APPENDIX E

LANDCOVER

Pre-Development Vegetation Communities of Southern Florida

.

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Acknowledgments

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Executive Summary

A geospatial database of pre-development vegetation within the boundaries of the South Florida Water Management District was created to provide a reliable and comprehensive data source for pre-development ecological conditions of the region. This geo-spatial database offers an improvement over previous efforts in its extent (16 counties), its reliability (verification with historic field descriptions) and detail.

As a first step, a literature search was conducted to identify all previous studies that examined or created maps of historical vegetation within the central and south Florida region. Source data and maps varied in their formats and usability. More recent efforts were available in an electronic format, such as a Geographical Information System (GIS) spatial database. Older sources were available only as paper maps. In these cases, the maps were scanned and geospatially rectified using ArcGIS® tools.

A vegetation classification scheme was then developed to define major natural community types that would also meet anticipated data requirements of hydrological models and restoration projects.

The study area of this project is the full geographical extent of all 16 counties contained within the South Florida Water Management District. To facilitate analysis and verification, the project area was divided into subregions having unique or similar vegetation patterns. Each subregion map of historic vegetation was created from existing pre-development vegetation map sources obtained from the literature review. A base map was compiled by using a default historic map (usually, the earliest source with the highest resolution) and filling data gaps or areas of questionable accuracy with other historic information. Vegetation communities and descriptions in this base map were converted to the vegetation community classes developed by this project.

The resulting map and geospatial database were "verified" by comparing vegetation descriptions in the base map with General Land Office (GLO) survey field note descriptions and maps from the mid- to late-1800s. Typically, GLO field descriptions followed the township-range-section line grid laid out by the original survey staff. Where agreement was found between the base map and the GLO description, the polygon attributes were considered verified. Base map attributes were changed to reflect the GLO conditions when disagreement between the GLO data and base map occurred.

As a final step in database development, additional data fields were added to provide information considered useful to hydrologic models and other target users. These

fields included transpiration coefficients and hydrologic characteristics associated with central and south Florida vegetation community types.

The geospatial database will be completed in two phases; the first phase will map and document the region between the Atlantic and Gulf coasts from Lake Okeechobee to Florida Bay. The second phase, which is anticipated to be released within 6 months of the first, will map and document the region from the Kissimmee Chain of Lakes to Lake Okeechobee, as well as the Fisheating Creek and St. Lucie watersheds. A third document, which will be released concurrent with the first document, will contain a description of how the database was adapted and applied to the development of a Natural Systems Regional Simulation Model.

This database will have application to a number of projects that require a reliable estimate of the pre-development ecological and hydrological landscape. The pre-development condition can be used as a baseline to measure alteration of the landscape that has occurred within an area and provides another source of information from which a restoration target can be developed. Some projects that may benefit from use of this database include the development of a Regional Simulation Natural Systems Model, the Comprehensive Everglades Restoration Plan and local restoration plans.

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Note: Only Attachment A is provided in this Appendix. The other Attachments can be found on the NSRSM Peer Review web site[1]

[1] https://my.sfwmd.gov/portal/page?_pageid=1314,2555966,1314_2608149:1314_2564292&_dad=portal&_schema=PORTAL

ACRONYMS AND ABBREVIATIONS

CERP	Comprehensive Everglades Restoration Plan
District	South Florida Water Management District
GIS	Geographical Information System
GLO	General Land Office
kveg	A coefficient of crop transpiration
Mannings *n*	A coefficient for open channel flow
NRCS	Natural Resources Conservation Service
SFWMD	South Florida Water Management District
SSURGO	Soil Survey Geographic Database

PROJECT OVERVIEW

Objectives

The purpose of this project is to construct a reliable regional Pre-Development Landscape Database (PDLD) of southern Florida encompassing the 16 county area within the boundaries of the South Florida Water Management District (SFWMD or District). Vegetation community characterizations, spatially-related soil information (from county soil surveys) and hydrologic modeling parameters will be included. A key product of this study will be a "field" verified" pre-development vegetation map based on vegetation classifications. The geodatabase and map will be viewable in a Geographic Information System (GIS)

Florida's regional pre-development condition serves as a baseline from which to measure alterations to the area's landscape and it is a valuable source of information for ecological and hydrological restoration target development. The PDLD will have application to a number of projects including the Natural System Regional Simulation Model (NSRSM) implementation, the Comprehensive Everglades Restoration Plan (CERP) evaluation, and local restoration plan formulation.

The PDLD project will be completed by subregion and documented in two publications. Part I encompasses the area south of Lake Okeechobee (see map insert inside of cover jacket). Subregions in this area include Southwest Florida, the historical Everglades-Okeechobee area and the Lower East Coast. Part II will include the area north of Lake Okeechobee (shaded area on map insert). Documentation for the PDLD Part II is expected to be completed within six months. To facilitate use of the database and maps, a data CD is included with this report document. The CD contains the PDLD database, an atlas of maps corresponding to the study area discussed in this document, and an electronic copy of this report. This material is also available from the District's Web site at: http://www.sfwmd.gov.

Approach

Completion of this geodatabase project required development of a vegetation classification system designed to meet anticipated data requirements of hydrological models and restoration projects. Using an ecological community classification approach, we consolidated and then refined existing classification systems of major plant assemblages found in southern Florida (current and historical), resulting in a system that met our objectives (**Attachment A)**.

Initially, baseline information was compiled based on ecological community attributes of the Soils Classification Database (Zahina *et al*., 2001) and available pre-development vegetation studies of the region, including Austin *et al*. (1977), Richardson

(1977), Steinberg (1980), Hohner (1994), Duever (2004) and McVoy *et al*. (2005). The data sources were then cross walked to the project classification system.

Using GIS, vegetation community attributes in the database and map were refined and verified with the U.S. Government's General Land Office (GLO) and U.S. Coast and Geodetic Survey information from the mid-to-late 1800s.

BACKGROUND

Previous Efforts to Characterize Pre-Development Vegetation

General Land Office Surveys of Central and South Florida (1800s)

The United States Government General Land Office (GLO) sponsored a survey of lands in Florida in response to the Land Ordinance of 1785 requiring Public Lands be surveyed prior to settlement. The resulting survey effort established the township-range-section lines still in use today. Surveys of Florida's public lands began in the mid 1800s and continued through the latter part of the 19th century. As part of this historic effort, field notes describing significant natural features observed along section lines (including plant community types) were recorded and maps of townships were created based on the descriptions provided in the survey field notes. The Florida Department of Environmental Protection (FDEP) provides electronic copies of original survey field notes and map documents on its Web site, http://data.labins.org.

The GLO survey field notes contain measured lengths between landscape features along section lines. However, the detail of vegetation descriptions varied by surveyor, so caution must be exercised to properly interpret the vegetation community types. Additionally, the terminology used by the surveyors may require scrutiny by the reader. For example, a "prairie," the term used to describe a treeless expanse of grass-like plants, may indicate a dry prairie (a level upland), wet prairie (a short-hydroperiod wetland) or an expanse of sawgrass (marsh). Typically, additional descriptions contained within the field notes allow the reader to make a determination of which modern definition is best applied.

The GLO's initial survey effort represents the earliest and most comprehensive field descriptions and documentation of vegetation across the south and central Florida region. The survey field note descriptions are of sufficient quality to be used as a "field verification" of the region's pre-development vegetation as it existed at the time of the survey effort. But, a notable limitation of the documentation is that landscape features are only recorded along section lines. Descriptions and map features of areas not along these transects (i.e. within the center of a section block) are inferred and not reliable as measured or observed data.

Davis (1943a) Vegetation Map of Southern Florida

John Henry Davis is credited with producing the first comprehensive vegetation map of central and south Florida. The familiar "Davis Map" accompanied the Florida Geological Survey report entitled, *The Natural Features of Southern Florida Especially the Vegetation, and the Everglades* (Davis 1943a). Based on 1940 surveys and photographs, this vegetation map generally reflects the landcover present at the time of the survey.

It is important to note the Davis Map represents the post-drainage condition of the Kissimmee-Okeechobee-Everglades Region, which had been subject to drainage activity and associated development for 50 years before the area was surveyed. Existing urban and agricultural areas in the Everglades and adjacent coastal regions were classified based on an estimated natural (but not necessarily "pre-drainage") condition. Also, while landscape level features are well represented spatially in this study, vegetation communities, such as bay heads, tree islands and scattered isolated marshes were "roughly estimated" due to limited mapping capabilities. The Davis Map was of a generally low resolution (by modern standards) and useful only as a landscape-level view of plant community distribution. It was not intended to provide site-specific information.

Although the Davis Map cannot be considered representative of south Florida vegetation prior to impacts from drainage, it is a valuable source of surveyed data. It provided a reference condition from which to estimate "pre-canal drainage" landcover in the Everglades Basin for subsequent studies (i.e., Davis *et al.* 1994, [no relation to J.H. Davis]; McVoy *et al*. 2005).

Richardson (1977) Vegetation of the Atlantic Coastal Ridge of Palm Beach County

Pre-drainage vegetation patterns of the Atlantic Coastal Ridge of Palm Beach County were mapped using survey information from 1845 to 1870; 1940 aerial photographs; and, 1913–1973 soil surveys and qualitative ground truth studies. Eleven community types were defined in this study.

One limitation of Richardson's map is that its reliability is based on the author's interpretation of pre-development written accounts, post-development aerial photography and maps. Additionally, the map was not systematically verified with pre-development field data (i.e., GLO field notes and maps), and the agreement between pre-development vegetation descriptions and GIS map polygons was not tested.

Steinberg (1980) Vegetation of the Atlantic Coastal Ridge of Broward County

A vegetation map of the Atlantic Coastal Ridge of Broward County was produced from 1940s aerial photography, for the purpose of aiding in the assessment of human interference and non-native species spread into natural habitats. Ten vegetation types were recognized in this effort.

Steinberg's vegetation map was produced using standard stereoscopic techniques with aerial photography from the years 1940, 1947, 1948 and 1949. Changes in the area's vegetation occurring before 1940 are not shown on the map. The reliability of Steinberg's map is limited due to its reliance on the author's interpretation of post-development (1940s) aerial photography. It is also important to note that some of the author's interpretations were based on qualitative, not quantitative, sources. The map was not systematically verified with pre-development field data (i.e., GLO field notes and maps) and the agreement between pre-development vegetation descriptions and GIS map polygons was not tested.

Zahina *et al*. (2001) Vegetation Map of 19 Counties in South and Central Florida.

A large geospatial soil database of 19 counties in south Florida was developed as part of the Comprehensive Conservation, Permitting and Mitigation Strategy (Wetland Conservation Strategy). Development of the database was a multi-agency cooperative effort between the South Florida Water Management District, the U.S. Environmental Protection Agency (USEPA), the U.S. Army Corps of Engineers (USACE) and the Florida Department of Environmental Protection. The corresponding GIS map polygons follow the Soil Survey Geographical Database (SSURGO), developed by the Natural Resources Conservation Service (NRCS). As part of this effort, soil survey data were used to infer historic vegetation, as represented within each polygon, by examining hydrogeographic patterns. Additionally, soil survey staff related an ecological community type with a soil type, using a guidebook of 26 ecological communities commonly found in Florida (Soil Conservation Service 1989). This study's analysis of the distribution of ecological communities and their associated soils resulted in a classification scheme based on 10 ecological community types.

An advantage of the Zahina *et al.* map is its large coverage area (19 counties), which is viewable at a resolution of at least 5 acres. It should be noted that the accuracy of the community types represented in the map has only been verified in a few areas of the SFWMD using GLO field notes and maps. Areas verified for this effort include the Loxahatchee Watershed (Taylor Engineering 2005), Loxahatchee Slough Natural Area (Zahina and Kramp 2004), Upper Kissimmee Basin (unpublished data) and Lake Istokpoga area (SFWMD 2005). In each of these areas, at least 90 percent agreement exists between the soil pre-development data and GLO field notes and maps.

One limitation of the Zahina *et al.* map's reliability relates to the paucity of soil data available in parts of the study area. Unfortunately, several large land tracts were never surveyed by the NRCS, creating data gaps in the soil and pre-development vegetation maps. Most of the resulting data gaps occur where permission to survey was denied on private lands; in national parks; and, in metropolitan areas, where significant disturbance occurred before the soil survey was initiated.

For some applications, the generalized definitions of some vegetation classes present another limitation of the Zahina *et al.* map. For example, it is not possible to resolve between some wetland (i.e. sawgrass or bald cypress) or flatwood (pine flatwoods or dry prairie) community sub-types based on soils. Also, the historic reliability of the map may not be consistent across the entire study boundary because the map was based upon an association between a soil taxon and a vegetation community type. In areas where the soil type was not significantly altered by the time the soil survey was conducted, the reliability of the inferred vegetation community is high. In areas where the soil type was largely altered from its historic form, the ability to predict the historic vegetation community is reduced.

Duever (2004) Southwest Florida Pre-Development Vegetation Map

The Natural Systems Group of the Southwest Florida Feasibility Study (SWFFS) Team developed a map of pre-development vegetation communities as part of the Comprehensive Everglades Restoration Plan (CERP) effort. The study area spans from the western edge of the Everglades to the Gulf Coast, and from the Fisheating Creek Watershed to Florida Bay. Counties included in the study area are Charlotte, Collier, Glades, Hendry, Lee and Monroe. The Big Cypress National Preserve and adjacent Everglades National Park lands were not included in the soil surveys. For these areas, more recent vegetation maps were reclassified into the same plant community classes as the rest of the study area. Determinations of pre-development communities were based upon soil survey information and best professional judgment. The latest version of this document is provided as **Attachment B**[2].

The Duever PDV map offers a fairly high resolution of 15 major community types across the region. The map, which has undergone extensive scrutiny, offers the advantage of a seamless geospatial database across five counties. Additionally, the historical extent of plant communities in the region (as depicted in the map), reflects a general consensus of the CERP team members. The CERP team's collective field experience in the region, which is extensive, also provided guidance for the GIS polygon definition development.

The limitation of this database is its reliability, which is based on the subjective interpretation of soil information and team members' experience. Also, the map has not been systematically verified with pre-development field data, and the agreement between observed pre-development vegetation and map polygons has not been quantified.

McVoy *et al.* (2005) Pre-Drainage Everglades Landscapes and Ecology

This project was originally designed to independently verify the SFWMD Natural System Hydrologic Simulation Model (NSHSM) output. Scientific studies, historical

[2] This attachment is not provided in this document. The full Technical Publication with all attachments is available on-line at https://my.sfwmd.gov/portal/page?_pageid=1314,2555966,1314_2608149:1314_2564292&_dad=portal&_schema=PORTAL

narratives and surveyed data were integrated to characterize mid-19th century pre-development Everglades landscapes and hydrology, for this effort. Primary source material, included: quantitative information from prior studies, surveys, profiles, major expeditions, early maps and narrative accounts. Anecdotal information was also considered (in context).

McVoy *et al.'s* work resulted in the identification and characterization of historical Everglades landscapes and bordering areas, in terms of spatial extent, vegetation, soils, topography, and associated water depths and hydroperiods (**Attachment C**). The peer-reviewed vegetation mapping and hydrologic characterizations from the Everglades landscape descriptions provided in **Attachment C** were converted to GIS (the Pre-drainage Everglades database) and applied in the District's Regional Simulation Modeling for the natural system. Documentation of this effort has since been expanded to include discussion of basin flow in the Everglades. (The flow portion of the document is still in development. The study will be published in its entirety following a review process.)

An important finding that emerged from this research was the realization that a significant amount of historical pre-development information exists, is accessible, and is usable to produce a defendable representation of Everglades landscapes and hydrology prior to the region's development.

METHODS

Pre-Development Vegetation Database Development

An outline of the process used to create the Pre-Development Vegetation (PDV) database and map is depicted in **Figure 1**. The first steps involved defining the study area and subregions of similar hydro-geomorphic characteristics. The study area established for this project included the full geographical extent of all 16 counties contained within the South Florida Water Management District. To facilitate our analysis and verification processes, the study area was divided into subregions, organized by their unique or similar vegetation patterns (**Figure 2**).

A literature search was conducted to identify all previous studies that examined or created maps of historical vegetation within the central and south Florida region. Available source data and maps varied in format and usability. While recent efforts were available in an electronic format, such as a GIS cover or layer file, older sources were available only as paper maps. In such cases, the maps were scanned and geospatially rectified using Arc GIS tools.

A vegetation classification scheme (summarized in **Table 1)** was developed to group similar vegetation community types together and to meet the anticipated data requirements of hydrological models and restoration projects. A detailed description of the vegetation classes identified by this effort is presented in **Attachment A**.

Within each subregion, a base map was created by compiling existing pre-development vegetation map sources. Typically, one map source was identified as the primary source (usually, the source with the highest resolution). The remaining sources were used to fill in where questions of accuracy or gaps existed in the original source. Ecological community descriptors and classes provided by the original map sources were converted to the vegetation community descriptors developed for this project (**Table 1**).

Attribute (polygon) data from individual sources were retained and additional fields (attributes) were added to the GIS (see **Table 2**). A more detailed description of these attributes is provided in **Attachment D**.

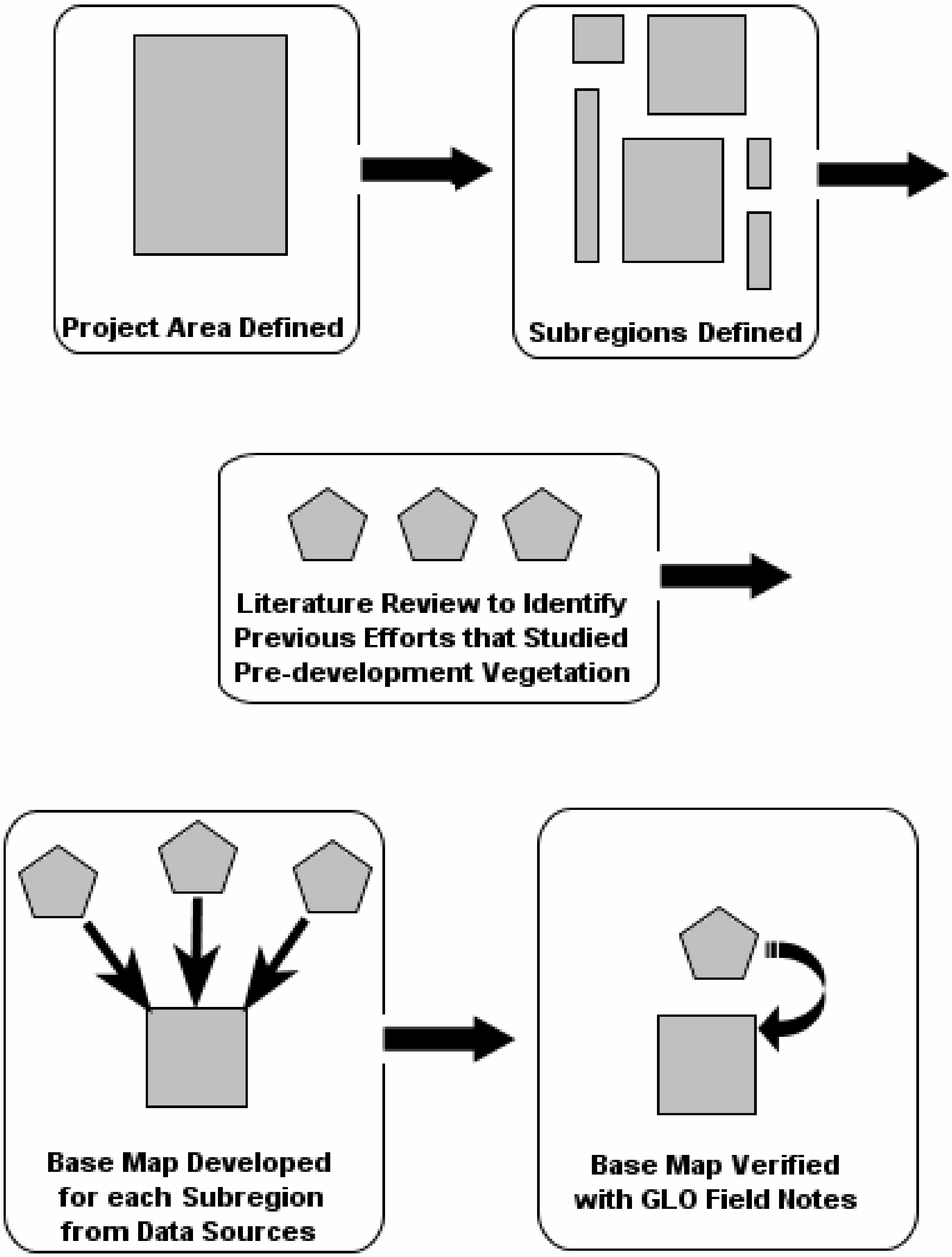


Figure 1. Process Diagram of the Method Used to Create a Pre-Development Map of Central and South Florida.

