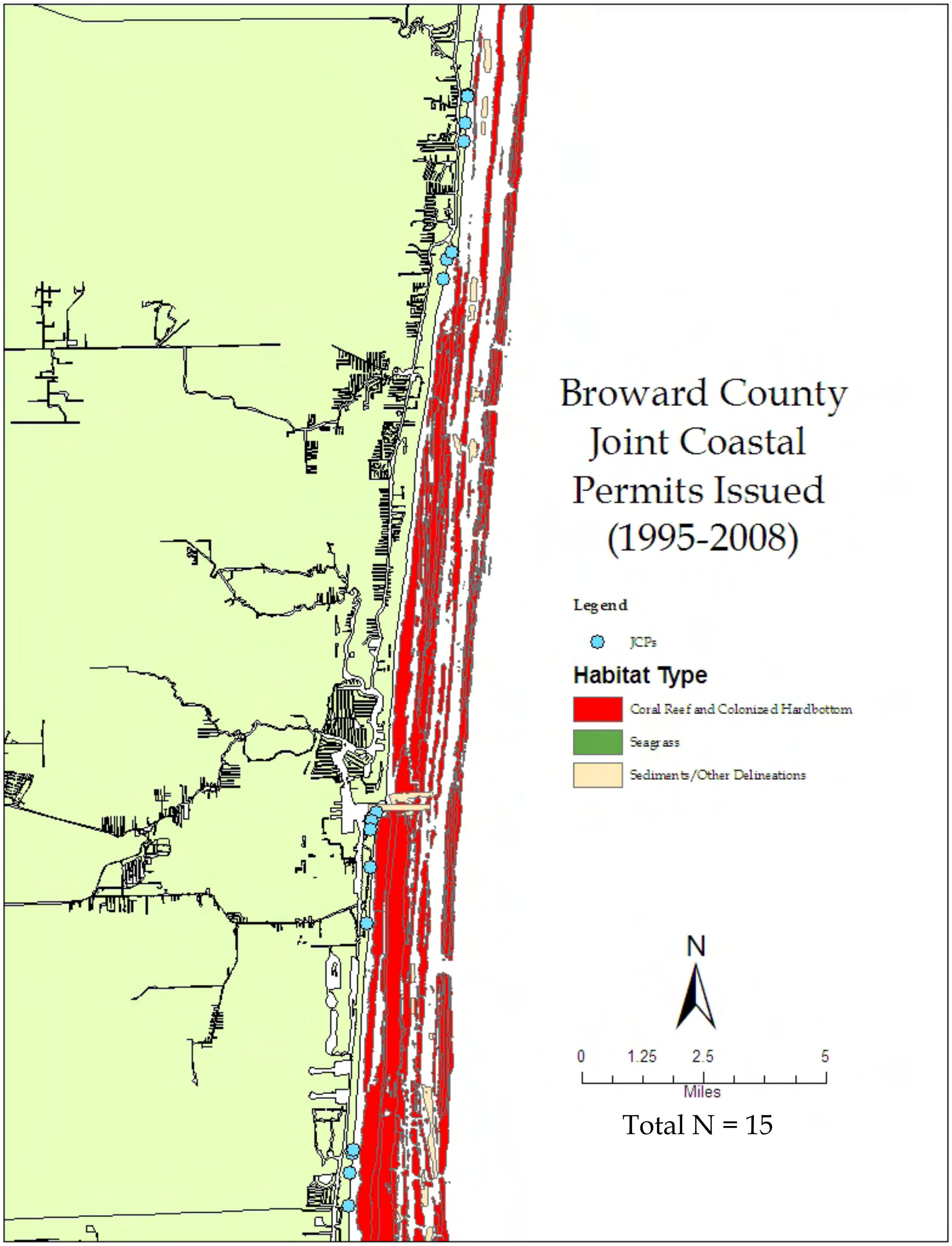


Figure 75: JCPs issued in Broward County: 1995 - 2008. Points represent general location of impact, therefore, one permit (N) may contain multiple points.

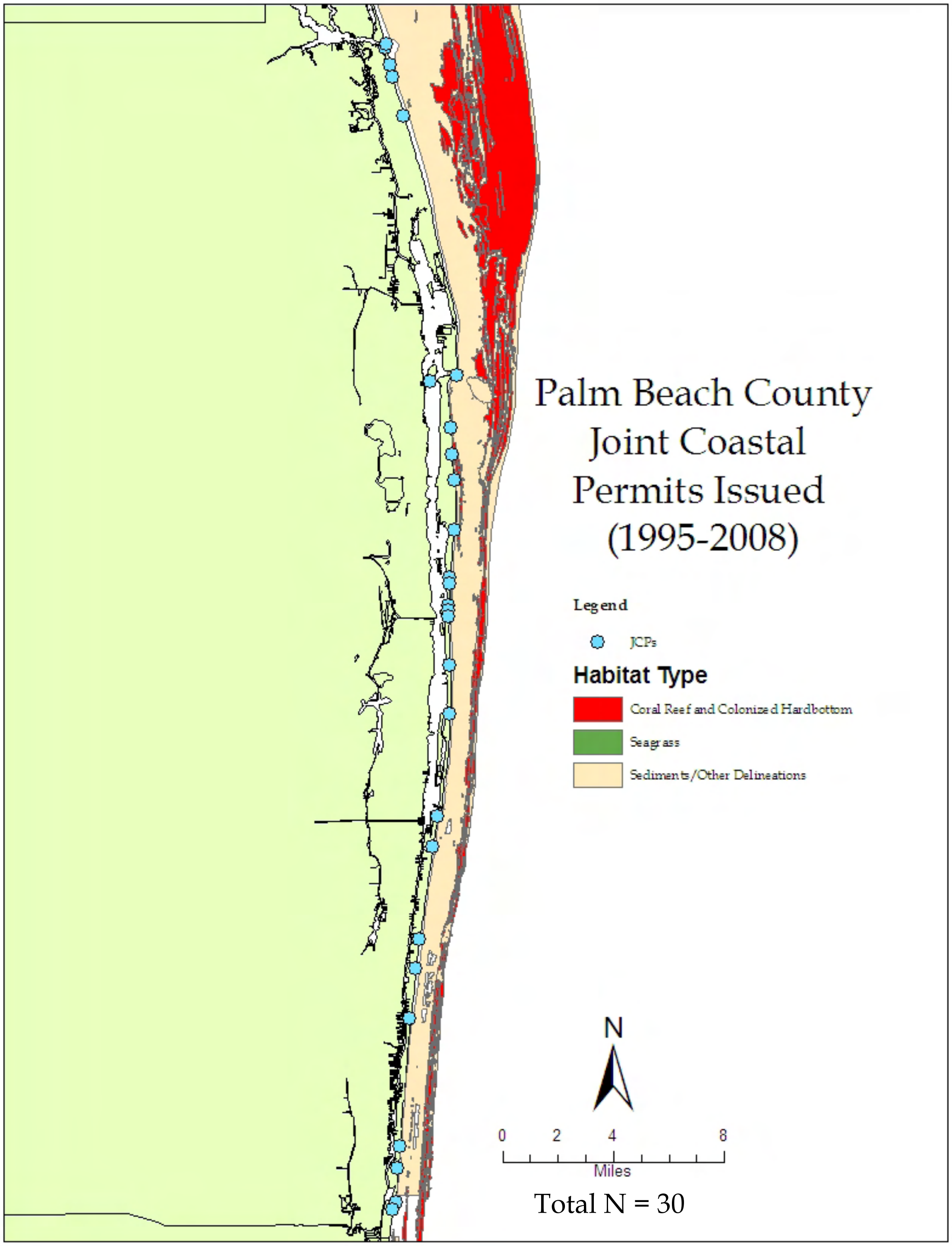


Figure 76: JCPs issued in Palm Beach County: 1995 - 2008. Points represent general location of impact, therefore, one permit (N) may contain multiple points.

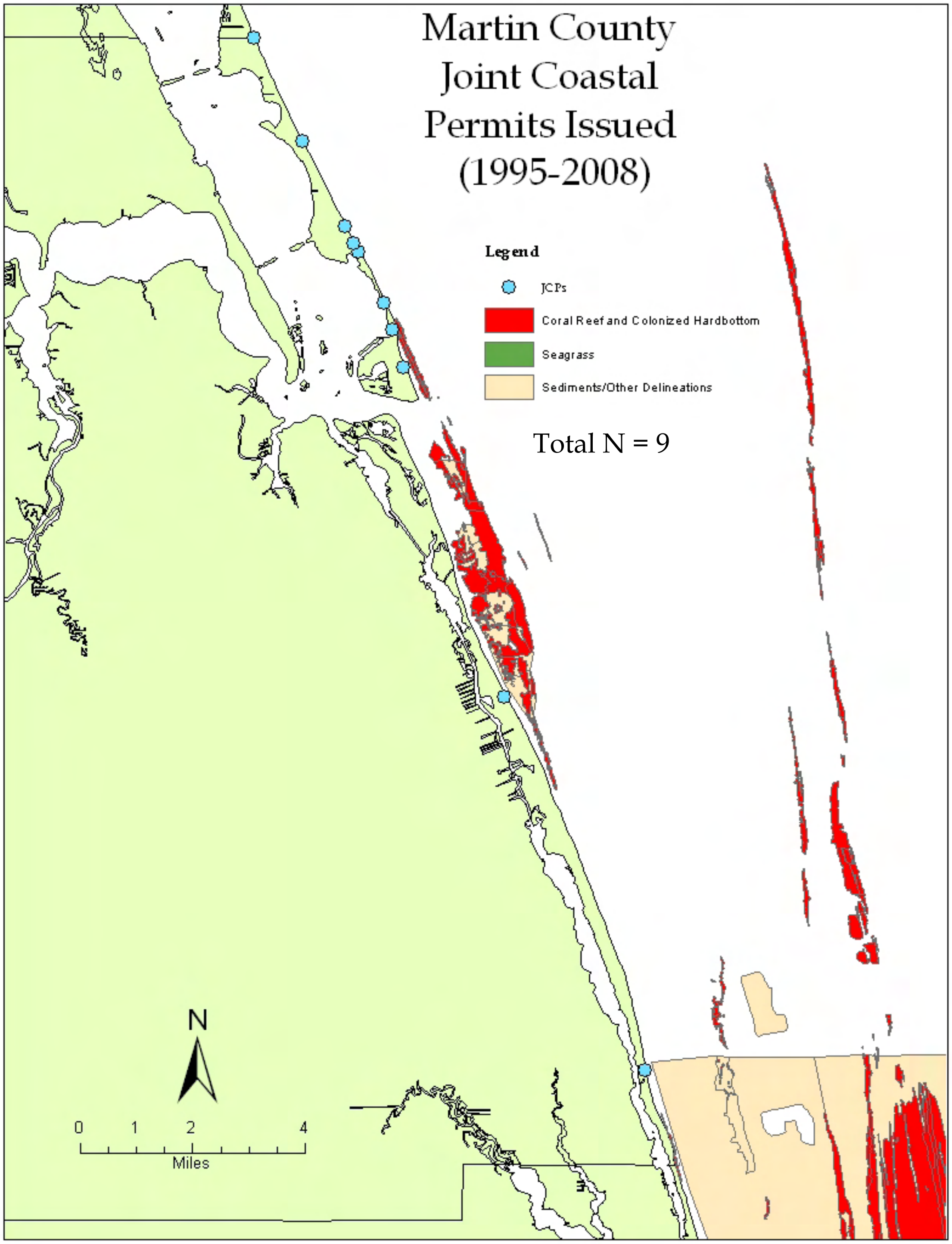


Figure 77: JCPs issued in Martin County: 1995 - 2008. Points represent general location of impact, therefore, one permit (N) may contain multiple points.

