NORTH FORK ST. LUCIE RIVER FLOODPLAIN VEGETATION TECHNICAL REPORT

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ACRONYMS AND ABBREVIATIONS

° C	degrees Celsius
° F	degrees Fahrenheit
%SM	percent soil moisture
blh	bottomland hardwood
CERP	Comprehensive Everglades Restoration Plan
CCA	canonical correspondence analysis
cfs	cubic feet per second
CH3D	Curvilinear Hydrodynamics Three Dimensional
cm	centimeter
cS/cm	centisiemens per centimeter
dbh	diameter at breast height
DBHYDRO	South Florida Water Management District's corporate environmental database
DEM	Digital Elevation Model
District	South Florida Water Management District
EC	soil electrical conductivity
FAC	facultative
FACW	facultative wetland
FACU	facultative upland
FDEP	Florida Department of Environmental Protection
GIS	geographic information system
GPS	global positioning system
HH	hydric hammock
LIDAR	light detection and radar
m	meter
M	marsh
m^2	square meter
MFL	minimum flows and levels
MH	mesic hammock
NAVD	North American Vertical Datum
NGVD	National Geodetic Vertical Datum of 1929
NSM	Natural Systems Model
OBL	obligate wetland
OPTI	optimization model developed to simulate delivery of the flows in the CERP reservoirs to meet target flow distributions
R	riverine
RM	River Mile
sw	swamp
TIN	triangular irregular network
U	obligate upland
UT	upper tidal
VEC	valued ecosystem component
WaSh	a watershed hydrologic model created to evaluate watershed inflows with future CERP projects and without conditions

INTRODUCTION

River floodplains are an important part of any watershed system. They provide storage and filtration of surface water, diverse habitats for plants and animals, corridors for the movement of animals and dissemination of plants, and provide a supply of nutrients to estuarine environments (Darst et al., 2003). In Mitsch and Gosselink's book *Wetlands* (2000, page 514), Gregory et al. described these riparian zones as "the interface between terrestrial and aquatic ecosystems. As ecotones, they encompass sharp gradients of environmental factors, ecological processes and plant communities and are composed of mosaics of landforms, communities and environments within a larger landscape." Vegetation types within floodplains clearly differ as a result of changes in hydrology, topography, soils, and proximity to the coast (Darst et al., 2003). Burke et al. (2003) noted that flooding intensity (i.e. hydroperiod) was the major factor affecting community structure in temperate blackwater floodplain forest. Secondarily, they found the physical and chemical characteristics of the soil, particularly water-holding capacity, affects plant community sustainability during low river flow periods and droughts. Other factors noted for affecting species composition in floodplains include logging and fire history, presence or absence of exotics, and the availability of nutrients and light.

The St. Lucie River Watershed (**Figure 1**) is located on the southeastern coast of Florida in Martin and St. Lucie counties and is the target of this investigation. It is divided into two major subwatersheds (St. Lucie River and Indian River Lagoon) and encompasses 781 square miles. The western basins of the St. Lucie River (C-25, C-24, C-23 and C-44) consist primarily of agricultural lands dominated by citrus and improved pasture. The eastern basins of the St. Lucie River and Indian River Lagoon are more urban with some remaining agricultural activities. The St. Lucie Canal (C-44) is used primarily for regulatory releases (i.e. flood control, and water delivery and navigation) and is governed by the United States Army Corps of Engineers' schedule of lake levels for Lake Okeechobee.

The North Fork St. Lucie River (**Figure 2**) drains an area of approximately 108,165 acres (169 square miles) in eastern St. Lucie County and northeastern Martin County (Post, Buckley, Schuh & Jernigan Inc., 2003). During the nineteenth century, the North Fork was known as the Halpatiokee River (Teas, 1971). Today its major tributaries are Ten Mile and Five Mile creeks. The main body of the North Fork is about four miles long with a channel depth of approximately 10 feet as a result of dredging. The width of the floodplain varies from 100 feet at it upper limits to 4,000 feet at its downstream end. The North Fork is tidally driven up to Five Mile Creek and to the control structure on Ten Mile Creek at Gordy Road (SFWMD, 2002). It is the primary drainage outlet for the C-23 and C-24 canals, the City of Port St. Lucie, most of the City of Fort Pierce and the North St. Lucie River Water Control District.

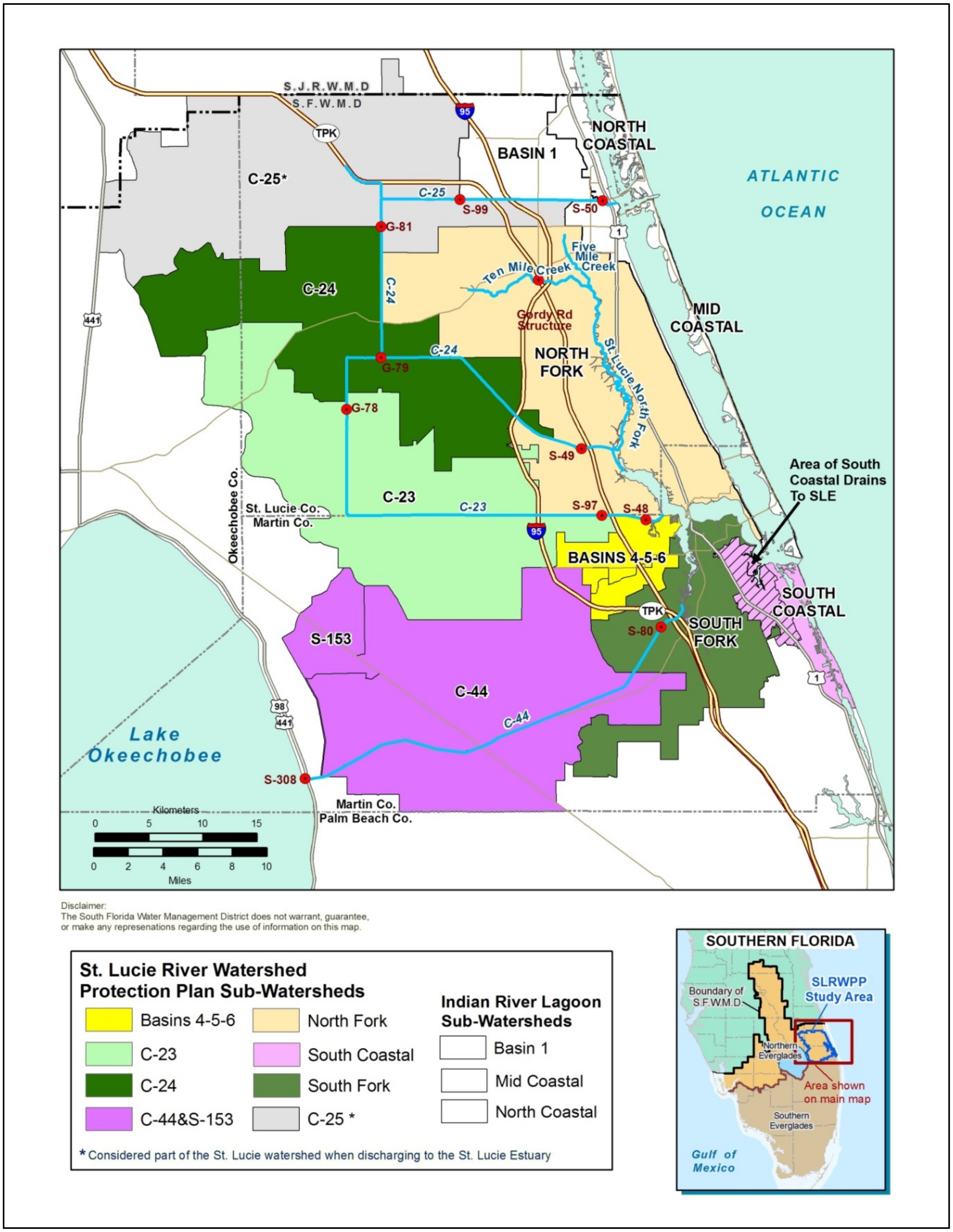


Figure 1. Location map for the St. Lucie River Watershed and its surrounding subwatersheds. (Note: SFWMD – South Florida Water Management District, SLE – St. Lucie Estuary and SLRWPP – St. Lucie River Watershed Protection Plan.)

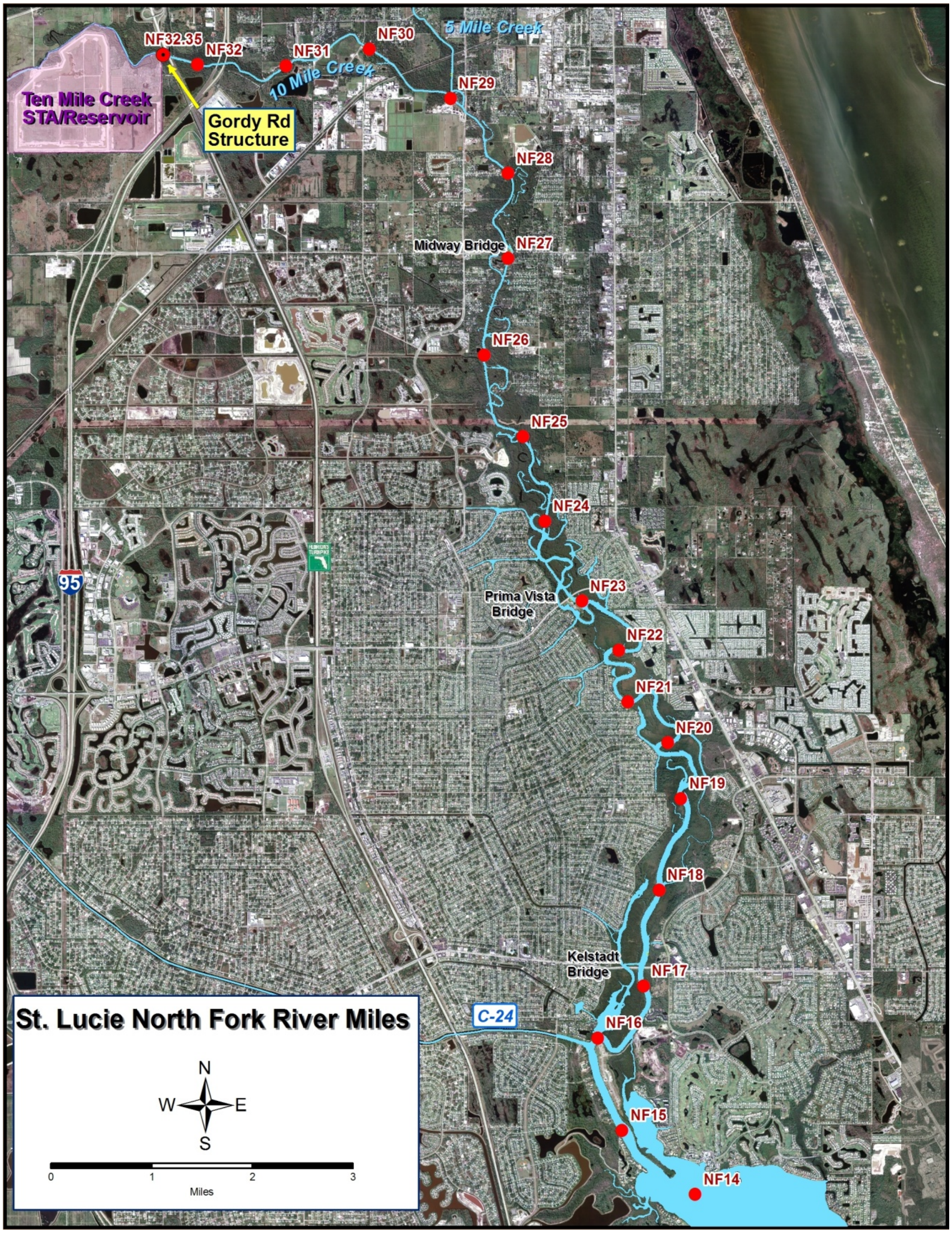


Figure 2. River miles and some major water control structures on the North Fork St. Lucie River. (Note: STA – stormwater treatment area.)

In 1971, the Florida Board of Trustees of the Internal Improvement Trust Fund established most of the riparian areas of the North Fork as the North Fork St. Lucie Aquatic Preserve. The boundaries of the preserve run from approximately River Mile (RM) 12 (Lighthouse Point) to RM 27 (Midway Road) (**Figure 2**). The 5,000-acre area was to be managed as a wilderness preserve by the Florida Department of Natural Resources, Division of Recreation and Parks, Bureau of Environmental Land Management. The *North Fork St. Lucie River Aquatic Preserve Management Plan* was completed in 1984 (Florida Department of Natural Resources, 1984). In the plan, vegetative communities were listed as mangrove, freshwater swamp forest or swamp hammocks, marine grassbeds and tidal flats. With the increasing pressure of development particularly within the City of Port St. Lucie, Davis (1982) described the river system as "holding its own." Today, bobcats (*Lynx rufus*) still roam through the preserve although it is surrounded by highly urbanized lands.

The floodplains of the St. Lucie River consist of tropical and temperate zone riparian forest and marshes that have evolved within the climate and rainfall patterns typical of the South Florida peninsula. Average seasonal temperatures range from 17.8 degrees Celsius (° C) (64° Fahrenheit [° F]) during the winter to about 27.2° C (81° F) during summer (U.S. Department of Commerce, 2010). Average annual rainfall based on 52 years of data was estimated at approximately 51 inches with considerable variations from year to year . As with the seasonal rainfall pattern of South Florida, a somewhat variable wet season occurs between May through October and a dry season occurs between November and April.

Most of the region is very flat and contains poorly drained lands that are subject to frequent flooding. **Figure 3** is a black and white aerial photograph of the region taken in 1940. Natural surface water flow was via large expanses of sloughs and marshes such as St. John's Marsh, Allapattah Slough, Cane Slough and the Savannas. Flow was generally towards the east. Historically, Allapattah Slough flowed during wet years from southeastern St. Lucie County into Martin County and into the St. Lucie River. This was depicted in a rough 1856 map of the area compiled by the Surveyor General's Office in St. Augustine. Approximately 400 square miles was labeled "Alpatiokee Swamp" (see SFWMD, 2002, Appendix E, Figure E-6). Highways, railroads, and drainage projects have modified this flow pattern. Current day Allapattah Slough has been reduced to isolated creeks, ponds, wet prairies, hammocks and sloughs. Cane Slough originally flowed northwest to southwest and acted as a recharge area for the headwaters of the St. Lucie River; however, today it has been channelized and diked and is directly connected to the St. Lucie Canal (C-44) for drainage. Isolated cypress areas, ponds and wet prairies are the only remaining wetland systems in Cane Slough. In the *Technical Documentation to Support Development of Minimum Flows and Levels for the St. Lucie River and Estuary*, Christopher McVoy concluded that "Although there appears to have been variation in spatial pattern and apparent interconnection between the ponds present in the watershed, generally there does not appear a strong suggestion of extensive connection nor of extensive surface runoff. The most important contribution of the watershed to the St. Lucie River may have been more through groundwater contribution to base flow than through surface water runoff" (SFWMD, 2002, Appendix E).

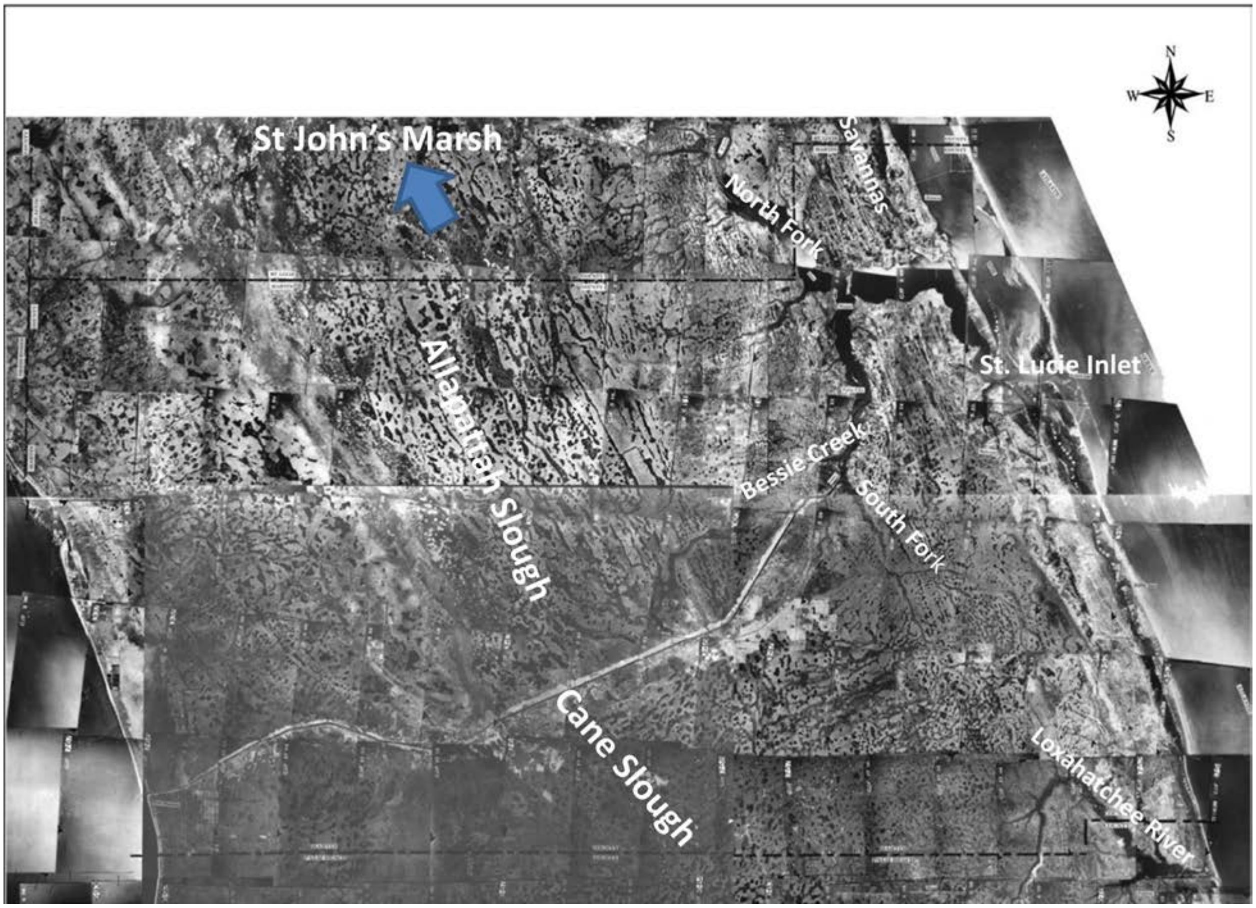


Figure 3. 1940 black and white aerial photograph of the lower St. Lucie River Watershed. (Source: United States Department of Agriculture)

When the first European settlers colonized the coastal area in the early 1800s, the St. Lucie River was a freshwater stream flowing into the Indian River Lagoon. In James Henshall's 2012 book *Camping and Cruising in Florida: One Hundred Years Ago*, he wrote "The St. Lucie is the largest stream emptying into Indian River, and its waters, including those of the bay at its mouth, are quite fresh…In the broad bay at the mouth of the St. Lucie we saw growing great quantities of a grass-like plant, resembling wild celery, or eel grass, upon which were feeding thousands of coots and ducks." The freshwater manatee grass (*Syringodium filiforme*) was killed with the opening of the St. Lucie inlet in 1892. The grass was replaced with oyster bars, which in turn, were killed within years of the completion of the Lake Okeechobee Waterway in 1923 (Osborn, 2012).

The hydrology of the lower river was permanently altered in 1892 when local residents dredged an inlet creating the St. Lucie River Estuary. The Florida Legislature created the Drainage Commission in 1905, which was followed by the 1916 Florida Drainage Acts establishing taxing districts to drain land for flood control and agriculture. The St. Lucie Canal (C-44) was constructed between 1916 and 1924 to provide an outlet for Lake Okeechobee floodwaters. Ft. Pierce Farms Drainage District and North St. Lucie River Water Control District were established between 1918 and 1919 to provide flood control and drainage for area citrus production. At RM 32.2 of the river system, the Gordy Road water control structure provides freshwater flow to the North Fork via Ten Mile Creek.

An enlargement of the North Fork Hallapata River from an 1856 Lieutenant J.C. Ives Military Map shows sawgrass (*Cladium jamaicense*) swamp and floodplain forest adjacent to the river with surrounding upland areas of pine forest (**Figure 4**). Many of the current oxbow systems are not evident because the floodplain vegetation community was much wider and hydrologically more well defined prior to man-made channel dredging activities. During the process of dredge and filling, the North Fork St. Lucie River was “straightened” and dredge material was placed along the banks of the river creating berms that ranged between 2 and 25 feet high and 10 to 50 foot wide. Osborn (2012) gives an historical account of the dredging of the North Fork St. Lucie River:

> In 1922 (as the St. Lucie Canal was constructed a few miles to the south) there was dredging on the north fork of the St. Lucie Estuary (including Five and Ten-Mile Creeks) to make the body more navigable for boats to connect the new agriculture industry being built on the freshly drained lands with markets. To this end, there was a cut-off of historic oxbows to the straightened north fork, and construction of high earthen embankments with the fill from the river bottom, a canalization pattern used in many rivers in Florida, most notably the Kissimmee River. These embankments separated the system’s historically small floodplains and came to host non-native vegetation. These alterations dramatically increased the amount of water entering the St. Lucie during wet summer months and decreased the water discharge in the dry season.

The need for additional agricultural lands in this region was fueled by the need for agricultural produce during World War I (1940s). The system of land reclamation was so affective that regional citrus acreages doubled between 1959 and 1965 (Osborn, 2012, reference 325).

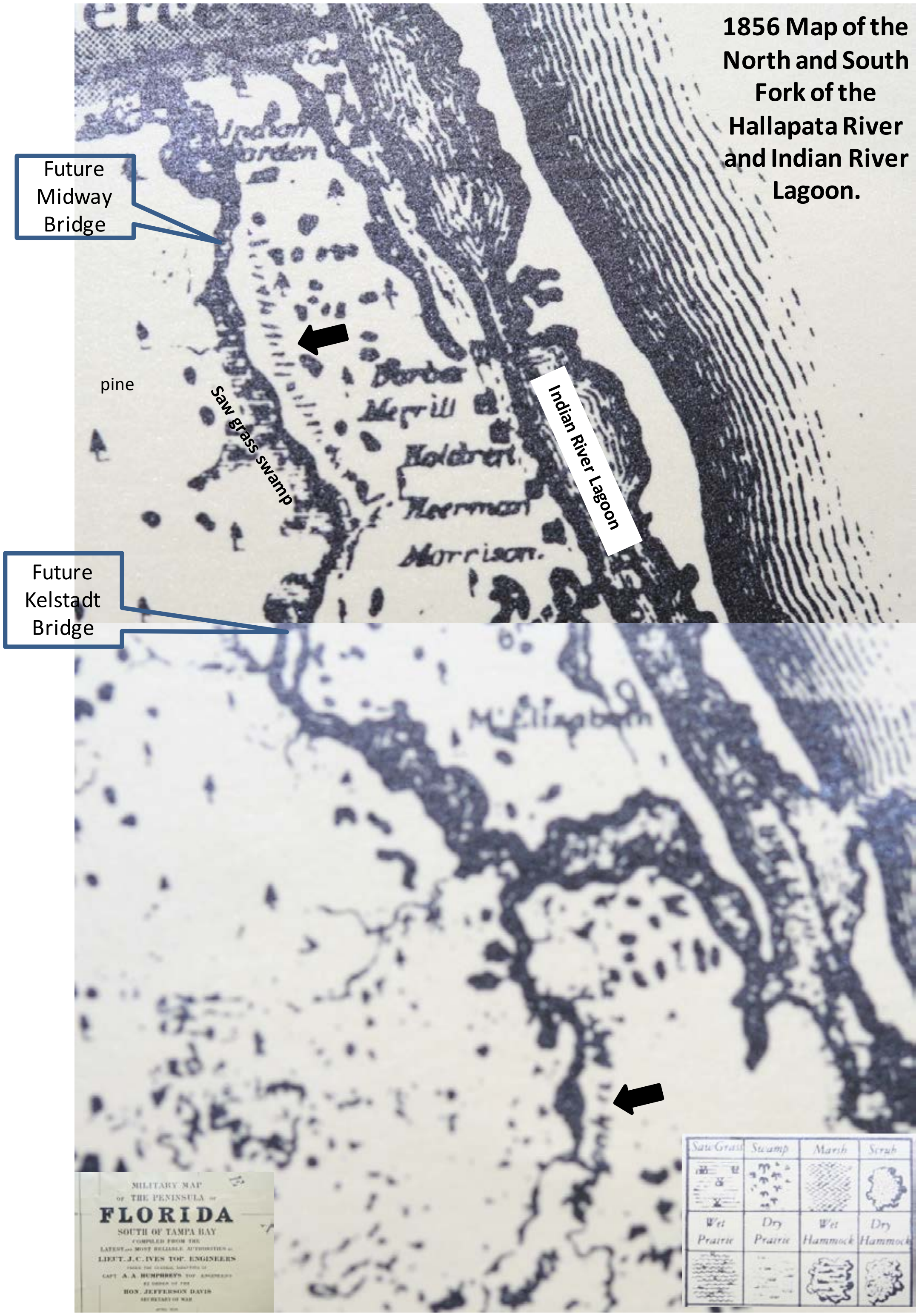


Figure 4. 1856 J. C. Ives Military Map of the Peninsula of Florida South of Tampa Bay enlarged to show the St. Lucie River System (North and South forks) and some of its first residents. Note the sawgrass swamp between the Midway Bridge and Kelstadt Bridge areas.

After several flooding events associated with hurricanes, the Central and Southern Florida Flood Control District was created in 1949. Shortly thereafter, the St. Lucie Canal was enlarged and deepened to nearly double its previous volume. By this time, canals and levees were used additionally to store water for irrigation during the dry season. Development was knocking at the door by 1958, when General Development Corporation began to create the community of Port St. Lucie on 80 square miles of wetlands and pine forest land adjacent to the North Fork St. Lucie River.

1944 and 1958 black and white aerials of the North Fork are pictured in **Appendix A**. In **Appendix A-1**, the dredged and bermed North Fork of today was very evident in 1944. Small tributaries on the west side of the river appear to be intact with no surrounding development, while land to the east already appears to be subdivided into sections with one north/south road for access. The canopy community within the floodplain appears to be very young. In the 1958 aerial (**Appendix A-2**), there are many new drainage ditches on the west side of the river. There is some development on both sides of the river, but mainly on the east side; and, the railroad is present over Five and Ten Mile creeks (**Appendix A-3**). The floodplain canopy community in the 1958 aerial photographs appears to be much more mature than the 1944 community. Some of the oaks and cabbage palms on the berms would be approximately 36 years old in the 1958 aerial photographs. It is not known how long commercial logging continued in this area of St. Lucie County. On the Loxahatchee River, commercial river logging ended around 1940.

PURPOSE AND SCOPE

This current floodplain vegetation study was initiated by the South Florida Water Management District's (District's) Coastal Ecosystem Section to characterize and quantify existing floodplain vegetation communities, examine their current health, and make recommendations on the impact of enhancing current freshwater flow and salinity patterns on the North Fork St. Lucie River. Better management of flow will improve water quality, reduce sediment deposition in the St. Lucie Estuary, and reduce the impact of saltwater intrusion within the North Fork. In fact, with the digging of the inlet and channels and with rises in sea level, the St. Lucie River is becoming more saline. Therefore, it is imperative for us to examine ways to protect and enhance hydrological conditions on the remaining river floodplain communities. Data collected for this study will be useful information for updates of the minimum flows and level rule, water reservations, estuarine protection plan, and the *North Fork St. Lucie River: Aquatic Preserve Management Plan* (Florida Department of Natural Resources, 1984). This information will also be helpful when developing adaptive management of flows from the Ten Mile Creek Water Preserve Area and the improved management of flows from the future reservoir/stormwater treatment area facility.

Man-made impacts have greatly affected the distribution of floodplain vegetation on the St. Lucie River and its major tributaries. The formation of a regional flood control system (**Figure 1**) and the stabilization of the St. Lucie Inlet resulted in a redistribution of vegetative communities in the floodplains. Salt tolerant mangroves from the Indian River Lagoon system eventually established further upstream within the St. Lucie Estuary and in the lower reaches of the tributaries, while the main branch of the North Fork and its associated floodplains were dredged for flood control and navigation by the North St. Lucie Water Control District and the United States Army Corps of Engineers. Since the placement of the berms, a significant portion of the floodplain of the North Fork St. Lucie River is partially or completely isolated from the main river channel. This has resulted in altered salinity gradients, stagnant stream reaches and sedimentation within the isolated oxbow systems (Post Buckley Schuh & Jernigan, Inc., 2003).

In addition, freshwater discharges to the North Fork have been reduced by 40% (SFWMD, 2002) as a result of the diversion of water into the C-24 Canal. The Ten Mile Creek Project, which was authorized by the United States Congress under Section 528 of the Water Resources Development Act of 1996, is underway to attenuate wet season stormwater flows to the North Fork St. Lucie. The Ten Mile Creek Reservoir/Stormwater Treatment Area (**Figure 3**) was constructed to capture and store storm water, which will be passed through a polishing cell for additional water quality treatment and then released into the North Fork. Dry season discharges from the reservoir will recharge local irrigation canals and reduce local dependence on the Floridan Aquifer.

In 2002, a minimum flows and level (MFL) criteria was established for the St. Lucie River and Estuary based on the determination that significant harm occurs to the oligohaline zone on the North Fork when net freshwater flows to the estuary are at or below zero for a period of two consecutive months for two or more years in succession. Performance measures addressed the maintenance of a salinity of 5 in the oligohaline zone at a point seven miles above the Kellstadt Bridge. Results of the analysis indicated a flow of 70 cubic feet per second (cfs) at the Gordy Road Structure would be needed to maintain the oligohaline zone seven miles above Kellstadt Bridge (RM 24) while 240 cfs would be needed to maintain a salinity of 5 at or below the bridge (Port St. Lucie Boulevard, RM 17.5).

In 2003, Post, Buckley, Schuh & Jernigan Inc., under contract to the Florida Department of Environmental Protection (FDEP), conducted a study to determine the restoration potential of reconnecting isolated oxbows and wetlands along the North Fork St. Lucie River. They determined that isolation of oxbows and floodplain wetlands had resulted in the lost use of important habitats for wading birds, fish, reptiles and other wildlife along with the loss of filtration capacity of the floodplain and the spread of salt tolerant mangroves and exotic vegetation. They concluded that this was due to changes in hydrology and the disposal of spoil material along the banks of the river. FDEP aquatic preserve staff have completed several oxbow and wetland reconnection projects along the river and are currently examining the possibility of future projects to restore hydrology to these isolated wetland systems.

On a larger scale, the Comprehensive Everglades Restoration Plan (CERP) has committed to the restoration of the North Fork St. Lucie River through its Indian River Lagoon-South Project. The primary purposes of this project are to reduce high volumes of freshwater discharges in the system and restore a more natural timing and distribution of flows to the estuary, which should, in turn, provide a healthier environment for biota populations. Through the water reservation process, the District has made a commitment to protect the quantities of water necessary for each CERP project (SFWMD, 2009). A water reservation was developed for the North Fork to ensure healthy and sustainable native fish and wildlife communities. Through the review of empirical data and literature, a low salinity zone (0 to 10) was identified within the North Fork that provides critical habitat for larval and juvenile fishes. The specific target area of this critical habitat corresponds to the area between Kelstadt and Prima Vista bridges (RM 17.2 and RM 23.1, respectively). A mean monthly flow of 130 cfs was identified to maintain this critical habitat between the bridges. Appendix B of the *Technical Document to Support a Water Reservation Rule for the North Fork of the St. Lucie River* (SFWMD, 2009) document contains the methodology that produced and the results of the digital elevation model for the floodplains of the North Fork St. Lucie River. The resulting model was also used to analyze floodplain inundation, storage capabilities and restoration potential for the vegetation transects of this study. The results of this modeling exercise will be discussed under the Topographical Characteristics and Geographical System Coverage section of this document.

Previous Vegetation and Water Quality Studies

In 1970, General Development Corporation, owner of approximately 600 acres of land on the North Fork St. Lucie River and 40,000 acres of an adjacent subdivision known as "Port St. Lucie" hired Dr. Howard Teas with Dr. Taylor Alexander of the University of Miami to conduct a resource inventory of an area they called the St. Lucie Sanctuary or the Halapatiokee Natural Area. This area is located between RM 18 and RM 21 (**Figure 2**). From his December 19–20, 1970 field trip, Dr. Alexander identified three plant community types in this area: high hammock, low hammock and swamp. High hammock was defined as a climax stand of oaks, cabbage palm (*Sabal palmetto*), saw palmetto (*Serenoa repens*), strangler fig (*Ficus aurea*) and water hickory (*Carya aquatica*) in the northern portion (**Figure 5**) (Teas, 1970). Low hammock was defined as a more frequently flooded association of cabbage palm, red maple (*Acer rubrum*), strangler fig, wax myrtle (*Myrica cerifera*), pond apple (*Annona glabra*) and water ash (also known as pop ash, *Fraxinus caroliniana*). The swamp community was defined as a frequently flooded area dominated by red mangrove (*Rhizophora mangle*), pond apple, wax myrtle, groundsel bush (*Baccharis halimifolia*) with a dense understory of fern. Their 1971 plant list is given in **Appendix B** and contains 64 plant species. In freshwater areas, the floodplain was separated into two types: forests and prairies. Prairies were dominated by cordgrass (*Spartina bakeri*). Brackish water areas were dominated by red and white (*Laguncularia racemosa*) mangroves with the common occurrence of leather ferns growing more than head high along with spectacular displays of epiphytes (*Tillandsia*, air plants). Upland areas were dominated by slash pine (*Pinus elliottii*) frequently with cabbage palms and live oaks (*Quercus virginiana*), and sand (*Pinus clausa*) or scrub (*Pinus virginiana*) pine pinelands. It was noted that some of the plant communities occurred abruptly side by side and thus ecotones were not distinguishable. In his summary, Dr. Alexander noted that bald cypress (*Taxodium*

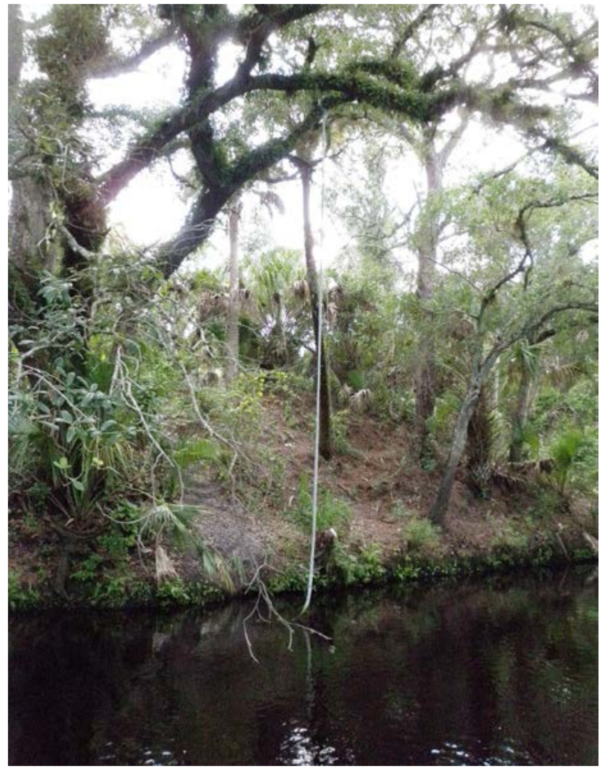


Figure 5. An example of Dr. Alexander's high hammock (oaks, pine and saw palmetto) that formed on the berms (i.e. spoil material from dredging) along the river channel.

distichum) was missing from the North Fork St. Lucie River but he made no suggestions as to why they were missing. Teas' report also examined wildlife in the form of birds, mammals, reptiles and amphibians within the study area (Teas, 1970).

In a supplemental report in 1971, Dr. Alexander collected 17 cores from trees within the floodplain to examine annual rings for age determination. In the river forest hardwood community, he collected cores from red maple, water hickory, oaks, sand pine and slash pine from the surrounding uplands. The mature red maple and hickory canopies were estimated in the 50-year class, which would date back to about 1922 when the berms were created on the North Fork. Water oak (*Quercus nigra*) or laurel oak (*Quercus laurifolia*) could not be aged because the coring device would "freeze" in the trunk and could not be extracted. The oldest of the live oak canopy was estimated at about a century old.

Additionally, Dr. Alexander noted that the tidally inundated systems contained all three species of mangrove, red, black (*Avicennia germinans*), and white, along with buttonbush (*Conocarpus erectus*) and leather fern (*Acrostichum danaeifolium*). Other vegetation associated with the mangrove communities included salt bush (*Distichlis spicata*), black needle rush (*Juncus roemerianus*), spike rush (*Eleocharis cellulose*), cordgrass (*Spartina spp.*), glass wort (*Salicornia spp*.), sea purslane (*Sesuvium portulacastrum*), salt wort (*Batis maritima*), and sea ox-eye (*Borrichia frutescens*). In his 1971 report, he concluded that in the tidal areas, salt sensitive species would die out while resistant species would survive and, as conditions changed, species would reinvade according to their tolerances. He noted that large areas of plants were killed in the area after Hurricane Donna in 1960 and Hurricane Betsy in 1965. He particularly noted the need to allow artificial impoundment areas to be flushed of salt.

An additional report within the 1971 Teas document looked at water quality within the North Fork. The report was entitled *A Limnological Reconnaissance of the North Fork of the St. Lucie River* by Burton P. Hunt and Thomas E. Lodge. Their six sampling locations were located at Prima Vista Bridge (RM 23), White City Bridge (RM 27), Hawley Road (RM 29), Five Mile Creek at Highway 70, Selvitz Road (RM 30) and Coolidge Road (RM 32) on Ten Mile Creek. **Table 1** Illustrates the condition of salinity and conductivity in surface waters on January 30, 1971. Additional data collected in January and March of 1971 showed salinities of 2.3, 6.7 and 1.4 at the Prima Vista Bridge and 0.8, 0.8 and 0.7 at the White City Bridge. The salinity and conductivity readings were considerably higher than what they had observed in most inland waters of South Florida.

Table 1. Surface water salinity and conductivity readings collected by Hunt and Lodge on the North Fork St. Lucie River in 1971.

Location	Salinity	Conductivity (microsiemens [µS])
Prima Vista Bridge	1.4	2,650
White City Bridge	0.7	1,600
Hawley Road	0.7	1,750
Selvitz Road	0.7	1,650
Coolidge Road	0.7	1,600
Highway 70	0.3	980

Detailed geographic information system (GIS) analyses of the St. Lucie Watershed vegetation were compiled by Kautz et al. (1994) and Post, Buckley Schuh & Jernigan (1999). Again, it was noted that much of the forested freshwater wetlands had undergone extensive conversion to agricultural use. Forested freshwater communities in the watershed were associated with cypress, scrub and brushland, and mixed hardwood. Cypress systems occurred as strands and domes and associated with the river and sloughs. Strands are dominated by bald cypress but also contain red maple, water hickory, laurel oak, red bay (*Persea borbonia*) and strangler fig. Scrub and brushlands were characterized by canopies of red maple, bald cypress and red bay with shrubby vegetation dominated by Carolina willow (*Salix caroliniana*), wax myrtle, button bush (*Cephalanthus occidentalis*), primrose willow (*Ludwigia* sp.), elderberry (*Sambucus canadensis*) and Brazilian pepper (*Schinus terebinthifolius*). Mixed forested wetlands were dominated by slash pine, cabbage palm, and hardwoods (red maple, sweet bay (*Persia* sp.), water oak, wax myrtle and wild coffee (*Psychotria* sp.). Non-forested wetlands were dominated by a wide variety of herbaceous species such as maidencane (*Panicum* sp.), wiregrass (*Aristida* sp.), bluestem (*Andropogon* sp.), St. John's wort (*Hypericum* sp.), pickerelweed (*Pontederia* sp.), and arrowhead (*Sagittaria* sp.). The *North Fork St. Lucie River: Aquatic Preserve Management Plan* (Florida Department of Natural Resources, 1984) also includes a category called "Freshwater Swamp Forest" or "Swamp Hammock". This category is encountered in the upper reaches of the preserve and includes dense stands of maple, pop ash, cabbage palm, sweet bay and laurel oak.

Several other ongoing background studies and monitoring efforts on the North Fork and St. Lucie Estuary are useful in assessing the current health of the floodplain vegetation communities. Base case historical flows have been obtained for the period from 1965 to 1995 (31 years) for five of the tributaries to the St. Lucie Estuary to simulate today's St. Lucie Watershed while the Natural Systems Model (NSM) was utilized to predict historical hydrological conditions (SFWMD, 2002). A two-dimensional hydrodynamic/salinity model was developed to predict salinity conditions based on tidal exchange, river flow and basin configuration (Hu, 2000). More specifically the model was developed to analyze the relationship between freshwater flow (from Ten Mile Creek, Five Mile Creek, rainfall and groundwater seepage) and salinity at various distances along the river. A three-dimensional estuarine hydrodynamic model (Curvilinear Hydrodynamics Three-Dimensional [CH3D] code) was developed to simulate salinity within estuarine portions of the St. Lucie River (SFWMD, 2009). The model was used to establish the salinity performance measure (i.e. 1 isohaline) and flow target for the North Fork St. Lucie River. In addition, a watershed hydrologic model (WaSh) was created to evaluate watershed inflows with future CERP projects and without conditions, while an OPTI (Version 6) Model was developed to simulate delivery of the flows in the reservoirs to meet target flow distributions.

Topographical Characteristics and Geographical Information System Coverage

One of the most important data sets for understanding the hydrology and hydrodynamics of this river is elevation. In 2009, a digital elevation model (DEM) was developed for the floodplain area of the North Fork St. Lucie River (SFWMD, 2009, Appendix B). The DEM model was created as a tool to examine floodplain inundation, water storage capabilities and better direct restoration efforts. The DEM model can be used in the identification of the extensive system of berms (i.e. spoil material) that were created when the river was dredged for flood control and navigation; and can be used to identify potential areas for oxbow or floodplain reconnections. To create this tool, three bathymetry data sets from 1998, 2003 and 2006 were obtained for the North Fork St. Lucie River. Using the tools in ESRI's ArcGIS, the bathymetry data sets were converted to the National Geodetic Vertical Datum (NGVD29), and units of feet as needed, then merged into a single point shape file. Elevations at the shoreline were established by averaging several years of stage data from stage recorders located at Kelstadt, Prima Vista and Midway Road (White City) bridges. In 2007, terrestrial Light Detection and Ranging (LIDAR) was flown over the North Fork floodplain for floodplain mapping. Because of the dense vegetation in the floodplain, LIDAR was collected using a helicopter. After all of the bathymetry and LIDAR data were ready, the first step in creating the DEM was to interpolate the bathymetry data to produce a triangular irregular network (TIN) for the area of the river. A TIN is a vector-based representation of land use, in this case the bed of the river channel. It consists of irregular, non-overlapping triangles that interpret the data between the nodes of the triangles. The second step for creating the DEM was to produce a TIN from the floodplain's LIDAR data. The TINS for both the bathymetry and LIDAR data sets were converted to ESRI grids (raster data sets) with a 5-foot pixel resolution and merged into one grid for the North Fork Narrows Floodplain DEM (**Figure 6**).

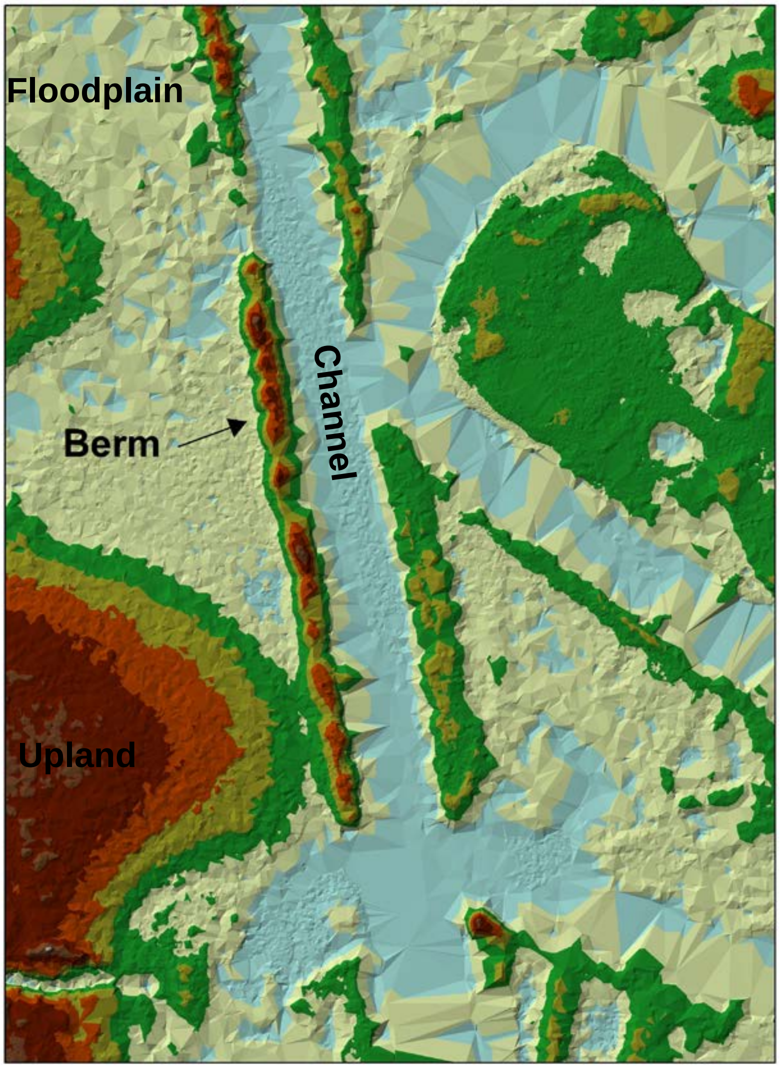


Figure 6. LIDAR TIN of the North Fork St. Lucie River illustrating the effect of spoil mounds (berms) reducing the inundation of the floodplain areas adjacent to the Oxbow Eco-Center (RM 25.7).

The DEM was then used to establish the river stage needed to connect the river's main channel to the floodplain for fish habitat and enhancing hydroperiods for the wetland communities. Floodplain inundation was examined for four different stages of the river—1 foot, 1.5 feet, 2 feet and 2.5 feet. The results of this analysis indicated that a stage of approximately 2 feet is needed for significant floodplain inundation (SFWMD, 2009, Appendix B). In addition, from examining the existing stage data, it was determined that there was not a significant difference between stage levels at the three monitoring sites; therefore, the DEM Model could be applied throughout the North Fork and its floodplain. It was concluded that as the river is managed today, a stage of floodplain inundation can be reached but not for any significant period of duration.

Ecological Conceptual Model of Floodplain Vegetation

Floodplain vegetation is an important valued ecosystem component (VEC) on the North Fork St. Lucie River because these communities respond directly to salinity and soil conditions, rainfall, and freshwater inflow and they provide habitat for fish and wildlife. In 2009, vegetation and soil studies were initiated on the North Fork St. Lucie River to obtain baseline information on floodplain communities. A conceptual ecological model for a floodplain forest VEC (**Figure 7**) was introduced in the *Loxahatchee River Science Plan* (SFWMD et al., 2010) and has been adapted here for the St. Lucie River and Watershed. Sea level rise, climate change and water management are identified as the drivers while nutrients, hydrology and hydrodynamics, soil type and other factors are identified as stressors. Effects are shown as salinity, saltwater intrusion, flow, altered hydroperiods, hurricane, fire, lumbering, changes in light and canopy cover, and the invasion of exotic vegetation species.

North Fork St. Lucie River Floodplain Taxonomic Plant Survey

In 2009, the North Fork St. Lucie River Floodplain Taxonomic Plant Survey was conducted by Habitat Specialist Inc. along the four newly established vegetative transects: Miller Oxbow (RM 30), River's Edge (RM 26.3), Beach Avenue (RM 19.5) and Crowberry Drive, (RM 18.3). The purpose of the survey was to provide initial support on the identification of floodplain vegetation communities, to prepare an inventory list of plants to be encountered, as well as to prepare a dried collection of voucher specimens using standard herbarium practices for species verification that would serve as a reference collection. Vouchers for each species were collected in the vicinity of the transects under an FDEP permit acquired for the North Fork St. Lucie River Floodplain Project. Each species was assigned a collection number and information was recorded in a field notebook. The taxonomic plant collections were conducted between February 25 and April 23, 2009.

During the follow-up field day on June 30, 2009, more mature specimens were sought for unidentifiable sterile juvenile specimens collected in early spring. Low-lying epiphytes were collected, however, the rare or high reaching Florida butterfly orchid (*Encyclia tampensis*, which was seen outside the transects) and rare wild pines (*Tillandsia utriculata* and *T. fascicularis*) were noted in the species list but not collected.

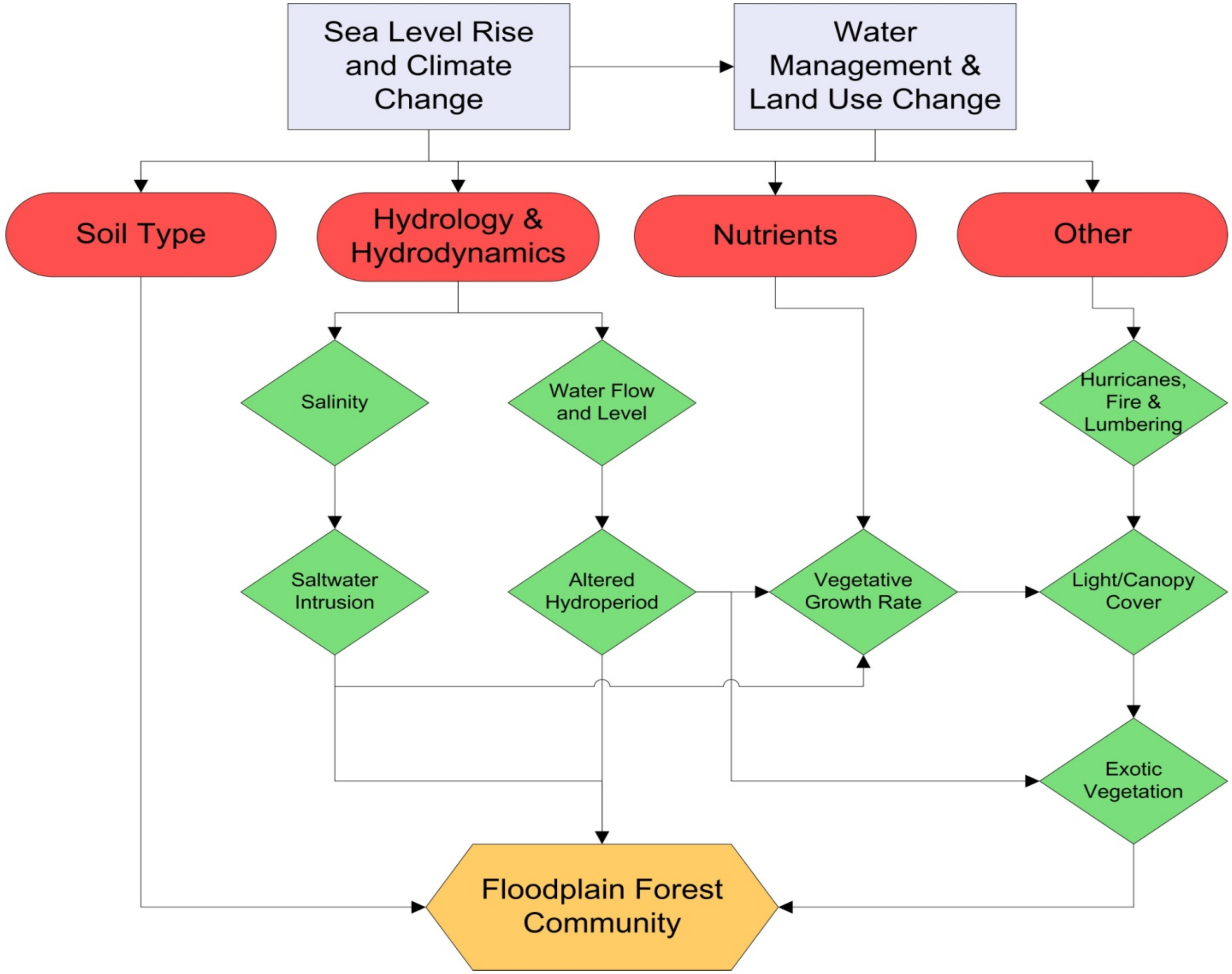


Figure 7. Conceptual ecological model of a South Florida river floodplain and adapted for the St. Lucie River and Watershed floodplain communities.

As a result of the initial taxonomic plant survey, 163 plant species were identified along the four transects. **Appendix C** includes a list of the plant species that were encountered. The percent of wetland indicator species ranged from 34% at Miller Oxbow to 59% at Crowberry Drive. The entire voucher specimen collection was photographed and is available on compact disk and the collection itself is stored at District headquarters for reference use. **Figure 8** is a photograph of a dried specimen of red bay from the collection.

Figure 8. Photograph of a red bay voucher specimen from the North Fork St. Lucie River Floodplain Study Collection.

METHODS

Air, Temperature and Rainfall

Mean daily air temperatures (° C) and rainfall in inches were obtained for the years 1995 to 2010. The Savannas Preserve Weather Station (SVWX) was used for air temperature while data from water control structures on the C-23, C-24 and C-25 canals, and the Gordy Road structure (North Fork) were used for rainfall. All of these databases are available in the District's corporate environmental database, DBHYDRO.

Soil Characteristics, Soil Electrical Conductivity and Soil Moisture Sampling

The *Soil Survey of St. Lucie County Area, Florida* was used to determine general soil types along each transect (USDA et al., 1977). Field work for these surveys was conducted between 1973 and 1977 by the collaborative effort of the United States Department of Agriculture's Soil Conservation Service with University of Florida's Institute of Food and Agricultural Sciences and Agricultural Experiment Stations, Soil Science Department, and the Florida Department of Agriculture and Consumer Services. Soil electrical conductivity (EC) and percent soil moisture (%SM) for our study were examined with an Aquaterr EC-300 probe at each segment pole (i.e. every 10 meters) once during the field study.

River Flow and Salinity

Flow data has been measured daily on the St. Lucie River since 1964 from District water management structures—S-80 (C-44 Canal), S-49 (C-24 Canal), and S-97 (C-23 Canal). The Gordy Road Structure is operated by the North St. Lucie Water Control District. Early flow data for the Gordy Road Structure was scarce; however, flow data was available for the period from 1999 to 2011. The WaSh Model was used to provide flow from areas not covered by the above structures. A groundwater model and a channel routing model were added to the WaSh model to simulate hydrology in watersheds with high groundwater tables and dense drainage canal networks like the St. Lucie River. Surface flow from the tidal North Fork and tidal South Fork were treated as distributed flow. The CH3D Model was developed to simulate the hydrodynamics/salinity and sediment transport of the St. Lucie Estuary. Model development, calibration and verification are summarized in the *Technical Document to Support a Water Reservation Rule for the North Fork St. Lucie River* (SFWMD, 2009, Appendix D). The model uses data collected over a nine-year period (1997–2005).

Since 1997 until the present day, almost continuous stage, salinity and temperature have been measured at 15-minute intervals at the A1A, US1 and Kelstadt bridges. Monitoring stations at the Prima Vista and Midway bridges were added in 2003. All of the hydrological data mentioned above is stored within the District's DBHYDRO database. Stage analysis was not included in this report, because it was concluded that the average stage at the three remaining monitoring sites on the North Fork differed by only 0.16 feet (SFWMD, 2009, Appendix B).

Vegetative Sampling

On November 1 and 29, and December 10, 2007 car and boat reconnaissance trips were conducted along the North Fork St. Lucie River to groundtruth floodplain vegetation adjacent to the main channel and several oxbows. Major vegetative species and berms were noted on enlarged 2005 aerial maps of the river system and potential sites for belt transects were located.

The North Fork St. Lucie River Floodplain Vegetation Study consists of 4 transects with a total of 77 vegetative segments or plots that were examined between February 2 and May 5, 2009 (**Figure 9**). The Miller Oxbow Transect is located at RM 30 on Ten Mile Creek and is the site of a 2010 oxbow reconstruction project and has 13 plots. The River's Edge Transect is located at RM 26.3 on the North Fork St. Lucie River at River's Edge Elementary School and has 10 plots. The Beach Avenue Transect is located at RM 19.5 and has 21 plots. The Crowberry Drive Transect is located at RM 18.3 just upstream of the St. Lucie Boulevard Bridge. It has 33 plots. All four transects have partial berms (old spoil mounds) adjacent to the river channel. Only the Miller Oxbow Transect on Ten Mile Creek is freshwater tidal. The other three sites are exposed to various levels of salinity. River mile of each transect is based on distance from the mouth of the St. Lucie Inlet.

The transects were positioned perpendicular to the river and the existing elevational gradient as with similar floodplain studies in northern Florida (Darst et al., 2003; Light et al., 2002b) and previous studies on the Loxahatchee River (SFWMD, 2006, 2009). Transects began where emergent vegetation first occurred on the river's edge and continued inland to the upland edge of the wetland. PVC pipes were placed along the center line every 10 meters of the rectangular-shaped belt transect. A survey benchmark was established at the upland end of each transect. State plane coordinates were obtained for each PVC pipe using a global positioning system (GPS) and ArcGIS. Transect ground elevations were also measured with a laser level. This information was used to analyze the frequency of inundation and flow stage relationships for the DEM Model.

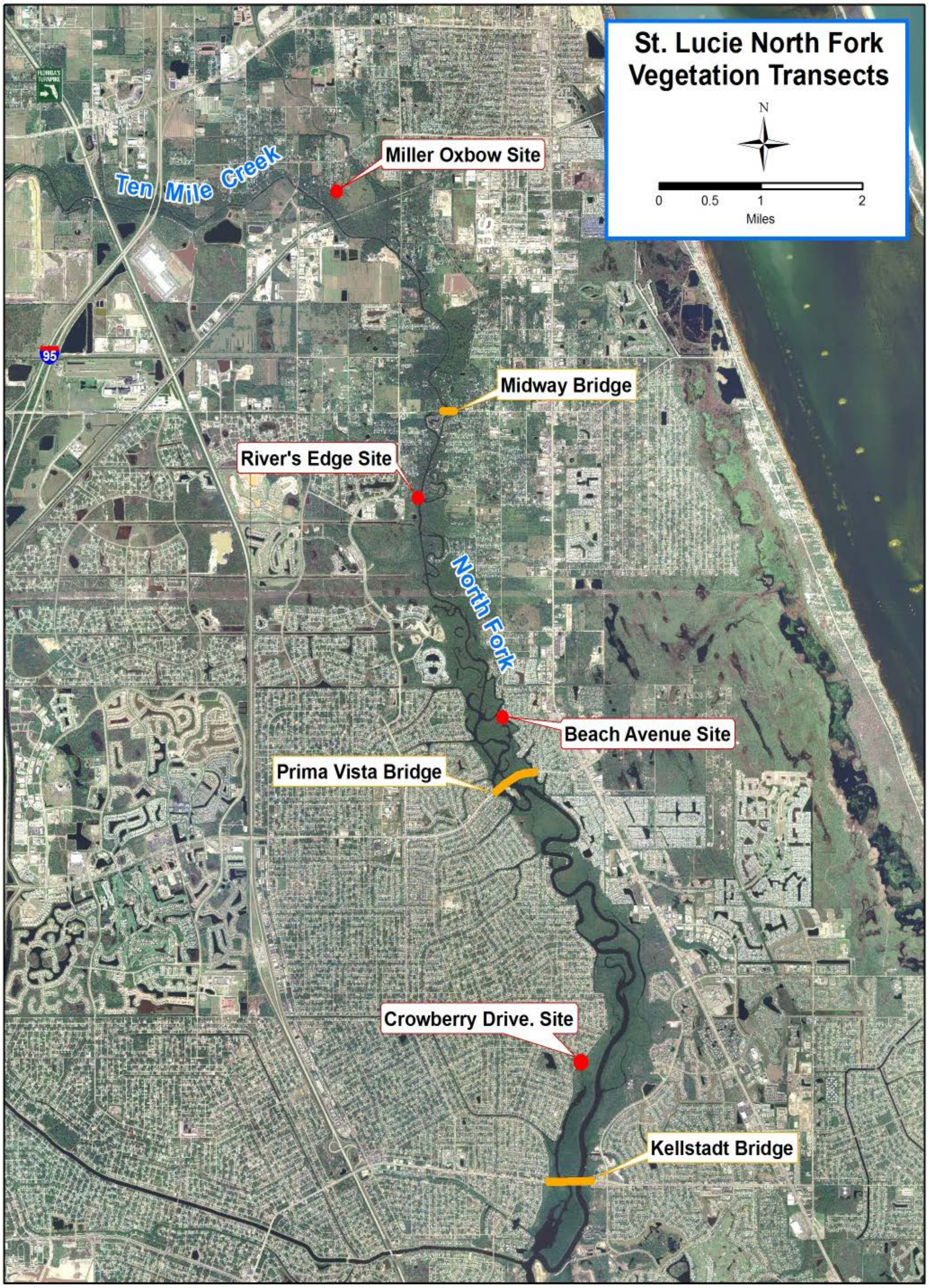


Figure 9. Location of vegetation transects on the North Fork St. Lucie River.

Within each 10 x 10-meter (m) plot of a transect (**Figure 10**), all trees greater than 5 centimeters (cm, 4 inches) diameter at breast height (dbh) were identified to the lowest taxonomic level and dbh measured (**Figure 11**). Cover, by species, of all woody shrub species with a height greater than 1 m (3 feet) and dbh less than 5 cm were measured within a 10 x 1-m subplot nested within each 10 x 10-m plot. Percent cover and stem counts of all herbaceous groundcover species under 1 m in height were measured within two 1 x 1-m subplots nested within each 10 x 10-m plot (**Figure 12**). Additional information collected at each segment included estimates of percent cover and percent leaf litter within a subplot.

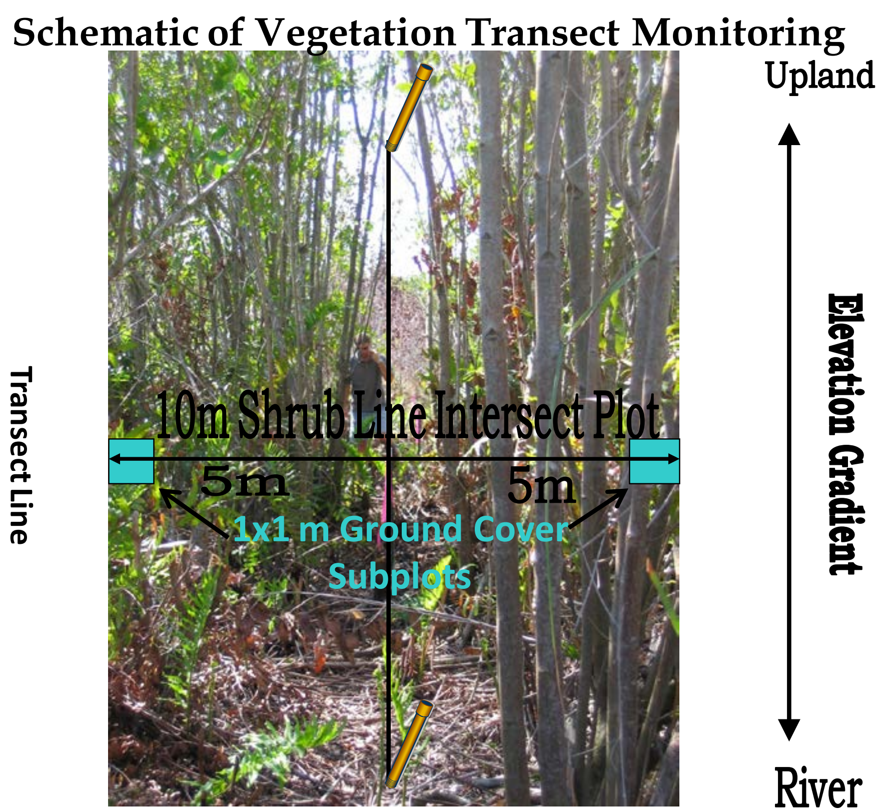


Figure 10. Schematic of transect vegetation monitoring.

Figure 11. Measuring tree canopy dbh.

Figure 12. Measuring groundcover within a meter square area in the hammock on the Miller Oxbow Transect.

Plant and Forest Type Identification

Plants were identified to the lowest possible taxonomic level. Plant identification and nomenclature followed that of Wunderlin and Hansen (2003). Plant species, common names and electronic code names are listed in **Appendix C**. The identification of floodplain forest types was based on the canopy tree species that generally grow together in recognizable communities such as swamps, bottomland hardwoods and hammocks. The process that was used for this study and the Loxahatchee River Study was modified from the work of Darst et al., 2003 and 2008 on the floodplain forests of the Suwannee and Apalachicola rivers of northern Florida. The relative basal area of each tree species within a plot was calculated by dividing the total basal area of a species by the total basal area of all species measured within the plot. Multi-trunk trees were considered separate trees for this analysis. Adjustments were made to a few plots where the canopy clearly did not reflect the character of surrounding shrub and groundcover communities due to microtopography or, in some cases, due to the absence of any canopy.

Plant community analysis was conducted on the canopy, shrub and groundcover layers. Canopy data were examined for species richness, abundance, distribution, basal area, and dbh frequency. Shrub and groundcover data were examined for species richness, percent cover and overall distribution by forest type. Additionally, seedling and saplings counts were made within groundcover meter square areas. With regard to shrub and groundcover data, notation was made of each species wetland indicator status using categories created by the United States Department of Agriculture's Natural Resources Conservation Service. Those categories included obligate wetland (OBL), facultative wetland (FACW), facultative (FAC), facultative upland (FACU), and obligate upland (U). The definitions of these terms are included in **Appendix F**.

Statistical Analysis

Statistical programs used to analyze the data for this study included Microsoft Excel and PC-ORD (McCune and Grace, 2002; Peck, 2010; and McCune and Mefford, 2011). PC-ORD Version 6.0 was used to perform a variety of ordination analyses with canopy abundance and shrub percent cover data sets. Those plots without canopy/shrub were removed from the analysis along with those plots that were identified as marsh. All 16 canopy species identified during the study were included in the ordination analysis in order to observe diversity by forest type community. Of the 44 shrub species encountered during the study, 40 of the most common species were used in the ordination analysis. A complete listing of the six letter genus/species codes can be obtained from the list of species in **Appendix C**.

Cluster analysis (Bray Curtis) and canonical correspondence analysis (CCA) were used to cluster the matrix of canopy and shrub species with the matrix of environmental variables. Prior to clustering, a general relativization by column (i.e. species) was performed on both canopy and shrub data sets to reduce the effect of responses with high totals of abundance and percent cover relative to those with lower values. This measure retains the variation in abundance and percent cover across sample units, but tends to reduce the influence of very common species and increases that of rare species.

For the CCA analysis, both the abundance and percent cover matrixes and environmental variables (%SM and EC) were transformed using natural log+1 and Ward's Method was used to link the groups while Euclidean (Pythagorean) was used as a measure of distance (Sorensen, Bray-Curtis). By default, Hill's scaling was used to rescale the site scores. The environmental variables included EC, %SM and river mile. Statistical correlations (Pearson Product Moment and Kendall tau [Rank]) were calculated for the relationships between the plant species and the environmental variables.