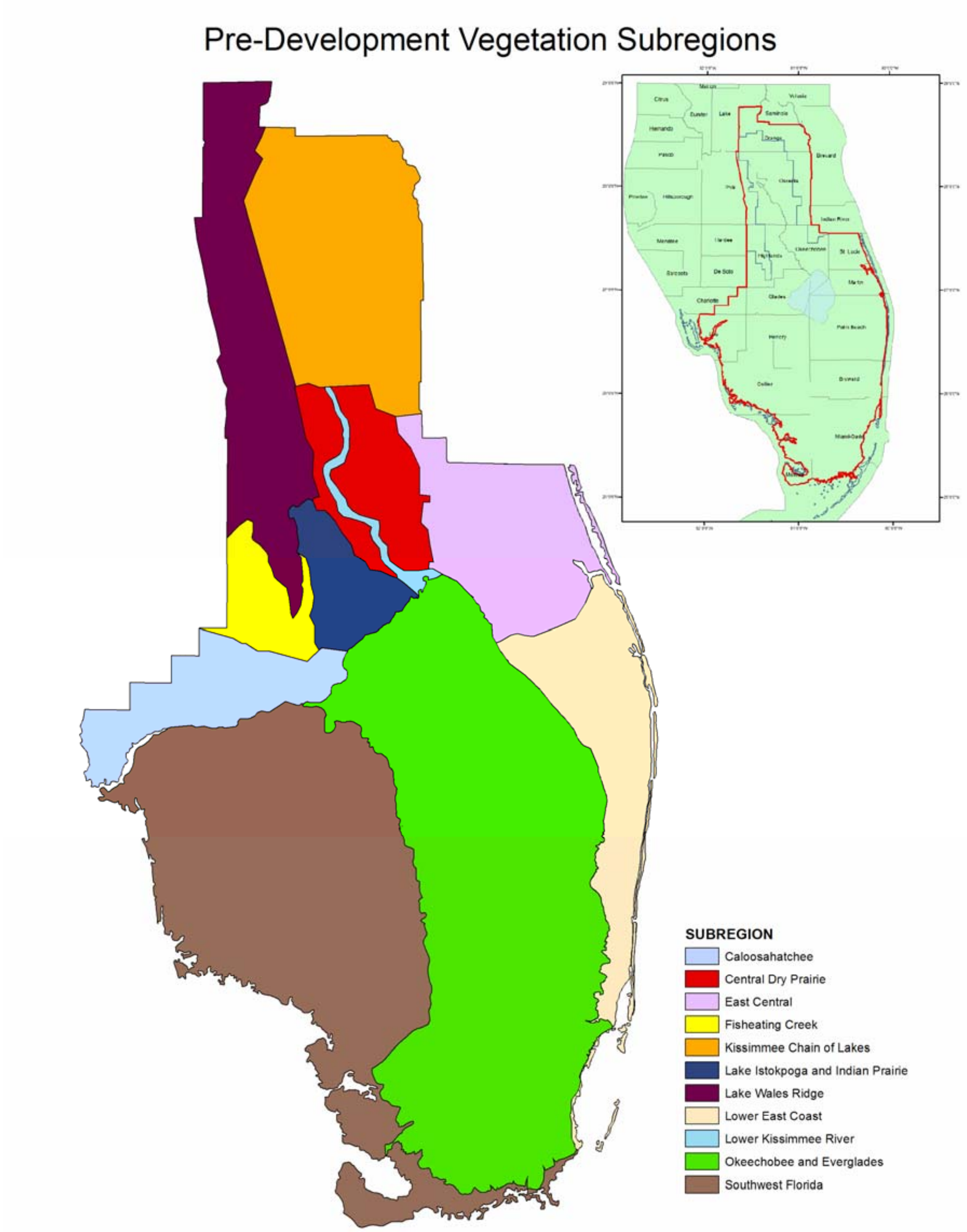


Figure 2. Map of Project Area and Subregions.

Table 1. Vegetation Classifications Used to Develop the Pre-Development Landscape Map and Database

Vegetation Type	Description[3]	*Classification Code*
Water	Permanently inundated site; includes freshwater, estuary and marine systems.	*1*
Intra-tidal Wetland	Tidally inundated sites; vegetation community is influenced by magnitude of daily flooding regime and saltwater exposure.	*2*
Beach	Consolidated substrate (e.g., rock) or unconsolidated deposits (e.g., sands) on shorelines influenced by moving water.	*3*
Forested Freshwater Wetland	Forested freshwater wetlands (swamps).	*4*
Cypress Swamp	Freshwater swamp dominated by cypress.	*4.1*
Hardwood Swamp	Freshwater swamp dominated by broadleaf trees.	*4.2*
Non-Forested Freshwater Wetland	Freshwater wetland dominated by herbaceous vegetation; non-forested.	*5*
Long-hydroperiod Marsh	Freshwater marsh with hydroperiods extending from 11 to 12 months on average.	*5.1*
Ridge and Slough Marsh	Everglades-specific community mosaic of alternating open water sloughs and sawgrass ridges interspersed with tree islands.	*5.11*
Sawgrass Plain	Northern Everglades-specific community consisting of a generally unbroken expanse of sawgrass across a large spatial extent.	*5.12*
Medium-hydroperiod Marsh	Freshwater marsh with hydroperiods extending from 6 to 10 months on average.	*5.2*
Marsh with Scattered Cypress	Freshwater marsh with hydroperiods (from 6 to 10 months on average) that contain scattered stunted cypress.	5.21
Everglades Marl Marsh	Everglades-specific community consisting of a medium-hydroperiod marsh with marl soils derived from calcareous algae; most extensive in the southern Everglades.	5.22
Wet Prairie	Short-hydroperiod treeless wetlands that have hydric soils, hydroperiods extending from 2 to 6 months, and inundation to 1 foot on average.	5.3
Wet Prairie with Scattered Trees	Wet prairie with scattered trees, including pine, cypress and bay.	5.31
Wet Prairie with Cypress	Wet prairie with scattered cypress.	5.32

[3] Additional description detail is included in **Attachment A**.

Table 1 (cont). Vegetation Classifications Used to Develop the Pre-Development Landscape Map and Database

Vegetation Type	Description	Classification Code
Hydric Upland	Moist woodlands on non-hydric soils in level, low landscapes than may have some short-duration flooding each year. Fire frequency is the primary factor in shaping dominant vegetation type.	6
Hydric Flatwood	Hydric flatwoods typically are dominated by slash pine.	6.1
Hydric Hammock	Hydric hammocks typically are dominated by hardwood species.	6.2
Mesic Upland	Mesic communities are found on upland (non-hydric) soils; short-duration flooding may occur only during high-rainfall events. Fire frequency is the primary factor shaping dominant vegetation type.	7
Dry Prairie	Non-forested upland community composed primarily of grasses and palms; high fire frequency.	7.1
Mesic Pine Flatwood	Forested upland community composed primarily of pines; moderate fire frequency.	7.2
Mesic Hammock	Forested upland community composed primarily of broadleaf trees; low fire frequency.	7.3
Xeric Upland	Xeric communities are found on highest elevation sites with the water table well below (more than 3 feet) the soil surface all year. Xeric plant communities are dominated by species that have special adaptations for survival in dry conditions. Fire frequency is the primary factor shaping dominant vegetation type.	8
High Pine (Sandhill)	Dry pine communities on undulating sandy soils that are dominated by longleaf pines and wiregrass; these communities are typically found in central Florida.	8.1
Scrub	Scrub communities are dominated by sand pine or oak scrub species and are typically found on pure, deep sands of relic dune systems.	8.2
Coastal Strand	Coastal strand communities are typically found on excessively drained elevated sites, such as coastal dunes, ridges, rocky outcrops or shell mounds. Vegetation species are primarily of tropical and Caribbean origin.	8.3

Table 2. Field Attributes Added to the Pre-Development Vegetation Database.

Pre-Development Vegetation Database Field Attribute	***Description of Attribute***
Vegetation Class	*Pre-development vegetation community type – dominant species*
Classification Code	*Vegetation classification code*
*Mannings n**	*Roughness coefficient for overland flow*
Pd	*Open water ponding depth*
*Kveg**	*Vegetation reference crop potential evapotranspiration correction coefficient*
*Rd**	*Shallow root zone depth*
*Xd**	*Soil depth below which no evapotranspiration occurs*
Hydroperiod	*Inundation duration range*
Seasonal Water Levels	*Wet season and dry season average water levels*
*Fire**	*Fire frequency*

* Indicates a new attribute added to the vegetation database

Identification and Management of Potential Sources of Error

Throughout the process of creating and verifying the Pre-Development Vegetation Database and Map, a number of potential sources of error and uncertainties were discovered. A set of guidelines were developed by the project team to manage potential error sources. These quality control measures were designed to: 1) increase the reliability of the product to the greatest extent possible; 2) track and maintain the “minimum reliable mapping unit” a user should expect within a subregion; and 3) identify, compile and present a description of data application limitations along with guidelines for proper interpretation of the data to the user. It is anticipated that this process created a more reliable product, as well as clearly-identified limitations to use of the database. Following are descriptions of the types of potential sources of error identified during this effort.

Variations in General Land Office Source Information and Maps

During the verification process, a number of variations in the U.S. Government’s General Land Office’s (GLO) field note descriptions and maps were identified and found to be potential sources of error. Variations arose from three general sources: 1) differences in what and how different surveyors recorded their observations, 2) interpretation of what was recorded relative to the context of the era, and 3) cartographic quality of maps produced in the mid-to-late 1800s.

Variations in Field Note Descriptions by Different Surveyors

After reading numerous field notes from across the region, it was apparent that not all surveyors interpreted the landscape in exactly the same way; each individual had a unique style for recording major features along survey lines. Typically, all surveyors recorded significant timber or agriculture-related resources, such as descriptions of the forest (pineland, hardwood or cypress stand) observed along a survey line; but, not all surveyors included descriptions of the forest quality (1st, 2nd or 3rd rate), site wetness (inundated, boggy or impracticable) or soil quality (barren, sandy or boggy). A few surveyors provided little or no vegetation descriptors in the field notes; this was especially striking when comparing site notes for the same area with other map sources (e.g., soils) that indicated a more heterogeneous landscape. In these situations, it was assumed the surveyor had omitted some details of natural features along the survey line that were considered incidental. In areas where the surveyor typically provided only brief descriptions (a few words or less) and the general description along a survey line was in agreement with the base map, additional details in the base map were retained (e.g., small inclusions of other vegetation community types). It was assumed these small features were likely present in the pre-development landscape, but not of interest to the GLO team; and, therefore not recorded.

The amount of detail provided in field note descriptions also varied according to the types of natural features encountered; most surveyors provided the greatest detail when encountering a wetland, stream or water body. A few surveyors provided a description of nearby features that did not lie exactly on the section line being surveyed. Within the context of the variety of detail encountered in GLO field notes, descriptions of dominant landscape features, such as “pines with saw palmetto,” were taken literally. However, if the word “pines” appeared alone, the description was not interpreted to include or exclude “saw palmettos” (an indicator of a mesic rather than hydric flatwood community), or any other species associated with pine flatwoods, except if other descriptors or sources indicated otherwise.

Interpretation of GLO Field Notes within their Historical Context

The GLO surveys were conducted well before most modern plant taxonomy and ecological community classifications were established for Florida’s natural systems. Typically, surveyors were not trained biologists, so they would not interpret or describe the natural vegetation communities as modern-day botanists would record the same ecological systems.

In many instances, the context of the field note descriptions (from the same surveyor) became clear only after examination of numerous entries across the landscape. And, because surveyors across the region applied a term such as “prairie” to any number of communities that may be described differently today, its meaning as implied by one surveyor in a specific subregion was not necessarily carried into another area. In the context of that era, a “prairie” meant a “treeless expanse”. Hence, some surveyors have applied the term “prairie” to an expanse of sawgrass (sawgrass prairie), to a large (medium-hydroperiod, mixed species) marsh, as well as to communities that modern classification conventions call wet prairie and dry prairie communities. In cases when the exact meaning of the descriptor was not explicit, the question was usually resolved by examining additional field note descriptions, surrounding landscape features, or consulting other sources (such as soil data).

GLO Mapping Precision and Quality

Maps created by GLO survey staff were hand-drawn and based on field note descriptions and measurements. Occasionally, translation errors arose during the process of creating paper maps from field notes and information. Often, these errors were minor; however, in a few cases the geographical representation of some maps has been found to be skewed or mis-drawn. Another potential source of translation errors can occur when a paper map is converted to an electronic image format. Usually, both of these types of distortions can be corrected when geo-rectifying the image in a GIS program.

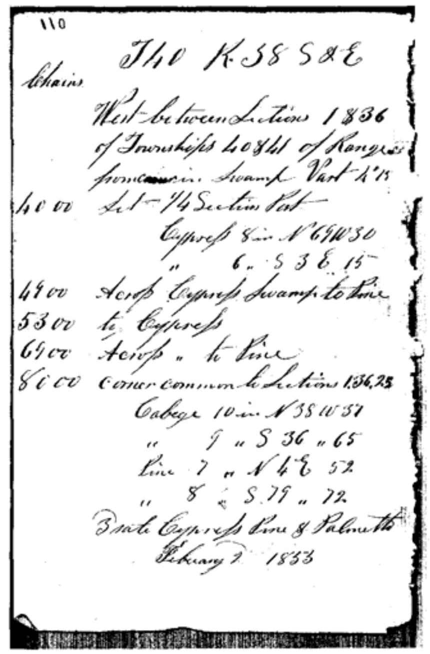
Mapping a Complex Landscape Mosaic

One of the most challenging sources of potential error was the interpretation of complex landscape mosaics. Usually, these areas are low, flat landscapes that contain a mix of forested and non-forested wetland types with inclusions of uplands. The difficulty arises from one, or all, of the following circumstances: 1) polygons for each community type are typically small with poorly-defined ecotones between communities; 2) polygons defining different vegetation communities may be close to, or less than, the minimum mapping unit of the base map; 3) the landscape lacks a clear directionality, such as flowways, which could be used to define vegetation patterns.

Throughout the verification process, it became evident that when differences between the base map and GLO descriptions occurred, these differences were not always consistent across the landscape, even on smaller scales. One example of this was found with pine flatwood soils in areas dominated by shallow wetlands. In areas where a polygon of mesic pine flatwood community was relatively large, the GLO descriptions and base map were typically in agreement. In areas where there were small polygons of mesic pine flatwoods which were surrounded by wetlands, GLO field note descriptions usually indicated that these polygons were better described as “hydric flatwoods” or “wet prairie with pine.” One likely explanation for the difference in what was indicated by the base map and the actual GLO field observation is the influence of the surrounding wetland hydrology on the small isolated stand of pines. In cases such as these, every effort was made to change the base map to agree with the GLO descriptions. However, it is impossible to analyze and verify every polygon within the base map for accuracy; indeed, insufficient historic data exists to conduct such an effort. It is important for the user of the Pre-Development Vegetation database and map to understand the map is most reliable when applied at a landscape (rather than a localized) scale, in areas where a mosaic of wetland and non-wetland community types exists.