4. Recommendations on Addressing Cumulative and Indirect Impacts Resulting from Coastal Construction Activities on Coral Reefs and Associated Ecosystems

This document, along with the geo-spatial permit database, was developed to be of benefit to project planners, reviewers, and permitters of large-scale coastal construction projects. The primary objective was to help ensure a sufficient and consistent level of baseline information were readily available for the decision-making process. This document contains essential references, discusses past project lessons learned, and presents a holistic view of resource issues as needed for project planners, reviewers, and permitters in the southeast Florida coastal region.

The project activities and analyses led to the following key findings:

1. Permit records of past projects, especially those that predated the NEPA era (or prior to the early 1970s), were largely unavailable and, where available, were of an uneven quality and detail. This patchiness in data availability and quality was overcome by developing trends for coastal construction and resource assessment, such that planners, reviewers, and permitters could have sufficient information on inter and intra-county conditions and changes in those conditions over time;
2. Permit data over the ERP/JCP era, with the exception of certain JCP projects, largely lacked information related to during permit variances and post-permit monitoring. Therefore, cumulative and indirect impacts could not be accurately assessed from the permit records alone;
3. Activities and uses across sectors that were (because of the nature of the exercise) excluded from consideration in the assessment of cumulative and indirect impacts may have interacted synergistically with coastal construction activities in some cases to exacerbate impacts and antagonistically in other cases to dampen impacts;
4. Permitting conditions under the three main permit types are structured such that pre-permit assessments must either find no-net impacts or that the permittee must conduct mitigation. Thus, if the conditions are taken at face value, then it has to be assumed that permits cannot have impacts.

In terms of the first finding, much of the data located for coastal construction projects in southeast Florida predating the ERP/JCP era were obtained from permit files, assessments, and environmental impact statement documentation. A majority of state level coastal construction permit files were unavailable in digital format and would require considerable effort in locating, copying, and scanning either microfiche or hard copies. Similarly, older assessments and NEPA documentation (FONSI, EA, EIS) became less available with older projects, especially those pre-dating the NEPA era. Historical and US Census reports, documents, and statistics provided the means by which a six-decade trend in coastal construction in southeast Florida was developed, highlighted by large-scale projects that were well documented. Coastal resource conditions and changes over time to those resource conditions were obtained using peer-reviewed and gray literature and reports. As conducted for coastal construction, coastal resource conditions were presented in terms of trends, where major shifts were provided based on literature availability.

In terms of the second finding, part from JCPs, which were among the largest and most comprehensive permitted projects analyzed as part of the study, most permits entered into the geo-referenced database did not contain much monitoring or compliance information. Indeed, smaller scale ERPs and a majority of the CCCL projects evaluated did not contain conditions related to post-project monitoring. Those that did included separate monitoring and assessment studies, on mitigation plans related to seagrass planting, dune construction, etc.; however, within the permitted project files and related material, the medium term success (i.e., greater than two years) of such plans could not be ascertained (the separate MICCI Project 27,47,48 is focused on monitoring standards). Moreover, because the focus of this project was on acquiring and entering permits, it became clear that if permits are to be used as the main unit via which to evaluate impacts, it would be most useful if each permit contained information on the effectiveness of its actions. Two examples from the permit database illustrate this point:

- First, the JCP database included several permit files on large beach nourishment projects that involved soft stabilization as a core objective. Nourishment would likely have the impact of maintaining or increasing visitation rates; indeed, tourism and beachfront values are among the ancillary benefits of beach nourishment in Florida (FDEP, 2008). However, increased beach visitation and demand on local resources may in fact lead to a higher strain on local infrastructure, requiring increased housing and other structures, the need for capital improvement, and surveillance and monitoring, all of which may in fact exacerbate cumulative impacts.
- Similarly, high-density development projects as identified mainly in Miami-Dade and Broward counties permitted under the CCCL program may not result in net impacts from coastal construction activities (e.g. excavation, fill, debris, lighting, etc.); however, in many cases, these activities involve the demolition of smaller multi-family residences,

which are replaced with larger ones that can house many more residents. Thus, while the impacts from coastal construction may be ameliorated by permitted special conditions, the impacts resulting from an increased waterfront population, its demands, and its activities may in fact add to cumulative impacts in the area.

While many studies (Wanless and Maier, 2007; Peterson and Bishop, 2005; etc.) have argued that permitted activities result in greater impacts than estimated during the permitting process, few studies have evaluated how permitted projects have varied from their original conditions, and how the variances (or nonconformity) have affected the overall region and led to indirect and cumulative impacts. Brody and Highfield (2005) examined the spatial distribution of Florida wetland resource permits over a ten-year period to evaluate the level of conformity within permit clusters in the state. Their results demonstrated that while permits in the most urbanized parts of the state mostly conformed to their permit conditions (in terms of spatial distribution), the sheer volume of permits in areas like South Florida, coupled with lower capital investments (related to infrastructure development in transportation, for example), led to development out of the urban fringe, increasing nonconformity. These variances were indeed departures from the original permitting and planning approach and represented a post-permit impact that could not be adequately captured by a permit analysis.

Similarly, Ruppert (2008) argued that due to the allowance for variances, emergency permits, and after the fact permits, the CCCL program has undermined its permitting criteria, and that such exceptions vary considerably from the program's intent and, most importantly, lead to cumulative impacts. Finally, in a 2001 report completed by the Office of Program Policy Analysis and Government Accountability (OPPAGA), it was determined that under the ERP program, cumulative impacts could not be precisely identified. A lack of data and understanding between the causal relationship between development and its environmental impacts was cited as the reason for the disconnect. Furthermore, mitigation may not address cumulative impacts due to limitations in designing, assessing, and implementing mitigation programs. The report also found that up to a third of all permitted projects did not meet their mitigation requirements, a finding that could not have been obtained solely from evaluating permit conditions and which required post-permitting monitoring and evaluation.

In terms of the third finding, cumulative impacts could not be attributed to a single sector of activities (i.e., coastal construction), from the agency permit databases and ancillary information (e.g. EISs, EAs, and other literature), especially for a highly urbanized and complex environment such as southeast

Florida. As stated in the OPPAGA report (OPPAGA, 2001), cumulative impacts are often not identified due to a lack of data and understanding of causality between coastal construction and environmental impacts. This was particularly the case with the use of a permit database in ascertaining cumulative impacts, in part due to the incompleteness of permitting data as these relate to the aforementioned variances and permit nonconformities, as well as complexities of cumulative impacts (see Appendix 1 for a detailed description on cumulative impact assessment methods, for instance). Permit data, for example, may be able to provide the impact footprint directly related to permitting conditions; however, permit data on their own would be unable to estimate how the permitted project may result in activities that may work synergistically in exacerbating (or even limiting) impacts.

This is not to state that the geo-referenced permit database could not be used in support of identifying and even quantifying cumulative impacts, but the major benefits may be in using the former approach, that of identifying potential impacts. Due to the spatial nature of the database, potential impacts could be identified using a series of layers related to coastal construction, direct and indirect uses, and resource conditions, among others. Similarly, the database's spatial dimension could be used in support of identifying a series of coastal construction clusters, defined as those areas (either via monument location or ranges of monuments) that attract a variety of activities across permit types (See Appendix 1). For example, monuments covering the Broward County Beach Nourishment Segment III project extend from Broward Monuments R-86 to R-92 and R-98 to R-128. Using a clustered approach, all CCCL permits and ERPs could be identified for the monument ranges, and the impacts associated with each permit type could be added to determine the overall impact of these various activities. Similarly, each additional project within a pre-determined proximity (e.g. 5 mile radius) could be added to the cluster such that additional impacts could be assessed over time. Finally, independent resource assessments could also be added as a layer, to both demonstrate the location of resources such as coral reefs and associated ecosystems and the status or trend of those resources.

In terms of the fourth main finding, it was determined that because the permitting structure has been established in a manner that permitted activities need to minimize impacts and conduct mitigation such that there is no net loss of key resources, the information provided in the permits themselves could not be used to directly identify impacts, cumulative or otherwise.

Under the CCCL program, the general criteria state that FDEP can deny any application that "individually or cumulatively would result in a significant adverse impact, including potential cumulative impacts" [62B-33.55 (3)(a), F.A.C.], including impacts related to the removal of native vegetation that may affect the dune system, the removal of the sandy soils of the beach systems, discharges into the seaward direction, net excavation of sandy soils seaward of the CCCL or 50 ft setback, an increase in structure induce scour that would result in a significant adverse impact during a storm event, and impacts to sea turtles [62B-33.55 (3), F.A.C].

Within the ERP/JCP program, permit applications are first reviewed to ensure that they do not have any unpermittable adverse impacts related to whether the activities will adversely impact fish, wildlife, listed species and their habitats, and if the activities will result in violations of state surface and groundwater water quality standards (with a higher standard for projects located in Outstanding Florida Waters) (FDEP, 2007). ERP permit applications are also reviewed in terms of their secondary and cumulative impacts. Importantly, because it is the program's intent that there be no net loss in wetland and surface water functions, mitigation is employed as an option after other modifications have been made to eliminate or reduce adverse impacts. These rules do not apply to exempt activities that are defined as those activities "capable of causing no more than minimal individual and cumulative adverse impacts to wetlands and surfaces waters" (FDEP, 2007, p. 9). Exempt activities include construction, repair, and replacement of small, private docks, maintenance dredging of existing channels and canals, construction and alteration of certain sized boat ramps, construction, repair, and replacement of seawalls and riprap in artificial waters, and repair and maintenance of structures.

Based on these criteria and the regulatory oversight, the permits analyzed as part of the database would not have been issued if the permits had not met criteria set forth by the permitting entities. Thus, the permit database can only provide information on anticipated impacts and can present anticipated mitigation approaches (i.e., general and special conditions) that must be undertaken to offset the anticipated impacts. If significant impacts occur after the completion of a project, which are nevertheless related to the project that cannot be reflected in the permit database as the chief assumption in the permit database is that such impacts would not be permitted and therefore cannot occur. Again, this reinforces the need for better follow-up documentation and monitoring, as well as enforcement.

4.1 Final Recommendations

The following recommendations were derived from conducting the various project activities, especially those related to the completeness of the geo-referenced permit database as a source for all permitted activities and as a tool for assessing cumulative impacts resulting from coastal construction activities. The recommendations provide practical (and largely feasible) mechanisms by which to improve the database so that more complete and updated information can be provided to users.

4.1.1 Recommendations for Improvements to Geo-Referenced Database

Recommendation 1: Permitting conditions as reflected in the geo-referenced permit database represent pre-project impact and mitigation estimates and decisions and are based on the then best scientific information, and the actual, medium, and long-term impacts need to be (a) documented and (b) linked to the database to best evaluate secondary and cumulative impacts.