RESULTS

Air, Temperature and Rainfall

Minimum daily and average monthly air temperatures at the Savannas Preserve Weather Station (SVWX) were examined between 1997 and 2010 to look for periods of cold and freezing weather that might have affected vegetative communities, particularly the mangroves (**Table 2**). Once a low minimum temperature was identified, the mean daily air temperatures were examined to determine the length of the period of low temperatures; because, mangroves reportedly may defoliate at 7.2° C (45° F, yellow spaces in **Table 2**) and may be more severely damaged or killed at temperatures near freezing—0 to 4° C (32–39° F, blue spaces)—for more than 3 days (Odum et al., 1982). January and December 2010 had the lowest minimal monthly air temperature over the 14-year period; however, daily average air temperatures were below 7.2° C for two and three days, respectively. Both January and February 2009 had minimum monthly air temperatures in the range to defoliate mangroves. These two events only lasted a day; however, canopy size white mangroves (> 5-cm dbh) with dead foliage were observed on two plots (CD130 and CD170) of the Crowberry Drive Transect. These two plots coincided with the edges of an open area of several plots with no canopy but primarily sawgrass as the main groundcover. EC and %SM within these plots ranged from 1,506 to 1,516 centisiemens per meter (cS/m) and 74 to 78% moisture, respectively, which is in range for white mangroves. Large leather ferns also appeared to be affected by cold air temperatures in this open area.

Average monthly rainfall on the North Fork St Lucie River for 10- and 5-year periods between 1995 and 2010 are given in **Table 3** for the C-23, C-24 and C-25 canals, and North Fork (Gordy Road) structures. Highest rainfall values were reported from June to September of each year. Of the four subbasins in **Table 3**, North Fork had the lowest mean annual total rainfall values. Both 1995 and 2010 were reportedly above average wet years, while 2001, 2002 and 2007 were drought years. Both Hurricanes Frances and Jeanne impacted the St. Lucie River Watershed during September 2004. Runoff from these storms probably accounts for the higher average monthly values in all four subbasins during the 1995–2005 period. Monthly rainfall totals (DBHYDRO) for the SVWX weather station are given in **Figure 13** for the year leading up to and during the field survey. After a very wet August 2008 (16.92 inches), conditions were very dry leading up to the field survey period. Monthly rainfall totals were 0.43, 0.4 and 0.15 inches in December 2008 through February 2009, respectively. The wet season began in May with rainfall monthly totals reaching 5.21 inches.

Table 2. Average minimum monthly air temperatures at the SVWX Weather Station. (data from DBHYDRO)

Year	Monthly Minimum Air Temperatures (° C) for the Savannas Preserve Weather Station (SVWX)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1997	N/A	N/A	N/A	N/A	23.29	24.96	25.95	25.18	25.71	18.71	14.89	M
1998	13.89	11.43	10.94	16.83	22.68	26.64	25.54	26.04	25.23	21.7	17.37	12.72
1999	7.99	11.14	13.73	17.73	15.96	24.56	24.50	25.10	25.15	19.21	17.41	10.1
2000	7.64	11.81	19.99	13.85	24.07	24.86	24.98	25.75	25.42	21.14	13.81	5.09
2001	7.85	15.11	12.39	17.95	22.23	23.91	23.41	24.67	22.94	17.61	19.87	11.37
2002	6.12	12.02	14.19	21.91	22.53	24.46	24.22	25.31	25.3	22.32	13.4	11.74
2003	4.07	13.57	12.35	15.98	23.34	24.25	25.25	24.61	23.72	22.34	13.41	9.13
2004	11.65	11.41	14.82	15.74	22.79	24.96	25.28	24.73	26.44	N/A	N/A	N/A
2005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2006	N/A	N/A	N/A	N/A	N/A	N/A	24.79	24.9	24.82	16.18	10.23	12.41
2007	10.24	9.45	13.77	15.33	20.46	23.57	25.03	25.18	24.4	22.89	14.4	11.43
2008	8.53	13.08	15.36	14.01	22.25	24.71	23.59	25.2	24.01	14.14	12.79	14.49
2009	6.07	5.88	11.35	13.51	22.12	23.96	25.03	25.76	24.51	14.9	12.14	10.08
2010	2.87	8.00	9.22	17.77	23.86	25.5	24.98	25.6	23.81	20.16	11.86	3.05

N/A = data not available
Green = field period
Blue = freezing temperatures
Yellow = possible defoliation of mangroves

Table 3. Average monthly rainfall in inches between 1995 and 2010 on the St. Lucie River.

Month	Average Monthly Rainfall on the North Fork St. Lucie River							
	C-23 Canal		C-24 Canal		C-25 Canal		North Fork	
	1995–2005	2006–2010	1995–2005	2006–2010	1995–2005	2006–2010	1995–2005	2006–2010
January	1.49	0.83	1.32	0.79	1.87	1.13	1.47	0.81
February	1.89	1.78	1.56	1.88	2.29	3.07	2.05	1.63
March	3.85	3.11	2.72	1.55	3.11	4.26	3.34	3.24
April	1.97	2.26	1.77	2.54	2.53	2.94	2.53	2.12
May	3.57	3.79	2.82	2.8	4.71	4.62	3.13	3.2
June	7.08	4.71	10.53	8.59	8.88	7.06	6.78	5.34
July	6.49	7.89	9.5	10.49	5.44	6.84	6.25	7.34
August	8.37	9.32	10.54	11.61	7.21	6.29	8.11	8.86
September	8.03	5.86	9.54	9.23	9.23	8.93	7.37	5.22
October	4.74	2.6	3.53	1.88	6.43	3.91	5.31	3.27
November	3.11	1.1	2.06	0.99	3.54	2.17	2.97	1.01
December	1.36	3.23	1.52	1.83	2.25	3.12	1.4	2.98
Mean Annual Total	**51.95**	**46.48**	**57.41**	**54.18**	**57.49**	**54.34**	**50.71**	**45.02**
Mean Wet	**38.28**	**34.17**	**46.46**	**44.60**	**41.90**	**37.65**	**36.95**	**33.23**

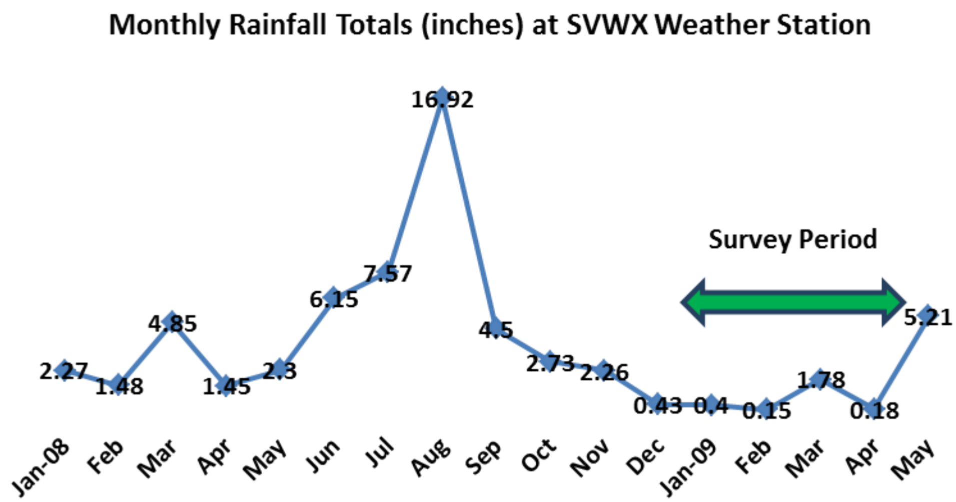


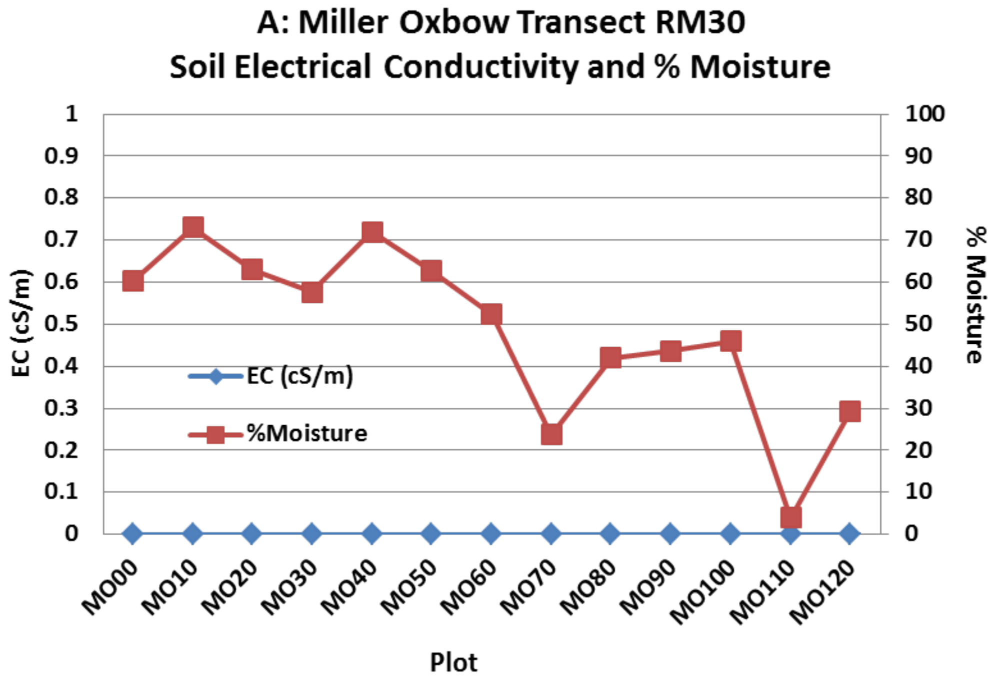
Figure 13. Monthly rainfall totals from SVWX weather station prior to and during the field survey (DBHYDRO).

Soil Types, Soil Electrical Conductivity and Soil Moisture

According to the 1977 United States Department of Agriculture soil survey map, there are 14 major soil types on the North Fork St. Lucie River floodplain. **Appendix D** contains a list and definition of these soil types along with general hydrological conditions (e.g. general plant community type, depth of water table and duration of flooding), and area soil maps. These soils ranged from white to gray fine sands to inland and coastal organic mucks. The most notable change in floodplain soil type occurs between RM 23.5 and RM 24 (**Figure 2**) on the North Fork. This change is located just upstream of the Prima Vista Bridge and downstream of the Beach Avenue Transect and appears to be at a junction where the river channel begins to widen (**Appendix D**, **Figure D-2**, page 33 plate). In this area, there is a switch in soil type from primarily Fluvaquents (code 14) to Terra Ceia Muck (code 45). Both of these are poorly drained soils; however, Terra Ceia Muck is generally inundated for a longer period of time and found more on the lower floodplains of rivers and streams than Fluvaquents. Fluvaquents have been characterized as being young, recently deposited sediment on floodplains of rivers and creeks with primarily a canopy of cabbage palms and wetland hardwoods with an understory of saw palmetto and herbaceous plants. Terra Ceia Muck is more characteristic of freshwater marshes or depressions with willow, sweet bay, maple and wax myrtle and an understory of giant ferns, vines and open areas of sawgrass.

Of our four vegetative transect sites, half are characterized as Terra Ceia Muck and half as Fluvaquents. At the most downstream transect, Crowberry Drive (RM 18.3, **Appendix D**, **Figure D-2**, page 39 plate) the hammock area adjacent to the roadway contained Electra Fine Sands and the swamp area contained Terra Ceia Muck. Electra Fine Sands are somewhat poorly drained gray fine sand to a depth of 7 inches with 40 inches of white sand below. Water depth in the Electra Fine Sands is at 25 to 40 inches for 4 months of the year and below 40 inches during dry periods. The water table in the Terra Ceia Muck soil would normally be at or above the surface for 6 to 9 months of the year (i.e. subject to flooding). The Beach Avenue Transect (RM 19.5, **Appendix D**, **Figure D-2**, page 33 plate) contained Pendarvis-Urban Land Complex up in the hammock area and Terra Ceia Muck in the swamp area. The Pendarvis soils are gray soils with 6 inches of very dark gray sand and a subsurface layer of light gray sand to about 42 inches. The water table in the Pendarvis soils is generally perched above the subsoil for 1 to 4 months during the rainy season and falls between 40 to 60 inches during dry periods. Offsite fill material had probably been mixed with the Pendarvis soils. Both the River's Edge (RM 26.3, **Appendix D**, **Figure D-1**, page 27 plate) and Miller Oxbow (RM30, **Appendix D**, page 21) transects were primarily Fluvaquents. The water table here is at a depth of less than 10 inches for 4 to 6 months and within a depth of 40 inches for 9 to 12 months of the year. These areas are flooded generally once every 2 years for 7 to 30 days.

EC and %SM at each of the four transects are illustrated in **Figures 14A** through **D**. EC and %SM were examined at each segment pole during the plant collections (i.e. February to May 2009) to further interpret community composition and observe saltwater intrusion on the floodplain in areas with and without berms. EC was not detected at all on the Miller Oxbow transect (RM 30, **Figure 14A**). %SM ranged from 30% on top of the berm adjacent to the river channel (plot MO120) to 73% (plot MO10) in the oxbow ditch, which for the most part had no visible surface water. EC was very low at the River's Edge Transect (RM 20.5, **Figure 14B**) ranging from 0 cS/m in the hammock (plot RE00) and on the berm adjacent to the river channel (plot RE90) to 328 cS/m in the freshwater swamp area at RE30. %SM generally paralleled EC with the lowest %SM recorded on the berm (0%) and highest in the swamp areas (plots RE20 and RE30, 97 and 96%) and closer to the river at RE70 and RE80 (104 and 100%) due to the breach in the berm just south of the transect, which allows the internal plots exposure to tidal flooding from the river. Similarly, the highest EC and %SM on the Beach Avenue Transect (RM 19.5) were low areas that were internal to the site due to tidal inundation along the adjacent oxbow on the south side. EC ranged from 0 cS/m in the hammock to 899 cS/m in the swamp area at plot BA80 (**Figure 14C**). %SM ranged from 15% in the hammock adjacent to the uplands (plot BA00) to 92% in the hammock area near the river channel (plot BA183). The bottomland hardwood and swamp plots were somewhat drier at 57 to 89 % probably because they were further away from the river channel. EC at the Crowberry Drive (RM 18.3, **Figure 14D**) transect ranged from 70 cS/m in the hammock to 1,518 cS/m in the middle of the white mangrove/sawgrass swamp and 1,534 cS/m on the berm adjacent to the river channel. %SM ranged from 0% in the hammock to 85% in the white mangrove area.



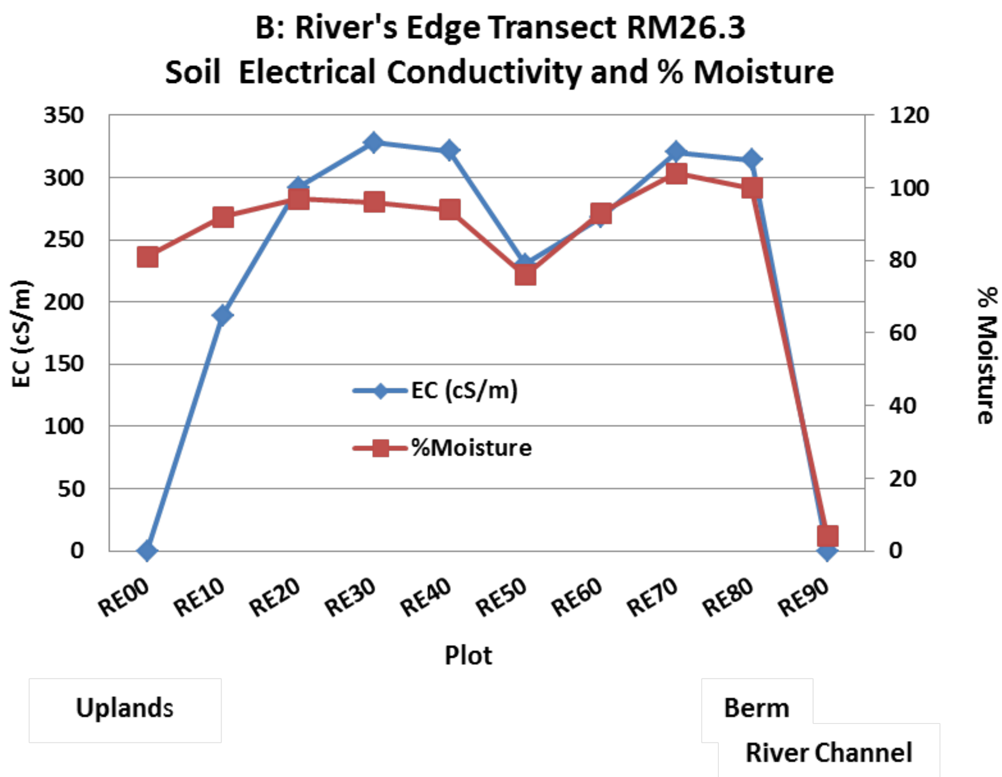
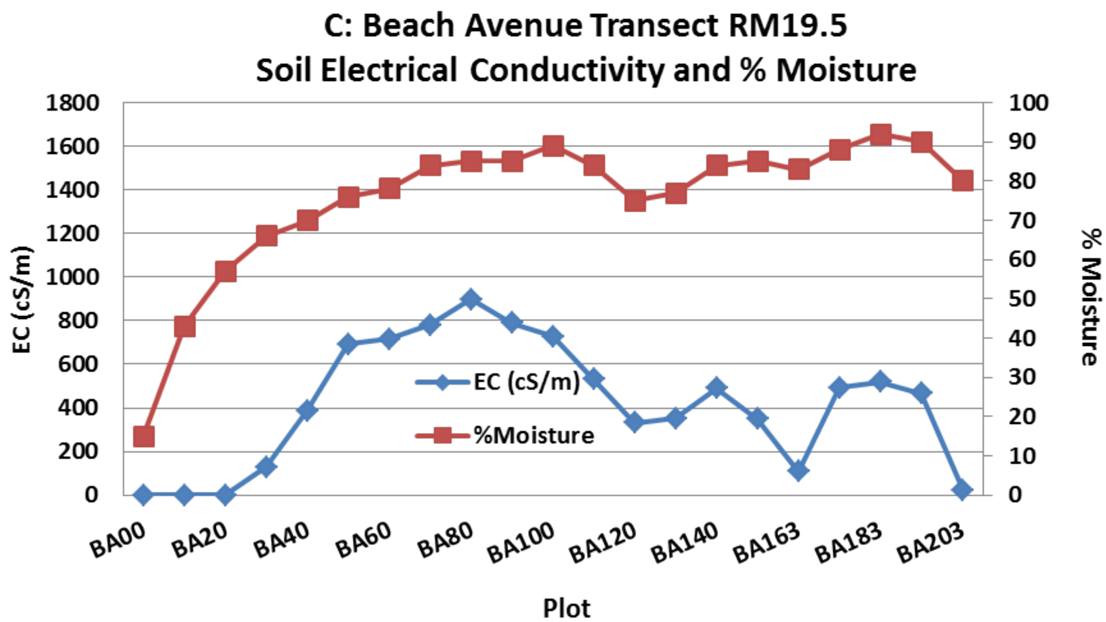


Figure 14. EC and %SM on the A. Miller Oxbow Transect RM 30 and B. River's Edge Transect RM 26.3.



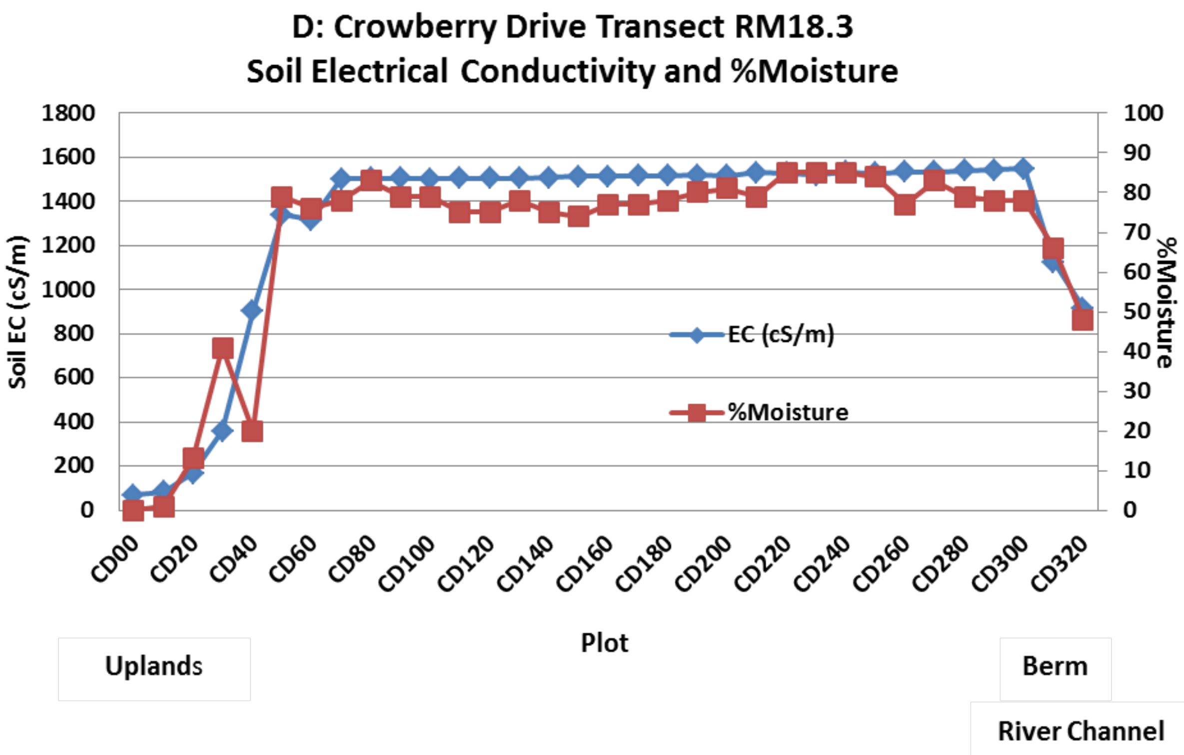


Figure 14 (continued). EC and %SM on the C. Beach Avenue Transect RM 19.5 and D. Crowberry Drive Transect RM 18.3.

River Flow and Salinity

Figure 15 presents the average annual freshwater flows to the North Fork from the Gordy Road structure, S-49 and S-97 between 1999 and 2011. Average annual flows from the Gordy Road structure (dashed line) dropped below the 130-cfs target flow during 1999, 2000, 2006, 2007 and late 2008 to early 2011. The Gordy Road structure's reaction to the 2004 Hurricanes Frances and Jeanne appeared to produce higher flows than S-49 and S-79 during the same time period while the opposite reaction occurred for Hurricane Wilma in 2005 with lower flows produced at the Gordy Road structure. Gordy Road structure flows appeared to be at their lowest in early 2009 when the field surveys were conducted; therefore, we were probably examining the floodplain vegetation under relatively dry conditions even for a dry season.

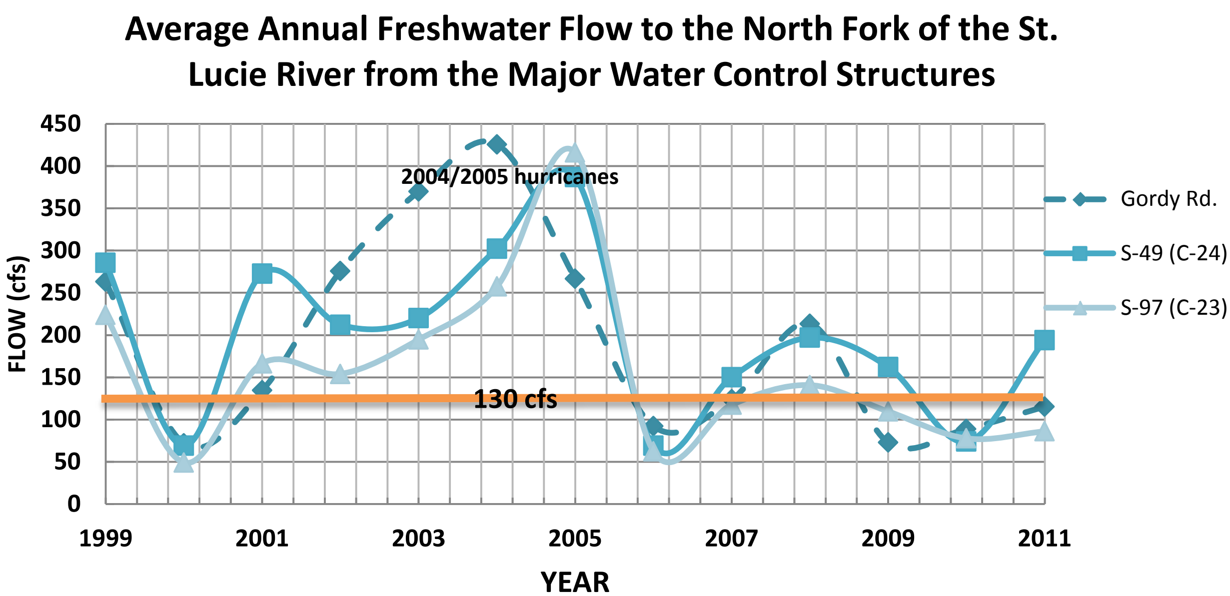


Figure 15. Major contributions to freshwater flow on the North Fork St. Lucie River (DBHYDRO).

Mean monthly flows for the Gordy Road structure between 1999 and 2011 are presented in **Table 4**. Blue-colored cells represent the mean monthly flows recorded during Hurricanes Frances and Jeanne (September 2004) and Wilma in October 2005, and represent three of the highest flows recorded at the structure. Yellow-colored cells represent mean monthly flows less than the targeted 130 cfs for dry and wet season, while the green-colored cells represent those flows that met the water reservation target flow during the dry season. While 2003 through 2005 appeared to successfully meet the target for all dry season months, the flow has been generally below the target for 2006 through 2011.

Table 4. Mean monthly flow at the Gordy Road structure 1999–2011 (DBHYDRO, DBKEY JW239).

Year	Mean Monthly Flow at the Gordy Road Structure 1999–2011 (cfs)												Average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
1999							1579	1062	260	338	103	97	263
2000	80	76	38	62	5	113	176	149	140	73	23	24	72
2001	48	29	31	44	82	136	278	313	219	158	188	83	134
2002	87	160	73	74	85	387	490	418	386	281	319	539	276
2003	475	365	358	362	382	439	279	119	357	394	454	380	370
2004	418	406	399	324	196	305	379	369	1177	385	395	380	426
2005	432	380	199	301	467	130	153	154	119	521	324	158	267
2006	90	143	65	62	44	49	128	161	136	40	83	114	92
2007	79	52	41	55	37	105	216	206	202	314	125	70	124
2008	65	70	84	208	47	120	283	1017	191	293	89	78	213
2009	70	60	44	41	80	235			131	62	49	122	73
2010	117	128	143	118	66	134	84	67	93	46	42	43	89
2011	63	61	53	68	40	45	183	159	223	210	132	141	115
Average	**169**	**161**	**127**	**143**	**128**	**183**	**352**	**350**	**280**	**240**	**179**	**171**	**193**

Wet Season
Hurricanes
Dry and Wet Season < 130 cfs
Dry Season > 130 cfs

The CH3D Model was able to simulate a very wide range of hydrologic and hydraulic conditions on the North Fork St. Lucie River. With regards to floodplain vegetation, we were looking along the river and the interior of the floodplain for potential signs of saltwater intrusion and possible areas where salt might be accumulating and not necessarily the location of the low salinity zone for which the model is generally used. The model accurately simulated salinity on the river for the very dry 2000 and 2007 to the very wet 2004, 2005 and 2010. The model simulated the salinity gradient on the North Fork satisfactorily particularly between Prima Vista and Kellstadt bridges using the Gordy Road structure flows for 1999 to 2011. This information is summarized in Appendix D of the *Technical Document to Support a Water Reservation Rule for the North Fork of the St. Lucie River* (SFWMD, 2009).

Using the CH3D Model, the 1, 6 and 14 isohalines were plotted in terms of river mile to represent the extent and range of salinity conditions within the North Fork St. Lucie River (**Figure 16**). The results indicated that the 14 isohaline (green line) slightly reached above Prima Vista Bridge (RM 23.1) during 2000; and in general, it did not recede below the Kellstadt Bridge (RM 17.1) except during wet seasons. On a few occasions, the 14 isohaline reached up to the Beach Avenue Transect and was commonly seen in the channel during the dry season at the Crowberry Drive Transect. The upstream location of the 14 isohaline may be particularly stressful to some freshwater floodplain species such as red maple and water hickory bottomland hardwood species, which are intolerant of salt and long-term flooding. Although the 14 isohaline never reached the Midway Bridge (RM 27) the 6 and 1 isohalines did. The 6 isohaline (red line) behaved similarly in that it only reached above the Prima Vista Bridge during 2000 and did not recede below the Kellstadt Bridge except during wet seasons. As mentioned previously, this river system did not contain natural populations of bald cypress, which is very tolerant of flooding but intolerant of salt. The few young bald cypress observed in the riverine and upper tidal reaches appeared to have been recently planted. Other freshwater species such as water hickory, were not observed near the river channel below Midway Bridge (RM 27) while general flood tolerant and salt tolerant species, such as pond apple, were not observed below Kellstadt Bridge. However, pond apple became prevalent along the river, just downstream of the Prima Vista Bridge (RM 23). Salt tolerant red mangrove was present along the shoreline of the North Fork St. Lucie River from the mouth to the junction of South St. Lucie River Water Control District's #102 Canal at RM 27.5. It was not found in the interior of the floodplain transects probably due to the berms and the shortened hydroperiods on the floodplain behind the berms.

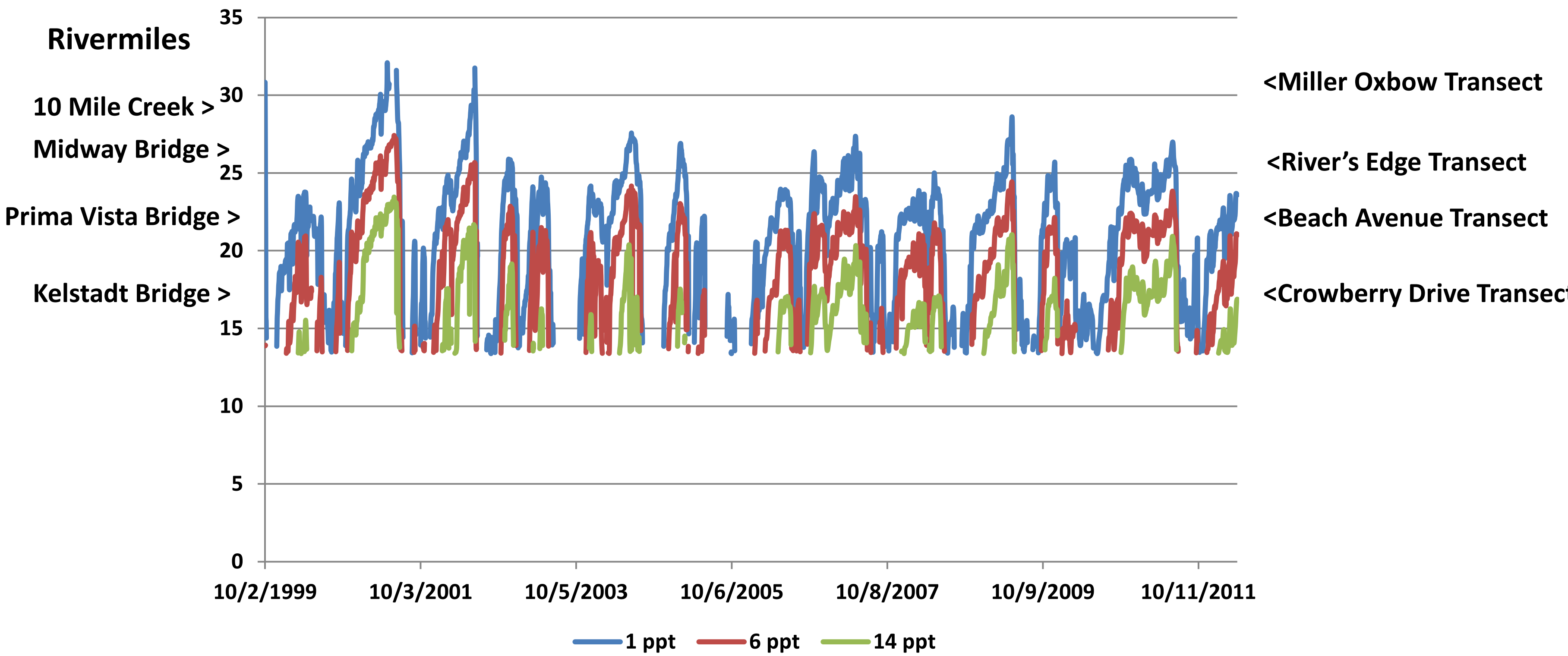


Figure 16. Isohalines for 1, 6 and 14 salinities on the North Fork St. Lucie River as simulated by the CH3D Model.

Floodplain Vegetative Communities

The St. Lucie River floodplain was divided into three distinct reaches (**Figure 17**, orange lines) based on canopy communities within the four transects and vegetative communities observed along the river channel and oxbows during the 2007 reconnaissance trips. The riverine reach includes Five Mile and Ten Mile creeks; the main North Fork channel downstream to the Midway Bridge (RM 27); the St. Lucie Canal upstream of the S-80 structure; and, the non-tidal portions of the South Fork. The upper tidal reach includes that portion of the North Fork from approximately RM 26.9 to RM 14 in the mid-estuary and the mouth and the tidal portions of the South Fork. The lower tidal reach consists of the mid-estuary, adjacent segments of the Indian River Lagoon to the opening of the St. Lucie Inlet (RM 13.9 to RM 0). The riverine reach has primarily a freshwater canopy that is generally unaffected by salinity while the upper tidal reach has a mixture of freshwater/brackish mixed canopy that has experienced some saltwater intrusion due to tidal influences and reduced freshwater flows. Post, Buckley, Schuh & Jernigan Inc. (2003) refers to this segment of the river as the scrub-scrub tidal wetlands of the North Fork. The lower tidal reach is dominated by salt tolerant species and is highly influenced by tides and salinity in surface waters and soils.

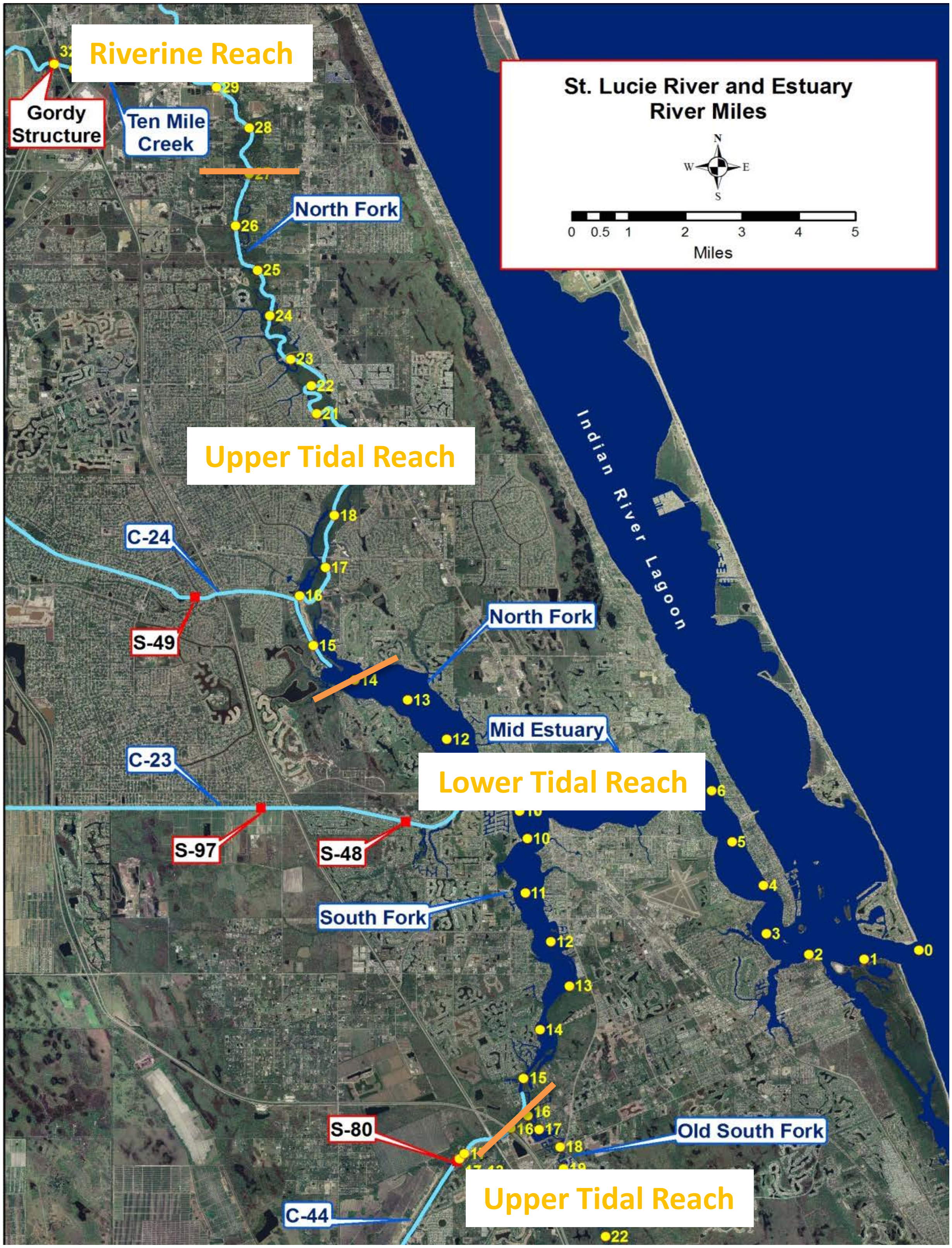


Figure 17. Reaches of the St. Lucie River based on floodplain vegetation communities.

Forest Community Types

In previous studies on the Loxahatchee River (SFWMD, 2006, 2009), 17 forest community types were identified. Only 11 of these communities were identified as occurring on the North Fork St. Lucie River (**Table 5**). The five major community types on the North Fork were swamp (sw), bottomland hardwood (blh), hydric hammock (HH), freshwater marsh (M) and uplands (U). The number associated with the forest type distinguishes observed differences in elevation occurrences. The higher the number associated with the community type, the higher the elevation the plant community can be found. For example, low bottomland hardwood species (low blh, found at lower elevations) would include such species as red maple, button bush, swamp bay, and Carolina willow while high bottomland hardwood (high blh) would include such species as water hickory, cocoplum (*Chrysbalanus icaco*), dahoon holly (*Ilex cassine*), and laurel oak. Also, split and mixed plots occurred as a result of microtopography on the transects.

Appendix F contains a summary of forest type determinations, hydrological conditions, soil textures and dominant canopy species of each species. A glossary of forestry terms for South Florida floodplains as modified from Light et al. on other Florida river systems (2002a) is provided following the Literature Cited section.

Table 5. Forest community types in the North Fork St. Lucie River floodplain transects based on relative basal area of the canopy species.

Forest Type	Riverine (R)	Upper Tidal (UT)
Marsh		M
Swamp		UTsw1 UTsw3
Low Bottomland Hardwood High Bottomland Hardwood	Rblh2 Rblh3	UTblh1 UTblh2 UTblh3 UTmix
Hydric Hammock	HH	HH
Upland	U	U

Transect Summaries

Canopy Communities

The 2009 study of the four transects identified 16 species of floodplain canopy trees (i.e. greater than 5-cm dbh) on the North Fork St. Lucie River. Ten of the 77 plots had no canopy size trees. The most abundant canopy species were cabbage palm (26%), white mangrove (22%), laurel oak (12%) red maple (9%) pop ash (9%), pond apple (7%), and wax myrtle (5%) (**Figure 18**). Additionally, red mangroves were adjacent to the Crowberry Drive Transect on the shore of the river channel, but not within the transect plots. Three non-native canopy species were present in very small numbers. These were Brazilian pepper (1%), strawberry guava (*Psidium cattleianum*, 1%) and tamarind (*Tamarindus indica*, 1%). With regard to forest types (see **Appendix F**), pond apple, pop ash, and white mangrove were classified as swamp species while water hickory, red maple, Carolina willow, strawberry guava and laurel oak were classified as bottomland hardwood. The remaining canopy species were classified as hammock—red bay, live oak, and cabbage palm—or upland—slash pine, Brazilian pepper and saw palmetto.

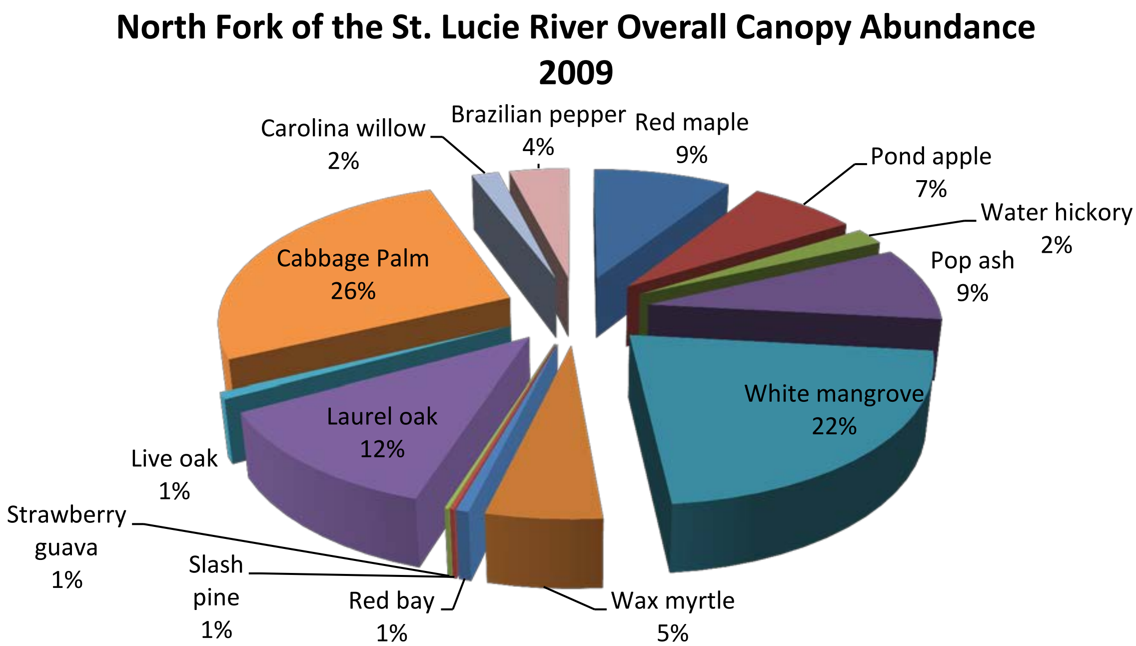


Figure 18. Overall abundance of canopy species in the 2009 study.

Canopy species assemblages varied by transect and by river mile. Miller Oxbow (RM 30) and Crowberry Drive (RM 18.3) transects had the least number of canopy species with 5 and 9 species respectively. River's Edge Transect (RM 26.3) had 10 species while Beach Avenue Transect (RM 19.5) had 11 species.

Sometimes because of the effect of multiple trunks on canopy tree density, basal area more accurately reflects the actual aerial coverage rather than the abundance of each canopy species in the floodplain forest. **Figure 19** presents the overall percent basal area of each of the canopy species. Most of the canopy basal area was represented by six species; cabbage palm (45%), laurel oak (25%), red maple (7%), saw palmetto (7%), water hickory (4%) and live oak (4%). Therefore, most of the floodplain plant communities consisted of hydric hammock and bottomland hardwood communities. Note that swamp species such as white mangrove, pond apple, and pop ash were very low in coverage (2%, 1% and 2%, respectively). Low percentages indicated that these were apparently young swamp trees for the most part. No bald cypress trees were present as canopy trees. Additional graphics for basal area by transect are presented in **Appendix G-1**. The Beach Avenue Transect had the greatest amount of basal area (119,068 square meter [m^2]), followed by Miller Oxbow (47,579 m^2), River's Edge (32,407 m^2), and Crowberry Drive (13,560 m^2) transects.

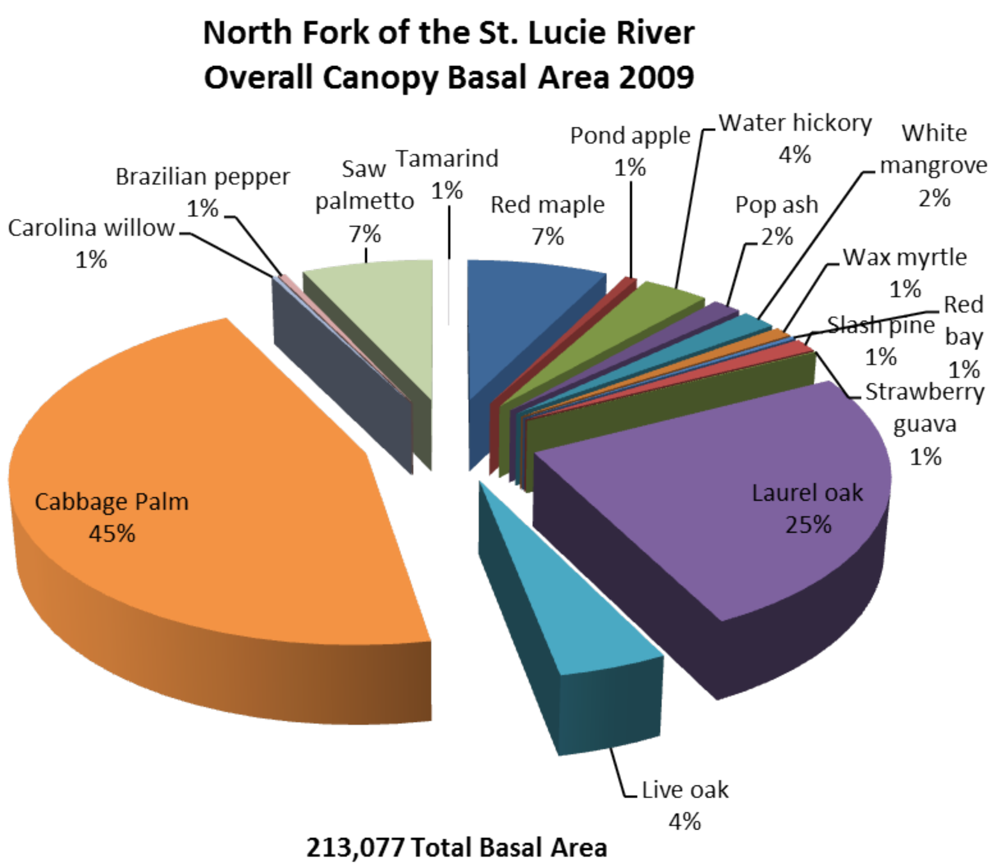


Figure 19. Overall basal area of canopy species in the 2009 study.

To evaluate size, relative age and recruitment success of canopy trees, a dbh size frequency analysis was conducted. **Figure 20** shows a plot of total number of trees by dbh of the canopy species examined during the study. The figure indicates a very young forested floodplain with a few older hammock and bottomland hardwood areas. Most of the trees occurred within the 5–20 cm and 21–40 cm size class frequencies (dark blue and red columns). Only red maple, slash pine, laurel oak, live oak (*Quercus virginiana*) and cabbage palm had trees within the 41–60 cm size class frequency. Laurel oak had the largest specimens of trees with 27 (5–20 cm), 23 (21–40 cm), 7 (41–60 cm) and 5 (61–80 cm). Red maple had three size class frequencies with 32 (5–20 cm), 11 (21–40 cm) and 3 (41–60 cm) trees. Cabbage palm also had three size class frequencies with 5 (5–20 cm), 126 (21–40 cm) and 4 (41–60 cm) trees. Pond apple, white mangrove, strawberry guava, Carolina willow, Brazilian pepper, and tamarind were only from the 5–20 cm size class frequency. There were no trees in the 81–99+ cm group, which is generally held by old bald cypress trees in South Florida wetland systems. New canopy recruitment (5–20 cm) was greatest primarily in white mangrove followed in much lesser recruitment by pop ash, pond apple, red maple and wax myrtle.

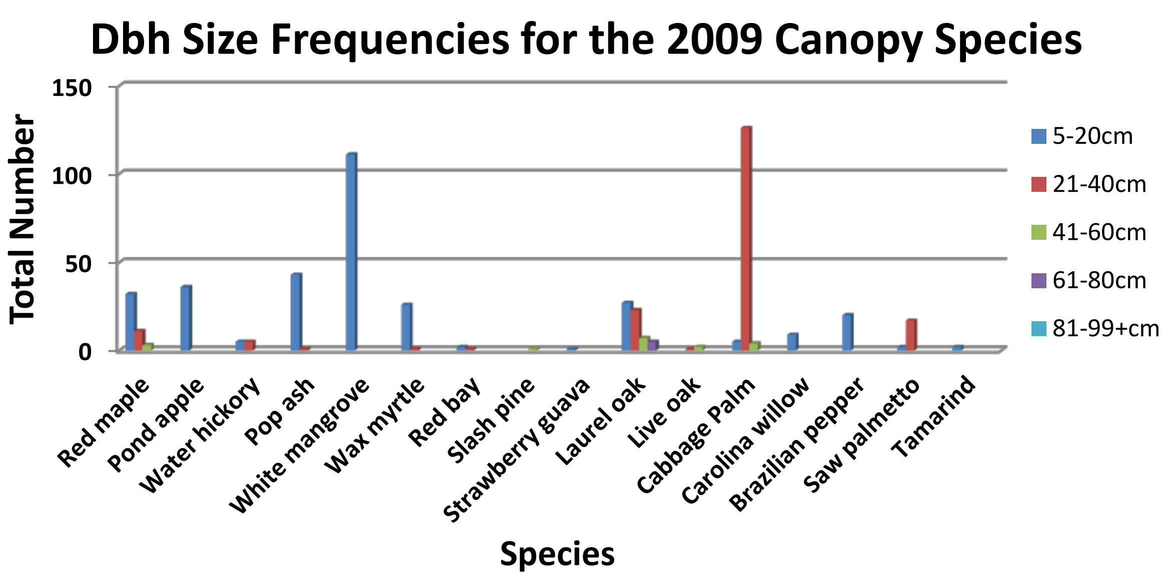


Figure 20. Dbh size frequencies for all 2009 canopy species.

In 1971, Dr. Alexander estimated the age of mature red maple and hickory canopies along the river as in the 50-year class, which would have dated these plant communities back to about 1922 when the river was dredged and the berms were created. The oldest live oaks were estimated at a century old.

Canopy Abundance and Forest Type by Transect

Miller Oxbow Transect

On the Miller Oxbow Transect (13 plots), which is located at RM 30, 51% of the canopy tree species was cabbage palm (**Figure 21**). The two bottomland hardwood species, laurel oak and water hickory composed 26% and 13% of the canopy community. Pop ash, the only canopy swamp species on this transect, was growing along the edges of the small oxbow ditch and comprised 8% of the canopy assemblage. Two small tamarind trees (5.7 and 8.3 cm dbh) were observed on the transect and were probably introduced along the trail as seeds or seedlings. Species diversity is assumed to be low on this transect because of the reduced light availablity due to the existing mature canopy and poor hydrological conditions from the prominent berm along Ten Mile Creek.

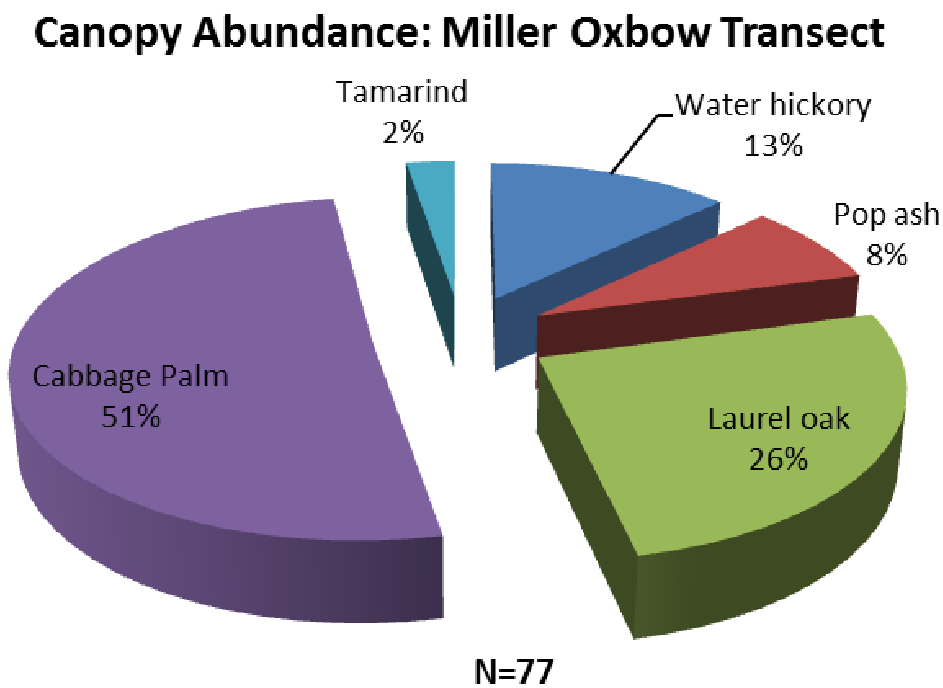


Figure 21. Canopy abundance on the Miller Oxbow Transect in 2009.

Figure 22 illustrates the maturity of the cabbage palm, laurel oak and water hickory trees that were measured along the Miller Oxbow Transect. Water hickory and laurel oak both occurred from the 41–60 cm size class while all species except for tamerind occurred from the 5–20 cm and 21–40 cm size classes. Most of the cabbage palms appeared to be members of one size class, 21–40 cm. Only sparse new recruitment of canopy trees was evident in this area of the floodplain.

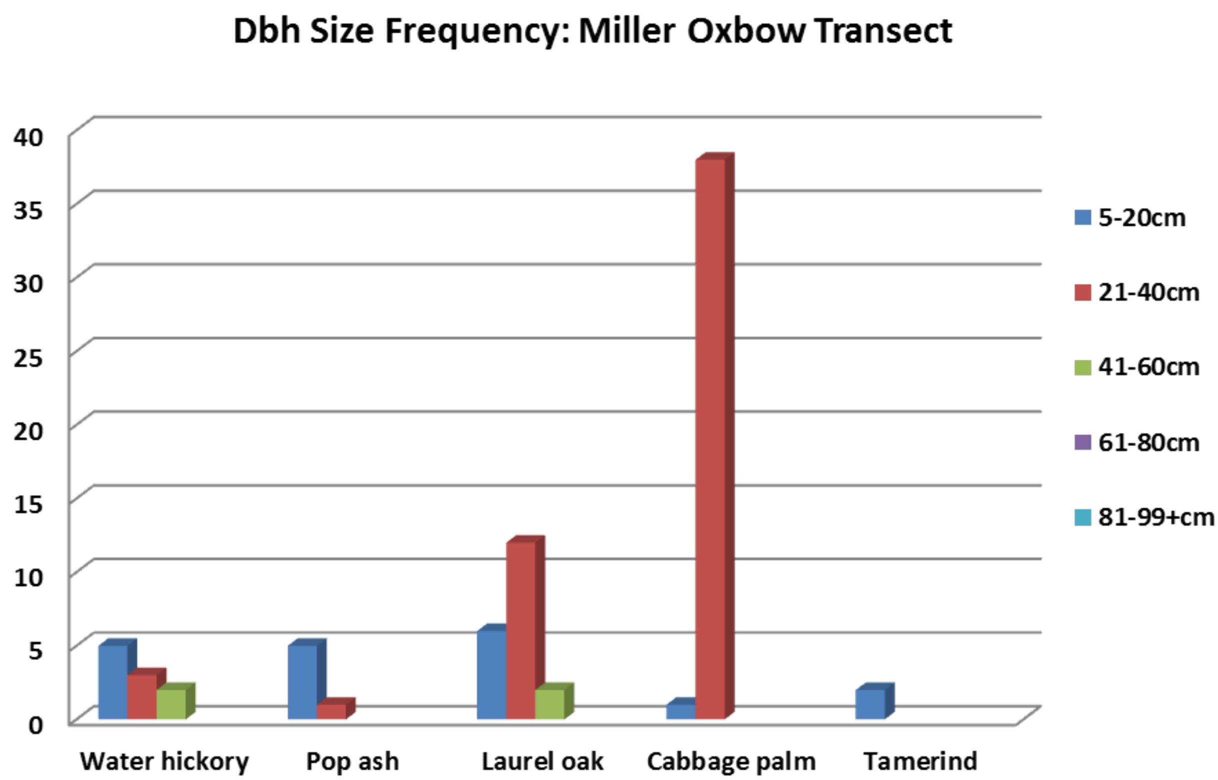


Figure 22. Dbh size class frequency on the Miller Oxbow Transect in 2009.

The Miller Oxbow Transect is primarily high bottomland hardwood (Rblh3) (**Figure 23**). Of the 13 total plots, 10 were Rblh3 and Rblh2 due to the dominance of laurel oak and water hickory within them. Cabbage palm was mixed throughout these plots but dominated the remaining 2 hydric hammock plots (MO90 and MO120). One plot (MO70) had no canopy. Two old oxbow channels ran through the middle of this site. The southernmost oxbow was dredged and reopened to the creek in 2010. A very high berm (9–15 elevation North American Vertical Datum [NAVD] feet) had been separating most of the transect from direct contact with the channel of Ten Mile Creek.

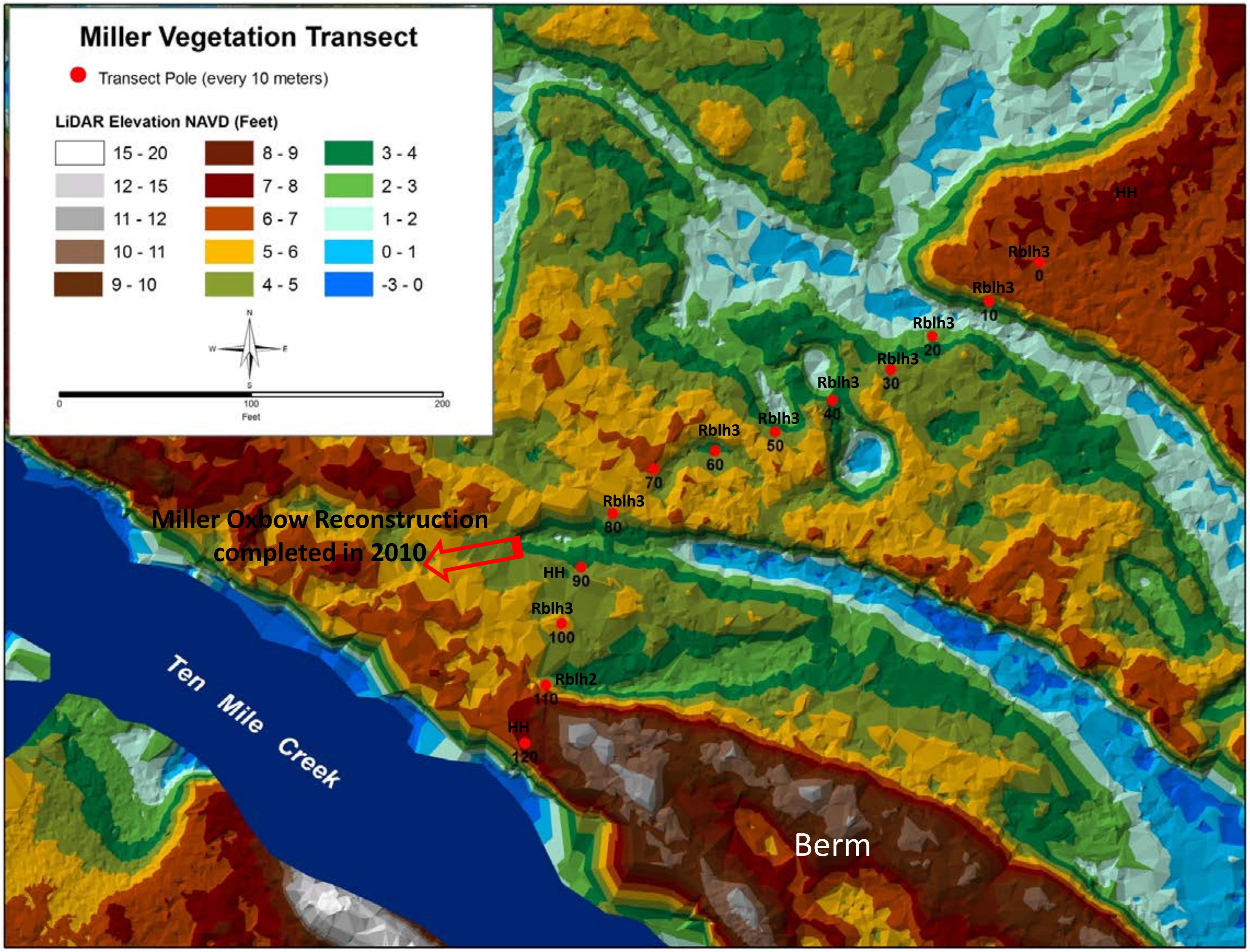


Figure 23. LIDAR interpretation of elevation data and plot locations on the Miller Oxbow Transect in 2009.

River's Edge Transect

The canopy at the River's Edge Transect, located at RM 26.3, is mainly composed of swamp and bottomland hardwood species (**Figure 24**). Pop ash (33%) and pond apple (9%) are both swamp species. Red maple (19%) and Carolina willow (2%) are low bottomland hardwood species while laurel oak and strawberry quava (1%) are high bottomland species. The remaining species, cabbage palm (10%) and wax myrtle (13%) are hydric hammock while saw palmetto (1%) and Brazilian pepper (2%) are considered as upland species that may occur in wetland systems.

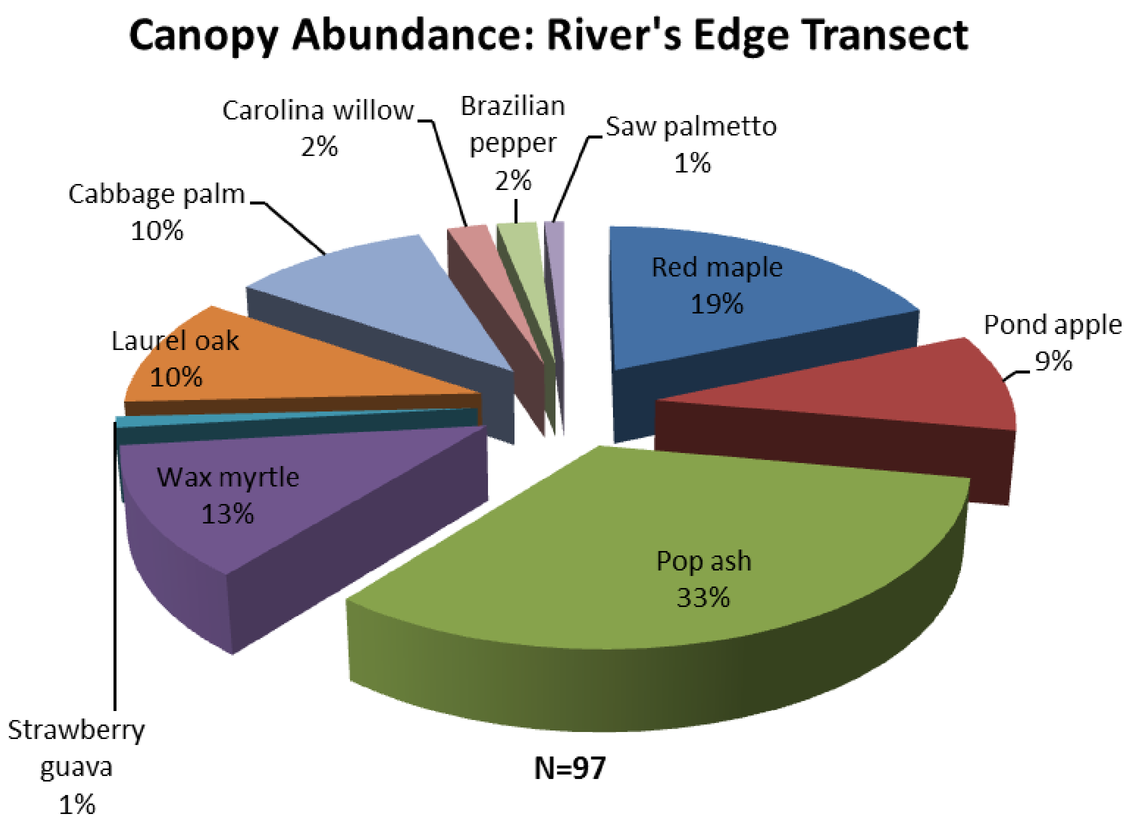


Figure 24. Canopy abundance on the River Edge Transect in 2009.

Most of the canopy trees at the River's Edge transect were in the youngest dbh size class frequency (5–20 cm, **Figure 25**). All of the pond apple, pop ash, wax myrtle, strawberry quava, Carolina willow and Brazilian pepper were members of this size class. Laurel oak had representatives of 4 size class frequencies (5–20, 21–40, 41–60 and 61–80 cm). Red maple had representatives of 3 size class frequencies (5–20, 21–40 ans 41–60 cm).

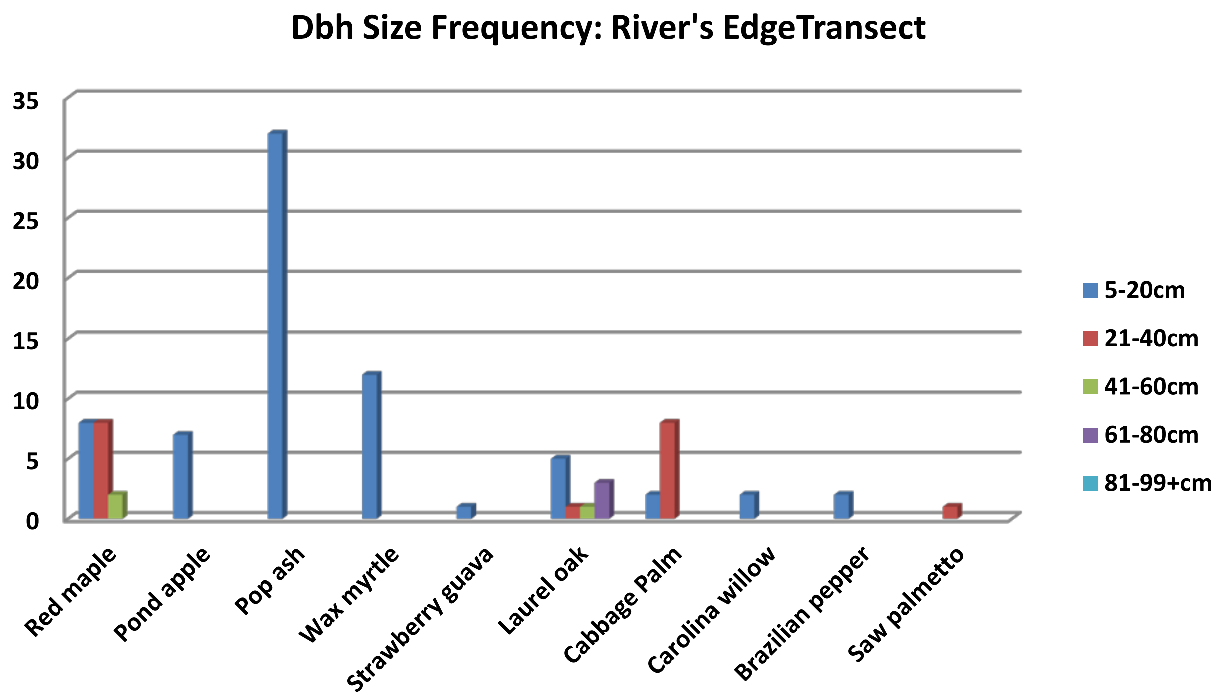


Figure 25. Canopy dbh size class frequency on the River's Edge Transect in 2009.