Verification of Pre-Development Vegetation Maps by SubRegion

Areas of each subregion base map were compared with the GLO field notes as a means to verify the accuracy of the Pre-Development Vegetation map. Vegetation descriptions from GLO field notes (**Figure 3**) and maps (**Figure 4**) along section lines in townships were examined and compared with polygon attributes in the base map. Where agreement was found between the GLO field note descriptions and vegetation community classes on the base map, the base map and was assumed to be correct or "verified" at that location. Where disagreement between the GLO descriptions and pre-development map was found, attributes of the base map were changed to the vegetation class (**Table 1**) that most closely matched GLO vegetation descriptions. A closer examination of the discrepancy between the base map and GLO descriptions for that community type was also conducted to determine to what extent the base map classes should be changed throughout the subregion. More detail of how this method was applied in different subregions is provided next.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Chains T40 R38 S&E

West between Sections 1 & 36
of Townships 40 & 41 of Ranges
from corner in Swamp Vart 4°15

40 00 Set 1/4 Section Post
Cypress 8 in N 69 W 30
" 6 " S 3 E 15
49 00 Across Cypress Swamp to Pine
53 00 to Cypress
69 00 Across " to Pine
80 00 Corner common to Sections 1, 36, 2, 35
Cabege 10 in N 38 W 57
" 9 " S 36 " 65
Pine 7 " N 4 E 52
" 8 " S 79 " 72
Cypress Pine & Palmetto
February 7 1833

Figure 3. Sample General Land Office (GLO) Field Note Page

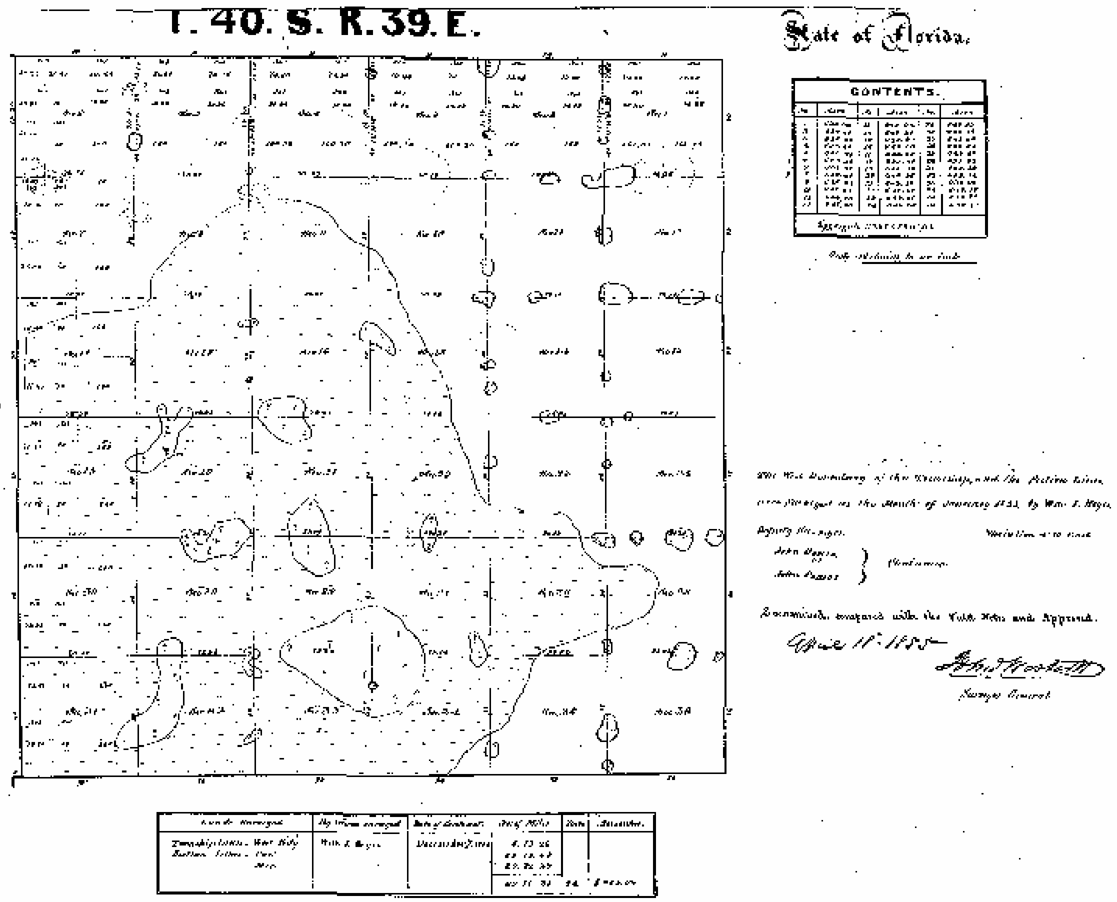

Figure 4. Sample General Land Office (GLO) Township-Range Map

Lower East Coast

This subregion encompasses portions of Miami-Dade, Broward, Palm Beach and Martin counties along the southeast peninsula of Florida, including the lower St. Lucie Watershed south of the present-day C-44 Canal (which contains the South Fork of the St. Lucie River), the Loxahatchee Watershed, and portions of the present-day southeast Florida metropolitan complex along the Atlantic coastline (**Figure 5**). Data sources used to create a base map in this subregion included vegetation maps derived from interpretation of early aerial photography (Richardson 1977, Steinberg 1980), soils by the Wetlands Conservation Strategy (Zahina *et al*. 2001) and surveys of relict areas (Austin 1977, Austin *et al*. 1977) (Figure 6). Detailed descriptions of distinct areas within the subregion are outlined next.

Martin and Palm Beach Counties

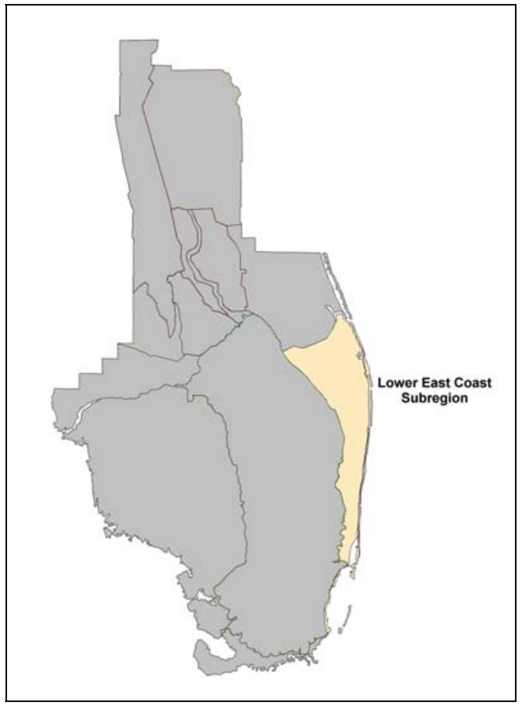

Figure 5. Lower East Coast Subregion

The portion of the Lower East Coast Subregion within Martin and Palm Beach counties is generally defined as the area between the Atlantic coastline and the historical Everglades, south of the St. Lucie River (including the South Fork) to the Broward County line. In the northern portion of this area, significant tracts of land are currently in public ownership as parks and preserves; some of these natural areas remain fairly unchanged from their pre-development condition. The base map used in this area was compiled from three map sources: 1) ecological classifications developed by the Wetlands Conservation Strategy (Zahina *et al.* 2001) were used for the area between the Everglades and the coastal zone where soils survey information was no longer available; 2) Richardson's (1977) photo-interpretative map of historical vegetation was used along the coastal zone and, 3) the U.S. Coast and Geodetic Survey of the coastal waterways from 1884 were used to define the extent of natural waterways. The soil maps were available in electronic format; however, the Geodetic Survey and Richardson's maps were only in paper format, and digitized to create an electronic geospatial version for this project. Figure 6 shows the source data used to create the base map in the Lower East Coast Subregion.

Vegetation descriptions from the Wetlands Conservation Strategy database (Zahina *et al.* 2001) and Richardson (1977) were converted to classifications used by this project (**Table 1**); the methods used are shown in **Table 3** and **Table 4**. This resulting base map was compared to GLO field notes and maps to determine its accuracy. Additional changes to the base map were made to more closely approximate vegetation community distribution recorded in GLO field notes and plat maps; these changes are shown in **Table 5**.

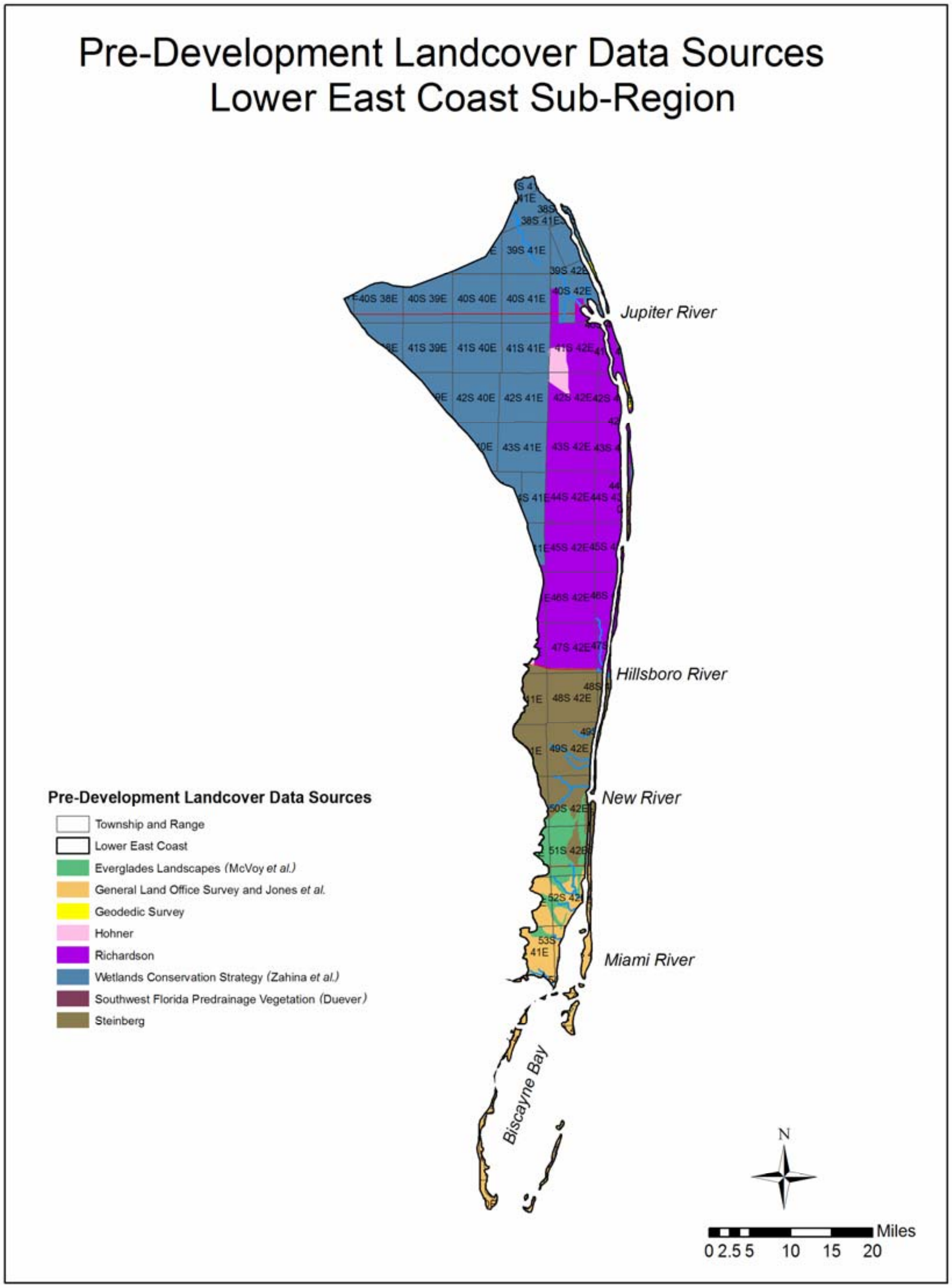

Figure 6. Source Data Used to Create the Base Map for the Lower East Coast Subregion.

Table 3. Wetland Conservation Strategy Database Vegetation Classification Crosswalk (Zahina *et al*. 2001).

Wetlands Conservation Strategy Vegetation Class	***Pre-Development Vegetation Class***	
	Description	**Classification Code**
Water	*Water*	*1*
Intra-Tidal Wetlands	*Intra-Tidal Wetland*	*2*
Beaches	*Beach*	*3*
Freshwater Wetlands	*Non-Forested Freshwater Wetland*	*5*
Wet Prairie	*Wet Prairie*	*5.3*
Swamp Hammock	*Hydric Upland*	*6*
Uplands	*Mesic Upland*	*7*
Flatwoods	*Mesic Pine Flatwood*	*7.2*
Highlands	*Xeric Upland*	*8*

Table 4. Richardson (1977) Vegetation Classifications Crosswalk.

Richardson's Vegetation Class	***Pre-Development Vegetation Class***	
	Description	**Classification Code**
Mangrove	*Intra-tidal Wetland*	*2*
Beach and Strand	*Beach*	*3*
Swamp	*Hardwood Swamp*	*4.2*
Marsh	*Medium-Hydroperiod Marsh*	*5.2*
Wet Prairie	*Wet Prairie*	*5.3*
Ponded Wet Prairie	*Wet Prairie with Cypress*	*5.32*
Low Hammock	*Wet Prairie with Scattered Trees*	*5.31*
Tropical Hammock	*Mesic Hammock*	*7.3*
Pine Flatwoods	*Mesic Pine Flatwood*	*7.2*
Dry Prairie	*Dry Prairie*	*7.1*
Scrub	*Scrub*	*8.2*

Table 5. Additional Modifications During Verification of Base Map in the Martin and Palm Beach County Area.

Township-Range	***Modifications to Vegetation Classification based on GLO Observations***
Township 40 – Range 40 *Township 40 – Range 41* *Township 41 – Range 41* *Township 42 – Range 41*	*Wet Prairie (# 5.3) in the base map derived from soil data was changed to Hydric Flatwood (# 6.1).* *Non-Forested Freshwater Wetland (# 5) in the base map derived from soil data was changed to Medium-Hydroperiod Marsh (# 5.2).* *Mesic Upland (# 7) in the base map derived from soil data was changed to Mesic Pine Flatwood (# 7.2); in Township 41 – Range 41 only, Mesic Upland was changed to Hydric Flatwood (# 6.1).* *Wet Prairie with Scattered Trees (# 5.31) in the base map derived from Richardson (1977) was changed to Hydric Flatwoods (# 6.1).*
Township 41 – Range 38	*Non-Forested Freshwater Wetland (# 5) in the base map derived from soil data was changed to Cypress Swamp (# 4.1).* *Wet Prairie (# 5.3) in the base map derived from soil data was changed to Wet Prairie with Cypress (# 5.32).* *Mesic Upland (# 7) in the base map derived from soil data was changed to Mesic Pine Flatwood (# 7.2).*
Township 41 – Range 39	*Non-Forested Freshwater Wetland (# 5) in the base map derived from soil data was changed to Cypress Swamp (# 4.1) in the western half of the township.* *Wet Prairie (# 5.3) in the base map derived from soil data was changed to Wet Prairie with Cypress (# 5.32) in the western half of the township and to Hydric Flatwoods (# 6.1) in the eastern half.* *Mesic Upland (# 7) in the base map derived from soil data was changed to Mesic Pine Flatwood (# 7.2) in the western half of the township.* *Small, isolated wetland polygons designated as Non-Forested Freshwater Wetlands (# 5) were changed to Medium Hydroperiod Marsh (# 5.2) in the northern half of the township.*
Township 41 – Range 40	*Wet Prairie (# 5.3) in the base map was changed to Hydric Flatwoods (# 6.1).* *Mesic Pine Flatwood (# 7.2) in the base map was changed to Hydric Flatwoods (# 6.1) in the southern half of the township.* *Wet Prairie with Scattered Trees (# 5.31) in the base map derived from Richardson (1977) was changed to Hydric Hammock (# 6.2) in the southern half of the township.* *Non-Forested Freshwater Wetland (# 5) was changed to Marsh with Scattered Cypress (# 5.21); small, isolated wetland polygons designated as "Non-Forested Freshwater Wetlands" (# 5) were changed to Medium Hydroperiod Marsh (# 5.2) in the northern half of the township.*
Township 41 – Range 42	*Wet Prairie (# 5.3) in the base map derived from Richardson (1977) was changed to Mesic Pine Flatwood (# 7.2) in the southern half of the township and to Hydric Flatwoods (# 6.1) in the northern half of the township.* *Wet Prairie with Scattered Trees (# 5.31) in the base map derived from Richardson (1977) was changed to Hydric Flatwoods (# 6.1).* *Medium Hydroperiod Marsh (# 5.2) in the base map derived from Richardson (1977) was changed to Marsh with Scattered Cypress (# 5.21).* *Non-Forested Freshwater Wetland (# 5) in the base map derived from Richardson (1977) was changed to Hydric Hammock (# 6.2).* *Hardwood Swamp (# 4.2) in the base map derived from Richardson (1977) was changed to Cypress Swamp (# 4.1).*

Table 5 (cont). Additional Modifications During Verification of Base Map in the Martin and Palm Beach County Area

Township-Range	*Modifications to Vegetation Classification based on GLO Observations*
Township 42 – Range 42 *Sections 6, 7, 17, 18, 19, 20 (western half only), 30 and 31*	*Wet Prairie (# 5.3) in the base map derived from Richardson (1977) was changed to Hydric Flatwoods (# 6.1).*
Sections 8, 16, 21, 28 and 33	*Medium-Hydroperiod Marsh (# 5.2) in the base map derived from Richardson (1977) was changed to Marsh with Scattered Cypress (# 5.21).* *Hardwood Swamp (# 4.2) in the base map derived from Richardson (1977) was changed to Cypress Swamp (# 4.1).*
Township 41 – Range 43 *Township 42 – Range 43* *Township 43 – Range 43*	*Hardwood Swamp (# 4.2) in the base map derived from Richardson (1977) was changed to Cypress Swamp (# 4.1).*
Township 43 – Range 42 *Sections 2, 11, 14, 23, 26 and 35*	*GLO field survey information defines a transition from mesic to hydric community types. Wet Prairie (# 5.3) in the base map derived from Richardson (1977) was changed to Mesic Pine Flatwoods (# 7.2) along the east side of the transition zone and to Wet Prairie with Scattered Trees (# 5.31) along the west side of the transition zone.*
Sections 1, 12, 13, 24 and 25	*Hardwood Swamp (# 4.2) in the base map derived from Richardson (1977) was changed to Cypress Swamp (# 4.1).*

Broward County Area

The base map for eastern Broward County up to the historic edge of the Everglades was developed from 1940s aerial photography (U.S. Department of Agriculture 1940) as interpreted by Steinberg (1980). The District staff digitized and generated polygons from the paper map published as part of that study. Additional polygons outlining xeric communities, which were not well defined by Steinberg, were taken from the 1948 soils map (Jones 1948). Figure 6 shows the source data used to create the base map in Broward County.

Steinberg's vegetation descriptions were converted to the vegetation classes defined for this study (**Table 1**), following the method outlined in **Table 6**. Soils designated as St. Lucie Fine Sand were selected from the 1948 soil map and delineated as isolated scrub communities[4]. Examination of GLO field notes indicated the descriptions of these areas include not only the xeric (scrub) areas, but transitional zones between pine flatwoods. This resulting base map was compared to GLO field notes and maps to determine its accuracy. Additional changes to vegetation classifications were made to the base map vegetation community types according to GLO field note descriptions and plat maps (**Table 7**).

[4] St. Lucie Fine Sand is an excessively drained soil that is associated with relic dune systems; typically these sites support xeric and scrub vegetation, and have a seasonal high water table at least six feet below the soil surface (Zahina *et al.* 2001). Other soils of this type include Archbold and Pomello.

Table 6. Steinberg (1980) Vegetation Classification Crosswalk

Steinberg Vegetation Class	***Pre-Development Vegetation Class***	
	Description	**Classification Code**
Mangrove	*Intra-tidal Wetland*	*2*
Beach and Strand	*Beach*	*3*
Swamp	*Hardwood Swamp*	*4.2*
Marsh	*Medium-Hydroperiod Marsh*	*5.2*
Wet Prairie	*Wet Prairie*	*5.3*
Low Hammock	*Wet Prairie with Scattered Trees*	*5.31*
Tropical Hammock	*Mesic Hammock*	*7.3*
Pine Flatwoods	*Mesic Pine Flatwood*	*7.2*
Dry Prairie	*Dry Prairie*	*7.1*
Scrub	*Scrub*	*8.2*

Table 7. Additional Modifications During Verification of the Base Map for the Eastern Broward County Area.