In the case of certain permit types, such as ERPs, the permitting information available did not confirm whether a project had been initiated or if the project had been successfully completed. Within other permit types, such as the CCCL permits, information on how impacts varied from permitted impacts was not readily available unless those were conducted as modifications to the original permits. If the database were to provide more accurate information on actual project impacts, it is imperative that the information be gathered and added to the database.

Recommendation 2: The geo-referenced permit database represents a sample of three coastal construction permits and does not consider certain activities that fall below the permitting threshold (especially exemptions in the ERP program and field permits in the CCCL program) and are delegated to local levels, and these activities need to be folded into the database in a future effort such that the total impacts of coastal construction can be evaluated.

ERP exemptions and CCCL field permits both require documentation that can be added to populate parts of the database, including spatial information, activity types, and potential impacts. While the activities consist of over 15,000 projects, a simplified approach to input the aforementioned basic information would be timely, cost effective, and – most importantly – would greatly enhance the utility of the database in identifying all projects associated with the three coastal construction permit types associated with the database. Additional permits that can be added to the database include the SFWMD and Broward County delegated ERPs, Miami-Dade County ERP exemptions, and county-level permits, including mangrove alteration and trimming permits delegated to Broward and Miami-Dade counties.

Recommendation 3: The geo-referenced permit database used the ERP/JCP era as the evaluation period for the project, but permits from the pre-ERP/JCP era should be included for analysis.

The Florida Legislature established the CCCL program in 1985, and FDEP BBCS maintains a microfiche collection of CCCL permits dating back to the 1980s. Prior to the merger that created FDEP from the then Florida Departments of Environmental Resources (DER) and Natural Resources (DNR), activities consolidated into an ERP/JCP permit required various state and federal permits. Permits such as the State of Florida surface water management permits and USACE dredge and fill permits that predate the ERP/JCP era should be included over time so that the database can better reflect older projects and their potential, cumulative impacts (Fumero, 1995).

Recommendation 4: Projects from the pre-ERP/JCP era should be identified and included for cumulative impact analysis.

As recommended above in 3, there needs to be a focus on identifying and recording projects from the pre-ERP/JCP permitting system within the various permitting systems such that data from older projects are entered into a digital format. This effort should also include data collection relevant to actual impacts, as obtained from existing records and habitat data, remote sensing data, and field sampling.

Recommendation 5: The geo-referenced permit database should be linked to the inland construction databases, including the South Florida Water Management District ERP database and county building and inland construction activity databases such that the entire spectrum of impacts can be evaluated, from inland areas to the coast.

Under the Florida Coastal Zone Management Program of 1978, the entire state of Florida is designated as part of the state's coastal zone, due to the fact that its low-lying elevation and relative distance to the coast from any point result in "an interrelationship between the land and coastal waters which makes it difficult to establish a boundary that would exclude inland areas." (DCA, 1998). Inland activities that directly (by means of affecting water flow, interrupting coastal processes, etc.) or indirectly (by increasing population pressure on coastal resources) affect coastal resource quality must be considered, and it is highly recommended that all construction (rather than just coastal construction) be included in a future iteration of the database, and that the spatial dimensions of construction activities (size of construction, location of construction, etc.) also be included so that inland impacts can be evaluated on a regional scale.

4.1.2 Recommendations for Improved Regulatory Permitting Processes

Recommendation 6: Permitting conditions as reflected in the coastal construction permitting systems need to represent pre-project impact and mitigation estimates, and the actual, medium, and long-term impacts need to be (a) documented and (b) linked across different coastal construction permitting systems to best evaluate secondary and cumulative impacts.

Both FDEP BBCS and SED maintain digital and hard copy records of permits, which are comprised of mainly pre-project planning and impact evaluation reports, along with periodic progress reports. However, as determined by Ruppert (2008) for CCCL permitting and OPPAGA (2001) for ERP permitting, special conditions as finalized prior to the project commencement do not always represent the final impacts. Moreover, due to the paucity of post-project monitoring data, the medium to long-term impacts of individual and cumulative permits remain under-evaluated. There is a need to increase the amount of post-project monitoring across all permitting systems to determine to the extent to which estimated impacts match actual impacts and how much deviation occurs in location, area, and magnitude of impacts. Also, agencies should consider requiring all major projects, notably JCPs, to include periodic (e.g. annual, biennial) compliance reports from project proponents, as well as periodic compliance inspection reports to determine if all permitted conditions were fulfilled, or modified in the event that these were violated and subsequently rectified, if at all.

Recommendation 7: Permitting systems do not consider certain activities that fall below the permitting threshold (especially exemptions in the ERP program and field permits in the CCCL program) and are delegated to local levels. These activities need to be better documented such that the total impacts of coastal construction can be evaluated.

While minor activities under the ERP permitting system and field permits under the CCCL permitting system both undergo a permitting review and planning process, the cumulative impacts of these permits remains poorly understood. That is, because the activities are considered to have negligible impacts, the activities are generally allowed without medium or long-term monitoring. Moreover, although an accumulation of minor activities can exceed a threshold that may result in significant impacts, there exists no mechanism by which to monitor the effects of multifold permits. It is recommended that permitting systems evaluate the overall impacts by identifying and analyzing randomly defined permit clusters (ex. via range monuments) such that the frequency and type of permit activity (across permitting systems) can be identified and assessed.

Recommendation 8: Permitting systems involved in coastal construction activities should standardize their databases such that different systems can be linked and evaluated collectively, and permitting systems should incorporate impact descriptions into their databases (also see Recommendation 7).

Presently, there are several coastal construction databases available (ex. CCCL, FDEP and WMD and county delegated ERPs, JCP, and USACE permit databases, among others); however, each of these systems uses a separate numbering system, documents differing levels of descriptive data, and may or may not include information related to project progress, geo-spatial characteristics, or impact types. Thus, while it may be possible to link permitting systems' databases, without common indicators, the linked database may not be of much use. Also, because many of the databases offer summary data on permits (e.g. final orders available on FDEP BBCS's MapDirect viewer), much of the information required to evaluate direct, indirect, and cumulative impacts may not be readily available or at least not available across permitting systems' databases. If data from various permitting systems are to be effectively organized so that users can combine information across systems, a common set of data entry rules need to be established.

Recommendation 9: Use the geo-spatial permit database and existing data sources, including those identified, and the coastal construction and resource condition trends to implement the MICCI 26tool (or similar approach) to assess potential project impacts and to avoid and minimize impacts to coral reefs and associated resources.

As shown in Appendix 1, the MICCI Project 26 impact assessment tool or a similar approach that uses a variety of data sources and assessment methods [see the OPPAGA (2001) review (p. 23) of different cumulative impact assessment methods]can be used to determine a potential project's impacts and how that project may be affected by, and in turn impact other, projects. An approach as developed for MICCI Project 26 uses a stepwise process which relies on the type of permit data information available in the geo-spatial permit database, but the approach also requires other existing data that may not be available for smaller permits. However, in such cases, projects located in the same area, when considered in permit clusters, may provide key information on how series of smaller permits may overlap and affect each other and the surrounding resources. Thus, versions of the MICCI Project 26 approach can be modified to address both data-rich and data-poor permits in a spatial framework.

Recommendation 10: Permit-based mitigation measures must be assessed over time in terms of efficacy, durability, and persistence.

Agencies should consider implementing long-term assessments of various mitigation measures, ranging from compensatory mitigation measures such as dune restoration, seagrass planting, coral reef restoration, etc. to minimization and avoidance measures, to determine whether and how well the measures perform and if the measures result in long-term benefits that are tantamount to project-related impacts. Comparisons should also be made in terms of the benefits of on versus off-site mitigation, the effectiveness of creating new habitat versus minimizing the loss of existing habitat, and the probability of mitigation measures (e.g. reconstructed dunes) leading to habitat alteration or damage (e.g. smothering of corals and other benthic communities).

Recommendation 11: The State of Florida should integrate new spatial and temporal technology offered by Geographic Information Systems (GIS) in its permitting process.

FDEP BBCS currently offers a web-based marine spatial data mapping through its Map Direct GIS software development and application. This mapping application should include additional layers that would show historical, issued, and pending permit applications overlaid with biological and physical geographic attribute layers to evaluate the potential cumulative impacts of additional coastal development to southeast Florida's coral reefs. Additionally, data on the status of coral reefs, coastal erosion and recession rates, demographic characteristics, and similar data within each of the designated monuments should be included as data layers.

Recommendation 12: The State of Florida should develop and expand its use of technical tools and technology transfer to make these tools available to permitting agencies, counties, municipalities and individuals.

It is important that any template on how to use the tools and data for permitting process should be created using a common framework in guiding agencies and applicants in the permitting process, and that the template be simple to understand and operate across multiple platforms. If not, the process may result in a template that is not used by agencies or applicants.

4.1.3 Recommendations for Improved Monitoring in Southeast Florida

Recommendation 13: To improve the assessment of permitting effectiveness and to improve coral resource management for large, individual dredge and fill projects, measurable improvements are needed in the statistical design of environmental monitoring, the analysis of sediment compatibility, presence and effects of turbidity changes, and the effectiveness of mitigation activities.

Measurable improvements in the fundamental statistical validity of environmental impact monitoring design are needed: many specific design recommendations are provided in Bishop and Peterson (2005). Measurable improvements in carbonate sediment compatibility analyses at the scale of large dredge and fill projects are needed: details and specific analytical recommendations are provided in Wanless and Maier (2007).

Since corals are photosynthetic, measurable improvements in the assessment of long-term turbidity changes on coral health are needed (e.g., chronic sediment re-suspension) (Bush et al., 2004). Since mitigation is such a common component of permitting, measurable improvements in the assessment of mitigation effectiveness are also needed (MICCI Project 19, 2010; Peterson and Bishop, 2005).

Recommendation 14: A systematic ecosystem-based monitoring program should be implemented for the southeast Florida region, especially for the beach and dune systems, nearshore hardbottom communities, and coral reefs.

A systematic comparison of the cumulative frequencies of permitted projects, with targeted independent scientific studies examining the status of coastal ecosystems and the threats these experience at the appropriate spatial and temporal scales, will have to be implemented in order to better assess cumulative impacts. The scales of ecosystem monitoring studies are at much larger spatial scales than those at which project specific permits operate, and to show whether permitted projects contribute to cumulative impacts, it is critical that compliance monitoring be required as an explicit functional component of the permitting process. As a means by which to address effective monitoring, agencies should consider improvements in environmental monitoring design and in the assessment of long-term turbidity changes to coral health.

Also within this recommendation, numerical models based on monitoring data simulating nutrient and sediment loads to nearshore hardbottom and coral reef ecosystems should be developed and implemented to determine whether currently permitted activities cumulatively have reached threshold loads; if so, then such results should trigger the modification of the permitting process.

Recommendation 15: A systematic inlet-based monitoring program should be implemented for the maintained inlets in southeast Florida.