Pop ash and wax myrtle appeared to have the greatest amount of new recruitment on the River's Edge Transect. It is a short transect consisting of 10 plots that run from an upland saw palmetto/slash pine community (RE00 and U/HH) into a bottomland hardwood/swamp community (RE10 to RE90, UTblh1, UTblh2, UTblh3 and UTsw2) and then back into a hammock community on top of the berm adjacent to the river channel (**Figure 26**). The transect is tidally flushed from a culvert that runs beneath the man-made trail north of the site and at the large break in the berm on the south side of the transect. Microtopography within the transect area (**Figure 26**, dark blues and light greens) accounts for the multiple forest type communities. This site is located behind River's Edge Elementary School. The man-made trail runs from adjacent to the school property to a raised boardwalk that transitions the area between the uplands and hammock area and provides limited public access to the river front.

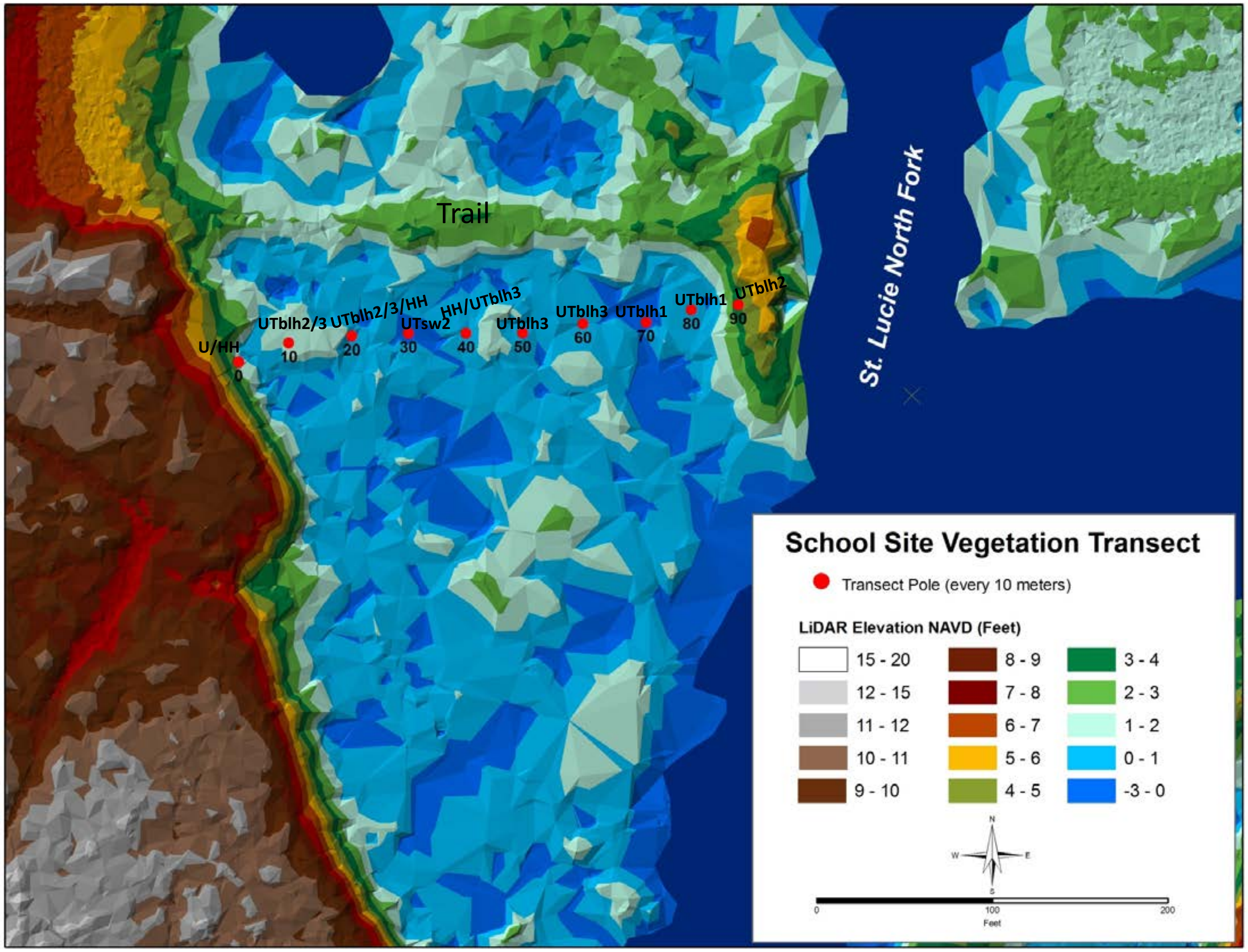


Figure 26. LIDAR interpretation of elevation data and plot locations on the Rivers Edge Transect.

Beach Avenue Transect

The canopy within the Beach Avenue Transect, located at RM 19.5, consists primarily of cabbage palm (43%), laurel oak (14%), pond apple (13%), red maple (11%) and saw palmetto (10%) (**Figure 27**). Combining the cabbage palm, wax myrtle, live oak and red bay accounts for allmost 50% of the transect hammock with the remaining plots 26% bottomland hardwood, 16% swamp and 10% upland.

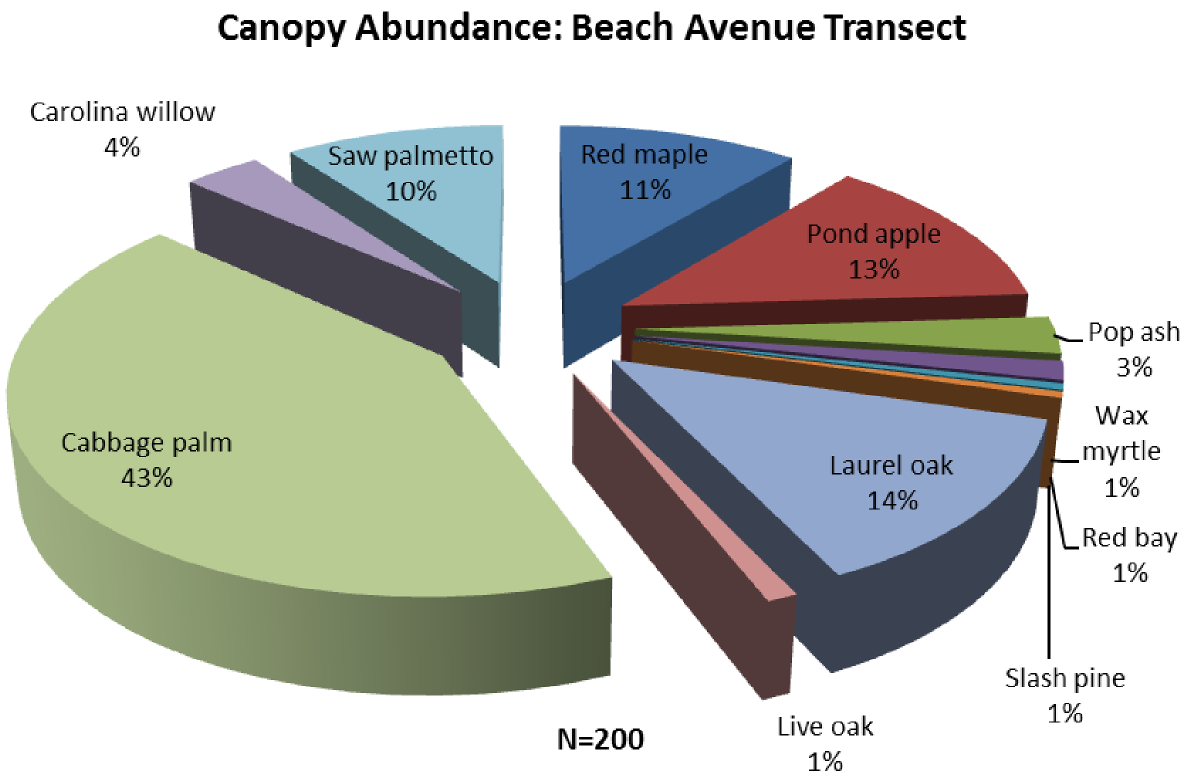


Figure 27. Canopy abundance at the Beach Avenue Transect in 2009.

The cabbage palms within the Beach Avenue Transect were representative of 3 dbh size frequency classes (5–20, 21–40 and 41–60 cm) although the great majority were of the middle group (**Figure 28**). As with the River's Edge Transect, laurel oaks on the Beach Avenue Transect had representatives of 4 dbh size class frequencies (5–20, 21–40, 41–60 and 61–80 cm). Saw palmetto and red maple had representives of 3 dbh size frequency classes (5–20, 21–40 and 41–60 cm). There were only a few small trees of pop ash, wax myrtle, red bay, and Carolina willow.

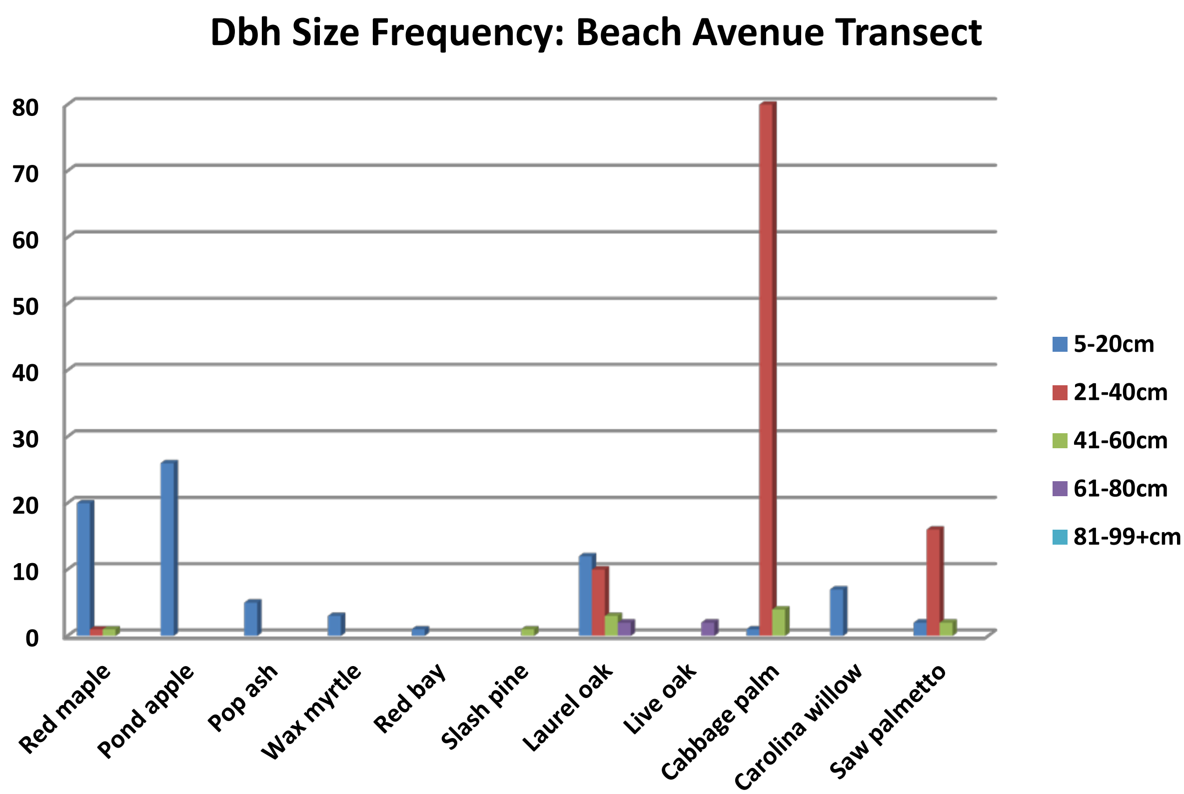


Figure 28. Canopy dbh size class frequency on the Beach Avenue Transect in 2009.

Three distinct hammock areas were present on the Beach Avenue Transect (**Figure 29**, plots BA00 to BA10, BA163 to BA173, and BA193 to BA203). An upper tidal swamp area was present between plots BA70 to BA100 and then it reverted back into bottomland hardwood/hammock communities (plots BA110 to BA203). Plot BA183 had no canopy trees. Some of the highest elevations along this transect are along the river channel and may represent old spoil material. Tidal waters inundate the area primarily from an oxbow system along the south side of the transect. There were red and white mangroves and a few small bald cypress present on this oxbow but not on the transect line or the interior of the floodplain.

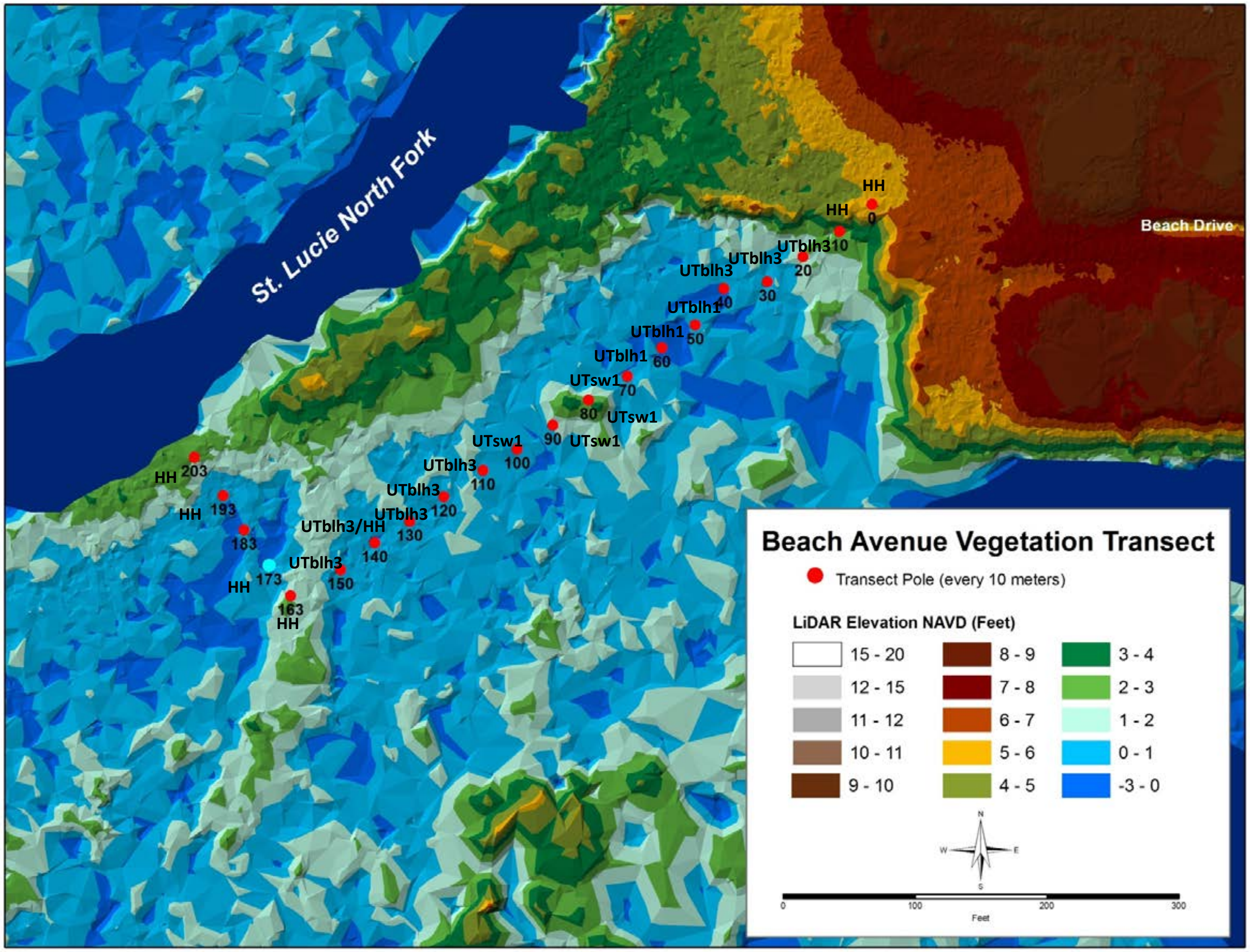


Figure 29. LIDAR interpretation of elevation data and plot locations on the Beach Avenue Transect in 2009.

Crowberry Drive Transect

The Crowberry Drive Transect (RM 18.3) had the largest percentage of swamp canopy trees and the smallest percentages of bottomland hardwood and hammock canopy trees of the four transects on the North Fork St. Lucie River. It was also our longest transect with 33 plots. Seventy percent of the canopy trees were young white mangrove while another one percent were pond apple (**Figure 30**). Red maple was the only bottomland hardwood species and they were present at 4%. The hammock species, red bay, cabbage palm, live oak, laurel oak, and wax myrtle totaled 14% of the community. Brazilian pepper was the only upland species and it was present at 11%.

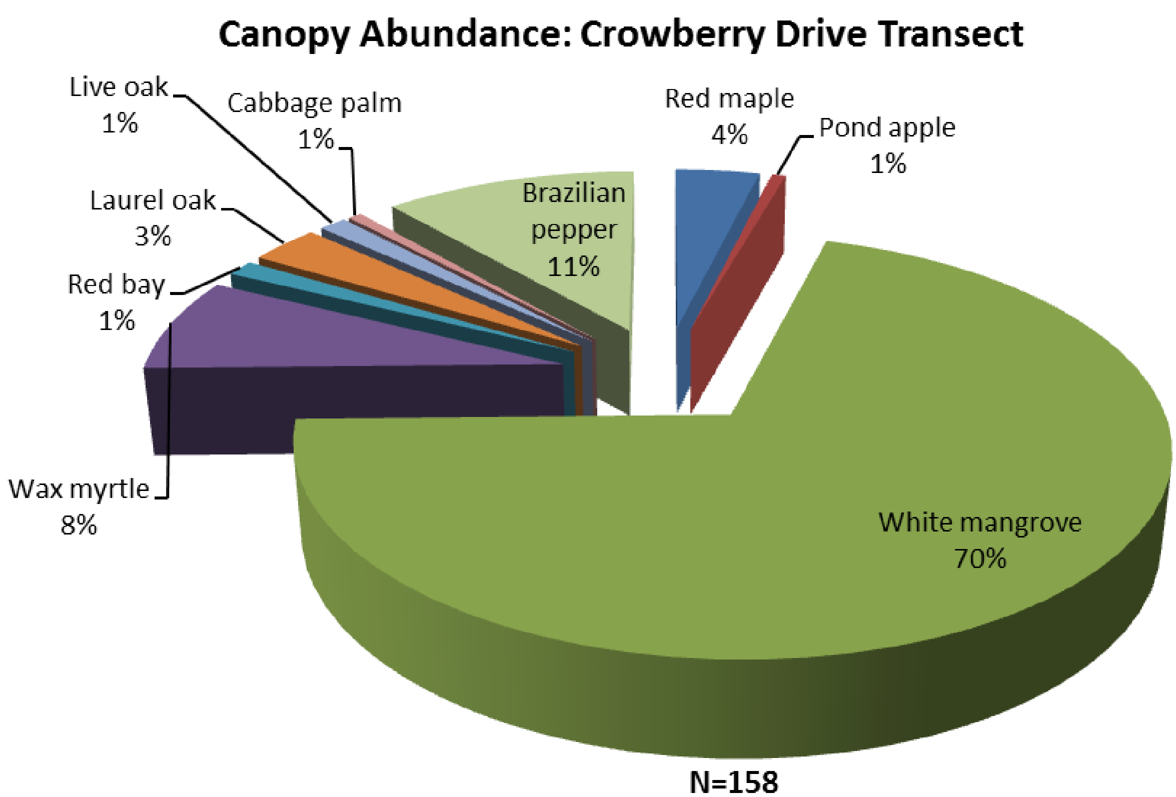


Figure 30. Canopy abundance on the Crowberry Drive Transect in 2009.

The great majority of the canopy trees present on the Crowberry Drive Transect were of the smallest size class frequency 5–20 cm (**Figure 31**). Those white mangroves that made it to canopy size were all of this small size class frequency, which indicated a trend of strong new recruitment in this lower portion of the upper tidal reach of the North Fork St. Lucie River. One laurel oak was representative of the 41–60 cm size class while red maple, wax myrtle, red bay and live oak had representatives of the 21–40 cm size class.

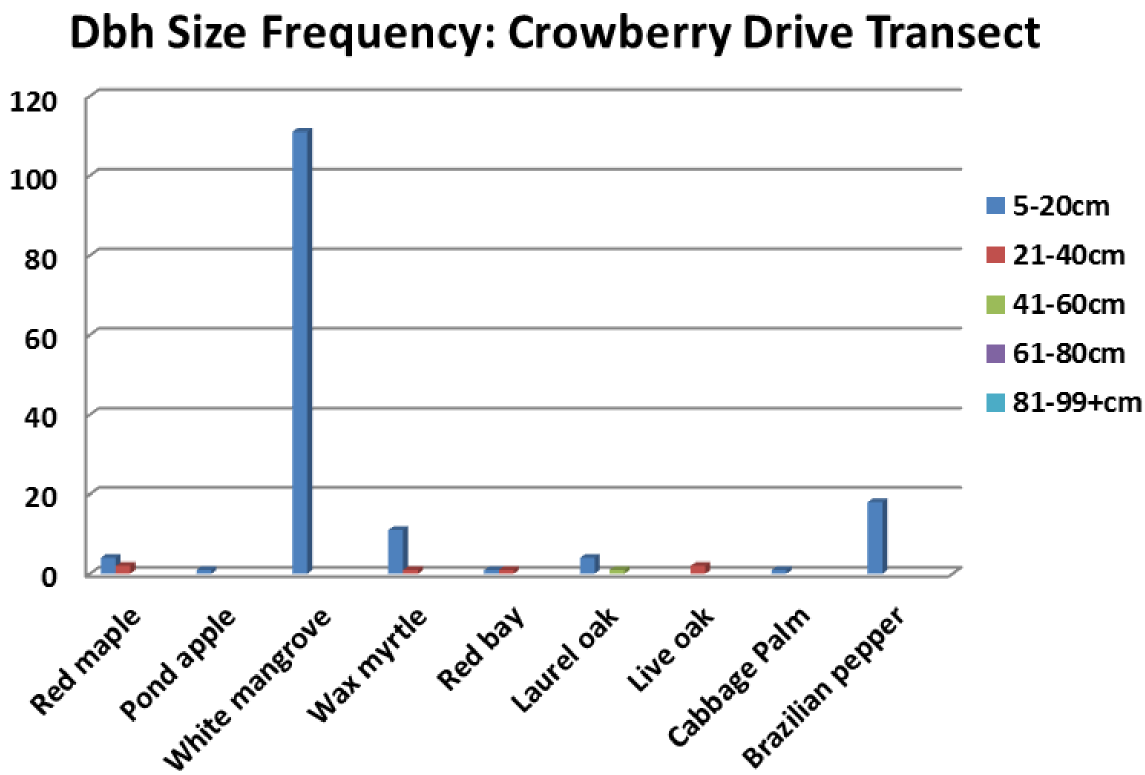


Figure 31. Canopy dbh size class frequency for the Crowberry Drive Transect in 2009.

The Crowberry Drive Transect is located between the Prima Vista and Kelstadt bridges. In the vicinity of the transect, there was a berm that runs along the shoreline and river channel (**Figure 32**). The berm was breached just north of the transect. South of the transect, tidal waters may reach the site via Long Creek; however, the site appeared to be relatively dry with the exceptions of a small tidal stream at plot CD210 and the marsh area. The Crowberry Drive Transect had a small mixed hammock and bottomland hardwood area adjacent to the uplands (plots CD0 to CD60) and on the berm (plots CD310 to CD320) adjacent to the main river channel (**Figure 32**). Plots CD260 to CD290 had no canopy and were identified as a freshwater marsh community consisting primarily of saw grass. Midway through the marsh was a circular area (approximately 10 meters or one plot) where the sawgrass had been flattened. This was identified as a possible alligator resting area although no alligator has been cited there to date. The remaining plots CD70 to CD250 consisted primarily of young white mangrove trees surrounded by remenant sawgrass marsh.

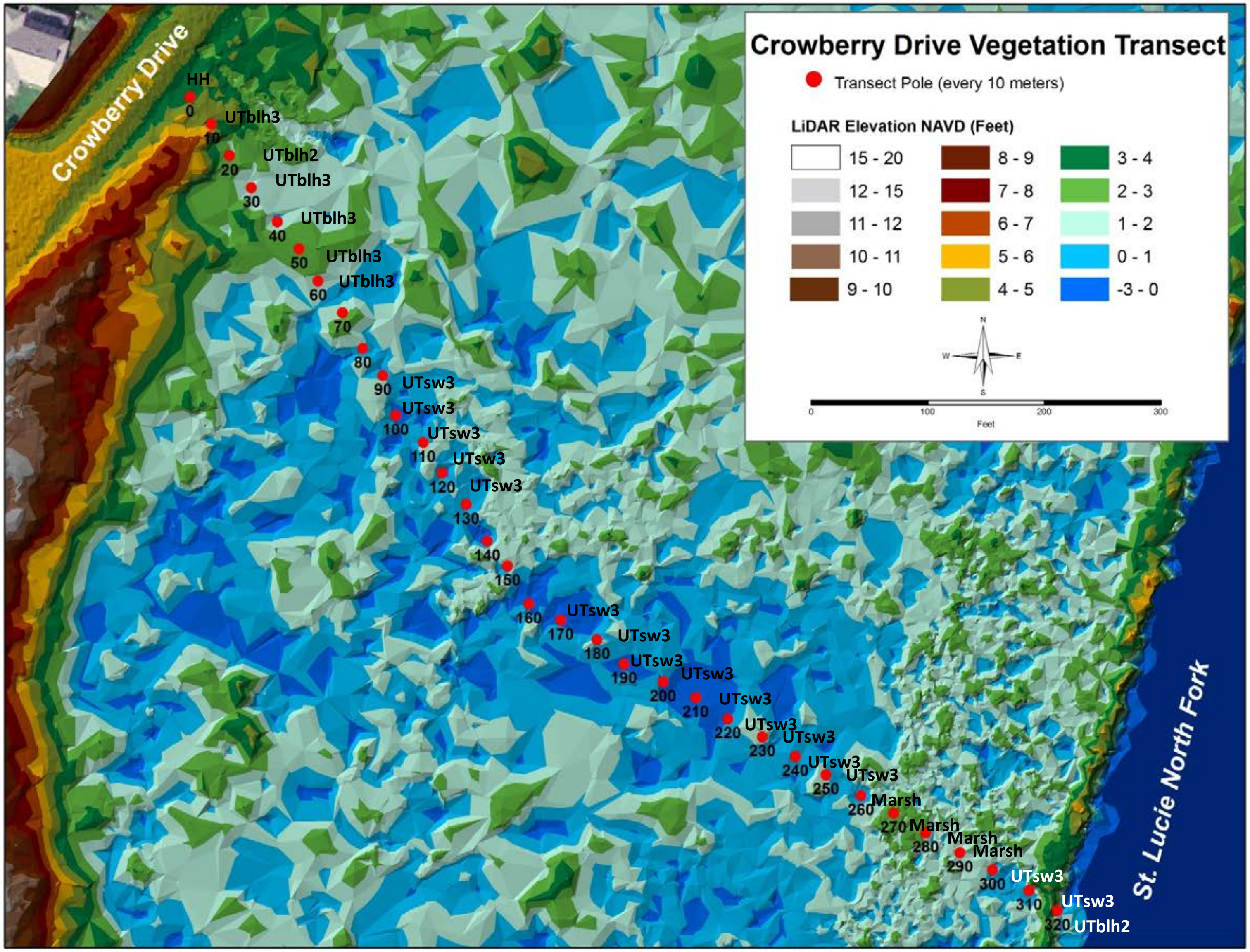


Figure 32. LIDAR interpretation of elevation data and plot locations on the Crowberry Drive Transect in 2009.

The Structure of the Floodplain Canopy Community Using Multivariate Analysis

The purpose of this section was to describe the 2009 floodplain canopy community along the North Fork St. Lucie River using multivariate analysis as a tool. With PC-ORD's two- and three-dimensional capabilities, we wanted to identify whether EC and percent %SM properties along with river mile were important factors in determining the floodplain canopy structure. In addition, we were trying to understand the impact of the existing berm and berm breaches on the hydrological condition and community structure of vegetation within each plot and transect. In this manner, we wanted to try and answer the question whether additional breaching of the berms would contribute to further saltwater intrusion or improve hydrological conditions. Also, we wanted to identify target plant species that would signify improved hydrology in lower and higher conductivity areas of the St. Lucie River floodplain.

A total of 16 canopy tree species were found within the 77 vegetative plots established on the North Fork St. Lucie River floodplain. For the canopy community ordination analysis, 8 plots with no canopy and 4 marsh plots were removed for a total of 65 plots. A cluster analysis (Bray Curtis) was used to create a dendrogram illustrating the relative similarity among groups on the vegetative transects coded by plot (a two letter transect name code and distance from the uplands in meters) (**Figure 33**). Using all 16 canopy species and 532 trees, the resulting cluster dendrogram produced two major canopy groups (i.e. saltwater swamp, and a mixture of hammock, bottomland hardwood and freshwater swamp species) with 10 color-coded subgroups on the left of the figure. The 10 color coded subgroups represented saltwater swamp, freshwater swamp, freshwater swamp mixed with bottomland hardwood, bottomland hardwood mixed with swamp and hammock, hammock mixed with bottomland hardwood, upland species, and hydric hammock (i.e. primarily cabbage palm and live oak). The percent information remaining for each of the 10 subgroups is given in the small box in the upper right hand corner of the figure. White mangrove swamp had the highest percent information remaining at 50% and comes in as the most well defined subgroup and major group.

Four forest community types were identified: 1) freshwater swamp (pond apple, pop ash); 2) bottomland hardwood (laurel oak, red maple and water hickory); 3) hammock (cabbage palm, saw palmetto and live oak); and 4) saltwater swamp (white mangrove) (**Figures 33** and **34**). With regards to Shannon's Diversity indices (H) for each plot, the monoculture white mangrove swamp had the lowest values (0) while several of the wetter mixed bottomland hardwood/swamp plots on the River's Edge Transect (plots RE40 to RE80, **Figure 23**) had the highest diversity values (0.92–1.58). Cabbage palm, live oak, red maple and white mangrove had the highest H values on the 65 plots with values of 3.16, 3.13, 2.84 and 2.53, respectively (**Appendix G**).

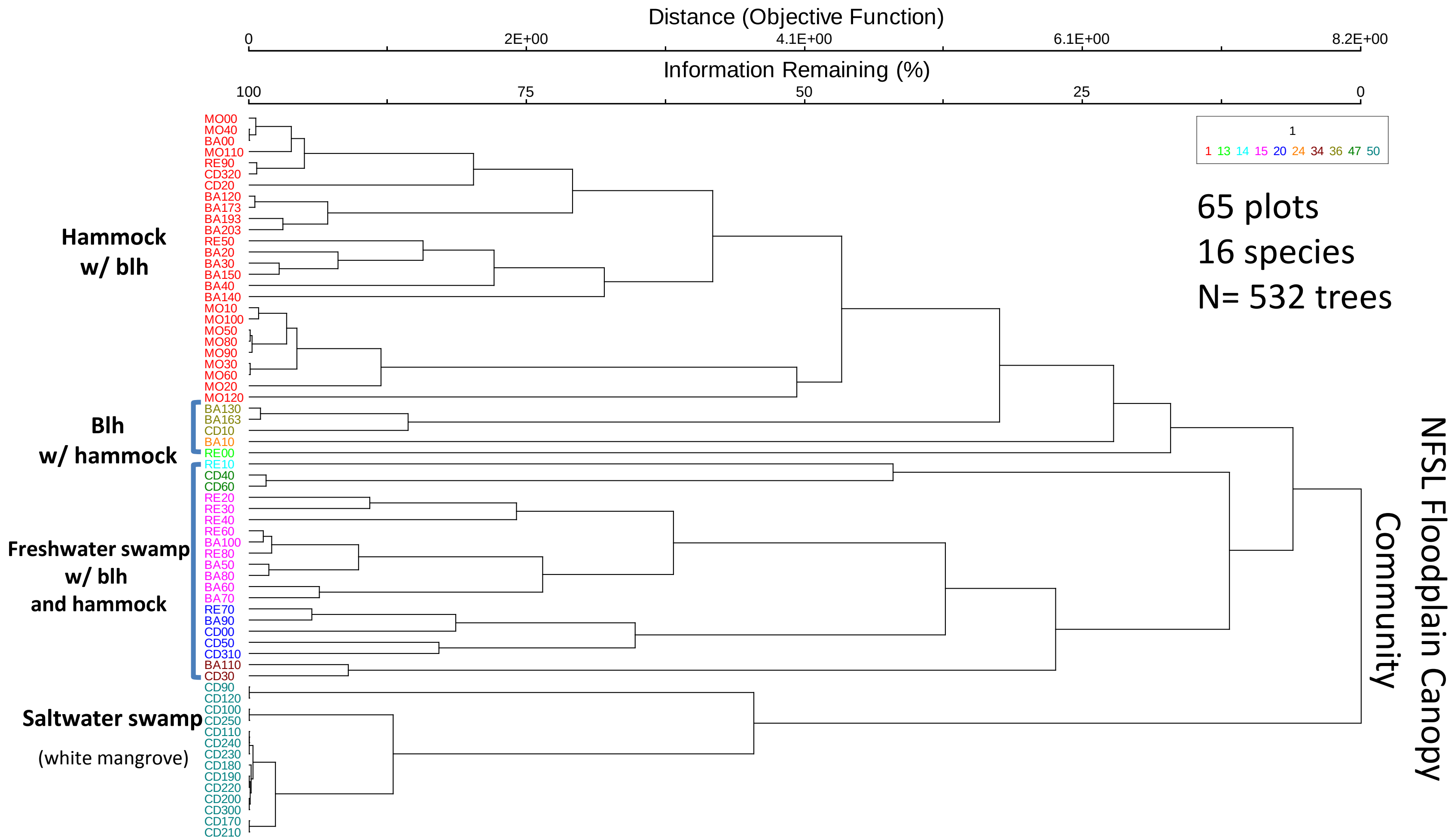


Figure 33. Dendrogram resulting from the cluster analysis of 16 canopy species in 65 plots for the floodplain along the North Fork St. Lucie River.

(Note: NFSL – North Fork St. Lucie River.)

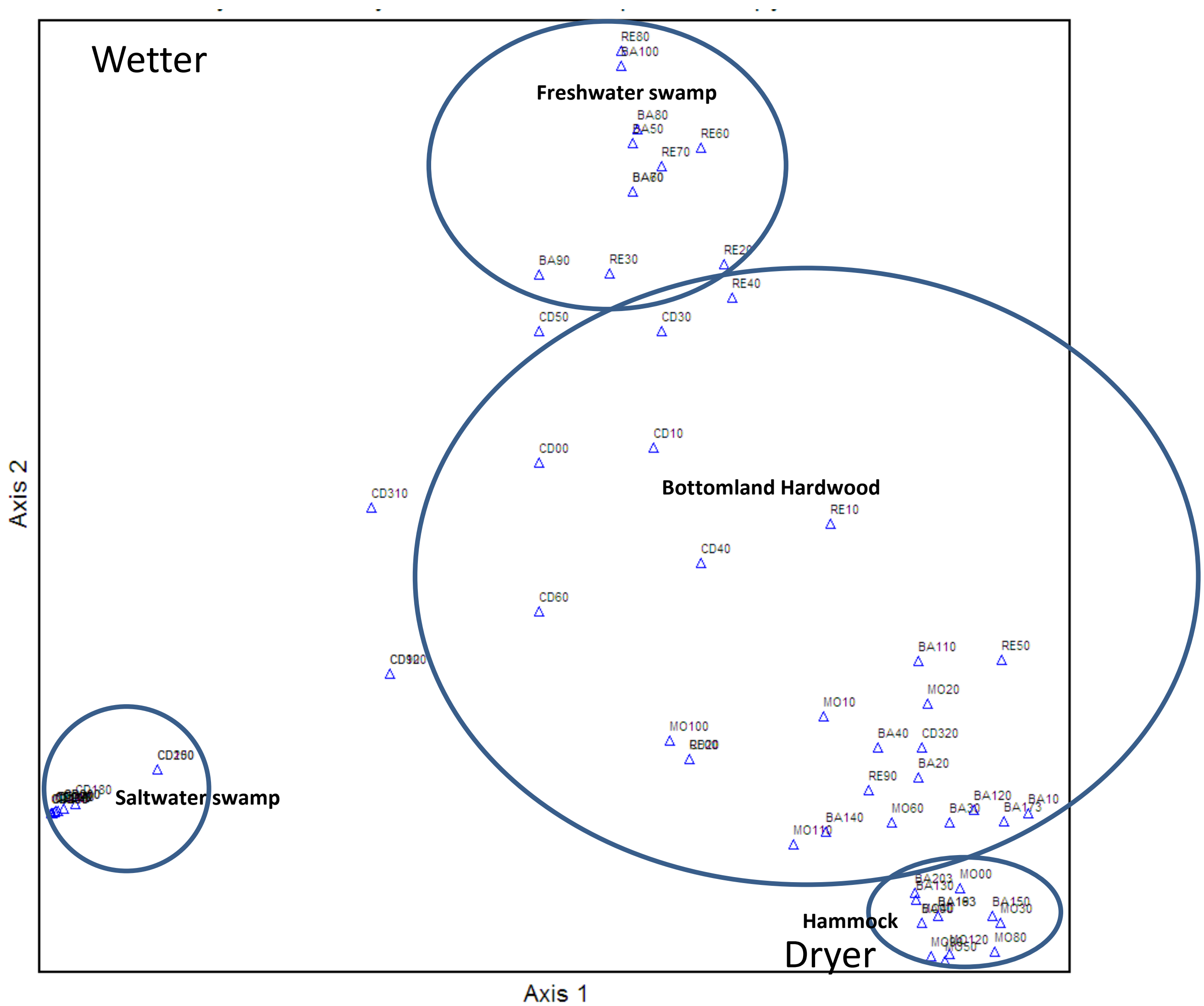


Figure 34. Two-dimensional scatterplot of the 65 vegetative plots by major forest community group.

Examples of this were the hammock and bottomland hardwood communities at the back of the floodplain and those plots on the berm on the Crowberry Drive Transect (**Figures 32** and **33**). On the other hand, swamp plots from the River's Edge and Beach Avenue transects, which are more regularly inundated by daily tides due to breaches in the berm or the presence of the oxbow clustered in the middle of the dendrogram (**Figure 33**) and contain primarily pond apple and pop ash. In fact, the swamp community of the River's Edge Transect had the highest %SM (**Figure 14B**) of any of the vegetative plots and had visible surface water during most high and low tides while the downstream Crowberry Drive Transect was drier at all tidal stages due to the berm.

Figure 34 is a two-dimensional scatterplot of the 65 plots identified by major forest community. The largest and most diverse of the groups appears to be the bottomland hardwood community that was represented on all 4 transects. Freshwater swamp communities were present on the River's Edge and Beach Avenue transects, while the saltwater swamp community was present only on the Crowberry Drive Transect. In this figure, the saltwater community appears as an outlier of the other three canopy communities. The tight hammock group here appears to have only representatives from the Miller Oxbow and Beach Avenue transects, which have in common cabbage palm and laurel oak, as observed in **Figure 35**.

Figure 35 illustrates a two-way cluster analysis dendrogram for the North Fork St. Lucie River floodplain canopy communities. Forest plots are coded as transect name and distance from the uplands while canopy species were given a two letter code. The matrix coding is based on minimum and maximum abundance values within each plot. The four major forest community groups are shown in **Figures 34** and **35** with regards to the vegetative plots while the 16 canopy species separated into generally 3 clusters (green circles): 1) saltwater swamp, 2)freshwater swamp, and 3) mixed swamp/bottomland hardwood/hammock.

There were some interesting tree clusters in **Figure 35**. While pond apple would not be considered to be a rare swamp species in South Florida, for this survey, it was not widely distributed. It was present on one plot of Crowberry Drive (CD50, 6.8-cm dbh) with wax myrtle and Brazilian pepper and on 8 plots within the Beach Avenue and River's Edge transects with the higher levels of %SM. These last two transects featured larger breaches between the berm and the river channel with daily tidal flushing. White mangrove clustered totally by itself with its infrequent flushing behind the berm on the Crowberry Drive Transect. Pop ash, a swamp species, clustered directly with red maple, a low bottomland hardwood species. Also, cabbage palm, a hammock species, clustered directly with laurel oak and indirectly with water hickory, both of which are bottomland hardwood species. Finally, slash pine and tamarind did not cluster directly with any other species as both are upland species.

Figure 36 presents the three-dimensional CCA ordination analysis of the 16 canopy species (green asterisks) and the two environmental variables (%SM and EC) and river mile as red vectors. This graphic illustrates how EC on the floodplain increased with decreasing river mile, while %SM peaked at mid-river with the two breached transects (Beach Avenue and River's Edge) and then steadily decrease to zero at the top of the berm on Ten Mile Creek. This figure further shows slash pine and live oak as outliers from the remaining 14 canopy species. These two species are mainly growing on the berms as upland canopy.

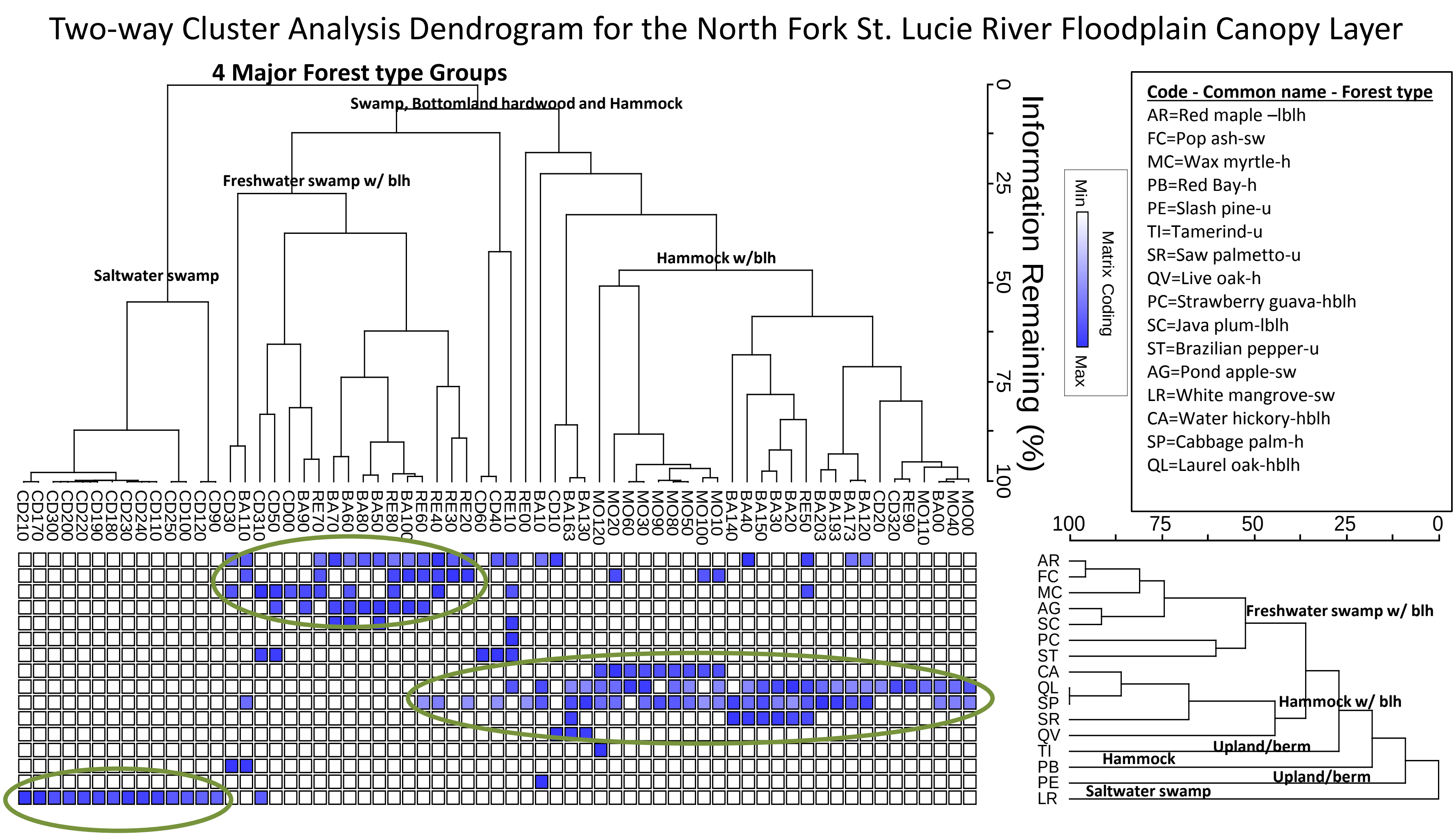
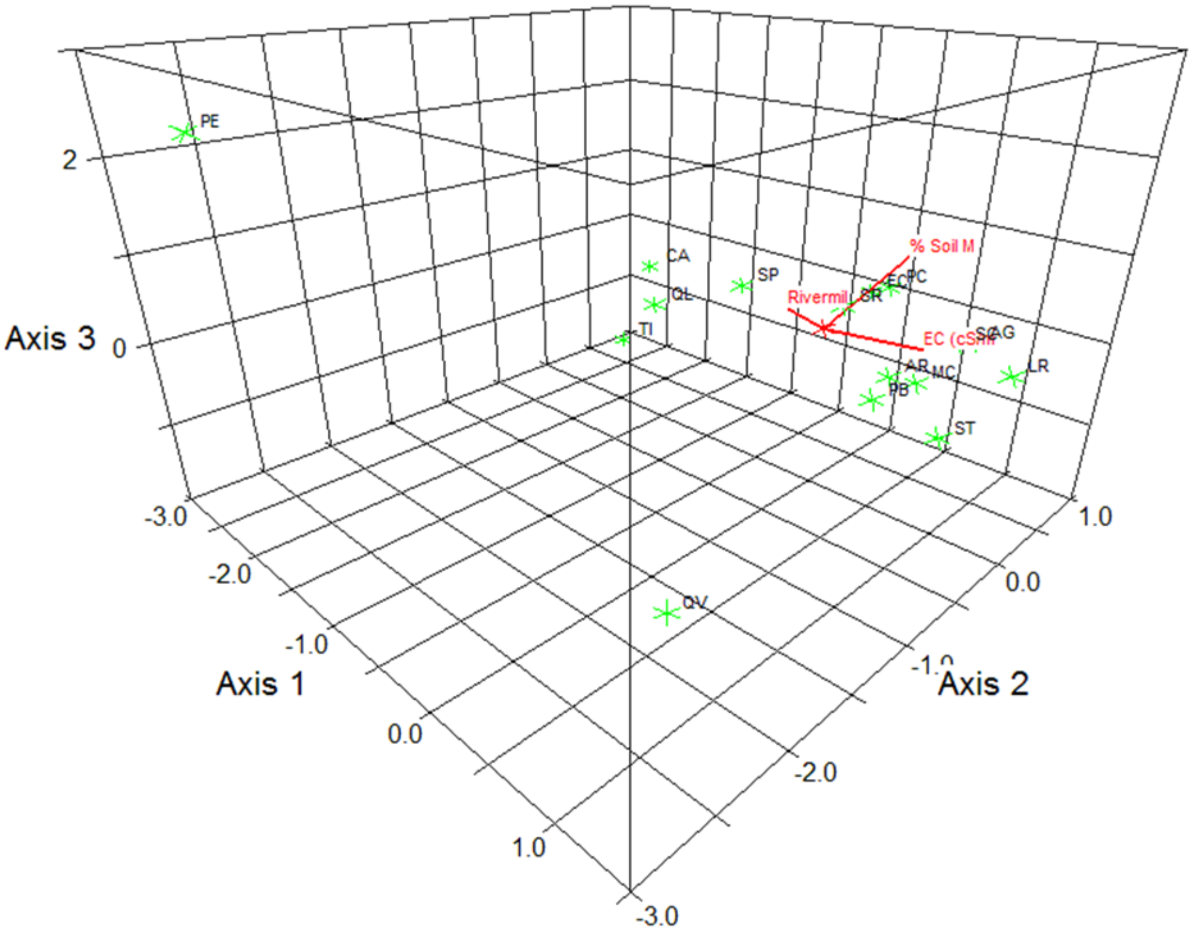


Figure 35. A two-way cluster analysis of vegetative plots by minimum/ maximum of canopy species.



Code		Common Name	Forest Type	Code		Common Name	Forest Type
AR	=	Red maple	lblh	PC	=	Strawberry guava	hblh
FC	=	Pop ash	sw	SC	=	Java plum	lblh
MC	=	Wax myrtle	h	ST	=	Brazilian pepper	u
PB	=	Red bay	h	AG	=	Pond apple	sw
PE	=	Slash pine	u	LR	=	White mangrove	sw
TI	=	Tamarind	u	CA	=	Water hickory	hblh
SR	=	Saw palmetto	u	SP	=	Cabbage palm	h
QV	=	Live oak	h	QL	=	Laurel oak	hblh

Figure 36. Three-dimensional CCA ordination analysis using the 16 canopy species and the two environmental variables and river mile.

Table 6 provides the results of the CCA analysis using log transformed data. The correlation between EC and %SM was only 0.358. Axis 1 accounted for 11% of the variance of the cumulative variance while Axis 2 accounted for 14% and Axis 3 accounted for 16.2% of the variance among species distribution. Pearson correlations between the species and the environmental variables were 0.831 for Axis 1 and 0.655 for Axis 2. Intra-set correlations were -0.992 for EC on Axis 1, 0.683 for %SM on Axis 3 and -0.885 for river mile on Axis 1 while inter-set correlations were 0.824 for EC on Axis 1, 0.446 for %SM on Axis 2 and -0.735 for river mile on Axis 1. Significant Pearson, Kendall tau were observed for water hickory (-0.685, 0.469 and -0.465) on Axis 1; white mangrove (0.463, 0.214, 0.561) on Axis 1; laurel oak (-0.603, 0.364,-0.5) on Axis 1; and cabbage palm (-0.424, 0.180,-0.414) on Axis 1. EC had the highest Pearson Kendall tau with 0.989, 0.978 and 0.871 on Axis 1. %SM had the second highest values with 0.798, 0.636 and 0.521 on Axis 3.

Table 6. CCA results for the North Fork St. Lucie River floodplain canopy abundance by species.

CORRELATIONS AMONG VARIABLES IN SECOND MATRIX			
	EC (cS/m)	**%SM**	**River Mile**
EC (cS/m)	1.000	0.358	-0.831
%SM	0.358	1.000	-0.107
River Mile	-0.831	-0.107	1.000

AXIS SUMMARY STATISTICS Total variance ("inertia") in the species data: 4.8825			
Statistics	**Axis 1**	**Axis 2**	**Axis 3**
Eigenvalue	0.516	0.161	0.112
Variance in species data			
% of variance explained	10.6	3.3	2.3
Cumulative % explained	10.6	13.9	16.2
Pearson Correlation, Species-Environment*	0.831	0.655	0.614
Kendall (Rank) Correlation, Species-Environment	0.727	0.470	0.330

* Correlations are "intra-set correlations" of ter Braak (1986)

CORRELATIONS AND BIPLOT SCORES for 3 variable						
Variable	**Correlations***			**Biplot Scores**		
	Axis 1	**Axis 2**	**Axis 3**	**Axis 1**	**Axis 2**	**Axis 3**
1 EC (cS/m)	0.992	0.125	0.019	0.690	0.115	0.018
2 %SM	0.262	0.681	0.683	0.183	0.624	0.644
3 River Mile	-0.885	0.408	-0.224	-0.616	0.374	-0.211

* Correlations are "intra-set correlations" of ter Braak (1986)

Table 6. Continued.

INTER-SET CORRELATIONS FOR THREE ENVIRONMENTAL VARIABLE			
Correlations			
Variable	Axis 1	Axis 2	Axis 3
1 EC (cS/m)	0.824	0.082	0.012
2 %SM	0.218	0.446	0.420
3 River Mile	-0.735	0.267	-0.138

Pearson and Kendall Correlations with Ordination Axes, N = 65 Yellow highlighted numbers indicate significance									
Common Name	Axis								
	1			2			3		
	r	r^2	tau	r	r^2	tau	r	r^2	tau
Red maple	.231	.053	-.005	.080	.006	.137	-.052	.003	-.035
Pond apple	.203	.041	.109	.214	.046	.202	.028	.001	-.062
Water hickory	-.685	.469	-.465	.323	.104	.444	-.133	.018	-.341
Pop ash	-.039	.001	-.191	.288	.083	.378	.070	.005	.066
White mangrove	.463	.214	.561	.064	.004	-.164	.123	.015	.197
Wax myrtle	.205	.042	.044	.055	.003	.037	-.026	.001	.011
Sweet bay	.090	.008	.053	-.048	.002	-.060	.009	.000	-.068
Slash pine	-.172	.030	-.099	-.261	.068	-.154	.239	.057	.165
Strawberry Guava	.016	.000	-.066	.059	.003	.049	.051	.003	.137
Laurel oak	-.603	.364	-.500	-.131	.017	.015	.090	.008	-.039
Live oak	.062	.004	-.051	-.268	.072	-.150	-.251	.063	.000
Willow	.119	.014	.051	.127	.016	.124	.015	.000	-.054
Cabbage palm	-.424	.180	-.414	.144	.021	.150	.219	.048	.077
Saw palmetto	.050	.002	-.102	.010	.000	-.107	.147	.022	.179
Brazilian pepper	.205	.042	.142	-.038	.001	-.162	-.050	.002	.042
Tamarind	-.210	.044	-.121	.064	.004	.060	-.131	.017	-.143
EC (cS/m)	**.989**	**.978**	**.871**	**.163**	**.026**	**-.135**	**.073**	**.005**	**.136**
%SM	**.218**	**.048**	**.146**	**.758**	**.574**	**.316**	**.798**	**.636**	**.521**
River Mile	**-.882**	**.778**	**-.756**	**.374**	**.140**	**.559**	**-.167**	**.028**	**-.149**

*Significant correlations are highlighted in yellow.

Figure 37 presents a two-dimensional ordination of just the 16 canopy species (green dots) with the three vectors. The exotic or nonnative species are shown in red. Pop ash and strawberry guava showed more of an affinity towards %SM while white mangrove clearly preferred higher EC. Water hickory, tamarind, laurel oak, slash pine and live oak are shown here more as outliers to the other members of the community. With the exception of the tamarind trees, perhaps these other species also represent an older generation of true hammock and bottomland hardwood communities that have survived today's even shorter hydroperiods on the floodplain by mixing together along the North Fork St. Lucie River.

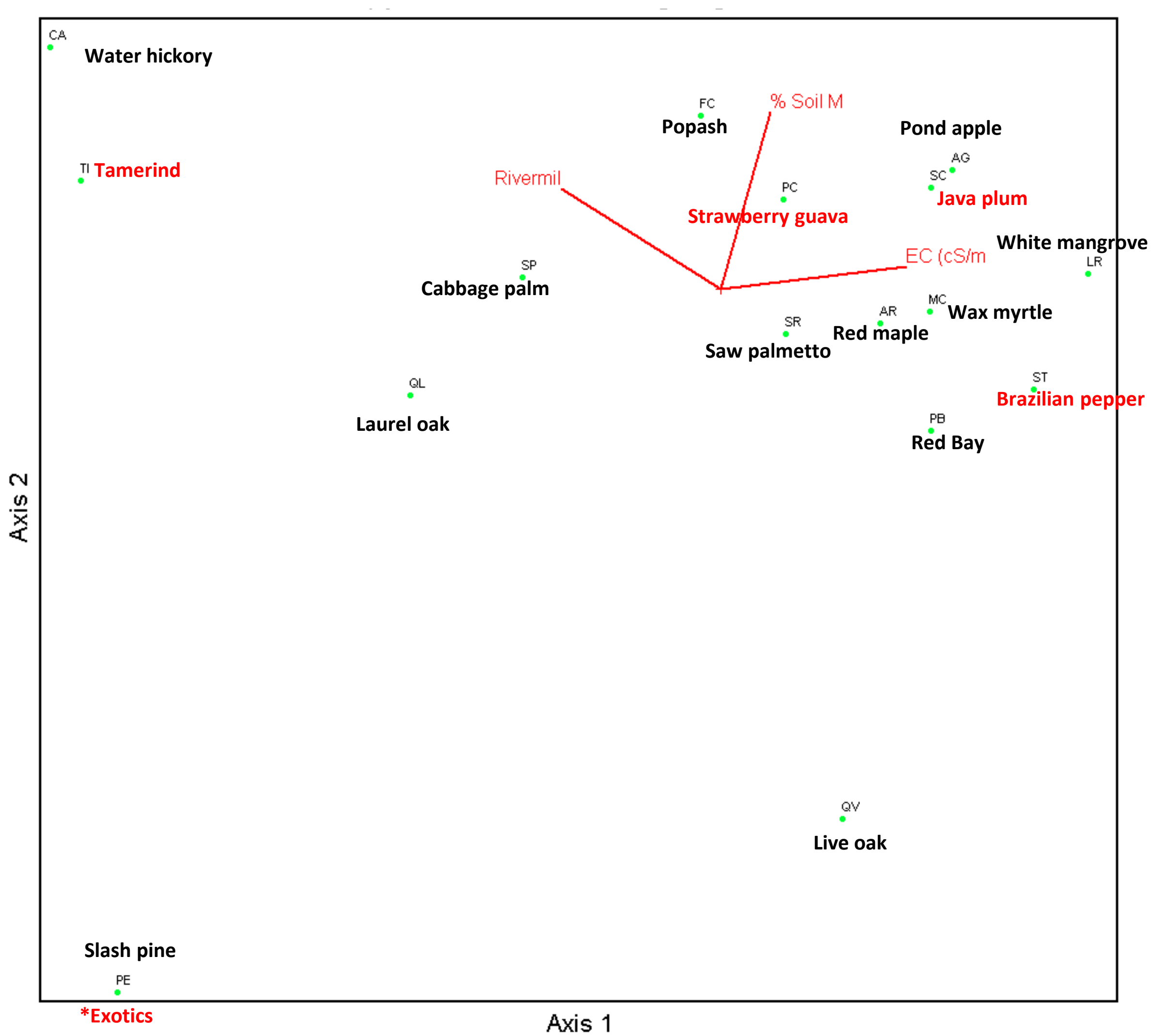


Figure 37. Two-dimensional scatterplot of the 16 canopy species (green dots) shown with the three vectors.

The Bray Curtis analysis results in **Table 7** indicated that there may have been additional linear relationships between at least 5 of the canopy species and the environmental variables. White mangrove was highly positive to EC (r = 0.743, r^2 = 0.552 and tau = 0.590) and slightly negative to %SM (r = -0.385, r^2 = 0.148 and tau = -0.461). They were not found at ECs of < 1,503 cS/m (plot CD100) and %SM of < 66% (plot CD310). In **Table 7**, pond apple showed the second highest r, r^2 and tau values (0.727, 0.528 and 0.496) of any of the 16 canopy species and these values were for Axis 2. Pond apple appeared to prefer %SM levels greater than 75% (**Appendix H**, **Figure H-3**). So, they were most abundant (larger triangles) where %SM was highest. Therefore, upstream and downstream pond apple distribution appeared to be limited by %SM and not EC. Pop ash also was positive for %SM (r = 0.503, r^2 = 0.253 and tau = 0.411). Pop ash clustered primarily around the River's Edge and Beach Avenue transects (i.e. highest %SM) along with a small group in the oxbow channel of the Miller Oxbow Transect. Pop ash appeared to prefer levels of EC < 728 cS/m (plot BA100) and %SM levels > 46% (plot MO100) (**Appendix H**, **Figure H-6**). Cabbage palm was highly negative (r = -0.693, r^2 = 0.81 and tau = -0.764) for EC. Laurel oak appeared to have a negative relationship with EC (r = -0.435, r^2 = 0.189 and tau = -0.441) and preferred drier soils. Red maple showed a slight positive relationship with %SM (r = 0.394, r^2 = 0.155 and tau = 0.450, **Table 7**); however, it appeared to be negatively correlated to about 1,000 cS/m and downstream portions of the North Fork (**Appendix H**, **Figure H-4**). Water hickory was negatively correlated with EC (i.e. cluster of large triangles at the higher river miles) (r = -.348, r^2 = 0.121 and tau = -0.294) (**Appendix H**, **Figure H-5**). They were not observed downstream of the River's Edge Transect. Red bay was slightly positive to %SM and negative to EC (**Appendix H**, **Figure H-9**). Strawberry guava (**Appendix H**, **Figure H-10**) and slash pine (**Appendix H**, **Figure H-11**) appeared to prefer drier soils and lower EC. Saw palmetto was negative to EC and slightly positive to %SM (**Appendix H**, **Figure H-16**). Brazilian pepper was positive to %SM and negative to EC (**Appendix H**, **Figure H-17**) while tamarind was strongly negative to EC and %SM (**Appendix H**, **Figure H-18**).

Shrub and Groundcover Communities

Shrub and groundcover species composition and distribution have been used as indicators of the changing health of floodplain plant communities. Darst et al. (2002) indicated that these species can be used as indicators of even subtle changes in floodplain plant communities that occur as a result of flow reduction from changes in inundation, saturation, flood depths and salinity. Perry and Herschner (1999) found that most groundcover species in wetland habitats are perennials that live for many years. However, their abundance and distribution can change significantly with varying hydrological conditions whether due to a seasonal (dry/wet seasons) change or driven by an event such as a hurricane or prolonged flood. Shrub layer plants tend to show a more intermediate response to hydrology between the tree canopy and the groundcover communities. Hydrology has repeatedly been identified as one of the most important factors in maintaining natural wetland systems in South Florida.

Table 7. A summary table of the results from the Bray Curtis analysis of canopy species and the environmental variables.

(Pearson and Kendall Correlations with Ordination Axes, N= 65.)

Common Name	Axis								
	1			2			3		
	r	r^2	tau	r	r^2	tau	r	r^2	tau
Red maple	-.109	0.12	-.039	.394	.155	.450	-.119	.014	-.028
Pond apple	.063	.004	.176	.727	.528	.496	-.199	.040	-.139
Water hickory	-.348	.121	-.294	-.123	.015	-.092	.065	.004	.104
Pop ash	-.020	.000	-.030	.503	.253	.411	-.170	.029	-.206
White mangrove	.743	.552	.590	-.385	.148	-.461	-.295	.087	-.312
Wax myrtle	.051	.003	.150	.344	.118	.383	-.081	.007	.090
Red bay	-.038	.001	-.022	.045	.002	.078	-.061	.004	-.078
Slash pine	-.135	.018	-.107	-.090	.008	-.034	.098	.010	.113
Strawberry guava	.008	.000	.017	.038	.001	.079	.226	.051	.147
Laurel oak	-.435	.189	-.441	-.228	-.052	-.097	.796	.634	.533
Live oak	-106	.011	-.141	-.042	.002	-.145	-.067	.004	-.053
Java plum	.040	.002	.130	.290	.084	.259	.027	.001	.093
Cabbage palm	-.693	.481	-.764	-.397	.157	-.259	-.147	.022	-.037
Saw palmetto	-.194	.038	-.210	-.123	.015	-.079	.009	.000	.173
Brazilian pepper	.033	.001	.094	.081	.006	.172	.031	.001	.172
Tamarind	-.139	.019	-.118	-.104	.011	-.056	.029	.001	.101

Appendix C contains a complete listing of canopy, shrub and groundcover species for the 2009 pre-survey and transect data sets. For the 2009 transect survey, there were 40 species of shrub and 76 species of groundcover identified. Summary statistics for all of the plots and species are listed in **Appendix H**, **Table H-4**. Of the 40 species, there were 4 exotic shrubs and 11 exotic groundcover species. There were no shrub species that were not also found in the groundcover. Most of the shrub and groundcover species of the North Fork St. Lucie River floodplain were classified as FAC (i.e. found equally in non-wetlands as in wetlands) or FACW (i.e. more frequently found in wetlands). Upland species were limited to slash pine, saw palmetto and live oak; however, these three species are tolerant of short-term flooding periods. OBL (always found in wetlands) shrub and groundcover species were limited by the berms and dry conditions. Of the 40 species of shrub encountered on the four transects only eight species— leather fern, pond apple, buttonbush, water hickory, sawgrass, pop ash, white mangrove, pickerel weed and Carolina willow—were classified as OBL.

Shrub Community

Table 8 presents the results of the percent cover of shrubs by transect. The Crowberry Drive Transect contained the greatest percent cover of shrubs due to the prevalence of giant leather fern and remnant sawgrass. The Beach Avenue Transect contained the most shrub species (26) while the other three transects contained similar amounts to each other (Miller Oxbow, 19; Crowberry Drive, 15; and River's Edge, 14). The greater number of both shrub and groundcover species on the Beach Avenue Transect was attributed to human impacts from the dumping of vegetation into the hammock area adjacent to the public road and private homes. The Beach Avenue Transect was the only transect site that had no government fencing or transitional zone between the Savannas Preserve State Park property and the adjacent residential area. Shoebutton ardisia (*Ardisia elliptica*), which is native to Asia, was prevalent in the hammock areas of primarily the Beach Avenue Transect. Its black fruit is eaten by many animals and spread across sites through fecal droppings.

Dominance of shrub species on the four transects appeared to be related to the level of %SM across the site and the presence or absence of a berm adjacent to the river channel. Upstream in the riverine portion of the river, shrubs on the Miller Oxbow Transect were dominated by the exotic Caesarweed (*Urena lobata,* 32%); shortleaf wild coffee (*Psychotria sulzneri,* 22%), the exotic Brazilian pepper (14%); false indigo (*Amorpha fruiticosa,* 10%), and red bay (10%). OBL shrub species were very minor on this transect and would have only been found in the oxbow ditches. Most of this site is rarely inundated due to the prevalent berm along Ten Mile Creek. Shrub species on the River's Edge Transect were dominated by more OBL and FACW species including giant leather ferns *(*38%), shoebutton ardisia (10%), button bush (10%) and salt bush (10%). Shrubs on the Beach Avenue Transect were dominated by shoebutton ardisia (14%), saw palmetto (13%), red maple (10%), giant leather fern (10%), saltbush (10%), sawgrass (8%) pond apple (6%) and Brazilian pepper (6%). The Crowberry Drive Transect was dominated by sawgrass in the marsh plots and white mangrove community (42%), giant leather fern (32%) under the white mangrove canopy and Brazilian pepper (10%) in the hammock and bottomland hardwood plots.

Table 8. 2009 Survey of shrubs by transect. An asterick indicates an invasive exotic species.