Township-Range	***Modifications to Vegetation Classification based on GLO Observations***
Township 48 – Range 42	*Hardwood Swamp (# 4.2) in the base map derived from Steinberg (1980) was changed to Hydric Flatwood (# 6.1).* *Wet Prairie with Scattered Trees (# 5.31) in the base map derived from Steinberg (1980) was changed to Mesic Hammock (# 7.3).* *Scrub (# 8.2) in the base map derived from Steinberg (1980) was changed to Mesic Pine Flatwood (# 7.2) in only the central and western sections of the township. Isolated scrub areas in central township were defined by soils map (Jones 1948).*
Township 49 – Range 42	*Hardwood Swamp (# 4.2) in the base map derived from Steinberg (1980) was changed to Cypress Swamp (# 4.1).* *Scrub (# 8.2) in the base map derived from Steinberg (1980) was changed to Mesic Pine Flatwoods (# 7.2) in only the central and western sections of the township. Isolated scrub areas in central township defined by soils map (Jones 1948).*
Township 50 – Range 42	*Hardwood Swamp (# 4.2) in the base map derived from Steinberg (1980) was changed to Cypress Swamp (Classification Code # 4.1) only in non-riverine wetlands. In areas adjacent to rivers (e.g., floodplains), Hardwood Swamp was changed to Hydric Hammock (# 6.2).* *Wet Prairie with Scattered Trees (# 5.31) in the base map derived from Steinberg (1980) was changed to Non-Forested Freshwater Wetland (# 5).* *Intra-Tidal Wetlands (# 2) in the base map derived from Steinberg (1980) were changed to Non-Forested Freshwater Wetland (# 5) for inland lakes that later became part of the Intracoastal Waterway; the water body that is now the inlet was not changed.* *Scrub (# 8.2) in the base map derived from Steinberg (1980) was changed to Mesic Pine Flatwoods (# 7.2) in only the central and western sections of the township. Isolated scrub areas in central township defined by soils map (Jones 1948).*

Miami-Dade County Area

Although much of Miami-Dade County was part of the historical Everglades (covered in another section), certain coastal areas were not. Along the coast, the base map was created primarily from the GLO maps with additional guidance from the soil map compiled by Jones (1948) (Figure 6). Vegetation classifications aggregated from Jones (1948) in McVoy *et al*. (2005) were converted to the vegetation classes defined for this study according to the method shown in **Table 8.** Since the base map was derived primarily from GLO maps and descriptions, the resulting base map was considered verified.

Table 8. Jones *et al*. (1948) Soil-Vegetation Classification Crosswalk

Soil-Vegetation Class (adapted from Jones)	***Pre-Development Vegetation Class***	
	Description	**Classification Code**
1 ,2 Custard Apple Swamp	*Hardwood Swamp*	*4.2*
6, 11, 12, 13, 8	*Medium-Hydroperiod Marsh*	*5.2*
10	*Mesic Pine Flatwood*	*7.2*
14	*Xeric Upland*	*8*

Southwest Florida

The Southwest Florida Subregion is generally defined as the area between the Caloosahatchee River and Florida Bay, bounded by the Gulf of Mexico to the west and merging with the Everglades in the east (**Figure 7**). This subregion includes the Big Cypress Swamp, the Fakahatchee Strand, Picayune Strand and lowlands that gradually decline in elevation to the southwest to form the Ten Thousand Islands. The base map for this subregion is the pre-development vegetation developed for the Southwest Florida Feasibility Study (Duever 2002, **Attachment** B). Duever's vegetation descriptions were crosswalked to the vegetation classes defined for this study (**Table 1**), following the method outlined in **Table 9**.

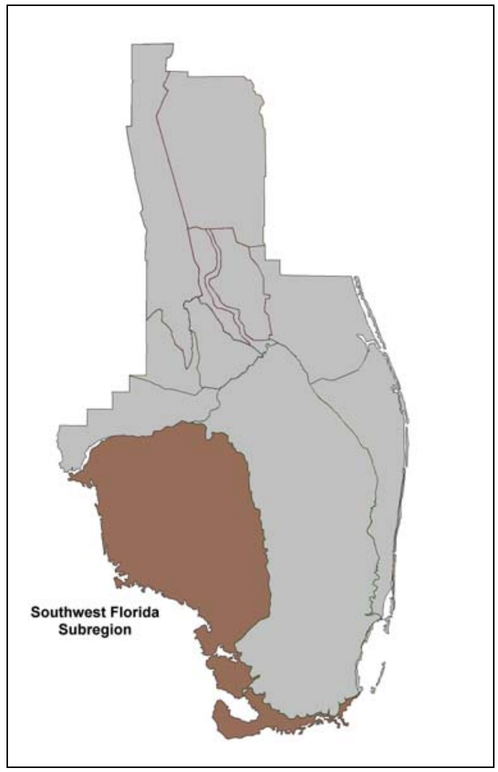

Figure 7. Southwest Florida Subregion

Table 9. Duever (2004) Vegetation Classification Crosswalk*.

Duever Vegetation Class	***Pre-Development Vegetation Class***	
	Description	**Classification Code**
Open Water	*Water*	*1*
Tidal Marsh, Mangrove	*Intra-tidal Wetland*	*2*
Beach	*Beach*	*3*
Cypress	*Cypress Swamp*	*4.1*
Swamp Forest	*Hardwood Swamp*	*4.2*
Marsh	*Medium-Hydroperiod Marsh*	*5.2*
Wet Prairie	*Wet Prairie*	*5.3*
Dwarf Cypress	*Wet Prairie with Cypress*	*5.32*
Hydric Hammock, Hydric Flatwood	*Hydric Uplands*	*6*
Mesic Hammock	*Mesic Hammock*	*7.3*
Mesic Flatwoods	*Mesic Pine Flatwood*	*7.2*
Xeric Hammock, Xeric Flatwood	*Xeric Upland*	*8*

* See **Attachment** B.

Okeechobee and Everglades

The Okeechobee and Everglades Subregion includes waters of pre-diked Lake Okeechobee (excluding the streams and wetlands to the north and northwest of the lake, which are included in other subregions) and the historical extent of the Everglades Basin, extending from the south rim of Lake Okeechobee to Florida Bay, and from the Big Cypress Swamp to the eastern fringing bald cypress swamps and flatwoods (**Figure 8**). The base map source was derived from the Pre-drainage Everglades Database (**Attachment C**), which was converted to the pre-development vegetation classes used by this project according to the method outlined in **Table 10**. Since this map and associated descriptions were based upon GLO maps, field observations and survey information, this subregion map was not further verified.

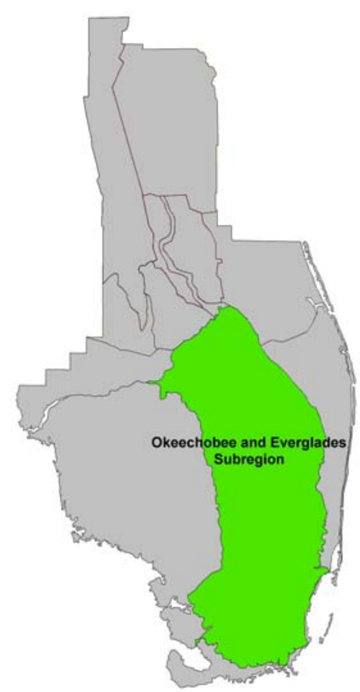

Figure 8. Okeechobee and Everglades Subregion

Tree Islands

Tree islands are significant features within the Everglades ridge and slough landscape. They vary in size, origin and vegetative composition, but are generally recognized as forming on a bedrock high or peat mound within the surrounding marsh, and having a tear drop shape with the tapered end oriented down stream of the surface water flow. Historical accounting of tree island size ranges from 0.1 acres (.04 hectares) to 100 acres (40.5 hectares) (McVoy *et al*. 2005). For the purpose of this project, we adopt the definition from the Avineon (2002) report.

> "Characteristically, tree islands are tear-shaped, their orientation follows the flow of surface water (NW to SE), the tallest trees and shrubs are at the upstream end of the island called the 'head', and behind the head there is an elongated v-shaped area called the 'tail'. While the head is typically dominated by trees and taller shrubs, the tail is dominated by shrubs and/or marsh species, such as sawgrass…"

Source data for tree island features in the pre-development database came from four sources:

The 1948 soil survey (Jones *et al*., 1948) was a key source as it remains the only comprehensive soil survey done in the Everglades. This survey is available as a GIS coverage. Polygons were reselected for the bay and myrtle landcover and gandy peat soil.

A tree island trend analysis conducted for the SFWMD by Avineon (2002) that documented changes in tree island vegetative communities in Water Conservation Area 3 (WCA) from the 1940s to 1995. In this study, tree islands were mapped from 1940s aerial photography. The minimum mapping unit was 1 hectare (2.8 acres).

The J.H. Davis Vegetation Map (1943) provided an estimate of tree island distribution in areas where these features have disappeared due to development or were not included in the soil surveys. Although many of Davis' tree island delineations correspond to actual locations, many were estimated based on his interpretation of this feature in the historical system. We included a subset of these islands where they seemed reasonably distributed and to scale.

Current satellite imagery. Significant tree island signatures interpreted from a 1994 Landsat mosaic were compared to the other three data sources. Features were added, if not accounted for in the other sources.

Although tree islands are numerous, georeferenced historical data is scarce. The GLO surveys did not extend into the Everglades beyond the fringes so we cannot "field verify" the tree island features in this project using our standard method. We are assuming the 1940s and satellite data can be considered to spatially represent tree islands accurately, whereas the islands derived from Davis' mapping are reasonable, but not spatially verifiable. A project to consider may be to map tree islands from the entire set of 1940s aerials.

Table 10. Pre-Drainage Everglades Database (McVoy *et al*.) Vegetation Classification Crosswalk

Pre-Drainage Everglades Database Vegetation Class	***Pre-Development Vegetation Class***	
	Description	**Classification Code**
Water, Lake	*Water*	*1*
Cypress	*Cypress Swamp*	*4.1*
Custard Apple Swamp, Willow and Elderberry	*Hardwood Swamp*	*4.2*
Eastern Marshes	*Long-Hydroperiod Marsh*	*5.1*
Ridge and Slough, Taylor Slough	*Ridge and Slough Marsh*	*5.11*
Sawgrass Plains	*Sawgrass Plain*	*5.12*
Peat Transverse Glades	*Medium-Hydroperiod Marsh*	*5.2*
Marl Marsh	*Everglades Marl Marsh*	*5.22*
Everglades Keys	*Xeric Uplands*	*8*

RESULTS

Summary of Products

A geospatial database was compiled from existing base map sources and additional data fields were added to reflect values for hydrological parameters associated with each vegetation community type. Data fields included in the database, as well as descriptions of the use of the data type are provided in **Attachment D**. The database was developed to display the extent of historical vegetation communities across the southern Florida landscape (see insert map in front cover). To facilitate use of this large database, the study area was divided into subregions, each of which contains a unique group of communities that are distributed in a particular spatial pattern. Generally, these patterns are determined by hydrological characteristics primarily influenced by local topography. A description of vegetation characteristics from each subregion is provided next.

Pre-Development Lower East Coast Subregion

The pre-development vegetation of the Lower East Coast Subregion is highly varied and distinctly arranged along elevation gradients and surface water flow patterns (**Figure 9** and **Figure 10**). This is in contrast to the fact that relief in southeastern Florida is low and any significant elevation gradients occur only along stream embankments and coastal ridges. Much of the landscape tends to be flat and low, supporting flatwoods and expansive wetland systems. The highest elevations are found along the coast in Martin, Palm Beach and Miami-Dade counties on relic dune systems, coral ridges and oolitic rock outcrops. These sites supported xeric communities, dominated by sand pine or oak scrub at more inland areas, and tropical hammocks or coastal strand along the coast and on barrier islands.

Most of the inland wetlands of Martin and Palm Beach counties that are part of the Loxahatchee and lower St. Lucie River watersheds exhibit only weak flow patterns because of the very poorly drained landscape. The potholes and swales in these low flatlands give rise to a complex of marsh, wet prairie and hydric flatwoods in the slightly undulating land surface. Wetlands adjacent to the historical Everglades exhibit a more articulated pattern of flow, indicating drainage towards the southwest. Cypress swamps tend to be associated with the transitional ecotone at the eastern edge of the Everglades marsh.

In contrast to vegetation in Martin and Palm Beach counties, wetland vegetation in Broward and Miami-Dade counties tends to exhibit a strong directionality associated with the flowways of the New River, the Miami River and the peat transverse glades.

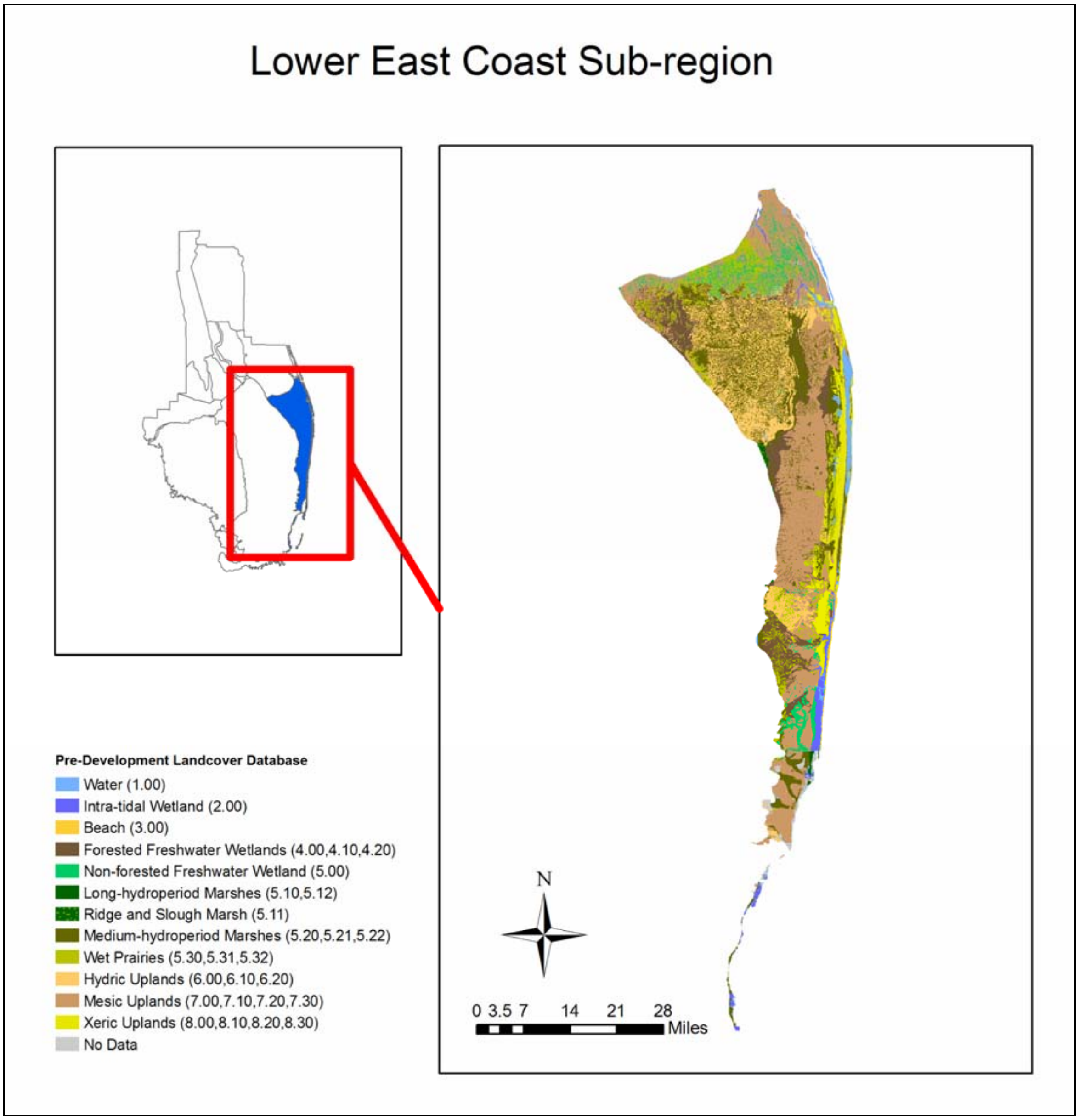

Figure 9. Generalized Map of the Pre-Development Vegetation Communities in the Lower East Coast Subregion.

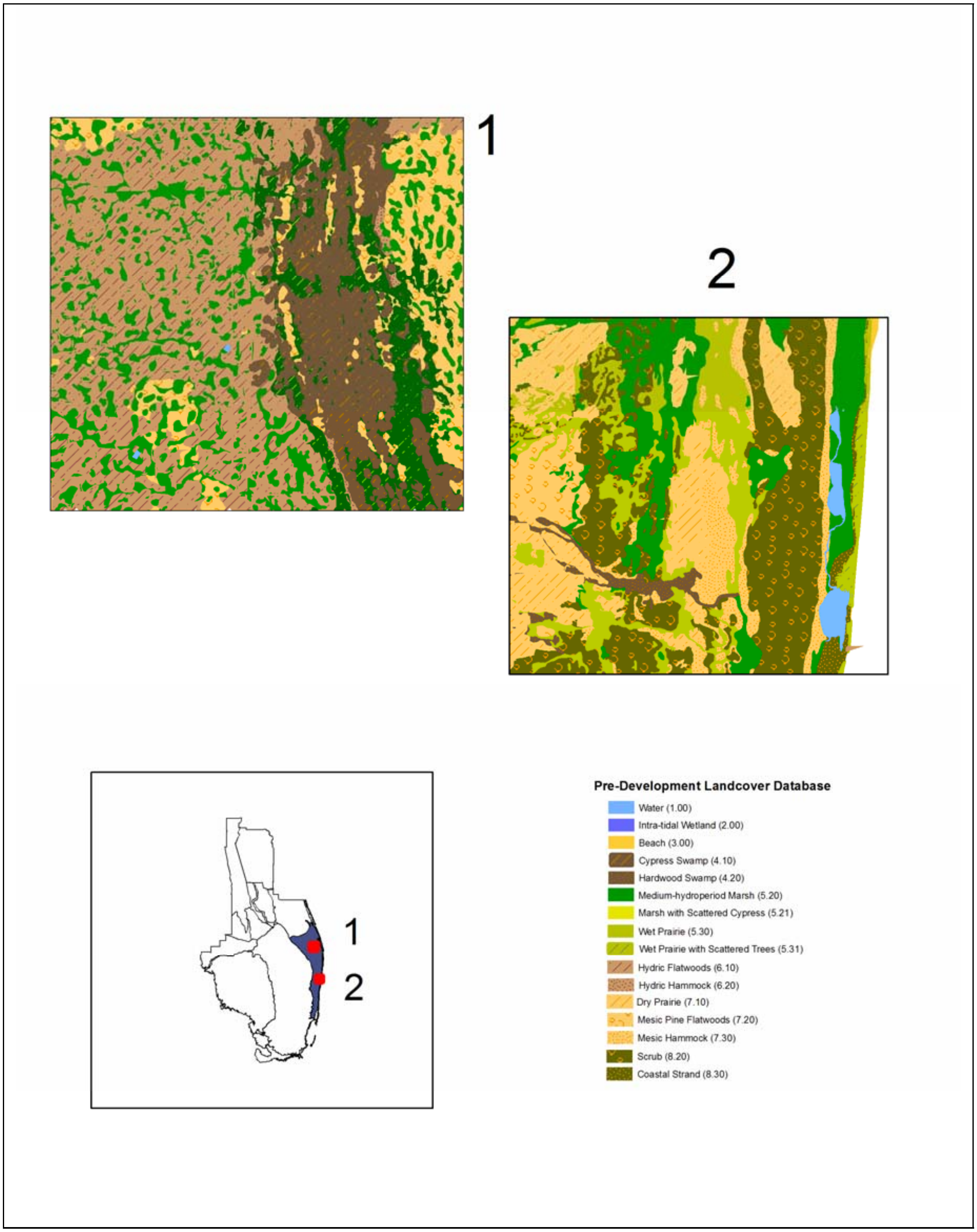

Figure 10. Detailed Maps of the Pre-Development Vegetation Communities in the Lower East Coast Subregion.