Maintained inlets have been identified as the major factor affecting critically eroding beaches in southeast Florida (Wanless, 2009). Beach nourishment is among the favored approaches to address beach erosion; and the associated sediment load mobilized by inlet dredging and beach nourishment is a major source of sediments impacting nearshore hardbottom and adjacent coral communities. A systematic examination of inlet management, beach nourishment and sediment impacts on reefs is needed to be conducted to provide a holistic approach on sediment management across these major activities that both the FDEP and the USACE plan for, permit, and execute.

Recommendation 16: A systematic region-based socioeconomic monitoring program should be implemented for the southeast Florida region, especially as related to changes in fishing, diving, and others uses, inland growth, and point and nonpoint sources of pollution.

A systematic socioeconomic monitoring program on changes in fishing, diving, and other uses, population and housing growth patterns, and point and nonpoint sources of pollution should be implemented to determine how these socioeconomic trends interact with coastal construction trends in affecting overall resource conditions, especially those of beach and dune systems and coral reefs.

5. References

Brody, S.D., S.E. Davis III, W.E. Highfield, S. P. Bernhardt. 2008. A Spatial-temporal Analysis of Section 404 Wetland Permitting in Texas and Florida: Thirteen Years of Impact along the Coast. *Wetlands* 28(1): 107-116.

Brody, S.D., and W.E. Highfield. 2005. Does Planning Work? Testing the Implementation of Local Environmental Planning in Florida. *Journal of the American Planning Association* 71 (2): 159-175.

Broward County. 2010. *Broward County Environmental Protection and Growth Management Department.* World Wide Web Document. Available at: http://www.broward.org/environment/.

Broward County. 2003. *Quick Facts for Broward County.* World Wide Web Document. Available at: http://www.broward.org/planningservices/bbtn2.pdf.

CH2M Hill, The Four Gates Company, and John C. Martin Associates. 2006. Port of Palm Beach Master Plan. World Wide Web Document. Available at: http://www.portofpalmbeach.com/pdf/031506_ppb_masterplan.pdf.

Collier C, Ruzicka R, Banks K, Barbieri L, Beal J, Bingham D, Bohnsack J, Brooke S, Craig N, Dodge R, Fisher L, Gadbois N, Gilliam D, Gregg L, Kellison T, Kosmynin V, Lapointe B, McDevitt E, Phipps J, Poulos N, Proni J, Quinn P, Riegl B, Spieler R, Walczak J, Walker B, Warrick D. In Review. The State of Coral Reef Ecosystems of Southeast Florida.IN Waddell, J.E. and A.M. Clarke (eds), *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008*. NOAA Technical Memorandum NOS NCCOS 73, Silver Spring, MD: NOAA/NCCOS Center for Coastal Monitoring & Assessment's Biogeography team, pp. 131-159.

Cook, M.I. M. Kobza (eds). 2009. *South Florida Wading Bird Report15*. 52 pp.

CSA International, Inc. 2009*. Ecological Functions of Nearshore Hardbottom Habitats in East Florida: A Literature Synthesis*. Stuart, Florida: CSA International, Inc.

Dean, C. 1999. *Against the Tide: The Battle for America's Beaches*. New York, NY: Columbia University Press.

Dovell, J.E. 1947. *A History of the Everglades of Florida*. Ph.D. Dissertation, University of North Carolina, 607 pp.

Finefrock, D. 1997. Suarez Back as Miami Mayor. Name's Not the Same: Now It's Miami-Dade County. Voters Say Yes to Hyphenation. *Miami Herald*, November 14, 1997: 1A.

Florida Center for Environmental Studies/Florida Atlantic University (FCES/FAU). 2007. *Methodology for Preparing Cumulative Impact Sections of Project Reviews and Assessments in Miami-Dade, Broward, Palm Beach, and Martin Counties.* World Wide Web Document. Available at: http://www.dep.state.fl.us/coastal/programs/coral/reports/MICCI/26/Methodology_Document_v1.pdf.

Florida Department of Community Affairs. 1998. *Florida Coastal Program Guide: A Guide to the Federally Approved Florida Coastal Management Program.* World Wide Web Document. Available at: http://www.dep.state.fl.us/cmp/publications/programguide98/index.htm.

Florida Department of Environmental Protection (FDEP). 2010. *Critically Eroded Beaches in Florida. World Wide Web Document.* Available at: http://www.dep.state.fl.us/beaches/publications/pdf/CritEroRpt07-10.pdf.

FDEP. 2008. *Strategic Beach Management Plan for the Southeast Atlantic Coast Region.* World Wide Web Document. Available at: http://www.dep.state.fl.us/beaches/publications/pdf/SBMP/Southeast%20Atlantic%20Coast%20Region.pdf.

FDEP. 2007. *Summary of the Wetland and Other Surface Water Regulatory and Proprietary Programs in Florida.* World Wide Web Document. Available at: http://www.dep.state.fl.us/water/wetlands/docs/erp/overview.pdf.

FDEP. 2005. *Joint Coastal Permit for Bakers Haulover Inlet and AIWW Maintenance Dredging*. October 21, 2005.

FDEP. 1999a. *Port Everglades Inlet Management Study.* World Wide Web document. Available at: http://www.dep.state.fl.us/beaches/publications/pdf/Port%20Everglades%20Inlet%20Mgmt.%20Study%20Imp.%20Plan.pdf.

FDEP. 1999b. *South Lake Worth Inlet Management Study*. World Wide Web document. Available at: http://bcs.dep.state.fl.us/bchmngmt/slkworth.pdf.

FDEP. 1997a. *Bakers Haulover Inlet Management Study*. World Wide Web document. Available at: http://bcs.dep.state.fl.us/bchmngmt/bkr_hlvr.pdf.

FDEP. 1997b. *Hillsboro Inlet Management Study.* World Wide Web document. Available at: http://bcs.dep.state.fl.us/bchmngmt/hillsbor.pdf.

FDEP. 1997c. *Boca Raton Inlet Management Study.* World Wide Web document. Available at: http://bcs.dep.state.fl.us/bchmngmt/boca_rtn.pdf.

FDEP. 1997d. *Jupiter Inlet Management Study.* World Wide Web document. Available at: http://bcs.dep.state.fl.us/bchmngmt/jupiter.pdf.

FDEP. 1996. *Lake Worth Inlet Management Study*. World Wide Web document. Available at: http://bcs.dep.state.fl.us/bchmngmt/lk_worth.pdf.

FDEP. 1995*. St. Lucie Inlet Management Study.* World Wide Web document. Available at: http://bcs.dep.state.fl.us/bchmngmt/st-lucie.pdf.

Florida Fish and Wildlife Conservation Commission (FWC). 2010. *Everglades Conservation Areas.* World Wide Web Document. Available at: http://myfwc.com/RECREATION/FW_forecasts_sor.htm#eca.

Florida Fish & Wildlife Research Institute (FWRI). 2007. *Development of GIS maps for Southeast Florida Coral Reefs (Palm Beach County)*. Final Report.

Fumero, J. J. 1995. Environmental Law: 1994 Survey of Florida Law – At a Crossroads in Natural Resource Protection and Management in Florida. *Nova Law Review* 77: 78-125.

Gabriel, M.C., D.M. Axelrad, T. Lange, L. Dirk. 2010. Chapter 3B: Mercury and Sulfur Monitoring, Research and Environmental Assessment in South Florida, IN *2010 South Florida Environmental Report*. World Wide Web document. Available at: https://my.sfwmd.gov/portal/page/portal/pg_grp_sfwmd_sfer/portlet_subtab_draft_rpt/tab19853145/chap/v1_ch3b.pdf.

Ingerbritsen, S.E., C. McVoy, B. Glaz, and W. Park. 1999. Florida Everglades. Subsidence Threatens Agriculture and Complicates Ecosystem Restoration, IN *Land Subsidence in the United States*, D. Galloway, D. R. Jones, S. E. Ingebritsen (eds.), Reston, VA: USGS, pp. 95-106.

Johns, G., V. R. Leeworthy, F. W. Bell, and M. A. Bonn. 2001. *Socioeconomic Study of Reefs in South Florida.* Hazen and Sawyer Environmental Engineers and Scientists, Hollywood, FL. World Wide Web document. Available at: http://marineeconomics.noaa.gov/reefs/02-01.pdf.

Jordan, L.K.B., K.W. Banks, L.E. Fisher, B. K. Walker, D. S. Gilliam. 2010. Elevated Sedimentation on Coral Reefs Adjacent to a Beach Nourishment Project. *Marine Pollution Bulletin* 60: 261-271.

Kentula, M.E., J.C. Sifneos, J. W. Good, M. Rylko, and K. Kunz. 1992. Trends and Patterns in Section 404 Permitting Requiring Compensatory Mitigation in Oregon and Washington, USA. *Environmental Management* 16 (1): 109-119.

Lapointe, B.E., P. J. Barile, M. M. Littler, D. S. Littler, B. J. Bedford, and C. Gasque. 2005a. Macroalgal Blooms on Southeast Florida Coral Reefs. I. Nutrient Stoichiometry of the Invasive Green Alga *Codium isthmocladium* in the Wider Caribbean Indicates Nutrient Enrichment. *Harmful Algae* 4: 1092-1105.

Lapointe, B.E., P.J. Barile, M. M. Littler, and D. S. Littler. 2005b. Macroalgal Blooms on Southeast Florida Coral reefs. II. Cross-shelf Discrimination of Nitrogen Sources Indicates Widespread Assimilation of Sewage Nitrogen. *Harmful Algae* 4: 1106-1122.

Leichter, J. J., H.L. Stewart, and S. L. Miller. Episodic Nutrient Transport to Florida Coral Reefs. *Limnology and Oceanography* 48(4): 1394-1407.

Lindeman, K.C. and D. B. Snyder. 1999. Nearshore Hardbottom Fishes of Southeast Florida and Effects of Habitat Burial Caused by Dredging. *Fishery Bulletin* 97: 508-525.

Martin County. 2010. *Martin County Growth Management, Environmental Division.* World Wide Web Document. Available at: http://www.martin.fl.us/portal/page?_pageid=355,378044&_dad=portal&_schema=PORTAL.

Miami-Dade County. 2010. *Miami-Dade County Department of Environmental Management*. World Wide Web Document. Available at: http://www.miamidade.gov/derm/.

McCook, L.J., G.R. Almany, M.L. Berumen, J.C. Day, A.L. Green, G.P. Jones, J.M. Leis, S. Planes, G.R. Russ, P.F. Sale, and S.R. Thorrold. 2009. Management under certainty: Guidelines for incorporating connectivity into the protection of coral reefs. *Coral Reefs* 2 8(2): 1432-0975.

McCormick, P., S. Newman, S. Miao, R. Reddy, D. Gawlick, C. Fitz, T. Fontaine, and D. Marley. 1999. Chapter 3: Ecological Needs of the Everglades, IN *SFWMD Everglades Interim Report*.

McPherson, B.F. and R. Halley. 1996. *The South Florida Environment – A Region Under Stress.*US Geological Survey Circular 1134.

Montague, C. L. 2008. Recovering the Sand Deficit from a Century of Dredging and Jetties along Florida's Atlantic Coast: A Reevaluation of Beach Nourishment as an Essential Tool for Ecological Conservation. *Journal of Coastal Research* 24 (4): 899-916.