Species	Code Name	Common Name	Transect			
			Miller Oxbow	River's Edge	Beach Avenue	Crowberry Drive
Acer rubrum	ACERUB	red maple	0.003	0.05	0.1	
Acrostichum danaeifolium	ACRDAN	giant leather fern		0.38	0.1	0.32
Amorpha fruiticosa	AMOFRU	false indigo	0.1		0.0004	
Annona glabra	ANNGLA	pond apple			0.06	
Ardisia elliptica**	ARDELL	shoebutton ardisia	0.02	0.09	0.14	0.01
Baccharis glomerulifora	BACGLO	salt bush		0.09	0.09	0.01
Blechnum serrulatum	BLESER	swamp fern		0.005	0.003	0.03
Callicarpa americana	CALAME	American beautyberry	0.02			
Cephalanthus occidentalis	CEPOCC	buttonbush	0.03	0.09	0.03	
Citrus aurantium	CITXAU	sour orange	0.01			
Cladium jamaicense	CLAJAM	sawgrass			0.08	0.42
Diospyros virginiana	DIOVIR	common persimmon			0.004	
Eclipta prostrata	ECLPRO	false daisy	0.01			
Ficus microcarpa**	FICMIC	laurel ficus				0.001
Fraxinus caroliniana	FRACAR	pop ash	0.01	0.05	0.008	
Hyptis verticillata*	HYPVER	musty mint/John Charles			0.03	
Ilex glabra	ILEGLA	gallberry, inkberry			0.01	
Laguncularia racemosa	LAGRAC	white mangrove				0.02
Momordica charantia	MOMCHA	balsam pear	0.001			
Myrica cerifera	MYRCER	wax myrtle		0.04	0.03	0.008
Osmunda cinnamomum	OSMCIN	cinnamon fern		0.04		0.03
Peltophorum pterocarpum	PELPTE	yellow poinciana	0.04			
Persea borbonia	PERBOR	red bay	0.1		0.03	0.02
Pontederia cordata	PONCOR	pickerelweed			0.0003	
Psidium cattleianum**	PSICAT	strawberry guava		0.05		
Psychotria nervosa	PSYNER	wild coffee	0.01		0.01	0.01
Psychotria sulzneri	PSYSUL	shortleaf wild coffee	0.22			
Quercus laurifolia	QUELAU	laurel oak	0.01	0.04	0.02	0.002
Rapanea punctata	RAPPUN	myrsine				0.001
Sabal palmetto	SABPAL	cabbage palm	0.07			
Salix caroliniana	SALCAR	Carolina willow			0.01	
Schinus terebinthifolius**	SCHTER	Brazilian pepper	0.14	0.004	0.06	0.09
Serenoa repens	SERREP	saw palmetto	0.01	0.07	0.13	0.04
Syagrus romanzoffiana*	SYAROM	queen palm			0.01	
Toxicodendron radicans	TOXRAD	poison oak			0.0004	
Urena lobata**	URELOB	Caesarweed	0.32		0.00009	
Viburnum obovatum	VIBOBO	Walter's viburnum			0.02	
Vitis aestivalis	VITAES	summer grape		0.01		
Vitis rotundifolia	VITROT	muscadine grape	0.001			
Vittaria lineata	VITLIN	shoestring fern			0.004	
Number of Species	**Total:**	**40**	**19**	**14**	**26**	**15**

*Non-native (exotic)
**Invasive

Table 9 breaks down the percent cover of shrubs by forest type for each transect and presents short lists of the most dominant species. On the Miller Oxbow Transect, the bottomland hardwood communities (Rblh3, 73% and Rblh2, 12%) were dominated by 5 species (Caesarweed (*Urena lobata*), shortleaf wild coffee, cabbage palm, Brazilian pepper and false daisy [*Eclipta prostrate*,]). Cabbage palm was present in all three forest types on this transect. Similarly, giant leather fern was present on all eight forest types of the River's Edge Transect with the exception of the mixed hammock/upland community. Most of the shrubs on this transect were present in bottomland hardwood/hammock (21%), and bottomland hardwood (UTblh3 [19%] and UTblh1 [17%]). These plant communities were similar to those on the Beach Avenue Transect. Most shrubs on the Beach Avenue Transect were also found in bottomland hardwood (UTblh3 [42%] and UTblh1 [20%]). Notably, salt bush was found in three different forest types, including hammock, bottomland hardwood (UTblh3), and swamp (UTsw1). Sawgrass and pond apple were prevalent within the wetter plots (UTblh1 and UTsw1) while shoebutton ardisia and saw palmetto were prevalent within the drier plots (H, H/UTblh3 and UTblh3). On the Crowberry Drive Transect, shrubs were mainly found within the swamp plots UTsw3 (71%). This forest type was dominated by OBLs: sawgrass, giant leather fern and white mangrove. Saw palmetto and swamp fern (also known as toothed midsorus fern, *Blechnum serrulatum*) were more prevalent within the drier plots (UTblh3 and UTblh2). There were no shrubs recorded in the one hammock plot adjacent to the uplands on the Crowberry Drive Transect.

For the shrub community ordination analysis, all 40 of the shrub species were used from the 75 vegetative plots. A cluster analysis dendrogram illustrating the relative similarity among groups on the vegetative transects was produced (**Figure 38**). Vegetative plots are coded as transect name and distance from the uplands in meters while shrub species were given six-digit codes using genus and species names and coded along with wetland status. The matrix coding is based on minimum and maximum within a plot. **Figure 38** depicts 2 major groups (mixed hammock/bottomland hardwood and a bottomland hardwood/saltwater-freshwater swamp) and 10 color-coded subgroups. Percent information remaining was highest for the one plot (MO70, Rblh3, 74%) that had no canopy. The drier hammock plots (i.e. lower %SM) are depicted at the bottom of the figure followed by hammock/bottomland hardwood, marsh, saltwater swamp, and freshwater swamp with bottomland hardwood and hammock. Shannon's diversity index (H) was highest on plots BA70, BA110, BA60, MO90 and BA120 (**Appendix H**, **Table H-4**). With regard to shrub species, giant leather fern, Brazilian pepper, shoebutton ardisia, sawgrass, and saltbush represented the highest H values within plots. For example, giant leather fern occurred on 41 of the 75 vegetative plots.

Table 9. Percent cover of shrubs by forest type and transect.

	Forest Types														
Transect	**H/U**	**H**	**H/UTblh3**	**Rblh3**	**Rblh2**	**UTblh2/3/H**	**UTblh3**	**UTblh2/3**	**UTblh2**	**UTblh1**	**UTmix**	**UTsw3**	**UTsw2**	**UTsw1**	**Marsh**
Miller Oxbow		0.16		0.73	0.12										
Most common species		SERREP PERBOR PSYNER SABPAL PELPTE		URELOB PSYSUL SABPAL SCHTER ECLPRO	PSYSUL SABPAL										
River's Edge	0.08		0.21			0.12	0.19	0.08	0.04	0.17			0.12		
Most common species	SERREP BACGLO VITAES		ACRDAN CEPOCC QUELAU ACERUB BACGLO			BACGLO ACRDAN OSMCIN MYRCER	ARDELL ACRDAN	ACRDAN OSMCIN	SERREP	ACRDAN ARDELL FRACAR			ACRDAN ACERUB OSMCIN BACGLO FRACAR		
Beach Avenue		0.16	0.03				0.42			0.2				0.18	
Most common species		BACGLO SERREP QUELAU ILEGLA ARDELL	ARDELL SERREP				ARDELL SERREP ACERUB ACRDAN BACGLO			CLAJAM ACERUB CEPOCC MYRCER ANNGLA				ACRDAN CLAJAM ANNGLA HYPVER BACGLO	
Crowberry Drive							0.11		0.06		0.03	0.71			0.09
Most common species							ACRDAN OSMCIN BLESER SERREP PERBOR		SERREP MYRCER BLESER ARDELL		ACRDAN CLAJAM	CLAJAM ACRDAN SCHTER LAGRAC			CLAJAM SCHTER ACRDAN LAGRAC

See Appendix C for species codes.
See Appendix F for forest type codes.

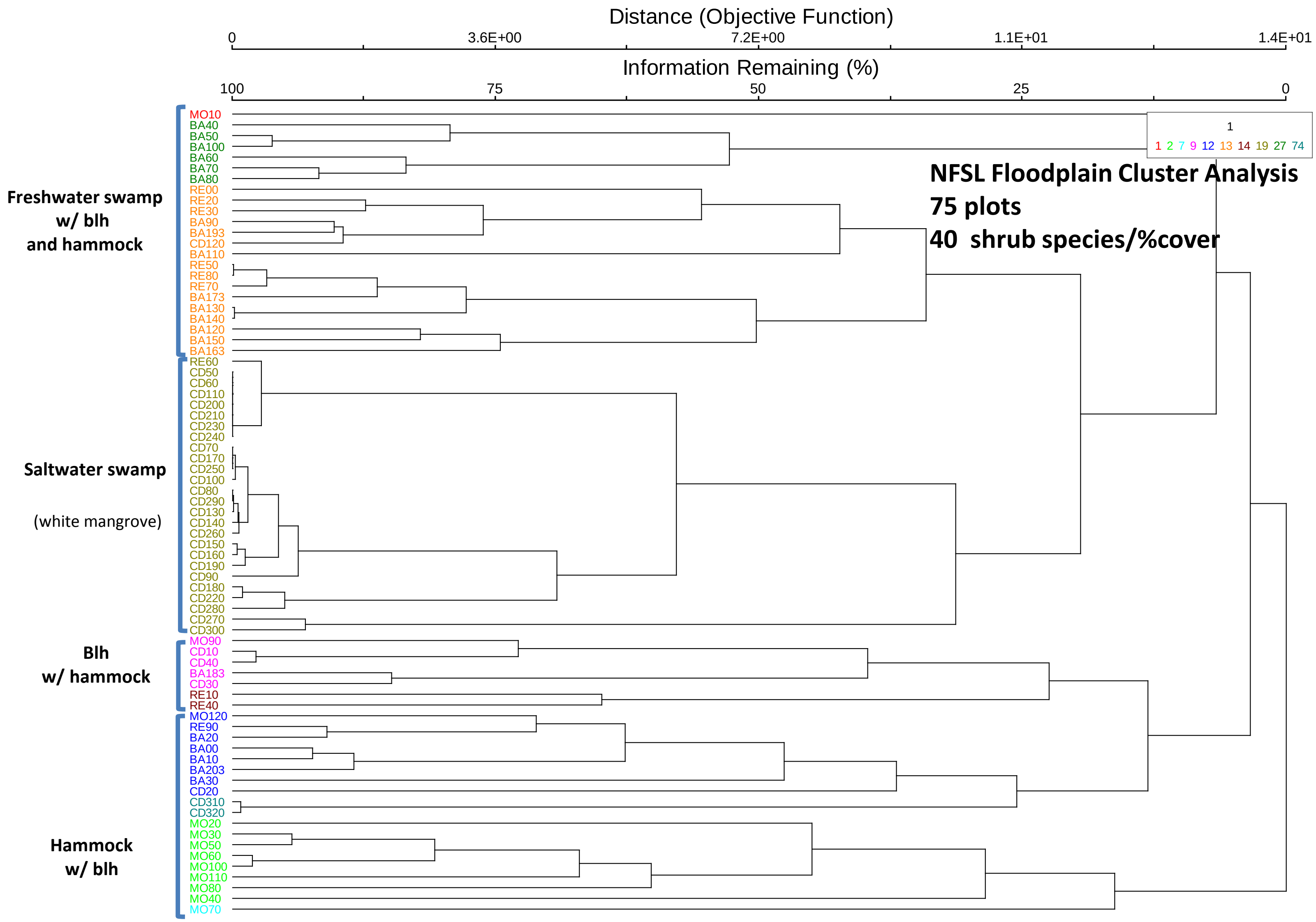


Figure 38. Cluster analysis dendrogram of percent cover for 75 vegetative plots and 40 shrub species. (Note: NFSL – North Fork St. Lucie River.)

Figure 39 depicts a two-way cluster dendrogram for the 75 plots and 40 shrub species found on the North Fork St. Lucie River floodplain. Levels of %SM run lower to higher from left to right (i.e. hammock to freshwater swamp). The white mangrove swamp with its higher EC clustered again in the middle with %SM levels not as high as the tidally inundated freshwater swamps with breeches in the berm. OBLs, leather fern, sawgrass, buttonbush and pond apple clustered together, while pop ash clustered with wild coffee. In addition, there were several direct associations between species including sawgrass and Brazilian pepper, pond apple and Carolina willow, laurel oak and strawberry guava, and wild coffee and Caesarweed.

Figure 40 illustrates the CCA two-dimensional clustering of shrub species (green dots) with notation of wetland status groups. The scatterplot includes an overlay of the three environmental variables (river mile, EC and %SM) illustrated as red vectors. The detailed results of the ordination are given in in **Appendix H**, **Table H-4**. Correlation values between species and environmental variables were r = -0.918 for river mile, r = 0.712 for EC and r = 0.507 for %SM on Axis 1. Again, the OBL shrub species separated into two distinct groups based on low (common buttonbush and pop ash) or high (sawgrass, white mangrove, leather fern, and pond apple) EC tolerance and low and high %SM levels. The position and length of the environmental vectors indicated that for shrubs, EC was the most important variable with a negative relationship with river mile (i.e. EC decreases with increasing river mile, r = -0.602) while %SM was also negative to river mile (r = -0.266) and positive to EC to a lesser degree (r = 0.354).

Table 10 provides the statistical analysis of the correlations between the 23 shrub species and the environmental variables (river mile, EC and %SM). Giant leather fern exhibited a positive relationship with EC (r = 0.851, r^2 = 0.725 and tau = 0.535) and a negative relationship with river mile (r = 0.-496, r^2 = 0.246, and tau = -0.494). Sawgrass exhibited negative relationships to both river mile (r = -0.639, r^2 = 0.408 and tau = -0.555) and EC (r = -0.508, r^2 = 0.258 and tau = -0.458). Wild coffee (*Psychotria nervosa*) displayed a negative correlation with %SM (r = -0.521, r^2 = 0.272 and tau = -0.396). Saw palmetto displayed positive relationships between both river mile (r = 0.657, r^2 = 0.432 and tau = 0.538) and %SM (r = 0.567, r^2 = 0.321 and tau = 0.484). Finally, Caesarweed displayed a negative correlation with %SM (r = -0.452, r^2 = 0.204 and tau = -0.271). Biplots for giant leather fern and sawgrass are shown in **Appendix H**, **Figures H-19** and **H-20**. Most of the larger sawgrass triangles fell downriver in the high EC (r = -0.639) whereas giant leather fern fell both in a wider range of higher EC (r = -0.496) and higher %SM with regard to river mile.

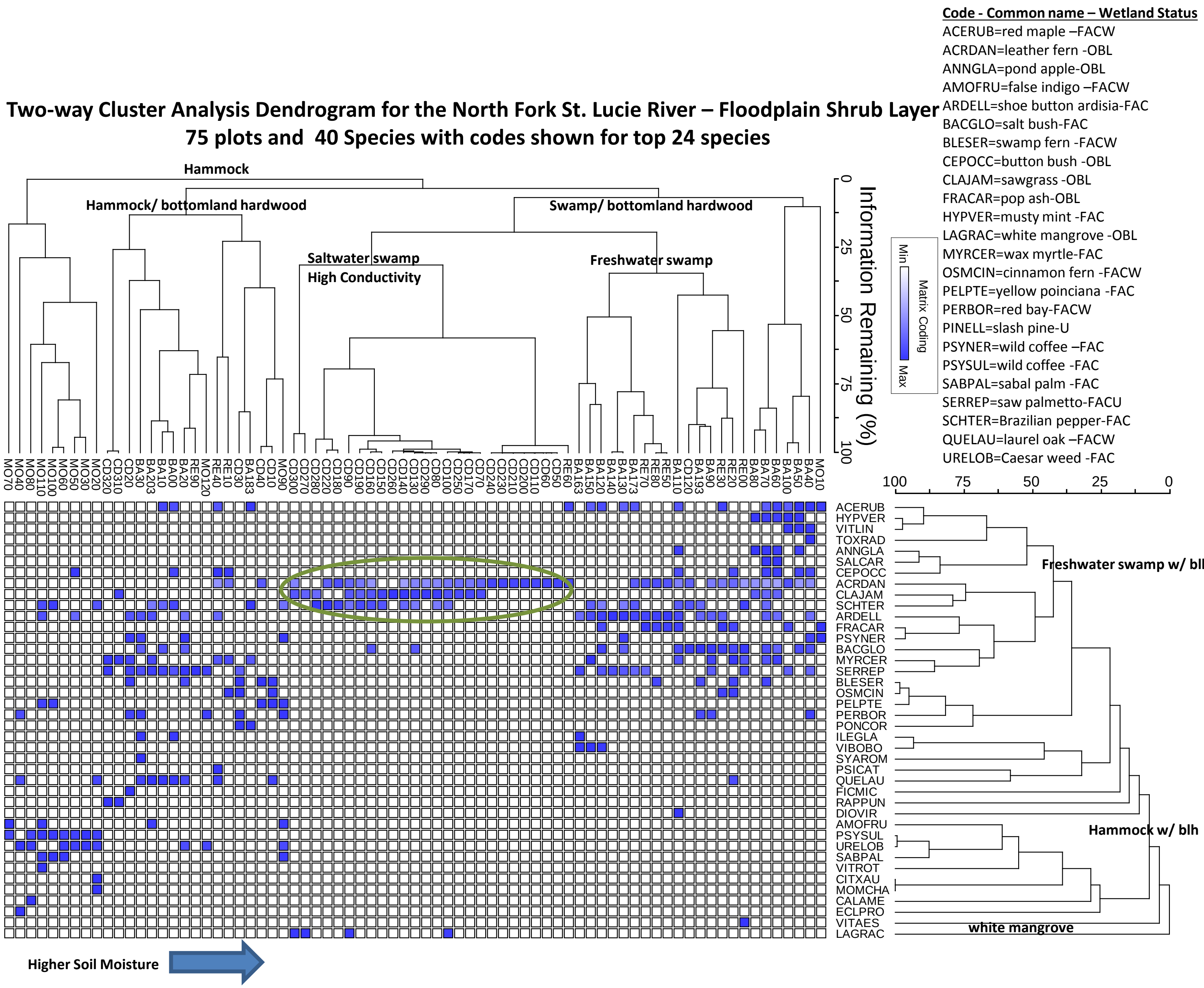


Figure 39. Two-way cluster analysis for the shrub layer using 75 plots and 40 species.

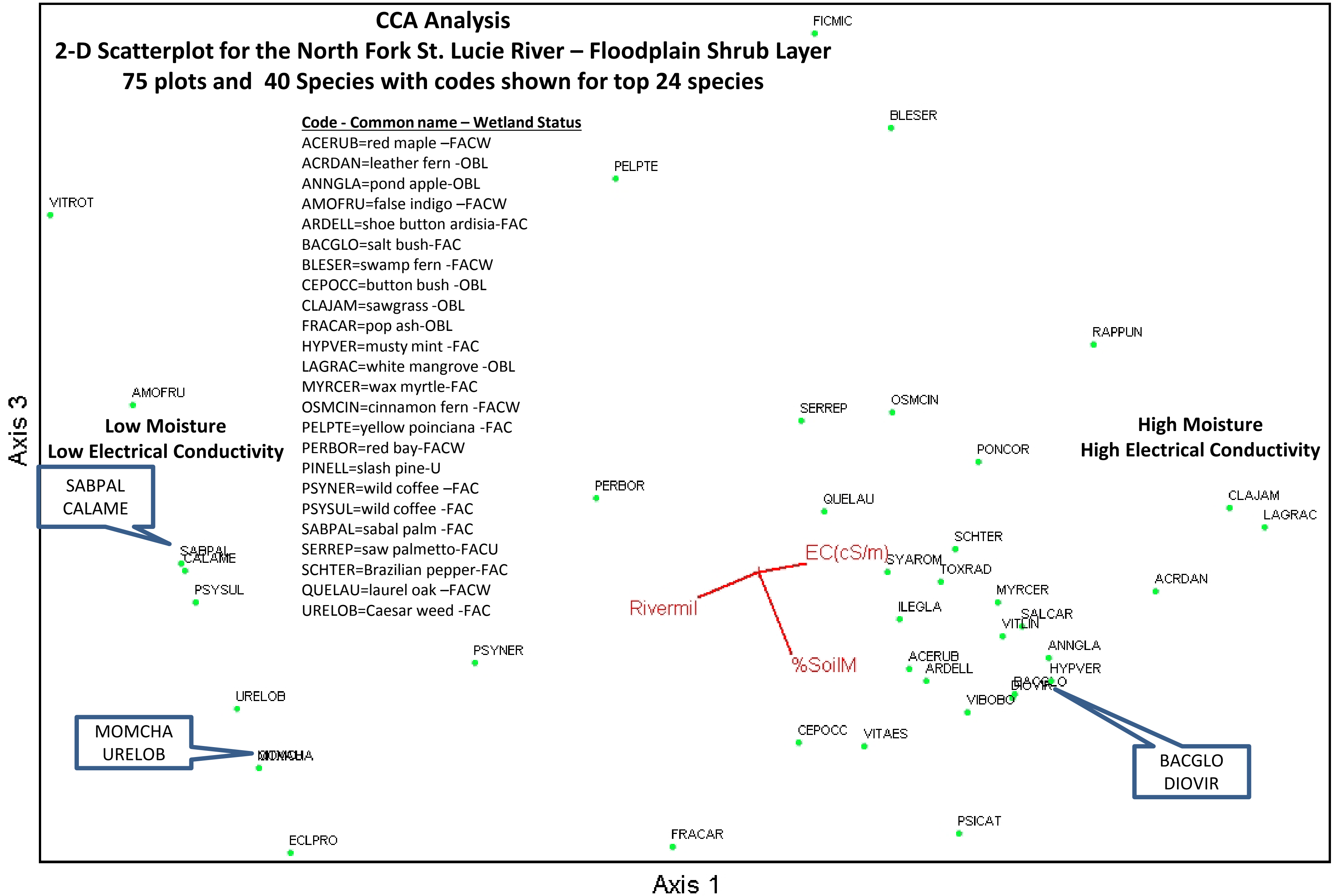


Figure 40. Two-dimensional scatterplot of 75 vegetative plots and 40 shrub species.

Table 10. CCA analysis of shrub species and environmental variables.
(Pearson and Kendall Correlations with Ordination Axes, N= 75 plots and 40 species.
Yellow highlighting indicates significance.)

Scientific Name	Common Name	Axis 1			Axis 2			Axis 3		
		r	r^2	tau	r	r^2	tau	r	r^2	tau
Acer rubrum	red maple	-0.023	0.001	-0.135	0.218	0.048	0.273	-0.172	0.030	-0.252
Acrostichum danaeifolium	giant leather fern	0.463	0.215	0.426	-0.386	0.149	-0.249	-0.093	0.009	-0.071
Amorpha fruiticosa	false indigo	-0.338	0.114	-0.276	0.011	0.000	0.050	0.116	0.013	0.086
Annona glabra	pond apple	0.070	0.005	0.048	0.003	0.000	-0.002	-0.096	0.009	-0.110
*Ardisia elliptica**	shoebutton ardisia	-0.008	0.000	-0.190	0.337	0.113	0.381	-0.220	0.048	-0.315
Baccharis glomerulifora	salt brush	0.080	0.006	-0.040	0.179	0.032	0.195	-0.218	0.048	-0.144
Blechum serrulatum	swamp fern	-0.029	0.001	-0.139	0.180	0.032	0.249	0.521	0.272	0.076
Callicarpa americana	American beautyberry	-0.244	0.060	-0.150	0.015	0.000	-0.009	-0.003	0.000	-0.009
Cephalanthus occidentalis	buttonbush	-0.103	0.011	-0.133	0.160	0.026	0.190	-0.235	0.055	-0.203
Citrus aurantium	sour orange	-0.220	0.048	-0.124	0.025	0.001	0.031	-0.114	0.013	-0.119
Cladium jamaicense	sawgrass	0.456	0.208	0.446	-0.610	0.372	-0.481	0.151	0.023	0.270
Diospyros virginiana	common persimmon	0.026	0.001	0.004	0.067	0.004	0.044	-0.074	0.005	-0.071
Eclipta prostrata	false daisy	-0.210	0.044	-0.119	0.029	0.001	0.035	-0.161	0.026	-0.146
*Ficus microcarpa**	laurel ficus	-0.039	0.002	-0.093	0.149	0.022	0.128	0.298	0.089	0.150
Fraxinus caroliniana	pop ash	-0.168	0.028	-0.098	0.142	0.020	0.226	-0.312	0.097	-0.361
Hyptis verticillata	musty mint/ John Charles	0.073	0.005	0.058	0.019	0.000	-0.008	-0.123	0.015	-0.120
Ilex glabra	gallberry, inkberry	-0.015	0.000	-0.135	0.223	0.050	0.245	-0.041	0.002	0.019
Laguncularia racemosa	white mangrove	0.147	0.022	0.250	-0.202	0.041	-0.230	0.028	0.001	0.087
Momordica charantia	balsam pear	-0.220	0.048	-0.124	0.025	0.001	0.031	-0.114	0.013	-0.119
Myrica cerifera	wax myrtle	0.066	0.004	-0.053	0.210	0.044	0.217	-0.065	0.004	-0.167
Osmundo cinnamomum	cinnamon fern	-0.026	0.001	-0.128	0.265	0.070	0.248	0.168	0.028	-0.052
Peltophorum pterocarpum	yellow poinciana	-0.193	0.037	-0.262	0.112	0.013	0.030	0.404	0.163	0.192
Persea borbonia	red bay	-0.288	0.083	-0.232	0.187	0.035	0.172	0.097	0.009	0.020
Pontederia cordata	pickerelweed	0.020	0.000	-0.027	0.138	0.019	0.111	0.080	0.006	0.011
*Psidium cattleianum**	strawberry guava	0.008	0.000	-0.035	0.107	0.011	0.079	-0.150	0.023	-0.137
Psychotria nervosa	wild coffee	-0.278	0.077	-0.245	0.128	0.016	0.227	-0.103	0.011	-0.022
Psychotria sulzneri	shortleaf wild coffee	-0.661	0.437	-0.407	0.045	0.002	0.012	-0.057	0.003	-0.057
Quercus laurifolia	laurel oak	-0.080	0.006	-0.271	0.364	0.133	0.384	0.067	0.004	-0.041
Rapanea punctata	myrsine	0.074	0.005	0.055	-0.046	0.002	-0.058	0.174	0.030	0.180
Sabal palmetto	cabbage palm	-0.465	0.216	-0.292	0.027	0.001	-0.009	0.001	0.000	0.013
Salix caroliniana	Carolina willow	0.032	0.001	0.023	0.020	0.000	-0.008	-0.038	0.001	-0.064
*Schinus terebinthifolia**	Brazilian pepper	0.032	0.001	0.074	-0.142	0.020	-0.074	0.041	0.002	0.032
Serenoa repens	saw palmetto	-0.167	0.028	-0.286	0.473	0.224	0.451	0.311	0.097	0.066
Syagrus romanzoffiana	queen palm	-0.015	0.000	-0.075	0.156	0.024	0.132	-0.004	0.000	-0.013
Toxicodendron radicans	poison oak	0.003	0.000	-0.062	0.095	0.009	0.066	-0.009	0.000	-0.018
*Urena lobata**	Caesarweed	-0.599	0.359	-0.402	0.058	0.003	0.088	-0.213	0.045	-0.142
Viburnum obovatum	Walter's vibernum	0.018	0.000	-0.063	0.211	0.045	0.186	-0.135	0.018	-0.135
Vitis aestivalis	summer grape	-0.023	0.001	-0.084	0.178	0.032	0.155	-0.102	0.010	-0.106
Vitis rotundifolia	muscadine grape	-0.288	0.083	-0.163	-0.004	0.000	-0.031	0.196	0.038	0.141
Vittaria lineata	shoestring fern	0.040	0.002	-0.013	0.083	0.007	0.059	-0.071	0.005	-0.077
River Mile		**-0.944**	**0.891**	**-0.701**	**0.263**	**0.069**	**0.418**	**-0.246**	**0.061**	**-0.470**
EC (cS/m)		**0.811**	**0.658**	**0.845**	**-0.896**	**0.803**	**-0.701**	**0.174**	**0.03**	**0.217**
%SM		**0.584**	**0.342**	**0.39**	**-0.219**	**0.048**	**-0.023**	**-0.790**	**0.624**	**-0.548**

* Invasive exotic species
Yellow highlights= significant correlations

Groundcover Community

The analysis of groundcover species provides a special view of new plant recruitment on the floodplain and gives us hints of seasonal and short-term changes in hydrology. Most of the 76 groundcover species observed on the four North Fork St. Lucie River transects were FAC and FACW wetland status. More OBLs were included among the list of groundcover species. The Miller Oxbow and Beach Avenue transects had the highest number of species (43 and 32, respectively) while the River's Edge Transect and Crowberry Drive Transect had the fewest (21 and 19, respectively). Eleven exotic species were present among the 76 groundcover species. At this time, ordination analysis has not been performed on the groundcover data sets.

Table 11 presents the results of the groundcover species stem count and percent cover data by transect. On the Miller Oxbow Transect stem counts were dominated by Caesarweed (434), Jack-in-the-bush (*Chromolaena odorata*, 340), common day flower (*Commelina diffusa*, 140), and whorled marsh pennywort (*Hydrocotyle verticellata*, 117). These plants are a combination of FAC and FACW species. Percent cover on the Miller Oxbow Transect was dominated by Jack-in-the-bush (39%), horsetail (*Conyza canadensis*, 20%) and lantana (*Lantana camara*, 16%), which are a combination of FAC and FACU species. Stem counts on the River's Edge Transect was dominated by more OBL species such as swamp fern (119), saw palmetto (70) and swamp lily (*Crinum americana*, 63), which are FACW, FACU and OBL species. Swamp fern (235%), lizard's tail (*Saururus cernuus*, 124%, OBL), and swamp lily dominated the percent cover across this transect. Two non-native or exotic species dominated the stem counts and percent cover on the Beach Avenue Transect. These were shoebutton ardisia (309, 145%, FAC) and creeping oxyeye (*Sphagneticola trilobata*, 218, 143%, FAC). Salt bush (FAC) was present at 116% cover. Groundcover stem counts on the Crowberry Drive Transect was dominated by white mangrove (2,783, OBL), Brazilian pepper (919, FAC) and creeping oxyeye (201). Percent cover on this transect was dominated by white mangrove (205%), creeping oxyeye (120%), herb-of-grace (*Bacopa monnieri*, 118%, OBL), swamp fern (83%) and Brazilian pepper (71%).

Table 11. Groundcover stem count and percent cover by transect.

Species	Code Name	Common Name	Transect							
			Miller Oxbow		River's Edge		Beach Avenue		Crowberry Drive	
			Stem Count	% Cover	Stem Count	% Cover	Stem Count	% Cover	Stem Count	% Cover
Abrus precatorius**	ABRPRE	rosary pea	4	0.02						
Acer rubrum	ACERUB	red maple			5	0.1	3	0.02		
Acrostichum danaeifolium	ACRDAN	giant leather fern	2	0.01	7	0.02	25	0.32	27	0.63
Alternanthera philoxeroides	ALTPHI	alligator weed					4	0.05		
Amorpha fruiticosa	AMOFRU	false indigo	4	0.05						
Annona glabra	ANNGLA	pond apple			1	0.05	1	0.02		
Ardisia elliptica**	ARDELL	shoebutton ardisia	9	0.03	24	0.48	309	1.45		
Baccharis glomerulifora	BACGLO	salt bush			1	0.05	36	1.16		
Bacopa monnieri	BACMON	herb of grace, water hyssop	18	0.01			78	0.42	82	1.18
Blechnum serrulatum	BLESER	swamp fern			119	2.35	31	0.25	57	0.83
Blechnum pyramidatum*	BLEPYR	Browne's blechum	6	0.01						
Callicarpa americana	CALAME	American beautyberry	7	0.03						
Cephalanthus occidentalis	CEPOCC	buttonbush					10	0.33		
Chamaecrista fasciculata	CHAFAS	partridge pea							4	0.2
Chromolaena odorata	CHRODO	Jack-in-the-bush	340	0.39	1	0.05	3	0.01		
Cladium jamaicense	CLAJAM	sawgrass					4	0.01	3	0.03
Commelina diffusa	COMDIF	common day flower	140	0.12						
Conoclinium coelestinium	CONCOE	blue mist flower	2	0.01						
Conyza canadensis	CONCAN	horsetail	2	0.2						
Crinum americana	CRIAME	swamp lily	5	0.05	63	1.03			19	0.3
Cyperus distinctus	CYPDIS	swamp flatsedge					23	0.05		
Cyperus ligularis	CYPLIG	swamp sedge	7	0.1						
Dalbergia ecastaphyllum	DALECA	coin vine							3	0.1
Desmodium incanum	DESINC	zarzabacoa, beggars's tick	74	0.14						
Dichanthelium commutatum	DICCOM	variable witchgrass	8	0.04						
Dichanthelium laxiflorum	DICLAX	rough witchgrass					17	0.29		
Dicanthelium portoricense	DICPOR	hemlock witchgrass							5	0.02
Dioscorea bulbifera**	DIOBUL	air-potato					5	0.04		
Drymaria cordata	DRYCOR	West Indian chickweed	1	0.01						

*Non-native (exotic)
**Invasive

Figure 11. Continued.

Species	Code Name	Common Name	Transect							
			Miller Oxbow		River's Edge		Beach Avenue		Crowberry Drive	
			Stem Count	% Cover	Stem Count	% Cover	Stem Count	% Cover	Stem Count	% Cover
Eclipta prostrata	ECLPRO	false daisy	4	0.01						
Emilia sonchifolia*	EMISON	lilac tassel flower	51	0.12						
Fraxinus caroliniana	FRACAR	pop ash			9	0.06	3	0.03		
Hydrocotyle verticellata	HYDVER	whorled marsh pennywort	117	0.14			25	0.06		
Hypoxis curtissii	HYPCUR	common yellow stargrass	10	0.1						
Hyptis verticillata*	HYPVER	musty mint/ John Charles	9	0.02			7	0.11		
Hypericum hypericoides	HYPHYP	St. John's wort	3	0.01						
Ipomoea sagittata	IPOSAG	morning glory					11	0.06		
Justicia brandegeana*	JUSBRA	shrimp plant	8	0.05						
Laguncularia racemosa	LAGRAC	white mangrove							2783	2.05
Lantana camara**	LANCAM	lantana verbena	64	0.16						
Lygodium microphyllum**	LYGMIC	Old World climbing fern			6	0.03	3	0.02		
Mikania scandens	MIKSCA	creeping hempvine	1	0.01						
Nephrolepis multiflora**	NEPMUL	Boston fern							1	0.02
Osmunda cinnamomum	OSMCIN	cinnamon fern	28	0.09						
Osmunda regalis	OSMREG	royal fern	5	0.01						
Oxalis spp.	OXASPP	false shamrock	1	0.01						
Parthenocissus quinquefolia	PARQUI	Virginia creeper	2	0.02						
Persea borbonia	PERBOR	red bay							1	0.01
Phyllanthus tenellus*	PHYTEN	Mascaren island leaf flower	2	0.01						
Pleopeltis polypodioides	PLEPOL	resurrection fern	5	0.05						
Psychotria nervosa	PSYNER	wild coffee	30	0.37			6	0.15	1	0.01
Psychotria sulzneri	PSYSUL	shortleaf wild coffee	55	0.26						
Quercus laurifolia	QUELAU	laurel oak	3	0.02	3	0.06	3	0.04	3	0.05
Quercus virginiana	QUEVIR	live oak					4	0.05		
Rhabdadenia biflora	RHABIF	rubber vine							11	0.19
Sabal palmetto	SABPAL	cabbage palm	36	0.24	1	0.05	23	0.08		
Sagittaria lancifolia	SAGLAN	arrowhead			9	0.8				
Saururus cernuus	SAUCER	lizard's tail			25	1.24				

*Non-native (exotic)
**Invasive

Figure 11. Continued.

Species	Code Name	Common Name	Transect							
			Miller Oxbow		River's Edge		Beach Avenue		Crowberry Drive	
			Stem Count	% Cover	Stem Count	% Cover	Stem Count	% Cover	Stem Count	% Cover
Schinus terebinthifolius**	SCHTER	Brazilian pepper					13	0.22	919	0.71
Scleria triglomerata	SCLTRI	tall nutgrass	25	0.08			3	0.01		
Senna pendula**	SENPEN	climbing cassia	8	0.03						
Serenoa repens	SERREP	saw palmetto			70	0.06	9	0.17		
Smilax auriculata	SMIAUR	earleaf greenbrier	3	0.02	3	0.05				
Smilax bona-nox	SMIBON	saw greenbrier	1	0.01					2	0.02
Smilax laurifolia	SMILAU	laurel greenbrier	1	0.01	1	0.05				
Spemacoce verticillata	SPEVER	false buttonwood	9	0.04						
Sphagneticola trilobata*	SPHTRI	creeping oxeye, wedelia					218	1.43	201	1.2
Symphotrichum carolinianum	SYMCAR	climbing aster					20	0.02		
Thelypteris dentata	THEDEN	downy shield fern	3	0.01						
Tillandsia spp.	TILSPP	airplant	2	0.1						
Toxicodendron radicans	TOXRAD	poison oak			26	0.33	82	0.42	6	0.03
Urena lobata**	URELOB	Caesarweed	434	1.34						
Viburnum obovatum	VIBOBO	Walter's viburnum								
Vitis aestivalis	VITAES	summer grape			8	0.06			10	0.03
Vitis rotundifolia	VITROT	muscadine grape	4	0.04			3	0.02		
Vittaria lineata	VITLIN	shoestring fern					44	0.26		
Number of Species			**76**		**43**		**21**		**32**	

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*Non-native (exotic)
**Invasive

Table 12 presents the total stem count and percent cover data by transect and by forest type along with some of the most common species. On the Miller Oxbow Transect, the hammock community was dominated by 4 species: tall nutgrass (*Scleria triglomerata*, FACW), cabbage palm (FAC), Jack-in-the-bush (FACW) and common day flower (FACW). Jack-in-the-bush was present in all three forest types (hammock, Rblh3 and Rblh2) while common day flower was present in both hammock and Rblh3. The other species that dominated Rblh3 and Rblh2 bottomland hardwood were whorled marsh pennywort, Caesarweed, American beautyberry (*Callicarpa americana*) and shortleaf wild coffee. On the River's Edge Transect, swamp fern was common on all three forest types (hammock, bottomland hardwood and swamp) while cinnamon fern (*Osmunda cinnamomum*) was common on both hammock and bottomland hardwood forest types. With the open tidal influence on this transect, it was notable that several OBLs were present in the bottomland hardwood communities including swamp lily, herb-of-grace, and lizards tail. Poison oak (*Toxicodendron radicans*) and shoebutton ardisia were present on the drier plots of H/UTblh3. Tall nut grass was common in the hammock and bottomland hardwood plots of the Beach Avenue Transect while swamp flat sedge (*Cyperus distinctus*, OBL) was only found in the hammock of this transect. Shoe string fern (*Vittaria lineata*, FAC) was common in both bottomland hardwood and tidal swamp while climbing aster (*Symhyotrichum carolinianum*), an OBL, was only found common in the UTblh3. On this transect, whorled marsh pennywort was present in the lower portion of the bottomland hardwood along with herb-of-grace and poison oak. The Crowberry Drive Transect was less diverse with white mangrove and herb-of-grace in the swamp plots and tall nutgrass, swamp fern and Brazilian pepper in the few hammock and bottomland hardwood plots.

Table 12. Groundcover stem count and percent cover by forest type.

Transect	Forest Types														
	H/U	H	H/UTblh3	Rblh3	Rblh2	UTblh2/3/H	UTblh3	UTblh2/3	UTblh2	UTblh1	UTmix	UTsw3	UTsw2	UTsw1	Marsh
Miller Oxbow - Stems		93		1695	54										
% Cover		0.53		4.12	0.29										
Most common species		SCLTRI SABPAL CHRODO COMDIF		HYDVER URELOB CHRODO COMDIF	CHRODO CALAME PSYSUL										
River's Edge - Stems	65		32			228	45	63	112	48			43		
% Cover	1.88		66			1.41	0.39	0.55	0.24	0.58			1.79		
Most common species	BLESER OSMCIN		TOXRAD ARDELL BLESER			BACSPP CRIAME OSMCIN	BLESER	CRIAME BACSPP SAUCER	SERREP	BLESER			BLESER CRIAME		
Beach Avenue - Stems		223	2				560			170				86	
% Cover		1.77	0.06				3.04			1.35				0.5	
Most common Species		SPHTRI CYPDIS	ARDELL				ARDELL SPHTRI VITLIN SYMCAR			BACMON TOXRAD HYDVER				BACGLO TOXRAD VITLIN	
Crowberry Drive - Stems		111					397		99		622	2699			217
%Cover		0.69					1.32		0.59		0.53	2.86			1.68
Most common species		SPHTRI					SCHTER BLESER SPHTRI		SPHTRI		SCHTER	LAGRAC BACMON			LAGRAC

See Appendix C for species codes.
See Appendix F for forest type codes.

DISCUSSION AND CONCLUSIONS

With regard to forest composition, Post, Buckley, Schuh & Jernigan (2003) stated that the health of floodplain vegetation on the North Fork St. Lucie River was primarily determined by duration of inundation and saturation, depth and frequency of floods, and salinity. Anderson and Lockaby (2011) found that along the Apalachicola River, two major physiochemical changes affected tidal and nontidal wetlands: 1) hydrodynamics or prolonged inundation due to regular tidal flooding along with elevation and microtopography, and 2) periodic exposure to salinity as a result of storm surge or periods of low river flow. Cluster analysis of their 12 dominant canopy species differentiated hydrologic and community groups. They noted that tidal wetlands on the Apalachicola River had smaller diameter trees but greater tree density, and their tidal wetlands had significantly lower concentrations of soil constituents than the non-tidal wetlands. They also found that as EC approached 4 S/cm, the osmotic impact on trees becomes significant to physiological stress that could reduce photosynthetic activity, tree growth and canopy cover. Additionally, they noted declines in understory vegetation further upriver reflecting greater canopy cover and flood energy in the riverine reach.

In our study of the North Fork St. Lucie River, air temperature was significant when it came to cold and freezing weather periods. In this watershed, inland mangroves were particularly affected by cold weather resulting in either defoliation or death. It was unclear whether defoliated giant leather ferns were affected both by cold weather and dry or high soil salinity periods. However, agricultural literature points to the fact that they can be grown in upland landscapes, if properly watered. It was a very arid dry season leading up to our field study although local rainfall proved not to be significant during this investigation.

There was a significant change in floodplain soil type noted between RM 23.5 and RM 24 where the river begins to widen. This area is just upstream of the Prima Vista Bridge and downstream of the Beach Avenue Transect. In this area, floodplain soils switched primarily from Fluvaquents to Terra Ceia Muck, reflecting a change also in plant species composition (i.e. more freshwater canopy species). In general, Terra Ceia Muck is inundated for longer periods of time (6 to 9 months) and more reflective of a lower tidal floodplain feature with marshes and depressions while Fluvaquents are more associated with upstream creeks and riverbeds with hammocks and wetland hardwoods, and are generally flooded once every 2 years for 7 to 30 days (USDA et al., 1977).

With regard to EC and %SM in our study, the highest EC values were associated with the transitional young mangrove forested areas with remnant sawgrass/leather fern marsh on the Crowberry Drive Transect while no or low ECs were associated with berms and hammock areas.

%SM values generally rose in areas adjacent to the river channel; and were highest on the River's Edge Transect with its significant breach in the berm and daily tidal inundation. Soils on the Miller Oxbow transect, which has the widest and tallest berm, were the driest overall.

In an MFL examination of modeled historical and current patterns of flows to the North Fork St. Lucie River between 1965 and 1995, it was concluded that freshwater flow had declined 39% due to reductions in high flow events although peak discharge events typically persisted for longer periods of time (SFWMD, 2002). The combined use of the watershed, hydrodynamic and salinity, and OPTI6 modeling produced a North Fork dry season water reservation target flow of 130 cfs at the Gordy Road structure in order to protect fish and wildlife from harm by maintaining the low salinity zone between the Kellstadt and Prima Vista bridges (RM 17.2 and RM 23.1). Results of the North Fork Narrows DEM concluded that it would take a 2-foot stage increase to inundate 18% of the floodplain (645 acres of 3,666 acres) (SFWMD, 2009, Appendix D). Mean monthly flow data from the Gordy Road structure showed that the MFL criteria (130 cfs) is only being partially met at this time. 2003 through 2005 appeared to successfully meet the water reservation target flow for all dry season months; however, the flow has been generally below the criteria for 2006 through 2011.

Modeled salinity data of the North Fork St. Lucie River showed the 14 isohaline reaching above the Prima Vista Bridge (RM 23.1, near the Beach Avenue Transect). It did not recede below the Kellstadt Bridge (RM 17.3) until wet season or high flows. The 6 and 1 isohalines reached up to the Midway Bridge (RM 27, near the River's Edge Transect) during low flow conditions and did not recede below the Kellstadt Bridge except under high flows in the wet season. These salinity conditions may contribute to saltwater intrusion within the North Fork St. Lucie River floodplain communities (notably Crowberry Drive and Beach Avenue transects, and during extreme droughts, River's Edge Transect). Therefore, these data may indicate to us that opening berms and restoring hydroperiod to floodplain areas may be an issue particularly to species such as water hickory, red maple and pop ash in the upper tidal reach of the river, if freshwater flow is not available from the Gordy Road or S-59 structure (C-24 Basin) to maintain low salinity levels in the river channel of the North Fork St. Lucie River.

In a 2009 examination of four vegetative transects with a total of 77 plots on the North Fork St. Lucie River and Ten Mile Creek, 17 forest community types, 16 canopy species, 40 shrub species, and 76 groundcover species were identified and enumerated. The six major forest types were bottomland hardwood, hydric hammock, fresh and saltwater swamp, tidal freshwater sawgrass marsh, and uplands. The most abundant canopy species were cabbage palm, white mangrove and laurel oak while the highest basal area canopy species were cabbage palm and laurel oak. With regards to canopy species size, the majority of the trees fell into the 5–20 cm and 21–40 cm dbh size class frequencies. Only red maple, slash pine, laurel oak, live oak and cabbage palm had trees greater than 40 cm. There were no trees that fell into the 81–

99+ cm size class frequency, which is commonly occupied by older bald cypress trees on the Florida peninsula. New recruitment to the canopy layer was dominated primarily by white mangrove on the downstream portion of the river; otherwise, there was a small amount of recruitment from pop ash, pond apple, red maple and wax myrtle in the shrub and groundcover layers. As with the Appalachicola River floodplain, there were smaller diameter trees but greater density in the tidal reach of the North Fork St. Lucie River.

In observance of canopy species distribution by transect, those transects with poorer hydrology (Miller Oxbow and Crowberry Drive) had fewer canopy species. The Miller Oxbow Transect (the driest of the four transects) had the tallest berm, the fewest number of canopy trees (77, 12 plots), and the smallest number of canopy species (5). The Crowberry Drive Transect had a smaller berm than Miller Oxbow, 158 canopy trees, 9 canopy species and the largest number of plots (31). However, 70% of the trees on this transect were small white mangrove (i.e. saltwater swamp), all of them within the 5–20 cm dbh size class frequency. The Beach Avenue Transect, with its small berm but backwater connection via an oxbow to the river, had 200 canopy trees (20 plots), 12 canopy species, and some of the largest laurel and live oaks, cabbage palm and saw palmetto. 54% of the canopy was hammock species while 16% was swamp and 16% was bottomland hardwood. The River’s Edge Transect was the shortest transect with just 10 plots (97 trees); however, it had 10 canopy species composed of 61% swamp and low bottomland hardwood species and about 36% hammock and high bottomland hardwood species.

Using ordination of the 16 canopy species and 65 of the total plots, the resulting cluster dendrogram identified two major canopy groups (i.e. saltwater swamp and mixed hammock, bottomland hardwood and freshwater swamp). Four forest community types were identified: 1) freshwater swamp (pond apple and pop ash); 2) bottomland hardwood (laurel oak, red maple and water hickory); 3) hammock (cabbage palm, saw palmetto and live oak); and 4) saltwater swamp (white mangrove). Mixed communities of hammock/bottomland hardwood and bottomland hardwood/swamp species were quite prevalent on the North Fork St. Lucie River probably due to the lack of inundation (i.e. poor hydrology) across most transects and the presence of the berms, which isolated much of the floodplain area.

Ordination analysis grouped canopy species by salt tolerance, %SM preference and river mile. EC by river mile was shown to have the strongest correlation followed by %SM and river mile for canopy species. EC values increased with decreasing river mile due to the higher salinities downstream and higher concentration of white mangroves downstream. While white mangrove showed a high positive correlation with EC, cabbage palm, live oak and water hickory showed a negative correlation using a Bray Curtis analysis. White mangroves were not found at ECs of < 1,503 cS/m or %SM levels of < 66%. Pond apple appeared to be indifferent with regards to EC. In a bald cypress and pond apple seedling mesocosm study, pond apple seedlings survived salinities of 25 for one week in both flooding and non-flooding conditions (Liu and Li, 2007).

%SM increased slightly with EC; however, the highest %SM values were mid-river on the River's Edge Transect, which is tidally flushed daily via a large breach in the berm. This area was dominated by swamp species, pond apple and pop ash. %SM was lowest adjacent to the uplands (i.e. hammock areas) and on berms adjacent to the river channel. White mangrove demonstrated a slightly negative response to %SM while pond apple, pop ash and red maple demonstrated significant positive responses. Pond apple were only observed at %SM > 75. It is assumed that the small population of pond apple trees on the North Fork St. Lucie River is attributed to the reduced hydroperiods on the floodplain areas that are isolated from the main channel. This is also probably the reason why red and black mangroves have not spread into the interior of the floodplain area.

There were 40 species of shrub and 76 species of groundcover identified within the four North Fork St. Lucie River transects. Most of these species were classified as FAC or FACW or could be found associated with wetland systems. There were only 9 shrub species classified as OBL or always found in association with wetland systems. There were 7 non-native (exotic) shrubs and 14 non-native (exotic) groundcover species encountered. The most frequently encountered exotics were shoebutton ardisia and Brazilian pepper. The highest percent cover of shrubs was attributed to the abundance of white mangrove, sawgrass and giant leather fern on the Crowberry Drive Transect. The Beach Avenue Transect had the highest number of shrub species due to human impacts from the dumping of vegetation inside the aquatic preserve property. The Miller Oxbow and the Beach Avenue transects had the highest number of groundcover species. Dominance of shrub and groundcover species on the four transects correlated highest with %SM and the presence or absence of a berm adjacent to the river channel. Shrub and groundcover species were frequently found within multiple forest types creating mixed communities of upland/hammock, hammock/bottomland hardwood and bottomland hardwood/swamp across changes in ground elevation. In an ordination analysis of the 40 shrub species, plant communities were sorted by low and high EC and low and high %SM preferences. Giant leather fern exhibited a positive relationship with EC while sawgrass exhibited a negative relationship to it. Alexander (1967) noted the recovery of vegetation (particularly sawgrass prairies) in the southeastern Everglades after Hurricane Betsy blew salt water far inland. Some species such as pond apple, salt bush, red bay, sawgrass and myrsine (*Myrsine cubana*) that were severely damaged began producing new root sprouts and seedlings within a few weeks after the storm while other species such as button bush, dahoon holly, Carolina willow, bald cypress and cabbage palm were much slower to recover.

Floodplain Forest Impacts

The riparian forested wetland systems within the St. Lucie River Watershed vary from dry to occasionally flooded stages as the river and its tributaries react to local rainfall events. The major forest types are upland, hammock, bottomland hardwood and freshwater and tidal swamp. The riparian forests are generally referred to in the southeastern United States as bottomland hardwood forests. They contain diverse vegetation that varies along gradients of flooding frequency. They are generally considered to be more productive than the adjacent uplands because of the periodic inflow of nutrients, especially when flooding is seasonal rather than continuous (Mitsch and Gosselink, 1993). In freshwater reaches of the St. Lucie River, the dominant bottomland hardwood species are red maple, water hickory and a variety of bay (*Persea* sp.). Swamps are defined as woody wetlands that have standing water for most if not all of the growing season. Swamps on the floodplains of the St Lucie River consist of red and white mangroves, pond apple and pop ash. Noticeably reduced in number are bald cypress and pond apple, which were probably logged as the river and tributaries were dredged and channelized.

It appears from our vegetation study of the North Fork St. Lucie River that much of the lower floodplain area no longer exists. As part of the early dredging activities around the 1920s, most of the floodplain canopy trees along the river were cut and removed for lumber. What remains of the floodplain is the middle and upper areas or the bottomland hardwood and hammock communities in the upper and middle part of the river system and some smaller areas of swamp and tidal marshes in the downstream tidal reach of the North Fork. Some of the areas of bottomland hardwood and hammock are natural while others are man-made by the system of berms that were created on both sides of the main channel. In the downstream area, most of the marshes are now located behind the berms and are in the process of converting to forested wetland systems as they have done on the Loxahatchee River.

This study showed that swamp species like pond apple, pop ash and sawgrass are clearly struggling to survive the shorten hydroperiods on the isolated floodplains of the North Fork St. Lucie River. While pond apple and pop ash may be visible along the shores of the river channel, they are not abundant within the interior of the floodplain and those that are present are relatively young and small. The largest canopy pond apple observed on the transects was 11.0-cm dbh on Beach Avenue (plot BA100). The largest canopy pop ash observed was 25.0-cm dbh on the Miller Oxbow Transect (plot MO20). Overall, mixed communities of upland/hammock, hammock/bottomland hardwood and bottomland hardwood/swamp are becoming the norm. The remaining proliferation of mixed community and forest types are indicative of floodplains with altered hydrology and signs of saltwater intrusion. The mixed bottomland hardwood community was truly a mixture of uplands (Brazilian pepper), hammock (wax myrtle and red bay), bottomland hardwood (red maple and strawberry guava) and even swamp species (pop ash). The mixed hammock group consisted of slash pine, saw palmetto and tamarind (upland species); cabbage palm (hammock species); water hickory and laurel oak (high bottom land hardwood species).

Floodplain Restoration and Future Studies

In the 2003 *Feasibility Study for the Reconnection of Wetlands and Oxbows along the North Fork of the St. Lucie River*, 26 berms were identified, 3 berm breach projects that had been conducted were described, and 21 oxbow reconnection/creation site locations and 21 berm breach site locations were identified (Post ,Buckley, Schuh & Jernigan, 2003). Cost and cost estimates were given or estimated for each project. However, some of the land is still under private ownership, so additional monies were needed for land purchases. Projects were ranked based on cost per acre of wetland habitat restored. At that time, they felt that more hydrologic modeling and fisheries studies were needed to evaluate the context of reconnection with respect to salinity zones and juvenile fish abundances in the river. They concluded that the environmental benefits of the reconnection of oxbows and isolated wetland habitats would reduce freshwater pulses and flow velocities, and provide greater retention time by creating a greater number of flow pathways longitudinally along the river. This, in turn, would increase the filtration capacity within the river and reduce suspended solids, nutrients, heavy metals, sediments and other pollutant loads to the downstream estuary. With breaches of sufficient width and depth, substantial flow conveyance would allow for greater wetted perimeter of the previously isolated wetlands and in turn allow for increased utilization by aquatic organisms. In addition, it is thought that increased inundation may reduce or further limit the spread of exotic vegetation such as Brazilian pepper. **Figure 41** illustrates the Florida Fish and Wildlife Conservation Commission’s 2010 Miller Oxbow Reconnection Project on Ten Mile Creek.

The *Central and Southern Florida Project Indian River Lagoon – South Final Integrated Project Implementation Report and Environmental Impact Statement* (USACE and SFWMD, 2004) listed five features that would be necessary to meet the identified project goals for the Indian River Lagoon – South Project. These features included 1) reservoirs, 2) stormwater treatment areas; 3) natural storage and treatment areas, including restoration within the North Fork floodplain; 4) diversion; and 5) muck removal and the creation of artificial habitat in the estuary. In addition to proposed treatment areas, the project includes preserving approximately 3,100 acres of floodplain wetlands and oligohaline habitat within the North Fork St. Lucie River. Preservation of the North Fork floodplain will provide some of the needed water storage, maintain wading bird habitat, improve water quality, and protect areas that currently serve as nursery areas for larval and juvenile fishes.

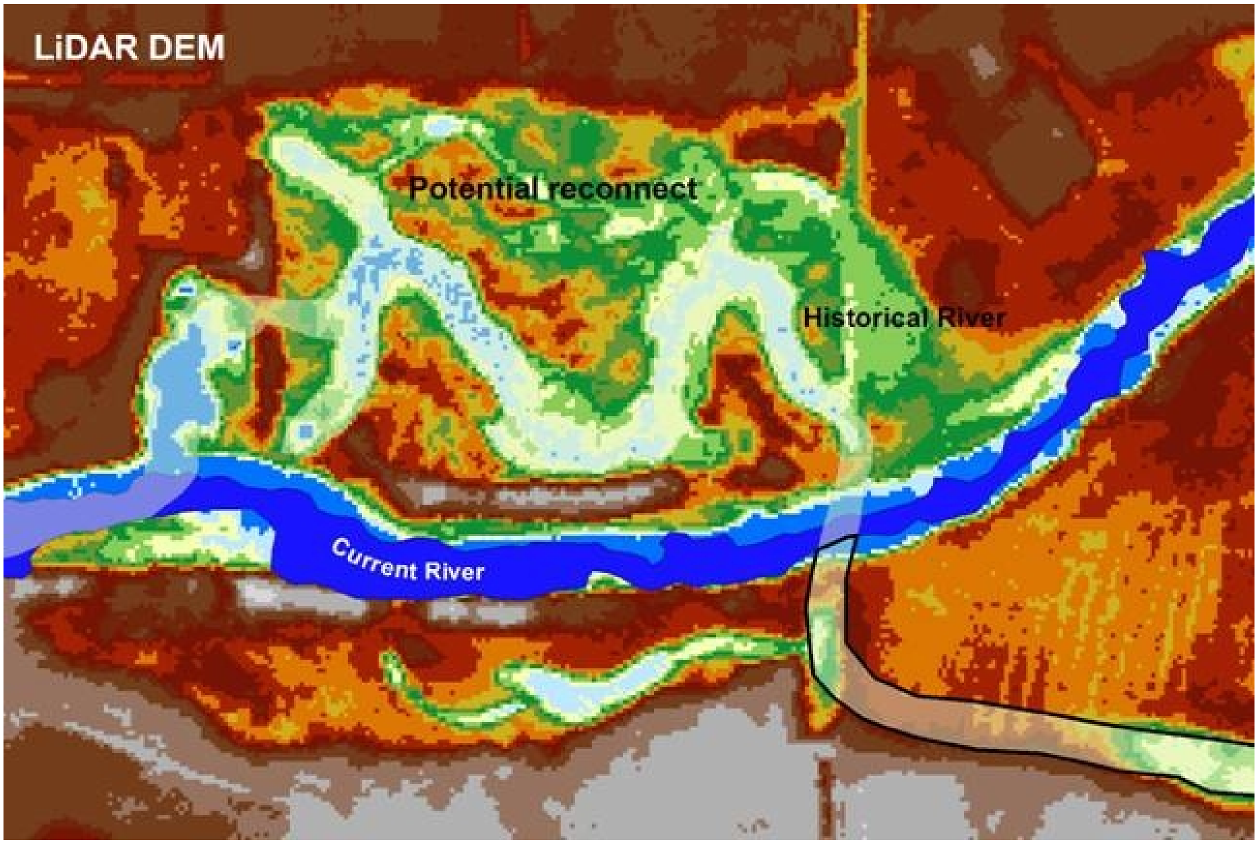

Figure 41. LIDAR of the 2010 Miller Oxbow Reconnection Project.

A water reservation rule was adopted in 2009 to ensure healthy and sustainable native fish and wildlife communities (SFWMD, 2009). Recommendations included the maintenance of a low salinity zone (0 to 10) between Kellstadt and Prima Vista bridges (RM 17.2 and RM 23.1) for critical larval and juvenile fish habitat with a mean monthly flow of 130 cfs from the Gordy Road structure. While these goals and objectives were quite admirably, they do not specifically address the issues of restoration and enhancement of the North Fork floodplain vegetative plant communities with regard to improving hydrological conditions and managing exotic plant distribution and forest growth. Forest management is also necessary for other wildlife. The North Fork St. Lucie River encompasses several large parcels in the floodplain that are in relatively pristine condition and also under public ownership. Paw prints along the Crowberry Drive Transect and testimony from adjacent residents verified that there is a resident population of bobcats frequently observed in this area of the floodplain.

Since the completion of the above three studies and the *Technical Documentation to Support Development of Minimum Flows and Levels for the St. Lucie River and Estuary* (SFWMD, 2002), new bathymetry and LIDAR have been obtained and the quality of the final mapping products has improved greatly since 2003. The mapping flights for our analysis were flown over St. Lucie County in 2010. The LIDAR data was obtained from the website http://www.floridadisaster.org/gis/lidar/. **Appendix I** contains a six map series of North Fork St. Lucie River floodplain grid maps, which covers the area of Five Mile and Ten Mile creeks (up to the Gordy Road structure and RM 32) downstream to the mouth of the North Fork adjacent to Kitching Cove and Howard Creek (RM 15 and RM 14). Some roadways and city names are labeled to assist in the identification of locations along the river. Shape files and jpg files of the maps are available to enlarge the figures for greater detail of the berms and vegetated areas. The darker brown and gold colors of the grid maps represent areas that were originally part of the river floodplain prior to urban development along the river. The extent and length of the wetland filling along the river channel (i.e. berms) is easily identifiable in each grid map. The density and distribution of vegetation along with back creeks and oxbows are also very visible for assessing and planning restoration and enhancement projects.

With the new grid maps, the originally identified oxbow reconnection and berm breach projects should be reassessed along with the possible identification of new projects areas. The 2003 Post Buckley, Schuh & Jernigan, Inc. feasibility project did not examine the river and floodplain downstream of the Prima Vista Bridge. There are some large floodplain parcels (such as the Crowberry Drive Transect area) in the lower North Fork that could be breached to allow for greater tidal inundation in the forest and marsh. With the improvement of hydrology, vegetative test plots could be established to reintroduce OBL plant species such as bald cypress and pond apple back into the interior of the floodplain and possibly discourage communities of monoculture white mangrove, which have taken advantage in the past of the reduced hydroperiods. To recreate some areas of lower floodplain along the river corridor, test plots could be established by dredging some berm areas to lower elevation and planting OBL or swamp species that would provide direct aquatic connections between river and floodplain habitats for aquatic organisms, fishes and wading birds. This would greatly increase juvenile fish habitat that for now is limited to small streams within the floodplain except in the case of major flooding events. Vegetation, EC and %SM monitoring should continue along with soil nutrients and juvenile fish assessments.

With regard to future floodplain monitoring and recommendations of target plant species, the white mangrove community with its high EC values and limited downstream distribution would classify as a major indicator species for saltwater swamp within the group of 16 species. Live oak, a hammock species, would classify as an indicator of higher elevation berms along the river channel and transitional areas within the inner floodplain landscape. Pond apple would be representative of the freshwater swamp species found primarily in the next highest EC values and the highest %SM values making the abundance of this species an indicator of healthy hydroperiods and acceptable EC levels in tidally influenced areas of this floodplain.

Impact of Climatic Events on Vegetative Changes

Odum et al. (1982) noted that one side effect of lowered freshwater flow and saltwater intrusion has been the inland expansion of mangrove forest. Examples in South Florida include much of the Everglades and the borders of Biscayne Bay. These mangrove forests have expanded inland since the 1940s in conjunction with man's alteration of surface and groundwater flow. This is also true for the St. Lucie River and the Loxahatchee River systems. Mangroves have spread up and down the Intracoastal Waterway and inland in both systems since the permanent openings of the inlets.

Hurricanes spread mangrove propagules and other plant seeds over long distances through storm surges and produce severe physical damage to vegetation. Major hurricanes and tropical storms have occurred along the Treasure Coast in 1898, 1903, 1924, 1926, 1928, 1933, 1948, 1949, 1964, 1979, 2004 (Hurricanes Charley, Francis, Ivan and Jeanne), and 2005 (Hurricane Wilma). Record winds of 153 miles per hour were recorded at the Jupiter Lighthouse in Tequesta, Florida during the Great Hurricane of 1949. Hurricane Francis made landfall on September 5 near Sewall's Point with maximum sustained winds recorded at 169 kilometers per hour (km/hr), a Category 2 storm. Approximately 3 weeks later, Hurricane Jeanne came ashore in the Stuart area on September 25 as a Category 3 storm with top sustaining winds of 193 km/hr (Tuckwood, 2004). Hurricane Wilma was also a Category 2 storm. On the Loxahatchee River, severe damage and mortality was most apparent in areas of the tallest canopy species (bald cypress, red maple and water hickory) (Roberts, et al, 2011). Flooding produced some problems with sedimentation and with the decreased canopy cover, shrub and groundcover communities reacted positively to the increase in sunlight and nutrients. Also, non-native plant species appeared to be on the rise after the hurricanes. In addition, amphibian studies noted a decline in the number of native frogs on the Loxahatchee River floodplain and a dramatic increase in the exotic Cuban tree frog (*Osteopilus septentrionalis*), which consumes smaller native green tree frogs (*Hyla cinerea*) and has a much shorter tadpole stage than our native frogs.

Severe droughts were reported on the Treasure Coast in 1937–1938, 1943–1944, 1950–1951, 1955–1956, 1960–1961, 1966–1967, 1970–1971, 1989–1990, 2000–2001 and 2007. Droughts effect vegetation through "water stress" and saltwater intrusion. Seeds of many freshwater plants, such as bald cypress, will not germinate without moisture and seedlings may not survive at higher salinities.

Inland mangroves appear to be more affected by lower regional winter air temperatures (i.e. freezes) here than coastal mangroves systems of Dade, Broward and Monroe counties. Historically, cold winters were reported in 1930–1940, 1957–1958, 1962–1963 and 1964–1965 (Alexander and Crook, 1975) and in 1977, 1983, 1985 and 1989 (FDEP, 2000). Infrared aerial photographs of the Northwest Fork Loxahatchee River taken during a special flight for the District in April 1985 showed signs of extensive mangrove defoliation with trees of 30 feet or more exhibiting broken branches and trunks. On the Treasure Coast, average monthly air temperatures for January and February 1985 were 7.7 and 11.1° C (46° and 52° F), respectively (United States Department of Commerce, Climatological Data: Florida). Temperatures had ranged as low as 3.9° C (25° F). Mangroves do not tolerate temperature fluctuations exceeding 7.8° C (18° F) or temperature below freezing (Odum et al, 1982). Mangroves may defoliate after exposure to 7.2° C (45° F) or less. Mangroves in more inland areas like the North Fork St. Lucie River seem to be more effected by low temperatures than those closer to the coast. Also, mangrove height appears to be suppressed by colder temperatures. In our 2009 study, areas of young white mangroves along with giant leather ferns were defoliated along the Crowberry Drive Transect near RM 18.3.