One notable natural feature along the peninsular coastline of southeastern Florida is a series of freshwater lakes and wetlands running parallel to the coast (excluding areas near inlets). This chain of freshwater wetland systems occupy a lowland area between natural ridges formed during earlier geological periods. These wetlands were often dominated by sawgrass or grassy vegetation (i.e., sedges). A representational map of this feature from the GLO survey is shown in **Figure 11**; section lines and numbers were removed from this map so that landscape features are more easily visible. Most of the coastal freshwater wetlands, lakes and streams became the primary channel route for the Intracoastal Waterway.

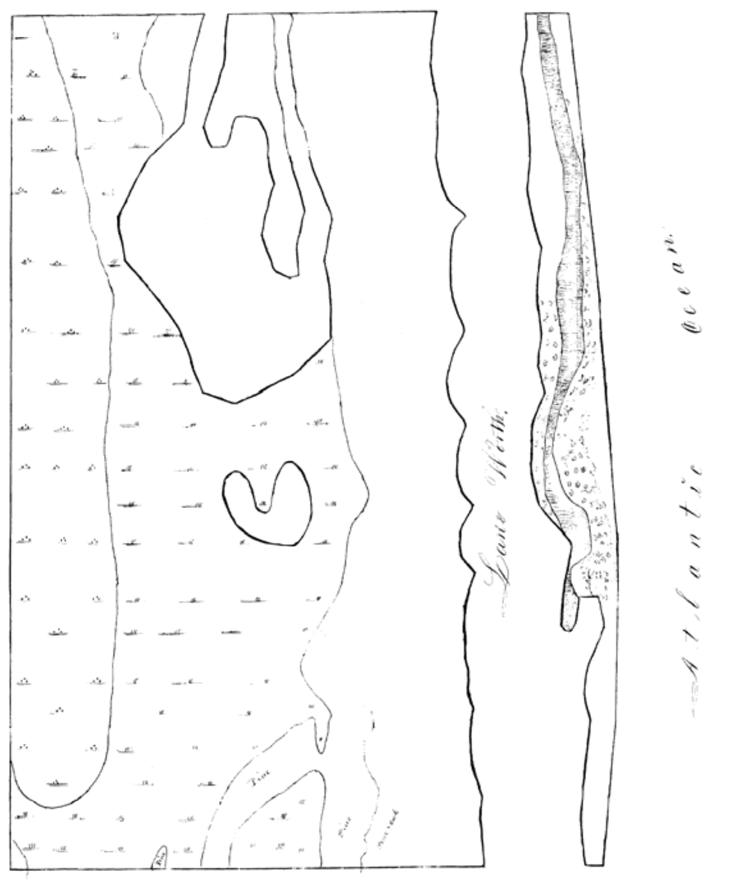

Figure 11. GLO Map of Coastal Freshwater Lakes and Wetlands at Present-Day Downtown West Palm Beach (Township 43 South, Range 43 East; originally surveyed 1845, 1870).

The extent of coastal mangrove swamp in the GLO maps and field notes may be useful as an indicator of the historic extent of saltwater-tolerant communities. In the Loxahatchee River, there are recorded accounts of mangrove fringing the central embayment where the three forks of the river converge. The next natural inlet to the south is at the outflow of the Hillsboro River where mangroves are recorded up to approximately one mile upstream. Mangroves are not recorded along the New River or its outlet, with the next significant population found in Biscayne Bay. There, mangroves are recorded from Dumfundling Bay south to Big Snake Creek and Arch Creek (**Figure 12**).

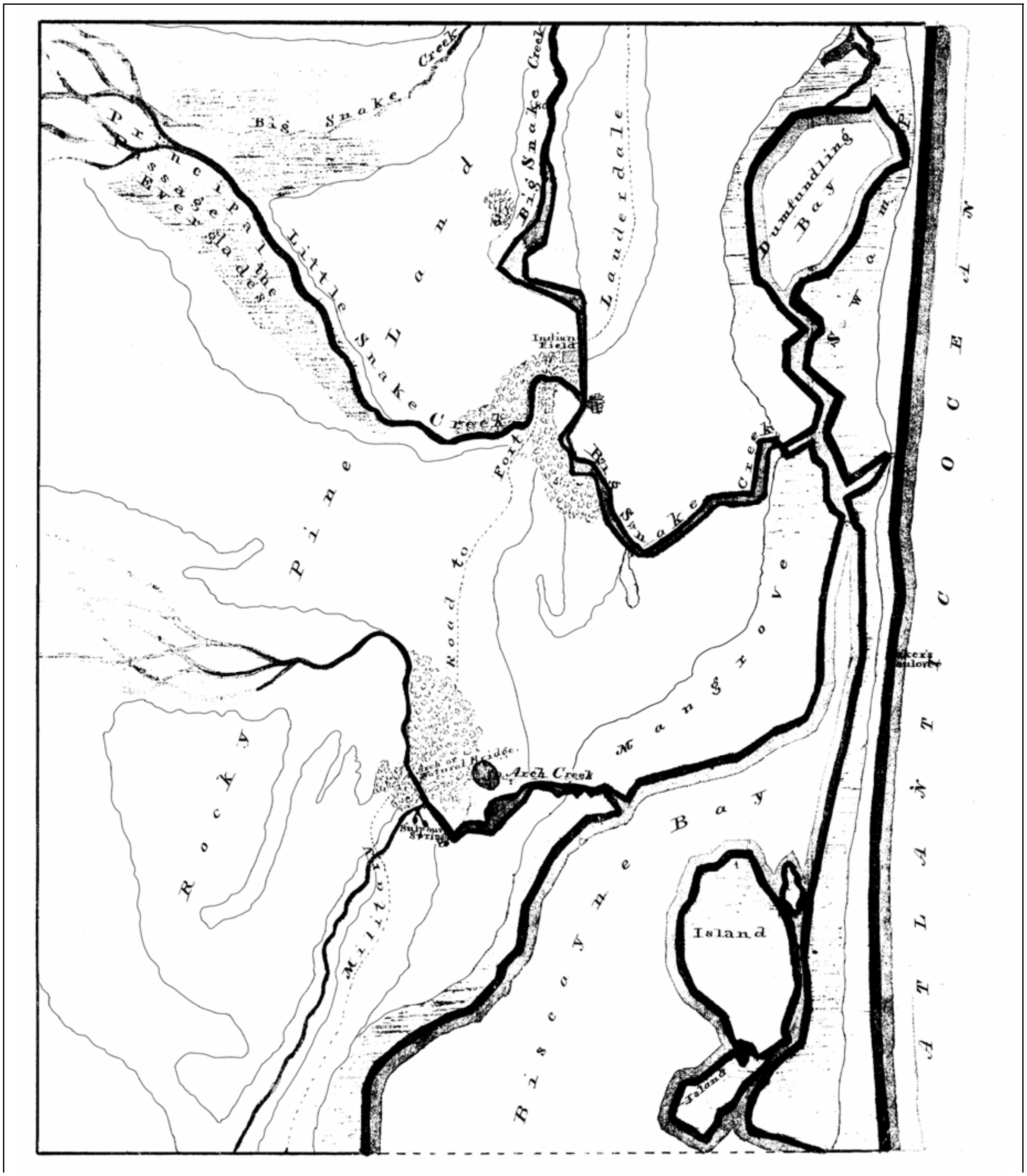

Figure 12. Map of Northern Biscayne Bay Area (Township 52 South, Range 42 East; originally surveyed 1845, 1870) from the GLO Surveys; Section Lines have been Removed.

Pre-Development Southwest Florida Subregion

The pre-development vegetation of the Southwest Florida Subregion contains a mosaic of wetlands and flatwoods that gradually slope downward in elevation from the Big Cypress Swamp to the Ten Thousand Islands and the Everglades. The slightly sloping landscape plays a key role in shaping the vegetation communities, which tend to be arranged along interconnecting channels and flowways that carry water from the interior wetlands to the coastal estuaries (**Figure 13**).

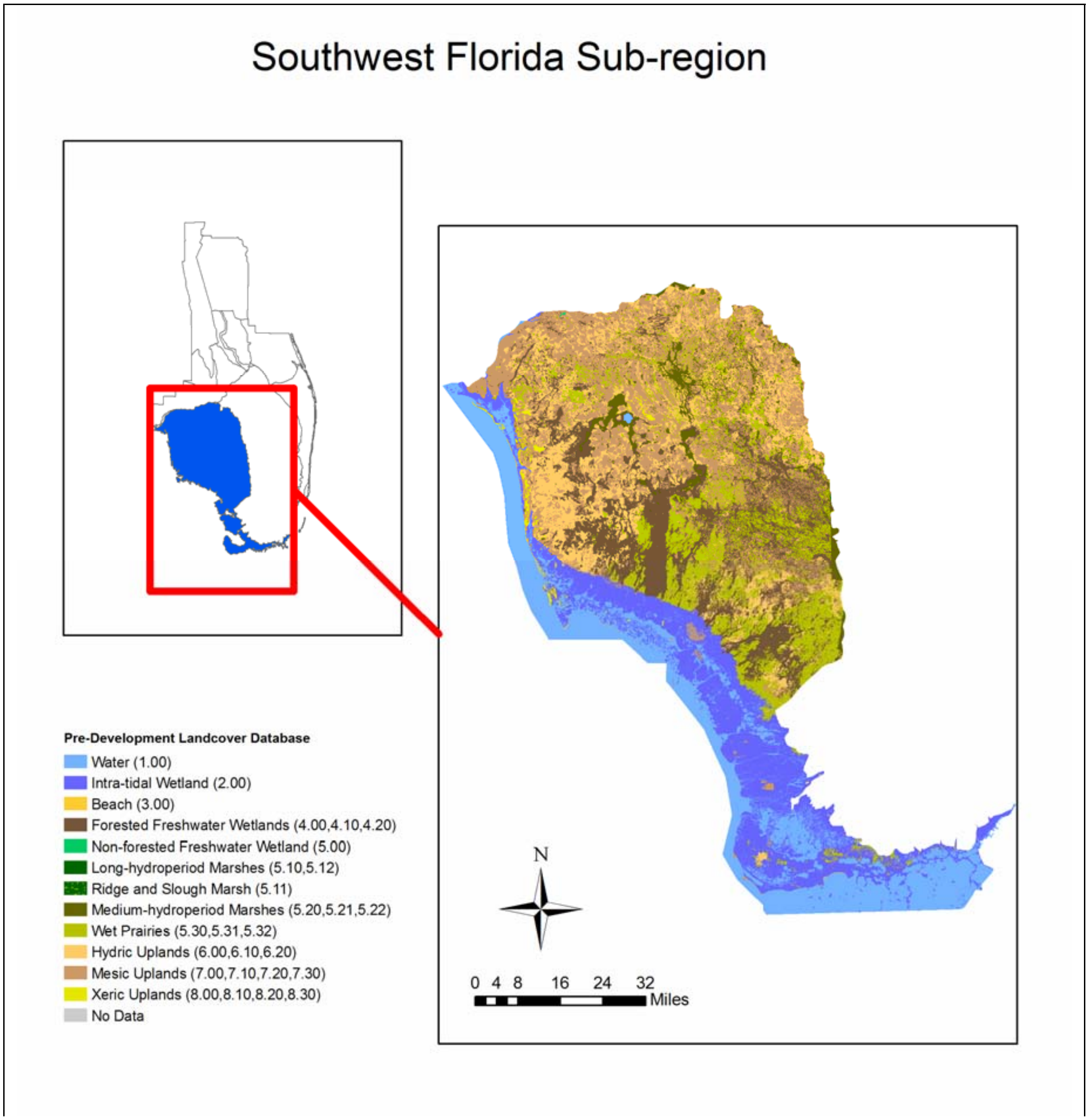

Figure 13. Generalized Map of the Pre-Development Vegetation Communities in the Southwest Florida Subregion.

Vegetation communities in this subregion range from the extensive mangrove forests located on the hundreds of islands along the Gulf of Mexico to the interior cypress swamps that contain trees of formidable age and stature: Big Cypress, Corkscrew, Fakahatchee Strand and Picayune Strand. Some portions of the Big Cypress Swamp contain diminutive dwarf cypress forests of scattered, stunted trees crowded in wet prairies. These swamps form major drainage flowways to the Gulf of Mexico (**Figure 14**).

Detailed descriptions of pre-development vegetation in Southwest Florida were prepared for the SFWMD Southwest Florida Feasibility Study by M. Duever (2002) and are included as (**Attachment B**).

Pre-Development Okeechobee and Everglades Subregion

Pre-development vegetation patterns in the Okeechobee and Everglades Subregion were influenced by seasonally pulsing water flows through an extremely flat wetland system that sloped slightly southward. The length of this great flowway was approximately 100 miles (160 kilometers), the distance from Lake Okeechobee to Florida Bay. Lake Okeechobee and the Everglades were intrinsically interconnected water bodies that sustained several major landscapes within a vast wetland system (**Figure 15)**.

Lake Okeechobee is a broad, shallow open water body with an indeterminate shoreline in many areas where lake levels were even with the surrounding landscape for most of the year. Overflow from the lake sustained an expansive sawgrass marsh along the northwest shoreline and provided substantial inflow to the Everglades from its southern shores.

An elongated pond apple swamp extended southward approximately 2 miles from the south and southeastern shore of Lake Okeechobee before giving way to an immense expanse of sawgrass marsh ("sawgrass plains") in the northern Everglades (**Figure 15**). Further downstream, the sawgrass plains transitioned into a "ridge and slough" mosaic of interconnected, undulating sawgrass ridges and water lily sloughs interspersed with hammock-bearing tree islands (**Figure 16**). Shallow soil marl marshes flanked the ridge and slough landscape in the southern Everglades. Other community types present include upland mesic and xeric communities associated with the relatively elevated Miami Rock Ridge in the southeastern area of this subregion.

Detailed descriptions of the pre-drainage Everglades landscapes and associated hydrology were developed for the SFWMD (McVoy *et al.*) and are included in **AttachmentC.**

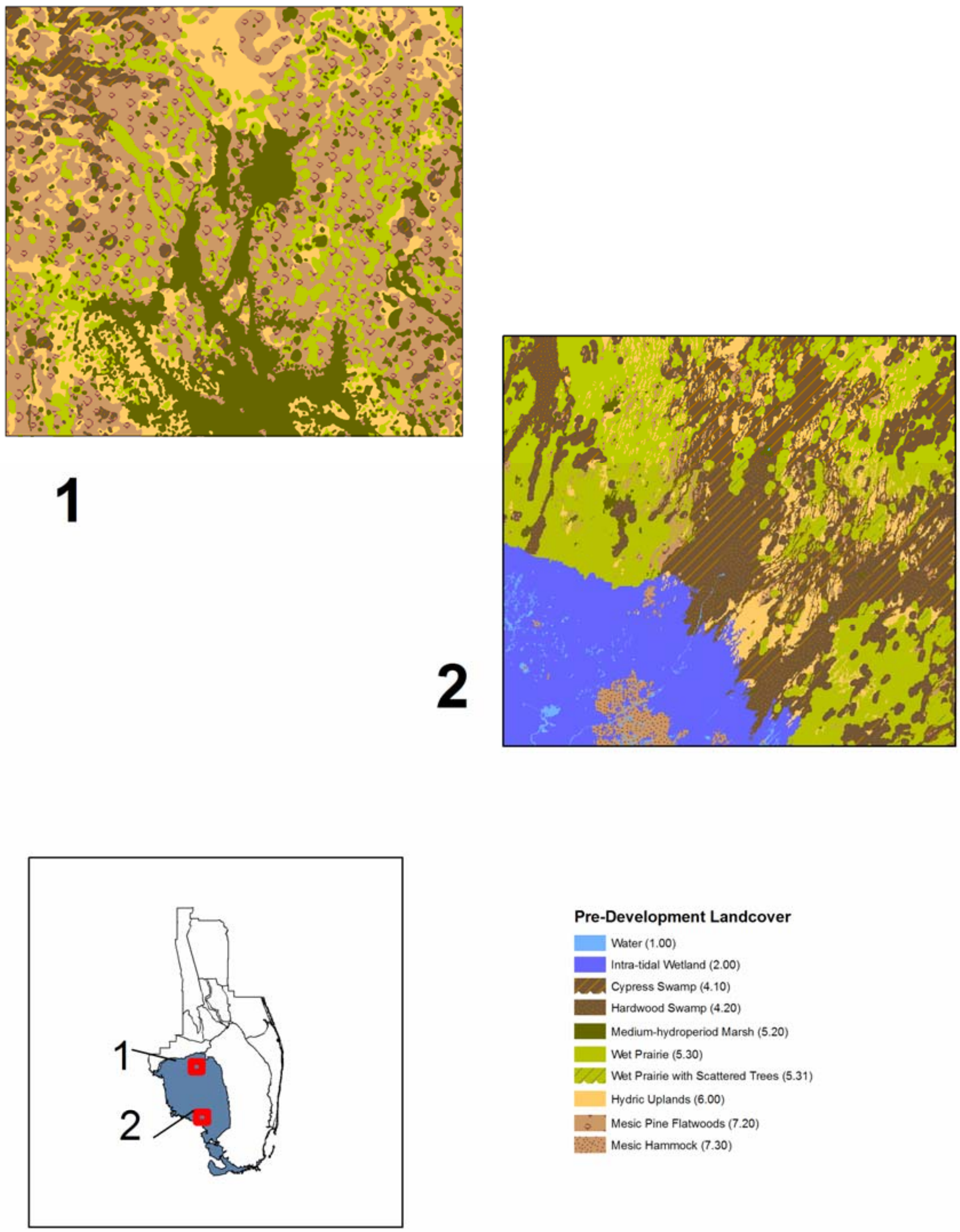

Figure 14. Detailed Maps of the Pre-Development Vegetation Communities in the Southwest Florida Subregion, Big Cypress Area (1) and Gulf of Mexico Inflows (2).