Murley, J.F., L. Alpert, M. J. Matthews, C. Bryk, B. Woods, and A. Grooms 2003.*Economics of Florida's Beaches: The Impact of Beach Restoration.* World Wide Web Document. Available at: http://www.dep.state.fl.us/beaches/publications/pdf/phase1.pdf.

National Research Council (NRC). 1995. *Beach Nourishment and Protection.* Washington, DC: National Academy Press.

NCRI (Nova Southeastern University National Coral Reef Institute. 2004. *Development of GIS Maps for Southeast Florida Coral Reefs (Broward County).* Final Report. 71 pp.

Office of Program Policy Analysis and Government Accountability. 2001. *Cumulative Impact Consideration in Environmental Resource Permitting.* World Wide Web Document. Available at: http://www.oppaga.state.fl.us/monitor/reports/pdf/0140rpt.pdf.

Ogden, J.C., W.B. Robertson, G.E. Davis and T.W. Schmidt. 1974. *Pesticides, Polychlorinated Biphenyls and Heavy Metals in Upper Food Chain Levels, Everglades National Park and Vicinity.* National Park Service PB-231 359. 27 pp.

Ogden, J. C. 1994. A comparison of wading bird nesting colony dynamics (1931-1946 and 1974-1989) as an indication of ecosystem conditions in the southern Everglades, IN *Everglades: The Ecosystem and Its Restoration*, S. M. Davis and J. C. Ogden (eds.), Delray Beach, FL: St. Lucie Press, pp. 553-570.

Palm Beach County. 2003. *A History of Palm Beach County Inlets*. World Wide Web Document. Available at: http://www.co.palm-beach.fl.us/erm/coastal/shoreline/south-lake-worth-inlet/pdf/history-south-lake-worth-inlet.pdf.

Palm Beach County. 2010. *Department of Environmental Resource Management.* World Wide Web Document. Available at: http://www.pbcgov.com/ERM/.

PBS&J. 2008. *Best Management Practices (BMPs) for Construction, Dredge and Fill and Other Activities Adjacent to Coral Reefs.* World Wide Web Document. Available at: http://www.dep.state.fl.us/coastal/programs/coral/reports/MICCI/MICCI_6_BMP_Manual.pdf.

Perez, L. 1992. Cuban Miami, IN *Miami Now! Immigration, Ethnicity and Social Change*, G. J. Grenier, A. Stepick III, editors, Gainesville, FL: University Press of Florida, pp. 83-108.

Peterson, C. H., and M. J. Bishop. 2005. Assessing the Environmental Impacts of Beach Nourishment. *Bioscience* 55 (10): 887-896.

Pilkey, O. H., and K. L. Dixon. 1996. *The Corps and the Shore*. Washington, DC: Island Press.

Renken, RA., J. Dixon, J. Koehmstedt, S. Ishman, A.C. Lietz, R.L. Marella, P. Telis, J. Rogers, and S. Memberg. 2005. *Impact of Anthropogenic Development on Coastal Ground-Water Hydrology in Southeastern Florida, 1900-2000.* U.S. Geological Survey Circular 1275. 77 pp.

Rood, B.E., J.F. Gottgens, J.J. Delfino, C.D. Earle, and T.L. Crisman. 1995. Mercury Accumulation Trends in Florida Everglades and Savannas Marsh Flooded Soils. *Water Air, and Soil Pollution* 80: 981-990.

Ruppert, R. K. 2008. Eroding Long-Term Prospects for Florida's Beaches: Florida's Coastal Construction Control Line Program. *Sea Grant Law and Policy Journal* 1 (10): 65-98.

Science Coordination Team, South Florida Ecosystem Restoration Working Group (SCT). 2003. *The role of flow in the Everglades. Ridge and Slough Landscape.* World Wide Web Document. Available at: http://www.sfrestore.org/sct/docs/SCT%20Flow%20Paper%20-%20Final.pdf.

South Florida Water Management District (SFWMD). 2010. *South Florida Environmental Report.* World Wide Web Document. Available at: https://my.sfwmd.gov/portal/page/portal/pg_grp_sfwmd_sfer/pg_sfwmd_sfer_home?_piref2714_14424184_2714_14424181_14424181.tabstring=tab2236033.

Sklar, F. + 18 authors. 1999. Chapter 2: Hydrologic Needs: The effects of altered hydrology on the Everglades, IN *SFWMD Everglades Interim Report*.

TetraTech EC, Inc. 2007. *Southeast Florida Coral Reef Initiative Maritime Industry and Coastal Construction Impacts Workshop Proceedings Report.* World Wide Web Document. Available at: http://www.dep.state.fl.us/coastal/programs/coral/reports/MICCI/MICCI_Project3_Report.pdf.

US Army Corps of Engineers (USACE). 2009. *Southeast Atlantic Regional Sediment Management Plan for Florida: Final Report.* Prepared by Taylor Engineering for USACE.

USACE. 2004a. *Miami Harbor, Miami-Dade County, Florida, Navigation Study: Final General Reevaluation Report and Environmental Impact Statement.* Jacksonville, FL: USACE Jacksonville District.

USACE. 2004b. *Port Everglades Harbor, FL: Feasibility Report with Draft Environmental Impact Statement.* Jacksonville, FL: USACE Jacksonville District.

USACE. 2003. *Navigation Study for Miami Harbor: Draft General Reevaluation Report and Environmental Impact Statement.* Jacksonville, Florida: USACE Jacksonville District.

USACE. 1997. *Intracoastal Waterway Vicinity Bakers Haulover: Environmental Assessment/ Finding of No Significant Impact.* Jacksonville, Florida: USACE Jacksonville District.

USACE. 1996. *Coast of Florida Region III: Beach Erosion and Storm Effects Study EIS and Feasibility Report.* Jacksonville, Florida: USACE Jacksonville District.

U. S. Census Bureau. 2000. Census 2000 Summary File 1. World Wide Web Document. Available at: http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US12&-_box_head_nbr=GCT-PH1&-ds_name=DEC_2000_SF1_U&-redoLog=false&-mt_name=DEC_2000_SF1_U_GCTPH1_ST2&-format=ST-2.

US Department of Interior (DOI). 1994. Chapter 7. Florida Everglades. In: *The Impact of Federal Programs on Wetlands, Volume II.*

U.S. Fish and Wildlife Service (USFWS). 2005. *USFWS Biological Opinion of the Intracoastal Waterway (IWW) in the Vicinity of the Bakers Haulover Inlet Channel with Spoil Placement on Bal Harbor Beach located in Miami-Dade County, Florida.* October 11, 2005.

USFWS. 1999. *South Florida Multi-species Recovery Plan.* Atlanta, GA: USFWS.

Walker, B.K. 2009. *Benthic Habitat Mapping of Miami-Dade County: Visual Interpretation of LADS Bathymetry and Aerial Photography*. Florida DEP report #RM069.Miami Beach, FL. 47 pp.

Walker, R. and W. Solecki. 2004. Theorizing Land-cover and Land-use Change: The Case of the Florida Everglades and its Degradation. *Annals of the Association of American Geographers* 94 (2): 311-328.

Wanless, H. R., and K L. Maier. 2007. An Evaluation of Beach Renourishment Sands Adjacent to Reefal Settings, Southeast Florida. *Southeastern Geology* 45 (10): 25-42.

Wanless, H. R. 2009. A History of Poor Economic and Environmental Renourishment Decisions in Broward County, Florida. *The Geological Society of America Special Paper* 460: 111-120.

Western Carolina University. 2010. *PSDS Beach Nourishment Database*. World Wide Web Document. Available at: http://www.wcu.edu/1038.asp.

6. Appendix I: Adopting the MICCI Project 26 Method to Estimate the Cumulative Impacts of Permitted Activities as Determined by Geo-referenced Permit Database Analysis

This appendix outlines a step-wise process to identify and assess the potential, cumulative impacts of a project, based on existing permitted projects in the immediate area and the attributes of these projects, as well as prevailing human conditions (i.e., population density, housing and other construction density, etc.). In part, the appendix uses the method developed under MICCI Project 26 (FCES/FAU, 2007) as a means by which to categorize projects, based on their individual impacts and those of other (for the basis of this example, past) projects; although the MICCI Project 26 worksheets are not filled out here, these can be completed as needed for other projects (FCES, 2007). It is expected that by following the step-wise process outlined here, geo-referenced permit database users will be able to identify and quantify the impacts presented by other projects in an area of interest, and that the users will be able to access more detailed information, as required, by accessing the data and report files available via the database.

The project selected as part of the appendix was the Bakers Haulover Inlet and Atlantic Intracoastal Waterway (AIWW) Maintenance Dredging Joint Coastal Permit (JCP), issued on October 21, 2005, by FDEP; the permittee was the ACOE (FDEP, 2005). The project was selected because it covers a large area (the inlet is located on Range Monument R-8, and the sand placement would be from Range Monuments R-28 to R-32) in Miami-Dade County, is located adjacent to a metropolitan region with several other inland and coastal projects, and involves the placement of dredged, beach-quality material along Bal Harbour Beach.

Step 1: (from MICCI Project 26) Provide project summary details:

1) The project name was Bakers Haulover Inlet and AIWW Maintenance Dredging;
2) The application number for the JCP was 0173188-002-JC;
3) The baseline condition was that the study area was between slightly and moderately degraded;
4) The impact site was identified as the AIWW in the vicinity of Bakers Haulover Inlet;
5) The estimated impact area was westward of the inlet, as well as the area between Range Monuments R-28 and R-32 (or 0.85 miles of beachfront), where the beach quality sand would be placed;
6) There were no special designations identified for the impact sites, but the

activity would take place mostly westward of the Biscayne Bay Aquatic Preserve;

7) The temporal scale of the project was not stated in permit documents, but the JCP would be active for ten years, through October 21, 2015;
8) The areas to be affected would be the marine environment over and around which the dredging would occur and the beach and subtidal areas where the dredged beach quality sand would be placed;
9) Significant nearby features included the coral reef tract located offshore, seagrass and other benthic communities located around the project area, and protected species that frequent the project area;
10) A biological opinion determined that the project may have impacts on protected species, in particular sea turtles, but also manatees; and,
11) Other issues and concerns with the dredging project were those related to the long-term impacts on sea turtle nesting in the nourished beach.

Figure A-1 shows the location of the Bakers Haulover Inlet and AIWW Maintenance Dredging Project, as situated both in the ICW (where the dredging would take place) and along the beachfront in Bal Harbour (where the beach quality sand would be placed). As shown in the figure, the beach quality sand placement would occur close to the region's coral reefs, as well as other hardbottom communities. Also, while the figure does not demonstrate other nearshore resources in the ICW, project documents did require that the permittee conduct a seagrass survey prior to construction activities.

Step 2: requires that all past, present, and foreseeable projects at the present location be listed and described to determine how past activities may have or will affect the location. At the Bakers Haulover Inlet and AIWW Maintenance Dredging Project site, there had been several previous instances of dredging activities. In fact, the inlet was itself constructed in 1925 and had undergone repairs following hurricane damage in 1928 and 1940. The inlet was widened in 1960, 1963, and 1964, and in 1986 the north jetty was extended to its present configuration, which is 400 feet wide and 0.25 miles long. The beach sand recipient site, Bal Harbour Beach, had been nourished several times prior to the present action, including in the mid-1970s, 1986, and most recently in 2002. Project information, as required for Step 2 from Project 26, was not always available, especially for historical projects. However, a modification to that approach adopted for the appendix, which also considered other projects within the project's area of impact (AOI), was the mapping of all other permitted projects in the vicinity (within five miles) of the Bakers Haulover Inlet and AIWW Maintenance Dredging Project. The concentration and proximity of these projects is shown in Figures A-2-4.