On the other hand with global warming, we appear to be having milder winters in the last decade, which has probably increased the distribution of mangroves in Florida and along the remaining Gulf Coast. Of concern on the Loxahatchee River and the North Fork St. Lucie River is that with sea level rise and the milder winters, mangroves, particularly white mangroves, may further intrude up into freshwater riverine areas and out compete freshwater plant species such as sawgrass and giant leather fern. It is of particular concern in the lower tidal reach of the North Fork when considering whether to reconnect isolated areas of floodplain to improve hydrology. Increased periods of inundation could discourage the recruitment of white mangrove and promote the recruitment of pond apple, pop ash and bald cypress. However, if freshwater flow is not available during low flow periods, then we could be exposing these tidal floodplain areas to increased salinities and the recruitment of more red and black mangroves.

Alexander had noted that conductivity data from the river swamp and exclusive of the mangrove areas revealed the influence of brackish water from the St. Lucie River (Teas, 1971). For example, he noted the restriction of water hickory (which is very salt sensitive) to mounds and ridges near the brackish water. He wrote "Experience with other but similar areas during storm tides indicates a delicate balance of salt content is to be expected in these soils. During dry seasons the water evaporates and the salt content of the soils increases. Readings of 4.0 mho/cm [S/cm] lie in the range of where many plants become sensitive. There is an extreme danger of salt water storm tides in the upper reaches of this site. If salt water is forced up the river valley and impounded in the low areas then as drying occurs, salt content will soar in the root zone. This accounted for large areas of plants being killed in affected areas after Hurricane Donna in 1960 and Hurricane Betsy in 1965. The destruction in the latter case was due primarily to saltwater impoundment behind man-made structures. Careful attention to this is needed of management of the North Fork St. Lucie River. Freshwater flow should be assured from the surrounding areas to flush out salt rapidly. No artificial impoundments are safe over long periods unless a relief system is built." He was referring to a system of freshwater storage during the wet season for release during the dry season, which essentially today is the goal of the CERP Indian River Lagoon – South Project.

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GLOSSARY

Basal area is the cross-sectional area of a trunk (in square meters), which is calculated from diameter breast height (dbh) (in centimeters) using the formula πr^2, in which: π=3.1416 and r = dbh/2. (See relative basal area.)

Belt transect is a long, narrow rectangular sampling area oriented along a centerline with a width of a few meters on one or both sides of the line.

Bottomland hardwoods (Rblh1, Rblh2, Rblh3, UTblh2 and UTblh3) are forests on ridges, flats and slopes of floodplains that are flooded continuously for several weeks or longer every 1 to 3 years and contain tree species adapted to periodic inundation and saturation.

Braided channels are characterized by the main river channel dividing into numerous interconnected channels.

Density is the number of individual plants (abundance) in a unit area. Trees with multiple trunks were considered separate trees.

Diameter at breast height (dbh) is the diameter of a tree trunk measured at about 1.4 to 1.5 meters above the ground.

Digital orthophoto quadrangle (DOQQ) is a digital image of color-infrared photographs (scale 1:40,000) that has been rectified to an orthographic projection. The geographic extent of a DOQQ is equivalent to on-quarter of a United States Geological Survey quadrangle map.

Dominant species are the most abundant species within a forest type, and have the most influence on the composition and distribution of other species. (See importance of a species.)

Elevation in this report is measured in the National Geodetic Vertical Datum (NGVD29).

Floodplain refers to the wide flat part of the watershed that is usually covered with water when the river floods but does not include open water in the main river channel.

Frequency is the number of times a species is recorded in a given sample size (or species presence).

Forest types are groups of canopy trees species that usually grow together in a relatively distinct and recognizable community. In this report, forest types have been botanically defined based on both vegetation sampling and elevations. (See general forest types and specific forest types).

General forest types refer to the following 16 forest types, some of which are combinations of specific types: Rsw1, Rsw2, Rblh1, Rblh2, Rblh3, Rmix, UTsw1, UTsw2, UTsw3, UTmix, LTsw1, LTsw2, LTmix, HH, MH and U. Forest types are determined by hydrology, topography, vegetation, soils and distance from the inlet. (See forest types and specific forest types.)

Geographic information system (GIS) is a collection of computer software and data files designed to store, analyze and display geographically referenced information.

Hammocks (MH and HH) refer to both mesic and hydric hammocks as described by Wunderlin and Hansen (2008). Hammocks are a unique forest type, rare outside Florida that supports characteristic mixed hardwood forest with evergreen and semi-evergreen trees.

Hummocks are mounds around the bases of trees live or dead that are elevated above the surrounding ground. Hummocks can be found in all floodplain swamp communities.

Importance of a species is used to compare species in a forest type of sampling area and is based on relative basal area for canopy species and relative density for subcanopy species. (See dominant species.)

Lower tidal reach (LTsw1, LTsw2 and LTmix) is that part of the floodplain forest of the lower river having a canopy forest composition influenced by tides and salinity in the water and soil. It includes the mid-estuary of the St. Lucie Estuary, Indian River Lagoon and the St. Lucie Inlet.

Mixed forests (Rmix, UTmix and LTmix) are forest types dominated by a mixture of swamp, hammock or bottomland hardwood species.

Oak/pine upland forests (oak/pine) are present at high elevations and are only inundated during the highest floods. Many tree species present in upland forests cannot survive more than brief periods of inundation. (See uplands.)

Relative basal area (RBA) is the percentage of a species in a forest type based on basal area. It is calculated by dividing the total basal area of that species (in square meters [m^2]) by the total basal area of all species (in m^2) in a vegetative plot.

River miles (RM) are used to indicate stream distances starting with River Mile 0 at the mouth of the river (St. Lucie Inlet).

Riverine reach (R) (Rsw1, Rsw2, Rblh1, Rblh2, Rblh3 and Rmix) Primary freshwater canopy forest that is generally unaffected by salinity. It includes Five Mile and Ten Mile creeks and downstream to River Mile 27 (Midway Bridge).

Sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD), which is a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Snag is a dead tree with a diameter at breast height of 10 centimeters or more and a height of 3 meters or taller. A tree was not considered to be a snag if any leaves were alive and are standing or down within the river channel.

Specific forest types refer to the following 16 forest types identified previously from the Loxahatchee River and its major tributaries: (See forest types and general forest types.)

Swamps (Rws1, Rsw2, UTsw1, UTsw2, UTsw3, LTsw1 and LTsw2) are forests in the lowest elevations of the floodplain that are either inundated or saturated most of the time. Swamps contain tree species that have special adaptations for survival in anoxic soils.

Uplands (U) generally refers to areas that are not considered wetlands or deep water habitats by the Florida Natural Areas Inventory (FNAI). (See oak/pine upland forest.)

Upper tidal reach (UTblh2, UTblh3, UTsw1, UTsw2, UTsw3, UTmix and M) is that part of the floodplain forest of the river having a canopy forest composition partially influenced by tides and saltwater intrusion. It extends from River Mile 27 (Midway Bridge) downstream to the mouth of the North Fork (River Mile 14) and South Fork St. Lucie River.

Watershed is the normal natural dividing line between the sources of a river from another river system.

Wetlands generally refer to areas that are considered wetlands by the United States Fish and Wildlife Service classification system. The percentage of these areas that would be classified as jurisdictional wetlands according to criteria in state and federal wetland regulations is not known.

Table F-13. Wetland indicator status by the United States Department of Agriculture, Natural Resources Conservation Service.

Indicator Code	Indicator Status	Comment
OBL	Obligate Wetland	Wetland; almost always is a hydrophyte, rarely in uplands
FACW	Facultative Wetland	Usually is a hydrophyte but occasionally found in uplands
FAC	Facultative	Commonly occurs as either a hydrophyte or non-hydrophyte
FACU	Facultative Wetland	Occasionally is a hydrophyte but usually occurs in uplands
U	Obligate Upland	Rarely is a hydrophyte, almost always in uplands

APPENDIX A:
1944 AND 1958 BLACK AND WHITE AERIALS OF THE NORTH FORK ST. LUCIE RIVER AND LOCATION OF TRANSECT BENCHMARKS

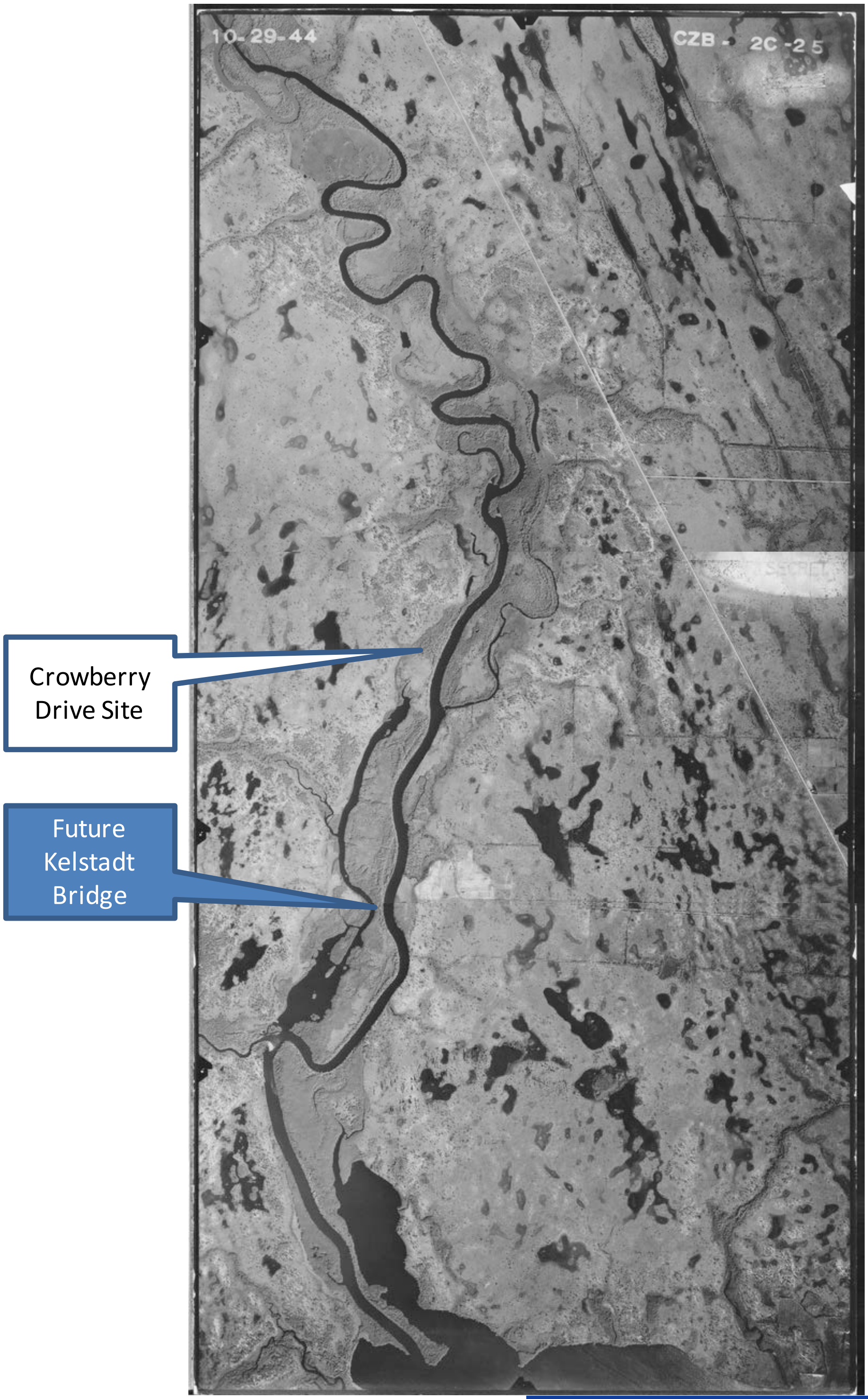


Figure A-1. 1944 black and white aerial of the lower portion of the North Fork St. Lucie River.

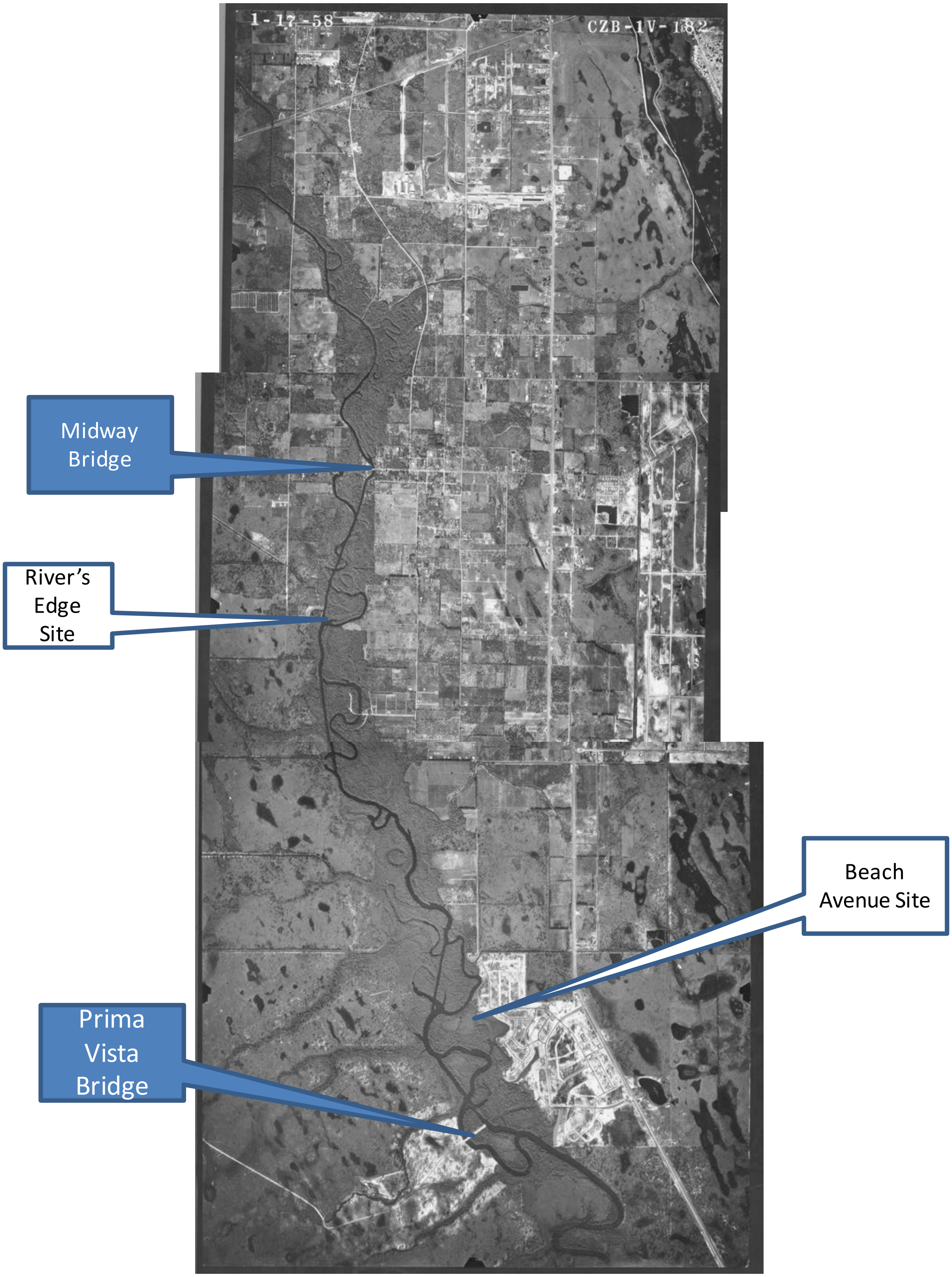


Figure A-2. 1958 black and white aerial of the North Fork St. Lucie River.

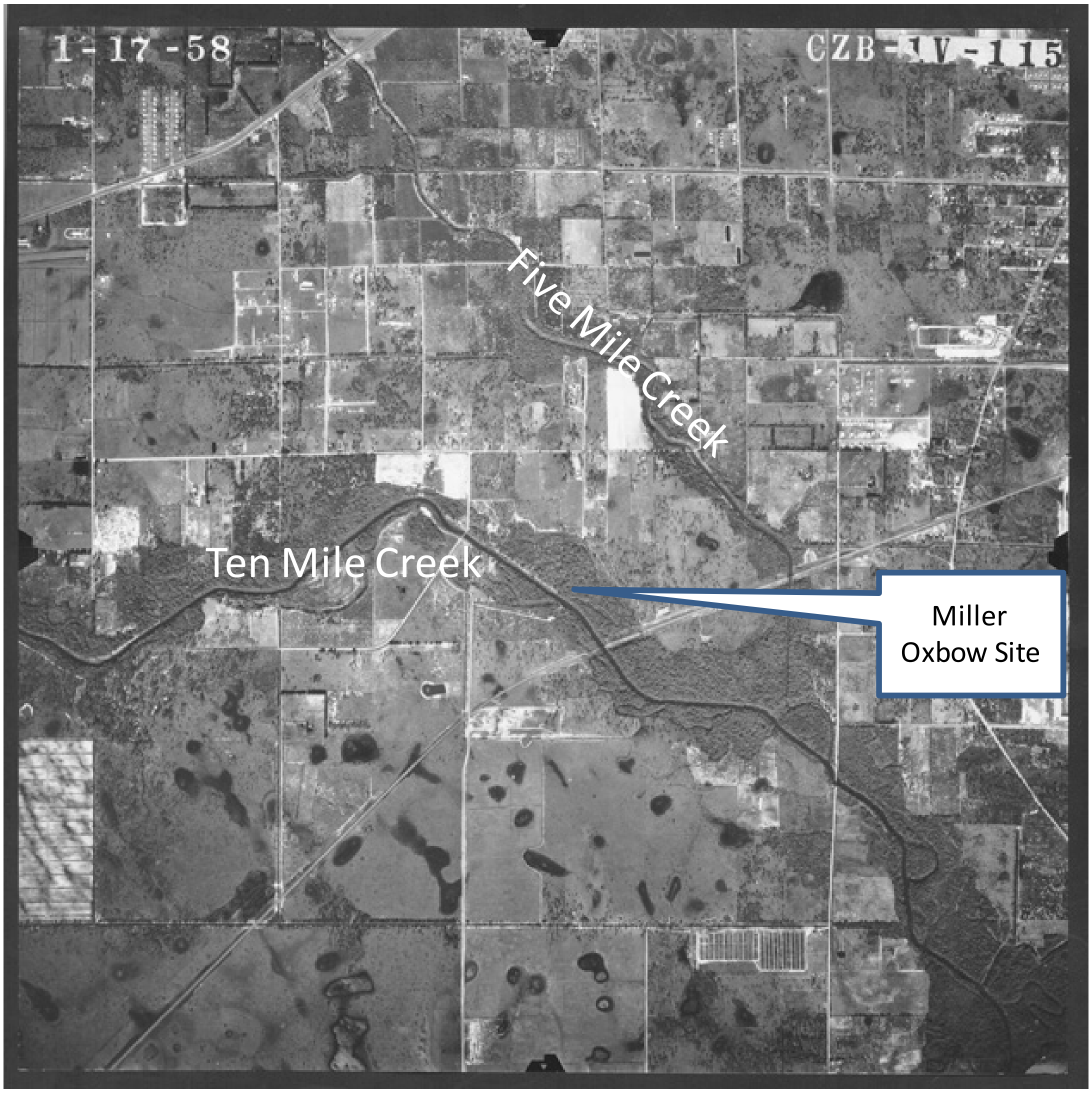


Figure A-3. 1958 black and white aerial of Five Mile and Ten Mile creeks

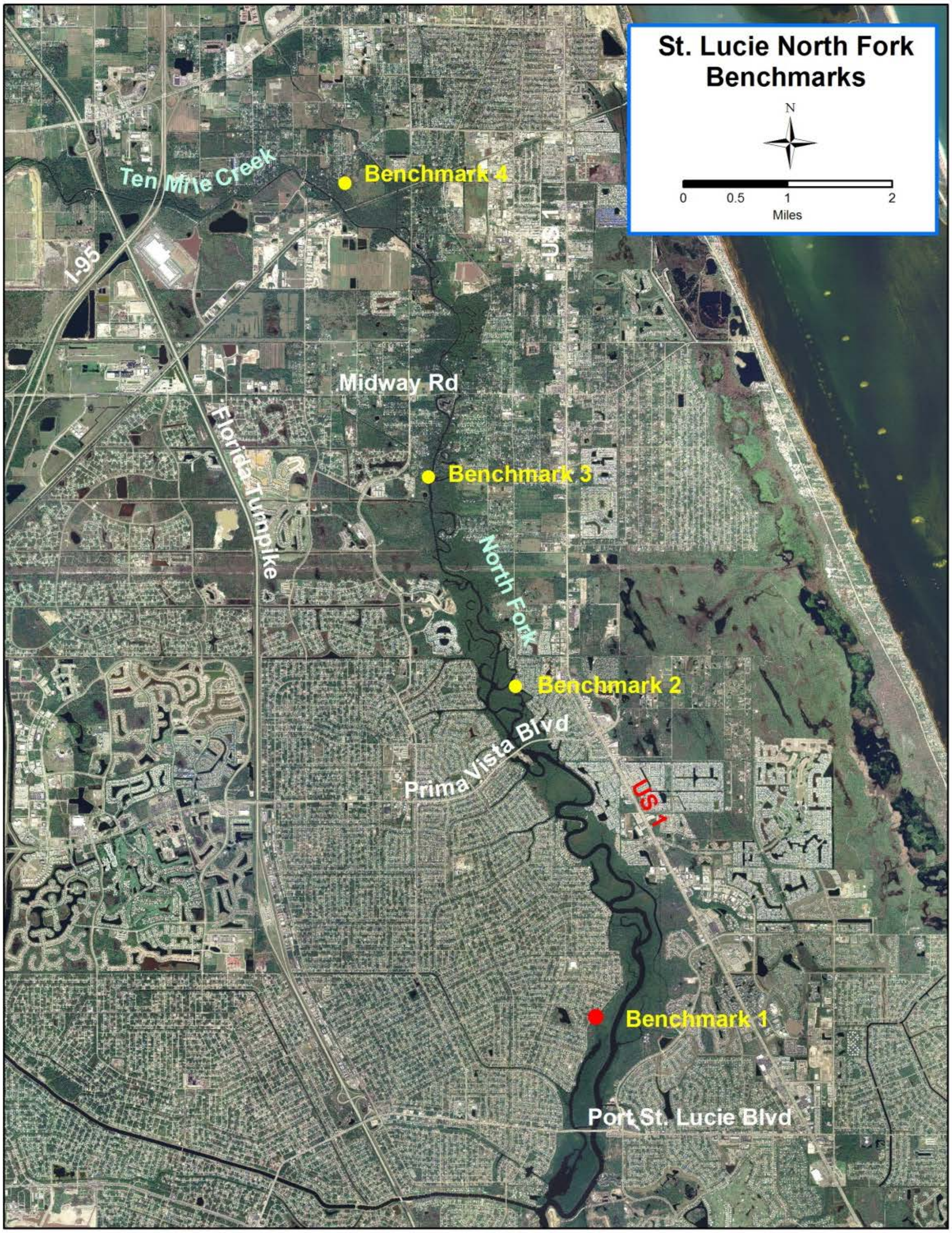
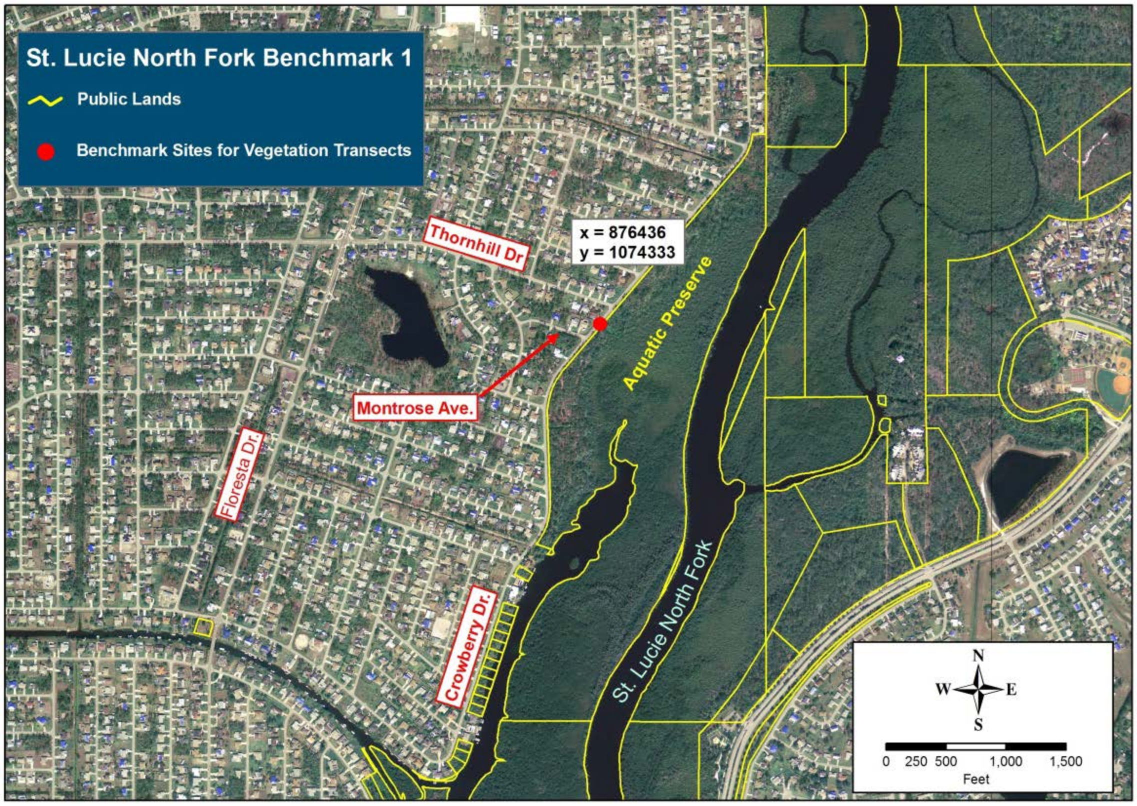


Figure A-4. Location of transect benchmarks.



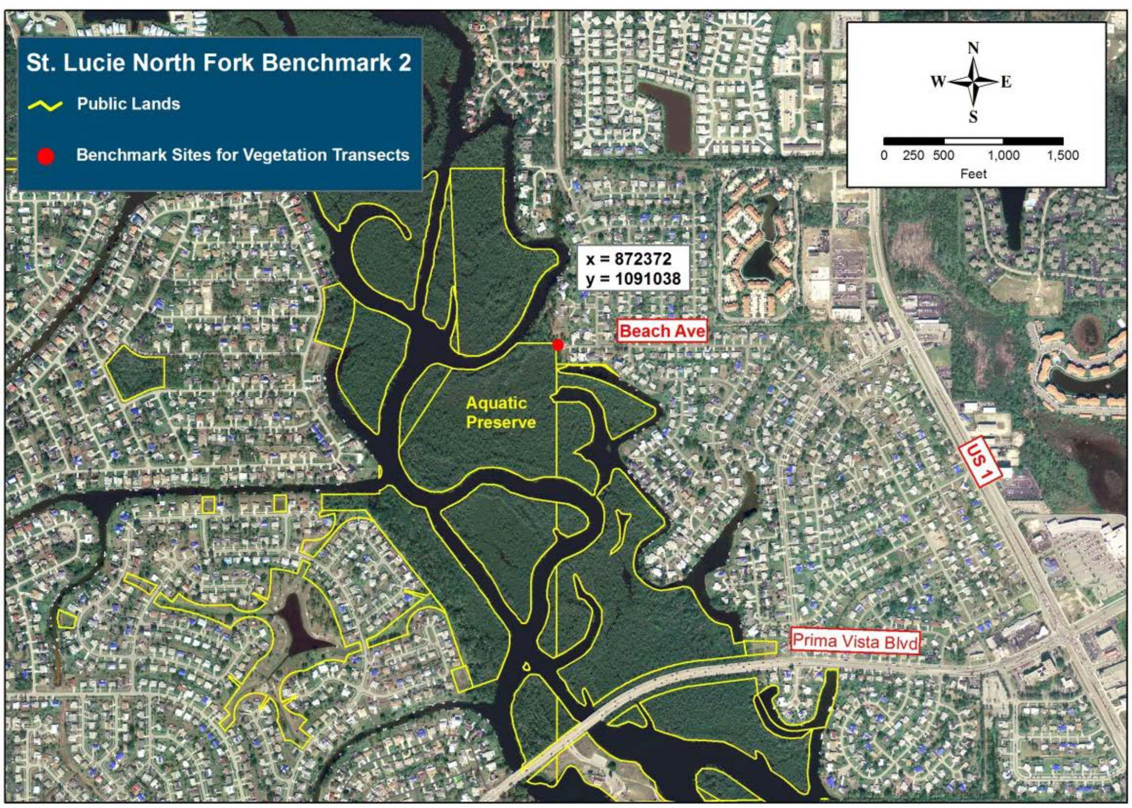
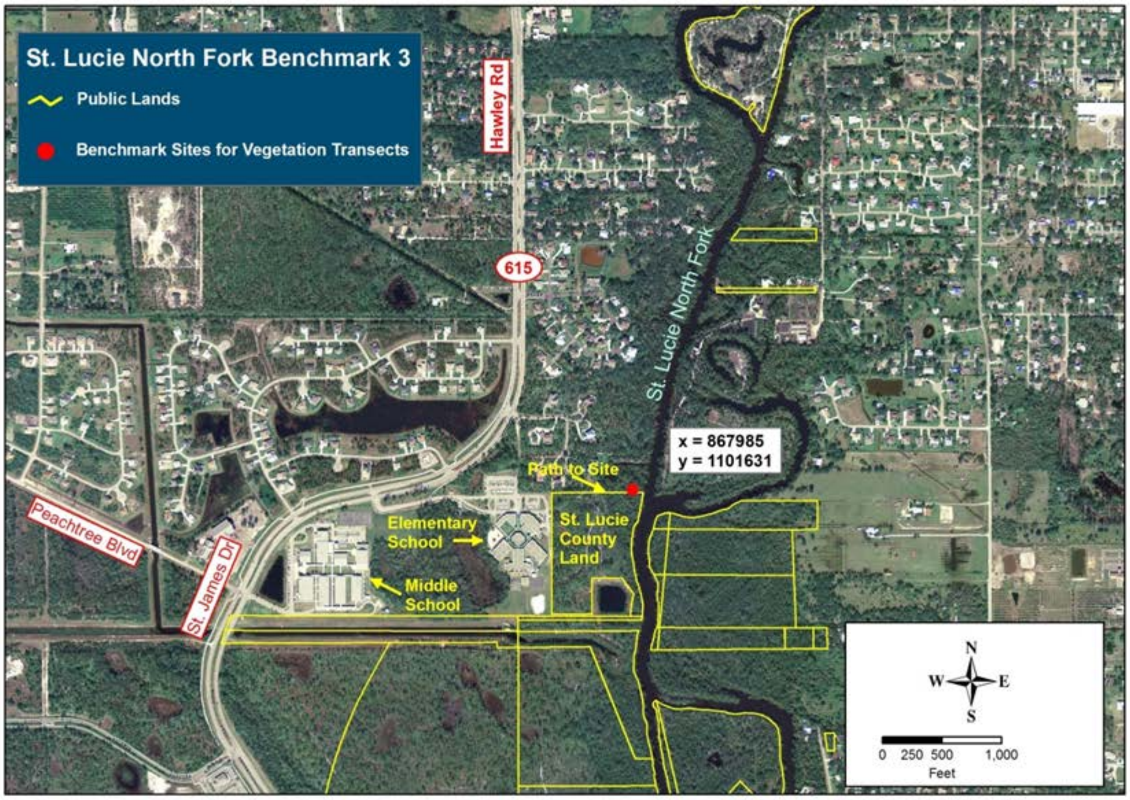


Figure A-5. Location of Benchmarks 1 and 2.



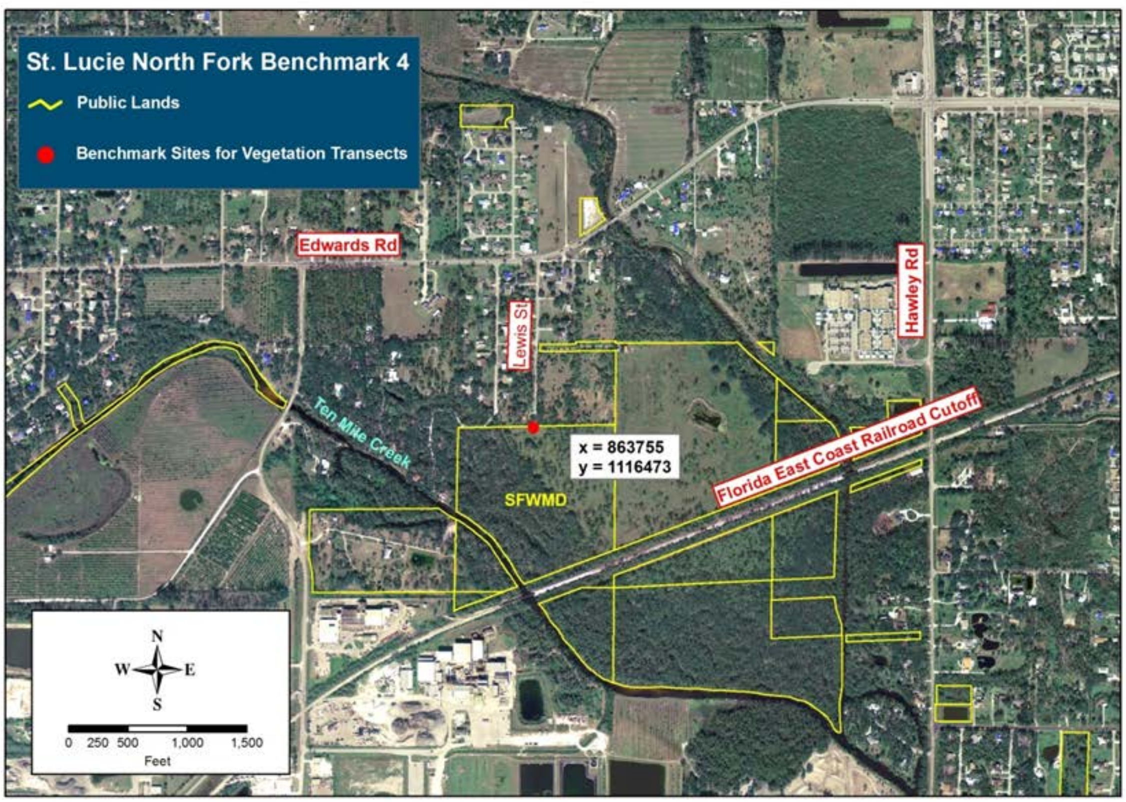


Figure A-6. Location of Benchmarks 3 and 4.

APPENDIX B:
1971 PLANT LIST FOR THE FRESHWATER SWAMP OF THE NORTH FORK ST. LUCIE RIVER

Table B-1. 1971 Plant list for the freshwater swamp of the North Fork St. Lucie River.

Scientific Name	Common Name
Acer rubrum	maple
Acrostichum danaeifolium	leather fern
Amorpha fruticosa	bastard indigo
Annona glabra	pond apple
Bacopa monnieri	water hyssop
Blechnum serrulatum	swamp fern
Bursera simaruba	gumbo limbo
Callicarpa americana	beauty berry
Campyloneuron phyllitides	strap fern
Carya aquatica	water hickory
Cephalanthus occidentalis	button bush
Cladium jamaicense	sawgrass
Colocasia esculenta	taro
Cornus foemina	stiff cornel dogwood
Crinum americanum	string lily
Dioscorea bulbifera	yam vine
Diospyros virginiana	persimmon
Encyclia tampensis	butterfly orchid
Eyrthrina herbacea	coral bean
Ficus aurea	strangler fig
Fraxinus caroliniana	water ash
Ilex cassine	dahoon holly
Ludwigia peruviana	primrose willow
Magnolia virginiana	sweet bay
Morus rubra	mulberry
Myrica cerifera	wax myrtle
Myrsine guianensis	myrsine
Nephrolepis exaltata	Boston fern
Ophioglossum palmatum	hand fern
Osmunda cinnamomea	cinnamon fern
Osmunda regalis	royal fern
Panicum joorii (Vasey) synonym of Dichanthelium commutatum (Schult.)	
Peltandra virginica	arrow arum
Phlebodium aureum	golden polypody
Polypodium polypodioides	resurrection fern
Psidium guajava	guava
Psilotum nudum	whisk fern
Psychotria sulzneri	wild coffee

Table B-1. Continued.

Scientific Name	Common Name
Psychotria undata	wild coffee
Quercus laurifolia	laurel oak
Quercus nigra	water oak
Sabal palmetto	sabal palm
Salix caroliniana	willow
Sambucus simpsonii	elderberry
Saururus cernuus	lizard's tail
Schinus terebinthifolia	Brazilian pepper
Serenoa repens	saw palmetto
Smilax bona-nox	greenbrier
Smilax laurifolia	bamboo vine
Thelypteris interrupta	wood fern
Thelypteris valustris	wood fern
Tillandsia balbisiana	reflexed wild pine
Tillandsia fasciculata	air pine
Tillandsia recurvata	ball moss
Tillandsia setacea	needle leaf air pine
Tillandsia usneoides	Spanish moss
Tillandsia utriculata	giant air pine
Toxicodendron radicans	poison ivy
Urena lobata	Caesar weed
Vitis rotundifolia	grape
Vitis shuttleworthii	calloose grape
Vittaria lineata	shoestring fern
Woodwardia virginica	chain fern

Source: General Development Corporation, 1980, and Maggy Hurchalla, personal communication Howard Teas and Taylor Alexander, University of Miami.

APPENDIX C:
2009 NORTH FORK ST. LUCIE RIVER PLANT SURVEY LIST

Table C-1. South Florida Water Management District's North Fork St. Lucie River Floodplain 2009 Survey of Plant Species.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect				Invasive Exotic Category[e]	Collection Date
						Beech Avenue	Crowberry Drive	River's Edge	Miller Oxbow		
553	?*Agdestis clematidius* ?*Ipomoea* sp?		0				x				23-Apr-09
427	*Abrus precatorius* L.	Fabaceae	1	Non-native FLEPPC(I)	Rosary pea				x	1	25-Feb-09
467	*Acer rubrum* L.	Sapindaceae	3	Facultative Wet	Red maple	x	x		x		27-Feb-09
474	*Acrostichum danaeifolium* Langsdorff & Fischer	Pteridaceae	4	Obligate	Giant leather fern	x	x	x			4-Mar-09
612	*Alternanthera philoxeroides* (Mart.)Griseb.	Amaranthaceae	4	Obligate, Non-native, FLEPPC(II)	Alligator weed				x	2	30-Jun-09
526	*Ambrosia artemisiifolia* L.	Asteraceae	1	Facultative Upland	Common ragweed	x			x		18-Mar-09
426	*Amorpha fruticosa* L.	Fabaceae	3	Facultative Wet	False indigo				x		25-Feb-09
498	*Ampelopsis arborea* (L.) Koene	Vitaceae	1	Facultative Upland+ (NWI)+F154	Peppervine	x	x	x			12-Mar-09
452	*Annona glabra* L.	Annonaceae	4	Obligate	Pond apple	x	x		x		27-Feb-09
492	*Apios americana* Medik.	Fabaceae	3	Facultative Wet	Groundnut		x	x			4-Mar-09
629	*Ardisia elliptica* Thunberg (in flower)	Myrsinaceae		Facultative, Non-native, FLEPPC(I)	Shoebutton ardisia	x		x	x	1	30-Jun-09
425	*Ardisia elliptica* Thunberg (in fruit)	Myrsinaceae	2	Facultative, Non-native, FLEPPC(I)	Shoebutton ardisia	x		x	x	1	25-Feb-09

a. Dark green shading indicates mounted species.
b. Light green shading indicates duplicate specimens. Orange shading indicates the two specimens are different dates or locations.
c. FDEP wetlands status code.
d. Source is Florida Department of Environmental Protection unless otherwise noted. Other sources are Florida Exotic Pest Plant Council (FLEPPC) I and II, and National Wetland Inventory (NWI). If just native or non-native is listed then no wetland status is available.
e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect: Beech Avenue	Transect: Crowberry Drive	Transect: River's Edge	Transect: Miller Oxbow	Invasive Exotic Category[e]	Collection Date
480	*Baccharis glomerulifora* Pers.	Asteraceae	2	Facultative	Silverling; salt bush	x	x	x			4-Mar-09
543	*Bacopa monnieri* (L.)Pennell	Veronicaceae	4	Obligate	Herb-of-grace	x	x	x			15-Apr-09
448	*Bidens alba* (L.) DC	Asteraceae	2	Facultative	Beggar ticks	x			x	2	27-Feb-09
590	*Bischofia javanica* Blume	Euphorbiaceae	1	Non-native FLEPPC(I)	Queensland umbrella tree		x			1	12-Mar-09
468	*Blechnum serrulatum* Richard	Blechnaceae	3	Facultative Wet	Toothed midsorus fern		x	x			4-Mar-09
466	*Blechum pyramidatum* (Lam.) Urban	Acanthaceae	1	Non-native FLEPPC(II)	Browne's blechum	x			x	2	27-Feb-09
486	*Boehmeria cylindrica* (L.) Swartz	Urticaceae	4	Obligate	False nettle, Bog hemp	x		x			4-Mar-09
409	*Callicarpa americana* L.	Lamiaceae	1	Facultative Upland	American beautyberry		x		x		25-Feb-09
530	*Campsis radicans* (L.) Seem.	Bignoniaceae	2	Facultative	Trumpet Creeper	x					18-Mar-09
431	*Carya aquatica* (F.Michx.) Nutt.	Juglandaceae	4	Obligate	Water hickory				x		25-Feb-09
464	*Centella asiatica* (L.) Urban	Araliaceae	3	Facultative Wet	Spadeleaf				x		27-Feb-09
568	*Cephalanthus occidentalis* L.	Rubiaceae	4	Obligate	Common buttonbush	x	x		x		23-Apr-09
611	*Cephalanthus occidentalis* L.	Rubiaceae		Obligate	Common buttonbush				x		30-Jun-09
624	*Chamaecrista fasciculata* (Michx.) Green.	Fabaceae	1	Facultative Upland (NWI)	Partridge pea		x	x			30-Jun-09
418	*Chromolaena odorata* (L.) R.M. King & H.Rob.	Asteraceae	1	Native	Jack-in-the-bush	x			x		25-Feb-09
429	*Citrus x aurantium* L.	Rutaceae	1	Non-native	Sour orange	x			x		25-Feb-09
517	*Cladium jamaicense* Crantz	Cyperaceae	4	Obligate	Jamaica swamp grass	x	x	x			12-Mar-09
482	*Colocasia esculenta* (L.) Schott	Araceae	1	Non-native FLEPPC(I)	Wild taro, Dasheen			x		1	4-Mar-09

a. Dark green shading indicates mounted species.
b. Light green shading indicates duplicate specimens. Orange shading indicates the two specimens are different dates or locations.
c. FDEP wetlands status code.
d. Source is Florida Department of Environmental Protection unless otherwise noted. Other sources are Florida Exotic Pest Plant Council (FLEPPC) I and II, and National Wetland Inventory (NWI). If just native or non-native is listed then no wetland status is available.
e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect: Beech Avenue	Transect: Crowberry Drive	Transect: River's Edge	Transect: Miller Oxbow	Invasive Exotic Category[e]	Collection Date
430	*Commelina diffusa* Burm.f.	Commelinaceae	3	Facultative Wet	Common day flower	x			x		25-Feb-09
445	*Conoclinium coelestinum* (L.) DC	Asteraceae	2	Facultative	Blue mist flower				x		27-Feb-09
438	*Conyza canadensis* (L.)Cronquist	Asteraceae	1	Facultative Upland (NWI)	Horsetail				x		25-Feb-09
434	*Crassocephalum crepidioides* (Benth.)S.Moore	Asteraceae	2	Facultative	Redflower ragleaf				x		25-Feb-09
453	*Crinum americana* L.	Amaryllidaceae	4	Obligate	Seven sisters string lilly		x		x		27-Feb-09
495	*Cupaniopsis anacardioides* (A.Rich) Radlk.	Sapindaceae	1	Non-native FLEPPC(I)	Carrotwood	x			x	1	27-Feb-09
435	*Cyanthillium cinereum* (L.)H. Rob.	Asteraceae	3	Facultative Wet	Little ironweed				x		25-Feb-09
595	*Cyperus croceus* Vahl	Cyperaceae	2	Facultative	Baldwin's flatsedge				x		30-Jun-09
575	*Cyperus distinctus* Steud.	Cyperaceae	4	Obligate	Swamp flatsedge	x					23-Apr-09
534	*Dalbergia ecastaphyllum* (L.) Taub.	Fabaceae	3	Facultative Wet+(NWI)	Coinvine		x				15-Apr-09
597	*Desmodium incanum* DC.	Fabaceae		Non-native	Zarzabacoa comun, beggar's ticks				x		30-Jun-09
442	*Desmodium incanum* DC.	Fabaceae	1	Non-native	Zarzabacoa comun, beggar's ticks				x		27-Feb-09
563	*Dichanthelium commutatum* (Schult.) Gould	Poaceae	2	Facultative	Variable witchgrass	x			x		23-Apr-09
593	*Dichanthelium laxiflorum* Gould	Poaceae	1	Native	Rough witchgrass	x			x		30-Jun-09
536	*Dichanthelium portoricense* (Desv. Ex Ham.) B.F. Hansen	Poaceae	1	Facultative Upland	Hemlock witchgrass		x				15-Apr-09

a. Dark green shading indicates mounted species.
b. Light green shading indicates duplicate specimens. Orange shading indicates the two specimens are different dates or locations.
c. FDEP wetland status code.
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e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect: Beech Avenue	Transect: Crowberry Drive	Transect: River's Edge	Transect: Miller Oxbow	Invasive Exotic Category[e]	Collection Date
549	*Dioscorea bulbifera* L.	Dioscoreaceae	1	Non-native FLEPPC(I)	Air-potato	x				1	23-Apr-09
578	*Diospyros virginiana* L.	Ebenaceae	2	Facultative	Common persimmon	x					23-Apr-09
421	*Drymaria cordata* (L.) Willd. Ex Schult.	Caryophyllaceae	2	Facultative	West Indian chickweed				x		25-Feb-09
564	*Dypsis lutescens* (H.Wendl.) Beentje & J.Dransf.	Arecaceae	1	Non-native	Areca palm	x		x			23-Apr-09
456	*Eclipta prostrata* (L.) L.	Asteraceae	3	Facultative Wet	False daisy	x			x		27-Feb-09
494	*Eleocharis flavescens* (Poir.) Urb.	Cyperaceae	4	Obligate	Baldwin's spikerush			x			4-Mar-09
437	*Emilia sonchifolia* (L.) DC.	Asteraceae	1	Non-native	Lilac tassel flower				x		25-Feb-09
0	*Encyclia tampensis* (Lindl.)Small	Orchidaceae	0	Native	Florida butterfly orchid	x		x			
507	*Eugenia uniflora* L.	Myrtaceae	1	Non-native	Surinam cherry	x	x	x			12-Mar-09
603	*Eupatorium capillifolium* (Lam.)Small ex Porter & Britton	Asteraceae	2	Facultative	Dogfennel				x		30-Jun-09
588	*Ficus benjamina* L.	Moraceae	1	Non-native	Weeping fig	x					20-May-09
566	*Ficus microcarpa* L.f.	Moraceae	1	Non-native FLEPPC(I)	Laurel fig	x				1	23-Apr-09
440	*Fraxinus caroliniana* Mill.	Oleaceae	4	Obligate	Pop ash	x			x		25-Feb-09
594	*Galactia volubilis* (L.)Britton	Fabaceae	3	Facultative Wet	Downy milk pea	x		x	x		30-Jun-09
583	*Galactia*?	Fabaceae	0			x					23-Apr-09
528	*Galium hispidulum* Michx.	Rubiaceae	1	Native	Coastal bedstraw	x					18-Mar-09
509	*Habenaria floribunda* Lindl	Orchidaceae	3	Facultative Wet	Rein orchid		x				12-Mar-09
617	*Hibiscus grandiflorus* Michx.	Malvaceae	4	Obligate	Swamp rosemallow	x					30-Jun-09
585	*Hydrocotyle* sp. w/ Sphagnum moss	Araliaceae	4	Obligate		x					23-Apr-09

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e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect				Invasive Exotic Category[e]	Collection Date
						Beech Avenue	Crowberry Drive	River's Edge	Miller Oxbow		
461	*Hydrocotyle verticellata* Thunb. Var. triradiata (A.Rich.) Fernald	Araliaceae	3	Facultative Wet	Whorled marshpennywort			x	x		27-Feb-09
500	*Hyparrhenia rufa* (Nees)Stapf	Poaceae	1	Non-native	Jaragua		x	x			12-Mar-09
459	*Hypericum hypericoides* Lam.	Clusiaceae	3	Facultative Wet	St.John's wort,Roundpod	x			x		27-Feb-09
602	*Hypoxis curtissii* Rose	Hypoxidaceae	3	Facultative Wet	Common yellow stargrass				x		30-Jun-09
449	*Hypoxis curtissii* Rose	Hypoxidaceae		Facultative Wet	Common yellow stargrass				x		27-Feb-09
424	*Hyptis verticillata* Jacq.	Lamiaceae	1	Non-native	John Charles				x		25-Feb-09
512	*Ilex cassine* L.	Aquifoliaceae	4	Obligate	Dahoon holly		x	x			12-Mar-09
506	*Ilex glabra* (L.)A. Gray	Aquifoliaceae	3	Facultative Wet	Gallberry, Inkberry		x	x			12-Mar-09
572	*Ipomoea sagittata* Poir.	Convolvulaceae	3	Facultative Wet	Saltmarsh morning-glory	x					23-Apr-09
626	*Kosteletzkya virginica* (L.)C.Presl ex A. Gray	Malvaceae	4	Obligate	Virginia saltmarsh mallow		x				30-Jun-09
518	*Laguncularia racemosa* (L.)Gaertn.f.	Combretaceae	4	Obligate	White mangrove		x	x			12-Mar-09
614	*Lantana camara* L.	Verbenaceae	1	Facultative Upland (NWI), Non-native FLEPPC(I)	Lantana, shrub verbena				x		30-Jun-09
618	*Ludwigia peruviana* (L.)H.Hara	Onagraceae	4	Obligate, Non-native, FLEPPC(I)	Peruvian primrosewillow	x				1	30-Jun-09

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e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect				Invasive Exotic Category[e]	Collection Date
						Beech Avenue	Crowberry Drive	River's Edge	Miller Oxbow		
476	*Ludwigia repens* J.R.Forst	Onagraceae	4	Obligate	Creeping primrosewillow	x		x			4-Mar-09
454	*Lygodium microphyllum* (Cav)R.Br.	Schizaeaceae	1	Non-native FLEPPC(I)	Small-leaf climbing fern	x			x	1	27-Feb-09
542	*Lyonia fruticosa*,(Michx.)G.S.Torr.	Ericaceae	2	Facultative	Coastalplain staggerbush		x				15-Apr-09
497	*Lyonia lucida* (Lam.)K.Koch	Ericaceae	3	Facultative Wet	Fetterbush, staggerbush		x	x			12-Mar-09
561	*Melothria pendula* L.	Cucurbitaceae	3	Facultative Wet	Creeping cucumber	x					23-Apr-09
515	*Mikania scandens* (L.)Willd.	Asteraceae	3	Facultative Wet+(NWI)	Creeping hempvine	x	x	x			12-Mar-09
604	*Mitchella repens* L.	Rubiaceae	1	Facultative Upland+(NWI)	Partridgeberry, twinberry				x		30-Jun-09
460	*Momordica charantia* L.	Cucurbitaceae	1	Non-native	Balsam pear				x		27-Feb-09
481	*Myrica cerifera* L.	Myricaceae	2	Facultative	Wax Myrtle; S.Bayberry	x	x	x			4-Mar-09
527	*Nephrolepis multiflora* (Roxb.)F.M.Jarrett ex C.V.Morton	Nephrolepidaceae	2	Facultative, Non-native, FLEPPC(I)	Asian sword fern	x				1	18-Mar-09
411	*Oplismenus hirtellus* (L.)P.Beauv.	Poaceae	2	Facultative	Woods grass				x		25-Feb-09
621	*Osmunda cinnamomum* L.	Osmundaceae	3	Facultative Wet	Cinnamon fern		x	x			30-Jun-09
488	*Osmunda regalis* L. var. spectabilis (Willd.)A.Gray	Osmundaceae	4	Obligate	Royal fern	x	x	x			4-Mar-09
606	*Oxalis* sp	Oxalidaceae	1	Native					x		30-Jun-09

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e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect: Beech Avenue	Transect: Crowberry Drive	Transect: River's Edge	Transect: Miller Oxbow	Invasive Exotic Category[e]	Collection Date
447	*Oxycaryum cubense* (Poepp. & Kunth)Palla	Cyperaceae	4	Obligate	Cuban bullrush				x		27-Feb-09
524	*Panicum maximum* Jacq.	Poaceae	1	Non-native FLEPPC(II)	Guineagrass	x				2	18-Mar-09
620	*Panicum repens* L.	Poaceae	3	Facultative Wet, Non-native, FLEPPC(I)	Torpedo grass		x			1	30-Jun-09
598	*Panicum rigidulum* Bosc ex Nees	Poaceae	3	Facultative Wet	Redtop panicum				x		30-Jun-09
521	*Parietaria praetermissa* Hinton	Urticaceae	2	Facultative	Pellitory	x					18-Mar-09
428	*Parthenocissus quinquefolia* (L.)Planch.	Vitaceae	2	Facultative	Virginia creeper;woodbne	x			x		25-Feb-09
610	*Paspalum conjugatum* P.J.Bergius	Poaceae	2	Facultative	Sour paspalum, hilo grass				x		30-Jun-09
605	*Paspalum setaceum* Michx.	Poaceae	2	Facultative	Thin paspalum				x		30-Jun-09
513	*Peltandra* sp.	Araceae	4	Obligate	Spoonflower		x	x			12-Mar-09
600	*Peltophorum pterocarpum* (DC.)Baker ex K.Heyne	Fabaceae	1	Non-native	Yellow poinciana				x		30-Jun-09
406	*Persea borbonia* (L.)Spreng.	Lauraceae	3	Facultative Wet	Red bay	x	x		x		25-Feb-09
416	*Phlebodium aureum* (L.)J.Sm.	Polypodiaceae	1	Native	Golden polypody	x			x		25-Feb-09
607	*Phlebodium aureum* (L.)J.Sm.	Polypodiaceae		Native	Golden polypody	x			x		30-Jun-09

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e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect: Beech Avenue	Transect: Crowberry Drive	Transect: River's Edge	Transect: Miller Oxbow	Invasive Exotic Category[e]	Collection Date
615	*Phyllanthus tenellus* Roxb.	Phyllanthaceae	1	Non-native	Mascaren Island leafflower				x		30-Jun-09
432	*Pleopeltis polypodioides* (L.) E.G. Andrews & Windham var michauxiana (Weth.)E.A.Andrews&Windham	Polypodiaceae	1	Native	Resurrection fern	x			x		25-Feb-09
579	*Pluchea odorata* (L.)Cass.	Asteraceae	3	Facultative Wet	Sweetscent	x					23-Apr-09
463	*Polygonum punctatum* Elliott	Polygonaceae	4	Obligate	Dotted smartweed	x		x	x		27-Feb-09
455	*Pontederia cordata* L.	Pontederiaceae	4	Obligate	Pickerelweed				x		27-Feb-09
546	*Pouzolzia zeylanica* (L.)Benn. & R.Br.	Urticaceae	1	Non-native	Pouzolz's bush	x					23-Apr-09
522	*Pseudognaphalium obtusifolium* (L.)Hilliard & B.L.Burtt	Asteraceae	1	Native	Sweet everlasting, rabit tobacco	x					18-Mar-09
490	*Psidium cattleianum* Sabine	Myrtaceae	1	Non-native FLEPPC(II)	Strawberry guava			x		2	4-Mar-09
489	*Psilotum nudum* (L.)P.Beauv.	Psilottaceae	1	Facultative Upland+(NWI)	Whisk fern	x		x			4-Mar-09
402	*Psychotria nervosa* Sw.	Rubiaceae	2	Facultative	Wild coffee	x	x		x		25-Feb-09
627	*Psychotria nervosa* Sw.	Rubiaceae		Facultative	Wild coffee				x		30-Jun-09
404	*Psychotria sulzneri* Small.	Rubiaceae	2	Facultative	Short leaf wild coffee	x	x		x		25-Feb-09
628	*Psychotria sulzneri* Small.	Rubiaceae		Facultative	Short leaf wild coffee				x		30-Jun-09

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Table C-1. Continued.

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537	*Pteridium aquilinum* (L.)Kuhn var. *pseudocaudatum* (Clute)Clute ex A.Heller	Dennstaedtiaceae	1	Facultative Upland	Bracken fern	x	x				15-Apr-09
547	*Ptilimnium capillaceum* (Michx.)Raf.	Apiaceae	3	Facultative Wet	Mock bishop's weed	x			x		23-Apr-09
422	*Quercus laurifolia* Michx.	Fagaceae	3	Facultative Wet	Laurel oak	x	x		x		25-Feb-09
502	*Quercus myrtifolia* Willd.	Fagaceae	1	Native	Myrtle oak		x	x			12-Mar-09
479	*Rapanea punctata* (Lam.)Lundell	Myrsinaceae	2	Facultative	Myrsine; colicwood	x	x	x			4-Mar-09
625	*Rhabdadenia biflora* (Jacq.)Mull.Arg.	Apocynaceae	3	Facultative Wet+ (NWI)	Rubber or mangrove vine		x				30-Jun-09
533	*Rhizophora mangle* L.	Rhizophoraceae	4	Obligate	Red mangrove		x				15-Apr-09
576	*Rhynchospora colorata* (L.)H.Pfeiff.	Cyperaceae	3	Facultative Wet	Starrush whitetop	x					23-Apr-09
525	*Rubus trivialis* Michx.	Rosaceae	2	Facultative	Southern dewberry	x					18-Mar-09
577	*Rumex verticellatus* L.	Polygonaceae	3	Facultative Wet	Swamp dock	x					23-Apr-09
403	*Sabal palmetto* (Walter)Ladd.ex Schult.&Schult.	Arecaceae	2	Facultative	Sabal palm	x			x		25-Feb-09
573	*Sabatia calycina* (Lam.) A. Heller	Gentianaceae	4	Obligate	Coastal rosegentian	x					23-Apr-09
601	*Sacciolepis indica* (L.)Chase	Poaceae	2	Facultative	Indian cupscale				x		30-Jun-09
567	*Sagittaria lancifolia* L.	Alismataceae	4	Obligate	Bull tongue; arrow head	x					23-Apr-09
557	*Salix caroliniana* Michx.	Salicaceae	4	Obligate	Carolina willow	x					23-Apr-09
408	*Salvia misella* Kunth	Lamiaceae	1	Native	Southern river sage				x		25-Feb-09

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e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect				Invasive Exotic Category[e]	Collection Date
						Beech Avenue	Crowberry Drive	River's Edge	Miller Oxbow		
516	*Samolus valerandi* L.subsp. *parviflorus* (Raf.)Hulten	Primulaceae	4	Obligate	Pineland Pimpernel		x				12-Mar-09
472	*Sarcostemma clausum* (Jacq.)Schult.	Apocynaceae	3	Facultative Wet	White twinevine		x	x			4-Mar-09
475	*Saururus cernuus* L.	Saururaceae	4	Obligate	Lizard's tail			x			4-Mar-09
415	*Schinus terebinthifolia* Raddi	Anacardiaceae	1	Non-native FLEPPC(I)	Brazilian pepper	x	x		x	1	25-Feb-09
412	*Scleria triglomerata* Michx.	Cyperaceae	3	Facultative Wet	Tall nutgrass		x		x		25-Feb-09
414	*Senna pendula* (Humb,&Bonpl.exWilld.) H.S.Irwin & Barneby var. *glabrata* (Vogel) H.S.Irwin & Barneby	Fabaceae	1	Non-native FLEPPC(I)	Valamuerto				x	1	25-Feb-09
520	*Serenoa repens* (W.Bartram)Small	Arecaceae	1	Facultative Upland	Saw palmetto		x	x			12-Mar-09
465	*Sida rhombifolia* L.	Malvaceae	1	Facultative Upland	Cuban jute; Indian Hemp	x			x		27-Feb-09
511	*Sisyrinchum angustifolium* Mill.	Iridaceae	3	Facultative Wet	Narrow leaf blue-eyed grass		x	x			12-Mar-09
470	*Smilax auriculata* Walter	Smilacaceae	1	Facultative Upland	Earleaf greenbrier			x			4-Mar-09
552	*Smilax bona*-nox L.	Smilacaceae	2	Facultative	Saw greenbrier	x					23-Apr-09
401	*Smilax laurifolia* L.	Smilacaceae	3	Facultative Wet	Laurel greenbrier	x	x	x	x		25-Feb-09

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Table C-1. Continued.

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523	*Solanum americanum* Mill.	Solanaceae	1	Facultative Upland + (NWI)	Amer. black nightshade	x					18-Mar-09
531	*Solanum diphyllum* L.	Solanaceae	1	Non-native FLEPPC(II)	Two leaf nightshade	x				2	18-Mar-09
539	*Spartina patens* (Aiton)Muhl.	Poaceae	3	Facultative Wet	Saltmeadow cordgrass		x				15-Apr-09
420	*Spemacoce verticillata* L.	Rubiaceae	1	Non-native	Shrubby falsebuttonwood				x		25-Feb-09
496	*Sphagneticola trilobata* (L.)Pruski	Asteraceae	1	Non-native FLEPPC(II)	Creeping oxeye	x	x	x		2	12-Mar-09
558	*Stenotaphrum secundatum* (Walter)Kuntze	Poaceae	2	Facultative	St. Augustine grass	x					23-Apr-09
569	*Symphyotrichum carolinianum* (Walter)Wunderl.&B.F.Hans	Asteraceae	4	Obligate, Native	climbing aster	x					23-Apr-09
493	*Syngonium podophyllum* Schott	Aracaceae	1	Non-native FLEPPC(I)	American evergreen			x		1	4-Mar-09
444	*Thelypteris dentata* (Forssk.)E.P.St.John	Thelypteridaceae	3	Facultative Wet	Downy maidenfern				x		27-Feb-09
469	*Thelypteris interrupta* (Willd.) K.Iwats.	Thelypteridaceae	3	Facultative Wet	Hottentot fern		x	x			4-Mar-09
559	*Thelypteris kunthii* (Desv.)C.V.Morton	Thelypteridaceae	3	Facultative Wet	Widespread maiden fern	x	x				23-Apr-09
0	*Tillandsia fasciculata* Sw.	Bromeliaceae	0	Native Endangered	Cardinal airplant	x			x		

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e. FLEPPC invasive exotic categories.

Table C-1. Continued.

Specimen Number[a]	Scientific Name[b]	Family	Wet[c]	Wetland Status[d]	Common Name	Transect: Beech Avenue	Transect: Crowberry Drive	Transect: River's Edge	Transect: Miller Oxbow	Invasive Exotic Category[e]	Collection Date
417	*Tillandsia setacea* Sw.	Bromeliaceae	1	Native	Southern needleleaf	x			x		25-Feb-09
423	*Tillandsia usneoides* (L.)L.	Bromeliaceae	1	Native	Spanish moss				x		25-Feb-09
0	*Tillandsia utriculata* L.	Bromeliaceae	0	Native Endangered	Giant airplant; Wild pine	x	x		x		
443	*Toxicodendron radicans* Mill.	Anacardiaceae	1	Facultative Upland	Poison oak		x		x		27-Feb-09
413	*Urena lobata* L.	Malvaceae	1	Non-native FLEPPC(II)	Caesarweed	x			x	2	25-Feb-09
503	*Vaccinium myrsinites* Lam.	Ericaceae	1	Facultative Upland	Shiny Blueberry		x	x			12-Mar-09
535	*Vaccinium stamineum* L.	Ericaceae	1	Facultative Upland (NWI)	Deerberry		x	x			15-Apr-09
574	*Viburnum obovatum* Walter	Adoxaceae	3	Facultative Wet	Walter's viburnum	x					23-Apr-09
623	*Vigna luteola* (Jacq.)Benth.	Fabaceae	3	Facultative Wet(NWI)	Hairypod cowpea		x				30-Jun-09
510	*Vitis aestivalis* Michx.	Vitaceae	3	Facultative Wet	Summer grape		x	x			12-Mar-09
407	*Vitis rotundifolia* Michx.	Vitaceae	2	Facultative	Muscadine	x	x		x		25-Feb-09
433	*Vittaria lineata* (L.) Small	Vittariaceae	2	Facultative	Shoestring fern	x			x		25-Feb-09
556	*Youngia japonica* (L.)Cass.	Asteraceae	1	Facultative Upland	Oriental false hawksbeard	x					23-Apr-09

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e. FLEPPC invasive exotic categories.

Summary of Information in Table

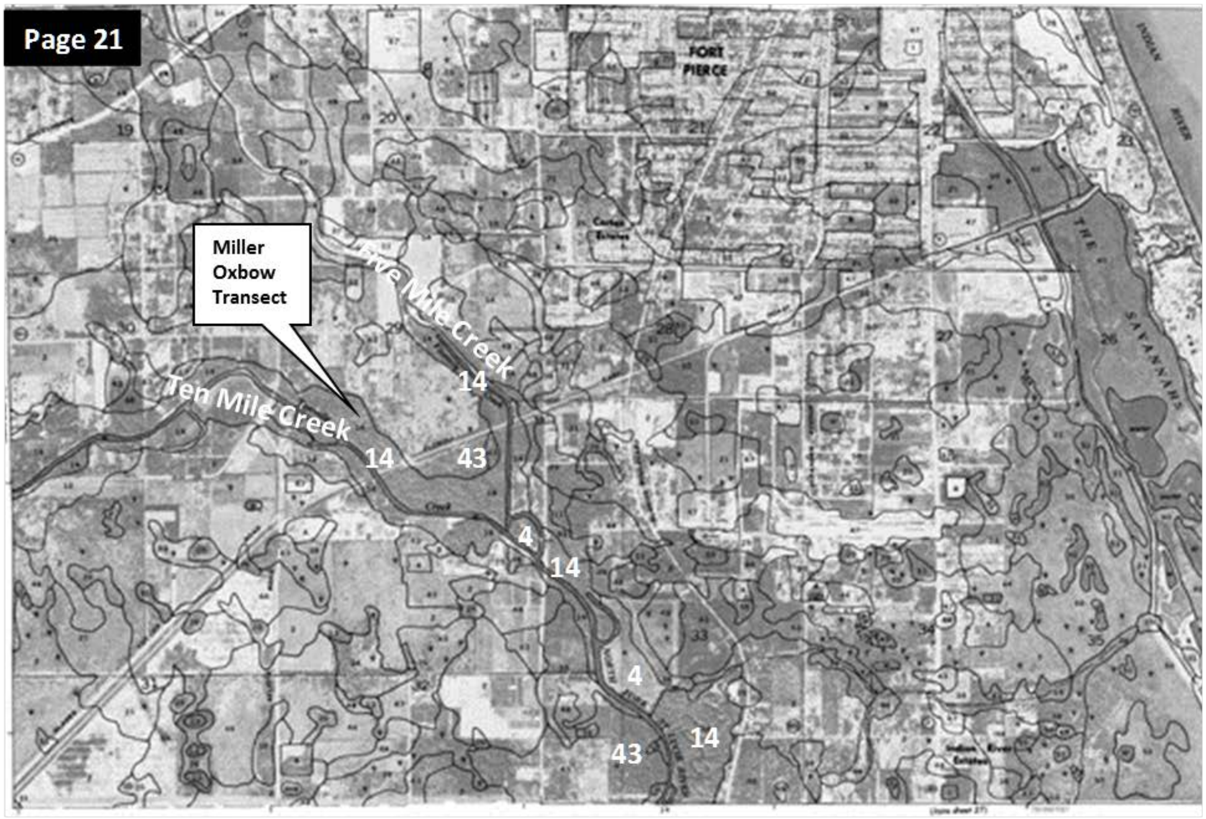
- 170 total specimens- 7 duplicates = 163 species identified on tracts or nearby.
- 163 species - 3 epiphytes not collected - 2 knowns unmounted = 158 mounted specimens.
- Wetland status: 31 obligates; 37 facultative wetland; 28 facultative; 55 facultative uplands, non-native, native; 5 unknowns, 3 epiphytes.
- 151 total number identified species in collection.
- 161 total number identified species along transects.
- 23 invasive species (Florida Exotic Pest Plant Council I or II).
- 33 non-native species.