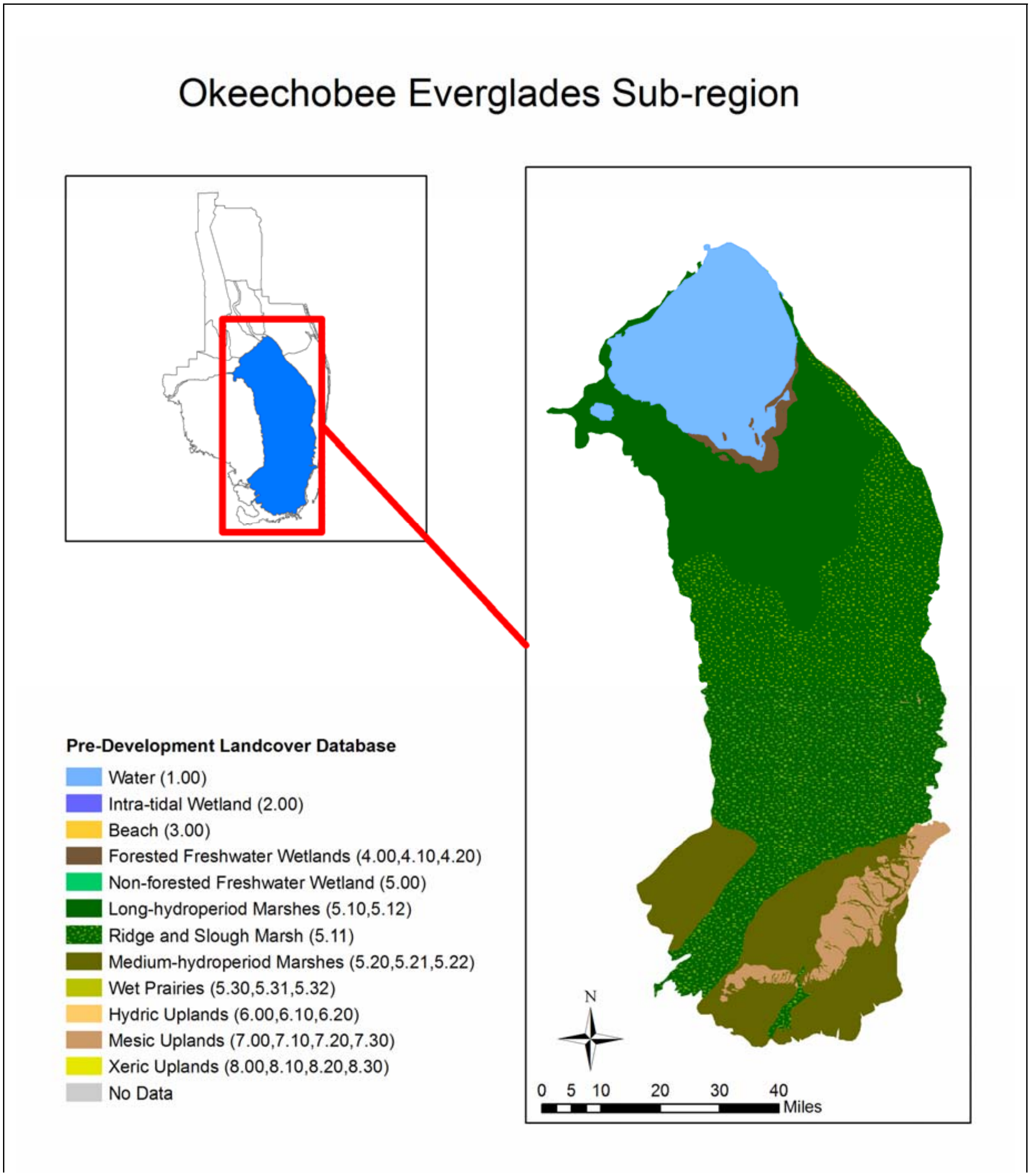

Figure 15. Generalized Map of the Pre-Development Vegetation Communities in the Okeechobee-Everglades Subregion Adapted from McVoy *et al*. (2005).

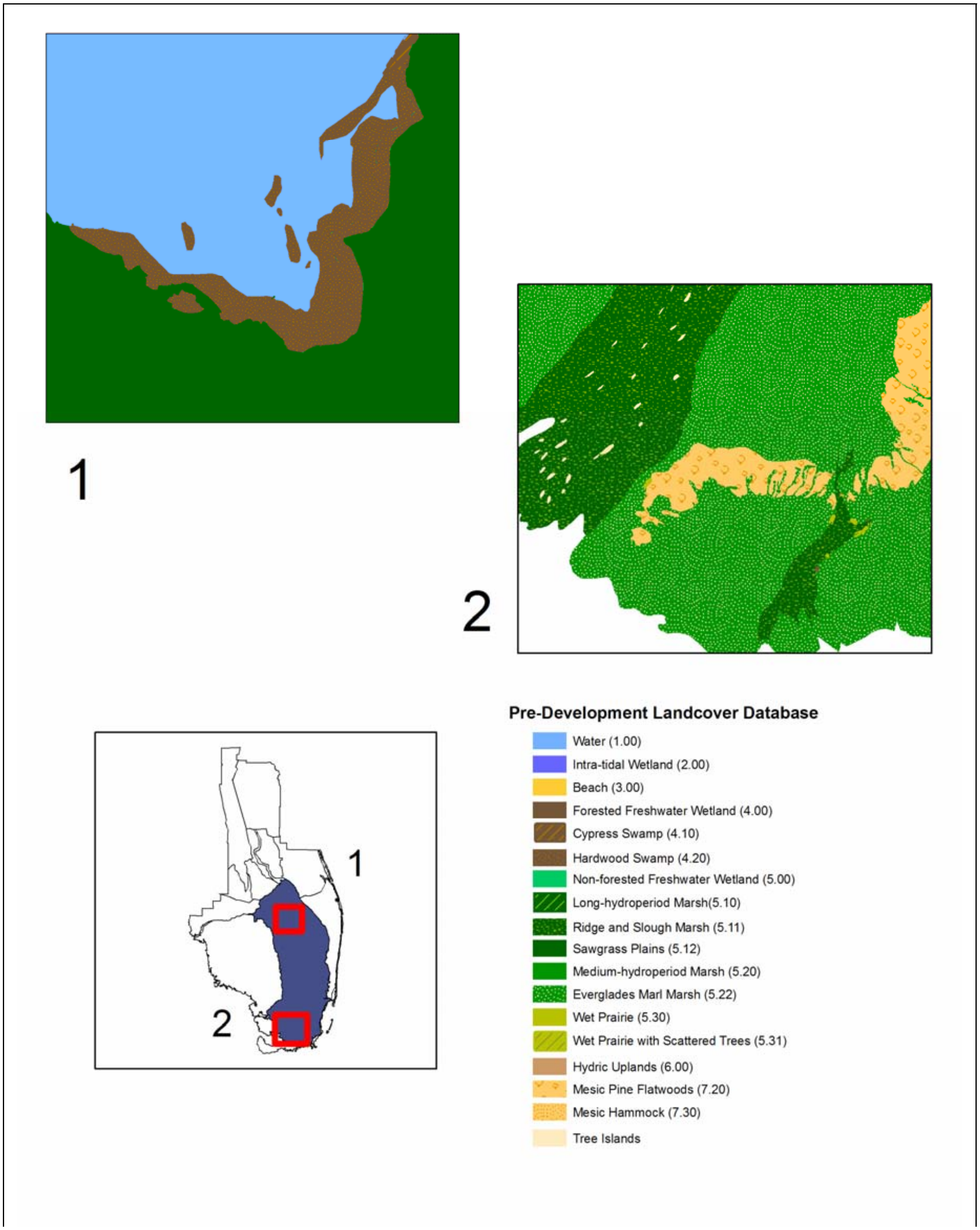

Figure 16. Detailed Maps of the Pre-Development Vegetation Communities in the Okeechobee-Everglades Subregion; South Shore of Lake Okeechobee (1) and Shark River Slough Inflow to Florida Bay (2).

Limitations of Data and Map Products

As with any data set and map product, there are limitations to the application and interpretation of the information that can affect the reliability of any analysis upon which they are based. When using data from the Pre-Development Vegetation Database or any map produced from the database, there are several limitations that should be recognized and considered. These include:

- Minimum Mapping Unit
- Landscape versus Local Application
- Extent of Verification
- Landscape Heterogeneity

When conducting an analysis based upon this database, the scale that is used in the analysis can affect the reliability or confidence of the result. As a general rule with maps, accuracy increases as one zooms out. Polygons defined in the database are representations of the distribution of vegetation communities across the landscape. Some sources for vegetation community polygons used in the database were derived from interpretation of aerial photography, which is an approximation of the extent of an area of similar character. Verification of these polygons was conducted along section lines in representative and special areas of interest; however, GLO field surveys usually did not measure within the section area. At times, the surveyors estimated the extent of a community type there. Given these limitations, the database and resulting maps are most reliable at the landscape level. When the reliability of a specific polygon or relatively small area of the Pre-Development Vegetation Map is important to an analysis, it is suggested additional confirmation is sought.

In some areas, the earliest available map contained some artifacts of development or landscape alteration. These features were filtered or corrected to give good correspondence to the GLO land surveys. However, the influence of these features on adjacent polygons may still persist at the local level, particularly near the coastline and major drainage canals.

Landscape heterogeneity should also be considered when reliability of the database on smaller scales is important. Generally, the more homogeneous a landscape is, the more reliable its representation is at a smaller scale.

FUTURE EFFORTS AND PRODUCTS

This document is the first of two technical publications that will describe the methods used to develop a pre-development vegetation database for southern Florida. The second document will contain the following subregions not included in this report: 1) Fisheating Creek, 2) Lake Istokpoga-Indian Prairie, 3) Lake Wales Ridge, 4) Kissimmee Chain of Lakes, 5) Lower Kissimmee River, 6) East Central Florida and 7) the Central Florida Dry Prairie.

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ATTACHMENT A: VEGETATION CLASSIFICATIONS USED TO DEVELOP THE PRE-DEVELOPMENT LANDSCAPE MAP AND DATABASE

As part of the effort to create a pre-development vegetation map for the Central and South Florida region, a classification scheme was developed to define the major plant community assemblages historically found within the study area. While compiling different studies and surveys of historical vegetation, it became clear that no two studies defined the same vegetation classes; this presented the challenge of discerning the intent of the original source material to properly interpret the species and hydrological characteristics associated with a particular vegetation category. It was determined that the vegetation classification scheme used by any one of the contributing studies was insufficiently inclusive and detailed to be applied across the extent of our study region. For this reason, a classification system that is unique to this study, but also contains elements of previous published works, was compiled.

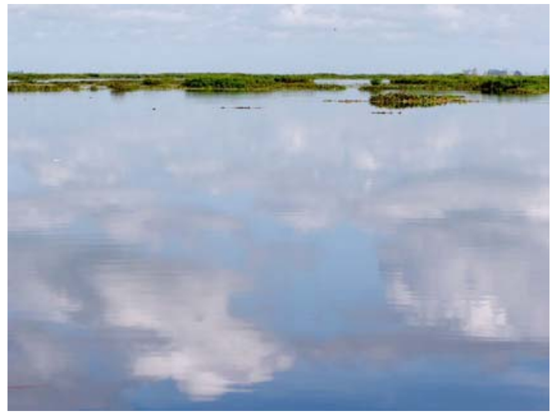
One challenge in developing any vegetation classification system is defining the limits of each class. Many natural communities do not occur as discrete entities, but instead are often arranged in the landscape along gradients so that mixtures and intermediate forms can be identified. One example of this is two types of communities that occupy the same landscape position and have similar hydrological characteristics but have markedly different tree densities based on fire frequency: dry prairies and mesic pine flatwoods. In places where there is a nearly treeless expanse of saw palmetto, a determination of the dry prairie community is easy to discern. However, at what density of pines does one definitively categorize the community as mesic pine flatwood rather than dry prairie? A similar challenge exists along some hydrological gradients; for example the change from a mesic to hydric flatwood in the natural landscape is often indeterminable in flat, low landscapes and the decision to categorize a site as one or the other is sometimes a factor of human decision rather than absolute certainty. In reality, the categories we have defined rely on describing the usual species and hydropattern found in a clearly-defined or pure example of the class type. Areas that contain intermediate and variant forms of a vegetation community occur in the natural world and how these features were classified was, out of necessity, based on professional judgment.

Generally, broad categories of community types were created: 1) water, or permanently flooded sites; 2) intra-tidal wetlands; 3) beaches; 4) forested freshwater wetlands; 5) non-forested wetlands; 6) hydric uplands; 7) mesic uplands; and 8) xeric uplands. Where it was considered necessary, subclasses and variant forms of these community types were included in the vegetation classification scheme.

Table A-1. Vegetation Classes for the Pre-Development Landscape.

Vegetation Type	Description	*Classification Code*
Water	Permanently inundated site; includes freshwater, estuary and marine systems.	1
Intra-tidal Wetland	Tidally inundated sites; vegetation community is influenced by magnitude of daily flooding regime and saltwater exposure.	2
Beach	Consolidated substrate (e.g., rock) or unconsolidated deposits (e.g., sands) on shorelines influenced by moving water.	3
Forested Freshwater Wetland	Forested freshwater wetlands (swamps).	4
Cypress Swamp	Freshwater swamp dominated by cypress.	4.1
Hardwood Swamp	Freshwater swamp dominated by broadleaf trees.	4.2
Non-Forested Freshwater Wetland	Freshwater wetland dominated by herbaceous vegetation; non-forested.	5
Long-hydroperiod Marsh	Freshwater marsh with hydroperiods extending from 11-12 months on average.	5.1
Ridge and Slough Marsh	Everglades-specific community mosaic of alternating open water sloughs and sawgrass ridges interspersed with tree islands.	5.11
Sawgrass Plain	Northern Everglades-specific community consisting of a generally unbroken expanse of sawgrass across a large spatial extent.	5.12
Medium-hydroperiod Marsh	*Freshwater marsh with hydroperiods extending from 6-10 months on average.*	5.2
Marsh with Scattered Cypress	Freshwater marsh with hydroperiods (6-10 months on average) that contain scattered stunted cypress.	5.21
Everglades Marl Marsh	Everglades-specific community consisting of a medium-hydroperiod marsh with marl soils derived from calcareous algae; most extensive in the southern Everglades.	5.22
Wet Prairie	Short-hydroperiod treeless wetlands that have hydric soils, hydroperiods extending from 2-6 months, and inundation to 1 foot on average.	5.3
Wet Prairie with Scattered Trees	Wet prairie with scattered trees, including pine, cypress and bay.	5.31
Wet Prairie with Cypress	Wet prairie with scattered cypress.	5.32
Hydric Upland	Moist woodlands on non-hydric soils in level, low landscapes than may have some short-duration flooding each year. Fire frequency is the primary factor in shaping dominant vegetation type.	6
Hydric Flatwood	Hydric flatwoods typically are dominated by slash pine.	6.1
Hydric Hammock	Hydric hammocks typically are dominated by hardwood species.	6.2
Mesic Upland	Mesic communities are found on upland (non-hydric) soils; short-duration flooding may occur only during high-rainfall events. Fire frequency is the primary factor shaping dominant vegetation type.	7
Dry Prairie	Non-forested upland community composed primarily of grasses and palms; high fire frequency.	7.1
Mesic Pine Flatwood	Forested upland community composed primarily of pines; moderate fire frequency.	7.2
Mesic Hammock	Forested upland community composed primarily of broadleaf trees; low fire frequency.	7.3
Xeric Upland	Xeric communities are found on highest elevation sites with the water table well below (more than 3 feet) the soil surface all year. Xeric plant communities are dominated by species that have special adaptations for survival in dry conditions. Fire frequency is the primary factor shaping dominant vegetation type.	8
High Pine (Sandhill)	Dry pine communities on undulating sandy soils that are dominated by longleaf pines and wiregrass; these communities are typically found in central Florida.	8.1
Scrub	Scrub communities are dominated by sand pine or oak scrub species and are typically found on pure, deep sands of relic dune systems.	8.2
Coastal Strand	Coastal strand communities are typically found on excessively drained elevated sites, such as coastal dunes, ridges, rocky outcrops or shell mounds. Vegetation species are primarily of tropical and Caribbean origin.	8.3

Water (Classification Code #1)



These are permanently inundated sites of open-water areas. Hydroperiods are typically 12 months per year on average. Some ponds or very shallow lakes may have exposed substrate during severe droughts. Water areas typically have little, if any, emergent vegetation (vegetated areas are typically classified as wetlands). This class includes freshwater, estuary and marine water bodies.

The greatest expanse of water areas in Florida occurs along the tidally-influenced coastline, estuaries and lagoons. The highest concentration of freshwater lakes occurs in the sandy ridge of central Florida. Most of Florida’s water bodies are shallow and have a maximum depth of less than 16 feet (5 meters) (Brenner *et al.* 1990).

In marine waters a variety of organisms may be found in waters adjacent to the coastline, including beds of sessile invertebrates (e.g. hard and soft corals, sponges and oysters), marine animals (e.g., chitons, urchins, octopus), fish and seagrasses such as manateegrass (*Syringodium filiforme*), shoalweed (*Halodule wrightii*), seagrass (*Halophila* spp.) and turtlegrass (*Thalassia testudinum*). Many of these organisms need a stable substrate for colonization or depend on sessile communities for habitat or foraging.

Freshwater communities vary according to water quality, substrate, water flow and depth of water. In lotic systems, flow magnitude and substrate type can significantly influence the benthic vegetation and invertebrate communities. Examples of lotic systems include rivers, streams, creeks and springs. Freshwater vegetation that can be found in these water bodies include tapegrass (*Vallisneria americana*), lemon bacopa (*Bacopa caroliniana*), waternymph (*Najas* spp.) floatingheart (*Nymphoides cristata*), water lettuce (*Pistia stratiotes*), Carolina mosquito fern (*Azolla caroliniana*), duckweed (*Lemna* spp.), and macroalgae such as *Chara* spp.

In freshwater lentic systems, trophic status may play a dominant role in determining the types of vegetation present (e.g., emergent, floating, submersed). Typically shallow water bodies support varied submersed and benthic communities; but deep water areas do not, as anoxic conditions prevail and light penetration is dampened at greater depths. Examples of lentic systems include sloughs, ponds and lakes.

Intra-tidal Wetlands (Classification Code #2)

These areas are tidally inundated with daily variable water levels and salinity concentrations. These communities are not permanently flooded (permanently flooded sites are classified as "Water"), but have a daily inundated regime associated with tides. The vegetation community composition is shaped by climate, magnitude of flooding, saltwater concentrations and degree of wave energy exposure. The frequency and magnitude of tidal inundation may vary between the Atlantic and Gulf coasts; however, the highest daily tidal magnitude of approximately 2.5 to 3.0 feet is typical along the Atlantic coast. Types of intra-tidal wetlands include tidal pools, tidal flats, salt marshes and mangroves, the latter being the most dominant community type in the more frost-free areas such as the southern Florida peninsula.

Salt marshes are communities with nonwoody, salt-tolerant plants occupying sites that are occasionally inundated with salt water. These communities are found where the inter-tidal zone is sufficiently large and wave energy is sufficiently low to allow their development and where mangroves are restricted (Montague and Wiegert 1990). The rate of primary production in salt marshes is among the highest measured in natural systems. The principal plants of salt marshes are needle rush (*Juncus roemerianus*) and saltmarsh cordgrass (*Spartina alterniflora*), which usually occur in monotypic stands (Kurz and Wagner 1957). High marsh plants are succulents or species that are adapted to soils of high salinity, such as glasswort (*Salicornia bigelovii*), saltwort (*Batis maritima*), saltgrass (*Distichlis spicata*), shoreline seapurslane (*Sesuvium portulacastrum*) and Carolina sealavender (*Limonium carolinianum*) (Kurz and Wagner 1957; Carlton 1975, 1977).