There were ten JCP projects located within the AOI of the Bakers Haulover Inlet and AIWW Maintenance Dredging Project. Most of the JCPs were related to beach nourishment activities, such as nourishment projects in Sunny Isles and Golden Beach and Surfside and the north-central Miami-Dade County beaches. While none of these nourishment and related projects had immediate impacts on the Bakers Haulover Inlet and AIWW Maintenance Dredging Project, the projects did each present a threat to protected species, especially sea turtles during nesting seasons.

Within the AOI, there were a total of 109 CCCL permits that had been issued from the mid-1980s to 2008. By considering a sample of 46 CCCL permits from the geo-referenced permit database, it was determined that 19.2% were related to commercial development, 15.3% involved local government projects, 48.1% were part of a multi-family home construction or re-construction project, and 17.3% were related to single-family homes. On average, the projects resulted in the excavation of 2,501 cy of sand and other material; the average fill was 2,710 cy of sand and other material, although only approved beach quality sand could be filled seaward of the CCCL. Because these projects were all located seaward of the CCCL, the projects would likely have more immediate impacts within the AOI. For example, because a majority of the CCCL permits concerned multi-family, or condominium, home construction, population densities and the resulting demand for increased infrastructure and services, as well as the potential for increased coastal and marine uses, may have significant effects on the local coastal resources (Dean, 1999; Pilkey and Dixon, 1996; NRC, 1995)

Also, within the AOI, there were a total of 135 ERPs that had been issued since 1995 to 2008. Unlike the CCCL permits and JCPs, which were wholly located seaward of the CCCL, ERPs were located across the mainland and the barrier islands, with ERP clusters located in Sunny Isles, around Bal Harbour, and the north-central beaches.

Step 3 from Project 26 calls for the evaluation of a project's general information and the determination of a general score based on the project's AOI, projects within the AOI, the degree to which impacts are uncertain or pose unknown risks, the degree to which the action establishes a precedent for future, deleterious actions, the potential for cumulative, significant impacts, and threshold levels. As determined for the Bakers Haulover Inlet and AIWW Maintenance Dredging Project, the project had the potential to impact (both positively by placing more sand on an eroding beach and negatively by affecting protected and other species) various other JCP, CCCL, and ERP projects. There had been a total of 254 such projects permitted in the AOI from the mid-1980s to 2008. As per the uncertainty of the risks posed by the project, these were minimal; that is, dredging and sand placement had been performed on the site several times in the past, and while the project may impact natural resources, special conditions listed in the JCP called for a minimization or mitigation of such impacts via best management practices and special measures. The degree to which the Bakers Haulover Inlet and AIWW Maintenance Dredging Project represented a precedent or held a potential to create cumulative impacts remained unclear. This is because dredging inlets is part of a State of Florida strategy and thus the project would not represent a precedent; nevertheless, as shown by the various projects within the AOI, it is likely based on the impacts that each project represents, the Bakers Haulover Inlet and AIWW Maintenance Dredging Project may contribute to cumulatively significant impacts.

Under Step 4 from Project 26, it was determined that:

1) There is a high degree of certainty that endangered and threatened species, as defined under the Endangered Species Act of 1973, will be affected by the project. The biological opinion concluded that the proposed action would affect both the Florida manatee in the construction site and a number of species of sea turtles, of which the most likely to be affected would be the loggerhead, green, leatherback, and hawksbill sea turtles. The opinion also concluded that because the Kemp's ridley sea turtle occurs offshore from the project site, it may potentially nest in the nourishment area and thus could be impacted as well (USFWS, 2005);
2) There would be no contradiction with federal, state, or local environmental protection laws, as the project would involve multiple partnerships;
3) Other National Environmental Policy Act (NEPA) analysis had been conducted for various, JCP projects in the region. The Coast of Florida Erosion and Storm Effects Study Region III with FEIS (USACE, 1996), the IWW Vicinity Bakers Haulover dredging and beach placement project EA (USACE, 1997), and various other JCP files on projects in the AOI contain information on the impacts on the region resulting from the project; and,
4) The nourishment part of the project was in part proposed to compensate for the effects of the inlet on downstream beaches, so the impact of past events have been significant (i.e., beach erosion resulting from the development of the inlet).

It should be noted that as with the project used in this example, there are many historical documents associated with projects in the region, especially if projects within an AOI are considered. Thus, with the Bakers Haulover Inlet and AIWW Maintenance Dredging Project, historical projects dating back to the cutting of the inlet in the 1920s onward, followed by several beach nourishment projects in the downstream beaches, and sundry coastal construction and related projects all have greatly influenced the status of the region's natural resources. However, because such project details are either incomplete or inaccessible (especially the historical projects), details on the impacts of the projects on natural resources and on the present-day conditions are difficult to estimate with a high degree of accuracy.

In terms of the risk characterization evaluation, as called for in Step 5 of Project 26, it was determined that the Bakers Haulover Inlet and AIWW Maintenance Dredging Project would:

1) Likely impact mobile organisms such as sea turtles, fishes, and invertebrates from beach sand placement activities and from dredging activities;
2) Potentially impact mobile organisms such as sea turtles and manatees from dredging activities;
3) Potentially impact attached organisms such as stony corals, soft corals, macroalgae, etc., from beach sand placement activities; and,
4) Potentially impact estuarine plant communities located in the dredging location and along the pipeline used to transfer sand.

Most of the likely and potential impacts to Valued Environmental Attributes (VEAs) identified in the risk characterization evaluation would result from suspended sediments and physical damage as a result of increasing turbidity in the dredging site, nourishment physically changing the beach site, and beach sand erosion resulting in sedimentation in the nearshore environment. Physical damage would occur most likely in terms of collisions with marine mammals and sea turtles, and the removal of benthic habitats, including seagrasses and the aforementioned hardbottom communities. The severity of the impacts could not be assessed, especially due to the JCP special conditions that outlined methods via which to mitigate against such impacts. Even VEAs such as endangered sea turtles, which had been impacted by several other past projects, would be protected using strict procedures outlined in the JCP special conditions.

Step 6 of Project 26 states that a project's potential impacts on the human systems in an area should be evaluated, especially based on social, economic, and cultural information. As shown in Figures A-5 and A-6, the human systems in the region are highly influential, both in terms of overall development (as measured by housing) and population. Population in the region exceeded 100,000 persons in the CCDs in and around the project area in 2000, with the Miami CCD having more than 850,000 persons and the Miami Beach CCD having almost 125,000 persons. In terms of housing, there were 340,000 housing units in the Miami CCD and almost 86,000 housing units in the Miami Beach CCD in 2000. Thus, almost one million residents in over 425,000 housing units lived in part of the AOI of the Bakers Haulover Inlet and AIWW Maintenance Dredging Project. Also, it should be noted that the two actions taken as part of the project would both result in greater use of the area and its coastal and marine resources. The deepening of the AIWW adjacent to the inlet would facilitate vessel access (and may in fact reduce groundings) into Biscayne Bay, and the beach nourishment project in Bal Harbour may attract more beach visitation and water-based activities.

If the present example had used the worksheets involved in the Project 26 stepwise process, it would evaluate the cumulative impacts by adding up the evaluations from the first six steps (in the development of a data sheet) and then by calculating an adjusted cumulative impact rating to determine whether the project should be submitted for agency action or if it may require more changes. By using a narrative approach, the Bakers Haulover Inlet and AIWW Maintenance Dredging Project example showed how permitting, coastal and marine resources, and human system resources, can be used in the absence of the data rich environment required under Project 26. That is, the example demonstrated how a particular permit from the geo-referenced permit database could be compared with other activities in its AOI (which the user can define based on the project's expected impact or influence), how past projects could be incorporated in the evaluation of how the project may impact coastal and marine resources, and how human systems related to population, housing, and other use patterns could be added to determine human-related effects on project performance.

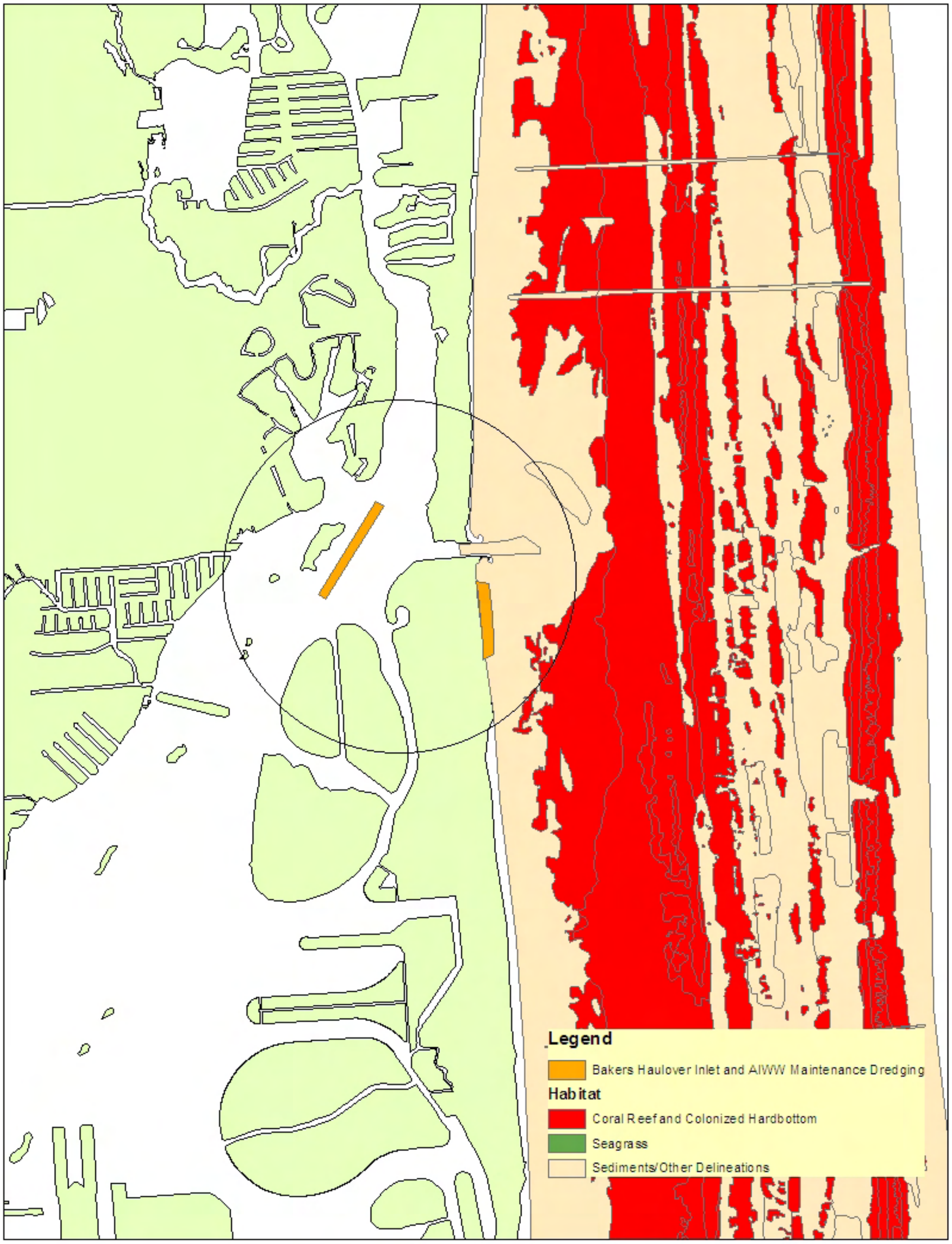


Figure A-1: Bakers Haulover Inlet and AIWW Maintenance Dredging Project study area.