APPENDIX D:
MAJOR SOILS, SOIL ELECTRICAL CONDUCTIVITY AND SOIL MOISTURE ON THE NORTH FORK ST. LUCIE RIVER FLOODPLAIN

Table D-1. Major soils of the North Fork St. Lucie floodplain

Code	Name	Description
4	Arents	Loose sandy mineral material with loamy soils from a variety of sources but used to fill low wet areas, water table is between 20 to 50 inches for most of the year
10	Canaveral Fine Sand	Moderate to poorly drained dark brown fine sand with shell fragments on low ridges and side slopes that border depressional areas
12	Electra Fine Sand	Somewhat poorly drained grey fine sand (7 inches) on the surface, white fine sand (40 inches) and dark reddish brown subsoil (80 inches) found on low ridges and knolls
14	Fluvaquents	Very poorly drained, nearly level soil on floodplains, rivers, and creeks, textures range from sand to clay, water table at a depth of< 10 inches 4 to 6 months and at 40 inches 9 to 12 months
17	Hobe Sand	Somewhat excessively drained grey, white and black layers of sand generally found in pine flatwoods with an understory of saw palmetto
29	Pendarvis Sand	Moderately well drained light, dark grey, reddish brown, yellowish brown and black sand found on gentle sloping pine and scrub oak areas
35	Pompano Variant-Kaligna Variant Association	Very poorly drained soils in tidal mangrove swamps with Kaligna Variant (25%, black muck) in the center of the swamp and Pompano Variant (65%, fine grey sand with shell fragments) on the outer edges. With Pompano Variant soils, the water table is at the surface while in Kaligna Variant soils it is at or above the surface
40	Samsula Variant-Myakka Variant Association	Very poorly drained marshes with organic material more than 52 inches deep, water table at or above surface 6 to 9 months a year
41	Satelite Sand	Somewhat poorly drained grey sand on low knolls and ridges with slash pine scrub oak and saw palmetto
43	Susanna Sand	Poorly drained black, grey and brownish sand on the flatwoods with slash pine and saw palmetto
45	Terra Ceica Muck	Very poorly drained black muck to a depth of 80 inches on the lower floodplains of rivers and streams and is at or above the water table 6 to 9 months annually with willow, sweet bay, maple and wax myrtle with an understory of sawgrass and giant fern
47	Urban Land	Fill material covered by more than 70% by some form of development
50	Waveland Fine Sand	Nearly level poorly drained sandy soil in broad flatwoods and ponded depressional areas, water table within 10 inches 1 to 4 months or 40 inches 6 months or more
55	Winder Loamy Sand	Poorly drained black and grey loamy sand found in hammocks, water table at a depth of < 10 inches 2–4 months annually in cabbage palm hammocks

Source: United States Department of Agriculture's Soil Conservation Service in cooperation with University of Florida Institute of Food and Agricultural Sciences and Florida Department of Agriculture and Consumer Services, 1977 Survey (USDA et al., 1977).



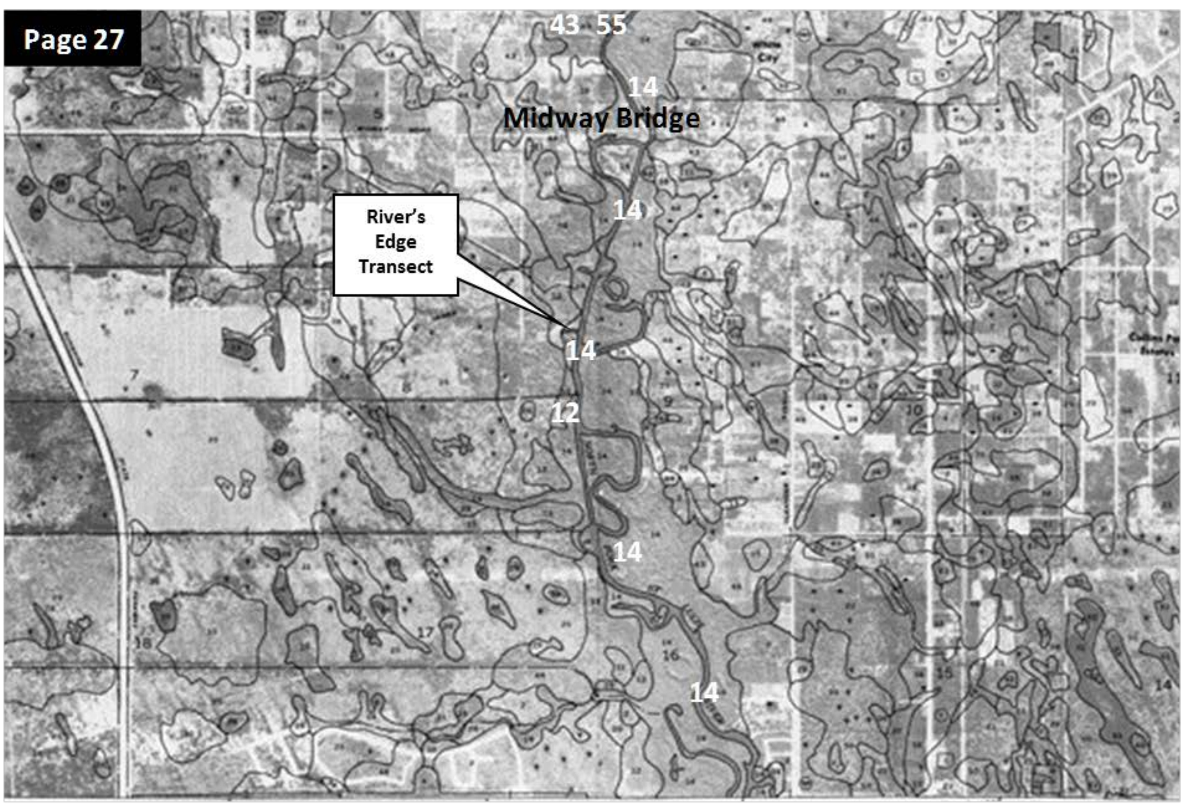
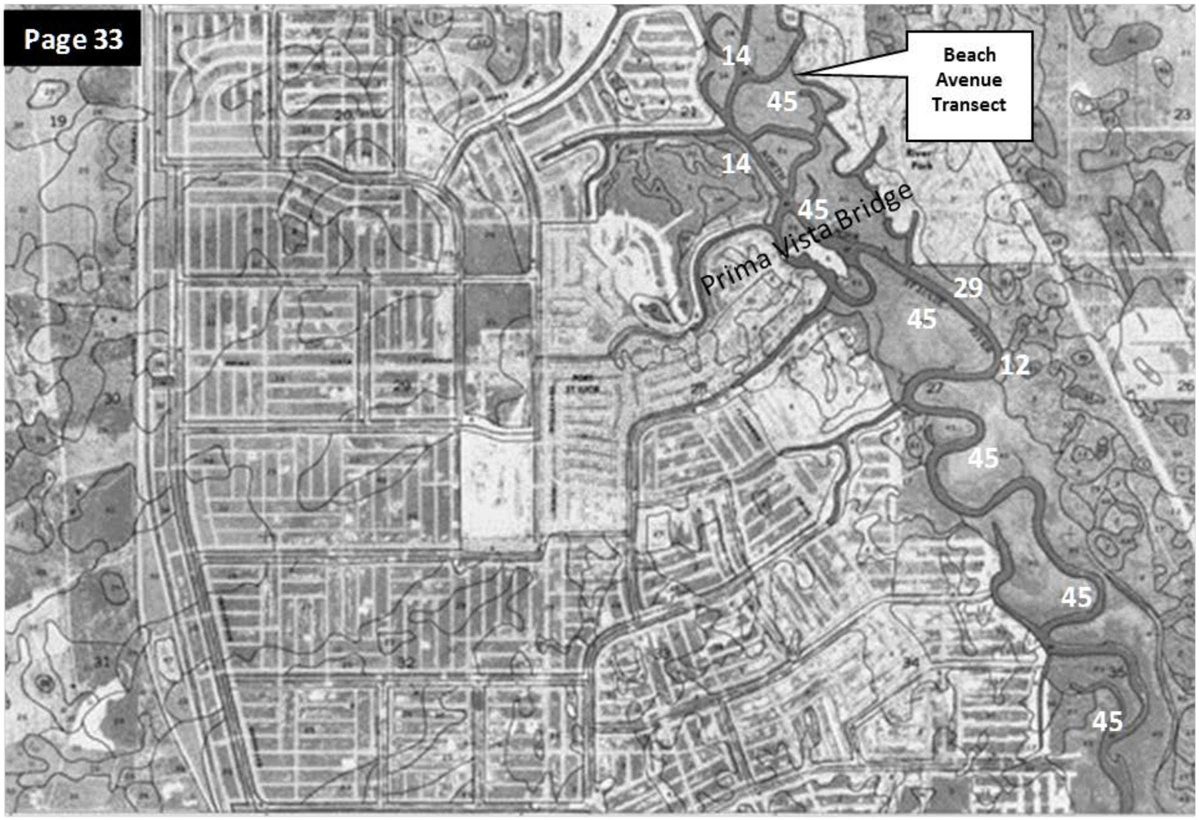


Figure D-1. Soil survey maps.



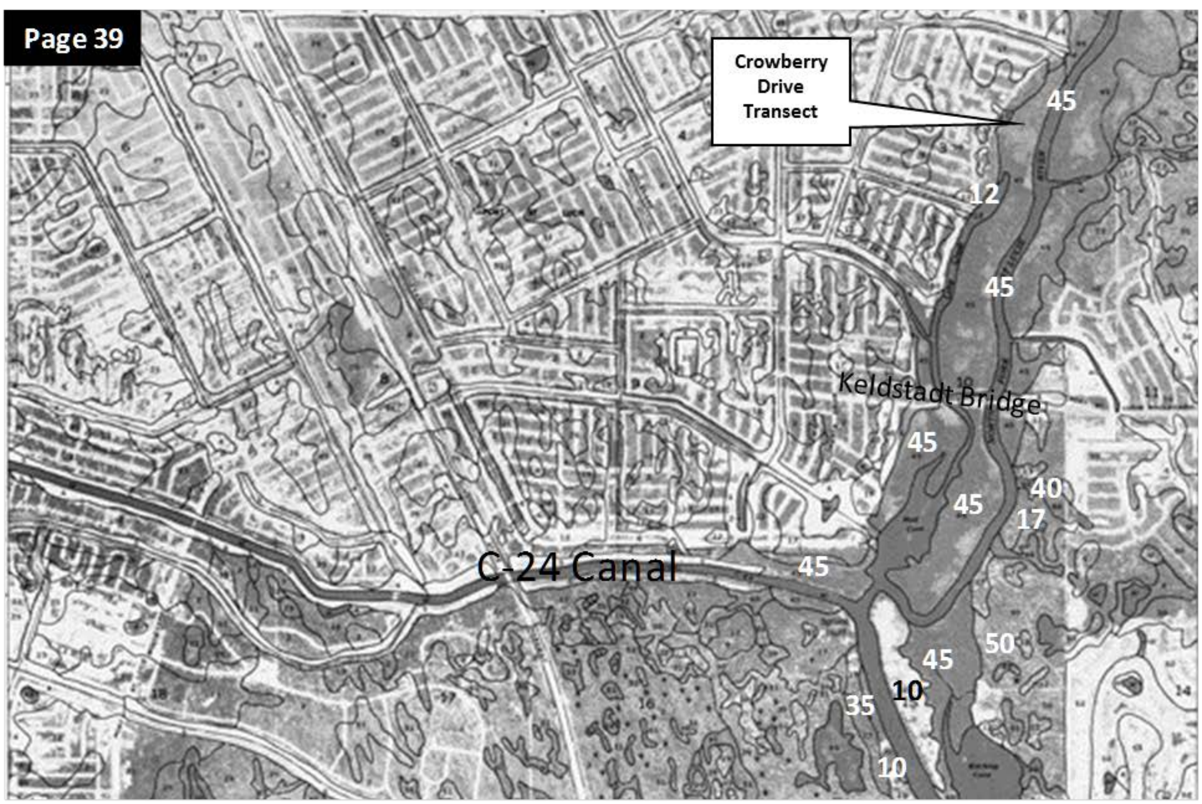


Figure D-2. Soil survey maps.

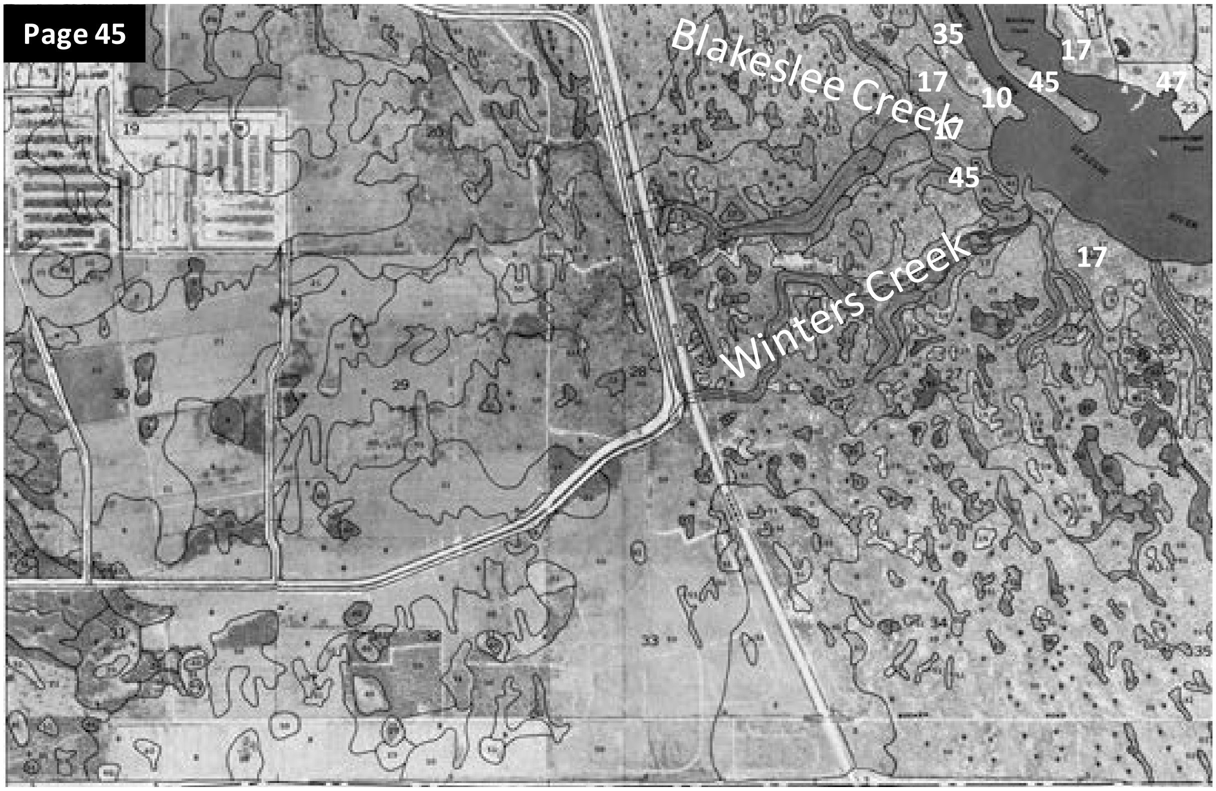


Figure D-3. Soil survey maps.

APPENDIX E: NORTH FORK ST. LUCIE RIVER FLOODPLAIN SOIL ELECTRICAL CONDUCTIVITY AND SOIL MOISTURE DATA SET

Table E-1. North Fork St. Lucie River floodplain soil electrical conductivity (EC) and percent soil moisture (%SM) data set. (Note: ° C – degrees Celsius, ° F – degrees Fahrenheit, cS/m – centisiemens per meter. See Appendix F for forest type definitions.)

Date	Plot	River Mile	Forest Type	Temp ° F	Converted ° F*	Temp ° C	EC (cS/m)	%SM	Comments
4/7/2009	MO00	30	Rblh3	77.9	69.9	21.1	0	60.3	
4/7/2009	MO10	30	Rblh3	78.8	70.8	21.5	0	73	ditch transition to hammock to bottom land hardwood and swamp
4/7/2009	MO20	30	Rblh3	77.7	69.7	20.9	0	63	ditch transition
4/7/2009	MO30	30	Rblh3	77.5	69.5	20.8	0	57.7	
4/7/2009	MO40	30	Rblh3	77.9	69.9	21.1	0	72	mixed with laurel; bottom land hardwood
4/7/2009	MO50	30	Rblh3	77.7	69.7	20.9	0	62.7	water hickory
4/7/2009	MO60	30	Rblh3	78.5	70.5	21.4	0	52.3	
4/7/2009	MO70	30	Rblh3	77.1	69.1	20.6	0	23.7	
4/7/2009	MO80	30	Rblh3	78.4	70.4	21.3	0	42	hammock
4/7/2009	MO90	30	HH	78.9	70.9	21.6	0	43.7	hammock with laurel oak
4/7/2009	MO100	30	Rblh3	79.9	71.9	22.2	0	46	mostly all laurel with a little bit of bottom land hardwood
4/7/2009	MO110	30	Rblh2	79.3	71.3	21.8	0	4	edge of berm
4/7/2009	MO120	30	HH	79.2	71.2	21.8	0	29.3	hammock on top of berm
4/9/2009	RE00	20.5	HH/U	75.2	67.2	19.6	0	81	grapevine, saw palmetto, Brazilian pepper, saltbush, cabbage palm
4/9/2009	RE10	20.5	UTblh2/3	72.4	64.4	18.0	189	92	pop ash, leather fern, wax myrtle, saltbush
4/9/2009	RE20	20.5	UTblh 2/3/HH	73.4	65.4	18.6	292	97	lizards tail, swamp lily, pop ash, saltbush
4/9/2009	RE30	20.5	UTsw2	72.7	64.7	18.2	328	96	pop ash, red maple, salt bush
4/9/2009	RE40	20.5	HH/UTblh3	74.3	66.3	19.1	321	94	pop ash, red maple, ardesia, leather fern, cabbage palm
4/9/2009	RE50	20.5	UTblh3	74.4	66.4	19.1	230	76	red maple, cabbage palm, ardesia, laurel oak
4/9/2009	RE60	20.5	UTblh3	72.4	64.4	18.0	268	93	leather fern, pop ash, cabbage palm, red maple
4/9/2009	RE70	20.5	UTblh1	75.5	67.5	19.7	320	104	pop ash, wax myrtle, leather fern, swamp lily
4/9/2009	RE80	20.5	UTblh1	73.9	65.9	18.8	314	100	pop ash, swamp lily, ardesia, wax myrtle
4/9/2009	RE90	20.5	UTlbh2	76.4	68.4	20.2	0	4	laurel oak, saw palmetto, ardesia
4/9/2009	BA00	19.5	HH	75	67	19.4	0	15	lots of trash
4/9/2009	BA10	19.5	HH	74.9	66.9	19.4	0	43	

Table E-1. Continued.

Date	Site	River Mile	Forest Type	Temp ° F	Converted ° F*	Temp ° C	EC (cS/m)	%SM	Comments
4/9/2009	BA20	19.5	UTblh3	73.4	65.4	18.6	0	57	
4/9/2009	BA30	19.5	UTblh3	73.2	65.2	18.4	128	66	
4/9/2009	BA40	19.5	UTblh3	72.7	64.7	18.2	387	70	red maple and pond apple
4/9/2009	BA50	19.5	UTblh1	73.3	65.3	18.5	691	76	red maple, willow, pond apple
4/9/2009	BA60	19.5	UTblh1	74.1	66.1	18.9	716	78	willow, bottomland, red maple
4/9/2009	BA70	19.5	UTblh1	73.3	65.3	18.5	779	84	pond apple, red maple, red bay, sawgrass
4/9/2009	BA80	19.5	UTsw1	73.2	65.2	18.4	899	85	pond apple, willow, swamp fern
4/9/2009	BA90	19.5	UTsw1	74.3	66.3	19.1	789	85	wax myrtle, cabbage palm, saltbush, swamp bay?
4/9/2009	BA100	19.5	UTsw1	73.6	65.6	18.7	728	89	popash, pond apple, swamp fern
4/9/2009	BA110	19.5	UTblh3	72.4	64.4	18.0	531	84	cabbage palm, popash, ardesia, wax myrtle
4/9/2009	BA120	19.5	UTblh3	73.4	65.4	18.6	332	75	cabbage palm, laurel oak, ardesia, red maple
4/9/2009	BA130	19.5	UTblh3	72.4	64.4	18.0	352	77	cabbage palm, ardesia, water hickory
4/9/2009	BA140	19.5	UTblh/HH	72.6	64.6	18.1	489	84	cabbage palm, ardesia, saw palmetto
4/9/2009	BA150	19.5	UTblh3	74	66	18.9	350	85	cabbage palm, laurel oak, ardesia, saltbush, wild coffee
4/9/2009	BA163	19.5	HH	76.1	68.1	20.1	107	83	live oak, cabbage palm, ardesia, saw palmetto
4/9/2009	BA173	19.5	HH	73	65	18.3	493	88	red maple, leather fern, ardesia, laurel oak
4/9/2009	BA183	19.5	HH	74.1	66.1	18.9	518	92	wax myrtle, red maple, leather fern
4/9/2009	BA193	19.5	HH	74.6	66.6	19.2	466	90	laurel oak, cabbage palm, saltbush
4/9/2009	BA203	19.5	HH	75.1	67.1	19.5	21	80	saw palmetto, cabbage palm, laurel oak, ardesia
4/14/2009	CD00	17.6	HH	82.9	74.9	23.8	70	0	wax myrtle, laurel
4/14/2009	CD10	17.6	UTblh3	81.4	73.4	23.0	83	1	red maple, laurel oak, grapevine
4/14/2009	CD20	17.6	UTblh2	80.6	72.6	22.6	167	13	wax myrtle, laurel oak
4/14/2009	CD30	17.6	UTblh3	80.3	72.3	22.4	361	41	red maple, bay, wax myrtle
4/14/2009	CD40	17.6	UTblh3	81.1	73.1	22.8	901	20	Brazilian pepper, red maple, saw palmetto
4/14/2009	CD50	17.6	UTblh3	81.1	73.1	22.8	1340	79	mostly Brazilian pepper with cabbage palm
4/14/2009	CD60	17.6	UTmix	81	73	22.8	1316	76	Brazilian pepper, willow, wax myrtle, leather fern
4/14/2009	CD70	17.6	UTmix	79.8	71.8	22.1	1503	78	mostly Brazilian pepper and leather fern

Table E-1. Continued.

Date	Site	River Mile	Forest Type	Temp ° F	Converted ° F*	Temp ° C	EC (cS/m)	%SM	Comments
4/14/2009	CD80	17.6	UTsw3	81.1	73.1	22.8	1505	83	white mangrove, Brazilian pepper, leather fern
4/14/2009	CD90	17.6	UTsw3	80	72	22.2	1505	79	ditch/tidal, sawgrass, white mangrove, Brazilian pepper, leather fern
4/14/2009	CD100	17.6	UTsw3	79.5	71.5	21.9	1503	79	white mangrove, Brazilian pepper, leather fern
4/14/2009	CD110	17.6	UTsw3	78.9	70.9	21.6	1504	75	white mangrove, leather fern and sawgrass
4/14/2009	CD120	17.6	UTsw3	79.3	71.3	21.8	1505	75	white mangrove
4/14/2009	CD130	17.6	ULTsw3	78.9	70.9	21.6	1506	78	white mangrove, sawgrass
4/14/2009	CD140	17.6	UTsw3	78.4	70.4	21.3	1508	75	white mangrove, sawgrass
4/14/2009	CD150	17.6	UTsw3	78.6	70.6	21.4	1513	74	white mangrove, sawgrass
4/14/2009	CD160	17.6	UTsw3	79	71	21.7	1514	77	small white mangrove
4/14/2009	CD170	17.6	UTsw3	78.6	70.6	21.4	1516	77	white mangrove, leather fern, sawgrass
4/14/2009	CD180	17.6	UTsw3	78.8	70.8	21.6	1518	78	white mangrove, leather fern, sawgrass
4/14/2009	CD190	17.6	UTsw3	79.5	71.5	21.9	1519	80	white mangrove
4/14/2009	CD200	17.6	UTsw3	80	72	22.2	1516	81	white mangrove, leather fern
4/14/2009	CD210	17.6	UTsw3	80.4	72.4	22.4	1530	79	tidal ditch
4/14/2009	CD220	17.6	UTsw3	80.1	72.1	22.3	1527	85	tidal ditch, white mangrove, leather fern
4/14/2009	CD230	17.6	UTsw3	80.4	72.4	22.4	1521	85	white mangrove, leather fern
4/14/2009	CD240	17.6	UTsw3	80.1	72.1	22.3	1535	85	white mangrove, leather fern
4/14/2009	CD250	17.6	UTsw3	79.7	71.7	22.1	1528	84	white mangrove, leather fern
4/14/2009	CD260	17.6	Marsh	80.2	72.2	22.3	1535	77	white mangrove, sawgrass
4/14/2009	CD270	17.6	Marsh	79.7	71.7	22.1	1534	83	sawgrass
4/14/2009	CD280	17.6	Marsh	80.1	72.1	22.3	1541	79	sawgrass, Brazilian pepper, saltbush
4/14/2009	CD290	17.6	Marsh	80	72	22.2	1543	78	white mangrove, sawgrass, leather fern
4/14/2009	CD300	17.6	UTsw3	80.4	72.4	22.4	1549	78	white mangrove, leather fern and sawgrass, small Brazilian pepper
4/14/2009	CD310	17.6	UTblh3	80.8	72.8	22.7	1124	66	hornet nest, white mangrove, wax myrtle, Brazilian pepper, sawgrass
4/14/2009	CD320	17.6	UTblh2	80.4	72.4	22.4	916	48	sandy beach, red mangrove, laurel oak, wax myrtle, cabbage palm

APPENDIX F:
SUMMARY OF FOREST TYPE DETERMINATIONS

Summary of Forest Type Determinations

Table F-1 provides a summary of forest type determinations.

Table F-1. Summary of hydrological conditions, soil textures, and dominant canopy species of forest types in the floodplains of South Florida (modified from Light et al., 2002a).

Forest Type	Typical Hydrological Conditions	Primary Soil Textures	Dominant Canopy Species
Uplands (U)	Flooded average of every 10 years; soils dry quickly after floods recede	Sand	*Pinus elliottii* *Quercus myrtifolia*
Hydric Hammock (HH)	Flooded average 2 months (30–60 days)	Sand	*Sabal palmetto*
Mesic Hammock (MH)	Rarely inundated at higher elevation; soils dry quickly after floods recede		*Quercus virginiana*
R/UTblh3 R/UTblh2	Flooded average of every 3 years, sometimes for durations of 1–2 months or more; soils dry quickly after floods recede	Sand	*Quercus laurifolia* *Chrysobalanus icaco* *Ilex cassine* *Carya aquatica* *Persea borbonia*
R/UTblh1	Flooded average of one month every year remain saturated another month	Sand, loam, clay	*Acer rubrum* *Cephalanthus occidentalis* *Persea palustris* *Salix caroliniana*
Rsw2 Rsw1	Flooded average 4–7 months every year; soils remain saturated another 5 months	Clay, muck	*Taxodium distichum* *Fraxinus caroliniana*
Rmix	Flooded 2–3 months every year	Sand	*Taxodium distichum* *Sabal palmetto*
UTmix	Flooded 2–3 months every year; soils dry quickly in some areas and remain continuously saturated in others	Loam, muck, sand	*Laguncularia racemosa* *Annona glabra* *Acer rubrum* *Salix caroliniana* *Cephalanthus occidentalis* *Taxodium distichum*

White= uplands
Green=riverine reach
Yellow=Upper tidal reach
Salmon=lower tidal reach

Table F-1. Continued.

<table>
<tr><th>Forest Type</th><th>Typical Hydrological Conditions</th><th>Primary Soil Textures</th><th>Dominant Canopy Species</th></tr>
<tr><td>UTsw3</td><td>Flooded monthly by high tides or high river flows</td><td rowspan="2">Muck</td><td rowspan="2">Annona glabra
Fraxinus caroliniana
Rhizophora mangle
Laguncularia racemosa</td></tr>
<tr><td>UTsw2
UTsw1</td><td>Flooded daily by high tides from 9–11 months of a year; most soils continuously saturated</td></tr>
<tr><td>Hammock</td><td>Flooded every 1–2 years by either storm surge or high river flows or high water table; surface soils on higher elevations dry quickly and soils continuously saturated in lower areas</td><td>Muck</td><td>Sabal palmetto
Chrysobalnus icaco
Quercus virginiana
Myrica cerifera</td></tr>
<tr><td>LTmix</td><td>Flooded daily or several times a month by high tides except in isolated areas; soils continuously saturated except for the interior of hammocks</td><td>Muck</td><td>Lagunularia racemosa
Sabal palmetto
Rhizophora mangle
Annona glabra</td></tr>
<tr><td>LTsw2</td><td>Flooded daily for 9 months every year</td><td>Muck</td><td>Laguncularia racemosa
Rhizophora mangle
Annona glabra</td></tr>
<tr><td>LTsw1</td><td>Flooded daily every year</td><td>Muck</td><td>Rhizophora mangle
Laguncularia racemosa</td></tr>
</table>

Uplands

Upland forests are present at the edge of the floodplain on both the riverine and tidal reaches of the river and are inundated only for short periods of time during the highest floods. Most of the plant species found in this type of forest community can only survive brief periods of inundation. These upland systems are dominated by slash pine (*Pinus elliottii*), myrtle oak (*Quercus myrtifolia*) and saw palmetto (*Serenoa repens*) (**Figure F-1**).

Figure F-1. Upland forest type.

Hammocks

Hammocks support a diversity of tropical and temperate plants including hardwood trees, palms, orchids and other air plants (Mitch and Gosselink, 1993). Hydric hammock communities are dominated by cabbage palms (*Sabal palmetto*); whereas mesic hammocks are dominated by live oaks (*Quercus virginiana*) (**Figure F-2**). Mesic hammocks are found at higher elevations than hydric hammocks. Other fairly common species in the hammocks are myrsine (*Myrsine cubana*), mulberry (*Morus rubra*), red bay (*Persea borbonia*), and ficus. Hammocks are generally found between the uplands or bottomland hardwood forests and swamp areas. They may also appear as isolated islands or berms and may border the riverbed where elevations are higher. Hammocks are briefly inundated by storm surges and characteristically have a high water table due to their proximity to wetland areas. Hydric hammocks are flooded continuously for several weeks or longer every 1 to 3 years depending on reach. Mesic hammocks are rarely flooded because of their higher elevations. Surface soils are mostly sandy in both types of hammock. Brazilian pepper (*Schinus terebinthifolia*) may occur as an exotic pest species where there is sufficient high elevations.

Figure F-2. Hammocks are found in both riverine and tidal reaches of the river.

Riverine and Upper Tidal Reaches and High Bottomland Hardwoods

In the riverine and upper tidal reaches, high bottomland hardwoods (Rblh2/Rblh3 and UTblh2/UTblh3) are found on higher ridges (**Figure F-3**) while low bottomland hardwoods (Rblh1 and UTblh1) are found on swamp margins. Blh3 canopy communities are dominated by water hickory (*Carya aquatica*), coco plum (*Chrysobalanus icaco*), dahoon holly (*Ilex cassine*), and laurel oak (*Quercus laurifolia*). The forest type blh2 has approximately equal amounts of low and high bottomland species while blh3 has combinations of high bottomland mixed with hammock or even some upland representatives. Blh1 forests are found at lower elevations than blh2 and blh3. Periods of inundation are generally 1 to 2 months every few years for high bottom land hardwood and about 2 months every year for low bottomland hardwood. Rblh1 canopy communities are characterized by red maple (*Acer rubrum*), buttonbush (*Cephalanthus occidentalis*), swamp bay (*Persea palustris*) and Carolina willow (*Salix caroliniana*). Riverine Mixed forests (Rmix and UTmix) support nearly equal mixtures of bald cypress (*Taxodium distichum*) and hammock species. The exotic plant species, java plum (*Syzygium cumini*) and strawberry guava (*Psidium cattleianum*) are found in both riverine and tidal bottomland hardwoods.

Figure F-3. Bottomland hardwood forest type (Miller Oxbow Transect).

Riverine Swamps

Riverine swamps are found growing on the lowest elevations and in the wettest areas that are inundated or saturated most of the time (**Figure F-4**). Soils are sandy with some muck or clay. On the Northwest Fork Loxahatchee River, older riverine swamps are dominated primarily by bald cypress in Rsw1 swamps. On the North Fork St. Lucie River, riverine swamps appear to be dominated by pop ash (*Fraxinus caroliniana*) and pond apple (*Annona glabra*). Deeper swamp communities and impacted areas (logged) are more populated by pop ash (Rsw2) occasionally. Bald cypress/cabbage palm (swamp/hammock) and bald cypress/red maple/cabbage palm (swamp/low bottomland hardwood/hammock) communities are present and are categorized as riverine mixed (Rmix). Pond apples are found in the riverine swamp but mostly only in association with the banks of the riverbed. Areas of riverine swamp Rsw1 (mostly older bald cypress) are present on some primarily upper Loxahatchee River tidal transects and have probably survived at the back of the tidal floodplains due to surface and groundwater runoff from the adjacent uplands. On the North Fork St. Lucie River, extensive areas of riverine swamp are not common probably due to early dredging of the river for navigation. The most problematic exotic pest plant species in riverine swamp communities are golden pathos (*Epipremnum aureum*), nephthytes (*Nephthytis* spp.) and wild taro (*Colocasia esculenta*).

Figure F-4. Riverine swamp forest type (Rsw1).

Upper Tidal Swamps

Upper tidal swamps are present at elevations below median monthly high stage (**Figure F-5**). Unlike riverine swamps, upper tidal surface soils consist of permanently saturated mucks. Upper tidal swamps are a mixture of brackish and freshwater vegetative communities. They primarily consist of pond apple, red (*Rhizophora mangle*) and white (*Laguncularia racemosa*) mangroves with smaller numbers of bald cypress, pop ash, red maple and Carolina willow. UTsw1 is defined as a community of mixed fresh and saltwater swamp species with primarily pond apple and a significant amount of red mangrove with generally lower topography and higher floodplain inundation. UTsw2 is very similar to UTsw1 but with greater percentage of pond apple and with a small amount of white mangrove. White mangrove is more dominant in the UTsw3 forest type and found at higher elevations than UTsw1 and UTsw2. White mangroves are most often found at higher elevations than red mangrove, bald cypress and pop ash; therefore, they should represent less relative basal area in the deeper mixed swamp communities. If the mixed swamp communities are less than 50%, and hammock, uplands and/or bottomland hardwood species are more dominant, then the forest type is identified as upper tidal mixed (UTmixed). However, if hammock represents greater than 50%, then the forest type is identified as hammock.

Figure F-5. Upper tidal swamp forest type (UTsw1).

Lower Tidal Forest

Lower tidal forest types are primarily mangrove forests (swamps) with some areas of hammock, which occur in areas with very little change in topography within the floodplains (**Figure F-6**). Soils are mucky with some areas of sand. LTsw1 is representative of a swamp dominated by red mangroves, while LTsw2 is representative of a white mangrove swamp with infrequent pond apples and red mangroves. Other plots contain mixtures of white mangrove, pond apple and cabbage palm. If the plot contains a mixture of hammock species such as cabbage palm and a significant number of swamp species such as white mangrove and pond apple, then the forest type is identified as lower tidal mixed (LTmixed). If hammock and bottomland hardwood species like cabbage palm and coco plum are greater than 50%, then the forest type is identified as hammock. Cabbage palm is found intermixed and in clumps with swamp species; however, those palms that were found at these low elevations and exposed to saltwater did not appear to be as healthy as those found at the higher elevations. Others were found growing on small mounds or hummocks.

Figure F-6. Lower tidal swamp forest type (LTsw1).

Freshwater and Saltwater Marshes

According to Kushlan (1990), freshwater and saltwater marshes are wetlands with less than one-third of the cover in trees and shrubs that are dominated by herbaceous plants rooted in and generally emergent from shallow water stands at or above the groundwater surface for much of the year. Most of the marshes associated with the Loxahatchee River were historically located in the North Fork Loxahatchee River. These former marsh communities (**Figure F-7**) have changed into young forested systems of primarily mixed hardwoods with red maple, dahoon holly, and buttonbush with heavy thickets of willow in some non-tidal areas and pond apple and white mangroves in tidally inundated areas. On the North Fork St. Lucie River, sawgrass (*Cladium jamaicense*) marshes are still present behind the berms. At some higher elevations remnant freshwater marshes have been invaded by white mangroves.

Figure F-7. Former saltwater marsh under power lines at River Mile 6.5 that has since converted to mangroves on the Northwest Fork Loxahatchee River (Bill Lund photograph from 1971).

References

Kushlan, J.A. 1990. Freshwater Marshes. IN R.L. Myers and J.J. Ewel Ecosystems of Florida, University of Central Florida Press, Orlando, FL pp.324-263.

APPENDIX G:
NORTH FORK ST. LUCIE RIVER FLOODPLAIN DATA SETS AND ADDITIONAL GRAPHS

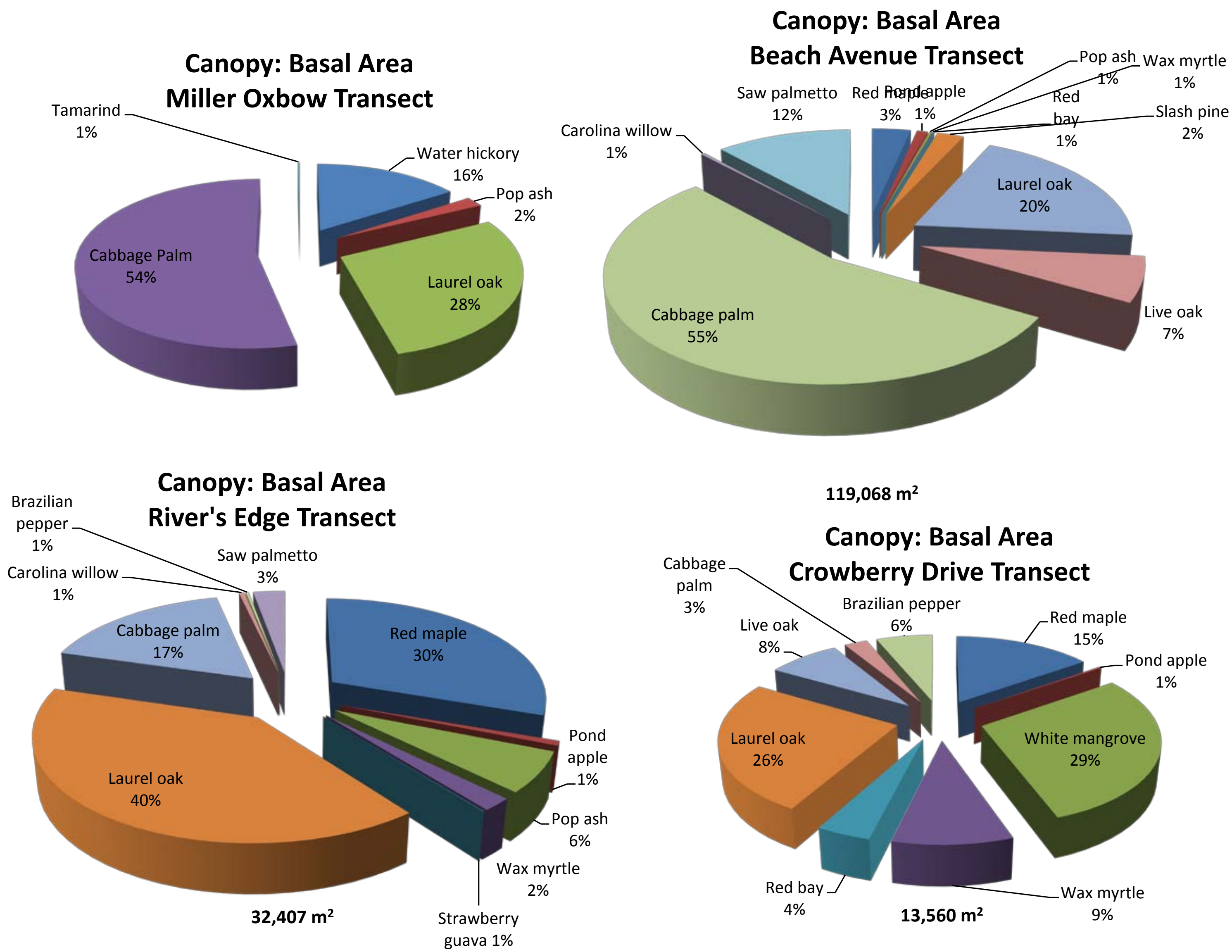


Figure G-1. Additional canopy basal area graphs by transect.

Table G-1. 2009 canopy data set.
(Note: %SM – percent soil moisture, cm – centimeters, cS/m – centisiemens per meter, dbh – diameter breast height and EC – soil electrical conductivity. See Appendix C for species codes and Appendix F for forest type codes.)

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/7/2009	Miller Oxbow	MO00	QUELAU	31.6	784.27	Rblh3	0	60.3	adjacent to uplands
4/7/2009	Miller Oxbow	MO00	QUELAU	36.7	1057.85	Rblh3	0	60.3	
4/7/2009	Miller Oxbow	MO00	QUELAU	21.5	363.05	Rblh3	0	60.3	
4/7/2009	Miller Oxbow	MO00	SABPAL	26.5	551.55	Rblh3	0	60.3	
4/7/2009	Miller Oxbow	MO00	SABPAL	26.1	535.02	Rblh3	0	60.3	
4/7/2009	Miller Oxbow	MO10	FRACAR	9.1	65.04	Rblh3	0	73	ditch transition, red maple subcanopy
4/7/2009	Miller Oxbow	MO10	FRACAR	8.1	51.53	Rblh3	0	73	
4/7/2009	Miller Oxbow	MO10	CARAQU	15	176.72	Rblh3	0	73	
4/7/2009	Miller Oxbow	MO10	QUELAU	13.2 dead		Rblh3	0	73	
4/7/2009	Miller Oxbow	MO10	QUELAU	22.3	390.57	Rblh3	0	73	
4/7/2009	Miller Oxbow	MO10	SABPAL	17.3	235.06	Rblh3	0	73	
4/7/2009	Miller Oxbow	MO10	SABPAL	24.9 dead		Rblh3	0	73	
4/7/2009	Miller Oxbow	MO10	SABPAL	22.5	397.61	Rblh3	0	73	
2/2/2009	Miller Oxbow	MO20	SABPAL	34	907.92	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	SABPAL	29.5	683.49	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	SABPAL	28.3	629.02	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	SABPAL	31.4	774.37	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	QUELAU	11	95.03	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	QUELAU	35	962.12	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	FRACAR	14.6	167.42	Rblh3	0	63	multi-trunk
2/2/2009	Miller Oxbow	MO20	FRACAR	12.5	122.72	Rblh3	0	63	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
2/2/2009	Miller Oxbow	MO20	FRACAR	25	490.88	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	CARAQU	36.5	1046.35	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO20	CARAQU	16.8	221.67	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO30	SABPAL	28	615.75	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	SABPAL	33.5	881.42	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	SABPAL	26	530.93	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	SABPAL	26	530.93	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	QUELAU	30.3	721.07	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	QUELAU	12	113.10	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	QUELAU	28.5	637.94	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	QUELAU	31	754.77	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	QUELAU	16	201.06	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO30	CARAQU	54.5	2332.83	Rblh3	0	58	
2/2/2009	Miller Oxbow	MO40	QUELAU	41	1320.26	Rblh3	0	72	
2/2/2009	Miller Oxbow	MO40	QUELAU	22	380.13	Rblh3	0	72	
2/2/2009	Miller Oxbow	MO40	SABPAL	22	380.13	Rblh3	0	72	marked to be removed for oxbox restoration
2/2/2009	Miller Oxbow	MO40	SABPAL	30	706.86	Rblh3	0	72	
2/2/2009	Miller Oxbow	MO50	CARAQU	37.5	1104.47	Rblh3	0	63	
2/2/2009	Miller Oxbow	MO50	QUELAU	19.5	298.65	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO50	SABPAL	29.5	683.49	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO50	SABPAL	31.5	779.31	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO50	SABPAL	34	907.92	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO50	SABPAL	24.5	471.44	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO60	CARAQU	20.8	339.80	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO60	SABPAL	33	855.30	Rblh3	0	52	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
2/2/2009	Miller Oxbow	MO60	SABPAL	26	530.93	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO60	SABPAL	33	855.30	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO60	SABPAL	30	706.86	Rblh3	0	52	
2/2/2009	Miller Oxbow	MO60	SABPAL	29.8	697.47	Rblh3	0	52	benchmark 1491-33
5/7/2009	Miller Oxbow	MO70			0.00	Rblh3	0	24	no canopy
5/7/2009	Miller Oxbow	MO80	QUELAU	37.7	1116.28	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO80	QUELAU	12	113.10	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO80	CARAQU	12.6	124.69	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO80	SABPAL	23.7	441.15	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO80	SABPAL	23.5	433.74	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO80	SABPAL	39	1194.59	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO80	SABPAL	22.6	401.15	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO80	SABPAL	23.5	433.74	Rblh3	0	42	
5/7/2009	Miller Oxbow	MO90	SABPAL	29.3	674.26	HH	0	44	
5/7/2009	Miller Oxbow	MO90	SABPAL	28.1	620.16	HH	0	44	
5/7/2009	Miller Oxbow	MO90	SABPAL	33.4	876.16	HH	0	44	
5/7/2009	Miller Oxbow	MO90	SABPAL	26	530.93	HH	0	44	
5/7/2009	Miller Oxbow	MO90	SABPAL	30.4	725.84	HH	0	44	
5/7/2009	Miller Oxbow	MO90	SABPAL	24.5	471.44	HH	0	44	
5/7/2009	Miller Oxbow	MO90	CARAQU	8.5	56.75	HH	0	44	
5/7/2009	Miller Oxbow	MO100	CARAQU	44.5	1555.29	Rblh3	0	46	
5/7/2009	Miller Oxbow	MO100	SABPAL	26	530.93	Rblh3	0	46	in ditch
5/7/2009	Miller Oxbow	MO100	FRACAR	7.2	40.72	Rblh3	0	46	
5/7/2009	Miller Oxbow	MO110	QUELAU	20	314.16	Rblh2	0	4	
5/7/2009	Miller Oxbow	MO110	QUELAU	28.8	651.44	Rbh2	0	4	up on berm at Ten Mile Creek

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/7/2009	Miller Oxbow	MO120	QUELAU	58.4	2678.65	HH	0	29	up on berm at Ten Mile Creek
5/7/2009	Miller Oxbow	MO120	QUELAU	27.8	606.99	HH	0	29	
5/7/2009	Miller Oxbow	MO120	TAMIND	5.7	25.52	HH	0	29	vouch#1 tamarind tree
5/7/2009	Miller Oxbow	MO120	TAMIND	8.3	54.11	HH	0	29	vouch#1 tamarind tree
4/7/2009	Miller Oxbow	MO120	CARAQU	25.8	522.79	HH	0	29	
4/7/2009	Miller Oxbow	MO120	SABPAL	37.3	1092.72	HH	0	29	
4/7/2009	Miller Oxbow	MO120	SABPAL	27.3	585.35	HH	0	29	
4/7/2009	Miller Oxbow	MO120	SABPAL	35.5	989.80	HH	0	29	
4/7/2009	Miller Oxbow	MO120	SABPAL	29.2	669.66	HH	0	29	
4/30/2009	Rivers Edge	RE00	SABPAL	27.7	602.63	HH/U	0	81	
4/30/2009	Rivers Edge	RE10	QUELAU	8.5 dead		UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	QUELAU	7.1	39.59	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	QUELAU	7	38.48	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	QUELAU	30.2	716.32	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	MYRCER	6.3	31.17	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	ACERUB	8.2	52.81	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	ACERUB	44.3	1541.34	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	SALCAR	7.5	44.18	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	SALCAR	12.1	114.99	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	SCHTER	8	50.27	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	SCHTER	7.2	40.72	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE10	PSICAT	4.5	15.90	UTblh2/3	189	92	
4/30/2009	Rivers Edge	RE20	ACERUB	27.1	576.81	UTblh2/3/HH	292	97	
4/30/2009	Rivers Edge	RE20	ACERUB	9.1	65.04	UTblh2/3/HH	292	97	
4/30/2009	Rivers Edge	RE20	FRACAR	7.3	41.85	UTblh2/3/HH	292	97	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/30/2009	Rivers Edge	RE20	FRACAR	6.2	30.19	UTblh2/3/HH	292	97	
4/30/2009	Rivers Edge	RE20	FRACAR	8.2	52.81	UTblh2/3/HH	292	97	
4/30/2009	Rivers Edge	RE20	FRACAR	6	28.27	UTblh2/3/HH	292	97	
4/30/2009	Rivers Edge	RE20	FRACAR	8.4	55.42	UTblh2/3/HH	292	97	
4/30/2009	Rivers Edge	RE20	SABPAL	22.1	383.60	UTblh2/3/HH	292	97	
4/30/2009	Rivers Edge	RE30	FRACAR	8.2	52.81	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	7.5	44.18	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	10	78.54	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	19.5	298.65	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	6.4	32.17	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	6	28.27	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	5.5	23.76	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	6	28.27	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	6.2	30.19	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	5.1	20.43	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	12.3	118.82	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	15	176.72	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	6.2	30.19	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	FRACAR	6.2	30.19	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	ACERUB	9.5	70.88	UTsw2	328	96	
4/30/2009	Rivers Edge	RE30	ACERUB	27.5	593.96	UTsw2	328	96	
4/30/2009	Rivers Edge	RE40	FRACAR	11.9	111.22	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	FRACAR	11.1	96.77	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	FRACAR	6.3	31.17	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	FRACAR	6.7	35.26	HH/UTblh3	321	94	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/30/2009	Rivers Edge	RE40	MYRCER	5.5	23.76	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	MYRCER	6.5	33.18	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	MYRCER	9	63.62	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	MYRCER	11.2	98.52	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	MYRCER	13.4	141.03	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	ACERUB	22.4	394.08	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	ACERUB	5.5	23.76	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	ACERUB	7.5	44.18	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	ACERUB	6.5	33.18	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	ACERUB	34.5	934.82	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	SABPAL	30	706.86	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE40	SABPAL	29.5	683.49	HH/UTblh3	321	94	
4/30/2009	Rivers Edge	RE50	ACERUB	34.5	934.82	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	ACERUB	7	38.48	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	ACERUB	50	1963.50	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	SABPAL	35	962.12	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	SABPAL	37.5	1104.47	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	SABPAL	27.2	581.07	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	SABPAL	22.5	397.61	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	SABPAL	8.1	51.53	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	SERREP	34	907.92	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	QUELAU	65.2	3338.77	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	QUELAU	70.4	3892.57	UTblh3	230	76	multi-trunk
4/30/2009	Rivers Edge	RE50	QUELAU	9.8	75.43	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	QUELAU	6.3	31.17	UTblh3	230	76	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/30/2009	Rivers Edge	RE50	MYRCER	6	28.27	UTblh3	230	76	
4/30/2009	Rivers Edge	RE50	MYRCER	6.4	32.17	UTblh3	230	76	
4/30/2009	Rivers Edge	RE60	ACERUB	30.7	740.23	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	ACERUB	33.7	891.97	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	FRACAR	9.9	76.98	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	FRACAR	6.7	35.26	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	FRACAR	6.9	37.39	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	FRACAR	5.9	27.34	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	SABPAL	20.5	330.06	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	ANNGLA	5.2	21.24	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	ANNGLA	6.2	30.19	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	ANNGLA	5.4	22.90	UTblh3	268	93	
4/30/2009	Rivers Edge	RE60	ANNGLA	6	28.27	UTblh3	268	93	
4/30/2009	Rivers Edge	RE70	FRACAR	10.3	83.32	UTblh1	320	104	
4/30/2009	Rivers Edge	RE70	ACERUB	31	754.77	UTblh1	320	104	
4/30/2009	Rivers Edge	RE70	MYRCER	8.3	54.11	UTblh1	320	104	
4/30/2009	Rivers Edge	RE70	MYRCER	11.5	103.87	UTblh1	320	104	
4/30/2009	Rivers Edge	RE80	ACERUB	15.5	188.69	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	FRACAR	11.5	103.87	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	FRACAR	8.8	60.82	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	FRACAR	8.5	56.75	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	FRACAR	11	95.03	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	MYRCER	6.5	33.18	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	MYRCER	5.8	26.42	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	ANNGLA	5	19.64	UTblh1	314	100	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/30/2009	Rivers Edge	RE80	ANNGLA	5.4	22.90	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	ANNGLA	5.8	26.42	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	ANNGLA	5.5	23.76	UTblh1	314	100	
4/30/2009	Rivers Edge	RE80	ANNGLA	6.8	36.32	UTblh1	314	100	
4/30/2009	Rivers Edge	RE90	QUELAU	19.1	286.52	UTblh2	0	4	on berm adjacent to river
4/30/2009	Rivers Edge	RE90	QUELAU	62	3019.08	UTblh2	0	4	
4/30/2009	Rivers Edge	RE90	QUELAU	44.5	1555.29	UTblh2	0	4	
4/23/2009	Beach Avenue	BA00	SABPAL	30.4	725.84	HH	0	15	
4/23/2009	Beach Avenue	BA00	SABPAL	25.5	510.71	HH	0	15	
4/23/2009	Beach Avenue	BA00	QUELAU	14.8	172.03	HH	0	15	
4/23/2009	Beach Avenue	BA00	QUELAU	9.8	75.43	HH	0	15	
4/23/2009	Beach Avenue	BA00	PERBOR		0.00	HH	0	15	no measurement
5/5/2009	Beach Avenue	BA10	SABPAL	29.5	683.49	HH	0	43	
5/5/2009	Beach Avenue	BA10	SABPAL	29.5	683.49	HH	0	43	
5/5/2009	Beach Avenue	BA10	SABPAL	33	855.30	HH	0	43	
5/5/2009	Beach Avenue	BA10	SABPAL	21	346.36	HH	0	43	
5/5/2009	Beach Avenue	BA10	SABPAL	23	415.48	HH	0	43	
5/5/2009	Beach Avenue	BA10	PINELL	59	2733.98	HH	0	43	
5/5/2009	Beach Avenue	BA10	QUELAU	8	50.27	HH	0	43	
5/5/2009	Beach Avenue	BA10	QUELAU	7	38.48	HH	0	43	
5/5/2009	Beach Avenue	BA10	QUELAU	28	615.75	HH	0	43	
5/5/2009	Beach Avenue	BA10	QUELAU	7.4	43.01	HH	0	43	
5/5/2009	Beach Avenue	BA10	ACERUB	8.2	52.81	HH	0	43	
5/5/2009	Beach Avenue	BA20	SABPAL	34.5	934.82	UTblh3	0	57	
5/5/2009	Beach Avenue	BA20	QUELAU	24.8	483.05	UTblh3	0	57	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/5/2009	Beach Avenue	BA20	QUELAU	42	1385.45	UTblh3	0	57	
5/5/2009	Beach Avenue	BA20	QUELAU	11.4	102.07	UTblh3	0	57	
5/5/2009	Beach Avenue	BA20	QUELAU	19.2	289.53	UTblh3	0	57	
5/5/2009	Beach Avenue	BA20	QUELAU	78	4778.37	UTblh3	0	57	
5/5/2009	Beach Avenue	BA20	QUELAU	74	4300.85	UTblh3	0	57	
5/5/2009	Beach Avenue	BA20	SERREP	20.1	317.31	UTblh3	0	57	
5/5/2009	Beach Avenue	BA30	QUELAU	14.5	165.13	UTblh3	128	66	multi-trunk
5/5/2009	Beach Avenue	BA30	QUELAU	29.1	665.08	UTblh3	128	66	
5/5/2009	Beach Avenue	BA30	QUELAU	16	201.06	UTblh3	128	66	
5/5/2009	Beach Avenue	BA30	QUELAU	22.2	387.08	UTblh3	128	66	
5/5/2009	Beach Avenue	BA30	SABPAL	28	615.75	UTblh3	128	66	
5/5/2009	Beach Avenue	BA30	SABPAL	27	572.56	UTblh3	128	66	
5/5/2009	Beach Avenue	BA30	QPALM		0.00	UTblh3	128	66	no measurement
5/5/2009	Beach Avenue	BA30	SERREP	25.1	494.81	UTblh3	128	66	
5/5/2009	Beach Avenue	BA30	SERREP	37	1075.21	UTblh3	128	66	
5/5/2009	Beach Avenue	BA30	SERREP	26	530.93	UTblh3	128	66	
5/5/2009	Beach Avenue	BA40	SABPAL	34.2	918.64	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	SABPAL	25	490.88	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	SABPAL	32.5	829.58	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	SABPAL	32.2	814.33	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	SABPAL	31.8	794.23	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	SERREP	22	380.13	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	SERREP	42	1385.45	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	SERREP	45.1	1597.51	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	QUELAU	51.1	2050.84	UTblh3	387	70	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/5/2009	Beach Avenue	BA40	ACERUB	18.8	277.59	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	ACERUB	6.8	36.32	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	ACERUB	7.2	40.72	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	ACERUB	8.4	55.42	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	ACERUB	12.5	122.72	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	ACERUB	12.5	122.72	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	ACERUB	8	50.27	UTblh3	387	70	
5/5/2009	Beach Avenue	BA40	ACERUB	5.1	20.43	UTblh3	387	70	
5/5/2009	Beach Avenue	BA50	ANNGLA	6.4	32.17	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	ANNGLA	6.2	30.19	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	ANNGLA	8.5	56.75	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	ANNGLA	7.4	43.01	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	ANNGLA	9	63.62	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	ANNGLA	7.5	44.18	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	ACERUB	13	132.73	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	ACERUB	9.5	70.88	UTblh1	691	76	
5/5/2009	Beach Avenue	BA50	SALCAR	8.1	51.53	UTblh1	691	76	
5/5/2009	Beach Avenue	BA60	ANNGLA	5.7	25.52	UTblh1	716	78	
5/5/2009	Beach Avenue	BA60	ANNGLA	6.7	35.26	UTblh1	716	78	
5/5/2009	Beach Avenue	BA60	ANNGLA	8.5	56.75	UTblh1	716	78	
5/5/2009	Beach Avenue	BA60	SALCAR	7.2	40.72	UTblh1	716	78	
5/5/2009	Beach Avenue	BA60	SALCAR	11	95.03	UTblh1	716	78	
5/5/2009	Beach Avenue	BA60	SALCAR	7.4	43.01	UTblh1	716	78	
5/5/2009	Beach Avenue	BA60	SALCAR	9.5	70.88	UTblh1	716	78	
5/5/2009	Beach Avenue	BA60	ACERUB	17	226.98	UTblh1	716	78	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/5/2009	Beach Avenue	BA60	MYRCER	10	78.54	UTblh1	716	78	
5/5/2009	Beach Avenue	BA70	ANNGLA	8.5	56.75	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	ANNGLA	7.5	44.18	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	ANNGLA	6.3	31.17	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	ANNGLA	5.1	20.43	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	ACERUB	26.1	535.02	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	ACERUB	8.8	60.82	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	ACERUB	8.2	52.81	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	SALCAR	7.1	39.59	UTblh1	779	84	
5/5/2009	Beach Avenue	BA70	SALCAR	8.2	52.81	UTblh1	779	84	
5/5/2009	Beach Avenue	BA80	ACERUB	5.8	26.42	UTsw1	899	85	
5/5/2009	Beach Avenue	BA80	ACERUB	5.5	23.76	UTsw1	899	85	
5/5/2009	Beach Avenue	BA80	ANNGLA	6	28.27	UTsw1	899	85	multi-trunk
5/5/2009	Beach Avenue	BA80	ANNGLA	5.6	24.63	UTsw1	899	85	
5/5/2009	Beach Avenue	BA80	ANNGLA	6.3	31.17	UTsw1	899	85	
5/5/2009	Beach Avenue	BA80	ANNGLA	5.6	24.63	UTsw1	899	85	
5/5/2009	Beach Avenue	BA80	ANNGLA	6.4	32.17	UTsw1	899	85	
5/5/2009	Beach Avenue	BA80	ANNGLA	6.3	31.17	UTsw1	899	85	
5/5/2009	Beach Avenue	BA90	MYRCER	7	38.48	UTsw1	789	85	
5/5/2009	Beach Avenue	BA90	MYRCER	6.1	29.22	UTsw1	789	85	
5/5/2009	Beach Avenue	BA90	ANNGLA	7.6	45.36	UTsw1	789	85	
5/1/2009	Beach Avenue	BA100	FRACAR	5.6	24.63	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	FRACAR	5.4	22.90	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	FRACAR	10	78.54	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	FRACAR	8	50.27	UTsw1	728	89	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/1/2009	Beach Avenue	BA100	FRACAR	5.7	25.52	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	ACERUB	7.9	49.02	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	ANNGLA	7.7	46.57	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	ANNGLA	11	95.03	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	ANNGLA	10	78.54	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	ANNGLA	9.5	70.88	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	ANNGLA	5.9	27.34	UTsw1	728	89	
5/1/2009	Beach Avenue	BA100	ANNGLA	6	28.27	UTsw1	728	89	
5/1/2009	Beach Avenue	BA110	ACERUB	8	50.27	UTblh3	531	84	
5/1/2009	Beach Avenue	BA110	ACERUB	10.4	84.95	UTblh3	531	84	
5/1/2009	Beach Avenue	BA110	SABPAL	34.1	913.27	UTblh3	531	84	
5/1/2009	Beach Avenue	BA110	SABPAL	37	1075.21	UTblh3	531	84	
5/1/2009	Beach Avenue	BA110	SABPAL	33.3	870.92	UTblh3	531	84	
5/1/2009	Beach Avenue	BA110	SABPAL	37.5	1104.47	UTblh3	531	84	
5/1/2009	Beach Avenue	BA110	PERBOR	5	19.64	UTblh3	531	84	
5/1/2009	Beach Avenue	BA110	FRACAR	8.8	60.82	UTblh3	531	84	
5/1/2009	Beach Avenue	BA120	SABPAL	26.5	551.55	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	SABPAL	28.2	624.58	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	SABPAL	36.5	1046.35	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	SABPAL	27.1	576.81	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	SABPAL	38.5	1164.16	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	SABPAL	38.2	1146.09	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	SABPAL	30.3	721.07	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	SABPAL	27	572.56	UTblh3	332	75	
5/1/2009	Beach Avenue	BA120	QUELAU	24.8	483.05	UTblh3	332	75	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/1/2009	Beach Avenue	BA120	ACERUB	45.8	1647.49	UTblh3	332	75	
5/1/2009	Beach Avenue	BA130	SABPAL	32.4	824.48	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	26.1	535.02	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	24.5	471.44	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	28	615.75	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	38.5	1164.16	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	33.4	876.16	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	29.2	669.66	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	27.4	589.65	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	23.4	430.05	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	SABPAL	26.1	535.02	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	QUELAU	24	452.39	UTblh3	352	77	
5/1/2009	Beach Avenue	BA130	QUEVIR	72.8	4162.49	UTblh3	352	77	
5/1/2009	Beach Avenue	BA140	SERREP	28.3	629.02	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	29.2	669.66	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	29	660.52	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	24.5	471.44	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	31.8	794.23	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	28.3	629.02	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	27.6	598.29	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	25	490.88	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SERREP	24.9	486.96	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SABPAL	30.5	730.62	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SABPAL	21.5	363.05	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SABPAL	33.2	865.70	UTblh3/HH	489	84	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/1/2009	Beach Avenue	BA140	SABPAL	37.3	1092.72	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SABPAL	29.5	683.49	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SABPAL	22.3	390.57	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SABPAL	23	415.48	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA140	SABPAL	29.5	683.49	UTblh3/HH	489	84	
5/1/2009	Beach Avenue	BA150	SERREP	27.1	576.81	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	SERREP	20.1	317.31	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	QUELAU	40.4	1281.90	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	QUELAU	35.7	1000.98	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	QUELAU	13.6	145.27	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	SABPAL	23.4	430.05	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	SABPAL	31.5	779.31	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	SABPAL	22	380.13	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	SABPAL	26.6	555.72	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	SABPAL	26	530.93	UTblh3	350	85	
5/1/2009	Beach Avenue	BA150	SABPAL	30	706.86	UTblh3	350	85	
5/1/2009	Beach Avenue	BA163	QUEVIR	72.1	4082.83	HH	107	83	
5/1/2009	Beach Avenue	BA163	SABPAL	36.5	1046.35	HH	107	83	
5/1/2009	Beach Avenue	BA163	SABPAL	26	530.93	HH	107	83	
5/1/2009	Beach Avenue	BA163	SABPAL	51	2042.83	HH	107	83	
5/1/2009	Beach Avenue	BA163	SABPAL	35.8	1006.60	HH	107	83	
5/1/2009	Beach Avenue	BA163	SABPAL	29.8	697.47	HH	107	83	
5/1/2009	Beach Avenue	BA163	SABPAL	54	2290.23	HH	107	83	
5/1/2009	Beach Avenue	BA163	SERREP	32.4	824.48	HH	107	83	
5/1/2009	Beach Avenue	BA163	SERREP	33.4	876.16	HH	107	83	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/1/2009	Beach Avenue	BA163	QUELAU	18.2	260.16	HH	107	83	
5/1/2009	Beach Avenue	BA173	QUELAU	16.8	221.67	HH	493	88	
5/1/2009	Beach Avenue	BA173	SABPAL	19.8	307.91	HH	493	88	
5/1/2009	Beach Avenue	BA173	SABPAL	33.8	897.27	HH	493	88	
5/1/2009	Beach Avenue	BA173	SABPAL	38.5	1164.16	HH	493	88	
5/1/2009	Beach Avenue	BA173	SABPAL	38.8	1182.37	HH	493	88	
5/1/2009	Beach Avenue	BA173	SABPAL	25.3	502.73	HH	493	88	
5/1/2009	Beach Avenue	BA173	ACERUB	15.6	191.13	HH	493	88	
5/1/2009	Beach Avenue	BA183			0.00	HH	518	92	no canopy; dead water hickory
5/1/2009	Beach Avenue	BA193	SABPAL	24.3	463.77	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	31.2	764.54	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	25.5	510.71	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	27.2	581.07	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	31.9	799.23	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	34.8	951.15	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	24.9	486.96	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	30.3	721.07	HH	466	90	
5/1/2009	Beach Avenue	BA193	SABPAL	27.1	576.81	HH	466	90	
5/1/2009	Beach Avenue	BA193	QUELAU	35.1	967.62	HH	466	90	
5/1/2009	Beach Avenue	BA203	SABPAL	42	1385.45	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	26	530.93	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	24.6	475.29	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	22.5	397.61	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	54	2290.23	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	30.5	730.62	HH	21	80	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
5/1/2009	Beach Avenue	BA203	SABPAL	28	615.75	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	31.6	784.27	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	36	1017.88	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	35	962.12	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	27.8	606.99	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	28	615.75	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	27.3	585.35	HH	21	80	
5/1/2009	Beach Avenue	BA203	SABPAL	29	660.52	HH	21	80	
5/1/2009	Beach Avenue	BA203	QUELAU	45.5	1625.97	HH	21	80	
5/1/2009	Beach Avenue	BA203	QUELAU	37.8	1122.21	HH	21	80	
4/24/2009	Crowberry Drive	CD00	PINELL	35.3 dead		HH	70	0	
4/24/2009	Crowberry Drive	CD00	MYRCER	6.4	32.17	HH	70	0	
4/24/2009	Crowberry Drive	CD10	ACERUB	8.8	60.82	UTblh3	83	1	
4/24/2009	Crowberry Drive	CD10	ACERUB	9.4	69.40	UTblh3	83	1	
4/24/2009	Crowberry Drive	CD10	ACERUB	12.4	120.76	UTblh3	83	1	
4/24/2009	Crowberry Drive	CD10	QUEVIR	22.2	387.08	UTblh3	83	1	
4/24/2009	Crowberry Drive	CD10	QUEVIR	29.5	683.49	UTblh3	83	1	
4/24/2009	Crowberry Drive	CD20	QUELAU	59.9	2818.02	UTblh2	167	13	
4/24/2009	Crowberry Drive	CD30	ACERUB	37.2	1086.87	UTblh3	361	41	
4/24/2009	Crowberry Drive	CD30	PERBOR	22.1	383.60	UTblh3	361	41	
4/24/2009	Crowberry Drive	CD30	PERBOR	15.4	186.27	UTblh3	361	41	
4/24/2009	Crowberry Drive	CD30	MYRCER	11.1	96.77	UTblh3	361	41	
4/24/2009	Crowberry Drive	CD40	SCHTER	9.2	66.48	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	SCHTER	5	19.64	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	SCHTER	5.1	20.43	UTblh3	901	20	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/24/2009	Crowberry Drive	CD40	SCHTER	7.3	41.85	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	SCHTER	5.5	23.76	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	SCHTER	7.7	46.57	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	SCHTER	7.2	40.72	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	SCHTER	5	19.64	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	SABPAL	20.9	343.07	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	ACERUB	27.7	602.63	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD40	ACERUB	11.8	109.36	UTblh3	901	20	
4/24/2009	Crowberry Drive	CD50	SCHTER	9.6	72.38	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD50	SCHTER	6.4	32.17	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD50	SCHTER	9.5	70.88	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD50	QUELAU	7.7 dead		UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD50	MYRCER	7.6	45.36	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD50	MYRCER	9.3	67.93	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD50	MYRCER	5.1	20.43	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD50	ANNGLA	6.8	36.32	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD60	SCHTER	5.3	22.06	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD60	SCHTER	9.3	67.93	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD60	SCHTER	11.5	103.87	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD60	SCHTER	9.8	75.43	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD60	SCHTER	7.4	43.01	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD60	SCHTER	7.3	41.85	UTblh3	1340	79	
4/24/2009	Crowberry Drive	CD70			0.00	UTmix	1503	78	NO CANOPY SCHTER 7.8 on the ground cut
4/24/2009	Crowberry Drive	CD80			0.00	UTsw3	1505	83	NO CANOPY
4/24/2009	Crowberry Drive	CD90	LAGRAC	5.1	20.43	UTsw3	1505	79	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/24/2009	Crowberry Drive	CD100	LAGRAC	6	28.27	UTsw3	1503	79	
4/24/2009	Crowberry Drive	CD100	LAGRAC	10.7	89.92	UTsw3	1503	79	
4/24/2009	Crowberry Drive	CD100	LAGRAC	8.2	52.81	UTsw3	1503	79	
4/24/2009	Crowberry Drive	CD100	LAGRAC	8.5	56.75	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.2	21.24	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5	19.64	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	6.4	32.17	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.5	23.76	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.7	25.52	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.5	23.76	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.6	24.63	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.2	21.24	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.3	22.06	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD110	LAGRAC	5.4	22.90	UTsw3	1503	79	
4/16/2009	Crowberry Drive	CD120	LAGRAC	5.3	22.06	UTsw3	1505	75	freshwater clams
4/16/2009	Crowberry Drive	CD130			0.00	UTsw3	1506	78	no canopy; white mangrove damaged by cold
4/16/2009	Crowberry Drive	CD140			0.00	UTsw3	1508	75	no canopy
4/16/2009	Crowberry Drive	CD150			0.00	UTsw3	1513	74	no canopy
4/16/2009	Crowberry Drive	CD160			0.00	UTsw3	1514	77	no canopy
4/16/2009	Crowberry Drive	CD170	LAGRAC	7.8	47.78	UTsw3	1516	77	cold burned leaves
4/16/2009	Crowberry Drive	CD170	LAGRAC	10.1	80.12	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	7.1	39.59	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	7.7	46.57	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	9.4	69.40	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	8.2	52.81	UTsw3	1516	77	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/16/2009	Crowberry Drive	CD170	LAGRAC	5.1	20.43	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	8.4	55.42	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	9.3	67.93	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	6.4	32.17	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	5.8	26.42	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	8.4	55.42	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	5.2	21.24	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD170	LAGRAC	7.1	39.59	UTsw3	1516	77	
4/16/2009	Crowberry Drive	CD180	LAGRAC	5.3	22.06	UTsw3	1518	78	
4/16/2009	Crowberry Drive	CD180	LAGRAC	8.4	55.42	UTsw3	1518	78	
4/16/2009	Crowberry Drive	CD180	LAGRAC	5	19.64	UTsw3	1518	78	
4/16/2009	Crowberry Drive	CD180	LAGRAC	5.3	22.06	UTsw3	1518	78	
4/16/2009	Crowberry Drive	CD180	LAGRAC	6.4	32.17	UTsw3	1518	78	
4/16/2009	Crowberry Drive	CD180	LAGRAC	6.3	31.17	UTsw3	1518	78	
4/16/2009	Crowberry Drive	CD180	LAGRAC	6.6	34.21	UTsw3	1518	78	
4/16/2009	Crowberry Drive	CD190	LAGRAC	5.1	20.43	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	5.1	20.43	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	5.3	22.06	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	5.7	25.52	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	8.6	58.09	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	7	38.48	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	5.3	22.06	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	6.1	29.22	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD190	LAGRAC	6.3	31.17	UTsw3	1519	80	
4/16/2009	Crowberry Drive	CD200	LAGRAC	7.1	39.59	UTsw3	1516	81	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/16/2009	Crowberry Drive	CD200	LAGRAC	7.1	39.59	UTsw3	1516	81	
4/16/2009	Crowberry Drive	CD200	LAGRAC	7.8	47.78	UTsw3	1516	81	
4/16/2009	Crowberry Drive	CD200	LAGRAC	7.2	40.72	UTsw3	1516	81	
4/16/2009	Crowberry Drive	CD200	LAGRAC	8.2	52.81	UTsw3	1516	81	
4/16/2009	Crowberry Drive	CD200	LAGRAC	5.5	23.76	UTsw3	1516	81	
4/16/2009	Crowberry Drive	CD200	LAGRAC	5.1	20.43	UTsw3	1516	81	
4/16/2009	Crowberry Drive	CD200	LAGRAC	6	28.27	UTsw3	1516	81	
4/16/2009	Crowberry Drive	CD210	LAGRAC	6	28.27	UTsw3	1530	79	at the tidal stream
4/16/2009	Crowberry Drive	CD210	LAGRAC	7.2	40.72	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	5.3	22.06	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	5.2	21.24	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	6.2	30.19	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	5.9	27.34	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	6.3	31.17	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	7.1	39.59	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	6.5	33.18	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	5.1	20.43	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	5.9	27.34	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	7.5	44.18	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD210	LAGRAC	7.1	39.59	UTsw3	1530	79	
4/16/2009	Crowberry Drive	CD220	LAGRAC	8	50.27	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	8.7	59.45	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	6.5	33.18	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	8.7	59.45	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	9.8	75.43	UTsw3	1527	85	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/16/2009	Crowberry Drive	CD220	LAGRAC	8.3	54.11	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	8.1	51.53	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	9.7	73.90	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	5.2	21.24	UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD220	LAGRAC	6.7 cut		UTsw3	1527	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	7.2	40.72	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	6.3	31.17	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	7.1	39.59	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	7.3	41.85	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	5.4	22.90	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	5.2	21.24	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	5.5	23.76	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	6	28.27	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	8.3	54.11	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	7.8	47.78	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD230	LAGRAC	5.9	27.34	UTsw3	1521	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	5.1	20.43	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	9.3	67.93	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	5.5	23.76	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	8.5	56.75	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	5.8	26.42	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	6.4	32.17	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	6.2	30.19	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	7	38.48	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD240	LAGRAC	7.6	45.36	UTsw3	1535	85	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/16/2009	Crowberry Drive	CD240	LAGRAC	6.4	32.17	UTsw3	1535	85	
4/16/2009	Crowberry Drive	CD250	LAGRAC	5.3	22.06	UTsw3	1528	84	
4/16/2009	Crowberry Drive	CD250	LAGRAC	5.3	22.06	UTsw3	1528	84	
4/16/2009	Crowberry Drive	CD250	LAGRAC	5.9	27.34	UTsw3	1528	84	
4/16/2009	Crowberry Drive	CD250	LAGRAC	6.3	31.17	UTsw3	1528	84	
4/15/2009	Crowberry Drive	CD260			0.00	M	1535	77	no canopy
4/15/2009	Crowberry Drive	CD270			0.00	M	1534	83	no canopy
4/15/2009	Crowberry Drive	CD280			0.00	M	1541	79	no canopy
4/15/2009	Crowberry Drive	CD290			0.00	M	1543	78	no canopy
4/15/2009	Crowberry Drive	CD300	LAGRAC	4.4	15.21	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD300	LAGRAC	5.7	25.52	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD300	LAGRAC	5.1	20.43	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD300	LAGRAC	5.3	22.06	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD300	LAGRAC	6.5	33.18	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD300	LAGRAC	5.9	27.34	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD300	LAGRAC	5.5	23.76	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD300	LAGRAC	7	38.48	UTsw3	1549	78	
4/15/2009	Crowberry Drive	CD310	MYRCER	21	346.36	UTsw3	1124	66	back side of berm
4/15/2009	Crowberry Drive	CD310	MYRCER	14.1	156.15	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD310	MYRCER	6.5	33.18	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD310	MYRCER	9.1	65.04	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD310	MYRCER	11.3	100.29	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD310	MYRCER	13.4	141.03	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD310	MYRCER	13.7	147.41	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD310	SCHTER	6.2	30.19	UTsw3	1124	66	