Three species of "true" mangroves are associated with the community type known as "mangrove community", these are: red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*) and white mangrove (*Laguncularia racemosa*). Buttonwood (*Conocarpus erecta*) is classified as a "mangrove associate" and often constitutes an important upland fringe of many Florida mangrove communities (Tomlinson 1980). All of these species have morphological adaptations that allow them to thrive in unstable, anaerobic sediments, fluctuating water levels and high salinity concentrations (Odum and McIvor 1990). Mangrove species may cohabit and are often arranged along an elevation gradient with red mangrove situated lower and white mangrove situated higher in the landscape.

Beaches (Classification Code #3)

Beaches consist of consolidated substrate (e.g., rock) or unconsolidated deposits (e.g., sands or shells) along shorelines that are influenced by moving water or fluctuating water levels. Beaches can be found along high-energy ocean shorelines, lake shores and can also form from alluvial deposits along rivers. Most beaches in Florida are associated with the Atlantic and Gulf of Mexico coastlines; some significant beach formations form along the Kissimmee River and some lake shores.

Atlantic and Gulf coast beaches in Florida consist of fine, well sorted silica sands mixed with organically-derived calcium carbonate (shell) components. Along Florida's Atlantic coastline, grain size increases from north to south (Benedet *et al*. 2004). Along the Gulf Coast, the contribution of shells to beach formation is particularly important; some beaches in the Ten Thousand Islands and Cape Sable areas consist of significant shell deposits.

Vegetation along Florida's Atlantic and Gulf coast beaches varies by site, being shaped by elevation, substrate, exposure and other factors. Along beaches that have a developed dune system, vegetation has been characterized by zones that contain species with similar characteristics and are generally arranged along an elevation gradient. These four zones are the: 1) open beach zone, 2) vine zone, and the 3) grass zone. All of these plants play important roles in stabilizing the dunes and may help to reduce beach erosion during normal conditions.

The open beach zone is influenced by the daily sweep of tides and is characterized by a lack of rooted vegetation. A well-defined wrack line of debris carried in by waves contains marine animals, plants, algae, shells, driftwood and drift seeds. The vine zone contains species of mostly tropical origin such as railroad vine (*Ipomoea pes-caprae* subsp. *brasiliensis*) and baybean (*Canavalia rosea*) that often crisscross the slope to the wrack line. These species rapidly recolonize following a disturbance event. The grass zone contains a number of grass and herbaceous species that represent a more or less permanent community; species include sea oats (*Uniola paniculata*), shoreline seapurslane (*Sesuvium portulacastrum*) and seacoast marshelder (*Iva imbricata*). The extensive and fibrous roots of the grasses provide an important dune stabilization and first-line defense against storm surge.

Forested Freshwater Wetland (Classification Code #4)

Forested freshwater wetlands, or swamps, are widely distributed throughout Florida. They can be found along rivers and surface flowways, or in isolated depressions. Swamps may also be found as part of a landscape and vegetation mosaic that may include uplands, hydric hammocks, hydric flatwoods and shrubby or scrubby vegetation. Many different types of swamp have been described from Florida, including heads, galls, domes, bogs, sogs, bays, strands and hammock (Ewel 1990). Many of the different forms of swamps that have been described reflect the landscape variability that influences hydrological conditions, species composition and community form.

At least four major environmental factors influence the range of structural and functional diversity within and among Florida swamps; these are: 1) hydroperiod, 2) fire frequency, 3) organic matter accumulation, and 4) water source (Ewel 1990). The duration of saturated soils or standing water throughout the year is the primary environmental factor influencing ecological characteristics of swamps, affecting soil aeration, plant survival and plant reproduction. When flooding persists, oxygen in the soil is gradually depleted and only a few species can tolerate the anoxic conditions and high concentrations of soluble iron, manganese and even hydrogen sulfide that develop in the root zone under such conditions (Ewel 1990). Annual average hydroperiods for swamps range from approximately 4 to 10 months and average seasonal water levels can range from 1 foot below to 2 feet above the soil surface.

Fire frequency can shape several characteristics of swamps. Fire may be important in reducing the amount of organic matter accumulation in both leaf litter and soils. It can also exclude the establishment of some species that are intolerant of fire, thereby influencing species dominance and species richness.

Common swamp species include cypress (*Taxodium* spp.), red maple (*Acer rubrum*), pop ash (*Fraxinus caroliniana*), laurel oak (*Quercus laurifolia*), water hickory (*Carya aquatica*), sweet gum (*Liquidambar styraciflua*), coastal plain willow (*Salix caroliniana*), pond apple (*Annona glabra*), bays (genera *Magnolia*, *Persea* and *Ilex*), strangler fig (*Ficus aurea*), wax myrtle (*Myrica cerifera*), cabbage palm (*Sabal palmetto*), buttonbush (*Cephalanthus occidentalis*), Virginia willow (*Itea virginica*), wild coffee (*Psychotria* spp.), wild grapes (*Vitis* spp.), catbriar (*Smilax* spp.) and ferns.

As part of this study, we have defined two major types of forested wetlands: cypress swamps (Classification Code # 4.1) and hardwood swamps (Classification Code # 4.2).

Cypress Swamps (Classification Code #4.1)

Cypress swamps are a type of forested wetland dominated by cypress; some authors distinguish between two forms – the pond cypress and bald cypress (*Taxodium* sp.). Cypress is among the most common wetland trees in Florida and is usually the dominant species in swamps with fluctuating water levels (Ewel 1990). Cypress swamps can take several forms and are often classified as strands, heads or domes. Hydroperiods may range from 5 to 10 months of the year and average seasonal water levels can range from 1.5 feet below to 1.5 feet above the soil surface.

Cypress strands are often elongated surface (channel-less) flowways that serve as drainage routes for basins. In some cases, these shallow depressions are ecotonal margins between flatwoods and marsh habitats. Two outstanding examples of cypress strands are the Fakahatchee Strand and the Corkscrew Swamp; other examples can be found along the southwestern area of the Big Cypress Swamp.

Cypress heads or domes are more-or-less round in shape and are isolated depressions within a landscape. Taller trees are concentrated in the center of the dome where deeper water and soils are found. In some cases, the dome was formed within a depression, cavity or sinkhole in the limestone bedrock.

Cypress swamps, regardless of form, characteristically contain a number of other species such as bays (genera *Magnolia*, *Persea* and *Ilex*), wax myrtle (*Myrica cerifera*), coccoplum (*Chrysobalanus icaco*), cabbage palm (*Sabal palmetto*) and ferns (genera *Thelypteris*, *Blechnum* and *Osmunda*). Besides these primary forest species, an abundance of air plants and orchids are found in cypress swamps including bromeliads (genera *Tillandsia*, *Guzmania* and *Catopsis*), epiphytic ferns (genera *Nephrolepis*, *Campyloneurum* and *Ophioglossum*) and epiphytic orchids (genera *Epidendrum*, *Encyclia* and *Vanilla*).

Hardwood Swamp (Classification Code #4.2)

Hardwood swamps are a type of freshwater wetland dominated by broadleaf trees. Species may include laurel oak (*Quercus laurifolia*), willow (*Salix caroliniana*), red maple (*Acer rubrum*), pop ash (*Fraxinus caroliniana*), water hickory (*Carya aquatica*), sweet gum (*Liquidambar styraciflua*), pond apple (*Annona glabra*), cabbage palm (*Sabal palmetto*) and bays (e.g., *Persea* spp., *Magnolia virginiana*). Cypress are also frequently found in hardwood swamps, but they are not the dominant canopy species. Hydroperiods may range from 4 to 10 months of the year and average seasonal water levels can range from 1 foot below to 2 feet above the soil surface.

Many forms of hardwood swamps have been described from Florida including riverine swamps and mixed swamps. Those types of swamps usually have a mix of species. However some hardwood swamps are dominated by a single tree species and are referred to as galls or heads; these may be monotypic stands (or nearly so) of pond apple, bay, hackberry (*Celtis laevigata*), maple, willow, elderberry (*Sambucus nigra*) or ash. It is generally believed that the species composition of hardwood swamps is influenced by fire frequency and some single-species hardwood swamps may be seral stages induced by fire.

As with cypress swamps, mixed swamps generally contain a number of herbaceous and epiphytic species such as mosses, terrestrial ferns (e.g., *Thelypteris* spp.) epiphytic ferns (genera *Pleopeltis*, *Campyloneurum* and *Ophioglossum*), bromeliads (genera *Tillandsia*, *Guzmania* and *Catopsis*) and epiphytic orchids (genera *Epidendrum*, *Encyclia* and *Vanilla*).

One of the most notable hardwood swamps was the pond apple forest that rimmed the southern shore of Lake Okeechobee. Bay galls were described from hydric flatwoods and wet prairie lands in the Loxahatchee and Hungryland Slough basins. River bottoms along the Northwest Fork of the Loxahatchee River, Fisheating Creek and Caloosahatchee River also contained areas of mixed swamp hardwoods.

Non-Forested Freshwater Wetland (Classification Code #5)

Non-forested freshwater wetlands, or marshes, are dominated by herbaceous vegetation of a variety of forms: rooted, non-rooted, submersed, benthic, emersed, floating-leaved, emergent, etc. Trees, shrubs and palms are absent or may be widely scattered, occupying less than one-third of the cover (Kushlan 1990). These communities are highly variable in species composition, which is influenced by topography, geology, soil composition, fire frequency, nutrient status, rainfall, evaporation and hydrological regime. Surface water is seasonally present (annual hydroperiod of 2 to 12 months) and average seasonal water levels can range from 2 feet below to 2.5 feet above the soil surface. Numerous marsh types have been described from Florida including bogs, fens, mires, sloughs, flats, prairies, wet prairies, savannas, wet savannas and single species marshes (e.g., sawgrass, reed, cattail, spikerush, pickerelweed, water lily). The Florida Natural Areas Inventory (1988) lists nine marsh types: basin marsh, bog, depression marsh, floodplain marsh, marl prairie, seepage slope, slough, swale and wet prairie (Kushlan 1990).

As part of this study, we have defined three primary marsh types that are generally assembled along a hydroperiod gradient (long-hydroperiod, medium-hydroperiod and wet prairie), each with two specialized variants that result from different fire frequency regimes. Long hydroperiod marshes have annual average hydroperiods that range from 9 to 12 months; these wetlands typically have sparse emergent vegetation and may dry only during extreme drought conditions. Medium-hydroperiod marshes have average annual hydroperiods of 6 to 10 months and experience drying nearly every year. Wet prairies are short-hydroperiod wetlands (annual average hydroperiods of 2 to 6 months) that are only shallowly covered with water and have a relatively high fire frequency. Some wetland soils may have significant accumulations of organic matter, depending on local conditions.

The most notable marsh in Florida is the Everglades, a vast expanse of mostly sawgrass marsh that once extended from Lake Okeechobee to Florida Bay between the Big Cypress Swamp and the Atlantic Coastal Ridge. Other large marshes are associated with the Kissimmee River floodplain and adjacent to the southeastern coastal ridge. In addition, significant areas of marsh are found as seasonal ponds in flatwoods, lake floodplains or as wet prairies.

Long Hydroperiod Marsh (Classification Code #5.1)

Long hydroperiod freshwater marshes have average hydroperiods extending from 9-12 months and average seasonal water levels can range from 0.5 feet below to 2 feet above the soil surface. Some long-hydroperiod marshes are dominated by a single species and others contain a mix of several species. Dominant vegetation includes water lily (*Nymphaea* spp.), spatterdock (*Nuphar adventa*), spikerush (*Eleocharis* spp.), bladderworts (*Utricularia* spp.) and other submersed, emersed or floating-leafed vegetation. Two unique variants of this community type are the *ridge and slough marsh* and *sawgrass plains* found chiefly in the Everglades.

Long hydroperiod marshes often have soils with at least some organic matter, resulting from prolonged inundation and anoxic conditions that retard decomposition in the benthic environment. These organic soils are important for retaining soil moisture during times of prolonged drought and play an important role in maintaining marsh habitats. In oligotrophic hard-water (alkaline) systems, calcium carbonate-derived muds (marl) may also be present, originating from seasonal calcareous algae mats that form in summer and fall.

The most significant long-hydroperiod marshes were located in the Everglades, Lake Kissimmee and Kissimmee River floodplain. Other significant marshes were found along the southern rim of Lake Istokpoga, Lake Okeechobee floodplain, the Loxahatchee Slough and Hicpochee Marsh.

The Everglades marsh, which was the largest in Florida, encompassed over 3,861 mi^2 (10,000 km^2) in an elongated basin spanning 62 miles (100 km) from Lake Okeechobee to Florida Bay (Kushlan 1990). Several other significant marshes were linked to the Everglades through flowways, including the Hicpochee marsh, the Loxahatchee Slough and the Hungryland Slough. The marshes in the Kissimmee River valley occupied 1,930 mi^2 (5,000 km^2) and extended along a 100 mi (160 km) distance connecting the wetlands along the shores of Lake Kissimmee and Lake Okeechobee.

Ridge and Slough Marsh (Classification Code #5.11)

The ridge and slough marsh is an Everglades-specific community that is comprised of a mosaic of interspersed open water sloughs and sawgrass (*Cladium jamaicense*) in elongated formations. Averaged hydroperiods within ridge and slough marsh can be from 10-11 months and average seasonal water levels can range from 0.5 feet below to 2.5 feet above the soil surface. Slough vegetation is typically composed of white water lily (*Nymphaea odorata*), bladderworts (*Utricularia* spp.) and spikerush (*Eleocharis* spp.).

Sawgrass Plains (Classification Code #5.12)

This historical Everglades-specific community consisted of a generally unbroken monotypic expanse of sawgrass across a large spatial extent and was found generally south of Lake Okeechobee in the northern Everglades. Soils are pure, deep peats that are derived from partially-decomposed sawgrass. These are oligotrophic hard water systems, which are a significant factor in determining the species inhabiting this community. Surface water flows in a continuous sheet rather than in distinct channels or flowways. Average annual hydroperiods range from 9 to 10 months and average seasonal water levels can range from 0.5 foot below to 1.5 feet above the soil surface. Soils may dry only during the most prolonged droughts. Fire is believed to play an important role in maintaining this community.

Relatively few other vascular plant species are associated with this habitat type. Where breaks do occur, some emergent marsh species may be present such as arrowhead (*Sagittaria lancifolia*), pickerelweed (*Pontederia cordata*), bladderworts (*Utricularia* spp.) and spikerush (*Eleocharis* spp.).

Medium Hydroperiod Marsh (Classification Code #5.2)

Medium hydroperiod freshwater marshes have hydroperiods extending from 6-10 months on average and average seasonal water levels can range from 0.6 feet below the soil surface to 1.5 feet above the soil surface.. Species composition is influenced by many different factors such as fire frequency, soil type, geology and hydrological conditions; however all marshes are composed of characteristic types of vegetation such as tall herbaceous sedges, reeds, rushes, grasses and broad-leafed herbs. Common species include sawgrass (*Cladium jamaicense*), cattail (*Typha* spp.), spikerush (*Eleocharis* spp.), St. John's-Wort (*Hypericum* spp.), arrow arum (*Peltandra* spp.), arrowhead (*Sagittaria* spp.), pickerelweed (*Pontederia cordata*) and bladderworts (*Utricularia* spp.).

These marshes may occupy isolated depressions within flatwood communities (flatwood marshes), occur as part of larger wetland systems, or may be associated with river floodplains or shallow lake littoral zones. Flatwood marshes are seasonally flooded ponds that occur throughout Florida's extensive pine flatwoods (Kushlan 1990). These marshes occur in shallow depressions within flatwoods and are usually small, although collectively they may cover a significant area within the landscape (Laessle 1943, Abrahamson *et al*. 1984, Winchester *et al.* 1985, Abrahamson and Hartnett 1990). Vegetation in these seasonal ponds includes beaksedges (*Rhynchospora* spp.), St. John's-Wort (*Hypericum fasciculatum*), maidencane (*Panicum hemitomon*) and bladderworts (*Utricularia* spp.).

Soils within these marshes may vary considerably. In flatwood marshes, they are situated on deep or shallow sands with a thin surface layer of organic matter. In other places, they may be found on deep peat soils, such as in the Everglades or along the south rim of Lake Istokpoga. The amount of sand or organic matter in the substrate is a function of local geology and hydrology.

Medium hydroperiod marshes vary considerably in vegetation, landscape position, geology, surface water and water quality. Two marshes may contain similar species assemblages, yet may not be hydrologically or geologically comparable. For example, a sphagnum bog can be found: 1) in a flatwood marsh, 2) on a seepage slope as a "hanging bog", and 3) in a perched wetland on top of a confining soil or rock stratum. Although these bogs may contain comparable species, the hydrogeological characteristics of the sites are entirely different.

Two unique variants of medium hydroperiod marsh are the *marsh with scattered cypress* and *Everglades marl marsh*, the latter of which is found chiefly in the southern Everglades.

Marsh with Scattered Cypress (Classification Code #5.21)

Marsh with scattered cypress is a variant of the medium hydroperiod marsh. These communities may be found along broad shallow lake littoral zone wetlands or in isolated wetlands, often adjacent to cypress swamps. Usually the cypress are scrubby, widely spaced and never attain the stature typical of a cypress swamp.

Everglades Marl Marsh (Classification Code #5.22)

The Everglades marl marsh or marl prairie is an Everglades-associated community, being found predominantly in the southern Everglades. Marl marsh is found in areas of thin calcitic soil with a limestone bedrock base. Average annual hydroperiods can range from 6 to 9 months and average seasonal water levels can range from 1 foot below to 1.5 feet above the soil surface. Species typically encountered in marl marsh include sawgrass (*Cladium jamaicense*), Tracy's beaksedge (*Rhynchospora tracyi*), spikerush (*Eleocharis* spp.), star rush whitetop (*Rhynchospora colorata*) and muhly grass (*Muhlenbergia capillaris*). Seasonal periphyton covers inundated portions of plants and submerged substrate, and is found in floating mats. Calcium precipitate from the algae is the primary constituent of marl soils.

Noteworthy marl marsh areas include the Rockland Marl Marsh and Perrine Marl Marsh along the southeastern Everglades, and the Ochopee Marl Marsh along the southwestern Everglades.

Wet Prairie (Classification Code #5.3)

Wet prairie communities are short-hydroperiod treeless wetlands that have hydric soils, average annual hydroperiods extending from 2-6 months, and average seasonal water levels that range from 2 feet below the soil surface to 1 foot above the soil surface. Wet prairies are distinguished from marsh by the shorter hydroperiod and prevalence of grass species; whereas dry prairies have no annual hydroperiod, upland species and non-hydric soils. Wet prairie soils are predominantly sandy with thin, if any, organic matter deposition. In south Florida, the substrate is a periphyton-derived marl (Kushlan 1990).

Typical plant species of wet prairies include grasses (e.g., Muhlenbergia capillaris, Panicum hemitomon and Spartina bakeri), sedges (e.g., Cladium jamaicense, Rynchospora spp.), St. John's-Wort (Hypericum fasciculatum), tenangle pipewort (Eriocaulon decangulare), sundews (Drosera spp.), yellow-eyed grass (Xyris spp.), marsh pinks (Sabatia spp.) and terrestrial orchids (Spiranthes spp., Calopogon spp. and Pogonia ophioglossoides). Occasional scattered trees may also be found in wet prairies, but the total coverage is small; species include wax myrtle (Myrica cerifera), cypress (Taxodium spp.), coastal plain willow (Salix caroliniana), bays and cabbage palm (Sabal palmetto). As part of this study, we have defined two unique variants of wet prairie: wet prairie with scattered trees and wet prairie with cypress, the latter of which is found most commonly in the Big Cypress Swamp.