Figure A-2: JCPs located in the AOI of Bakers Haulover Inlet and AIWW Maintenance Dredging Project.

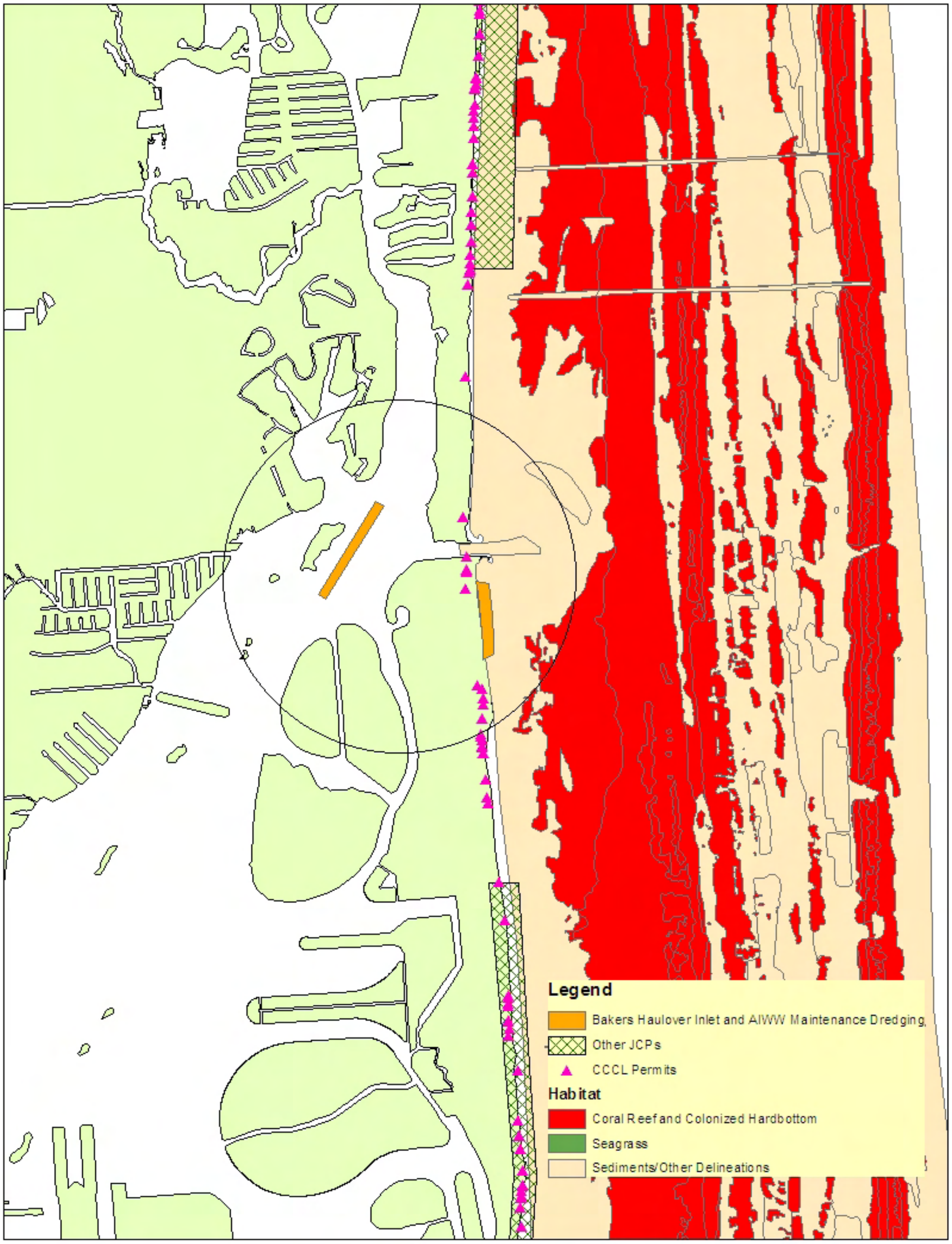


Figure A-3: CCCL permits located in the AOI of Bakers Haulover Inlet and AIWW Maintenance Dredging Project.

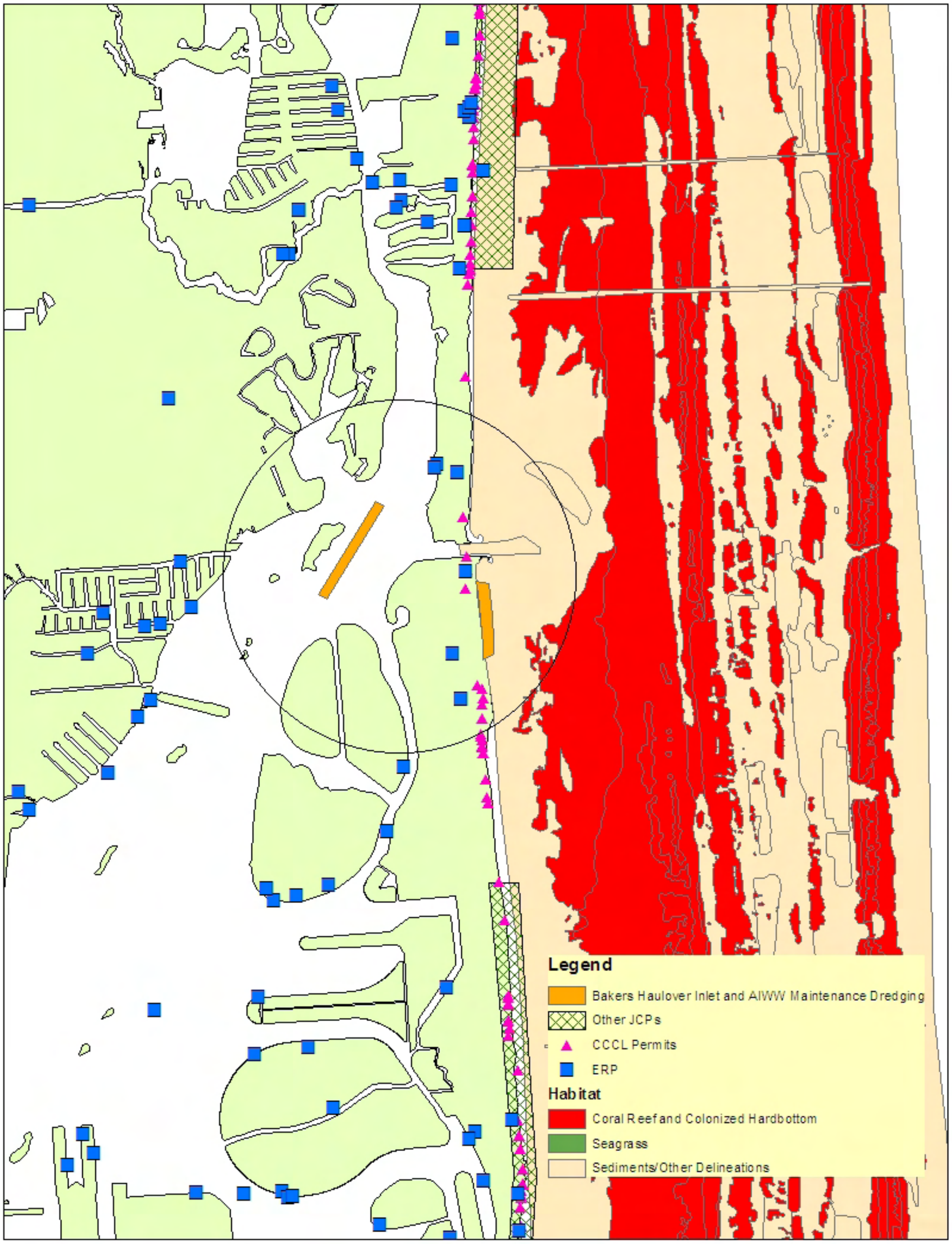


Figure A-4: ERPs located in the AOI of Bakers Haulover Inlet and AIWW Maintenance Dredging Project.

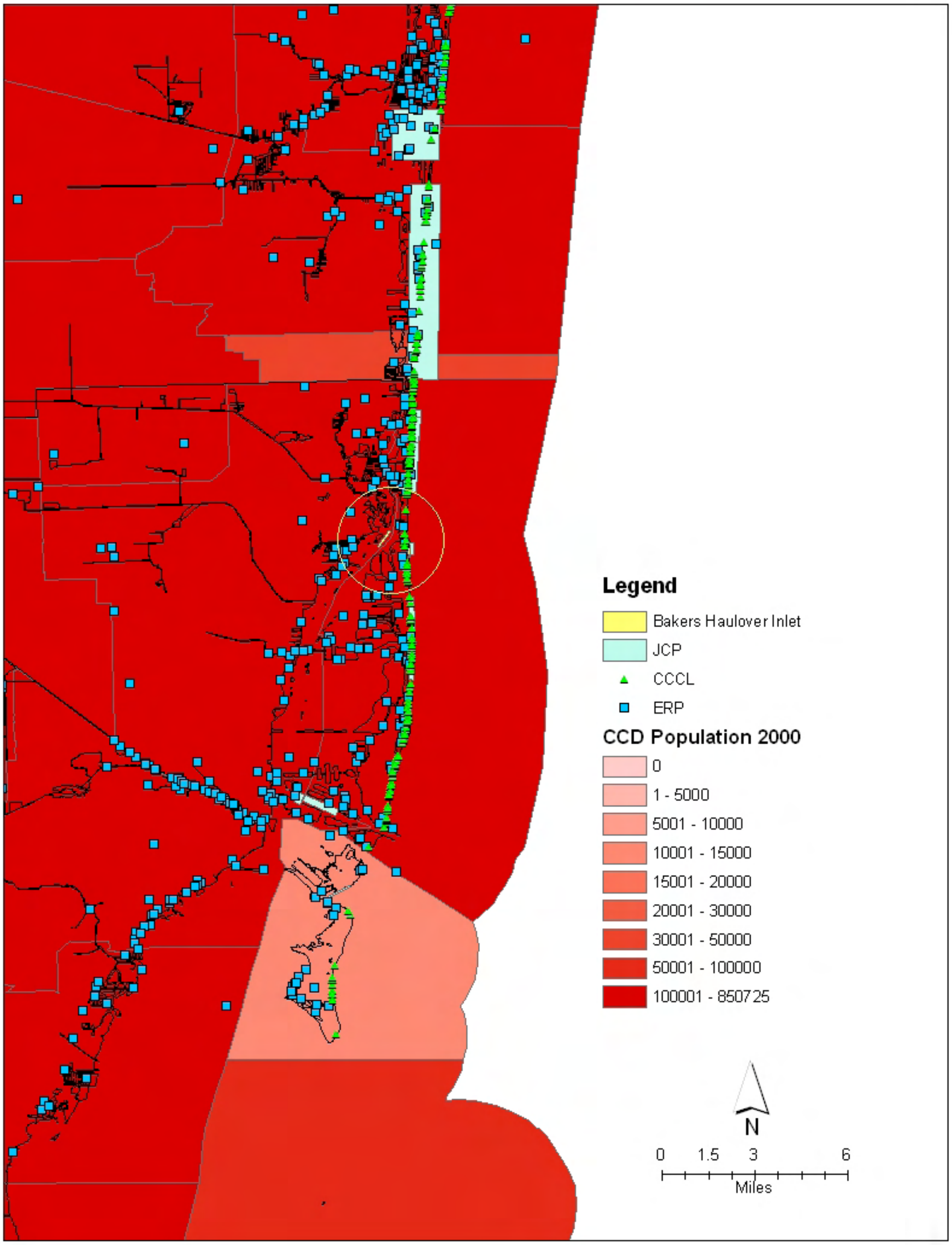


Figure A-5: Population in the CCDs in Miami-Dade County around the Bakers Haulover Inlet and AIWW Maintenance Dredging Project.