Table G-1. Continued.

Date	Transect	Plot	Species	Dbh (cm)	Basal Area	Forest Type	EC (cS/m)	%SM	Comments
4/15/2009	Crowberry Drive	CD310	LAGRAC	5.1	20.43	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD310	LAGRAC	8.6	58.09	UTsw3	1124	66	
4/15/2009	Crowberry Drive	CD320	QUELAU	11.2	98.52	UTblh2	916	48	berm/sandy beach
4/15/2009	Crowberry Drive	CD320	QUELAU	17.5	240.53	UTblh2	916	48	
4/15/2009	Crowberry Drive	CD320	QUELAU	15.3	183.85	UTblh2	916	48	
4/15/2009	Crowberry Drive	CD320	QUELAU	11.1	96.77	UTblh2	916	48	

APPENDIX H:
RESULTS AND ADDITIONAL MULTI-VARIATE ANALYSIS AND GRAPHS

Results Canonical Correspondence Analysis Canopy Layer

Results presented here are canopy abundance canonical correspondence analysis (CCA) log/log/log transformations. Data matrices include 1) main matrix has 65 plots (rows) and 16 species (columns) and 2) second matrix has 65 plots (rows) and 3 variables (columns)—soil electrical conductivity (EC; in centisiemens per meter [cS/m]), percent soil moisture (%SM) and river mile. Options selected included the following: 1) axis scores standardized by Hill`s (1979) method; 2) axes scaled to optimize representation of columns (species); 3) scores for species are weighted mean scores for plots; 4) scores for graphing plots are linear combinations of variables; and 5) no randomization test.

Table H-1. CCA canopy layer.

CORRELATIONS AMONG ENVIRONMENTAL VARIABLES IN SECOND MATRIX			
	EC (cS/m)	**%SM**	**River Mile**
EC (cS/m)	1.000	0.358	-0.831
%SM	0.358	1.000	-0.107
River Mile	-0.831	-0.107	1.000

WEIGHTED CORRELATIONS AMONG ENVIRONMENTAL VARIABLES IN SECOND MATRIX Weighted by row totals in main matrix			
	EC (cS/m)	**%SM**	**River Mile**
EC (cS/m)	1.000	0.358	-0.831
%SM	0.358	1.000	-0.107
River Mile	-0.831	-0.107	1.000

AXIS SUMMARY STATISTICS Total variance ("inertia") in the species data: 4.8825			
Statistic	**Axis 1**	**Axis 2**	**Axis 3**
Eigenvalue	0.516	0.161	0.112
Variance in species data			
% of variance explained	10.6	3.3	2.3
Cumulative % explained	10.6	13.9	16.2
Pearson Correlation, species-environment[a]	0.831	0.655	0.614
Kendall (Rank) Correlation, species-environment	0.727	0.470	0.330

a. Correlation between sample scores for an axis derived from the species data and the sample scores that are linear combinations of the environmental variables. Set to 0.000 if axis is not canonical.

Table H-1. Continued.

MULTIPLE REGRESSION RESULTS **Regression of plots in species space on environmental variable**							
Variable	**Canonical Coefficients**						**Standard Deviation**
	Standardized			**Original Units**			
	Axis 1	**Axis 2**	**Axis 3**	**Axis 1**	**Axis 2**	**Axis 3**	
1 EC (cS/m)	1.284	1.234	-1.560	1.073	1.031	-1.304	1.200
2 %SM	-0.106	0.465	1.133	-0.377	1.650	4.020	0.282
3 River Mile	-0.217	1.521	-1.413	-2.883	20.222	-18.785	0.075

CORRELATIONS AND BIPLOT SCORES FOR THREE ENVIRONMENTAL VARIABLES **Scores that are linear combinations or variables (linear combinations scores); final scores and raw data totals (weights) for 65 plots**						
Variable	**Correlations***			**Biplot Scores**		
	Axis 1	**Axis 2**	**Axis 3**	**Axis 1**	**Axis 2**	**Axis 3**
1 EC (cS/m)	0.992	0.125	0.019	0.690	0.115	0.018
2 %SM	0.262	0.681	0.683	0.183	0.624	0.644
3 River Mile	-0.885	0.408	-0.224	-0.616	0.374	-0.211

*Correlations are "intra-set correlations" of ter Braak (1986).

INTER-SET CORRELATIONS FOR THREE ENVIRONMENTAL VARIABLES			
Variable	**Correlations**		
	Axis 1	**Axis 2**	**Axis 3**
1 EC (cS/m)	0.824	0.082	0.012
2 %SM	0.218	0.446	0.420
3 River Mile	-0.735	0.267	-0.138

References

Hill, M.O. 1979. DECORANA—a FORTRAN program for detrended correspondence analysis and reciprocal averaging. .Ithaca, NY.: Ecology and Systematics, Cornell University.

ter Braak, C.J. F. and L.G. Barendregt. 1986. Weighted Averaging of Species Indicator Values: Its Efficiency in Environmental Calibration. Mathematical Biosciences 78:57-72.

Scatterplot Matrix for Floodplain Canopy Abundance

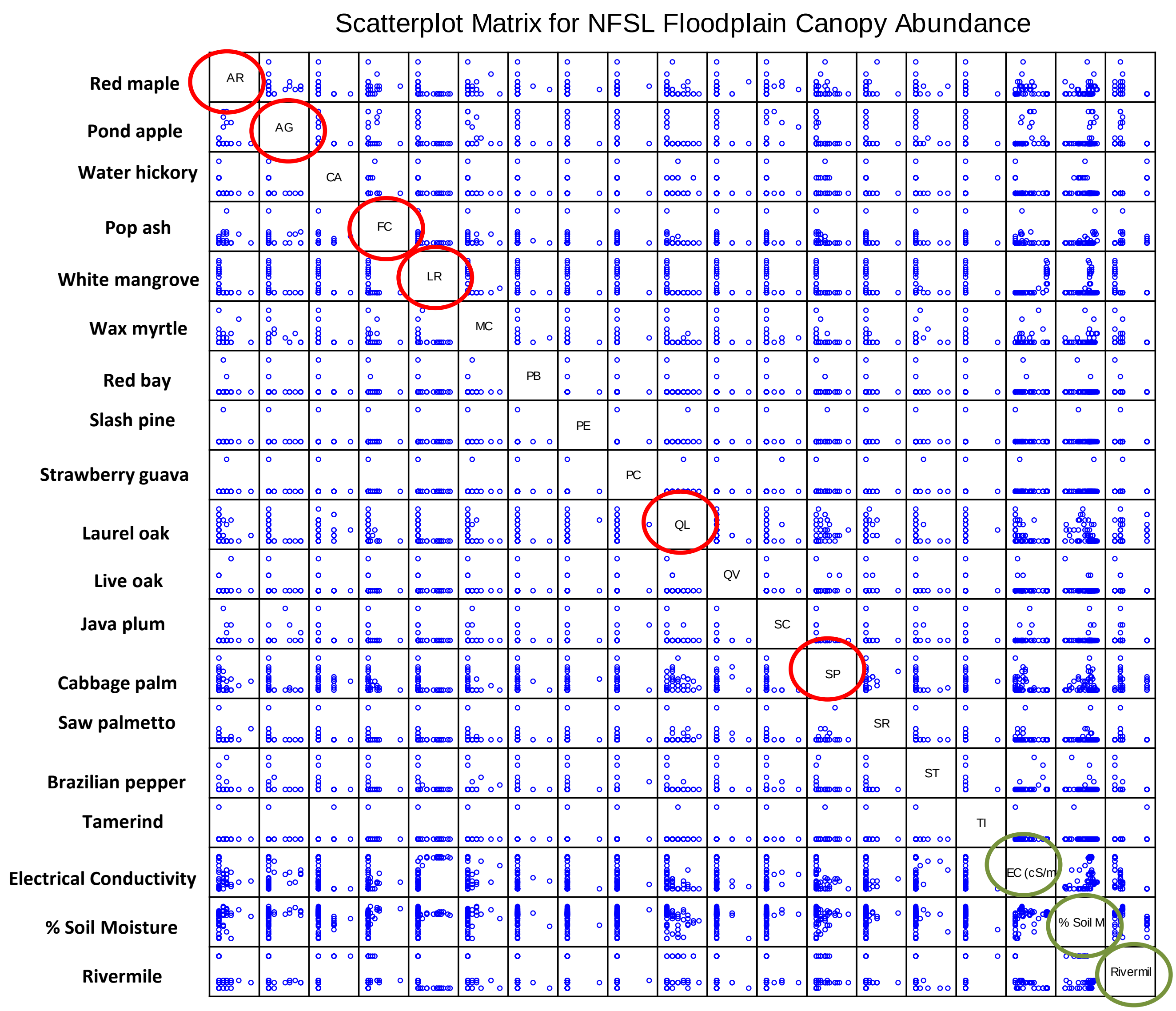


Figure H-1. Scatterplot matrix of the 16 canopy species and 3 environmental variable. (Note: NFSL – North Fork St. Lucie River. See Appendix C for scientific names.)

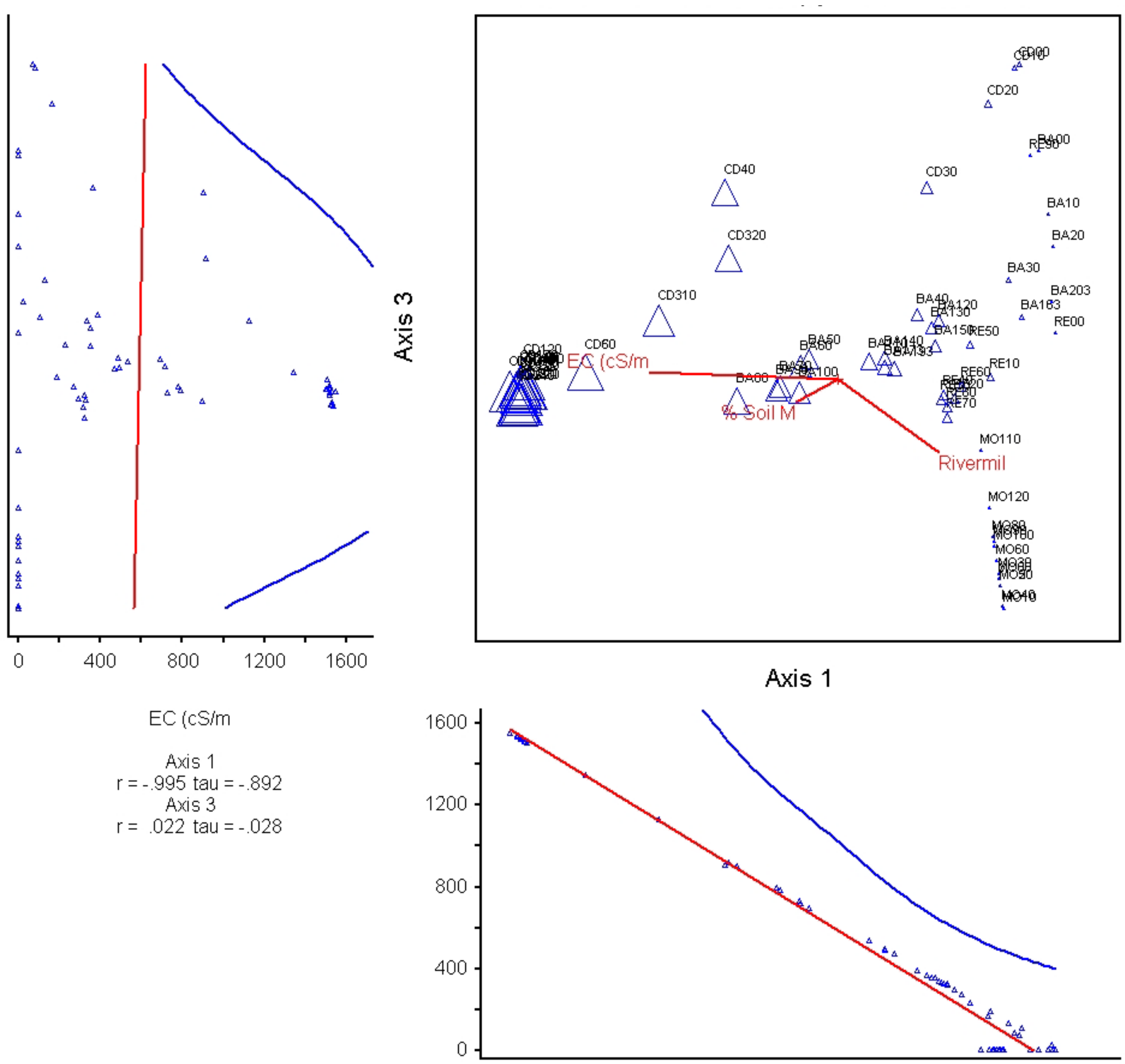


Figure H-2. Scatterplot matrix of all canopy species and environmental variables.

Canopy Bray-Curtis (BC) Biplots

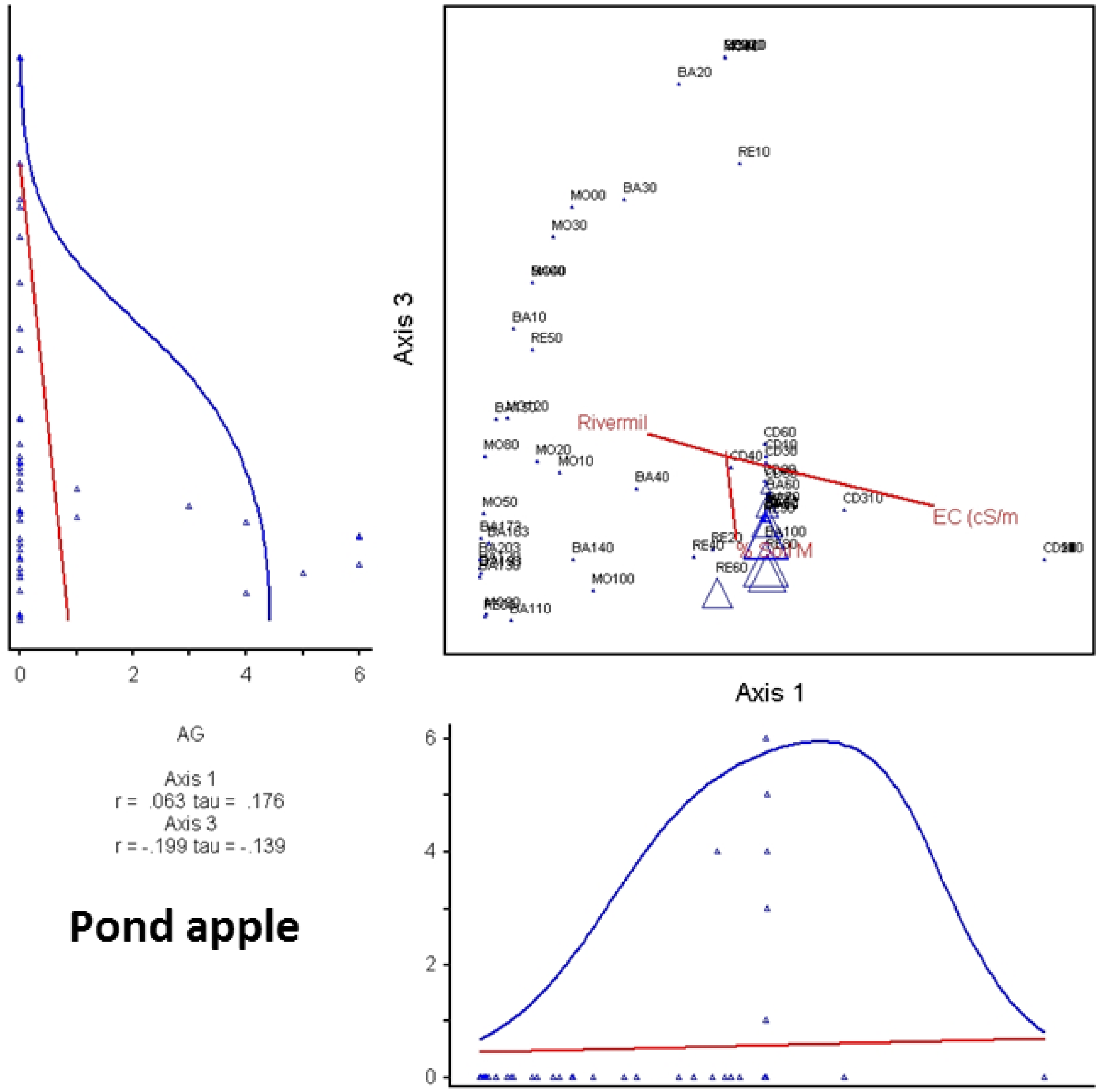


Figure H-3. Biplot for pond apple (*Annona glabra*) with EC and %SM.

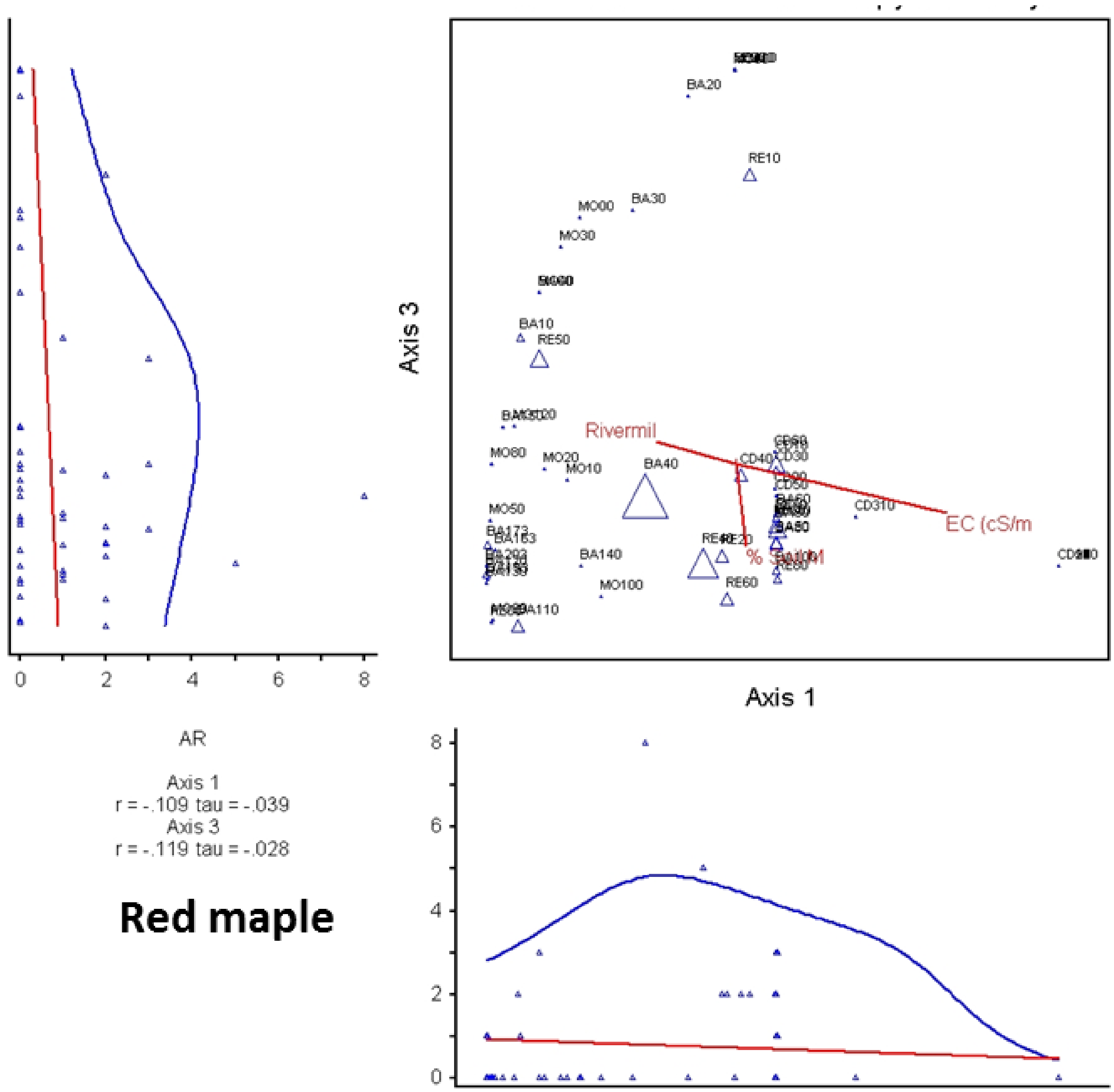


Figure H-4. Biplot for red maple (*Acer rubrum*) with EC and %SM.

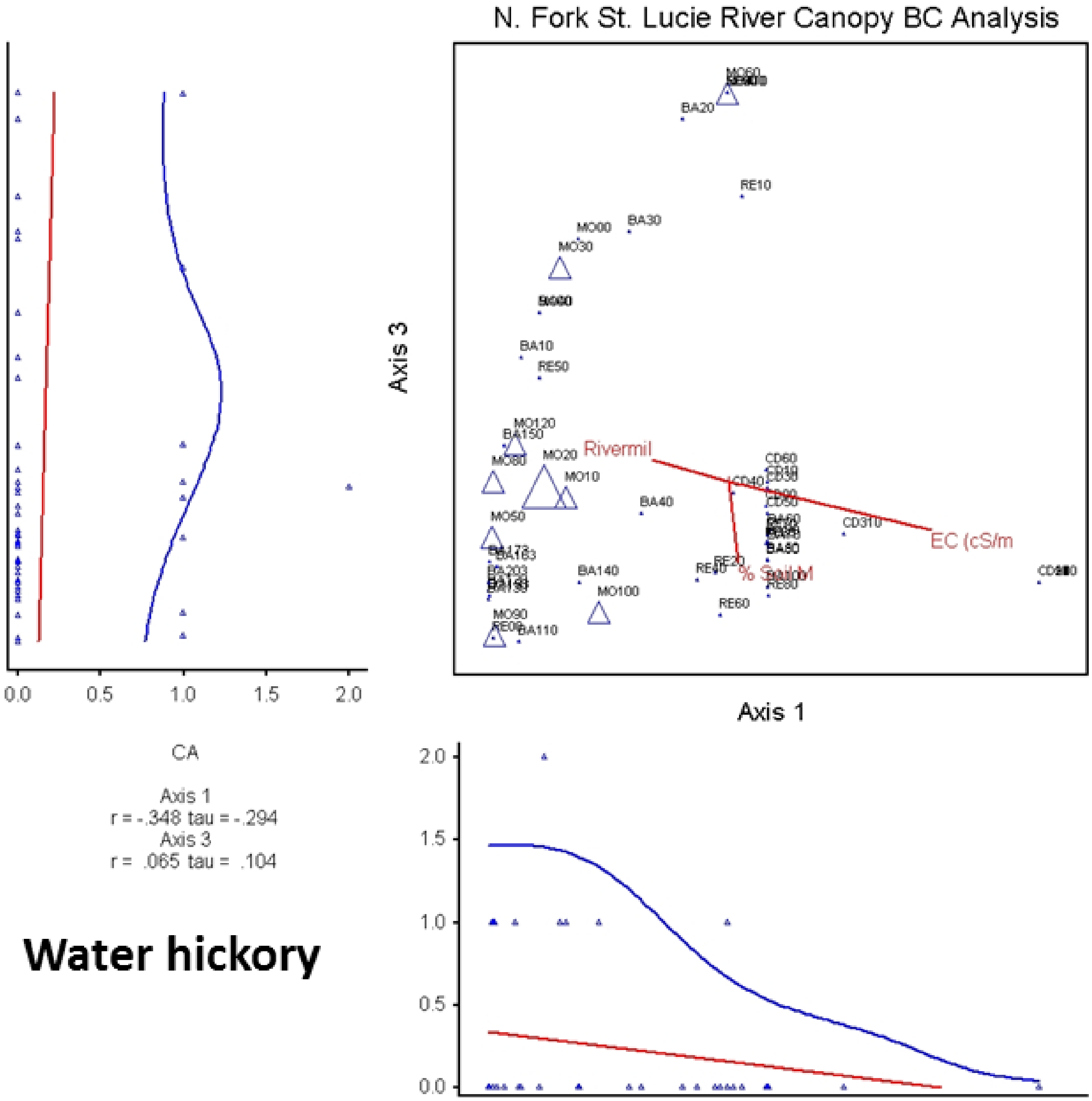


Figure H-5. Biplot for water hickory (*Carya aquatica*) with EC and %SM.

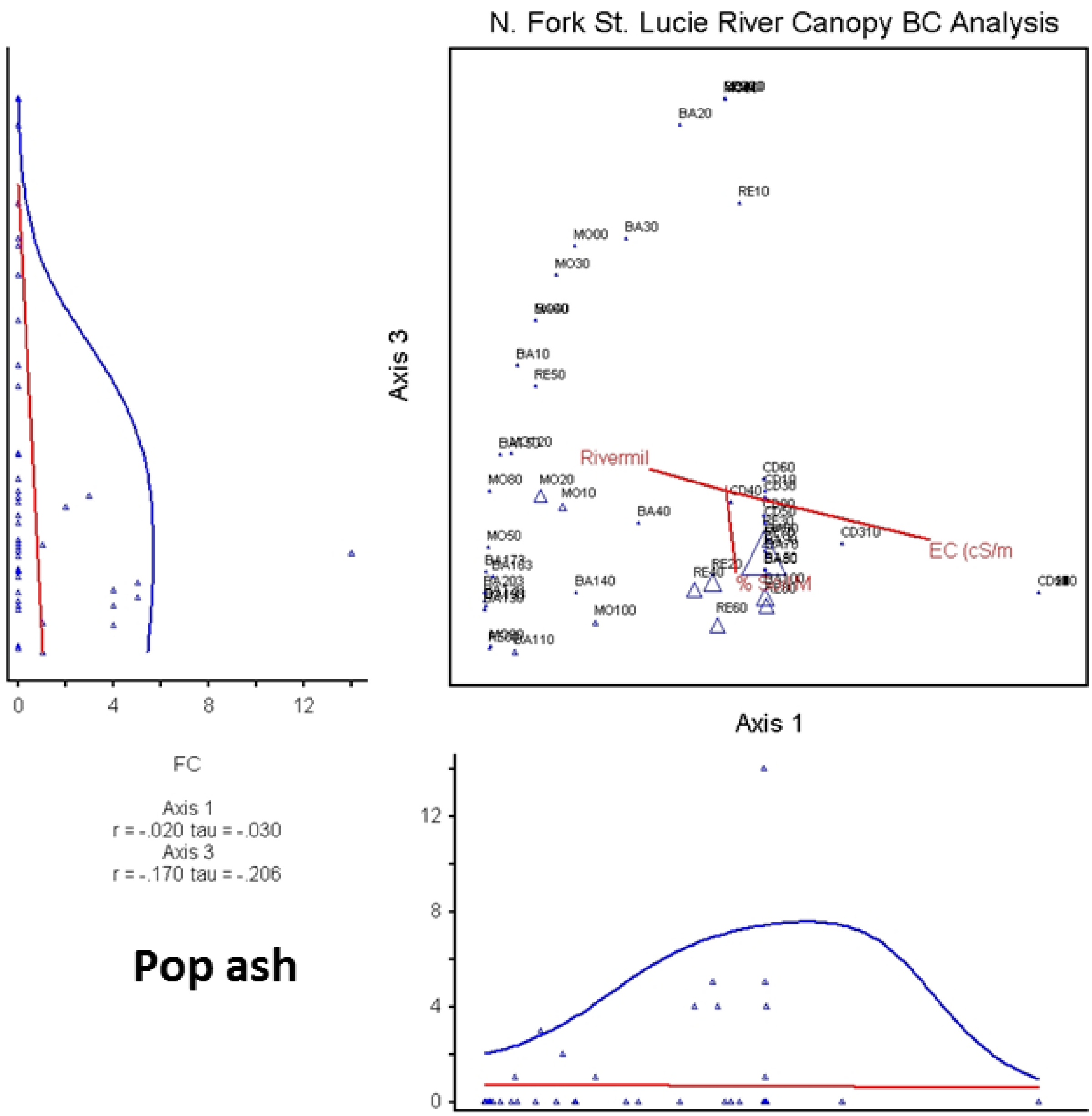


Figure H-6. Biplot for pop ash (*Fraxinus caroliniana*) with EC and %SM.

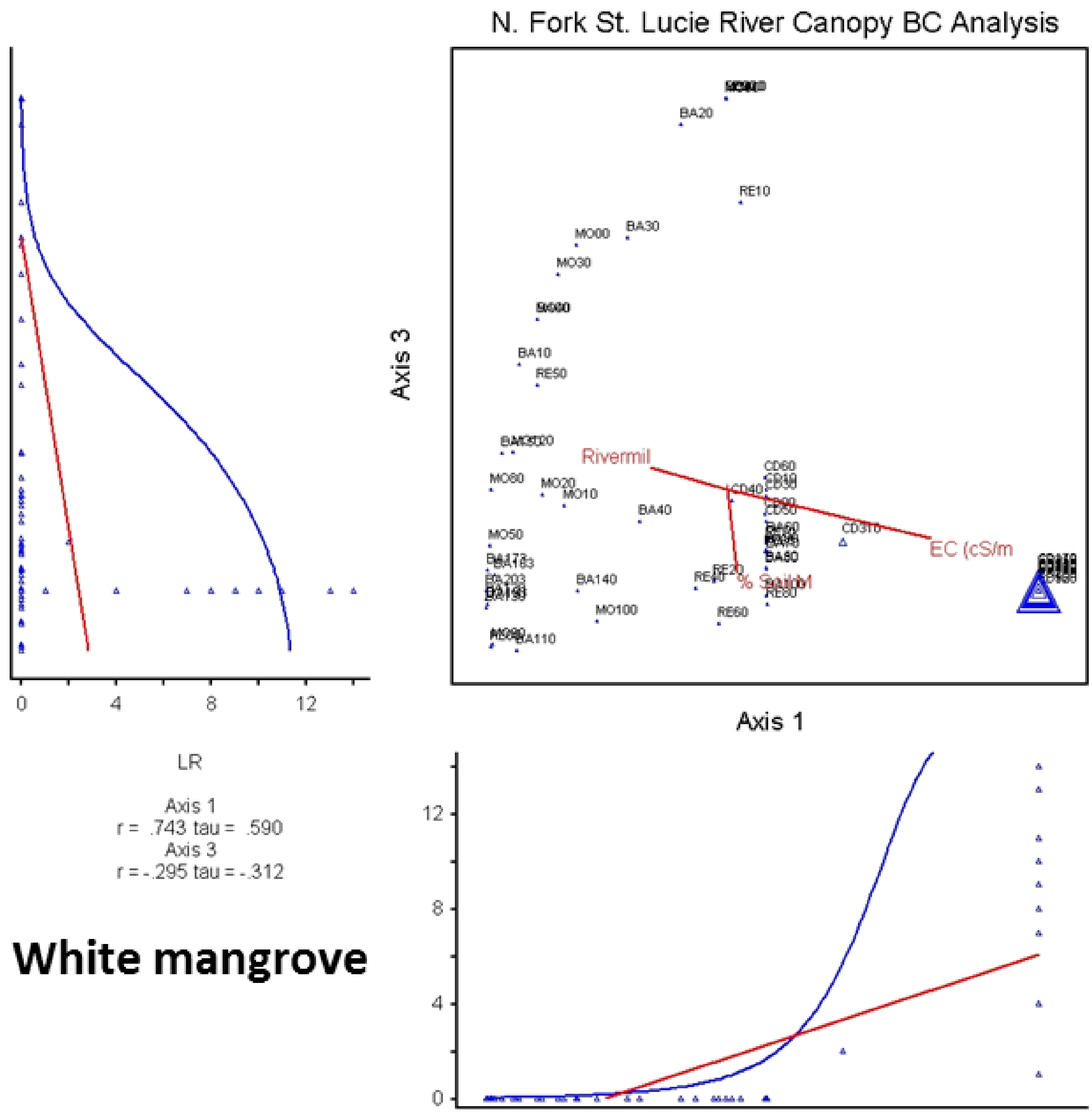


Figure H-7. Biplot for white mangrove (*Laguncularia racemosa*) with EC and %SM.

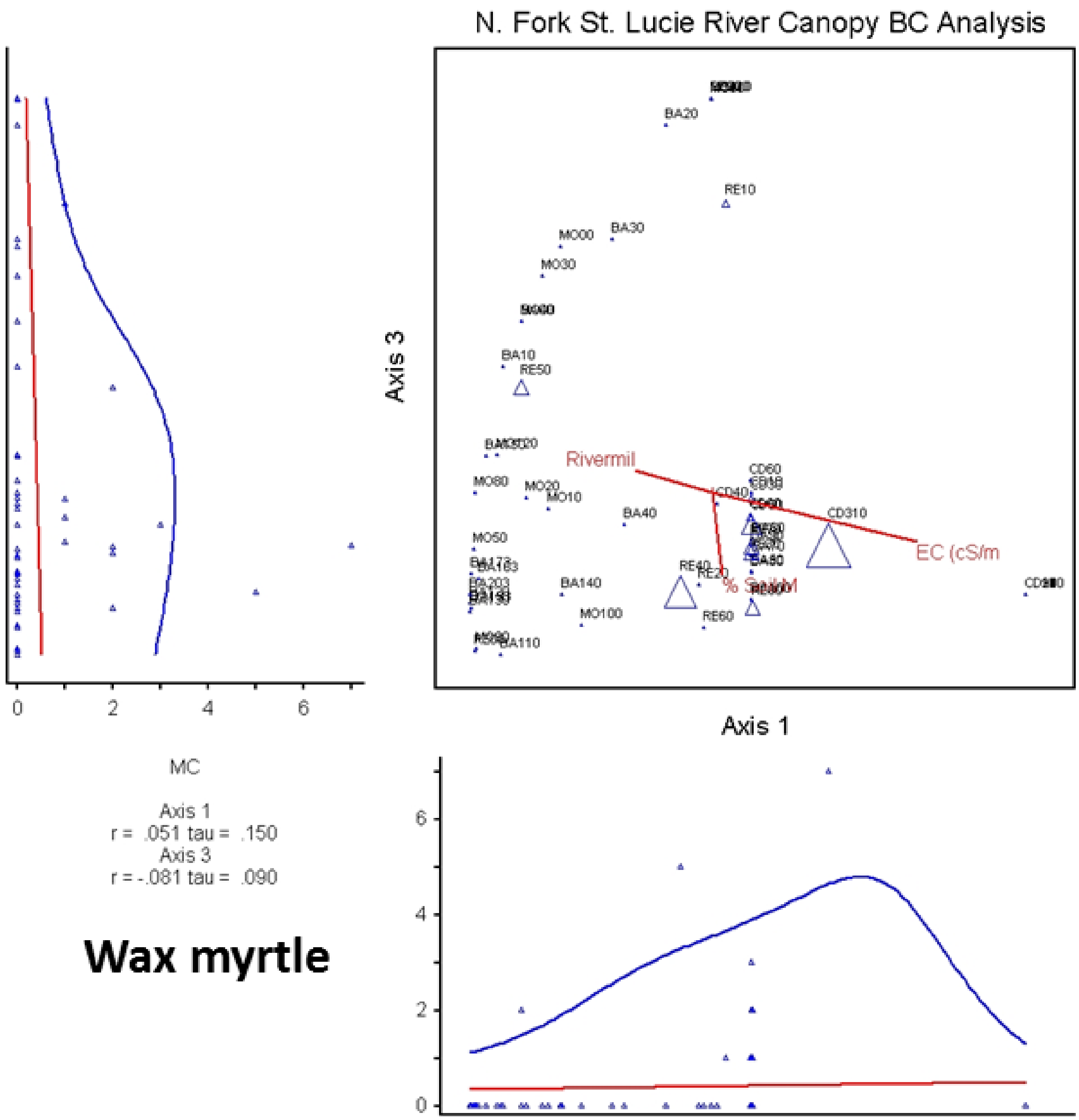


Figure H-8. Biplot for wax myrtle (*Myrica cerifera*) with EC and %SM.

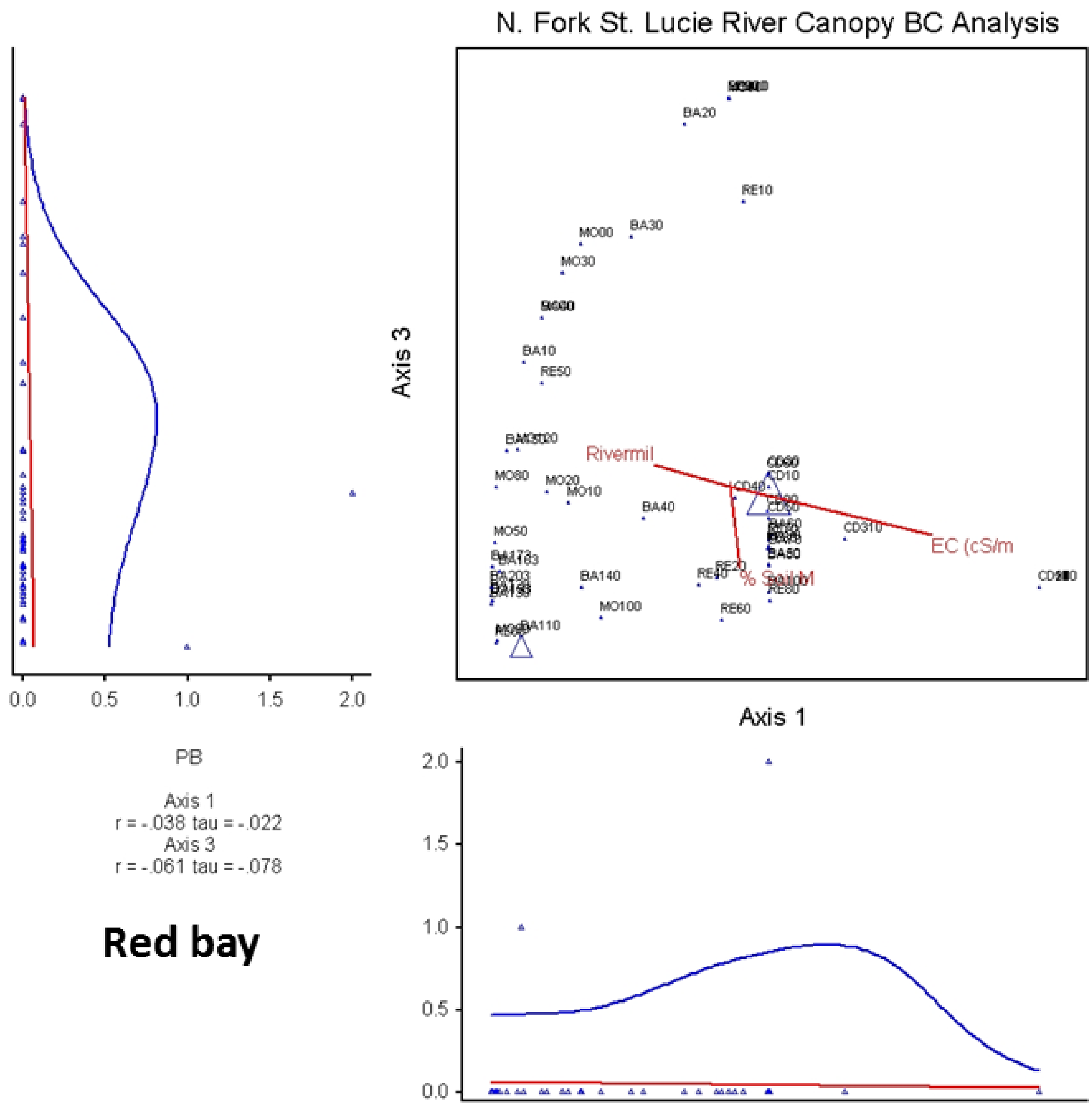


Figure H-9. Biplot for red bay (*Persea borbonia*) with EC and %SM.

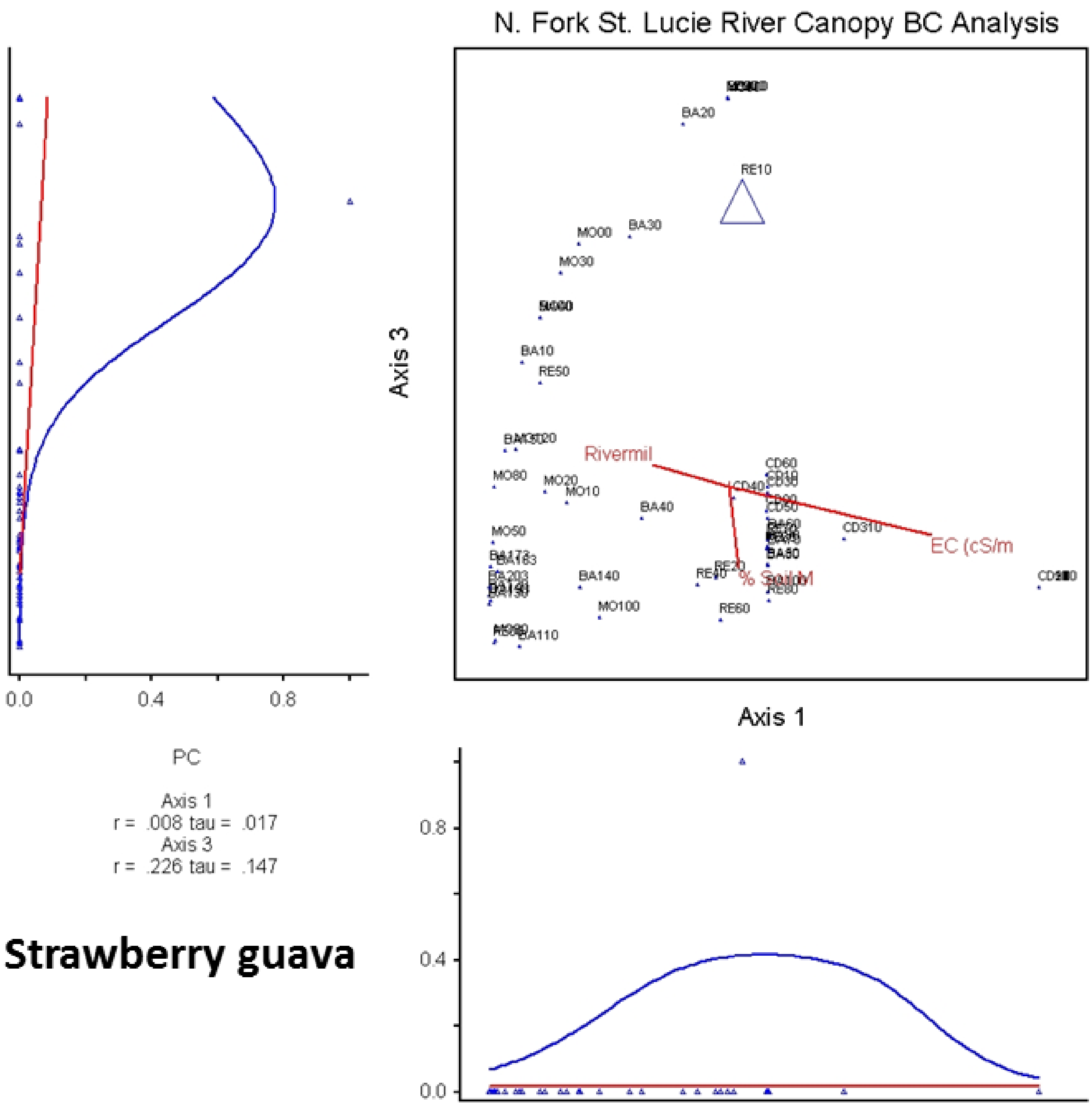


Figure H-10. Biplot for strawberry guava (*Psidium cattleianum*) with EC and %SM.

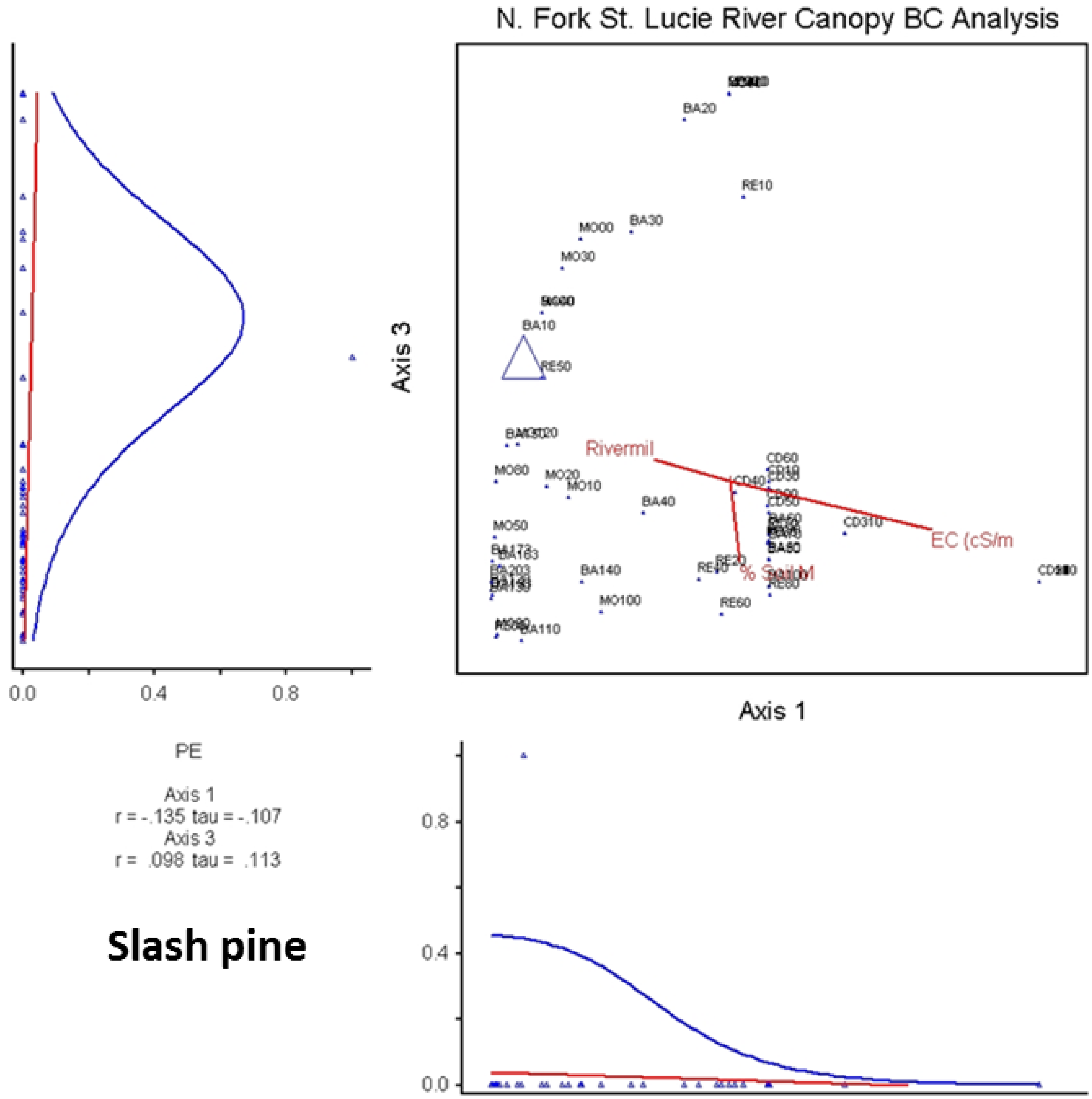


Figure H-11. Biplot for slash pine (*Pinus elliottii*) with EC and %SM.

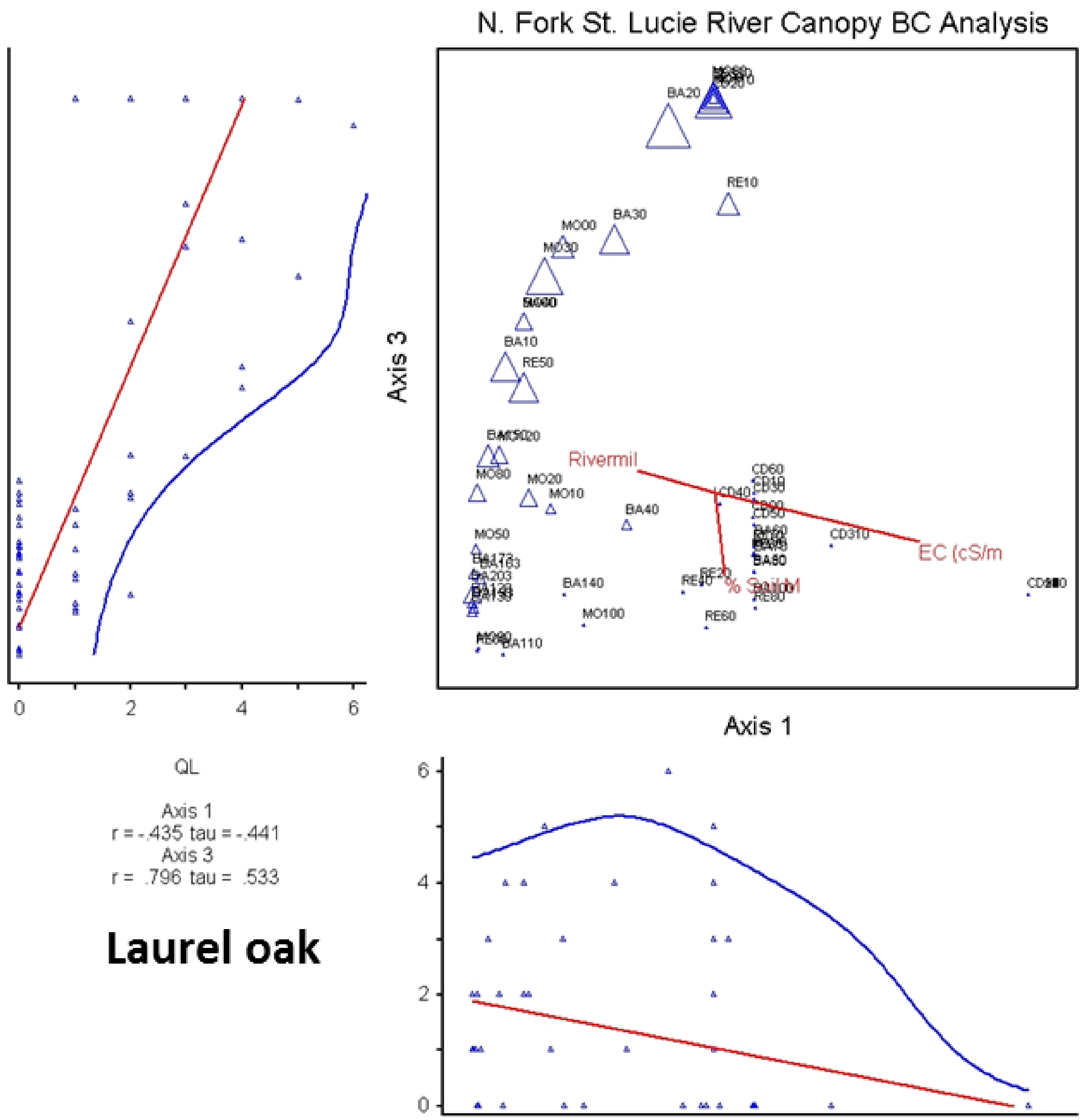


Figure H-12. Biplot for laurel oak (*Quercus laurifolia*) with EC and %SM.

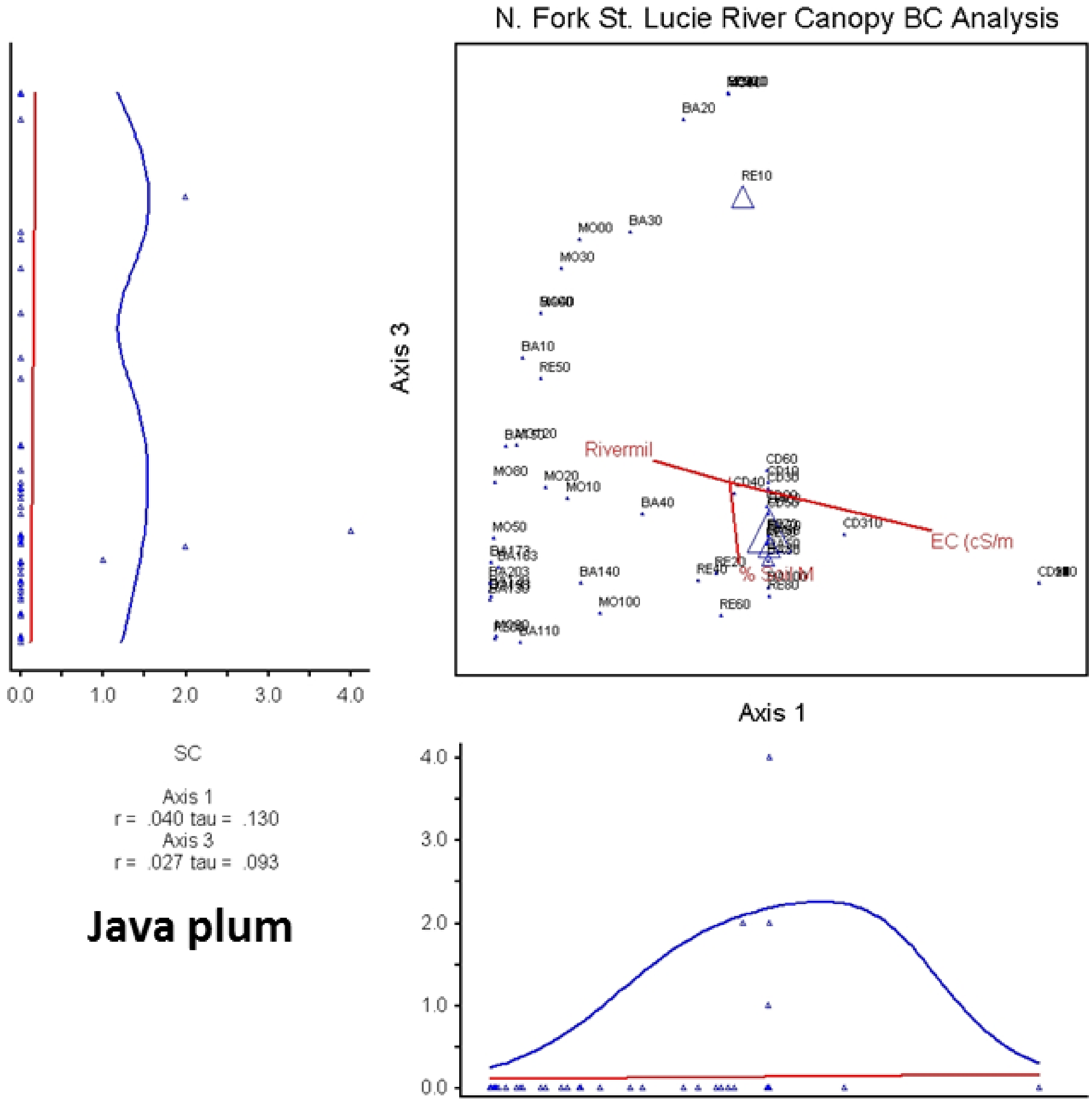


Figure H-13. Biplot for java plum (*Syzygium cumini*) with EC and %SM.