The largest extent of wet prairies lies to the east, northeast and west of the Everglades; these are transitional zones between the Everglades and coastal flatwoods or cypress swamps. Other significant areas of wet prairie are within the Indian Prairie, and Kissimmee River and St. Johns River valleys.

Wet Prairie with Scattered Trees (Classification Code #5.31)

This variant of the wet prairie community contains scattered and sometimes scrubby trees that cover less than approximately 30 percent of the total area of the community (Kushlan 1990). Typical tree species include wax myrtle (*Myrica cerifera*), bays (e.g., *Persea* spp.), coastal plain willow (*Salix caroliniana*), cabbage palm (*Sabal palmetto*) and slash pine (*Pinus elliottii*). The tree species present is often determined by nearby forest type; for example, scattered pines occur in wet prairies that are adjacent to pine flatwoods. Some less fire-tolerant species, such as bays, may be found within small (wetter) depressions in the prairie where they are protected from fire.

Wet Prairie with Scattered Cypress (Classification Code #5.32)

This variant of the wet prairie community contains scattered and sometimes scrubby cypress; cypress knees and vegetation associated with cypress swamps are absent. Often, this community type is adjacent to cypress forests. Trees that are only 5 to 10 feet tall may be as much as 50 to 100 years old, limited in growth by shallow soils and limited nutrients. The most extensive area of scattered cypress is within the Big Cypress Swamp and the transitional zone between the Everglades and east coast cypress and flatwood communities.

Hydric Uplands (Classification Code #6)

Hydric uplands are moist woodlands on hydric soils in level, low landscapes; fire frequency is the primary factor in shaping dominant vegetation type. The water table may be near the soil surface during the summer rainy season when periodic, short duration flooding may occur. Annual average hydroperiods are from 1 to 2 months and average seasonal water levels can range from 2.5 feet below to 0.5 feet above the soil surface. Soils are sandy with little surface organic matter.

Plants found in hydric uplands are a mixture of species associated with flatwoods (uplands) and wet prairies (wetlands). Species that may be found include cabbage palm (*Sabal palmetto*), slash pine (*Pinus elliottii*), saw palmetto (*Serenoa repens*), myrsine (*Rapanea punctata*), swamp fern (*Blechnum serrulatum*), laurel oak (*Quercus laurifolia*), sugarberry (*Celtis laevigata*), red mulberry (*Morus rubra*), wax myrtle (*Myrica cerifera*), coco plum (*Chrysobalanus icaco*), St. Johns-Wort (*Hypericum* spp.), candyroot (*Polygala nana*) and yellow-eyed grass (*Xyris elliottii*). Forest types are usually dominated by palms, pines or broadleaf trees.

One extreme variant of hydric uplands that occurs on somewhat alkaline sands is the cabbage palm savanna (Abrahamson and Hartnett 1990), which is common on the Indian Prairie northwest of Lake Okeechobee. Two variants of the hydric upland community that are most commonly encountered, *hydric flatwoods* and *hydric hammocks*, are the result of different fire frequencies; these are further described below.

Hydric Flatwoods (Classification Code #6.1)

Hydric flatwoods are fire-maintained moist pinelands in level, low landscapes. These communities often reside adjacent to marshes or wet prairies, or are situated in shallow depressions in mesic flatwoods. The water table may be at or near the soil surface during the summer rainy season. Average annual duration of flooding can range from 1 to 2 months and average seasonal water levels can range from 2.5 feet below to 0.5 feet above the soil surface. Soils may resemble mesic flatwood soils and may have a hardpan or spodic layer that is impervious or partially confining; this confining layer contributes to the poorly drained conditions of the site.

Dominant vegetation in hydric flatwoods can be superficially similar to mesic pine flatwoods; a canopy of slash pine (*Pinus elliottii*) and a sparse understory of saw palmetto (*Serenoa repens*) may be present. The pines often are of lower density or are smaller in stature than in mesic pinelands, likely a response to prolonged saturated soil conditions for significant durations throughout the year. Other species that may be common include bald cypress (*Taxodium* distichum), myrsine (*Rapanea punctata*), swamp fern (*Blechnum serrulatum*), wax myrtle (*Myrica cerifera*), coco plum (*Chrysobalanus icaco*), gallberry (*Ilex glabra*), groundsel tree (*Baccharis* spp.), american beautyberry (*Callicarpa americana*), St. Johns-Wort (*Hypericum* spp.), candyroot (*Polygala nana*), sundews (*Drosera* spp.), sedges and yellow-eyed grass (*Xyris elliottii*).

Hydric Hammock (Classification Code #6.2)

Hydric hammocks are moist broadleaf woodlands in level, low landscapes. These communities develop in areas of low fire frequency and, as a result, are dominated by hardwood species. Pines are rare or absent. These communities often reside adjacent to marshes or wet prairies, or are situated in shallow, fire protected depressions in mesic flatwoods.

The water table may be at or near the soil surface during the summer rainy season. Average annual duration of flooding is from 1 to 2 months and average seasonal water levels can range from 2.5 feet below to 0.5 feet above the soil surface. Soils may resemble mesic flatwood soils and may have a hardpan or spodic layer that is impervious or partially confining; this confining layer contributes to the poorly drained conditions of the site.

Dominant canopy species include laurel oak (*Quercus laurifolia*), sugarberry (*Celtis laevigata*), red mulberry (*Morus rubra*), red bay (*Persea borbonia*). cabbage palm (*Sabal palmetto*), wild coffee (*Psychotria* spp.), American beautyberry (*Callicarpa americana*), myrsine (*Rapanea punctata*), wax myrtle (*Myrica cerifera*), marl berry (*Ardisia escallioniodes*), stoppers (*Eugenia* spp.), poison ivy (*Toxicodendron radicans*) and catbriar (*Smilax* spp.).

Mesic Uplands (Classification Code #7)

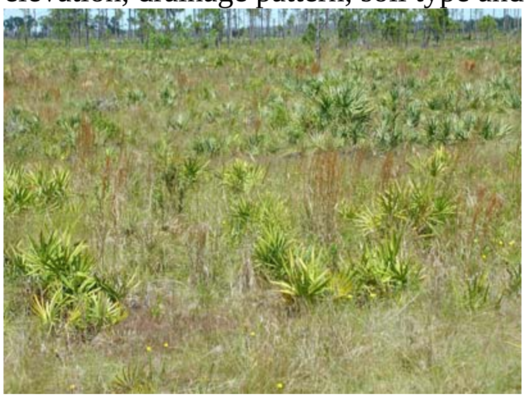
Mesic uplands are one of the most extensive types of terrestrial ecosystems in Florida (Abrahamson and Hartnett 1990), especially north of Lake Okeechobee. On this landscape position, three different types of communities may be encountered: mesic hammock, mesic pine flatwoods and dry prairie; these communities represent a gradient from low to high fire frequency. Some factors that influence fire frequency include local topography, proximity to wetlands, elevation and geography.

Mesic communities are found on upland (non-hydric) soils; the water table is below the soil surface most of the year and may be up to a meter below ground surface during the winter dry season. However, short-duration flooding may occur following high rainfall events; wetland species are absent or of low abundance, mostly a function of site-specific conditions. Soils are sandy substrates with little organic matter accumulation, except in hammocks where a layer of decaying leaf litter may be substantial. The presence of a confining or spodic layer is common in flatwood soils, which and affect local drainage and hydrologic conditions. Mesic uplands are often dotted with marshes or isolated ponds (flatwood marshes), which occur in shallow depressions and collectively they may cover a significant area within the landscape (Laessle 1942, Abrahamson *et al*. 1984, Winchester *et al.* 1985, Abrahamson and Hartnett 1990, Kushlan 1990).

Dry Prairie (Classification Code #7.1)

Florida dry prairie is a natural landscape that is endemic to the state (Fitzgerald and Tanner 1992, Bridges 1997), with no similar communities found in adjacent states (U.S. Fish and Wildlife Service 1999). It is geographically restricted to the interior of central, south-central and west-central peninsular Florida. Soils are usually poorly drained, nutrient-poor, acidic and sandy. Dry prairie is often found on the same soils, landscape positions and moisture regimes as mesic pine flatwoods, with dry prairie being the essentially treeless endpoint of a continuum of variation in canopy cover across pine flatwoods landscapes in central Florida (Abrahamson and Hartnett 1990, U.S. Fish and Wildlife Service 1999). Fire frequency is high compared to other community types, with fire occurring at least once every one to four years.

Vegetation of dry prairies is dominated by saw palmetto (*Serenoa repens*), wiregrass (*Aristida stricta*) and dwarf live oak (*Quercus minima*). Other common species include a variety of grasses (*Andropogon ternarius, Andropogon virginicus, Schizachyrium scoparium* and *Sorghastrum secundum*), gallberry (*Ilex glabra*), lyonias (*Lyonia ferruginea* and *Lyonia lucida*), tarflower (*Bejaria racemosa*) and shining blueberry (*Vaccinium myrsinites*.). Notable variation in this community type can be found associated with latitude. In south Florida rocklands, switch grass (Panicum virgatum) and short grasses are generally common, whereas on acidic sands wiregrass is often most abundant (Abrahamson and Hartnett 1990). Other factors that influence species composition and density are seasonal precipitation, temperature, topography, elevation, drainage pattern, soil type and fire regime.



Extensive areas of dry prairie vegetation occurred north and west of Lake Okeechobee (excluding the Istokpoga and Kissimmee lowlands) and in western St. Lucie, Indian River, Brevard and Volusia counties. In each of these Florida physiographic regions, dry prairie occurs on nearly level, poorly to somewhat poorly drained, interdrainage flatlands above major river/stream floodplain valleys. As with mesic pine flatwoods, dry prairies are often dotted with numerous isolated small shallow depressions (ephemeral ponds and marshes), but have very few surface drainage features.

Mesic Pine Flatwoods (Classification Code #7.2)

Pine flatwoods are an open forested mesic upland community composed primarily of open pineland (typically *Pinus elliottii*) and usually with an understory of saw palmetto (*Serenoa repens*). The density of the canopy and understory is related to fire frequency with fewer trees and shrubs in more frequently-burned sites. Seasonal precipitation, temperature, topography, elevation, drainage pattern, soil type, latitude and fire regime all play a role in shaping species composition and density.

This community is often characterized by low, flat topography and relatively poorly drained, acidic, sandy soil sometimes with an underlying organic horizon (Abrahamson and Hartnett 1990) or confining spodic zone. Mesic pine flatwoods are often dotted with numerous isolated small shallow depressions (ephemeral ponds and marshes), but have very few surface drainage features.

Characteristic vegetation, in addition to the pine overstory and palmetto understory, includes gallberry (*Ilex glabra*), lyonias (*Lyonia ferruginea* and *Lyonia lucida*), wax myrtle (*Myrica cerifera*), blueberries (*Vaccinium* spp.), tarflower (*Bejaria racemosa*), sumac (*Rhus copallinum*), wiregrass (*Aristia stricta*), catbriar (*Smilax* spp.), poison ivy (*Toxicodendron radicans*) and wild grapes (*Vitis* spp.). Considerable variation exists in understory species throughout Florida. For example, in southern Florida, the dominant pine is *Pinus elliottii* var. *densa*; in central and north Florida, this south Florida slash pine variety may be replaced by *Pinus elliottii* var. *elliottii* or *Pinus palustris* (longleaf pine). The understory species may also vary considerably by latitude. Understory species such as silver palm (*Coccothrinax argentata*), coontie (*Zamia pumila*) and dwarf live oak (*Quercus minima*) are common only in the southern portion of the peninsula.

Mesic Hammock (Classification Code #7.3)

Mesic hammock communities are a type of forested mesic upland community composed primarily of broadleaf trees. Mesic hammocks are believed to develop from the same landscape types as dry prairie and mesic pine flatwoods, however fire is naturally suppressed or excluded, allowing development of a hardwood forest.

Hammocks are generally defined as an island of trees in another vegetation type. Mesic hammocks may be found within a fire shadow of a pine flatwood or dry prairie. They may also develop on an elevated site that is surrounded by wetlands where fire is excluded.

The microclimate within a hammock is strikingly different from the surrounding prairie or flatwood. Typically, the canopy is closed and the amount of sunlight reaching the forest floor limits shrub and groundcover species to those that are shade tolerant. Temperatures within the hammock are more moderate than in the surrounding landscape, humidity is higher and evaporation is reduced as sunlight and air movement is dampened. As a result, species found within hammocks are strikingly different than those in areas outside of the hammock.

Species common to mesic hammocks vary considerably between sites and are especially influenced by latitude. In central Florida, live oak (*Quercus virginiana*) and cabbage palm (*Sabal palmetto*) dominate the canopies of most mesic hammocks. In the southernmost reaches of the peninsula, tropical species dominate, including West Indies mahogany (*Swietenia mahagoni*), lancewood (*Ocotea coriacea*), nettletree (*Trema micranthum*), wild tamarind (*Lysiloma latisiliquum*), paradise tree (*Simarouba glauca*) and pigeon plum (*Coccoloba diversifolia*). This latter forest type is also referred to as a "tropical hammock."

Xeric Uplands (Classification Code #8)

Xeric communities are found on elevated sites with the water table well below the soil surface (more than 3 feet) throughout the year. Xeric plant communities are dominated by species that have special adaptations for survival in dry soil conditions. Many such communities have leaves that have been reduced to needle-like forms, some plants have thick waxy cuticles and others have underground stems or specialized root structures to maximize water storage and retention—all are adaptations to an environment somewhat, but not entirely, desert-like. Soils are high, excessively drained sterile sands. Fire frequency, location and climate are the primary factors influencing dominant vegetation types.

Xeric communities, in contrast to pine flatwoods, are often found on rolling hills sand dunes or ridges. The primary aggregations of xeric uplands are along the Atlantic Coastal Ridge, on barrier islands and on central Florida's sand hills and ridges. Three unique variants of the xeric community are the *high pine* or *sandhill*, *scrub* and *coastal strand*. High pine communities are found primarily in central and north Florida on rolling sand hills. These open canopy communities are dominated by longleaf pine (*Pinus palustris*) and wire grass (*Aristida stricta*). Scrub occurs on interior relic sand dunes and ridges (e.g., Lake Wales Ridge), as well as along the Gulf and Atlantic coasts. This community is dominated by sand pine (*Pinus clausa*) or scrub oaks (*Quercus* spp.). Coastal strand is usually restricted to coastal dunes and slopes adjacent to shorelines or beaches. Vegetation in coastal strand is dominated by tropical hardwood species and is sometimes referred to as maritime hammock.

High Pine (Sandhills) (Classification Code #8.1)

High pine or sandhill communities are open pinelands characterized by longleaf pine (*Pinus* palustris) and wiregrass (*Aristida stricta*) on rolling or undulating sand in central and north Florida. High pine once stretched from Texas to Virginia and was one of the largest forest types in the southeastern United States. Fires in high pine occur with a frequency of approximately once every one to ten years (Myers 1990).

In addition to longleaf pine and wiregrass, other species common in high pine communities include deciduous clonal oaks such as turkey oak (*Quercus laevis*), bluejack oak (*Quercus incana*), southern red oak (*Quercus falcata*), sand post oak (*Quercus margaretta*) and blackjack oak (*Quercus marilandica*). Hardwoods in high pine are deciduous, in contrast to scrub that has evergreen or nearly-evergreen species. Herbaceous vegetation, grasses and forbs are abundant (Myers 1990). The forest is usually stratified into a pine overstory, deciduous oak understory and a grass/herbaceous groundcover. At the southern extent of its range on the Lake Wales Ridge, longleaf pine is replaced by south Florida slash pine (*Pinus elliottii* var. *densa*) (Abrahamson *et al.* 1984).

Soils in high pine communities are yellow or gray in color, and can vary considerably in texture, drainage and fertility.

Scrub (Classification Code #8.2)

Scrub communities are typically found on excessively drained, infertile, pure, deep sands on elevated sites, relic dunes and ridges. Scrub communities are characterized by sand pine (*Pinus clausa*) and scrub oaks (*Quercus spp*.) and variations in this community are often attributed to fire frequency, which occur from every 15 to 100 years (Myers 1990).

In addition to sand pine (which may or may not be present), scrub oaks are a dominant and defining species of scrub habitat, including myrtle oak (*Quercus myrtifolia*), sand live oak (*Quercus geminata*), scrub oak (*Quercus inopina*) and Chapman's oak (*Quercus chapmanii*). Other representative species include rosemary (*Ceratiola ericoides*), saw palmetto (*Serenoa repens*), silk bay (*Persea humilis*) and rusty lyonia (*Lyonia ferruginea*). Many species found in scrub are highly adapted to life in xeric conditions; as a result they are of very limited distribution. Some species are endemic to scrub and occur nowhere else; some scrub endemic species include scrub holly (*Ilex opaca* var. *arenicola*), silk bay, scrub hickory (*Carya floridana*), scrub plum (*Prunus geniculata*), garberia (*Garberia heterophylla*), palafoxia (*Palafoxia feayi*), wild olive (*Osmanthus megacarpus*) and Curtiss' milkweed (*Asclepias curtissii*).

The largest extent of scrub occurs in Florida's central peninsula situated on the high sands of the Lake Wales Ridge. Other coastal scrubs are found along the Atlantic and Gulf coasts associated with more recent dunes from the Pleistocene shoreline (Myers 1990).

Coastal Strand (Classification Code #8.3)

Coastal strand communities are found on excessively drained elevated coastal sites along the Gulf and Atlantic shorelines and estuaries. These communities may be situated on coastal dunes, sand ridges, rocky outcrops or shell mounds. Soils are usually sandy; however rocky, shelly or shallow soils may also be present in some sites. This community is strongly impacted by wind and salt spray, especially during storm events.

Vegetation may vary considerably between sites along Atlantic coast beaches, vines, shrubs, seagrape (*Coccoloba uvifera*), saw palmetto (*Serenoa repens*) and cocoplum (*Chrysobalanus icaco*) may be common. In southern Florida, species are primarily of tropical and Caribbean origin and may include inkwood (*Exothea paniculata*), gumbo-limbo (*Bursera simaruba*), paradise tree (*Simarouba glauca*), West Indies mahogany (*Swietenia mahagoni*), Jamaica caper (*Capparis cynophallophora*), nickerbean (*Caesalpinea bonduc*) and doller vine (*Dalbergia ecastaphyllum*). Coastal strand may take several different forms, each of which are points along a continuum of fire frequency, storm surge disturbance and other factors. In fire-exposed, storm surge protected sites, the strand is a treeless community composed of mostly saw palmetto interspersed with a few shrubby species. In fire-protected sites with periodic storm surge disturbance, seagrape, nickerbean and seashore shrubs such as bay cedar (*Suriana maritima*) and lantana (*Lantana involucrata*) dominate. In sites relatively free from fire and storm surge disturbance, coastal strand is dominated by tropical hardwood trees and may have a hammock-like form; this community is also referred to as a maritime hammock.

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