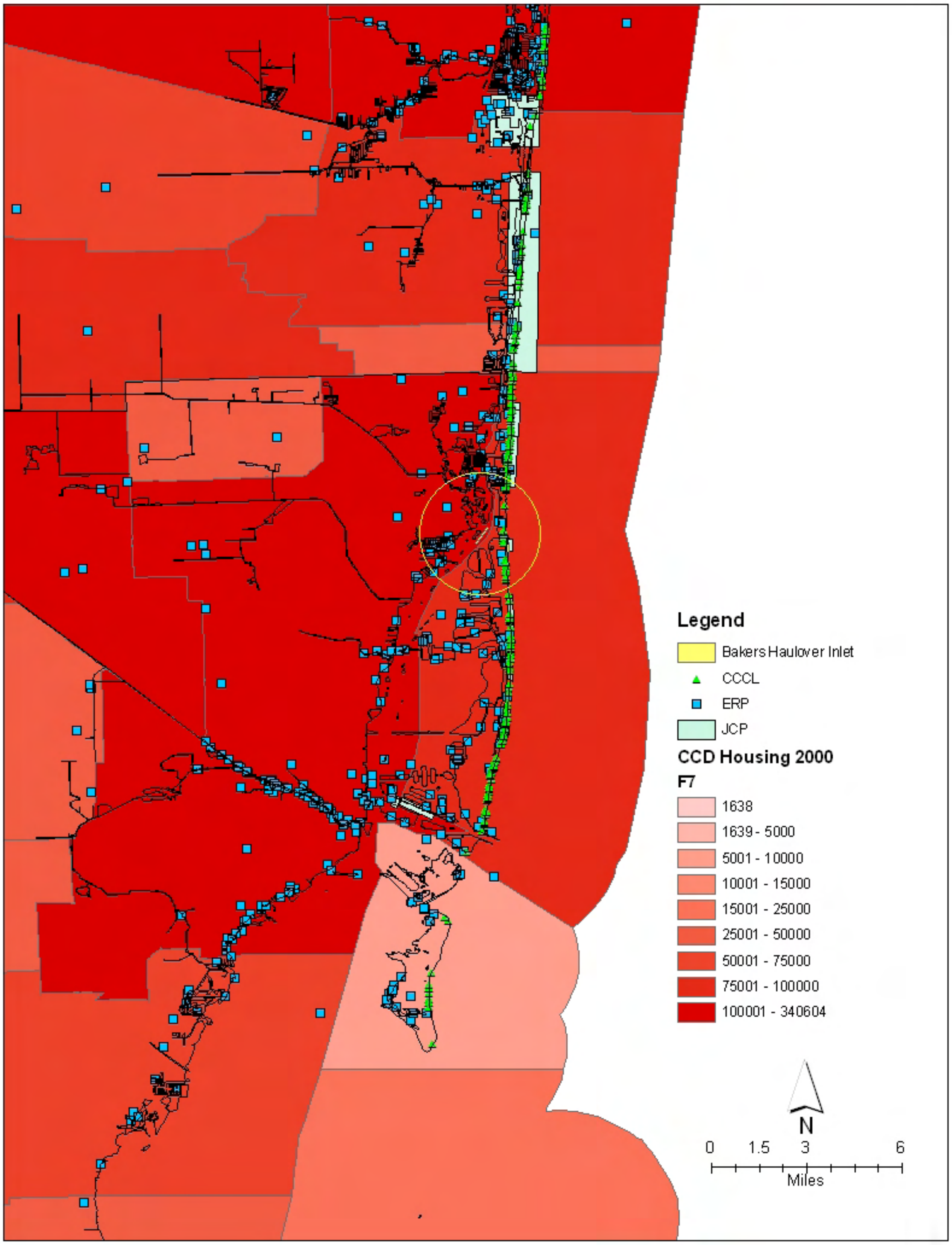


Figure A-6: Housing in the CCDs in Miami-Dade County around the Bakers Haulover Inlet and AIWW Maintenance Dredging Project.

7. Appendix II: Terminology Definitions

In this reference document, the definitions of impacts and other relevant terms were quoted from § 62B-41.002, F.A.C. Section 62B-41 provides the regulatory oversight for the permitting of coastal construction activities in the State of Florida by the FDEP. Associated federal permitting processes use terms defined by the NEPA and other federal regulations. Explanatory notes were included in subsequent sections to elucidate on the basic definitions provided in this section, where necessary.

1.1. Effects and Impacts Defined by 43 Federal Regulations (FR) 56003 (1978)

1.1.1. Cumulative impact (§ 1508.7)

"Cumulative impact" is the impact on the environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

1.1.2. Direct Effects (§ 1508.8)

"Direct effects" are caused by the action and occur at the same time and place.

1.1.3. Indirect Effects (§ 1508.8)

"Indirect effects" are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

1.2. Mitigation (§ 1508.20, 43 FR 56003)

"Mitigation" includes:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.
(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
(e) Compensating for the impact by replacing or providing substitute resources or environments.

1.3. Environmental Assessment (EA)(§ 1508.9, 43 FR 56003)

"Environmental Assessment":

(a) Means a concise public document for which a federal agency is responsible that serves to:

- Briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant

impact.
- Aid an agency's compliance with the Act when no environmental impact statement is necessary.
- Facilitate preparation of a statement when one is necessary.

(b) Shall include brief discussions of the need for the proposal, of alternatives as required by § 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

1.4. Environmental Impact Statement (EIS)(§ 1508.11, 43 FR 56003)

"Environmental Impact Statement" means a detailed written statement as required by § 102(2)(C) of the NEPA. "The primary purpose of an environmental impact statement is to serve as an action-forcing device to insure that the policies and goals defined in the Act are infused into the ongoing programs and actions of the federal government. It shall provide full and fair discussion of significant environmental impacts and shall inform decision makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. Agencies shall focus on significant environmental issues and alternatives and shall reduce paperwork and the accumulation of extraneous background data. Statements shall be concise, clear, and to the point, and shall be supported by evidence that the agency has made the necessary environmental analyses. An environmental impact statement is more than a disclosure document. It shall be used by federal officials in conjunction with other relevant material to plan actions and make decisions." (§ 1502.1, 43 FR 55994)

Based on a discussion of the proposed action, the affected environment, and the environmental consequences, an EIS should present the environmental impacts of the proposal and the alternatives in comparative form to provide "a clear basis for choice among options by the decision maker and the public". The direct, indirect and cumulative impacts of each alternative must be evaluated across the range of alternatives including the no action alternative that serves as the baseline scenario (CEQ, 1997). Such analysis is the heart of an EIS. In addition, the EIS shall list all federal permits, licenses and other entitlements necessary to implement the proposal.

1.5. Finding of No Significant Impact (FONSI) (§ 1508.13, 43 FR 56003)

"Finding of No Significant Impact" is a document by a federal agency briefly presenting the reasons why an action, not otherwise excluded (§1508.4), will not have a significant effect on the human environment and for which an EIS therefore will not be prepared. It shall include the EA or a summary of it and shall note any other environmental documents related to it [§ 1501.7(a)(5)]. If the assessment is included, the finding need not repeat any of the discussion in the EA but may incorporate it by reference.

1.6. Notice of Intent (NOI) (§ 1508.22, 43 FR 56003)

"Notice of Intent" means a notice that an EIS will be prepared and considered. The notice briefly:

(a) Describes the proposed action and possible alternatives.

(b) Describes the agency's proposed scoping process including whether, when, and where any scoping meeting will be held.
(c) States the name and address of a person within the agency who can answer questions about the proposed action and the EIS.

1.7. Categories of Impacts Defined by Florida Administrative Code (F.A.C.)

1.7.1. Adverse Impacts

"Adverse impacts are those impacts to the active portion of the coastal system resulting from coastal construction. Such impacts are caused by coastal construction which has a reasonable potential of causing a measurable interference with the natural functioning of the coastal system. The active portion of the coastal system extends offshore to the seaward limit of sediment transport and includes ebb tidal shoals and offshore bars." (F.A.C. 62B-41.002 (19) (a).

1.7.2. Significant Adverse Impacts

"Significant adverse impacts are adverse impacts of such magnitude that they are expected to alter the coastal system that result in either:

1. An increase in the rate of erosion;
2. Rendering the coastal system unstable or vulnerable to the effects of coastal storms or interfere with its ability to recover from the effects of a coastal storm;
3. A take, as defined in subsection 62B-41.002(48), F.A.C., unless, as provided for by the provisions of paragraph §379.2431(1)(f), Florida Statutes (F.S.); or
4. An inconsistency with the provisions of paragraph §379.2431(1)(c)1., F.S."

1.7.3. Cumulative Impacts

"Cumulative impacts are impacts resulting from the short-term and long-term impacts and the direct and indirect impacts the activity would cause in combination with existing structures in the area and any other similar activities already permitted or for which a permit application is pending within the same fixed coastal cell. The impact assessment shall include the anticipated effects of the construction on the coastal system and marine turtles. Each application shall be evaluated on its own merits in making a permit decision, therefore, a decision by the [FDEP] to grant a permit shall not constitute a commitment to permit additional similar construction within the same fixed coastal cell."

1.7.4. De Minimis Impacts

"De Minimis impacts are impacts that have been determined by the [FDEP] to be insignificant and not of a substantial nature either individually or cumulatively."

1.8. Permit & Permit Condition (F.A.C.)

"Permit is the authorization issued by the [FDEP] to conduct certain specified construction, excavation or alteration activities at a specified location on state sovereignty land seaward of the mean high-water line of any tidal water.""Permit Condition is a statement or stipulation issued with, and appearing on or referenced in, a coastal construction permit with which compliance is necessary for continued validity of the permit."