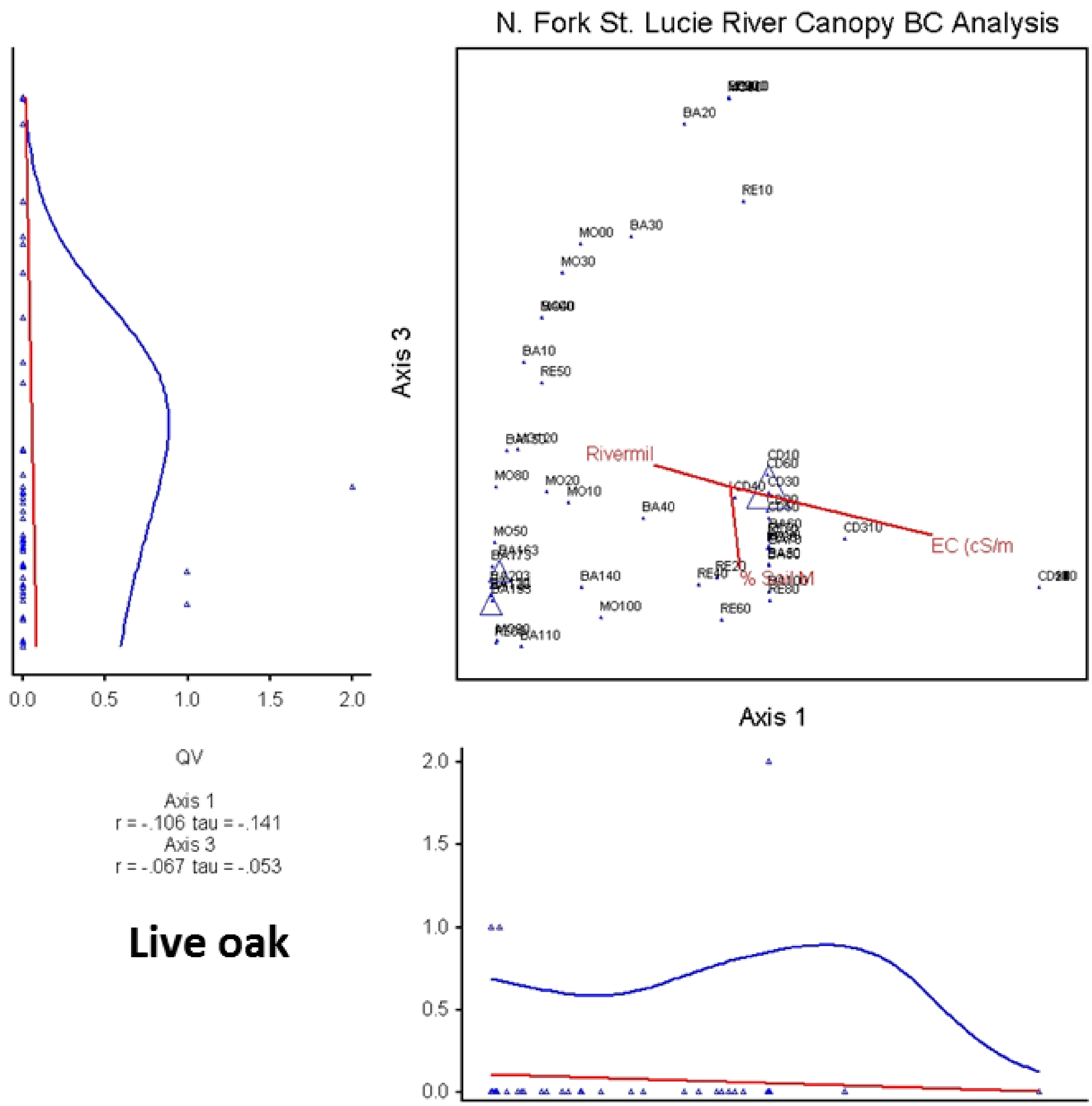


Figure H-14. Biplot for live oak (*Quercus virginiana*) with EC and %SM.

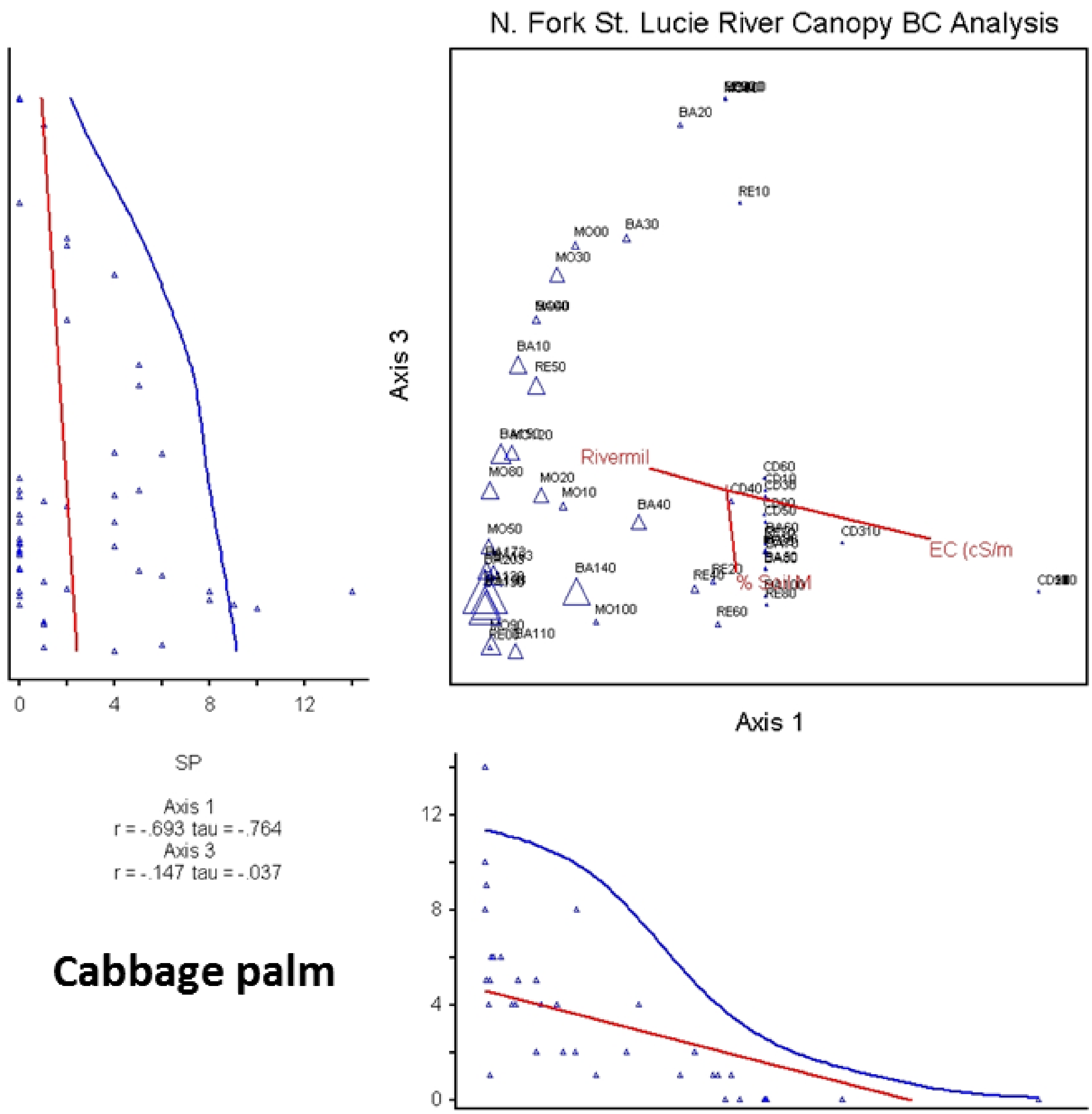


Figure H-15. Biplot for cabbage palm (*Sabal palmetto*) with EC and %SM.

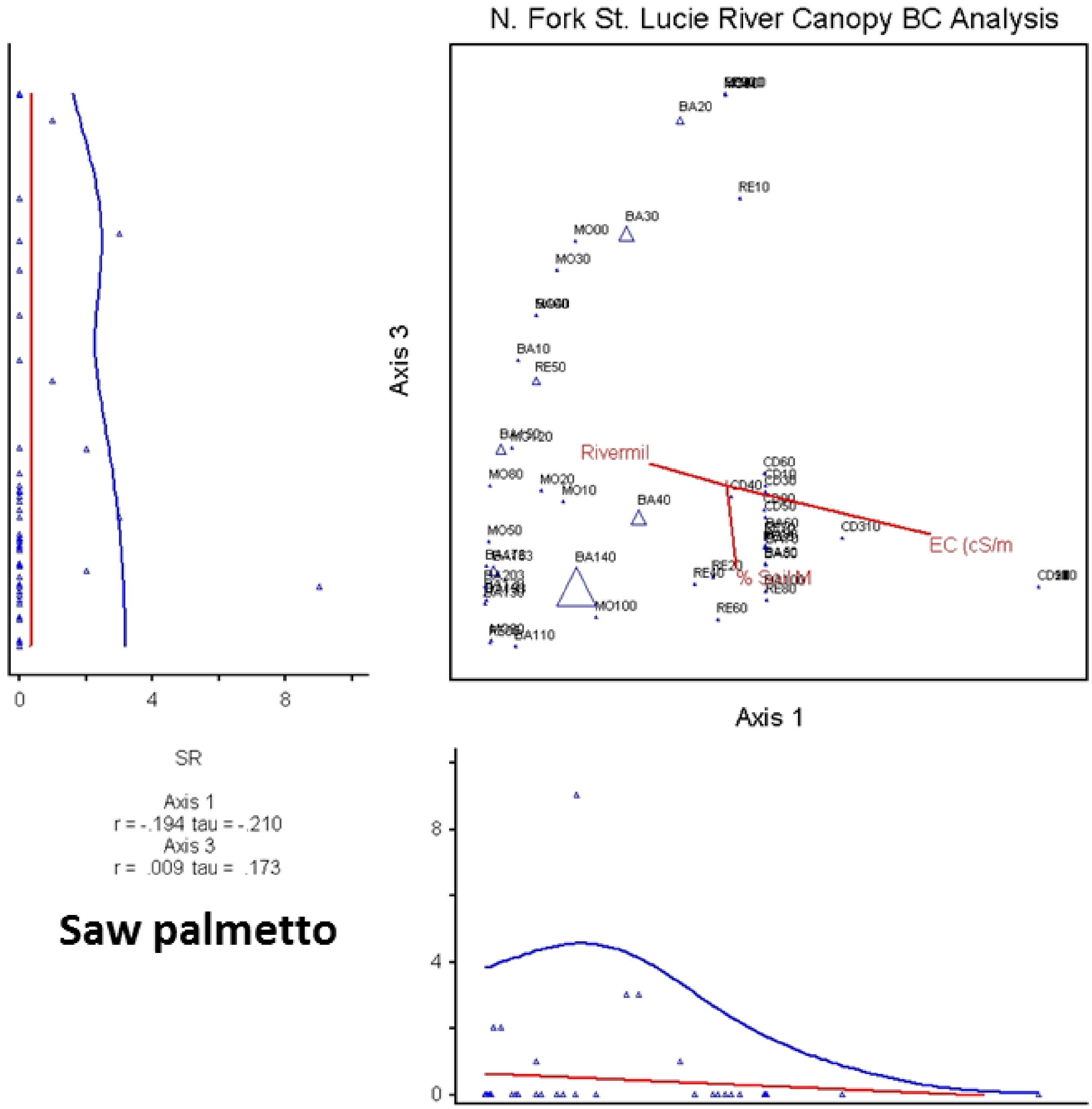


Figure H-16. Biplot for saw palmetto (*Serenoa repens*) with EC and %SM.

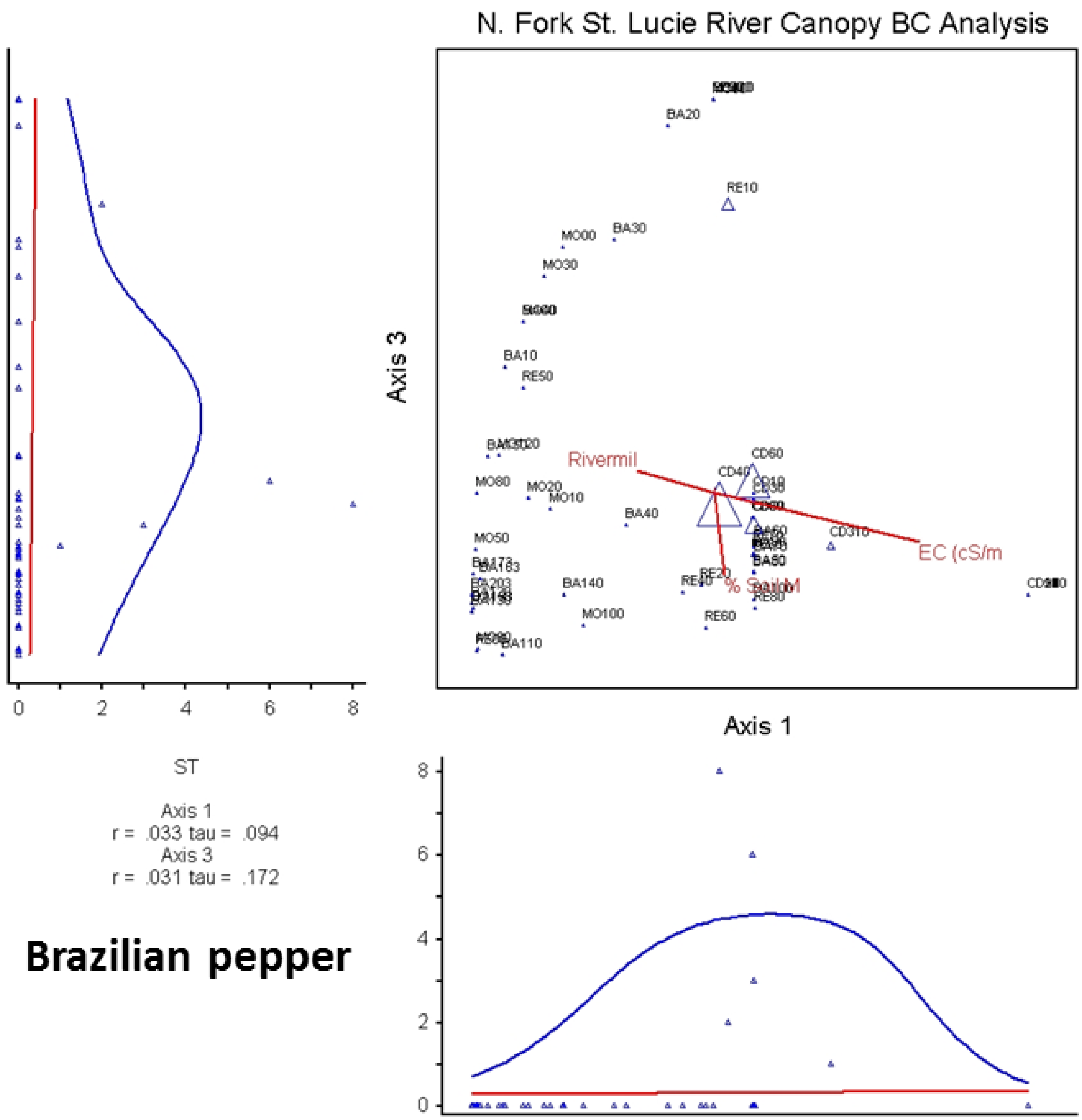


Figure H-17. Biplot for Brazilian pepper (*Schinus terebinthifolia*) with EC and %SM.

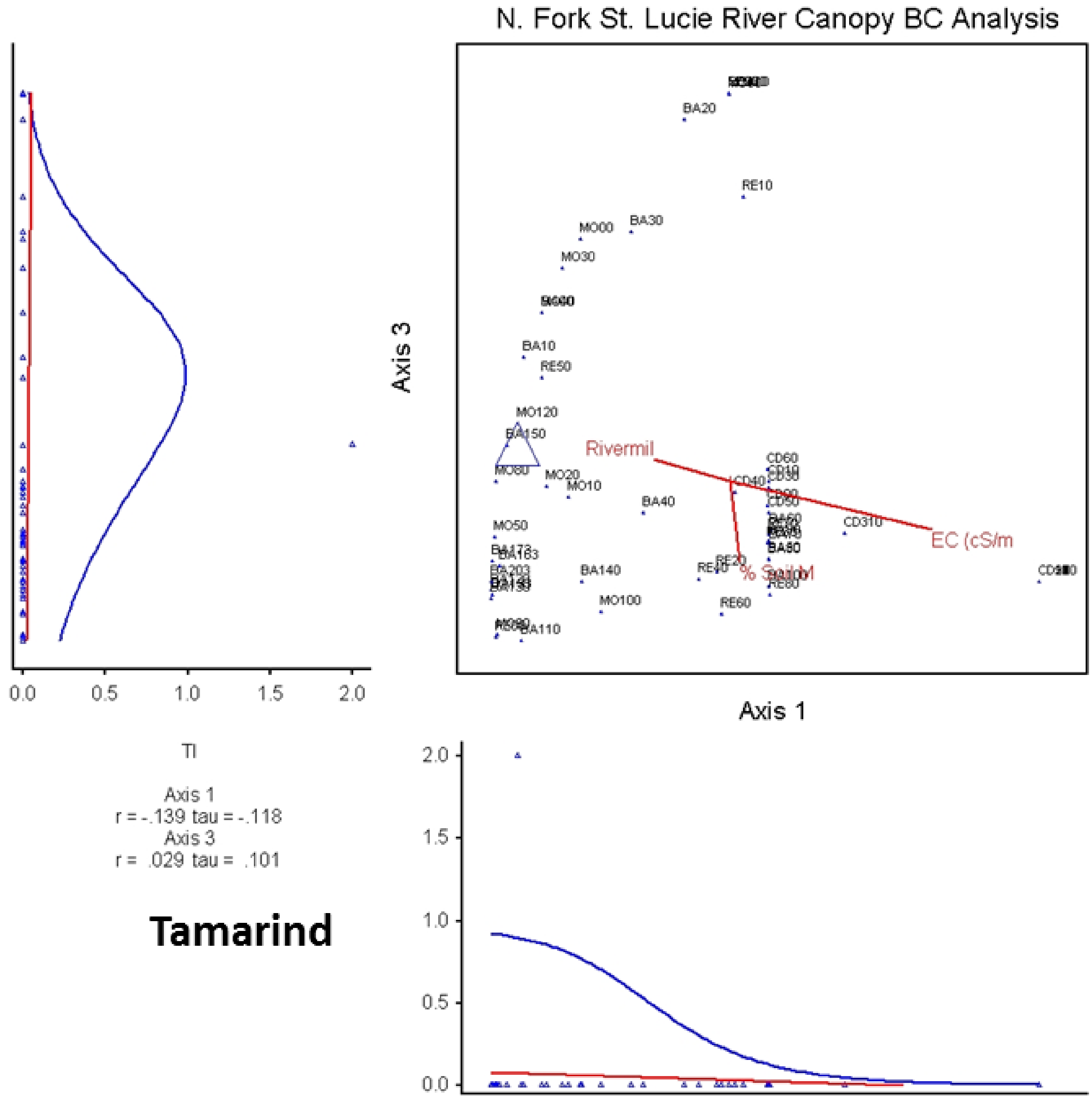


Figure H-18. Biplot for tamarind (*Tamarindus indica*) with EC and %SM.

2009 Shrub Percent Cover

Table H-2. Shrub percent cover in plot.

Number	Plot	Mean	Standard Deviation	Sum	Minimum	Maximum	S [a]	E [b]	H [c]	D [d]
1	MO10	0.026000	0.104000	1.02570	0.00	0.49100	3	0.846	0.929	0.5754
2	MO20	0.058000	0.221000	2.31300	0.00	1.00000	6	0.650	1.165	0.6204
3	MO30	0.009310	0.041160	0.37240	0.00	0.19630	2	0.998	0.692	0.4985
4	MO40	0.032000	0.161000	1.26260	0.00	1.00000	4	0.434	0.602	0.3401
5	MO50	0.012000	0.046000	0.49740	0.00	0.24100	4	0.796	1.103	0.6382
6	MO60	0.014000	0.056000	0.57610	0.00	0.30000	3	0.924	1.015	0.6094
7	MO70	0.020000	0.120000	0.79070	0.00	0.76000	2	0.237	0.164	0.0746
8	MO80	0.030000	0.159000	1.21180	0.00	1.00000	3	0.527	0.579	0.3028
9	MO90	0.025000	0.068000	0.99290	0.00	0.26900	7	0.851	1.657	0.7915
10	MO100	0.017000	0.065000	0.66340	0.00	0.38300	4	0.807	1.118	0.5988
11	MO110	0.038000	0.161000	1.52960	0.00	1.00000	7	0.604	1.176	0.5434
12	MO120	0.007567	0.028610	0.30270	0.00	0.15040	3	0.948	1.042	0.6264
13	RE00	0.031000	0.159000	1.25660	0.00	1.00000	6	0.427	0.765	0.3528
14	RE10	0.013000	0.055000	0.53260	0.00	0.29500	4	0.708	0.982	0.5652
15	RE20	0.009743	0.028650	0.38970	0.00	0.15980	8	0.824	1.714	0.7642
16	RE30	0.007899	0.022520	0.31600	0.00	0.08785	6	0.886	1.588	0.7768
17	RE40	0.035000	0.162000	1.40470	0.00	1.00000	7	0.464	0.903	0.4553
18	RE50	0.004697	0.018110	0.18790	0.00	0.09240	3	0.921	1.012	0.6125
19	RE60	0.002409	0.010640	0.09636	0.00	0.04940	2	1.000	0.693	0.4997
20	RE70	0.007983	0.036590	0.31930	0.00	0.22220	4	0.597	0.827	0.4630
21	RE80	0.004319	0.015000	0.17280	0.00	0.07107	4	0.884	1.225	0.6809
22	RE90	0.003571	0.022590	0.14290	0.00	0.14290	1	0.000	0.000	0.0000
23	BA00	0.011000	0.033000	0.42470	0.00	0.14900	6	0.843	1.511	0.7367
24	BA10	0.008281	0.032370	0.33130	0.00	0.19320	5	0.736	1.185	0.6025
25	BA20	0.007257	0.027390	0.29030	0.00	0.12730	7	0.604	1.175	0.6277
26	BA30	0.036000	0.160000	1.43520	0.00	1.00000	8	0.531	1.104	0.4927
27	BA40	0.043000	0.167000	1.71950	0.00	1.00000	10	0.552	1.272	0.6071
28	BA50	0.020000	0.064000	0.78760	0.00	0.33300	7	0.754	1.466	0.7161
29	BA60	0.038000	0.147000	1.51780	0.00	0.90500	10	0.579	1.333	0.6076
30	BA70	0.018000	0.050000	0.73000	0.00	0.26800	12	0.757	1.881	0.7922
31	BA80	0.018000	0.075000	0.70010	0.00	0.42300	4	0.637	0.883	0.5240
32	BA90	0.007340	0.024310	0.29360	0.00	0.12120	6	0.797	1.428	0.7076

a. S = Richness = number of non-zero elements in row
b. E = Evenness = H / ln (Richness)
c. H = Diversity = - sum (Pi*ln(Pi)) = Shannon`s diversity index
d. D = Simpson`s diversity index for infinite population = 1 - sum (Pi*Pi)

Table H-2. Continued

Number	Plot	Mean	Standard Deviation	Sum	Minimum	Maximum	S [a]	E [b]	H [c]	D [d]
33	BA100	0.021000	0.086000	0.84020	0.00	0.44200	6	0.554	0.992	0.5633
34	BA110	0.033000	0.158000	1.30130	0.00	1.00000	10	0.433	0.997	0.4011
35	BA120	0.010000	0.031000	0.40080	0.00	0.17100	7	0.809	1.574	0.7434
36	BA130	0.006664	0.029330	0.26660	0.00	0.17770	6	0.524	0.939	0.5029
37	BA140	0.005358	0.028840	0.21430	0.00	0.18010	2	0.634	0.440	0.2687
38	BA150	0.019000	0.084000	0.75310	0.00	0.50000	5	0.554	0.891	0.4916
39	BA163	0.028000	0.124000	1.11280	0.00	0.72300	4	0.587	0.813	0.4875
40	BA173	0.003453	0.010690	0.13810	0.00	0.05212	5	0.907	1.460	0.7414
41	BA183	0.015000	0.064000	0.61310	0.00	0.37500	4	0.685	0.950	0.5467
42	BA193	0.007733	0.038570	0.30930	0.00	0.24240	5	0.479	0.771	0.3686
43	BA203	0.014000	0.059000	0.57190	0.00	0.36100	6	0.637	1.142	0.5602
44	CD10	0.024000	0.081000	0.95630	0.00	0.37600	4	0.911	1.263	0.6974
45	CD20	0.036000	0.159000	1.43870	0.00	1.00000	7	0.584	1.137	0.4992
46	CD30	0.034000	0.117000	1.37290	0.00	0.62500	5	0.819	1.319	0.6920
47	CD40	0.015000	0.065000	0.61580	0.00	0.31100	3	0.759	0.833	0.5368
48	CD50	0.001419	0.008978	0.05678	0.00	0.05678	1	0.000	0.000	0.0000
49	CD60	0.001419	0.008978	0.05678	0.00	0.05678	1	0.000	0.000	0.0000
50	CD70	0.001882	0.009019	0.07528	0.00	0.05314	2	0.874	0.606	0.4153
51	CD80	0.002076	0.010950	0.08303	0.00	0.06882	3	0.514	0.565	0.2965
52	CD90	0.002934	0.009828	0.11740	0.00	0.04268	4	0.924	1.282	0.7015
53	CD100	0.002207	0.008537	0.08828	0.00	0.04965	4	0.817	1.133	0.6103
54	CD110	0.001419	0.008978	0.05678	0.00	0.05678	1	0.000	0.000	0.0000
55	CD120	0.004168	0.017910	0.16670	0.00	0.10600	3	0.816	0.896	0.5252
56	CD130	0.002244	0.010480	0.08977	0.00	0.06533	4	0.627	0.869	0.4431
57	CD140	0.002350	0.011980	0.09399	0.00	0.07404	3	0.527	0.579	0.3414
58	CD150	0.002616	0.011830	0.10460	0.00	0.06359	2	0.966	0.670	0.4768
59	CD160	0.002704	0.010140	0.10820	0.00	0.04704	4	0.814	1.128	0.6323
60	CD170	0.001920	0.009514	0.07680	0.00	0.05749	2	0.813	0.564	0.3764
61	CD180	0.002300	0.010420	0.09201	0.00	0.05624	2	0.964	0.668	0.4753
62	CD190	0.002439	0.009306	0.09756	0.00	0.04864	3	0.937	1.029	0.6201
63	CD200	0.001419	0.008978	0.05678	0.00	0.05678	1	0.000	0.000	0.0000
64	CD210	0.001419	0.008978	0.05678	0.00	0.05678	1	0.000	0.000	0.0000
65	CD220	0.002824	0.014560	0.11300	0.00	0.08968	2	0.734	0.509	0.3272
66	CD230	0.001419	0.008978	0.05678	0.00	0.05678	1	0.000	0.000	0.0000
67	CD240	0.001419	0.008978	0.05678	0.00	0.05678	1	0.000	0.000	0.0000

a. S = Richness = number of non-zero elements in row
b. E = Evenness = H / ln (Richness)
c. H = Diversity = - sum (Pi*ln(Pi)) = Shannon`s diversity index
d. D = Simpson`s diversity index for infinite population = 1 - sum (Pi*Pi)

Table H-2. Continued.

Number	Plot	Mean	Standard Deviation	Sum	Minimum	Maximum	S [a]	E [b]	H [c]	D [d]
68	CD250	0.001912	0.009412	0.07649	0.00	0.05662	2	0.826	0.573	0.3846
69	CD260	0.002178	0.013770	0.08711	0.00	0.08711	1	0.000	0.000	0.0000
70	CD270	0.018000	0.108000	0.71450	0.00	0.68600	2	0.243	0.169	0.0772
71	CD280	0.003476	0.019350	0.13900	0.00	0.12160	2	0.544	0.377	0.2192
72	CD290	0.002056	0.011620	0.08226	0.00	0.07317	2	0.501	0.347	0.1965
73	CD300	0.008113	0.042530	0.32450	0.00	0.26610	3	0.510	0.560	0.3053
74	CD310	0.015000	0.071000	0.60720	0.00	0.44000	3	0.702	0.771	0.4346
75	CD320	0.019000	0.091000	0.77250	0.00	0.56000	3	0.708	0.778	0.4363
Averages		**0.01333**	**0.05669**	**0.5333**	**0.00**	**0.3264**	**4.1**	**0.618**	**0.850**	**0.4560**

a. S = Richness = number of non-zero elements in row
b. E = Evenness = H / ln (Richness)
c. H = Diversity = - sum (Pi*ln(Pi)) = Shannon`s diversity index
d. D = Simpson`s diversity index for infinite population = 1 - sum (Pi*Pi)

Table H-3. Shrub percent cover by species.

Number	Species	Mean	Standard Deviation	Sum	Minimum	Maximum	S [a]	E [b]	H [c]	D [d]
1	ACERUB	0.013	0.039	1.000	0.000	0.206	17	0.817	2.315	0.874
2	ACRDAN	0.013	0.018	1.000	0.000	0.057	41	0.929	3.449	0.963
3	AMOFRU	0.013	0.089	1.000	0.000	0.760	4	0.552	0.765	0.397
4	ANNGLA	0.013	0.062	1.000	0.000	0.423	5	0.833	1.341	0.700
5	ARDELL	0.013	0.034	1.000	0.000	0.180	23	0.826	2.589	0.901
6	BACGLO	0.013	0.038	1.000	0.000	0.242	18	0.816	2.360	0.878
7	BLESER	0.013	0.054	1.000	0.000	0.311	9	0.744	1.634	0.769
8	CALAME	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
9	CEPOCC	0.013	0.049	1.000	0.000	0.249	10	0.774	1.783	0.808
10	CITXAU	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
11	CLAJAM	0.013	0.024	1.000	0.000	0.087	20	0.972	2.913	0.942
12	DIOVIR	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
13	ECLPRO	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
14	FICMIC	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
15	FRACAR	0.013	0.058	1.000	0.000	0.444	9	0.759	1.668	0.734
16	HYPVER	0.013	0.061	1.000	0.000	0.442	5	0.880	1.416	0.714

a. S = Richness = number of non-zero elements in row
b. E = Evenness = H / ln (Richness)
c. H = Diversity = - sum (Pi*ln(Pi)) = Shannon`s diversity index
d. D = Simpson`s diversity index for infinite population = 1 - sum (Pi*Pi)
See Appendix C for species code definitions.

Table H-3. Continued.

Number	Species	Mean	Standard Deviation	Sum	Minimum	Maximum	S [a]	E [b]	H [c]	D [d]
17	ILEGLA	0.013	0.086	1.000	0.000	0.723	3	0.711	0.781	0.438
18	LAGRAC	0.013	0.085	1.000	0.000	0.686	4	0.561	0.777	0.457
19	MOMCHA	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
20	MYRCER	0.013	0.037	1.000	0.000	0.191	14	0.876	2.313	0.884
21	OSMCIN	0.013	0.059	1.000	0.000	0.320	5	0.873	1.405	0.731
22	PELPTE	0.013	0.062	1.000	0.000	0.376	5	0.809	1.303	0.704
23	PERBOR	0.013	0.044	1.000	0.000	0.257	9	0.905	1.987	0.843
24	PONCOR	0.013	0.084	1.000	0.000	0.625	2	0.954	0.662	0.469
25	PSICAT	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
26	PSYNER	0.013	0.062	1.000	0.000	0.491	7	0.784	1.526	0.702
27	PSYSUL	0.013	0.042	1.000	0.000	0.196	8	0.957	1.991	0.856
28	QUELAU	0.013	0.051	1.000	0.000	0.361	10	0.790	1.820	0.791
29	RAPPUN	0.013	0.082	1.000	0.000	0.560	2	0.990	0.686	0.493
30	SABPAL	0.013	0.061	1.000	0.000	0.383	4	0.946	1.312	0.713
31	SALCAR	0.013	0.105	1.000	0.000	0.905	2	0.454	0.314	0.172
32	SCHTER	0.013	0.025	1.000	0.000	0.122	28	0.897	2.988	0.940
33	SERREP	0.013	0.030	1.000	0.000	0.143	20	0.905	2.710	0.921
34	SYAROM	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
35	TOXRAD	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
36	URELOB	0.013	0.044	1.000	0.000	0.225	9	0.882	1.937	0.845
37	VIBOBO	0.013	0.071	1.000	0.000	0.500	3	0.923	1.014	0.613
38	VITAES	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
39	VITROT	0.013	0.115	1.000	0.000	1.000	1	0.000	0.000	0.000
40	VITLIN	0.013	0.066	1.000	0.000	0.333	3	1.000	1.099	0.667
Average		0.013	0.072	1.000	0.000	0.545	7.800	0.603	1.221	0.523

a. S = Richness = number of non-zero elements in row
b. E = Evenness = H / ln (Richness)
c. H = Diversity = - sum (Pi*ln(Pi)) = Shannon`s diversity index
d. D = Simpson`s diversity index for infinite population = 1 - sum (Pi*Pi)
See Appendix C for species code definitions.

Results Canonical Correspondence Analysis of Shrub Layer

Results presented here are a CCA of the shrub layer. Data matrices include 1) main matrix has 75 plots (rows) and 40 shrub species (columns) and 2) second matrix has 75 plots (rows) and 3 environmental variables (columns)—river mile, EC and %SM.

Table H-4. CCA of shrub layer.

CORRELATIONS AMONG VARIABLES IN SECOND MATRIX			
	River Mile	EC (cS/m)	%SM
River Mile	1.000	-0.602	-0.266
EC (cS/m)	-0.602	1.000	0.354
%SM	-0.266	0.354	1.000

WEIGHTED CORRELATIONS AMONG VARIABLES IN SECOND MATRIX Weighted by row totals in main matrix			
	River Mile	EC (cS/m)	%SM
River Mile	1.000	-0.602	-0.266
EC (cS/m)	-0.602	1.000	0.354
%SM	-0.266	0.354	1.000

AXIS SUMMARY STATISTICS Total variance (“inertia”) in the species data: 18.2145			
Statistic	Axis 1	Axis 2	Axis 3
Eigenvalue	0.829	0.719	0.601
Variance in species data			
% of variance explained	4.6	3.9	3.3
Cumulative % explained	4.6	8.5	11.8
Pearson Correlation, species-environment[a]	0.967	0.939	0.902
Kendall (Rank) Correlation, species-environment	0.764	0.742	0.595

MULTIPLE REGRESSION RESULTS Regression of plots in species space on environmental variable							
Variable	Canonical Coefficients						Standard Deviation
	Standardized			Original Units			
	Axis 1	Axis 2	Axis 3	Axis 1	Axis 2	Axis 3	
River Mile	-1.867	-1.696	-0.657	-0.371	-0.337	-0.131	5.03
EC (cS/m)	0.442	-2.388	0.313	0.001	-0.005	0.001	447
%SM	0.614	0.285	-1.632	0.023	0.011	-0.061	26.7

a. Correlation between sample scores for an axis derived from the species data and the sample scores that are linear combinations of the environmental variables. Set to 0.000 if axis is not canonical.

CORRELATIONS AND BIPLOT SCORES FOR THREE ENVIRONMENTAL VARIABLES Scores that are linear combinations or variables (linear combinations scores); final scores and raw data totals (weights) for 65 plots						
Variable	Correlations[b]			Biplot Scores		
	Axis 1	Axis 2	Axis 3	Axis 1	Axis 2	Axis 3
1 River Mile	-0.949	-0.178	-0.260	-0.392	-0.094	-1.164
2 EC (cS/m)	0.737	-1.671	0.083	0.305	-0.356	0.053
3 %SM	0.524	-0.057	-0.850	0.217	-0.030	-0.537

b. Correlations are "intra-set correlations" of ter Braak (1986).

INTER-SET CORRELATIONS FOR THREE ENVIRONMENTAL VARIABLES			
Variable	Correlations		
	Axis 1	Axis 2	Axis 3
1 River Mile	-0.918	-0.167	-0.234
2 EC (cS/m)	0.712	-0.630	0.075
3 %SM	0.507	-0.054	-0.767

RANDOMIZED DATA FOR INTER-SET CORRELATIONS					
Axes	Real Data	Randomization Test (998 runs)			p[c]
	Eigenvalue	Mean	Minimum	Maximum	
1	0.829	0.533	0.348	0.746	0.0010
2	0.719	0.416	0.183	0.603	
3	0.601	0.279	0.088	0.429	

RANDOMIZATION TEST RESULTS SPECIES-ENVIRONMENT CORRELATIONS					
Axis	Real Data	Randomized Data Monte Carlo Test (998 runs)			p[c]
	Species-Environmental Correlation	Mean	Minimum	Maximum	
1	0.967	0.852	0.720	0.955	0.0010
2	0.939	0.789	0.593	0.898	
3	0.902	0.730	0.512	0.870	

c. p = proportion of randomized runs with species-environment correlation greater than or equal to the observed species-environment correlation; i.e., p = (1 + no. permutations >= observed)/(1 + no. permutations); p is not reported for axes 2 and 3 because using a simple randomization test for these axes may bias the p values.

Shrub Species Bray Curtis (BC) Bi-plots

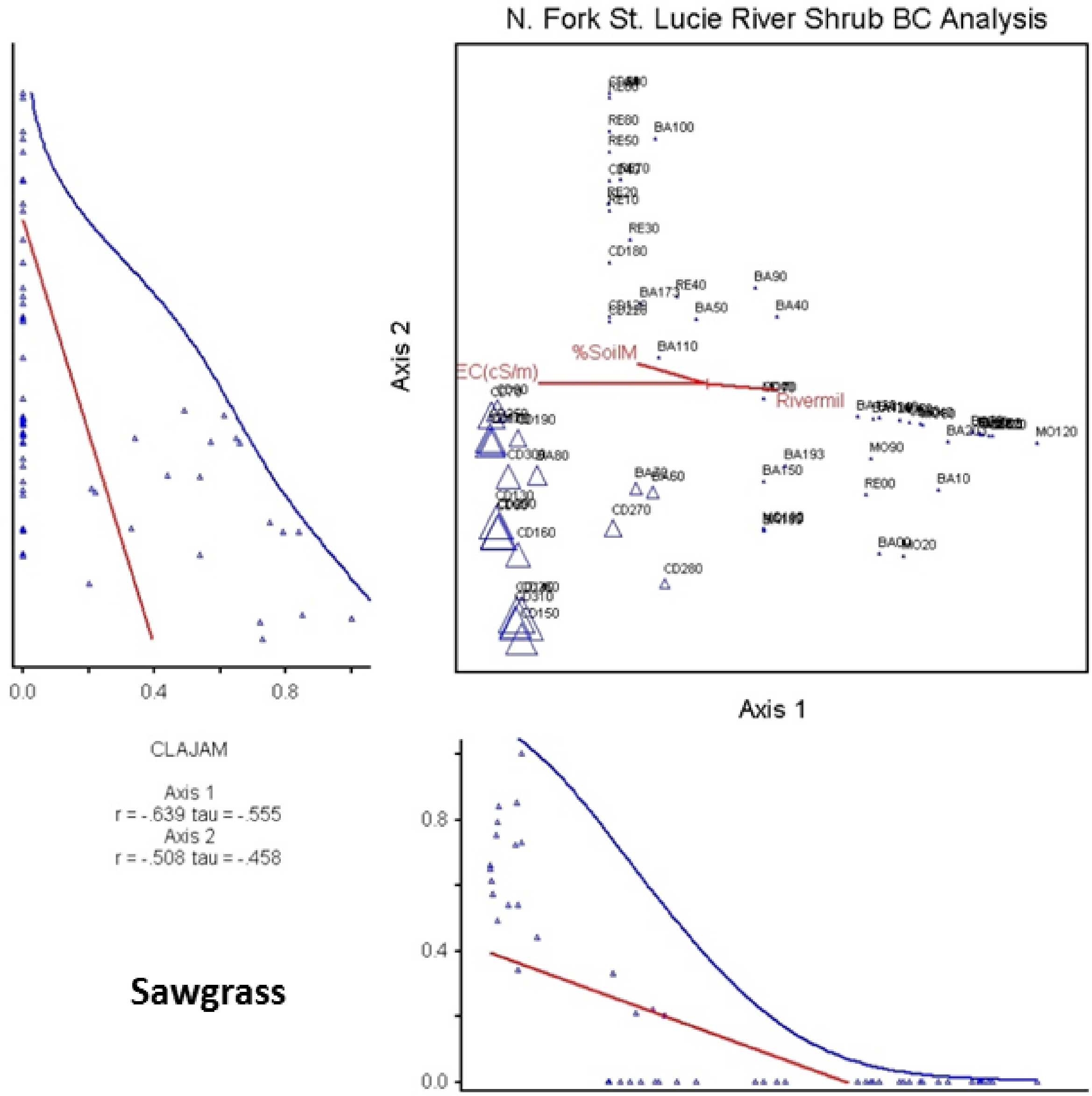


Figure H-19. Biplot of sawgrass (*Cladium jamaicense*) with the environmental variables.

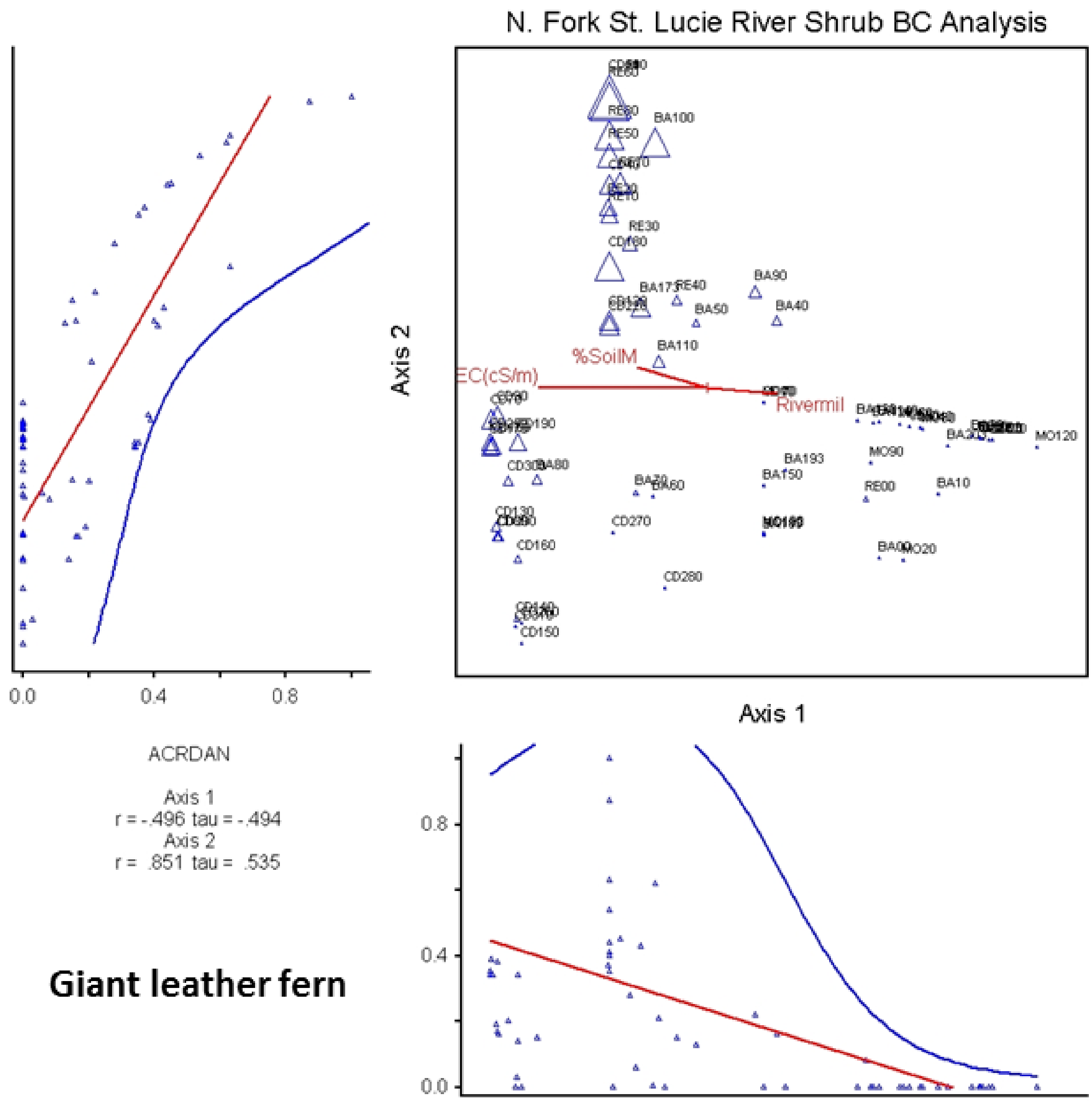


Figure H-20. Biplot of giant leather fern (*Acrostichum danaeifolium*) with the environmental variables.

APPENDIX I:
NORTH FORK ST. LUCIE RIVER FLOODPLAIN GRID MAPS

Floodplain LIDAR

The grid maps in this appendix were developed utilizing laser imaging detection and ranging (LIDAR) data from the following website: http://www.floridadisaster.org/gis/lidar/. The mapping flights were flown in 2010 for St. Lucie County.

For this study, the grid maps are used to illustrate the changes in topography (i.e. elevation) within the floodplain and adjacent upland areas of the North Fork St. Lucie River. The changes in topography are representative of land use cover (i.e. urban versus conservation lands), changes in vegetative communities (i.e. upland, hammock, bottomland hardwood, swamp and marsh), and changes caused by anthropogenic alterations (i.e. berms). Six grid maps are provided to give a more detailed view of the North Fork St. Lucie River floodplain. River miles (for example, **NF•14**) and some roadways and city names have been added to assist in the identification of location. A compact disc of the ARC GIS data set is provided with the hard copy of this report to view even more detailed analysis of the floodplain area. The data set can be viewed to search for possible areas of future reconnection to improve hydrological conditions behind berms or for identifying areas in need of exotic plant control.

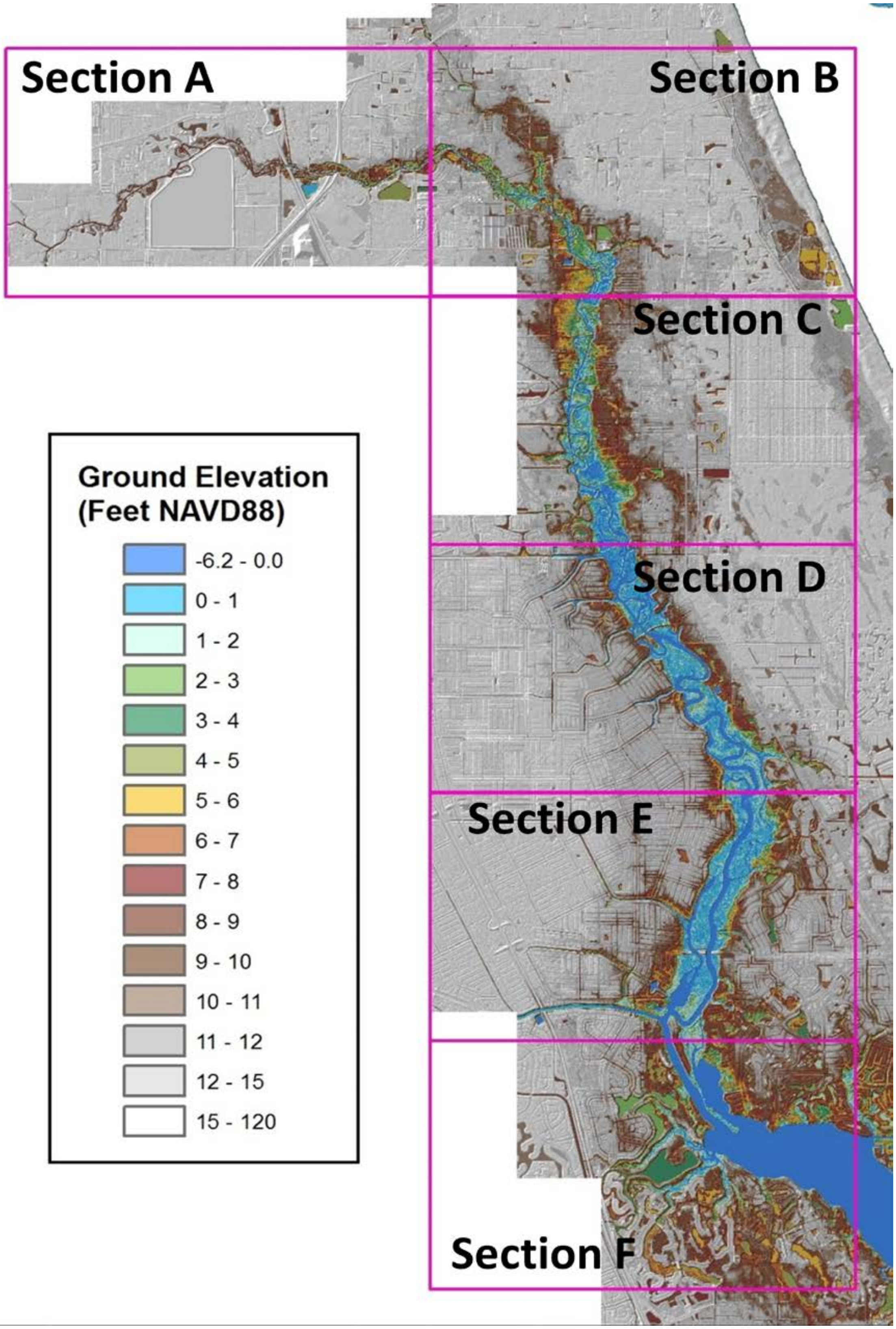


Figure I-1. Location of each of the following section maps along the North Fork St. Lucie River.

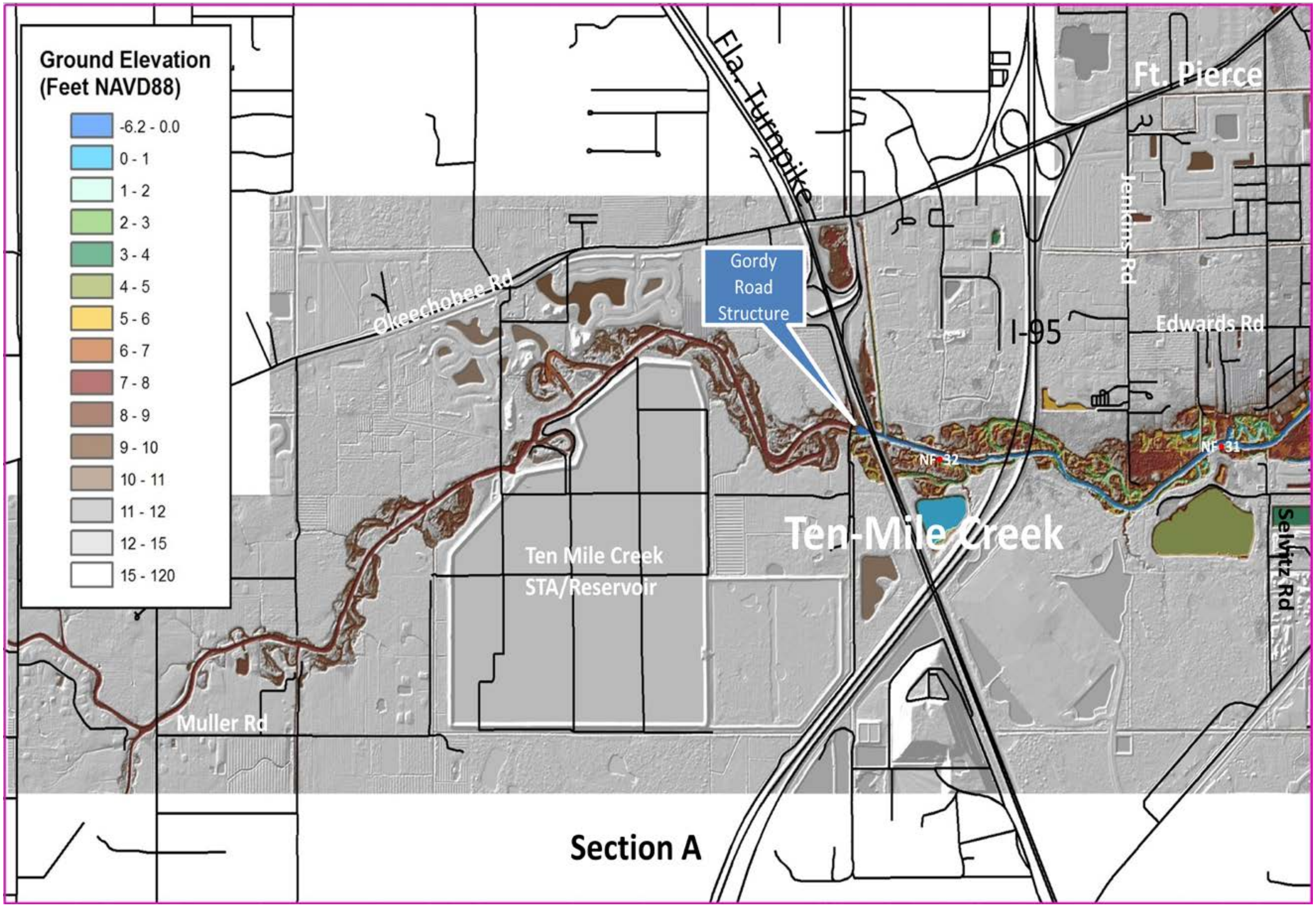


Figure I-2. Section A LIDAR map.

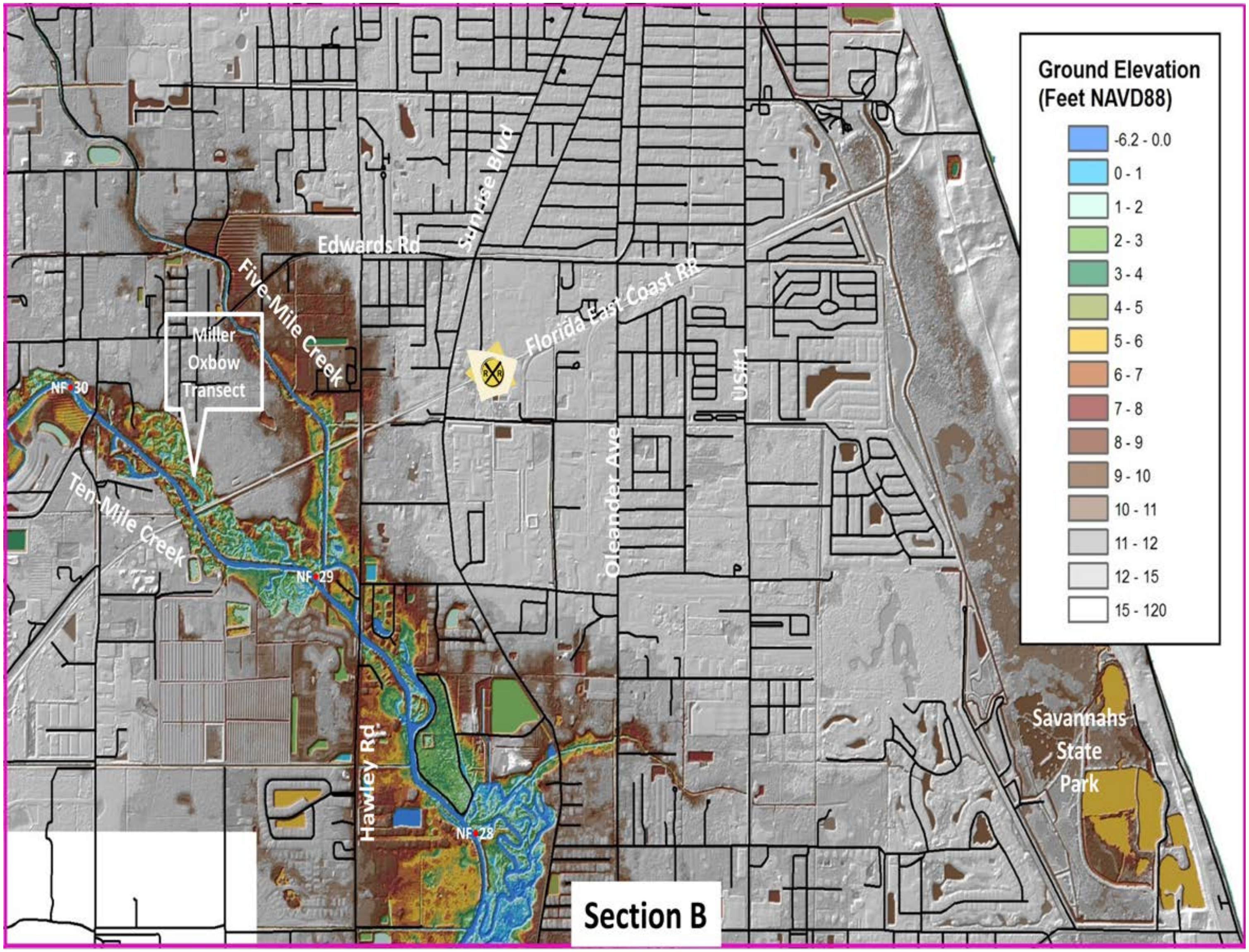


Figure I-3. Section B LIDAR map.

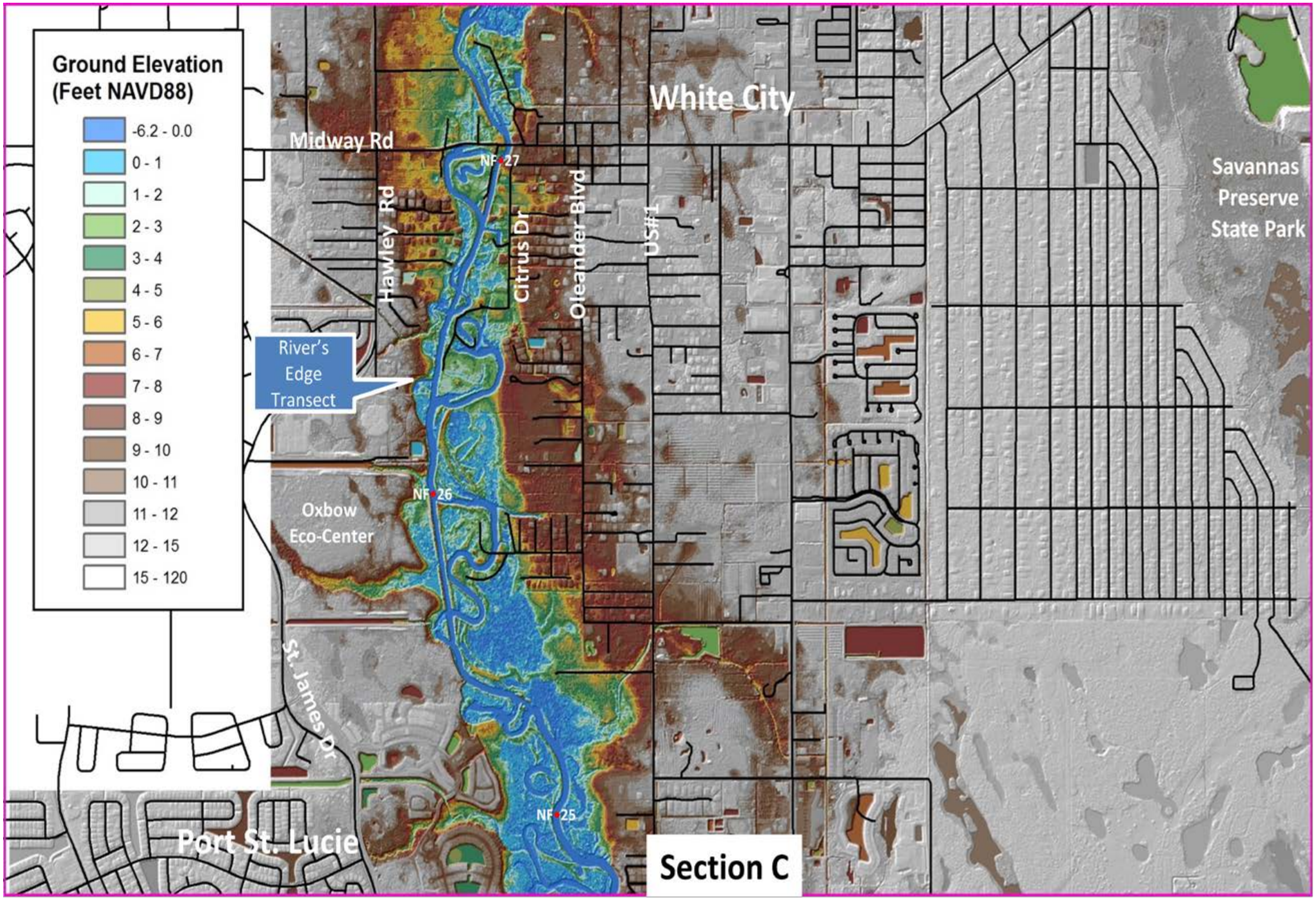


Figure I-4. Section C LIDAR map.

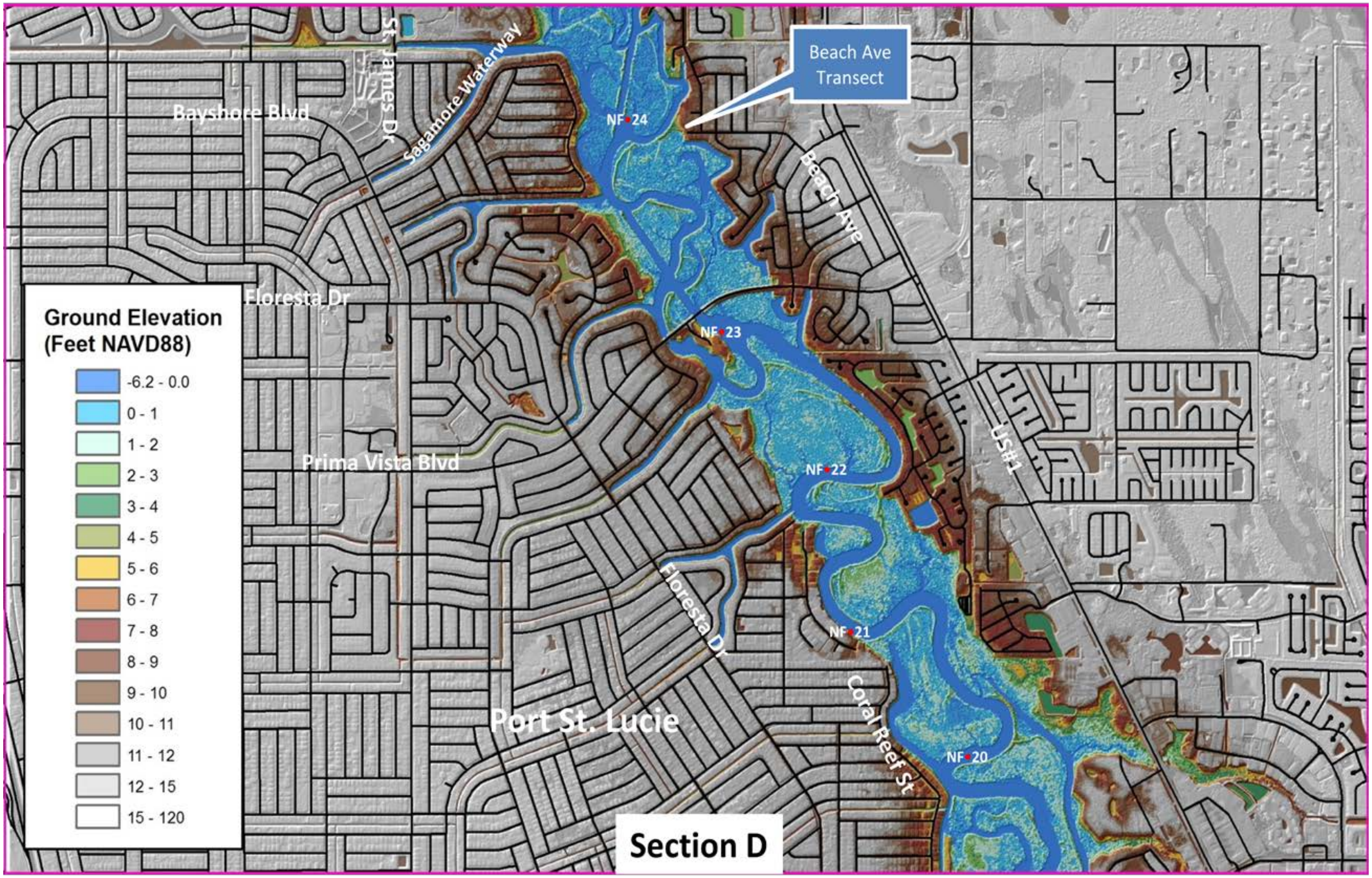


Figure I-5. Section D LIDAR map.

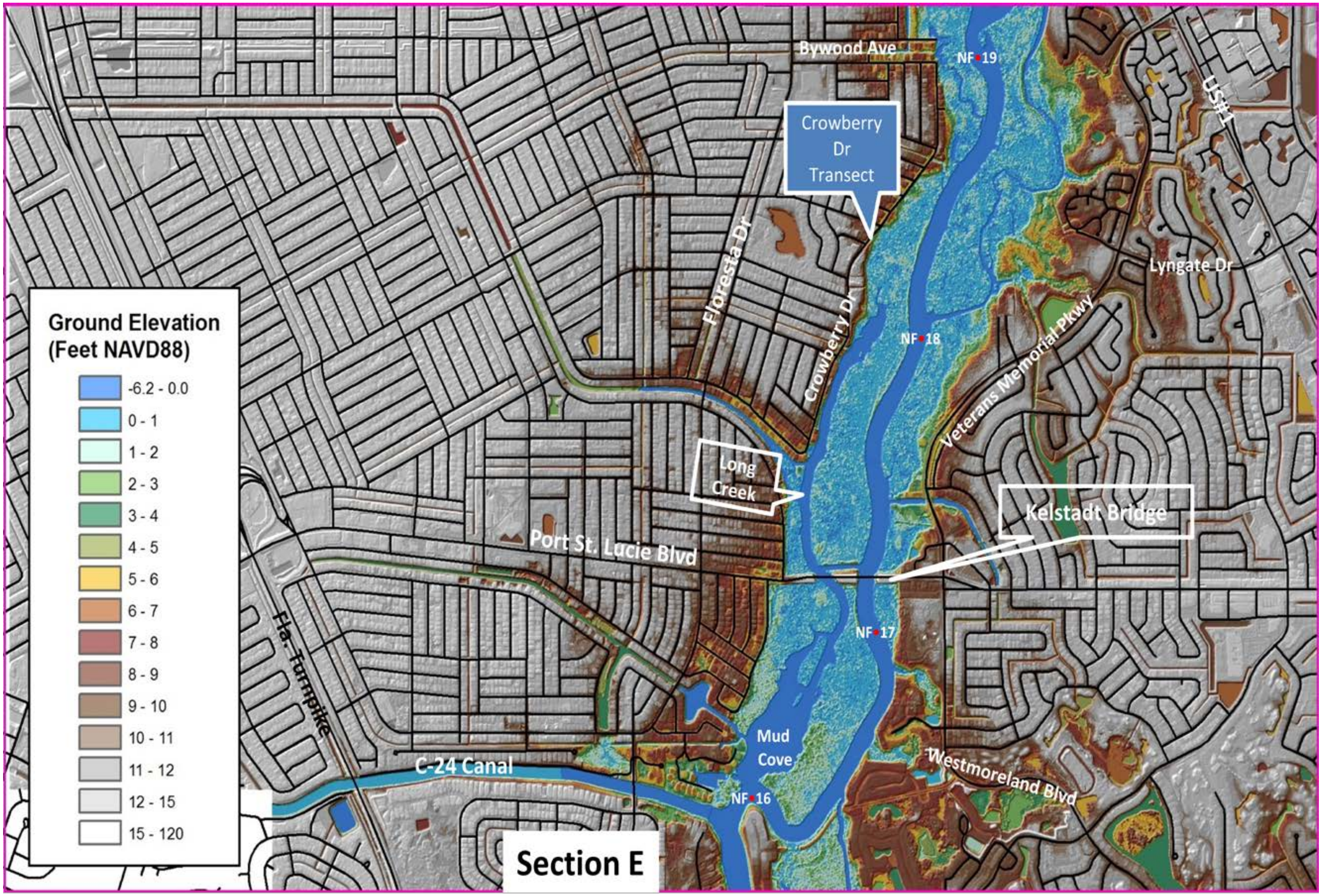


Figure I-6. Section E LIDAR map.

Figure I-7. Section F LIDAR map.